CASE 580C LOADER BACKHOE SERVICE MANUAL

580C LOADER BACKHOE TABLE OF CONTENTS AND SERVICE MANUAL INTRODUCTION

Table of Contents

Service Manual Introduction

Safety Rules

WARNING: Operate controls from the operator's seat only. 35-7

WARNING: Read operator's manual to familiarize yourself with control lever functions. 35-1

WARNING: Whenever the loader bucket must be raised to aid in servicing, block the bucket in place with lift cylinder stops or a suitable safety stand. 40-11

WARNING: When working in the area of the fan belt with the engine running, avoid loose clothing if possible, and use extreme caution. 35-4

WARNING: Whenever cycling the loader or backhoe to bleed air from circuits or to check operation, be sure area is clear of fellow workers. 40-12

WARNING: When performing checks and tests on the equipment hydraulic system or steering system, DO NOT deviate from the written procedure. 40-13

WARNING: This is a one man machine, no riders allowed. 35-8

WARNING: After installing tire on rim (wheel), place wheel in a safety cage before inflating tires. If proper equipment is not available, have a tire repair shop do the work. 40-5

CAUTION: Some components of this machine are very heavy. Use suitable lifting equipment or additional help as instructed in this service manual. 40-10

CAUTION: Pin sized and smaller streams of hydraulic oil under pressure can penetrate the skin and result in serious infection. Maintain all hoses and tubes in good condition. Make sure all connections are tight. Replace any hose or tube that is faulty or thought to be faulty. DO NOT use your hand to check for leaks; use a piece of cardboard or wood. 40-6

CAUTION: Use suitable floor (service) jacks or chain hoists to raise wheels off the floor. Always block machine in place with suitable safety stands. 40-7

CAUTION: When servicing or repairing the machine, keep the shop floor and operator's compartment and steps free of oil, water, grease, tools, etc. Use an oil absorbing material and/or shop cloths as required. Use safe practices at all times. 40-8

General

This service manual has been prepared with the latest service information available. Trouble shooting, removal, disassembly, inspection and installation procedures coupled with complete specifications and tightening references can be found in most sections. Some sections will have exploded views without accompanying text due to the simplicity of the procedure. This service manual is one of the most important tools available to the service technician. It is an invaluable aid in properly performing any phase of service.

The terms right-hand and left-hand as used in this manual indicate the right and left sides of the machine as viewed from the operator's seat for proper operation of the machine or attachment.

The information contained in this manual is current at the time of printing.

Table of Contents

The preceeding pages contain a Table of Contents which list the Series number and title, and the sections contained in each series. The individual sections, where required, will have a Table of Contents on the second page of that section.

Page Numbers

All page numbers consist of two sets of digits separated by a dash, such as 4002-9. The digits preceeding the dash identify the section. The digits following the dash represent the consecutive page number within that section. Page numbers will be found at the upper right or left of each page.

Text

If this manual covers more than one machine, or different models of component parts (planetary axles, gear boxes, control valves, etc.) the procedures will apply to all unless otherwise noted.

Illustrations

Where possible, illustrations are placed as close as possible to the accompanying text and should be used as part of the text.

Serial and Model Numbers

When requisitioning repair or replacement parts as it may be necessary to furnish the parts department with one or both numbers. Serial and model numbers will be found in the following locations.

Machine - Plate fastened to left front cab or canopy mounting bracket. Also stamped on top of chassis behind left-hand hydraulic reservoir.

Engine - Right-hand side of block below starter.

Component parts - plate attached to part or number stamped in part.

Torque References

Essentially two grades of fasteners (bolts, nuts and screws) are used on Case machinery. They are grade 5 and grade 8. Refer to Section 1051 for torque specifications and means of identification.

The specifications in Section 1051 are standard torque values and should be used on all fasteners during assembly and installation unless special torque values are noted in a particular section.

Classification of Lubricants

Oils, lubricants, and grease are classified and graded according to standards recommended by the Society of Automotive Engineers (SAE), the American Petroleum Institute (API), and the National Lubricating Grease Institute (NLGI).

Engine Oil

The SAE number indicates the viscosity of engine oils, for example, SAE 30, a single grade oil. Engine oils are also identified by dual numbers, SAE 10W30, a multigrade oil.

The API classification (MS DS SD CA) defines oil performance in terms of engine usage. Only oils specified in Section 1050 should be used. These oils contain sufficient chemical additives to provide maximum engine protection. Both the SAE grade and API designation must be found on the container.

Gear Lubricant

The SAE grade number also indicates the viscosity of gear lubricants defined by MIL-L-2105B. An example is SAE 90, a medium viscosity lubricant.

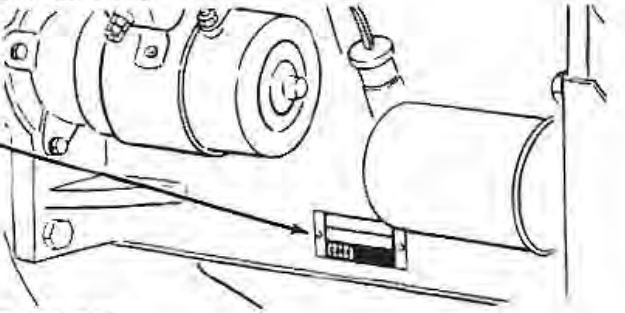
Grease

Semi-solid lubricants specified for pivot points must be that specified in Section 1050.

Section 1010

GENERAL ENGINE SPECIFICATIONS 580C TRACTORS

THE MODEL AND ENGINE SERIAL NUMBER IS STAMPED ON A PLATE LOCATED ON THE RIGHT SIDE OF THE ENGINE BELOW THE CRANKING MOTOR.



DIESEL ENGINES

General

Type	Case Open Chamber, 4 Cylinder, 4 Stroke Cycle, Valve-in-Head
Firing Order	1-3-4-2
Bore	4 Inches
Stroke	4-1/8 Inches
Piston Displacement	207 Cubic Inches
Compression Ratio	16.5 to 1
No Load Governed Speed	2230 to 2270 RPM
Rated Engine Speed	2100 RPM
Engine Idling Speed	700 to 750 RPM
*Valve Tappet Clearance (Exhaust)	(Hot and Cold) .014 Inch
(Intake)	(Hot and Cold) .012 Inch

*Hot Settings Are Made After the Engine Has Operated At Thermostat Controlled Temperature For At Least Fifteen Minutes.

Piston and Connecting Rods

Rings per Piston	3
Number of Compression Rings	2
Number of Oil Rings	1
Type Pins	Full Floating Type
Type Bearing	Replaceable Precision, Steel Back, Copper-Lead or Aluminum Alloy Liners

Main Bearings

Number of Bearings	5
Type Bearings	Replaceable Precision Steel Back, Copper-Lead or Aluminum Alloy Liners

Engine Lubricating System

Crankcase Capacity (Without Filter)	6 Quarts
(With Filter Change)	7 Quarts
Oil Pressure	50 to 70 Pounds with Engine Warm and Operating at Rated Engine Speed
Type System	Pressure and Spray Circulation
Oil Pump	Gear Type
Oil Filter	Full Flow Spin on Type

Fuel System

Fuel Injection Pump	Roosa-Master
Pump Timing	8 Degrees Before Top Dead Center
Fuel Injectors	Pencil Type (Opening Pressure 2800 PSI)
Fuel Transfer Pump	Vane Type, Integral Part of Injection Pump
Governor	Variable Speed, Fly-Weight Centrifugal Type, Integral Part of Injection Pump
Fuel Filters	Full Flow Spin on Type

Section
1026

DETAILED SPECIFICATIONS

207 Diesel Engines

FRACTION to DECIMAL to MILLIMETER CONVERSION TABLE

Fraction	Decimal	MM	Fraction	Decimal	MM	Fraction	Decimal	MM
1/64	.0156	0.397	23/64	.3593	9.128	45/64	.7031	17.859
1/32	.0312	0.794	3/8	.3750	9.525	23/32	.7187	18.256
3/64	.0468	1.191	25/64	.3906	9.922	47/64	.7343	18.653
1/16	.0625	1.587	13/32	.4062	10.319	3/4	.7500	19.050
5/64	.0781	1.984	27/64	.4218	10.716	49/64	.7656	19.447
3/32	.0937	2.381	7/16	.4375	11.113	25/32	.7812	19.844
7/64	.1093	2.778	29/64	.4531	11.509	51/64	.7968	20.240
1/8	.1250	3.175	15/32	.4687	11.906	13/16	.8125	20.637
9/64	.1406	3.572	31/64	.4843	12.303	53/64	.8281	21.034
5/32	.1562	3.969	1/2	.5000	12.700	27/32	.8437	21.431
11/64	.1718	4.366	33/64	.5156	13.097	55/64	.8593	21.828
3/16	.1875	4.762	17/32	.5312	13.494	7/8	.8750	22.225
13/64	.2031	5.159	35/64	.5468	13.890	57/64	.8906	22.622
7/32	.2187	5.556	9/16	.5625	14.287	29/32	.9062	23.019
15/64	.2343	5.953	37/64	.5781	14.684	59/64	.9218	23.415
1/4	.2500	6.350	19/32	.5937	15.081	15/16	.9375	23.812
17/64	.2656	6.747	39/64	.6093	15.478	61/64	.9531	24.209
9/32	.2812	7.144	5/8	.6250	15.875	31/32	.9687	24.606
19/64	.2968	7.541	41/64	.6406	16.272	63/64	.9843	25.003
5/16	.3125	7.937	21/32	.6562	16.669	1	1.0000	25.400
21/64	.3281	8.334	43/64	.6718	17.065			
11/32	.3437	8.731	11/16	.6875	17.462			

INCH to MILLIMETER CONVERSION TABLE

Inch	MM	Inch	MM	Inch	MM	Inch	MM
1	25.400	6	152.000	10	254.000	60	1,524.000
2	50.800	7	177.800	20	508.000	70	1,778.000
3	76.200	8	203.200	30	762.000	80	2,032.000
4	101.600	9	228.600	40	1,016.000	90	2,286.000
5	127.000	10	254.000	50	1,270.000	100	2,540.000

J I Case
A Tenneco Company

TENNECO

Rac. 9-78685

PRINTED IN U.S.A.

TABLE OF CONTENTS

RUN-IN-INSTRUCTIONS

Engine Lubrication

When the engine rebuild is complete, fill the engine crankcase with Case HDM oil and install new engine oil filter. **NOTE:** If Case HDM oil is not used, use only a Series 3 DS or CD Service Classification oil that has the proper viscosity rating for prevailing air temperature. Refer to vehicle Operator's Manual.

After the first 20 hours of operation, change the engine oil while the engine is hot and replace the engine oil filter. DO NOT DRAIN OIL UNTIL THE ENGINE HAS BEEN OPERATED 20 HOURS.

Change the engine oil and filter at the recommended intervals thereafter as outlined in the Operator's Manual.

Break-In Procedure for Rebuilt Engines (With a Dynamometer)

The following procedure must be implemented when using a PTO dynamometer to break-in the engine. The dynamometer will insure control of the engine load at each speed and will eliminate over stressing new parts during break-in.

During the break-in, continually check the oil pressure, coolant level, and coolant temperature.

STEP	TIME	ENGINE SPEED	DYNAMOMETER SCALE LOAD*
1	**10 Minutes	1000 RPM	None
2	**10 Minutes	1800 RPM	None
3	20 Minutes	1800 RPM	1/3
4	20 Minutes	1800 RPM	1/2
5	***30 Minutes	100 RPM below rated speed	3/4
6	Retorque the cylinder head bolts using the procedure described in Section 2015 of this service manual.		

*Based upon normal dynamometer scale load at rated speed for the particular vehicle model. Reduce this scale load as indicated.

**The most ideal break-in procedure would be to constantly vary the throttle between 750 to 1000 RPM for the first 10 minutes and from 1000 RPM to 1800 RPM for the next 10 minutes. The purpose of this changing RPM is to vary the lubrication and coolant flow.

***30 minutes at 3/4 load is a minimum amount of time the engine should be run. It is recommended that whenever possible the engine (especially turbocharged diesels) should be run for four (4) hours or more at the above speed and load before checking the full engine horsepower or before using the engine for heavy field work.

Break-In Procedure for Rebuilt Engines (Without a Dynamometer)

STEP	TIME	ENGINE SPEED	LOAD
1	*10 Minutes	1000 RPM	None
2	*10 Minutes	1800 RPM	None
3	30 Minutes	2/3 Rated RPM	Light Load
4	1 Hour	Full RPM (not over 2000 RPM)	80 to 90%
5	Retorque the cylinder head bolts using the procedure described in Section 2015 of this service manual.		

*If engine must then run at or near full load to operate the machine - for first hour remove load and run at high idle for a few minutes at 15 minute intervals.

Run-In Procedure (Agricultural Tractors)

For the first 8 hours of field operation stay one gear lower than normal. For the next 12 hours DO NOT "lug" the engine. Prevent "lugging" by shifting to a lower gear. The engine must not be "lugged" below its Rated Engine RPM during the early hours of life.

Run-In Procedure (Construction Equipment)

For the first 8 hours, operate the engine at full throttle maintaining a normal load. DO NOT baby the engine, but avoid prolonged converter or hydraulic stall. Engine must not be "lugged" below its Rated Engine RPM (Do not exceed 10 seconds of stall).

Run-In Procedure (Power Units)

For the first 1/2 hour, operate engine at 2/3 rated RPM with a light load or no load. For the next (1) hour, run engine at 80 to 90% load at rated RPM (but not over 2000 RPM). Then full load and rated RPM as required in application.

DETAILED ENGINE SPECIFICATIONS

Cylinder Sleeves

	U.S. Value	Metric Value
Type	Replaceable, Wet	
Material	Chrome Plated Steel	
I.D. of sleeve	4.000 to 4.0010"	101.600 to 101.625mm
Maximum Serviceable Limit	4.0020"	101.651mm
Sleeve out-of-round (installed in block)	.001" max.	.025mm max.
Taper (installed in block)	.002" max.	.051mm max.
Clearance to bottom of piston skirt, 90° to piston pin	.0040 to .0060"	.102 to .152mm
Maximum Serviceable Limit	.0080"	.203mm

Piston

Type	Cam ground	
Material	Aluminum Alloy	
O.D. at bottom of skirt, 90° to piston pin	3.9950 to 3.9960"	101.473 to 101.498mm
Minimum Serviceable Limit	3.9940"	101.448mm
I.D. of piston pin bore including wear	1.2500 to 1.2508"	31.750 to 31.770mm
Width of 1st ring groove	Keystone Type	
Width of 2nd ring groove	.097 to .098"	2.464 to 2.489mm
Maximum Serviceable Limit	.100"	2.540mm
Width of 3rd ring groove	.1885 to .1895"	4.788 to 4.813mm
Maximum Serviceable Limit	.1915"	4.864mm

Piston Rings

No. 1 Compression	Moly Faced Keystone	
End gap in 4.000 I.D. (101.600mm I.D.) sleeve	.015 to .025"	.381 to .635mm
Maximum Serviceable Limit	.035"	.889mm
Width	Not Measurable	
Side Clearance	Not Measurable	
No. 2 Compression	Rectangular Grooved Back	
End gap in 4.000 I.D. (101.600mm I.D.) sleeve	.013 to .023"	.330 to .584mm
Maximum Serviceable Limit	.033"	.838mm
Side clearance	.0035 to .0050"	.089 to .127mm
Maximum Serviceable Limit	.008"	.203mm

Piston Rings (Cont'd.)

	U.S. Value	Metric Value
No. 3 Oil Control Ring	Two Piece	
End gap in 4.000 I.D. (101.600mm I.D.) sleeve	.013 to .023"	.330 to .584mm
Maximum Serviceable Limit	.033"	.838mm
Side clearance	.0020 to .0035"	.051 to .089mm
Maximum Serviceable Limit	.005"	.127mm

Piston Pin

Type	Full Floating	
O.D. of pin	1.2495 to 1.2498"	31.737 to 31.745mm
Fit in piston	.0002 to .0010"	.005 to .025mm
Fit in rod bushing	.0004 to .0015"	.010 to .038mm

Connecting Rod

Bushing	Replaceable Bronze	
Bushing I.D. installed (ream to size)	1.2502 to 1.2504"	31.755 to 31.760mm
Maximum Serviceable Limit	1.2510"	31.775mm
Bearing liners	Replaceable	
Journal I.D. without bearing liners	2.4002 to 2.4007"	60.965 to 60.978mm
Bearing oil clearance	.0010 to .0040"	.025 to .102mm
Undersize bearings for service	.002,.010,.020,.030"	.051,.254,.508,.762mm
Side clearance	.005 to .011"	.127 to .279mm

Crankshaft

Type	Hardened Steel Balanced	
Main bearing liners	Replaceable	
End play, center main bearing cap	.001 to .015"	.025 to .381mm
Center main bearing thrust surface thickness	.1025 to .1045"	2.603 to 2.654mm
Connecting rod journal std. O.D.	2.2480 to 2.2490"	57.099 to 57.125mm
.002" (.051mm) O.D. undersize, grind to	2.2460 to 2.2470"	57.048 to 57.074mm
.010" (.254mm) O.D. undersize, grind to	2.2380 to 2.2390"	56.845 to 56.871mm
.020" (.508mm) O.D. undersize, grind to	2.2280 to 2.2290"	56.591 to 56.617mm
.030" (.762mm) O.D. undersize, grind to	2.2180 to 2.2190"	56.337 to 56.363mm
Connecting rod journal maximum taper	.001"	.025mm
Journals out-of-round	.0005"	.013mm
Undersize main bearing liners for service	.002,.010,.020,.030"	.051,.254,.508,.762mm
Main bearing oil clearance	.0012 to .0042"	.031 to .107mm

Crankshaft (Cont'd.)

	U.S. Value	Metric Value
Main bearing journal std. O.D.	2.8730 to 2.8740"	72.974 to 73.000mm
.002" (.051mm) O.D. undersize, grind to	2.8710 to 2.8720"	72.923 to 72.949mm
.010" (.254mm) O.D. undersize, grind to	2.8630 to 2.8640"	72.720 to 72.746mm
.020" (.508mm) O.D. undersize, grind to	2.8530 to 2.8540"	72.466 to 72.492mm
.030" (.762mm) O.D. undersize, grind to	2.8430 to 2.8440"	72.212 to 72.238mm
Main bearing journal bore I.D. without liners	3.066 to 3.067"	77.876 to 77.902mm
Main journal width between cheeks:		
2nd & 4th	1.185 to 1.189"	30.099 to 30.201mm
3rd	1.374 to 1.377"	34.900 to 34.976mm
5th	1.745 to 1.755"	44.323 to 44.577mm
Connecting rod journals width between cheeks	1.3105 to 1.3145"	33.287 to 33.388mm

Camshaft

Type	Hardened Iron Parabolic	
Bushings	5, Replaceable	
Bushing Lubrication:		
Front Bushing	Pressure lubricated from oil pump.	
Intermediate Bushing	Gravity Flow lubricated	
Rear Bushing	Pressure lubricated with rear oil metering.	
Oil clearance	.002 to .007"	.051 to .178mm
I.D. of bushing installed	1.752 to 1.753"	44.501 to 44.526mm
Maximum Serviceable Limit	1.755"	44.577mm
Bushing width:		
1st (front)	1.213 to 1.223"	30.810 to 31.064mm
2nd, 3rd and 4th	.490 to .500"	12.446 to 12.700mm
5th (rear)	1.213 to 1.223"	30.810 to 31.064mm
O.D. of each bearing surface	1.749 to 1.750"	44.425 to 44.450mm
Minimum Serviceable Limit	1.748"	44.399mm
Thrust washer thickness	.147 to .149"	3.734 to 3.785mm
Minimum Serviceable Limit	Maintain end clearance	
Camshaft end play	Taken up by thrust washer	
Camshaft end clearance	.003 to .007"	.076 to .178mm

Valve Push Rod Lifters

Material	Hardened Steel	
Type	Mushroom	
O.D. of lifter stem	.5605 to .5610"	14.237 to 14.249mm
I.D. of block bore, including wear	.5625 to .5650"	14.287 to 14.351mm

Gear Train

	U.S. Value	Metric Value
Backlash:		
Crankshaft gear to camshaft gear	.0002 to .006"	.005 to .152mm
Camshaft gear to idler gear	.0004 to .006"	.010 to .152mm
Idler gear to fuel pump gear	.0005 to .007"	.013 to .178mm
Crankshaft gear to oil pump gear	.002 to .008"	.051 to .203mm
Crankshaft gear to fuel pump gear	.0005 to .019"	.013 to .483mm
O.D. of idler gear shaft	1.3745 to 1.3755"	34.912 to 34.938mm
Minimum Serviceable Limit	1.3740"	34.900mm
I.D. of idler gear with bushing	1.376 to 1.377"	34.950 to 34.976mm
Maximum Serviceable Limit	1.377"	34.976mm
Idler gear thrust washer shims	.005,.006,.007,.009"	.127,.152,.178,.229mm
Idler gear end play	.003"	.076mm

Oil Pump

Positive displacement pump	Gear Type	
Backlash, pump gear to crankshaft gear	.002 to .008"	.051 to .203mm
Drive gear to pump body maximum clearance	.0035 to .010"	.089 to .254mm
Pump gears to body radial maximum clearance	.002 to .008"	.051 to .203mm
Pump gears to pump cover maximum clearance	.0015 to .008"	.038 to .203mm
Oil pressure	50 to 70 PSI	344.74 to 482.63 kPa
Relief valve spring:		
Free length	2.125"	53.975mm
Compressed 1.44" (36.58mm)	18 to 19 lbs.	8.16 to 8.62 kg

Cylinder Head

Warpage	.006" max.	.152mm max.

Intake Valve

Tappet clearance (COLD and HOT)	.012"	.305mm
Face angle	44°	44°
Face run-out	.002" max.	.051mm max.
Length	6.339 to 6.364"	161.011 to 161.646mm
O.D. of stem	.3409 to .3419"	8.659 to 8.684mm
Minimum Serviceable Limit	.3399"	8.634mm
O.D. of head	1.599 to 1.609"	40.615 to 40.869mm
Seat angle	45°	45°
Seat contact width	.0704 to .1057"	1.788 to 2.685mm
Seat run-out	.002" max.	.051mm max.

Exhaust Valve

	U.S. Value	Metric Value
Tappet clearance (HOT and COLD)	.014"	.356mm
Face angle	44°	44°
Face run-out	.002" max.	.051mm max.
O.D. of head	1.398 to 1.408"	35.509 to 35.763mm
O.D. of stem	.3399 to .3409"	8.634 to 8.659mm
Minimum Serviceable Limit	.3389"	8.608mm
Length	6.340 to 6.364"	161.036 to 161.646mm
Insert seat angle	45°	45°
Seat contact width	.0608 to .0962"	1.544 to 2.443mm
Seat run-out	.002" max.	.051mm max.
Insert height	.2475 to .2525"	6.286 to 6.413mm
O.D. of insert	1.4495 to 1.4505"	36.817 to 36.843mm
I.D. of insert	1.245 to 1.255"	31.623 to 31.877mm

Intake Valve Guides

Length	3.250"	82.550mm
O.D.	.6565 to .6575"	16.675 to 16.700mm
I.D. (installed and reamed)	.3429 to .3439"	8.710 to 8.735mm
Maximum Serviceable Limit	.3449"	8.760mm
Protrusion above cylinder head	.875"	22.225mm
Valve stem clearance in guide	.001 to .003"	.025 to .076mm
Maximum Serviceable Limit	.004"	.102mm

Exhaust Valve Guides

Length	3.125"	79.375mm
O.D.	.6565 to .6575"	16.675 to 16.702mm
I.D. (installed and reamed)	.3429 to .3439"	8.710 to 8.735mm
Maximum Serviceable Limit	.3449"	8.761mm
Protrusion above cylinder head	.875"	22.225mm
Valve stem clearance in guide	.002 to .004"	.051 to .102mm
Maximum Serviceable Limit	.005"	.127mm

Valve Spring

Free length	2.375"	60.325mm
Total coils	8.25	
Wire diameter	.162"	4.115mm
I.D.	.958 to .978"	24.333 to 24.841mm
Compressed to 1.521" (38.633mm) (valve open)	110 to 118 lbs.	49.90 to 53.52 kg.
Compressed to 1.875" (47.625mm) (valve closed)	53 to 59 lbs.	24.04 to 26.76 kg.

Rocker Arm Assembly

	U.S. Value	Metric Value
O.D. of shaft	.622 to .623"	15.799 to 15.824mm
I.D. of arm bore	.624 to .626"	15.850 to 15.900mm
Shaft spring:		
Free length	2.5"	63.500mm
Compressed to 1.75" (44.450mm)	7.5 to 8.5 lbs.	3.40 to 3.86 kg.
Lubrication	Engine oil, camshaft metering	
Shaft oil holes	Toward valve side of engine. Shaft cannot be rotated.	

SPECIAL TORQUES

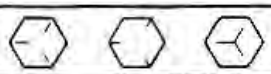
Engine

Camshaft nut	80 to 90 ft. lbs.	109 to 122 Nm
Camshaft thrust plate mtg. bolts	17 to 20 ft. lbs.	23 to 27 Nm
Connecting rod nuts	45 to 50 ft. lbs.	61 to 68 Nm
Crankshaft main bearing bolts	90 to 100 ft. lbs.	122 to 136 Nm
Crankshaft pulley nut	125 to 135 ft. lbs.	169 to 183 Nm
Cylinder head bolts (Gr. 8,12 pt. hd.)	105 to 115 ft. lbs.	122 to 137 Nm
Cylinder head stud nuts (1/2")	95 to 105 ft. lbs.	129 to 142 Nm
Cylinder head valve cover stud (3/8")	35 to 42 ft. lbs.	48 to 57 Nm
Cylinder head valve cover stud (1/2")	80 to 96 ft. lbs.	108 to 130 Nm
Cylinder head valve cover stud nuts (3/8")	4 to 6 ft. lbs.	5 to 8 Nm
Engine oil filter	Install until gasket contacts filter head, then hand tighten 1/2 turn. Loosen filter approximately one full turn and retighten until gasket contact is made, then hand tighten an additional 1/2 to 3/4 turn.	
Exhaust manifold stud nut	25 to 30 ft. lbs.	34 to 41 Nm
Fan mounting bolts	17 to 20 ft. lbs.	23 to 27 Nm
Flywheel to crankshaft bolts	65 to 70 ft. lbs.	88 to 95 Nm
Fuel pump drive gear nut	40 to 50 ft. lbs.	54 to 68 Nm
Idler gear journal mounting bolts	35 to 42 ft. lbs.	47 to 57 Nm
Intake manifold stud nut	30 to 35 ft. lbs.	41 to 48 Nm
Oil pan capscrews (stamped steel)	10 to 12 ft. lbs.	14 to 16 Nm
Oil pan drain plug	29 to 31 ft. lbs.	39 to 42 Nm
Oil pan to seal retainer	15 to 20 ft. lbs.	20 to 27 Nm
Oil pump cover capscrews	9 to 11 ft. lbs.	12 to 15 Nm
Oil pump suction tube nut	95 to 105 ft. lbs.	129 to 142 Nm
Oil seal retainer bolts	12 to 15 ft. lbs.	16 to 20 Nm
Rocker arm bracket bolts	25 to 30 ft. lbs.	34 to 41 Nm
Timing gear cover mounting bolts	25 to 30 ft. lbs.	34 to 41 Nm
Water pump body bolts	35 to 42 ft. lbs.	48 to 57 Nm

GENERAL TORQUE SPECIFICATION TABLE (Revised 2-74)

USE THE FOLLOWING TORQUES WHEN SPECIAL TORQUES ARE NOT GIVEN

NOTE: These values apply to fasteners as received from supplier, dry, or when lubricated with normal engine oil. They do not apply if special graphited or moly-disulphide greases or other extreme pressure lubricants are used. This applies to both UNF and UNC threads.

SAE Grade No.		2				5				8 *			
Bolt head identification marks as per grade NOTE: Manufacturing Marks Will Vary													
Bolt Size		Torque Foot Pounds		Newton-Meters		Torque Foot Pounds		Newton-Meters		Torque Foot Pounds		Newton-Meters	
Inches	Millimeters	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.	Min.	Max.
1/4	6.35	5	6	6.8	8.13	9	11	12.2	14.9	12	15	16.3	20.3
5/16	7.94	10	12	13.6	16.3	17	20.5	23.1	27.8	24	29	32.5	39.3
3/8	9.53	20	23	27.1	31.2	35	42	47.5	57.0	45	54	61.0	73.2
7/16	11.11	30	35	40.7	47.4	54	64	73.2	86.8	70	84	94.9	113.9
1/2	12.70	45	52	61.0	70.5	80	96	108.5	130.2	110	132	149.2	179.0
9/16	14.29	65	75	88.1	101.6	110	132	149.2	179.0	160	192	217.0	260.4
5/8	15.88	95	105	128.7	142.3	150	180	203.4	244.1	220	264	298.3	358.0
3/4	19.05	150	185	203.3	250.7	270	324	366.1	439.3	380	456	515.3	618.3
7/8	22.23	160	200	216.8	271.0	400	480	542.4	650.9	600	720	813.6	976.3
1	25.40	250	300	338.8	406.5	580	696	786.5	943.8	900	1080	1220.4	1464.5
1-1/8	25.58					800	880	1084.8	1193.3	1280	1440	1735.7	1952.6
1-1/4	31.75					1120	1240	1518.7	1681.4	1820	2000	2467.9	2712.0
1-3/8	34.93					1460	1680	1979.8	2278.1	2380	2720	3227.3	3688.3
1-1/2	38.10					1940	2200	2630.6	2983.2	3160	3560	4285.0	4827.4

* Thick nuts must be used with Grade 8 bolts

Section 1050

MAINTENANCE AND LUBRICATION

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

FLUIDS AND LUBRICANTS

COMPONENTS	CAPACITY U.S.	CAPACITY Metric	SPECIFICATIONS
Fuel tank	22 gallons	83 liters	Refer to Operator's Manual.
Engine crankcase Without filter change With filter change	 6 quarts 7 quarts	 5.7 liters 6.6 liters	Case HDM oil Engine oil, class CD, Above 32° F (0° C) . . . . . SAE 30 10°-50° F (-12°-10° C) . . . SAE 20W Below 32° F (0° C) . . . . . SAE 10W
Hydraulic system (approx.) Loader/backhoe Loader only Loader/three point hitch Reservoir refill	 30 gallons 21 gallons 25 gallons 17 gallons	 113 liters 79 liters 94 liters 64 liters	Case TCH Fluid Alternate oil Engine oil, SD or CA Above 32° F (0° C) . . . . SAE 10W Below 32° F (0° C) . . . . . SAE 5W Type C-2 transmission/hydraulic fluid such as Tenneco Hytrans Fluid.
Power shuttle and converter	8 quarts	7.6 liters	Case TCH Fluid.
Power steering system Reservoir refill	3 quarts 1 quart	2.8 liters 0.9 liter	Case TCH Fluid.
Mechanical shuttle	2 quarts	1.9 liters	Case TCH Fluid.
Transaxle	20 quarts	19 liters	Case FDL gear lubricant or lubricant meeting API-GL-4, specification Above 0° F (-18° C) . . . . . SAE 90 Below 0° F (-18° C) . . . . . SAE 80
Grease fittings	As required		No. 2 moly disulfide grease.
Front wheel bearings	As required		No. 2 moly disulfide grease.
Cooling system	21 quarts	19.8 liters	Mix ethylene glycol type antifreeze and water for lowest anticipated temperature.
Battery	As required		Add colorless, odorless drinking water.
Brake master cylinders	As required		DOT 3 brake fluid.

MAINTENANCE CHART

NOTE: This chart is based on maximum service intervals. If operating in severe working conditions, service more often.

INTERVAL	SERVICE	INSTRUCTIONS
Run-in period. Every two hours until stable	Torque front and rear wheel bolts to 115-130 foot-pounds (157-176 N m).	
	Torque transaxle mounting bolts to 250-300 foot-pounds (339-407 N m).	
	Torque swing cylinder trunnion plate mounting bolts to 520-640 foot-pounds (732-867 N m).	
	Torque drive shaft cap screws to 20-24 foot-pounds (27-32 N m).	
Run-in period after first 20 hours	Change engine oil and filter.	
	Change hydraulic oil filter.	Section 4002
	Check fan belt tension.	Section 8007
Every 10 hours of operation or daily, whichever occurs first	Grease loader pivot points.	
	Grease backhoe pivot points.	
	Grease extendable dipper, if so equipped.	
	Grease three point hitch, if so equipped.	
	Grease front axle pivot.	
	Grease front axle king pins.	
	Grease power shuttle bellcrank.	
	Check engine oil level.	
	Check hydraulic oil level.	
	Check radiator coolant level.	
	Clean air cleaner dust cup.	Section 2051
	Check power shuttle oil level (if so equipped).	Section 6202
	Check the machine and the ground under it for signs of leaks.	
	Check injection pump sediment bowl for water. If bowl has water, drain fuel tank, first stage fuel filter and sediment bowl.	

INTERVAL	SERVICE	INSTRUCTIONS
Every 100 hours of operation	Change engine oil.	
	Grease rear axle bearings.	
	Grease seat post.	
	Grease brake pedals and shaft bearings on power shuttle machines.	
	Grease brake pedals and clutch shaft on mechanical shuttle machines.	
	Check tire condition and pressure.	Section 6229
	Check battery fluid level.	Section 8005
	Check transaxle oil level.	
	Check mechanical shuttle oil level.	
	Check power steering oil level.	
	Clean spark arresting muffler if so equipped.	Section 2051
Every 200 hours of operation	Change engine oil filter.	Section 2555
	Check fan belt tension.	Section 8007
Every 500 hours of operation	Grease universal joints.	
	Lubricate hydraulic pump shaft.	Section 4005
	Replace fuel filters.	Section 3010
	Check brake master cylinder fluid level.	
	Repack front wheel bearings.	Section 5021
	Inspect Roll-Over Protection Structure.	Section 9061
	Change hydraulic oil filter.	Section 4002
	Clean hydraulic reservoir breather.	Section 4002
Every 1000 hours of operation or once a year, whichever occurs first	Change hydraulic oil.	Section 4002
	Change power shuttle oil, if so equipped.	Section 6202
	Replace power steering oil filter.	Section 5005
	Change mechanical shuttle oil, if so equipped.	
	Change transaxle oil.	
	Clean transaxle breather.	

INTERVAL	SERVICE	INSTRUCTIONS
Every 2000 hours of operation or once a year, whichever occurs first	Drain, flush and refill cooling system.	Section 2050
As required	After a wheel has been removed and installed, check bolt torque every two hours until stable.	
	Service air filter element whenever restriction warning light remains on with engine running at full throttle.	Section 2051
	Change hydraulic oil filter whenever restriction warning light remains lit.	Section 4002

Section 1051

TORQUE SPECIFICATIONS

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

U.S. AND METRIC TORQUE SPECIFICATIONS

Grade 5 Bolts, Nuts and Studs (Dry Threads)

Thread size	Ft-lbs	N m	Thread size	Ft-lbs	N m
1/4"-20 NC	5-10	7-13	3/4"-10 NC	235-285	319-386
1/4"-28 NF	10-15	13-20	3/4"-16 NF	270-330	366-447
5/16"-18 NC	15-20	20-27	7/8"-9 NC	360-440	488-597
5/16"-24 NF	15-20	20-27	7/8"-14 NF	395-490	536-664
3/8"-16 NC	25-35	34-47	1"-8 NC	520-640	705-867
3/8"-24 NF	30-40	41-54	1"-12 NF	575-705	780-955
7/16"-14 NC	45-55	61-74	1-1/8"-7 NC	720-820	976-1111
7/16"-20 NF	50-60	68-81	1-1/8"-12 NF	790-970	1071-1315
1/2"-13 NC	65-85	88-115	1-1/4"-7 NC	1010-1240	1370-1681
1/2"-20 NF	80-100	109-135	1-1/4"-12 NF	1115-1365	1512-1850
9/16"-12 NC	100-120	135-163	1-3/8"-6 NC	1315-1610	1783-2182
9/16"-18 NF	110-130	149-176	1-3/8"-12 NF	1510-1850	2047-2508
5/8"-11 NC	135-165	183-223	1-1/2"-6 NC	1745-2135	2366-2894
5/8"-18 NF	160-200	216-271	1-1/2"-12 NF	1880-2420	2549-3281

Grade 8 Bolts, Nuts and Studs (Dry Threads)

Thread size	Ft-lbs	N m	Thread size	Ft-lbs	N m
1/4"-20 NC	10-15	13-20	3/4"-10 NC	340-420	461-569
1/4"-28 NF	15-20	20-27	3/4"-16 NF	380-460	515-623
5/16"-18 NC	20-30	27-40	7/8"-9 NC	540-660	732-894
5/16"-24 NF	25-30	34-40	7/8"-14 NF	595-725	807-982
3/8"-16 NC	40-50	54-67	1"-8 NC	810-990	1098-1342
3/8"-24 NF	45-55	61-74	1"-12" NF	900-1100	1220-1491
7/16"-14 NC	60-80	82-102	1-1/8"-7 NC	1150-1400	1559-1898
7/16"-20 NF	70-90	95-122	1-1/8"-12 NF	1295-1585	1756-2148
1/2"-13 NC	100-120	136-162	1-1/4"-7 NC	1640-2000	2224-2711
1/2"-20 NF	110-130	149-176	1-1/4"-12 NF	1800-2200	2440-2982
9/16"-12 NC	135-165	183-223	1-3/8"-6 NC	2140-2620	2901-3552
9/16"-18 NF	155-190	210-257	1-3/8"-12 NF	2450-3000	3322-4067
5/8"-11 NC	200-240	271-325	1-1/2"-6 NC	2845-3475	3857-4711
5/8"-18 NF	215-265	292-359	1-1/2"-12 NF	3200-3900	4339-4880

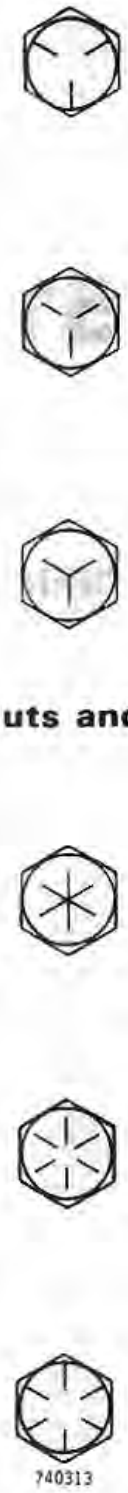


Figure 1

U.S. AND METRIC TORQUE SPECIFICATIONS

Hydraulic Fittings (Steel)

Dash Size	Tube O.D. Hose I.D.	Thread Size	37° Flare Torque		Straight Thread O-ring Torque	
			Ft-lbs	N m	Ft-lbs	N m
4	1/4"	7/16"-20	6-12	8-16	12-19	16-25
5	5/16"	1/2"-20	8-16	11-21	16-25	22-33
6	3/8"	9/16"-18	10-25	14-33	25-40	34-54
8	1/2"	3/4"-16	15-42	20-56	42-67	57-90
10	5/8"	7/8"-14	25-58	34-78	58-92	79-124
12	3/4"	1-1/16"-12	40-80	54-108	80-128	108-174
14	7/8"	1-3/16"-12	60-100	81-135	100-160	136-216
16	1"	1-5/16"-12	75-117	102-158	117-187	159-253
20	1-1/4"	1-5/8"-12	125-165	169-223	165-264	224-357
24	1-1/2"	1-7/8"-12	210-250	285-338	250-400	339-542

Split Flange Mounting Bolts (Grade 5, Dry Threads)

Flange Size	Thread Size	Torque	
		Ft-lbs	N m
1/2"	5/16"-18 NC	15-20	20-25
3/4"	3/8"-16 NC	20-25	26-33
1"	3/8"-16 NC	20-25	26-33
1-1/4"	7/16"-14 NC	35-45	47-61
1-1/2"	1/2"-13 NC	45-55	61-74
2"	1/2"-13 NC	55-65	74-88
2-1/2"	1/2"-13 NC	80-90	104-122
3"	5/8"-11 NC	140-150	190-203

740314

Figure 2

Section 1052

NOISE CONTROL

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

NOISE PROTECTION

J I Case provides noise abatement kits that may be factory or field installed. Each kit is made up of an acoustical foam material. This material must be kept clean and intact to maintain the proper level of noise protection.

Cleaning

If the padding becomes contaminated with surface dust or dirt, hose down with water. Steam clean parts that have become contaminated with oil or grease. Squeeze out the excess water.

If the padding is saturated with oil or grease and does not clean up, replace the contaminated part.

Replacement

WARNING: Be sure the area has good ventilation before applying the adhesive. 39-10

When installing padding make sure the metal surfaces are clean of all oil, grease, excessive rust and traces of old material. It is very important that the new piece cover the same area as the old one.

Use a brand name contact cement according to manufacturer's instructions to hold padding in place.

Checking Noise Protection

The laws of some cities, states or provinces may require that your machine be checked and certified for a maximum noise level. Be sure to check with local authorities to determine what the requirements are.

Listed below are checks that must be performed to insure continuing noise protection.

1. Check that all exterior parts and sheet metal fasteners are tight. All rattles close to the operator's area must be eliminated.

2. Check that all sealing and barrier materials are whole and intact. A small hole can admit a large amount of noise.

3. Check noise isolators such as engine mounts, rubber shock mounts, hydraulic tube isolators, etc. Replace if defective.

4. Check that the full throttle - no load engine speed is checked with an accurate tachometer. The engine speed must be within the limits as listed in Section 1010.

5. Check the full range of engine speed for resonance (loud, undampened vibration). To check, increase the engine speed from low idle to full throttle slowly. If excessive resonance is found, eliminate the vibration of the suspected part.

NOTE: For your general information, see the SAE recommended practice on sound levels and measurements. Refer to SAE J919a, J87 and J88 in the SAE Handbook.

Section 2001

ENGINE DIAGNOSIS

188 and 207 Diesel Engines

J I Case
A Tenneco Company

TENNECO

Rec. 9-78875

PRINTED IN U.S.A.

GENERAL INFORMATION

Before making any repairs or adjustments on an engine, a mechanic or technician must properly diagnose the trouble.

Locating the trouble and repairing it is only part of the job, a technician must find and eliminate the cause of the trouble as well. Too many repairs are made with no thought to removing the causes that made the repair necessary.

For any engine to start or perform properly, three main requirements must be present:

1. FUEL
2. COMPRESSION
3. COMBUSTION

When any of these requirements are not present or limited by some mechanical reason, the engine will not start and will fail to operate properly throughout the power range.

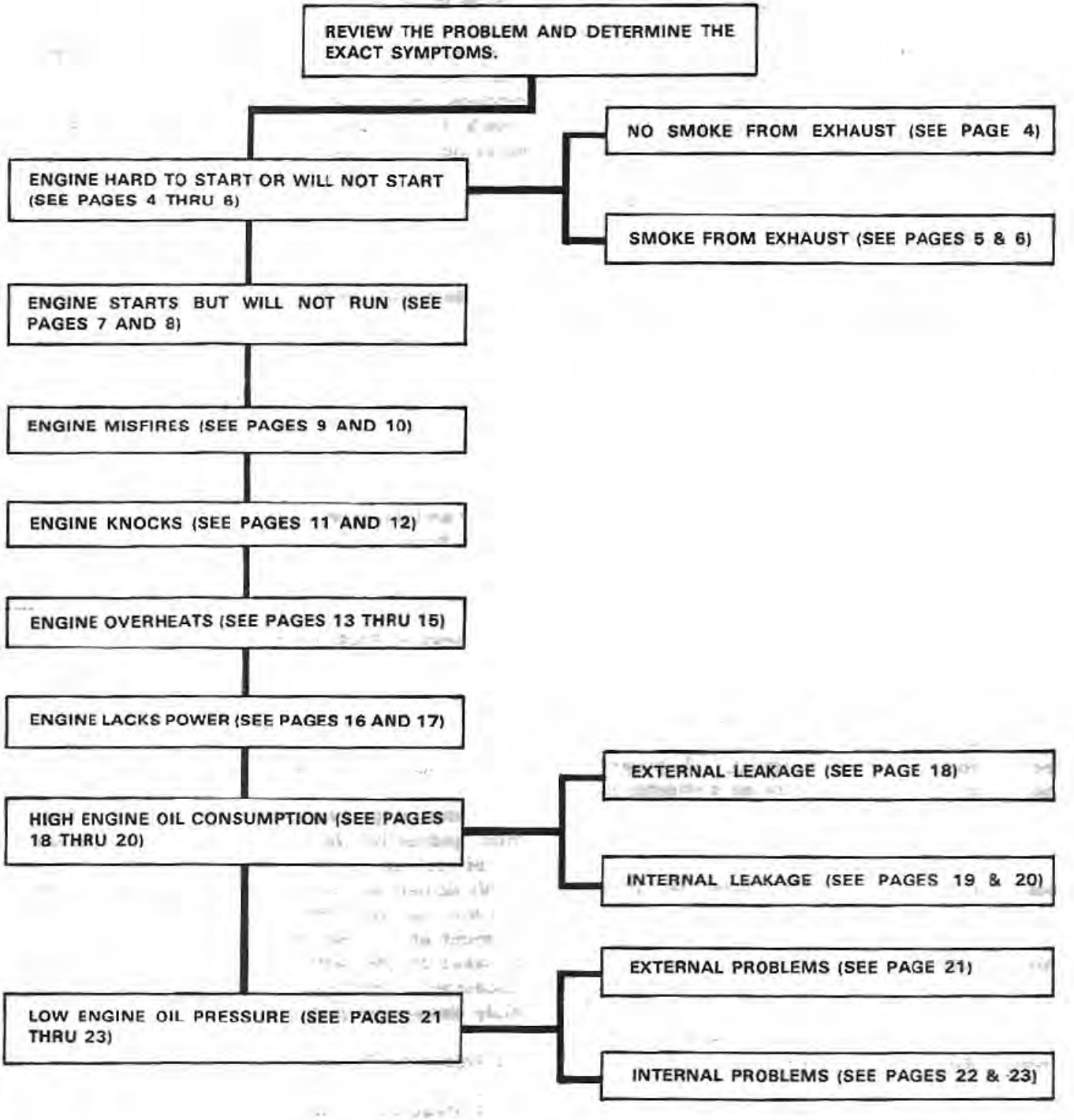
FUEL. Fuel system problems can be present anywhere from the fuel tank, through the filters and injection pump as well as the injectors. Correct injection pump timing is important in the overall fuel system performance.

COMPRESSION. Compression on an engine is related to the "breathing function". Proper compression is affected by the air cleaner condition, muffler restriction, valve condition and operation including proper valve adjustment, cylinder head gaskets, condition of sleeves, rings, pistons, camshaft, and camshaft timing.

COMBUSTION. Combustion is the result of adequate compression to develop enough heat in the air charge on the compression stroke to fire the fuel being injected into the engine cylinders. Proper spray pattern and atomization of the fuel by the injector is very important. Timing the fuel injection pump to the engine to a precise degree BTDC is a vital requirement for proper combustion.

The engine diagnosis contained in the following pages covers many trouble symptoms, the causes, and what will be necessary to repair or eliminate the problem. Under each symptom are listed the most common and reoccuring problems progessing to the not so common problems. Locate your problem symptom in the diagnosis chart and refer to the pages listed for the probable causes and remedies.

ENGINE DIAGNOSIS CHART



ENGINE HARD TO START OR WILL NOT START

No Smoke From Exhaust

1. Fuel Shut-Off Not Open Completely.

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

2. Final Air Filter Plugged

A dirty filter will cause rich fuel mixture and low engine power. Check filter restriction indicator and service final air filter if required.

3. Slow Cranking Speed

Starter must crank engine 200 to 300 RPM in order to ignite the diesel fuel. Check engine RPM while cranking. If cranking is slow, check starter amperage draw to help determine the following defective areas: batteries, cables, solenoid and starting motor.

Slow cranking speed can be caused by the following internal and external engine defects: scuffing and scoring of pistons and sleeves, improper crankshaft or camshaft end play, defective rod or crank bearings, oil pump, water pump, hydraulic pump or air compressor.

4. Fuel Supply Shut-Off or No Fuel

Check that fuel tank shut-off valve is open. Check fuel supply in tank.

5. Air In Fuel System

Bleed fuel system until fuel flows steadily with no bubbles. Check for air leaks at fittings between tank and fuel pump.

6. Camshaft Damaged

A sheared key in the cam drive gear or a broken cam shaft will throw valve timing out of sequence affecting engine operation. Remove cylinder head cover and check valve timing in reference to crankshaft timing marks with a dial indicator.

7. Fuel Injection Nozzle Not Seated In Head.

A nozzle that is not seated in the cylinder head will let compression leak by and not produce enough heat to fire the injected fuel. Check for damaged nozzle gasket or seals, loose nozzle, or broken stud.

8. Fuel Line Plugged

A fuel line plugged with dirt will not let fuel through to the injection pump. Remove line at fuel filters and check for fuel flow through line.

9. Clogged Fuel Filter

Check and service fuel filters.

10. Wrong Fuel or Contaminated Fuel

Wrong fuel (low centane) or contaminated fuel (water and dirt) can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

11. Sticking Rack Control

A sticking rack control will not let the fuel injection pump accept any fuel.

12. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubrication oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

13. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. Adjust or replace the injection pump. A common cause is a sheared key on the injection pump drive, preventing fuel to be delivered to injectors. Adjust or replace the injection pump.

ENGINE HARD TO START OR WILL NOT START
Smoke From Exhaust

1. Slow Cranking Speed

Starter must crank engine 200 to 300 RPM in order to ignite the diesel fuel. Check engine RPM while cranking. If cranking is slow, check starter amperage draw to help determine the following problem areas: batteries, cables, solenoid, and starting motor.

Slow cranking speed can be caused by the following internal and external engine defects: scuffing and scoring of pistons and sleeves, improper crankshaft or camshaft end play defective rod or crank bearings, oil pump, water pump, hydraulic pump or air compressor.

2. Fuel Shut-Off Not Open Completely.

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

3. Low Compression

Low compression on several cylinders, makes the engine hard to start and rough running, also does not generate enough heat to properly fire on all cylinders. Make a compression test on the engine.

4. Final Air Filter Plugged

A dirty filter will cause rich fuel mixtures and low engine power. Check filter restriction indicator and service final air filter if required.

5. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern, or plugged spray orifice will affect proper combustion in engine cylinders. Remove and test the fuel injection nozzles.

6. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause precombustion and serious damage to the engine. Check for proper engine timing.

7. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubricating oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

8. Valve Push Rods Bent

Bent push rods will affect valve operation and not allow cylinders to get a full charge of fuel and air, or not exhaust properly. This can usually be distinquished by excessive valve tappet noise. Remove cylinder cover and check for bent push rods.

9. Clogged Fuel Filter

Check and service fuel filters.

10. Fuel Injection Nozzle Not Seated In Head

A nozzle that is not seated in the cylinder head will let compression leak by and not produce enough heat to fire the injected fuel. Check for damaged nozzle gasket or seals, loose nozzle, or broken stud.

11. Tune-up Specifications Wrong

Check engine and unit serial number plates for correct specifications when performing engine tune-up.

12. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particle. This helps break down lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubrication system or cooling system, incorrect timing, pre-combustion, lugging or overloading, improperly fitting parts and improper break-in procedure. Remove piston assemblies and inspect.

ENGINE HARD TO START OR WILL NOT START

Smoke From Exhaust (Cont'd)

13. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to loose power and cause an engine to miss. Compression leaking into the water system can also cause the cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket, or remove radiator cap, run engine and check for gas bubbles rising in coolant at radiator opening.

14. Piston Ring Installation Faulty or Broken Rings

At times, piston rings are installed wrong, upside down, wrong size, overlapping of expanders, or expanders are cut on three piece oil rings. Be sure to carefully read the instructions before installing piston rings. Damaged rings can cause scoring of the piston sleeves and cause the engine to use oil.

15. Valves Sticking

Sticking valves can be caused by improper replacement of valve guides, no lubrication, rust vapors, bent valves, or carbon. A sticking valve will cause an engine miss and the valve could also hit the piston causing internal damage.

16. Wrong Fuel or Contaminated Fuel

Wrong fuel (low centane) or contaminated fuel (water and dirt) can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

17. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. A common cause is a sheared key on the injection pump drive, preventing fuel to be delivered to injectors. Adjust or replace the injection pump or parts as required.

18. Fuel Injection Line Cracked.

A cracked, chaffed or damaged fuel injector line will allow the fuel to escape externally and not inject fuel into the cylinder. This will cause an engine miss and low horsepower. Leaking fuel from a damaged injector line can easily be seen.

ENGINE STARTS BUT WILL NOT RUN

1. Fuel Shut-Off Not Open Completely

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

2. Final Air Filter Plugged

A dirty filter will cause rich fuel mixtures and low engine power. Check filter restriction indicator and service final air filter if required.

3. Air In Fuel System

Bleed fuel system until fuel flows steady with no air bubbles. Check for air leaks at fittings between fuel tank and injection pump.

4. Low Fuel Supply

Check fuel supply in tank and refill if necessary.

5. Injection Pump Rack Control Sticking

A sticking rack control will not allow the fuel injection pump to accept any fuel.

6. Low Compression

Low compression on several cylinders, makes the engine hard to start and rough running, also does not generate enough heat to properly fire on all cylinders. Make a compression test on the engine.

7. Valve Push Rods Bent

Bent push rods will affect valve operation and not allow cylinders to get a full charge of fuel and air, or not exhaust properly. This can usually be distinquished by excessive valve tappet noise. Remove cylinder cover and check for bent push rods.

8. Camshaft Damaged

A sheared key in the cam drive gear or a broken camshaft will throw valve timing out of sequence, affecting engine operation. Remove cylinder cover and check valve timing in reference to crankshaft timing marks with a dial indicator.

9. Wrong Fuel or Contaminated Fuel

Wrong fuel (low centane) or contaminated fuel (water and dirt) can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

10. Clogged Fuel Filter

Check and service fuel filters.

11. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern, or plugged spray orifice will affect proper combustion in engine cylinders. Remove and test the fuel injection nozzles.

12. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to loose power and cause an engine to miss. Compression leaking into the water system can also cause the cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket, or remove radiator cap, run engine and check for gas bubbles rising in coolant at radiator opening.

13. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubricating oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

ENGINE STARTS BUT WILL NOT RUN (Cont'd)

14. Valves Sticking

Sticking valves can be caused by improper replacement of valve guides, no lubrication, rust vapors, bent valves, or carbon. A sticking valve will cause an engine miss and the valve could also hit the piston causing internal damage.

15. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. A common cause is a sheared key on the injection pump drive, preventing fuel to be delivered to injectors. Adjust or replace the injection pump or parts as required.

16. Fuel Injector Line Cracked

A cracked, chaffed or damaged fuel injector line will allow the fuel to escape externally and not inject fuel into the cylinder. This will cause an engine miss and low horsepower. Leaking fuel from a damaged injector line can easily be seen.

17. Injection Pump Timing Incorrect

A fuel injection pump timed at wrong degrees, wrong stroke, or marks moved on pulley, will inject fuel into the cylinders at the wrong time, causing rough running, pre-combustion, low horsepower and other damage to the engine. Check for proper pump timing.

ENGINE MISFIRES

Low and High RPM

1. Wrong Fuel or Contaminated Fuel

Wrong fuel (low centane) or contaminated fuel (water and dirt) can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

2. Valve Push Rods Bent

Bent push rods will affect valve operation and not allow cylinders to get a full charge of fuel and air, or not exhaust properly. This can usually be distinquished by excessive valve tappet noise. Remove cylinder cover and check for bent push rods.

3. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern or plugged orifice will affect proper combustion in engine cylinders. Isolate faulty injector nozzle and remove.

4. Fuel Injection Nozzle Not Seated in Head

A fuel injection nozzle that is not seated in the cylinder head will let compression leak by and the cylinder does not produce enough heat to fire the injected diesel fuel. A damaged nozzle gasket or seals, loose nozzle, or broken stud can cause the nozzle not to be seated correctly.

5. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to loose power and cause an engine to miss. Compression leaking into the water system can also cause the cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket, or remove radiator cap, run engine and check for gas bubbles rising in coolant at radiator opening.

6. Low Compression

Low compression on several cylinders, makes the engine hard to start and rough running, also does not generate enough heat to properly fire on all cylinders. Make a compression test on the engine.

7. Fuel Injection Line Cracked

A cracked, chaffed or damaged fuel injector line will allow fuel to escape externally and inject fuel into the cylinder. This will cause an engine miss and low horsepower. Leaking fuel from a damaged injector line can easily be seen.

8. Injection Pump Malfunction.

A malfunctioning injection pump will usually under-fuel the engine. A common cause is a sheared key on the injection pump drive, preventing fuel to be delivered to injectors. Adjust or replace the injection pump or parts as required.

9. Injection Pump Timing Incorrect

A fuel injection pump timed at wrong degrees, wrong stroke, or marks moved on pulley, will inject fuel into the cylinders at the wrong time, causing rough running, pre-combustion, low horsepower and other damage to the engine. Check for proper pump timing.

10. Intake Manifold Gasket Damaged

A damaged intake manifold gasket can reduce the manifold pressure and cause an insufficient air-fuel mixture in the cylinders and result in low power.

11. Cylinder Head or Sleeve Cracked

A cracked head or sleeve will usually let engine coolant into the engine. This will cause an engine miss or pressure rise in the cooling system depending on how bad the leak is. Low coolant level, oil level, engine missing, and blowing water out the exhaust are evidence that coolant is getting into the engine combustion chambers.

ENGINE MISFIRES

Low and High RPM (Cont'd)

12. Valves Damaged

Damaged valves are caused by wear, improper grinding, hitting the pistons, wrong adjustment, loose seat, or broken valve spring. Defective valves can usually be heard through the intake or exhaust manifold. A low reading compression test usually indicates defective valves.

13. Valve Spring Worn (High RPM)

Weak valve springs will allow the valves to float at high speed. Broken valve springs will not close valve completely and valve could hit the piston doing internal engine damage. Always check and test valve springs when doing a valve job. Damping coils on spring should be assembled against the cylinder head.

14. Operating Temperature Low

The engine was designed for and will only develop full horsepower within its correct operating temperature range. Low operating temperature can result from a malfunctioning thermostat. Do not remove thermostat during the summer. Maintain 50% of permanent antifreeze all year for more efficient operation.

15. Engine Pre-combustion

Pre-combustion is the igniting of the fuel before the normal compression point occurs. This can cause severe knocking and engine power loss. High temperature and pressure from pre-combustion will cause other serious internal damage to the engine. The following are causes of pre-combustion:

A. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats.
B. Hot spots caused by an inefficient or damaged cooling system.
C. Injection nozzles set at incorrect cracking pressure.
D. Sharp edges in combustion chamber.
E. Timing incorrect.
F. Excessive lugging of engine.
G. Defective injection pump.
H. Wrong or contaminated fuel.

16. Valves Sticking

Sticking valves can be caused by improper replacement of valve guides, no lubrication, rust vapors, bent valves or carbon. A sticking valve will cause an engine miss and the valve could also hit the piston causing internal damage.

17. Bent Connecting Rod

A bent connecting rod will cause piston slap from scoring due to misalignment. The engine will run rough because of incomplete combustion and emit white exhaust smoke from the bad cylinder. Remove engine oil pan and inspect connecting rods for alignment. A comparison of piston heights at Top Dead Center with cylinder head removed may quickly indicate a bent rod condition. A difference of .020 inch in connecting rod can cause a noticeable miss at low RPM and cold engine conditions.

18. Tune-up Specifications Incorrect

Check engine and unit serial number plates for correct specifications when performing engine tune-up.

ENGINE KNOCKS

Low and High RPM

1. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause pre-combustion and serious damage to the engine. Check for proper engine timing.

2. Flywheel Loose (Low RPM)

A loose flywheel will chuck or pound at low speed making the engine sound like it has a loose connecting rod. As speed increases, the knock will go away. Replace flywheel if badly worn.

3. Engine Pre-combustion

Pre-combustion is the igniting of the fuel before the normal compression point occurs. This can cause severe knocking and engine power loss. High temperature and pressure from pre-combustion will cause other serious internal damage to the engine. The following are causes of pre-combustion:

A. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats.
B. Hot spots caused by an inefficient or damaged cooling system.
C. Injection nozzles set at incorrect cracking pressure.
D. Sharp edges in combustion chamber.
E. Timing incorrect.
F. Excessive lugging of engine.
G. Defective injection pump.
H. Wrong or contaminated fuel.

4. Rod Bearing Worn

A rod bearing going bad will have a sharp metallic sound which will increase as RPM increases. When the cylinder with the bad knock is grounded by cracking the injector line, the knock will stop or decrease considerably. Remove the engine oil pan and check rods with plasti-gauge.

5. Main Bearing Worn

A worn main bearing will have a thudding sound and increased engine vibration. Both symptoms will increase as engine speed increases. By grounding out (cracking injector line) the problem cylinder, the thudding sound will stop or decrease but the vibration will remain. Remove engine oil pan and check main bearing clearance will plasti-gauge. Also, low oil pressure can be the result of worn main bearings and excessive oil clearance.

6. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particles. This helps break down lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubrication system or cooling system, incorrect timing, pre-combustion, lugging or overloading, improperly fitting parts and improper break-in procedure. Remove piston assemblies and inspect.

7. Piston Ring Installation Faulty or Broken Rings

At times, piston rings are installed wrong, upside down, wrong size, overlapping of expanders, or expanders are cut on three piece oil rings. Be sure to carefully read the instructions before installing piston rings. Damaged rings can cause scoring of the piston sleeves and cause the engine to use oil.

ENGINE KNOCKS

Low and High RPM (Cont'd)

8. Bent Connecting Rod

A bent connecting rod will cause piston slap from scoring due to misalignment. The engine will run rough because of incomplete combustion and emit white exhaust smoke from the bad cylinder. Remove engine oil pan and inspect connecting rods for alignment. A comparison of piston heights at Top Dead Center with cylinder heads removed may quickly indicate a bent rod condition. A difference of .020 inch in connecting rod can cause a noticeable miss at low RPM and cold engine conditions.

9. Valve Spring Weak

Weak valve springs will allow the valves to float at high speed. Broken valve springs will not close valve completely and valve could hit the piston doing internal engine damage. Always check and test valve springs when doing a valve job. Damping coils on spring should be assembled against the cylinder head.

10. Piston Pin or Bushing Worn

Piston pin or bushing knock will increase with speed. When grounding out the cylinder (cracking injector line) the knock will be twice as bad. Due to combustion, every other revolution will keep the piston pin and bushing tight giving no knock. Remove and inspect piston assembly producing the knock.

11. Camshaft Bearing Worn

A camshaft bearing knock is not a very sharp sounding knock. The knock will be only at one-half of crankshaft speed and will not become worse at different engine speeds. Low oil pressure could result from worn bearings and excessive oil clearance from lack of replacing cam bearing at engine overhaul.

12. Crankshaft End Play Excessive

Excessive crankshaft end play will be indicated by one thudding sound when increasing RPM and one thud when decreasing RPM. Due to the angle of the teeth on crank gear and cam gear, as speed changes it pushes the crankshaft back and forth. Check crankshaft end play with a dial indicator.

13. Foreign Material In Cylinders

Foreign material such as pieces of broken valve, bolts, nuts, washers, or pieces of castings, in the cylinder will cause a noise everytime the piston comes to Top Dead Center. The noise will not change by shorting out the cylinder. Due to the metal-to-metal contact, the vibration can be felt on the side of the engine. Remove cylinder heads and inspect.

14. Cylinder Ridge Not Removed

When performing an engine overhaul and installing new rings, the cylinder ridge must be removed. If the ridge was not removed, it would cause the engine to knock on all cylinders as the top piston ring hits the ridge on every stroke. If the top ring continued to hit the ridge, it would cause ring land breakage between top and second ring, causing piston and sleeve scuffing and scoring. Remove heads and check for cylinder ridge.

15. Improper Use of Ether (Low RPM)

Spraying either into the engine air intake without cranking the engine, will cause one or more cylinders to receive a large amount of ether due to open valves. Then, when the engine is cranked, volatile, uncontrolled explosions will occur in these cylinders breaking ring lands and damaging the piston. Be sure engine is cranking before using ether. Remove cylinder heads and inspect pistons for damage.

16. Camshaft End Play Excessive

Excessive camshaft end play will be indicated by one thudding sound when increasing engine speed and one thud when decreasing speed, but will not be as pronounced as crankshaft end play. Due to the angle of the teeth on crank gear and cam gear, as engine speed changes, it pushes and pulls the camshaft back and forth. Excessive camshaft end play can be caused by worn thrust washer, loose cam gear, or broken or missing camshaft thrust spring. Remove front timing cover and check camshaft end play with a dial indicator.

ENGINE OVERHEATS

1. Fan Belt Loose

Check fan belt for proper tension. Check that the belt is not covered with oil or worn badly and riding very deep in pulley groove. Check for pulley groove wear.

2. Low Coolant Level

Check coolant level in radiator and refill if necessary.

3. Water Pump Malfunction

Remove the radiator cap and observe the coolant to see if there is movement which indicates the water pump is pumping. Move the fan back and forth to check for any defective bearings. Check around the water pump for any signs of coolant leakage indicating a bad water pump seal. Remove water pump and rebuild or replace.

4. Thermostat Inoperative

If there is high coolant temperature and boiling coolant, remove thermostat and test it.

5. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause pre-combustion and serious damage to the engine. Check for proper engine timing.

6. Tractor Mechanical Drag

A mechanical drag on a unit can cause low horsepower and engine overheating. Causes of some mechanical drags are defective brakes, bad bearings or gears in transmission.

7. Radiator Cap Inoperative

Test radiator cap to see that it relieves at the correct pressure. Inspect cap gasket for proper sealing. An inoperative cap can cause water pump cavitation and lower coolant boiling points.

8. Radiator Fins Bent

Bent or damaged fins can cause a cooling system to overheat because of restricted air flow through the radiator core. All of the fin area is needed to dissipate the engine heat from the radiator.

9. Radiator Fins Plugged With Dirt

Radiator fins must be clean so air can flow through the radiator fins and help dissipate the heat of the coolant. Items that affect radiator cooling are: oil and grease on fins, leaves, and attachments covering radiator air inlet.

10. Cylinder Head Gasket Blown

A blown cylinder head gasket will cause one or two cylinders to loose power and cause an engine to miss. Compression leaking into the water system can also cause the cooling system pressure to rise and blow engine coolant out the radiator overflow. Take a compression test to help determine a defective head gasket, or remove radiator cap, run engine and check for gas bubbles rising in coolant at radiator opening.

11. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. A common cause is a sheared key on the injection pump drive, preventing fuel to be delivered to injectors. Adjust or replace the injection pump or parts as required.

12. Radiator Baffling Missing

The removal of or non-reinstalling of radiator baffling, whether foam rubber or sheet metal, will cause cooling air flow to escape around the radiator instead of drawing in cool external air through the radiator.

13. Engine Low On Oil

An engine low on oil could lose lubrication to internal parts and start scoring pistons, sleeves and damage engine bearings. Proper oil level is required to help dissipate some of the engine heat. Check engine oil level every eight hours of operation. Low engine oil can also give low oil pressure readings.

ENGINE OVERHEATS (Cont'd)

14. Wrong Fuel or Contaminated Fuel

Wrong fuel (low centane) or contaminated fuel (water and dirt) can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

15. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particles. This helps break down lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubrication system or cooling system, incorrect timing, pre-combustion, lugging or overloading, improperly fitted parts and improper break-in procedure. Remove piston assemblies and inspect.

16. Water Pump Hose Worn

Water pump hoses can become worn from age and collapsing, cracking, chaffing against something or fan belts cutting through them. Inspect hoses for coolant leaks.

17. Bad Ground on Gauge or Sending Unit

A bad ground on gauges or sending units can many times be the only problem with a defective gauge. Take a jump wire and ground gauge or sending unit to machine, then recheck gauge. Pipe tape is often used to seal threads on oil sending units which destroys the biggest share of its' grounding ability.

18. Cylinder Head or Sleeve Cracked

A cracked cylinder head or sleeve will usually allow engine coolant into the engine, causing engine miss or pressure rise in the cooling system depending upon how bad the leak is. Coolant level low, oil level check, engine missing when first started, and water blowing out the exhaust are indications that coolant is getting into the engine combustion chambers.

19. Lack of Anti-Freeze

To illustrate the importance of having antifreeze in the cooling system year around, consider the following. Any ethylene glycol antifreeze with a 50% mixture and a 7 PSI cap will raise the coolant boiling point to 242 degrees. A 70% mixture will raise the boiling point to 253 degrees. With just water in the above cooling system, it would boil at 233 degrees.

20. Cylinder Sleeve O-Ring Damaged

A pinched, rolled, nicked, or hard sleeve O-ring can cause a coolant leak in the crankcase, contaminating the engine oil. This coolant leaking can go undetected for sometime causing engine heating and crankshaft damage. Remove engine oil pan and observe bottom of sleeves to detect slow coolant leak.

21. Radiator Leaking Externally

Inspect and repair or replace leaking radiator.

22. Tune-up Specifications Wrong

Check engine and unit serial number plates for correct specifications when performing engine tune-up.

23. Engine Pre-combustion

Pre-combustion is the igniting of the fuel before the normal compression point occurs. This can cause severe knocking and engine power loss. High temperature and pressure from pre-combustion will cause other serious internal damage to the engine. The following are causes of pre-combustion:

A. Valves operating at higher than normal temperature because of excessive guide clearance or improper seal with valve seats.
B. Hot spots caused by an inefficient or damaged cooling system.
C. Injection nozzles set at incorrect cracking pressure.
D. Sharp edges in combustion chamber.
E. Timing incorrect.
F. Excessive lugging of engine.
G. Defective injection pump.
H. Wrong or contaminated fuel.

24. Water Temperature Gauge Malfunction

The water temperture gauge, wiring, resistor or sending bult could give false or no temperature readings. To diagnose, remove wire at sending unit and ground to tractor. Turn key switch on, if gauge comes up, sending unit is malfunctioning. If gauge does not come up, use voltmeter and ohmeter to check wiring circuit.

ENGINE LACKS POWER

1. Fuel Shut-Off Not Open Completely

Improper cable adjustment, damaged cable, cable slipping in clamps, misadjusted or inoperative solenoid will not completely return fuel shut-off lever to open position. Check lever to be sure it is opening completely. A partially opened lever limits the amount of fuel to the injection pump and results in low engine horsepower.

2. Low Engine RPM

Check engine for correct RPM.

3. Tractor Mechanical Drag

A mechanical drag on a unit can cause low horsepower and engine overheating. Causes of some mechanical drags are damaged brakes, bad bearings or gears in transmission.

4. Final Air Filter Plugged

A dirty filter will cause rich fuel mixtures and low engine power. Check filter restriction indicator and service final air filter if required.

5. Wrong Fuel or Contaminated Fuel

Wrong fuel or contaminated fuel can cause the engine not to run or to have pre-combustion, causing serious damage to the engine. Drain fuel tank and refill with correct fuel.

6. Operating Temperature Low

The engine was designed for and will only develop full horsepower within a specific temperature range. Low temperature can result from defective thermostat. Do not remove thermostat during summer. Maintain 50% of permanent anti-freeze all year for more efficient operation.

7. Engine Timing Incorrect

Combustion will not occur in the cylinder at the correct moment (degrees BTDC) if the engine timing is incorrect. This can cause pre-combustion and serious damage to the engine. Check for proper engine timing.

8. Low Compression

Low compression on several cylinders makes the engine hard to start and also does not generate enough heat to properly fire on all cylinders and continue running. Make a compression check on the engine.

9. Fuel Injection Nozzles Malfunctioning

Low cracking pressure, improper spray pattern, or plugged spray orifice will affect proper combustion in engine cylinders. Remove and test the fuel injection nozzles.

10. Clogged Fuel Filter

Check and service fuel filters.

11. Air In Fuel System

Bleed fuel system until fuel flows steady with no air bubbles. Check for air leaks at fittings between fuel tank and injection pump.

12. Camshaft Timing Wrong

A camshaft can be installed one tooth out of time making all valves operate out of normal timing sequence in relation to the crankshaft. This would not allow the engine to develop full power or run smoothly. Valves could hit the pistons causing internal damage.

13. Crankcase Too Full of Oil

An over-full or completely full crankcase can cause a loss of power because the crankshaft is trying to turn in the extra high oil level. High oil level can be caused by coolant or fuel leakage into the crankcase, extra engine oil, or oil transferred from an adjoining compartment.

ENGINE LACKS POWER (Cont'd)

14. Valves Damaged

Damaged valves are caused by wear, improper grinding, hitting the pistons, wrong adjustment, loose seat, or broken valve spring. Defective valves can usually be heard through the intake or exhaust manifold. A low reading compression test usually indicates defective valves.

15. Valves Out of Adjustment

Careful valve adjustment is important to obtain a complete supply of fuel and air and to completely exhaust burned gases. Valves out of adjustment can cause damaged valves, valve seat wear, bent push rods, damaged pistons, rocker arm wear and camshaft wear.

16. Injection Pump Malfunction

A malfunctioning injection pump will usually under-fuel the engine. A common cause is a sheared key on the injection pump drive, preventing fuel to be delivered to injectors. Adjust or replace the injection pump or parts as required.

17. Fuel Line Plugged

A fuel line plugged with rust or dirt will not allow fuel through to the fuel injection pump. Remove line at injection pump and check fuel flow.

18. Engine Drag

Lack of power can be caused by the following internal and external engine defects:scuffing and scoring of pistons and sleeves, improper crankshaft or camshaft end play, worn rod or crank bearings, oil pump, air compressor, water pump, or hydraulic pump.

HIGH ENGINE OIL CONSUMPTION

External Leakage

1. Engine External Oil Leakage

Check for engine external oil leaks at the following locations:

A. Covers
B. Accessories
C. Valve cover gasket
D. Restricted breather
E. Oil pan gasket
F. Timing gear cover gasket
G. External oil lines
H. Camshaft welch plug
I. Engine oil filter
J. Engine oil cooler
K. Oil drain plug gasket
L. Front and rear crankshaft seal

HIGH ENGINE OIL CONSUMPTION

NOTE: CHECK CRANKCASE BREATHER FOR BLOW-BY AND EXHAUST FOR BLUE GRAY SMOKE.

1. Engine Internal Oil Leakage

Check for engine internal oil leaks in the cylinder head assembly and engine block assembly.

2. Valve Guides Worn

Excessively worn valve guides can account for high oil consumption. Gravity, inertia and air pressure differences act to force oil through the intake and exhaust valve guides. To check-out valve guides, restrict lubricating oil flow to the rocker assemblies for a short time. Run engine at idle and then accelerate quickly. If dark blue exhaust clears up, the valve guides are worn and defective.

3. Rocker Arm Assembly Worn

Worn rocker arm assemblies allow larger than normal amounts of lubricating oil into the valve compartment. The extra quantity of oil increases oil consumption past the valve guides. Run the engine with valve cover removed and check for excessive oil or oil flow from the rocker arms.

4. Piston and Sleeves Scuffed and Scored

Scuffing starts as a very small surface disturbance of torn out metal particle. This helps breakdown lubrication which increases heat and spreads the scuffing to adjacent areas. Scuffing and scoring are caused by malfunctioning of the lubricating system, or cooling system, incorrect timing, pre-combustion, lugging or overloading, improperly fitted parts and improper break-in procedure. Remove the piston assemblies and inspect.

5. Piston Rings Worn

As piston rings become worn, they lose tension and ability to seal and wipe lubricating oil off cylinder walls. Take a compression test to determine piston ring condition. If readings are low, squirt a small amount of oil into the cylinder and retest. If compression comes up because the oil helps the rings seal, it will be necessary to install new piston rings and possibly sleeve and pistons.

6. Rocker Arm Shafts Indexed Wrong

Incorrect rocker arms or rocker arm shafts indexed wrong can lead to excessive oil in the rocker arm compartment. This oil aggravates oil consumption especially past valve guides. Remove valve cover and check oil flow from rocker arm assemblies.

7. Excessive Oil In Rocker Arm Compartment

Excessive oil in rocker arm compartments can be caused by wrong rocker arms, rocker arm shafts indexed wrong, worn rocker arm bushings, high oil pressure and poor oil drainage back to crankcase. Remove cylinder cover and check for above problems.

8. Engine Speed Too High

Running at speeds higher than the engine is designed for will aggravate all oil consumption areas such as oil pressure, oil flow, throwoff onto cylinder walls and oil in rocker arm compartments. Check engine speeds and set according to specifications.

9. Connecting Rod Bearings Worn

Worn rod bearings cause more than normal throw-off of lubricating oil to cylinder pistons and liners. This excess oil is sometimes more than worn piston oil rings can control. The oil then passes the rings and on into the combustion chamber. Remove the engine oil pan and check rod bearings for wear using plasti-gauge. A worn rod bearing can cause the engine to knock and low oil pressure.

HIGH ENGINE OIL CONSUMPTION

10. Engine Oil Too Light

Using engine oil that is too light will aggravate all oil consumption areas because of additional oil flow and leakage of the lighter oil. Light engine oil will give lower than normal oil pressure readings. Check for proper weight oil and change oil if required.

11. Piston Rings Not Seated

Most piston rings will seat in the first few hours of operation. If engine continues to use oil, it is usually a problem other than piston rings. Items that can cause rings not to seat are: out-of-round sleeve, warped sleeve, improper deglazing of sleeves, rings installed wrong or improper break-in procedure. Do not add abrasives to intake system to seat rings. If it is suspected that rings are not seated, tear down engine and inspect.

12. Valve Guide Seals Worn

Worn valve guide seals allow oil to enter the engine through the valve guides. Gravity, inertia and air pressure differences all act to force oil through the intake and exhaust valve guides and into the combustion chamber. Remove rocker arm assemblies and valve springs and inspect or replace valve guide seals.

13. Engine Oil Pressure Too High

High oil pressure will cause additional oil throw-off from connecting rod bearings for lubrication of cylinder walls. This additional oil may be more oil than worn piston rings can control. High oil pressure will cause excessive oil in all areas and can cause oil consumption. Remove engine oil pan and adjust oil pump relief valve.

14. Piston Ring Installation Faulty or Broken Rings

At times, piston rings are installed wrong, upside down, wrong size, overlapping expanders, or expanders are cut off on three piece oil rings. Be sure to carefully read instructions before installing piston rings. Damaged rings can cause scoring of the piston sleeves and cause the engine to use oil.

15. Cylinder Head Gasket Damaged

A cylinder head gasket can be damaged or installed wrong allowing lubricating oil to enter the combustion chamber and to be burned in the engine. Remove cylinder head and check gasket if all other tests check out all right.

16. Oil Leakage Past Valve Guides and Valve.

Excessive valve stem-to-guide clearance can cause high oil consumption. A heavy carbon build-up on valve stems and face is the result of excessive oil leakage past valve guides, also a noticeable loss of engine power could result. In many cases, teflon valve seals will restore engine oil economy without the necessity of a complete engine overhaul. This is particularly true where the engine has low hours and the piston rings are in good condition, yet there has been a record of poor oil economy from the start. Refer to Page 24 for Installation of Teflon Valve Seals.

LOW ENGINE OIL PRESSURE

External Problems

1. External Oil Leakage

Check for oil leakage at the oil filter, external oil lines and oil cooler.

2. Oil Pressure Gauge Malfunction

Pressure gauges can malfunction and provide false readings. Tests with more than one gauge to be certain the readings are correct.

3. Oil Pressure Sending Unit Malfunction

Disconnect wire from sending unit to dash gauge. Ground this wire and turn on key switch. If gauge comes up, problem is in the sending unit.

4. Oil Pressure Gauge Wiring Damaged

If the gauge wiring is grounded at the sending unit with the key on and no gauge reading, the problem lies in the gauge or wiring. Hook a jumper wire from gauge terminal to ground and turn on the key. If a reading is obtained, the problem lines in the wiring. Replace the wiring harness or run a separate wire for oil pressure gauge.

5. Bad Ground On Gauge or Sending Unit.

A bad ground on gauges or sending units can many times be the only problem with a malfunctioning gauge. Take a jump wire and ground gauge or sending unit to machine, then recheck gauge. Pipe tape is often used to seal threads on oil sending units which destroys the biggest share of its' grounding ability.

LOW ENGINE OIL PRESSURE

Internal Problems

1. Engine Low On Oil

An engine low on oil could lose lubrication to internal parts and start scoring pistons, sleeves and damage engine bearings. Proper oil level is required to help dissipate some of the engine heat. Check engine oil level every eight hours of operation. Low engine oil can also give low oil pressure readings.

2. Oil Pump Relief Malfunction

Low engine oil pressure readings can be caused by a malfunctioning oil pump relief valve. A broken spring, a piece of metal under valve seat or abrasives could cause relief valve to score and hang up. Remove engine oil pan and oil pump assembly. Inspect pump relief valve and repair as necessary.

3. Engine Oil Too Light

Using engine oil that is too light will aggravate all oil consumption areas because of additional oil flow and leakage of the lighter oil. Light engine oil will give lower than normal oil pressure readings. Check for proper weight oil and change oil if required.

4. Oil Pump Suction Assembly Off Pump

It is possible for the oil pump suction assembly to come off the engine oil pump from improper installation, defective threads or jam nuts or worn cotter pin holding on the suction screen. With the pick up screen off, the pump would have little or no oil pressure. Remove oil pan and inspect oil pump suction assembly.

5. Engine Oil Pump Worn

The engine oil pump can be worn from long service, contaminates in the oil, improper installation or no backlash in pump drive gear. Remove engine oil pan and inspect oil pump.

6. Engine Main Bearings Worn

A worn main bearing will have a thudding sound and increased engine vibration. Both symptoms will increase as engine speed increases. By grounding out (cracking injector line) the problem cylinder, the thudding sound will stop or decrease but the vibration will remain. Remove engine oil pan and check main bearing clearance with plasti-gauge. Also, low oil pressure can be the result of worn main bearings and excessive oil clearance.

7. Connecting Rod Bearings Worn

Worn rod bearings cause more than normal throw off of lubricating oil to cylinder pistons and liners. This excess oil is sometimes more than worn piston oil rings can control. The oil then passes the rings and on into the combustion chamber. Remove the engine oil pan and check rod bearings for wear using plasti-gauge. A worn rod bearing can cause the engine to knock and low oil pressure.

8. Rocker Arm Shafts Indexed Wrong

Incorrect rocker arms or rocker arm shafts indexed wrong can lead to excessive oil in the rocker arm compartment. This oil aggravates oil consumption especially past valve guides. Remove valve cover and check oil flow from rocker arm assemblies.

9. Rocker Arm Assembly Worn

Worn rocker arm assemblies allow larger than normal amounts of lubricating oil into the valve compartment. The extra quanitity of oil increases oil consumption past the valve guides. Run the engine with valve cover removed and check for excessive oil or oil flow from the rocker arms.

10. Oil Pump Suction Screen Plugged

The oil pump suction screen can become plugged with sludge, metal filings and other contaminants in the oil. Many times the oil pressure will be normal when engine is first started. The longer the unit runs, the more contaminants are collected on the pick-up screen shutting off the supply of suction oil. Remove engine oil pan and inspect oil pump screen.

LOW ENGINE OIL PRESSURE

Internal Problems (Cont'd)

11. Internal Oil Passage Leak

A crack, missing plug, or bad "O" ring could cause an internal oil gallery leak resulting in low oil pressure readings. Another possible leak is the "O" ring that seals between the engine oil pump and oil gallery. If such leakage is suspected, attach air pressure to the oil gallery and watch for leaks with oil pan removed.

12. Key In Oil Pump Gear Worn

The key in the oil pump drive gear could become worn and shear. Remove oil pan and oil pump, disassemble oil pump and inspect.

13. Camshaft Bearing Worn

A camshaft bearing knock is not a very sharp sounding knock. The knock will be only at one-half of crankshaft speed and will not become worse at different engine speeds. Low oil pressure could result from worn bearings and excessive oil clearance from lack of replacing cam bearing at engine overhaul.

INSTALLATION INSTRUCTIONS FOR M20611 TEFLON VALVE SEAL KIT

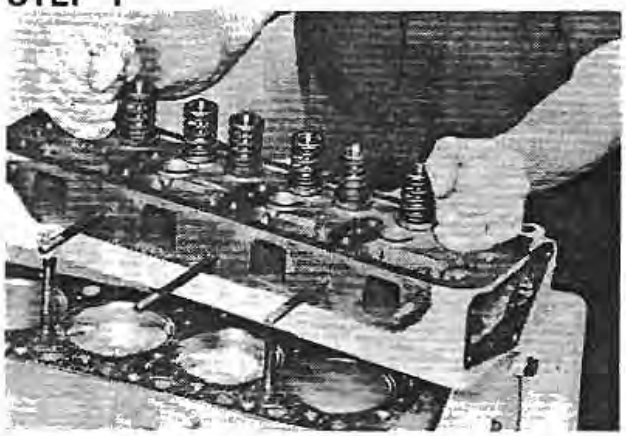
Special Tools Required

M20624 SEAL INSTALLATION TOOL

M20615 VALVE GUIDE CUTTING TOOL

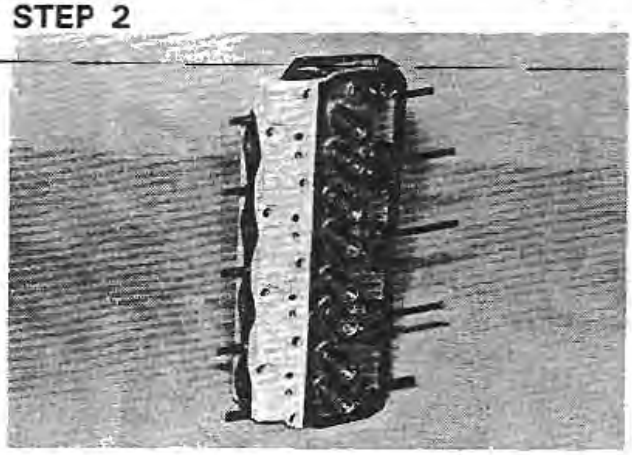
VALVE SPRING COMPRESSOR

STEP 1



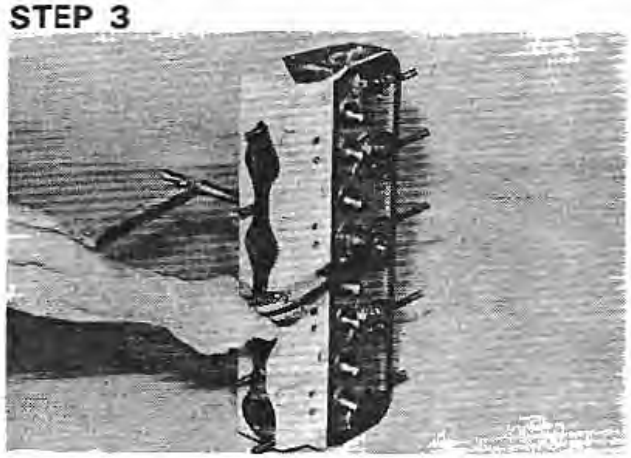
Remove the cylinder head from the engine block. Refer to section 2015 for head removal. *NOTE:* This cylinder head requires two M20611 Kits.

STEP 2



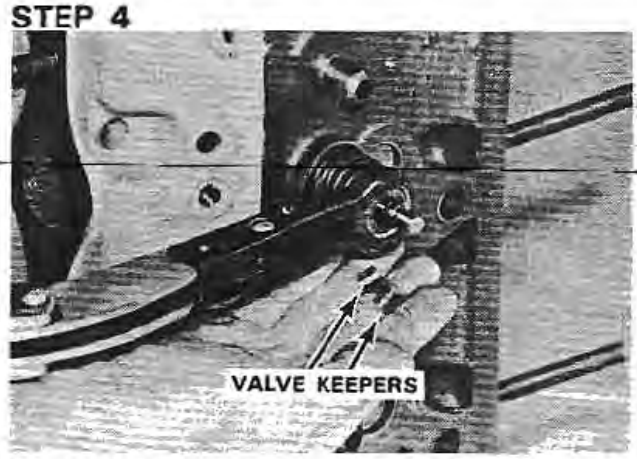
Place cylinder head on work bench.

STEP 3



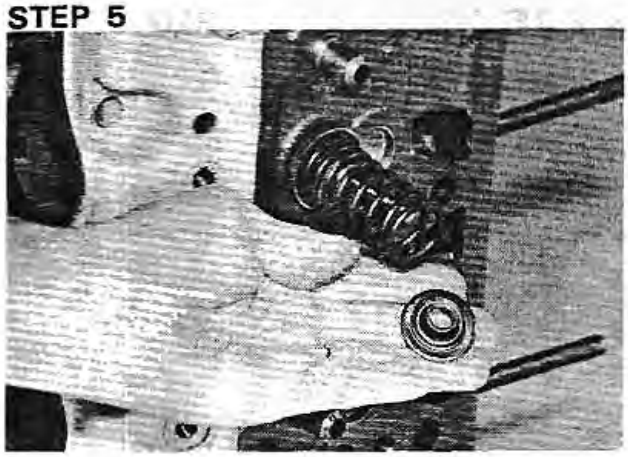
Install a valve spring compressor.

STEP 4



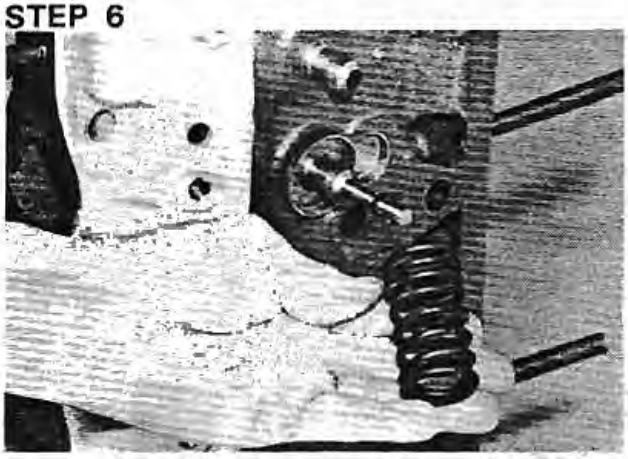
Compress valve spring and remove valve keepers. *IMPORTANT:* Valves and valve keepers should be marked when removed to insure that they will be reinstated in their original location.

STEP 5



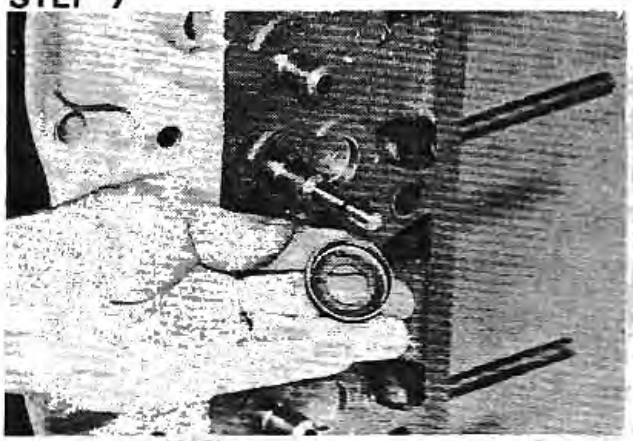
Remove spring retainer.

STEP 6



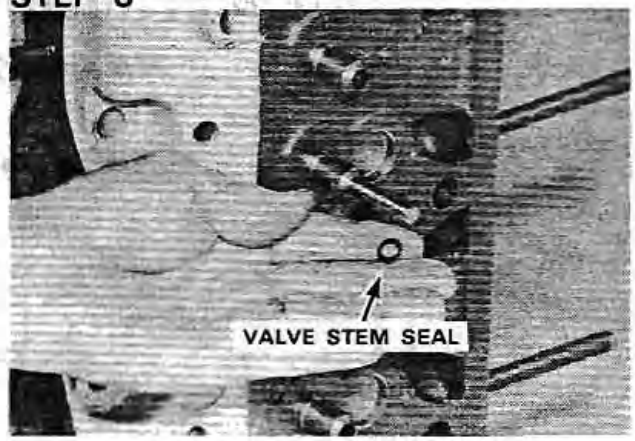
Remove spring.

STEP 7



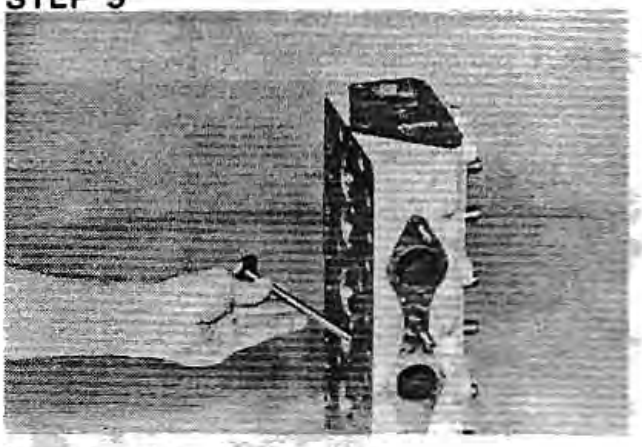
Remove spring seat.

STEP 8



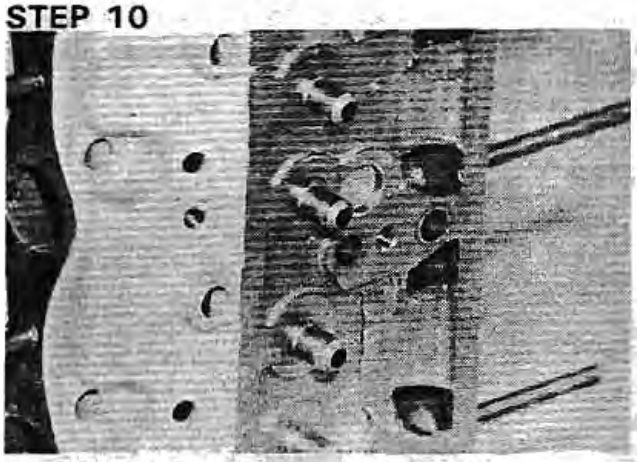
Remove valve stem seal.

STEP 9



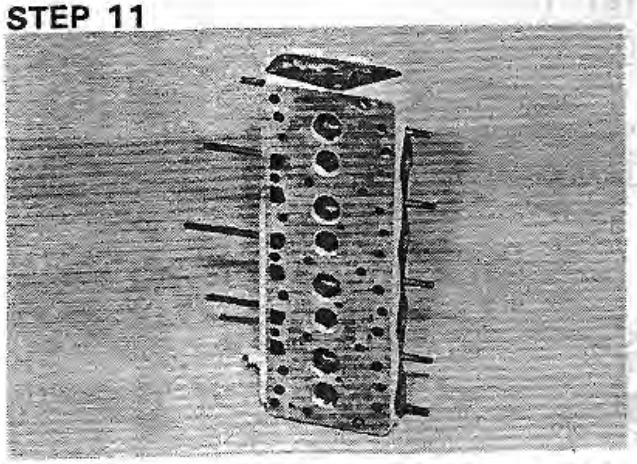
Remove valve.

STEP 10



Remove all the valve assemblies.

STEP 11

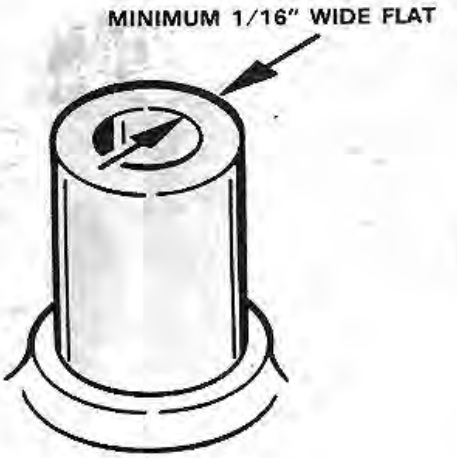


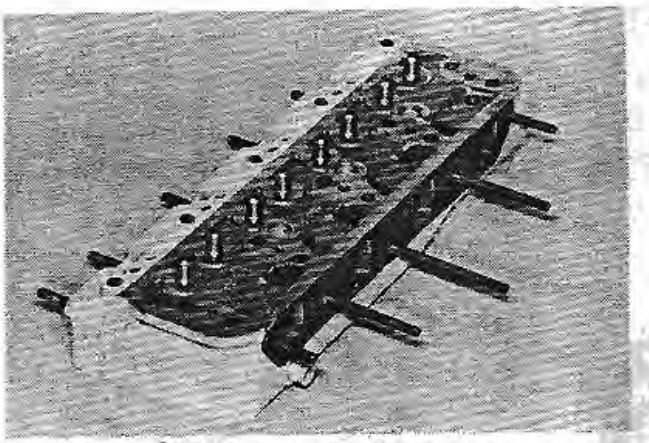
Wash, clean and inspect head. Use a rotary brush to clean around and down into valve ports. Refer to Section 2015 for complete head reconditioning.

STEP 12

Clean valves with a fine power drive wire brush, removing all carbon and varnish deposits. Be careful not to scratch valve stems. Refer to Section 2015 for valve inspection.

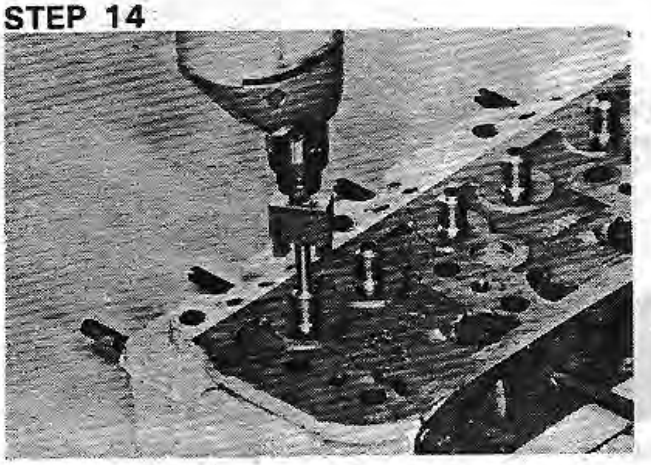
STEP 13





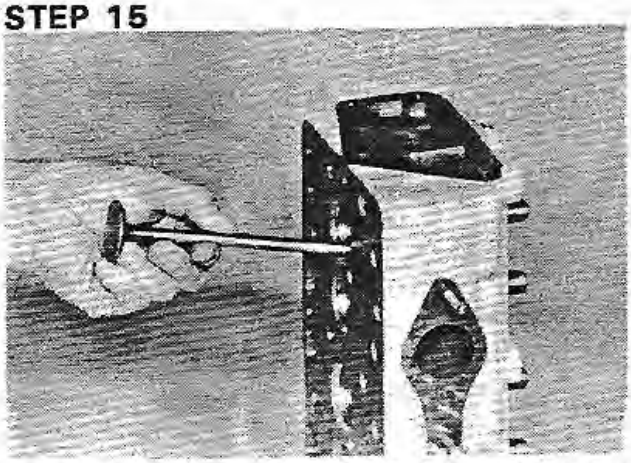
Check valve guide top surface. There must be a minimum of a 1/16" wide flat around entire top surface.

STEP 14



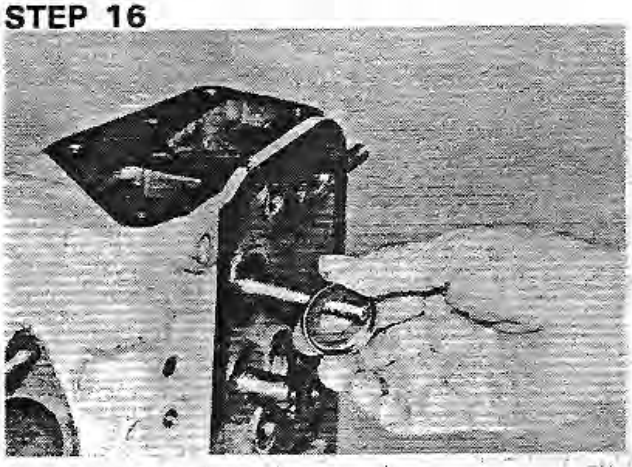
Use M20615 tool in a electric drill (if required) to provide necessary flat area on valve guide. *IMPORTANT:* Do not exceed 450 RPM drill speed when using valve guide cutting tool.

STEP 15



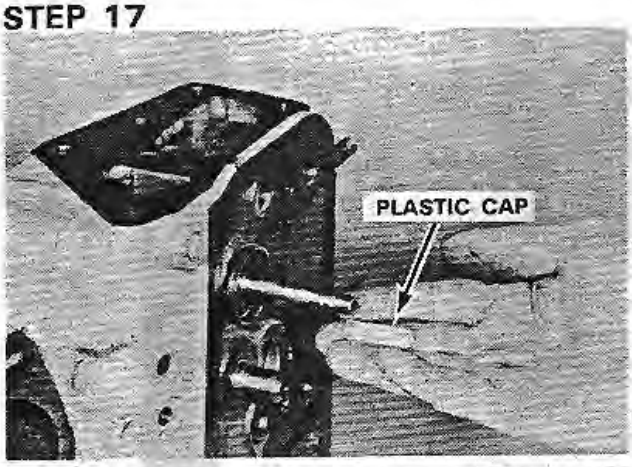
Dip valve stems into HDM #30 oil before assembly in cylinder head.

STEP 16



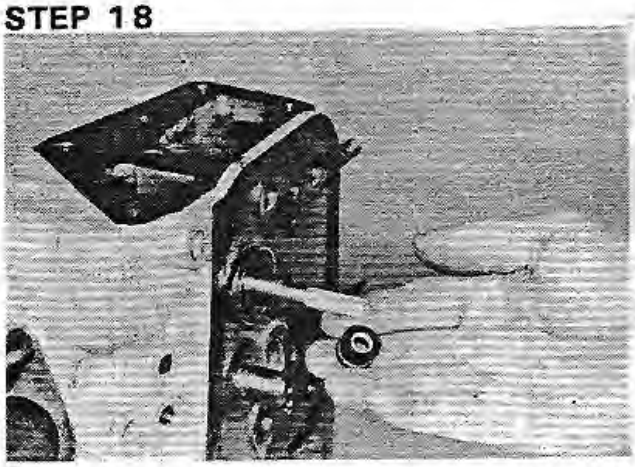
Install spring seat.

STEP 17



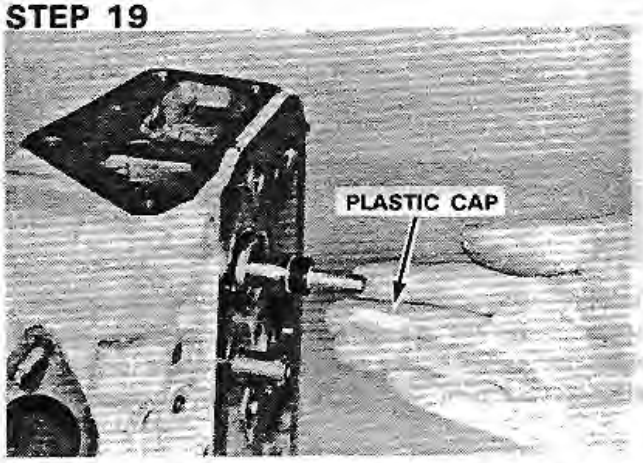
Place plastic installation cap, provided in kit, on the end of the valve stem. *NOTE:* Cap prevents sharp edges on valve stem grooves from cutting valve seal.

STEP 18



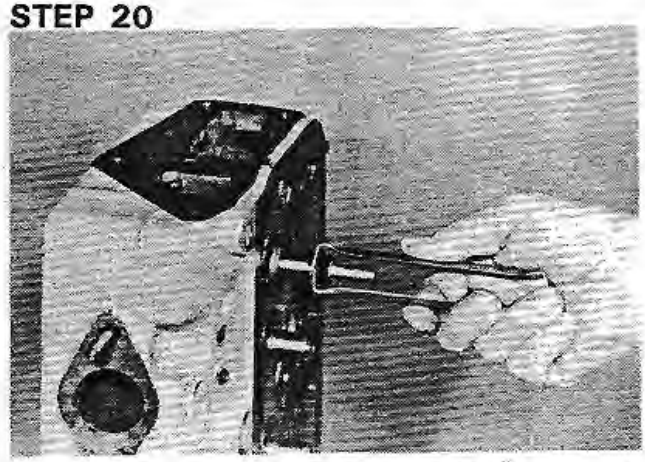
Carefully start valve seal on cap and hold thumb against white seal insert to avoid dislodging it. Push seal down until seal jacket touches top of valve guide.

STEP 19



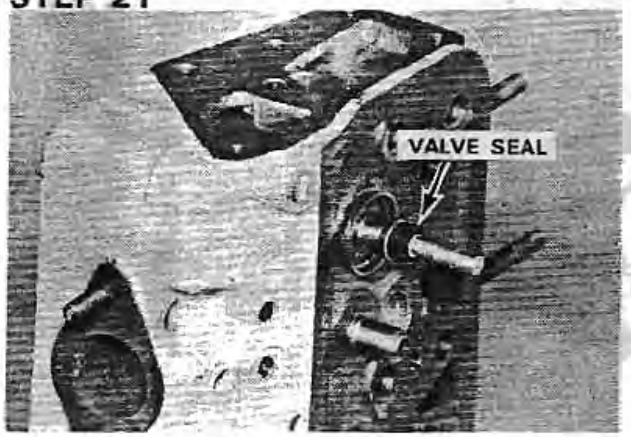
Remove installation cap and save, since it must be reused.

STEP 20



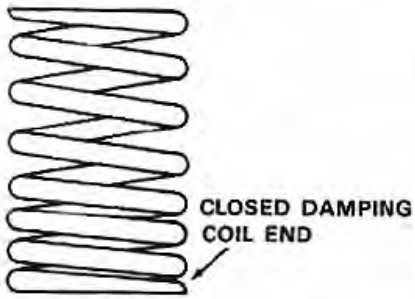
Use M20624 tool and press seal down over valve guide until seal is flush with top of guide.

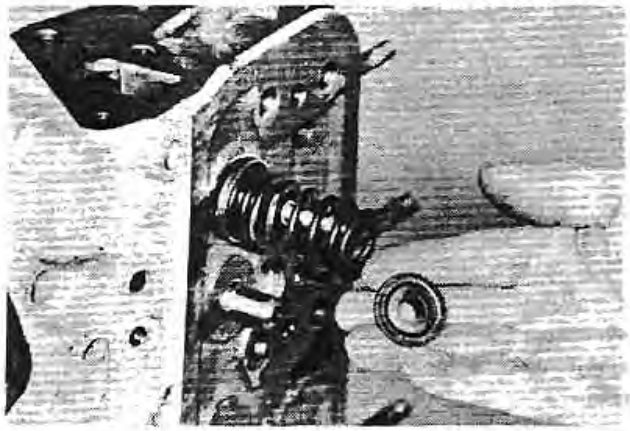
STEP 21



Valve seal installed.

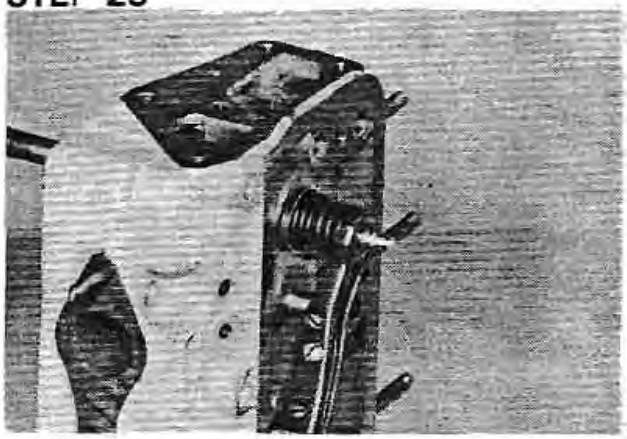
STEP 22





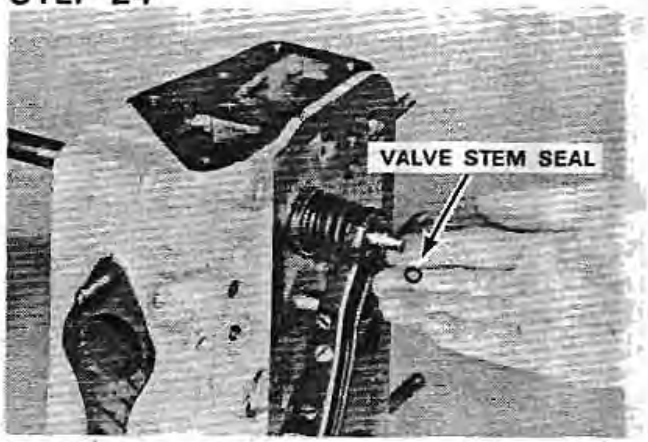
Install spring (damping coil end down) and spring retainer.

STEP 23



Install valve spring compressor.

STEP 24

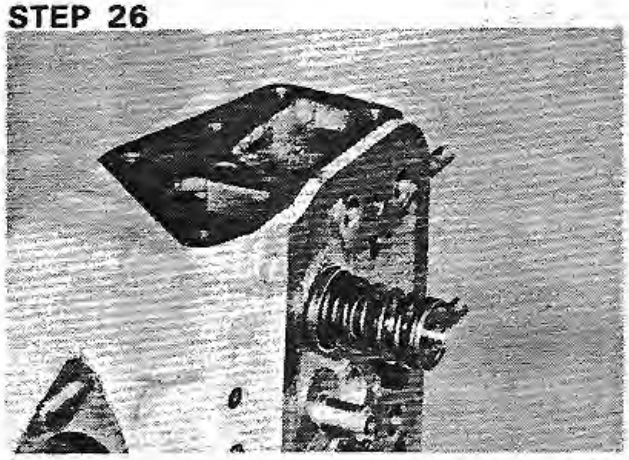


Install stem seal in lower valve stem groove.

STEP 25

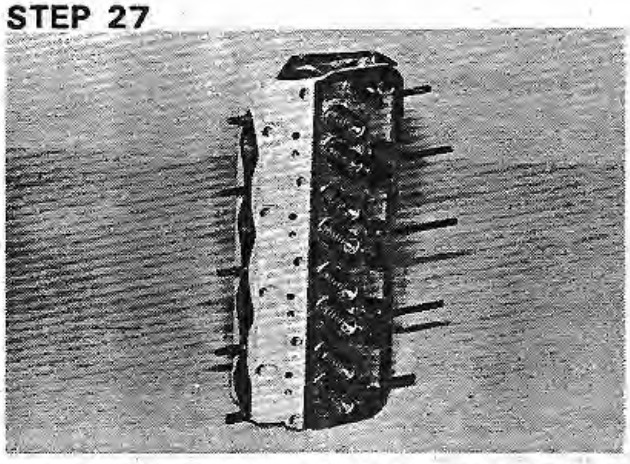
Install valve keepers in outer valve stem groove.

STEP 26



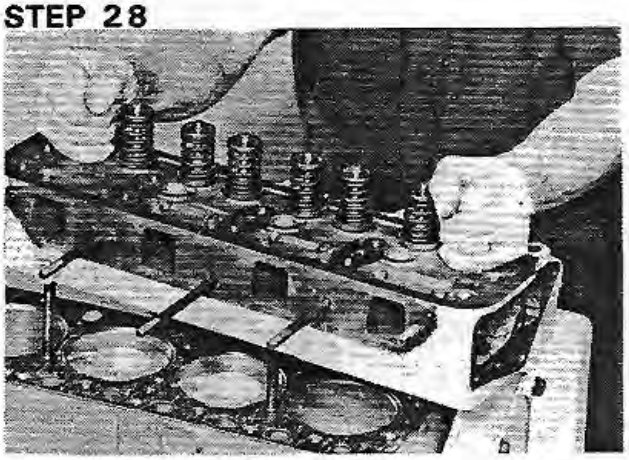
Remove spring compressor and tap valve stem end to seat keepers.

STEP 27



Install teflon seals on the other intake and exhaust valves, following the preceeding procedure.

STEP 28



Install cylinder head on engine block following procedure outlined in Section 2015.

Section 2002

ENGINE TUNE-UP

188 and 207 Diesel Engines

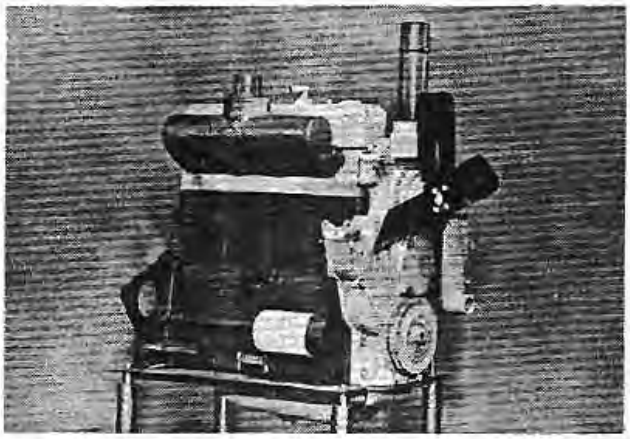
J I Case
A Tenneco Company

TENNECO

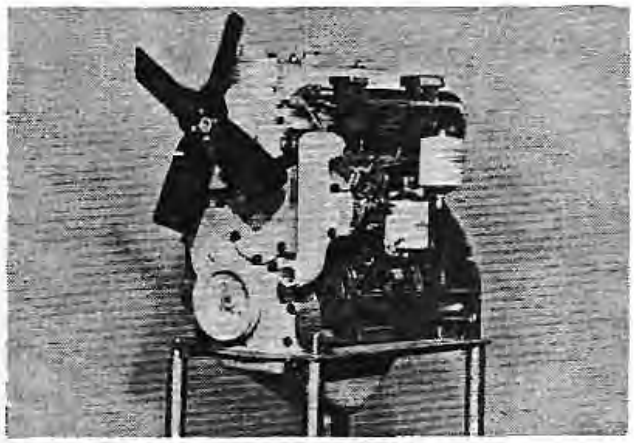
Rac. 9-78825

PRINTED IN U.S.A.

THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

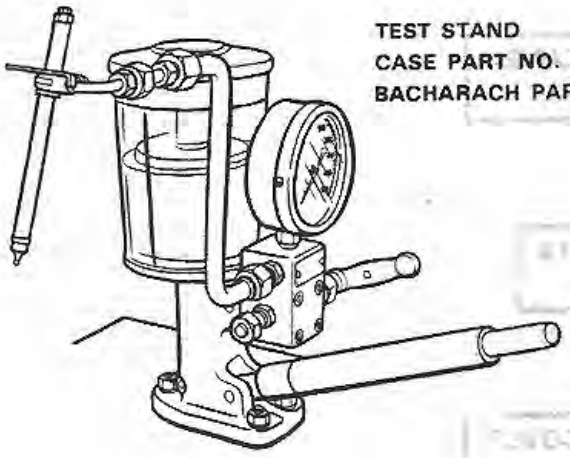


188 DIESEL ENGINE

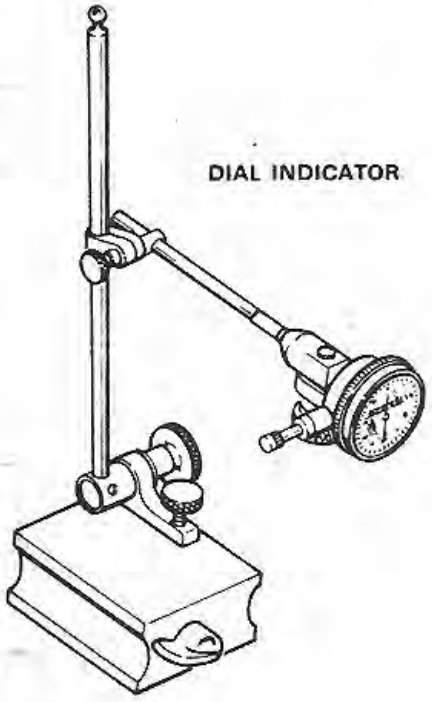


207 DIESEL ENGINE

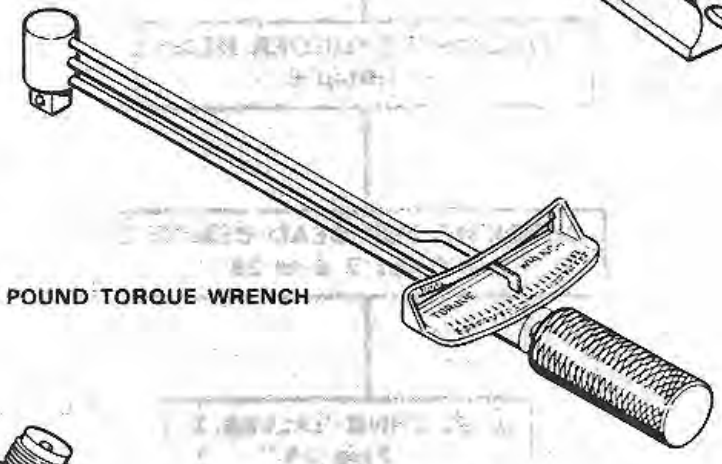
SPECIAL TOOLS



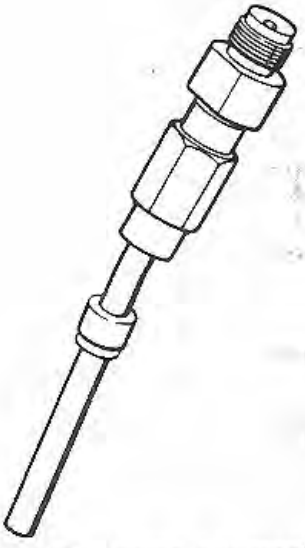
TEST STAND
CASE PART NO. M20322
BACHARACH PART NO. 65-934D



DIAL INDICATOR



INCH POUND AND FOOT POUND TORQUE WRENCH



COMPRESSION GAUGE ADAPTER
BACHARACH 70-0314 (D-558)
PART OF CASE M20520 KIT

A43278 INJECTOR
REMOVAL TOOL

A43277 INJECTOR
BORE CLEANER

ENGINE TUNE-UP

SERVICING AIR CLEANER
See Step 1

ADJUSTING BELTS
See Step 2

REMOVING VALVE COVER
See Steps 3 thru 5

TORQUING CYLINDER HEAD
See Step 6

CHECKING TOP DEAD CENTER
See Steps 7 thru 28

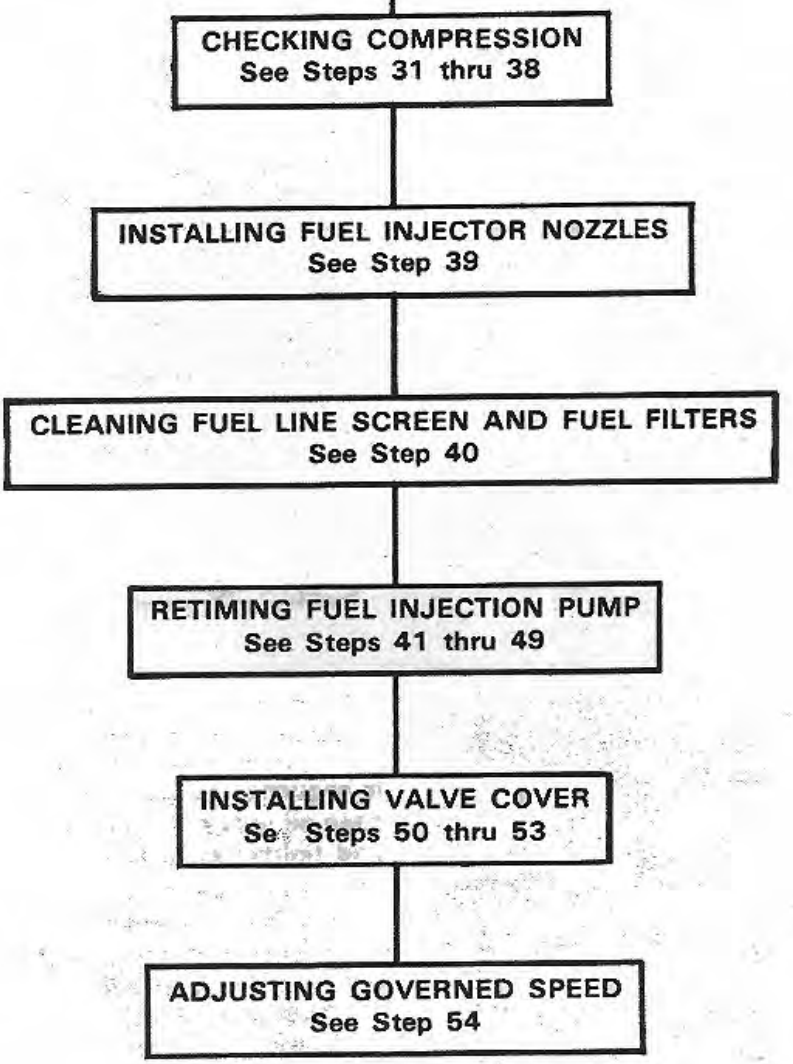
ADJUSTING VALVES
See Step 29

REMOVING FUEL INJECTOR NOZZLES
See Step 30

CHECKING FUEL INJECTOR NOZZLES
See Step 30

CONTINUED ON NEXT PAGE

ENGINE TUNE-UP CONTINUED



ENGINE TUNE-UP PROCEDURE

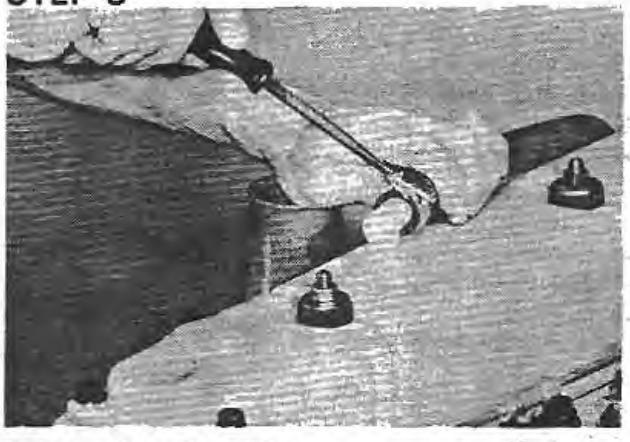
STEP 1

Service the air cleaner. Refer to your Operator's Manual.

STEP 2

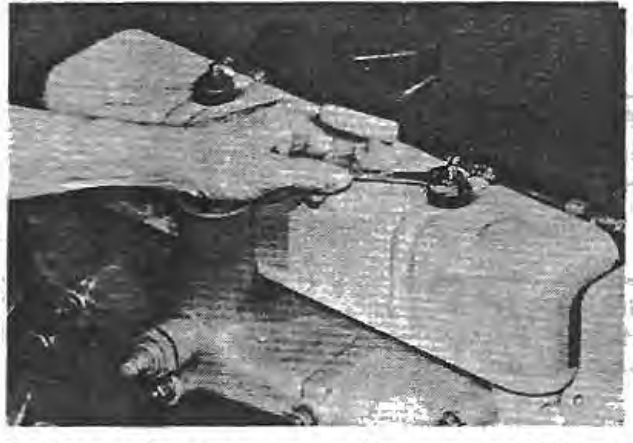
Adjust the belts. Refer to your Operator's Manual.

STEP 3



Remove breather tube.

STEP 4

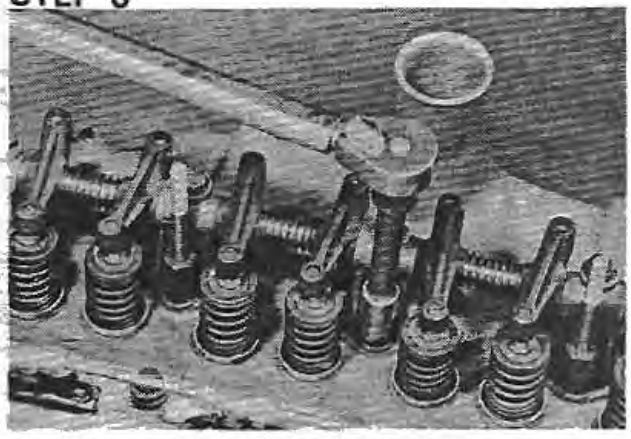


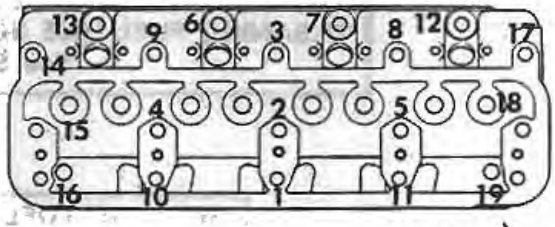
Remove valve cover mounting nuts and grommets.

STEP 5

Remove valve cover and gasket.

STEP 6

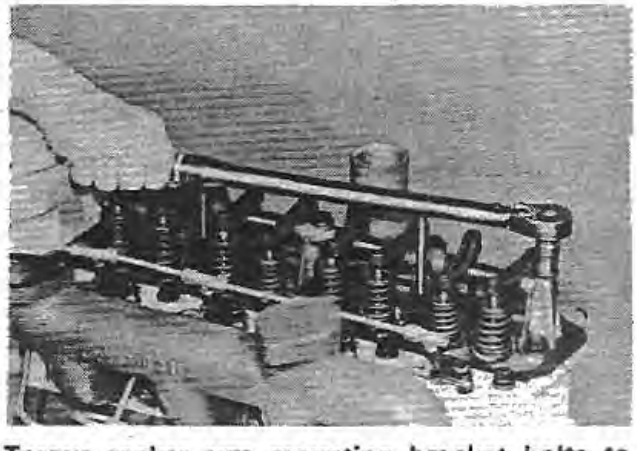




FAN

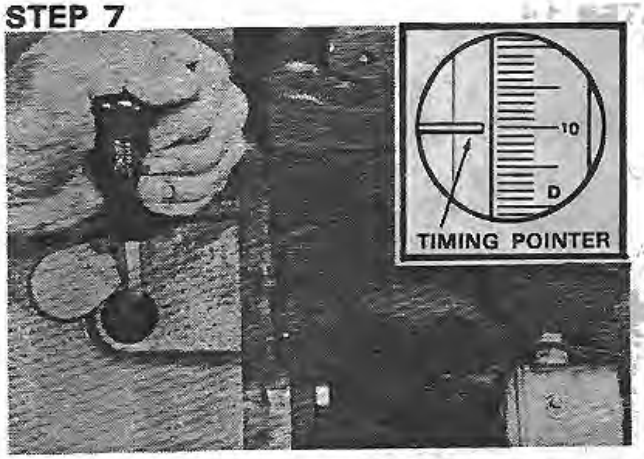
Loosen each cylinder head bolt or nut approximately 1/4 turn and then tighten bolt or nut to the specified torquing procedure as listed below and in sequence as shown above. *NOTE:* Do not loosen all nuts or bolts simultaneously but loosen and tighten each individual bolt and nut in the prescribed sequence. The bolt or nut is backed off 1/4 turn to break the set of the threads caused by heat, high stress and oxidation. If this is not done, a false reading is obtained.

1. Nuts w/hardened washers - torque 95-105 ft.lbs.
2. Grade 8, 12 pt. hd. bolts - torque 110-115 ft. lbs.
3. Flanged nuts - torque 90-100 ft. lbs.



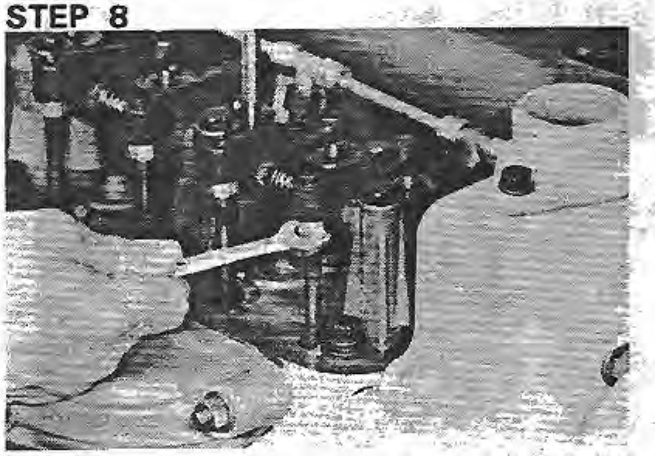
Torque rocker arm mounting bracket bolts to insure that the bolts have retained 25 to 30 ft. lbs. torque.

STEP 7



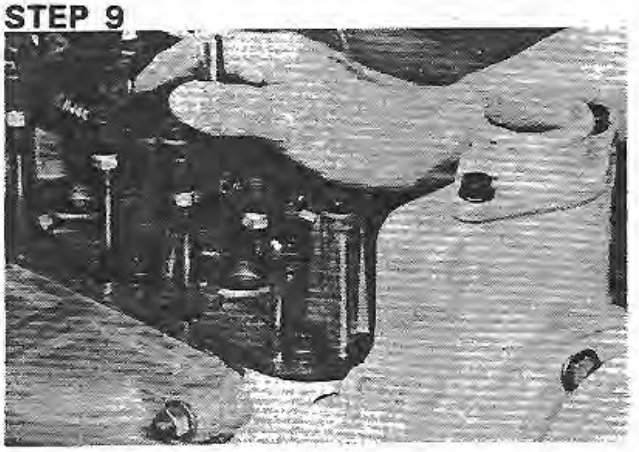
Crank engine by inserting a screwdriver into the timing hole in the flywheel housing or torque tube, and by engaging the ring gear teeth with the screwdriver, align the timing pointer with the 10° BTDC mark on the flywheel.

STEP 8



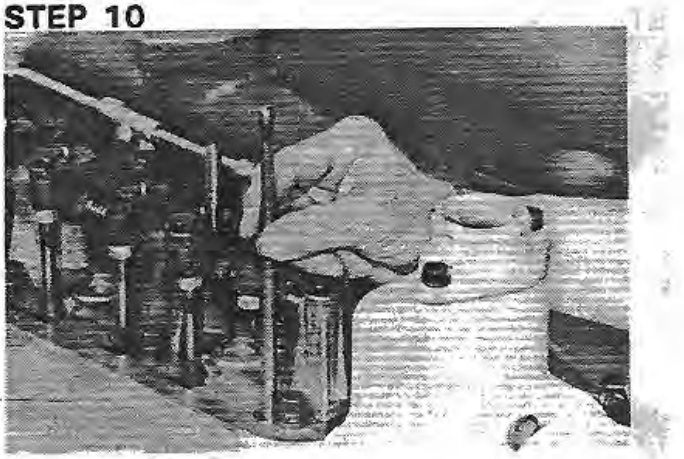
Turn the rocker arm adjusting screw on number one cylinder intake valve inwards to take pressure off the push rod.

STEP 9



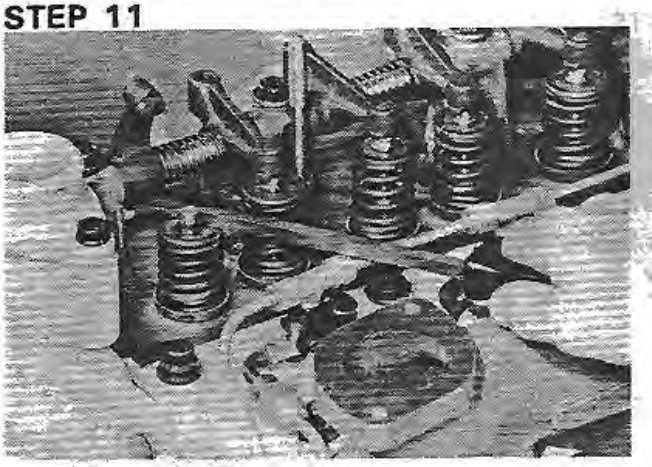
Push down on the number one cylinder intake valve spring and at the same time push the rocker arm assembly rearwards.

STEP 10



Remove the push rod.

STEP 11

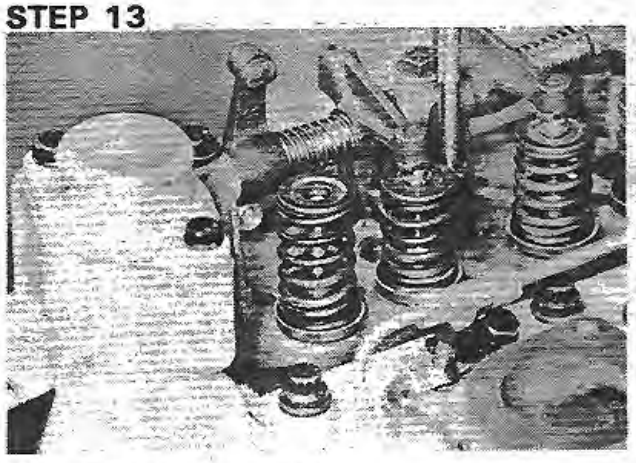


Compress exhaust valve spring on number one cylinder by using a screwdriver.

STEP 12

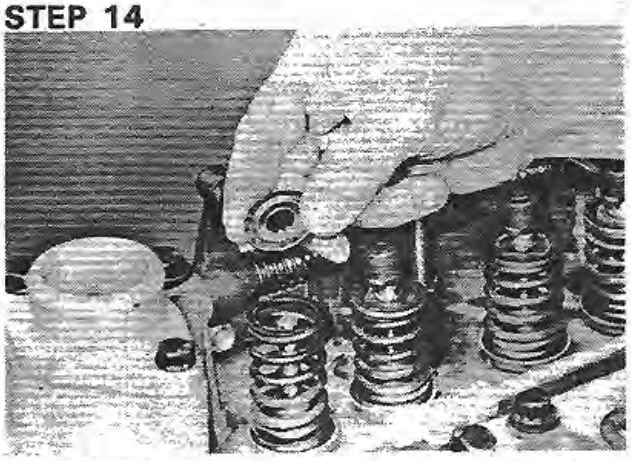
Remove the valve keepers.

STEP 13



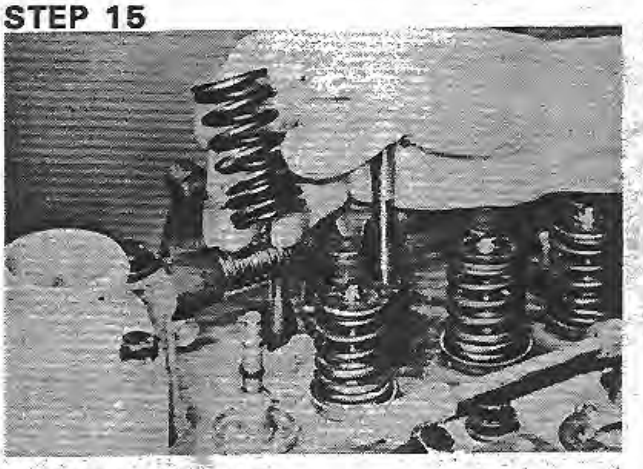
Valve keepers removed.

STEP 14



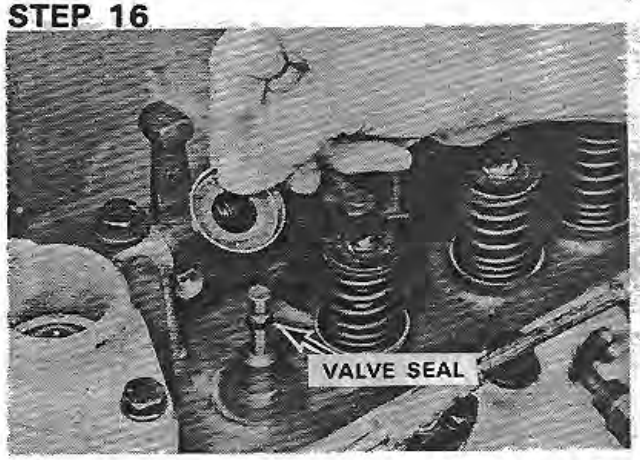
Remove valve spring retainer.

STEP 15



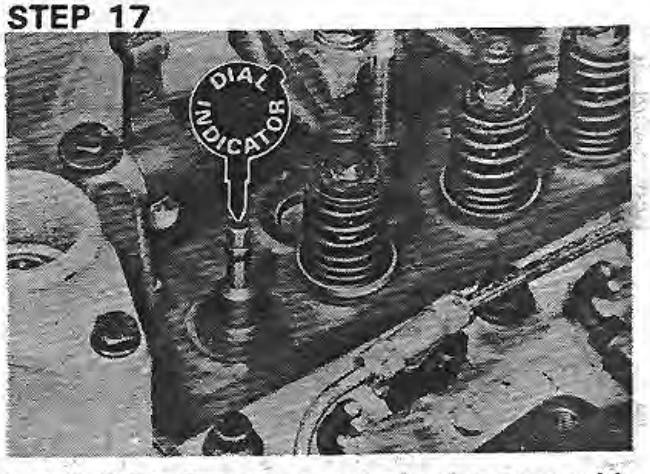
Remove valve spring.

STEP 16



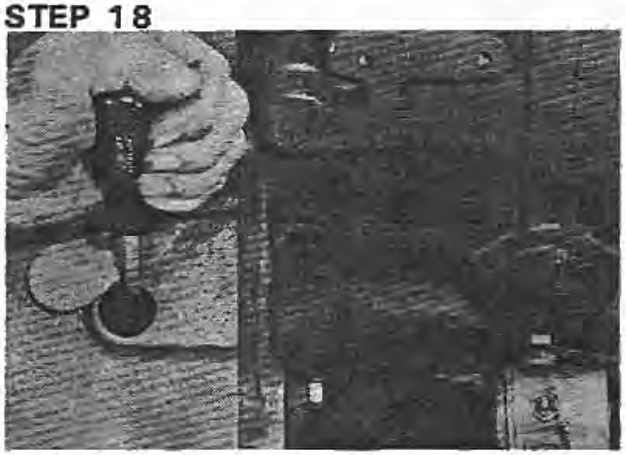
Remove valve spring seat. *NOTE:* Keep valve seal in place to prevent valve from falling through valve guide if the piston is moved too far.

STEP 17

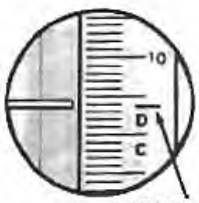


Install dial indicator on end of valve stem with valve resting on top of piston.

STEP 18

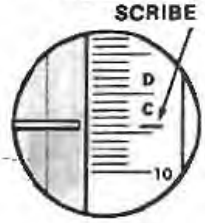


Crank engine clockwise until dial indicator hand stops moving. Reset indicator to zero.



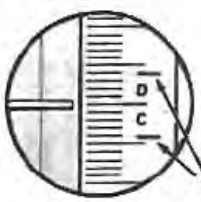
SCRIBE MARK

Crank engine clockwise until .010" shows on the dial indicator. Scribe a mark on the flywheel in line with timing pointer.



Crank engine counter-clockwise past zero mark on indicator until .010" shows on the dial indicator. Again, scribe a mark on the flywheel in line with timing pointer.

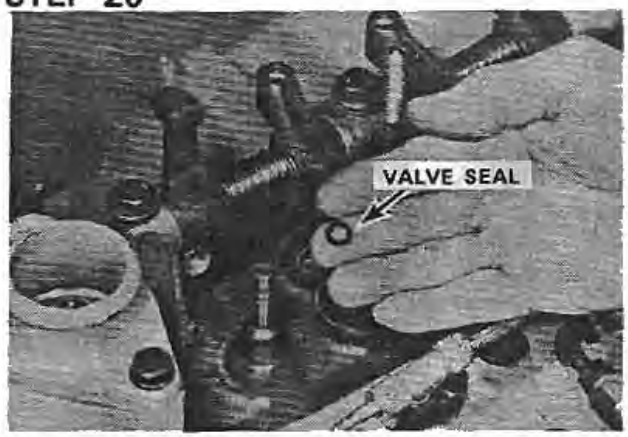
STEP 19



SCRIBE MARKS

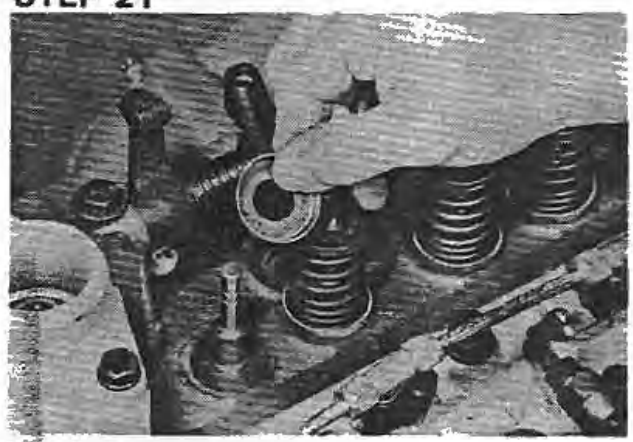
Half the distance between these two scribe marks on the flywheel will be the top dead center (TDC).

STEP 20



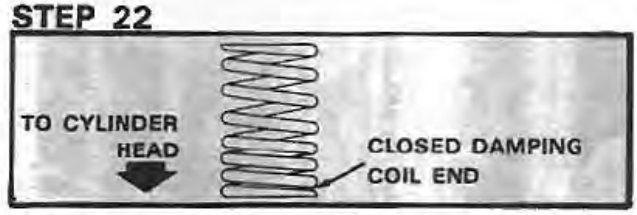
Remove valve stem seal from lower valve stem groove.

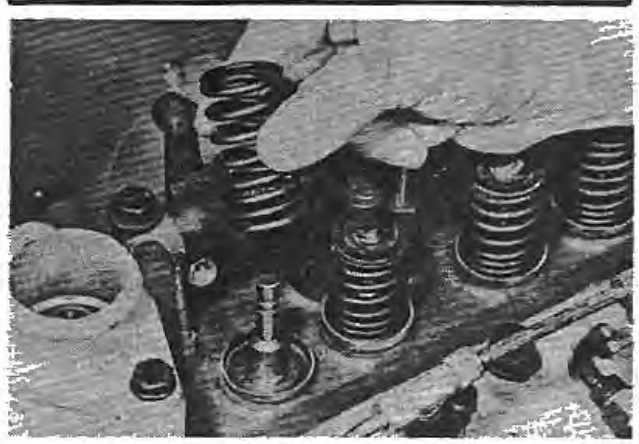
STEP 21



Install the spring seat.

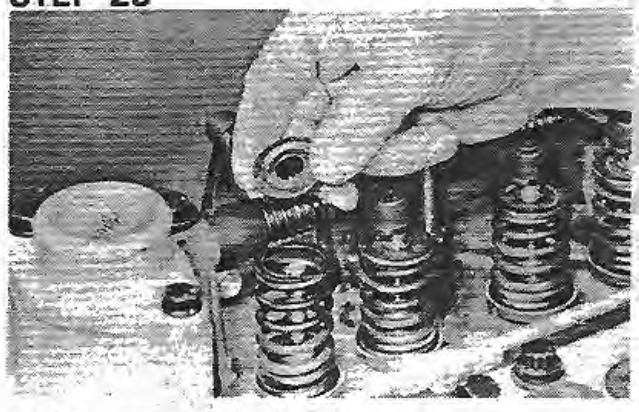
STEP 22





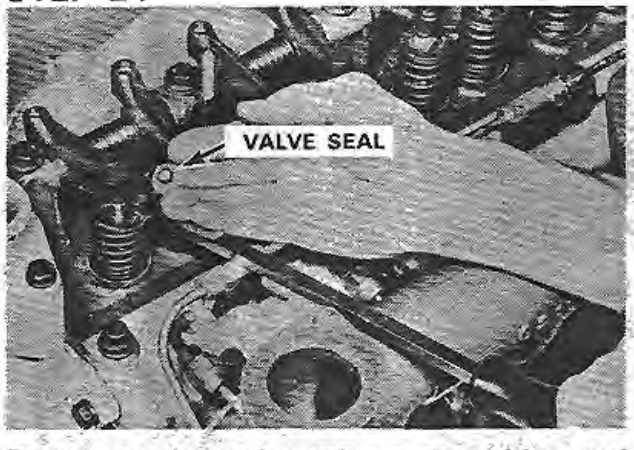
Install the spring with the damping coil end on top of the cylinder head. See inset above.

STEP 23



Install the spring retainer.

STEP 24

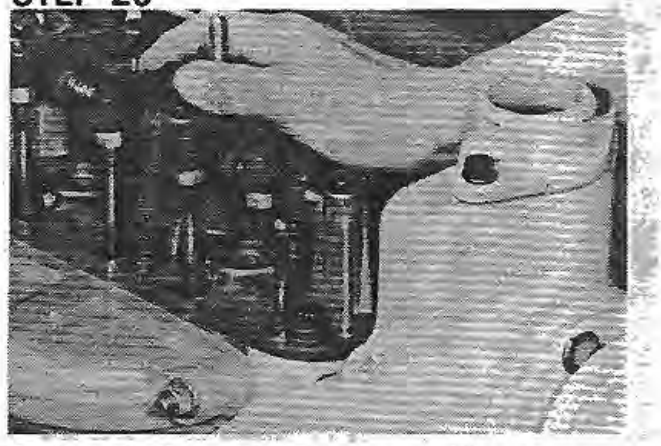


Compress valve spring using a screwdriver and install a new valve stem seal in the lower groove.

STEP 25

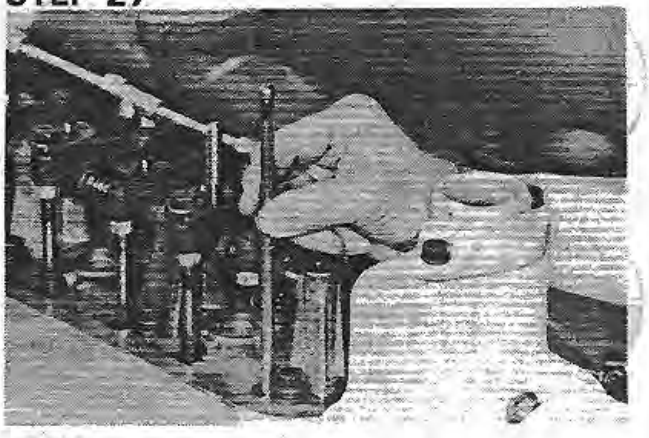
Keeping the valve spring compressed, install the valve keepers in the upper valve stem groove. Remove screwdriver and tap end of valve stem to seat keepers.

STEP 26



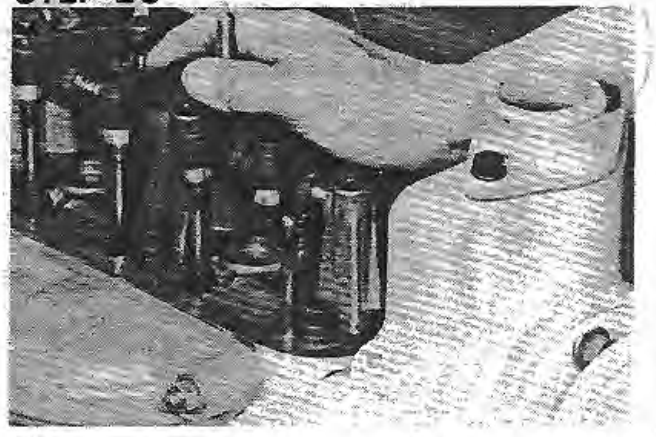
Push back the rocker arm assembly.

STEP 27



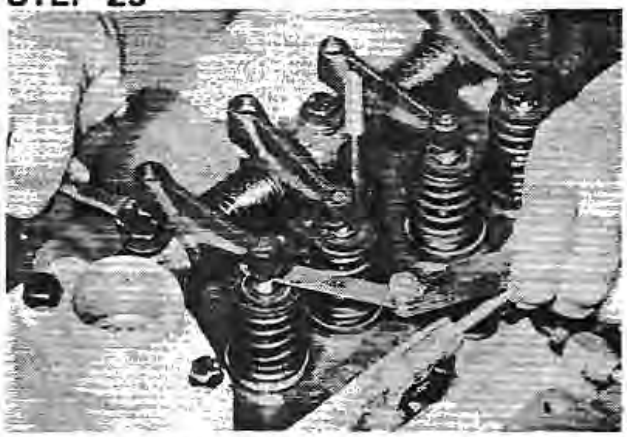
Install the push rod.

STEP 28



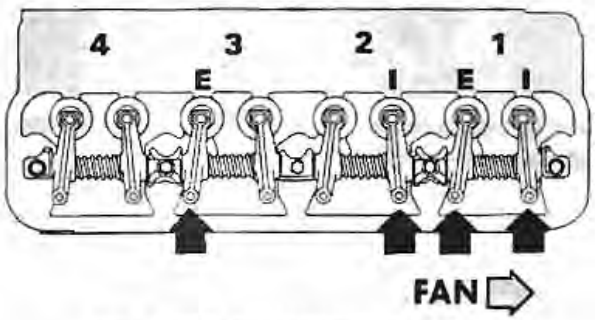
Release rocker arm assembly and position push rod beneath rocker arm adjusting screw.

STEP 29



Check and adjust the intake and exhaust valves as pointed out by the arrows below.

Tappet Clearance - Intake Valves .012"
Exhaust Valves .014"

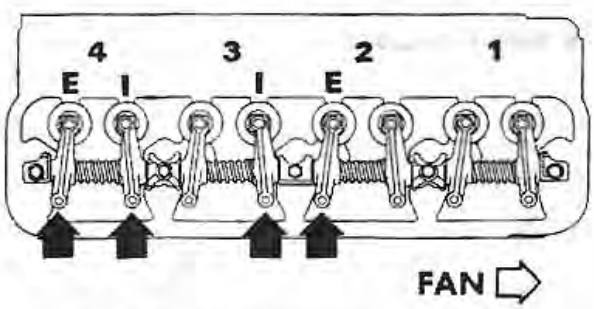


NO. 1 TDC COMPRESSION STROKE

Crank the engine one complete revolution and align the timing pointer with the TDC mark on the flywheel.

Check and adjust the intake and exhaust valves as pointed out by the arrows below.

Tappet Clearance - Intake Valves .012"
Exhaust Valves .014"



NO. 4 TDC COMPRESSION STROKE

STEP 30

Remove and check each fuel injector. Refer to Section 3013.

STEP 31

Perform a compression test on each cylinder befor installing fuel injector.

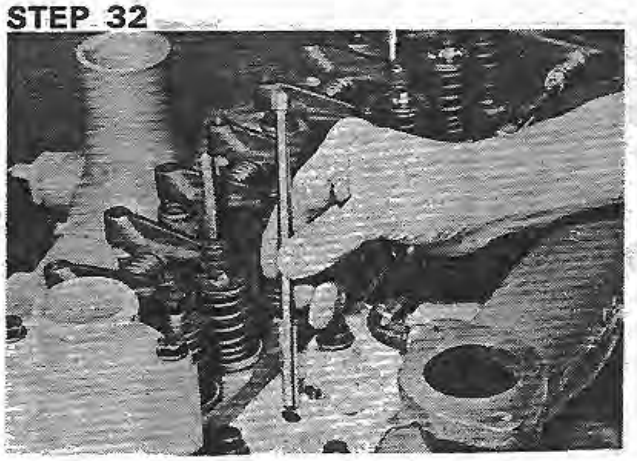
There are two methods of checking compression pressure - the cranking method and the engine running method. The engine must be at operating temperature for either method used.

A. CRANKING METHOD - Remove all fuel injectors.

B. RUNNING METHOD - Disconnect high pressure fuel line and leak-off line from No. 1 injector. Route fuel from these lines back to fuel tank or clean container. Repeat for each cylinder.

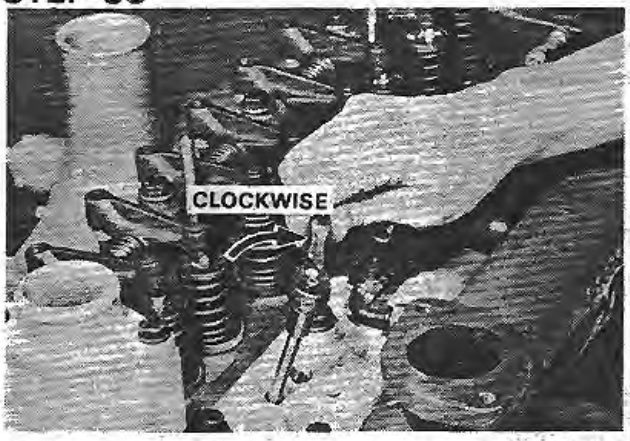
CAUTION *Before cranking engine, make sure all operating controls are in neutral, brakes are set and wheels are securely blocked.*

STEP 32



Clean cylinder head injector bore using bore cleaning tool A43277.

STEP 33

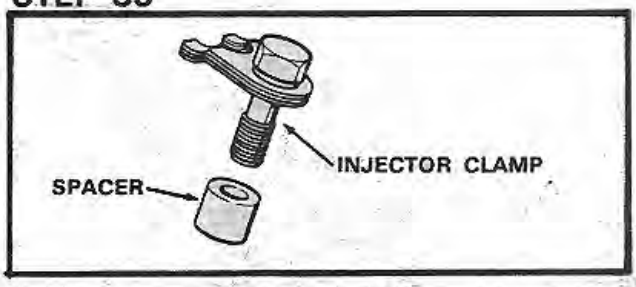


Always turn tool clockwise. Counter-clockwise rotation dulls tool. Blow out with compressed air.

STEP 34

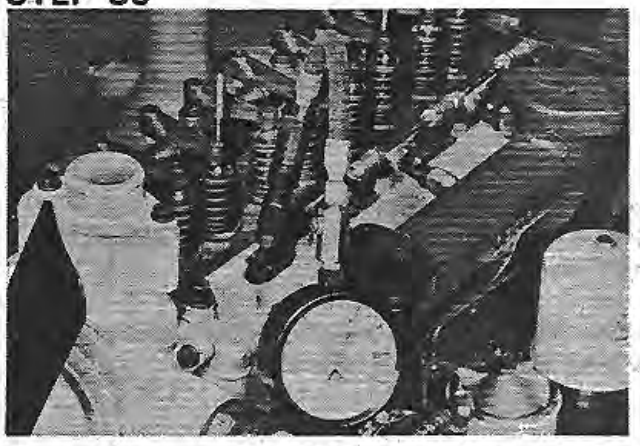
Install Bacharach 70-314 (D-558) compression gauge adapter.

STEP 35



Secure gauge adapter with an original injector clamp assembly and spacer.

STEP 36



Connect Case No. CD-504 compression gauge to adapter. *NOTE:* Take several compression readings on each cylinder using vent valve button to relieve gauge pressure.

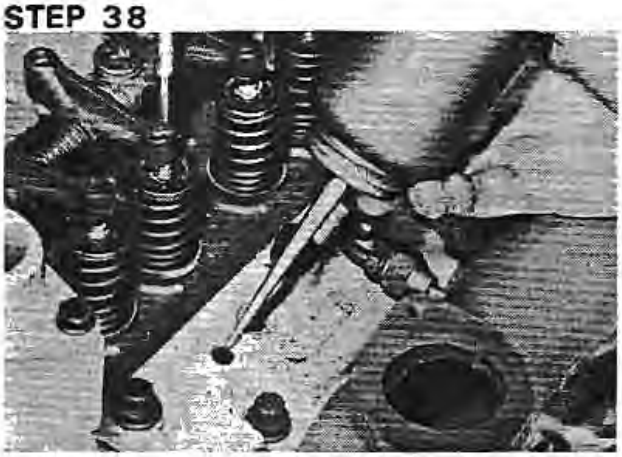
STEP 37

It is very important that all cylinder pressures be apprxomately the same. See chart for allowable compression pressure variation.

If compression is greater than normal, carbon deposits are indicated. If reading is below normal, leaking valves or excessive ring clearance is indicated.

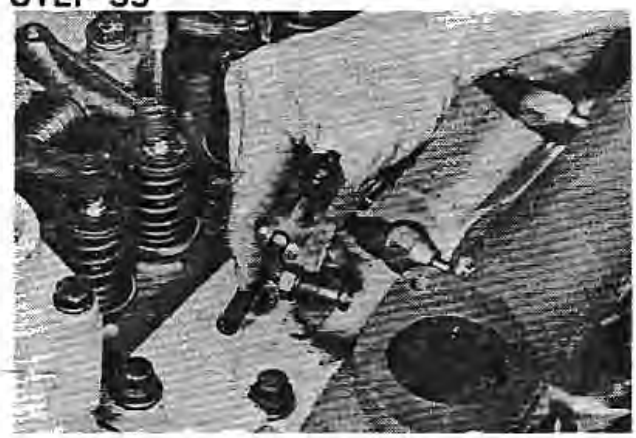
NOTE: To make a simple test when a compression leak is indicated, squirt a teaspoon of oil into cylinder and recheck compression. If pressure rises to near normal, compression loss is past the rings. Very little change in compression indicates leakage past the valves.

STEP 38



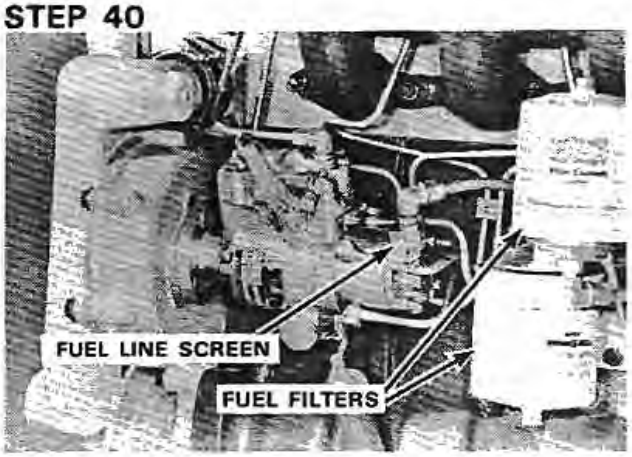
Squirt a few drops of clean engine oil in each cylinder head injector hole to provide lubricant for carbon dam at lower end of injector when being installed.

STEP 39



Install fuel injectors. Refer to Section 3013.

STEP 40

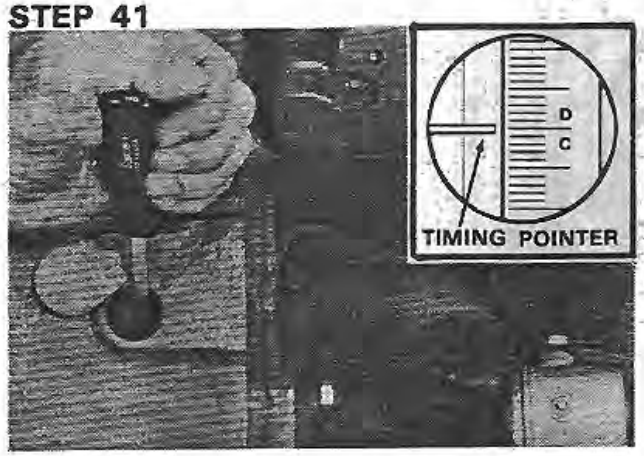


Refer to Section 3010 & 3012 for cleaning and servicing the fuel filters and system.

	ENGINE SPEED	NORMAL COMPRESSION PRESSURE	ALLOWABLE VARIATION BETWEEN CYLINDERS
CRANKING	APPROXIMATELY 200 RPM	400 PSI*	25 PSI
RUNNING	800 RPM	480 PSI*	20 PSI

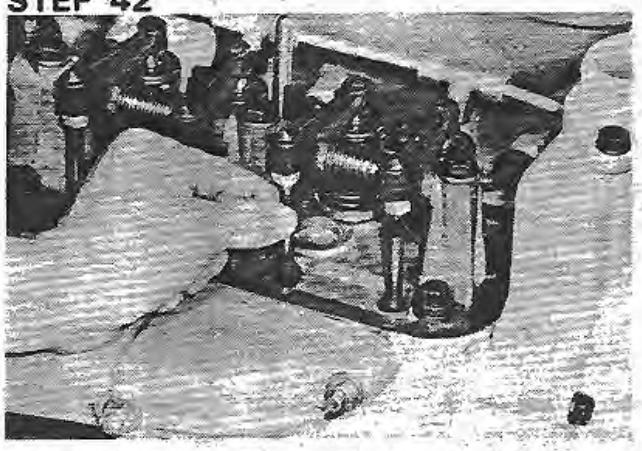
*NOTE: A 4% REDUCTION IN PSI MUST BE ALLOWED FOR EVERY 1000 FT. ABOVE SEA LEVEL.

STEP 41



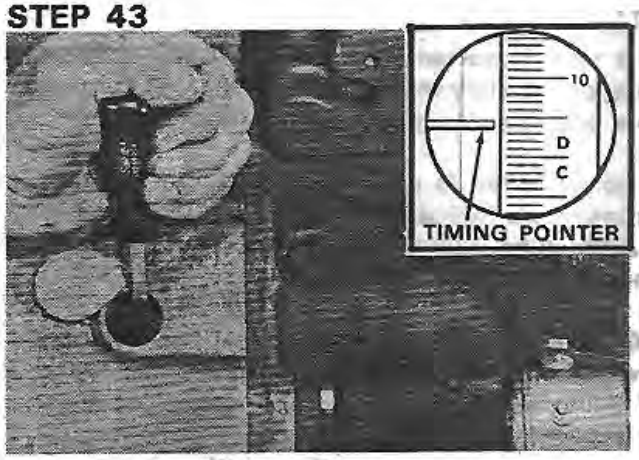
Crank engine clockwise until TDC mark on flywheel is in line with timing pointer as seen through the flywheel housing timing hole.

STEP 42



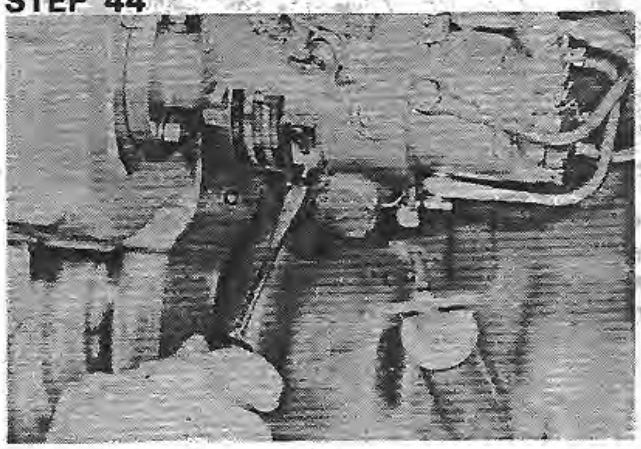
Both push rods of No. 1 cylinder should be loose when No. 1 cylinder is on TDC of compression stroke. If both push rods are tight, crank engine 360° and again check push rods.

STEP 43



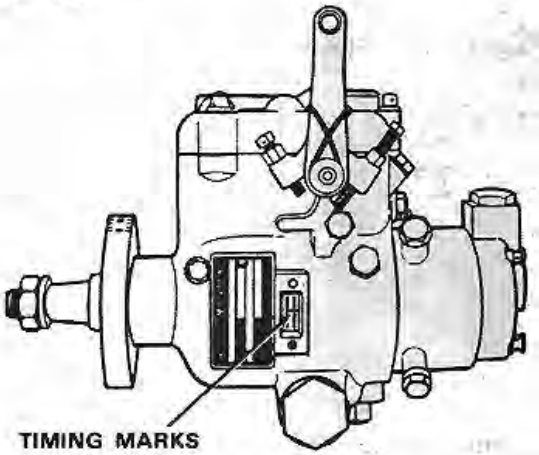
Crank engine counter-clockwise (as viewed from the flywheel end) past the specified pump timing; then crank engine clockwise until the timing pointer is in line with the specified pump timing mark on the flywheel. This procedure will remove the slack from the valve train and will insure correct pump timing. *NOTE:* Refer to engine data decal on engine valve cover or Operator's Manual for specified fuel pump timing.

STEP 44



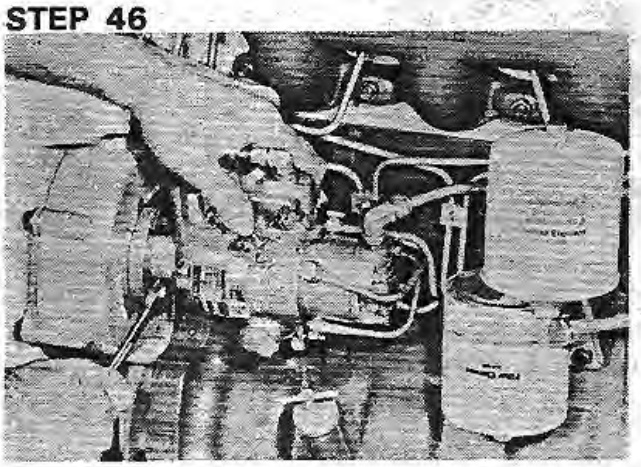
Remove the timing window cover from injection pump.

STEP 45



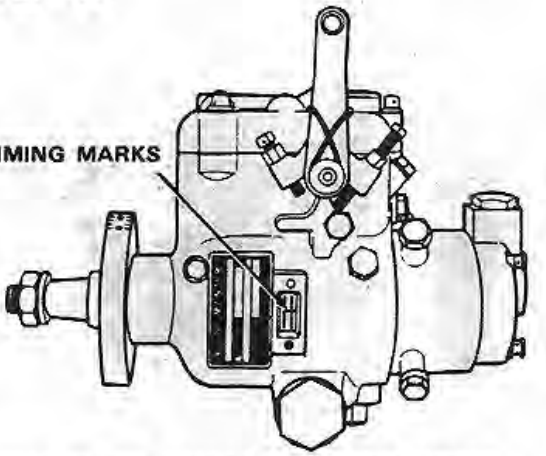
Check timing marks in timing window of injection pump. If marks are not aligned, proceed to next step. If marks are in line, the pump is in time.

STEP 46



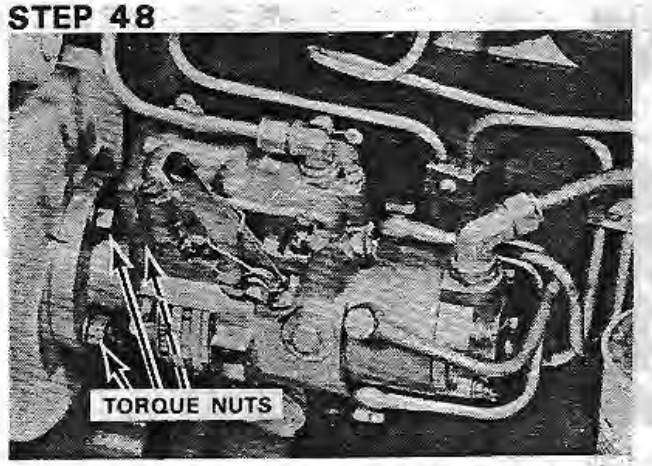
Loosen pump mounting nuts. Move pump toward or away from engine until timing marks are aligned. *NOTE:* To advance timing, move top of pump away from engine. To retard pump timing, move top of pump toward engine.

STEP 47



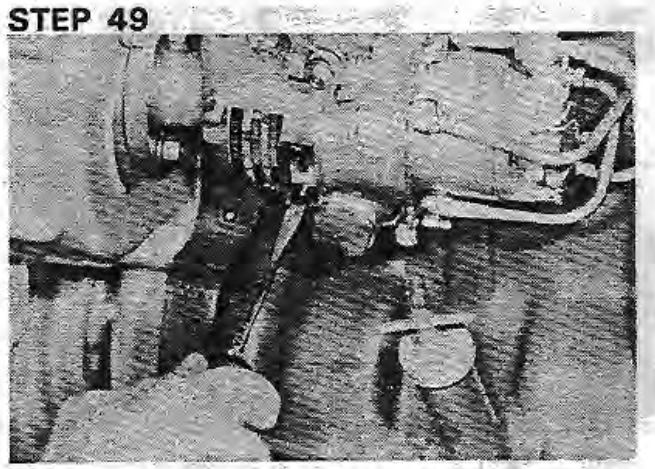
Timing marks aligned for proper timing.

STEP 48



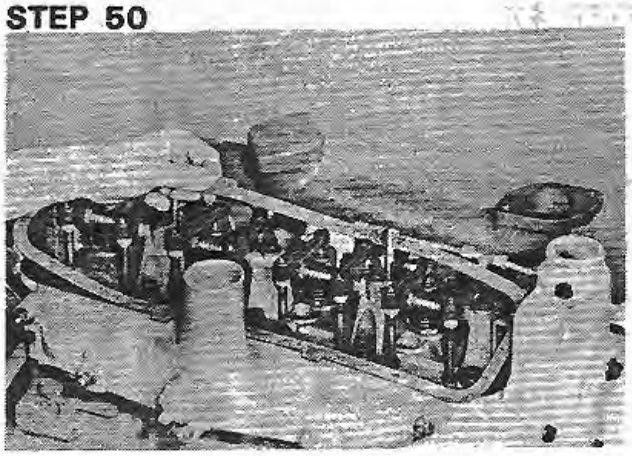
Torque pump mounting nuts 35 to 42 ft. lbs.

STEP 49



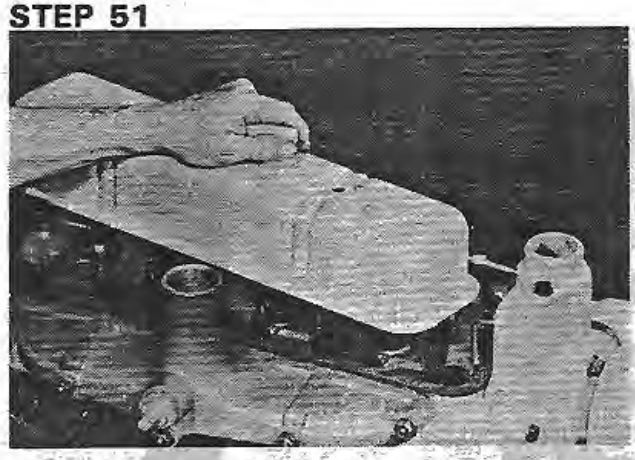
Install timing window cover on injection pump.

STEP 50



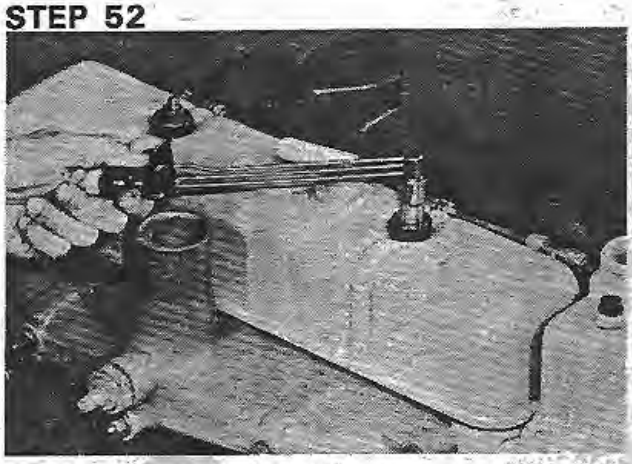
Install valve cover gasket.

STEP 51



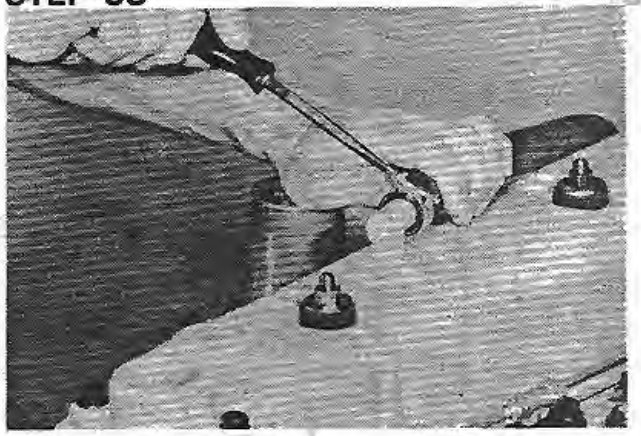
Install valve cover.

STEP 52



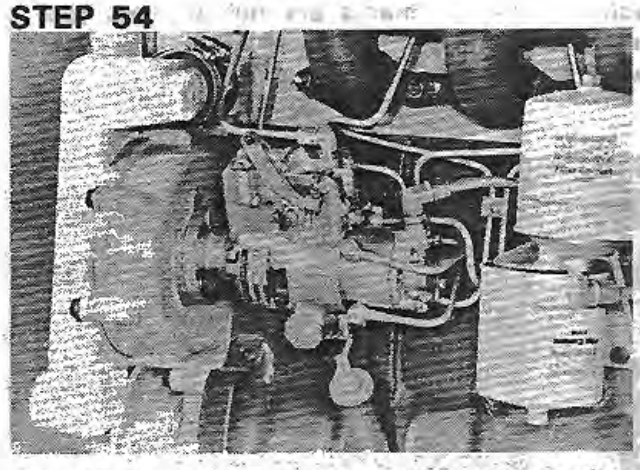
Torque retaining nuts 4 to 6 ft. lbs.

STEP 53



Install the breather hose.

STEP 54



Check and adjust the engine governed speed as outlined in Section 3012.

Section
2015

CYLINDER HEAD, VALVE TRAIN AND CAMSHAFT

188 and 207 Diesel Engines

J I Case
A Tenneco Company

TENNECO

Rac 9-78836

PRINTED IN U.S.A.

TABLE OF CONTENTS

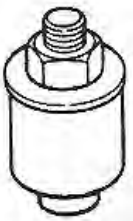
THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

SPECIAL TOOLS

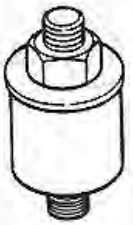
A43277 INJECTOR REAMER

A43278 INJECTOR
REMOVAL TOOL

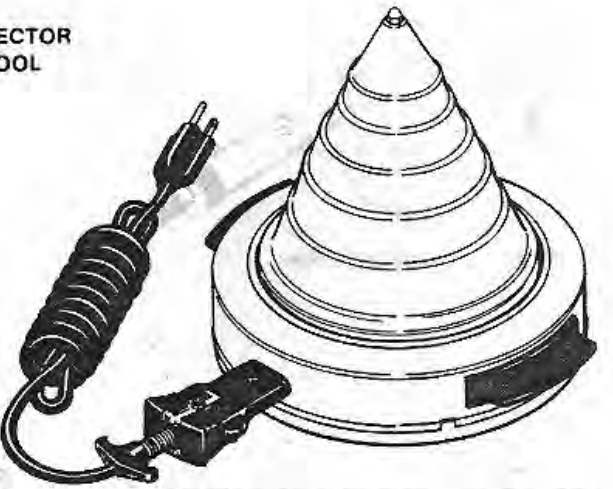
A43112 VALVE
GUIDE REAMER



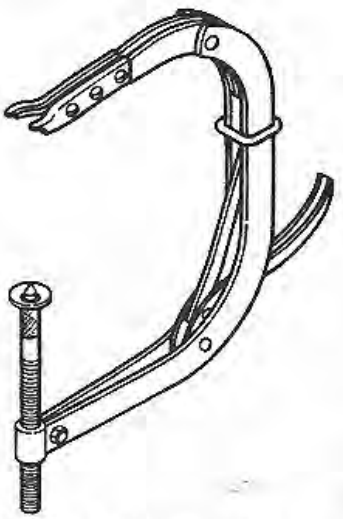
ASAE TACHOMETER
DRIVE REMOVAL TOOL
(SEE PAGE 5)



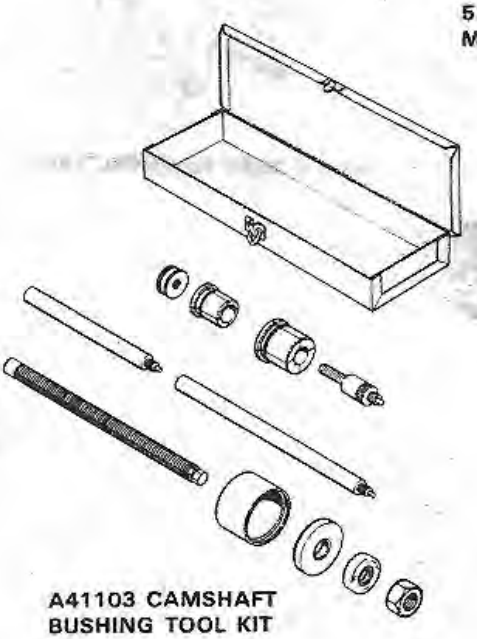
NON ASAE TACHOMETER
DRIVE REMOVAL TOOL
(SEE PAGE 5)



THERMO MOUNTER - MODEL "C"
ELECTRONIC DESIGNS, INC.
5164 N. 62ND STREET
MILWAUKEE, WIS. 53218

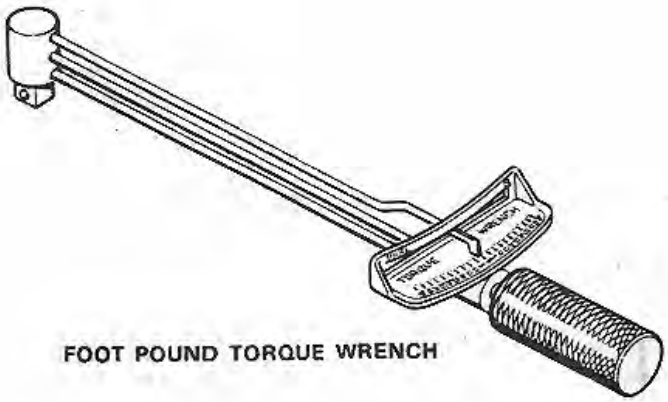


VALVE SPRING COMPRESSOR

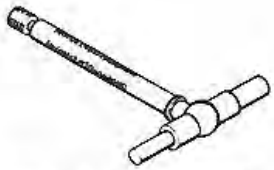


A41103 CAMSHAFT
BUSHING TOOL KIT

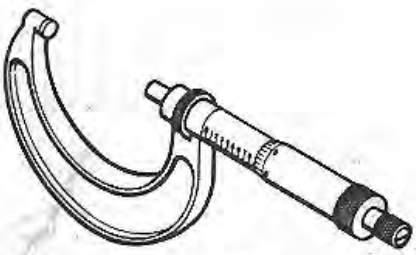
M20419 CYLINDER
HEAD WRENCH



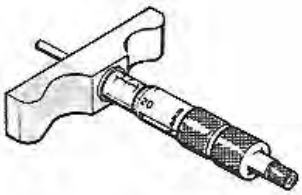
FOOT POUND TORQUE WRENCH



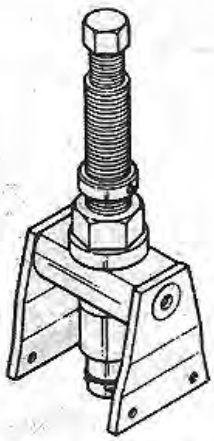
0" TO 5" BORE GAUGE
OR INSIDE MICROMETER



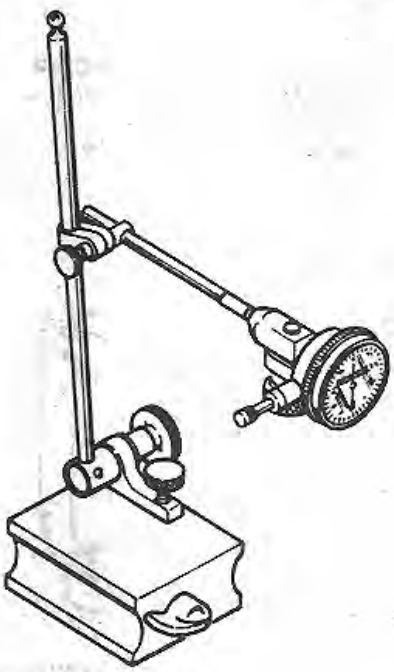
0" TO 5" MICROMETER



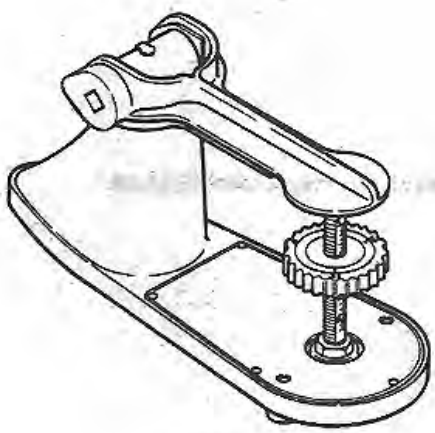
DEPTH MICROMETER



VALVE SEAT REMOVAL TOOL



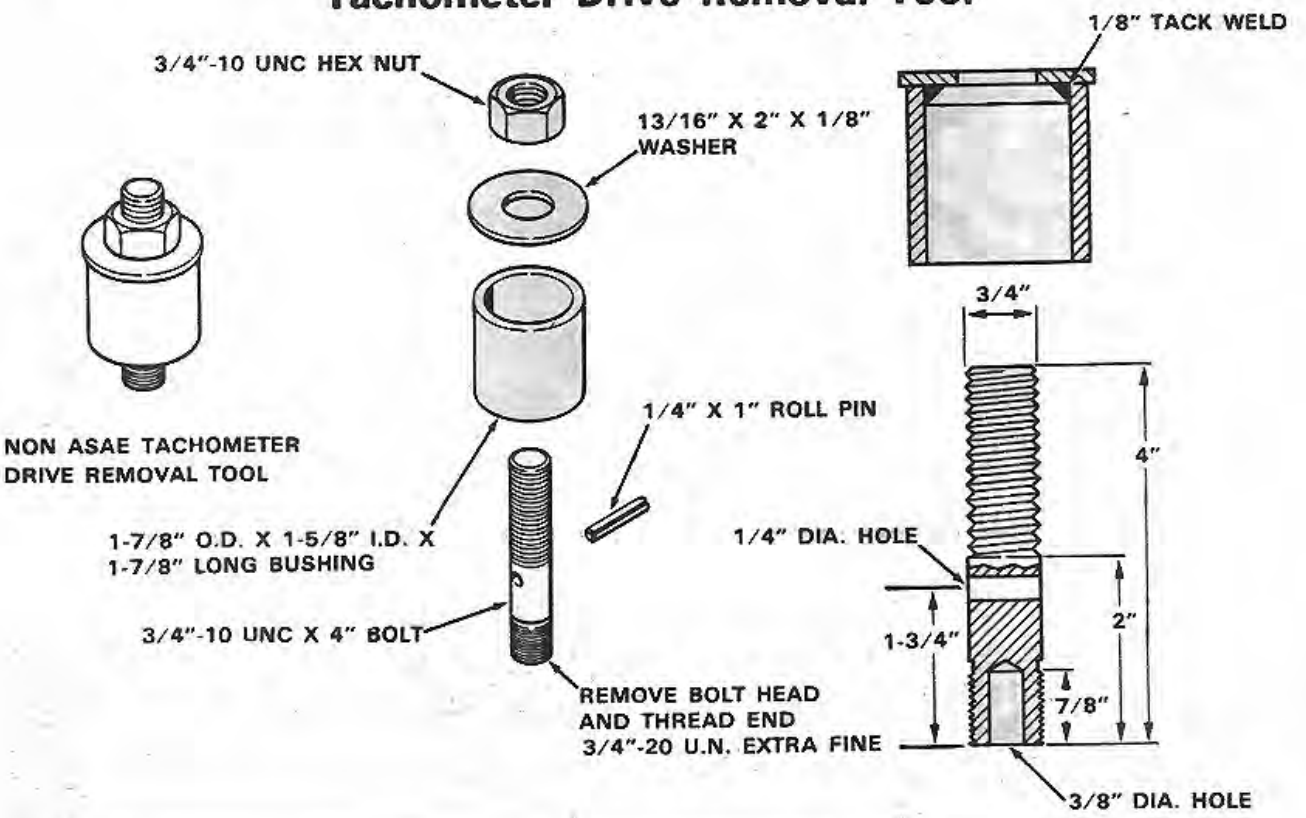
DIAL INDICATOR

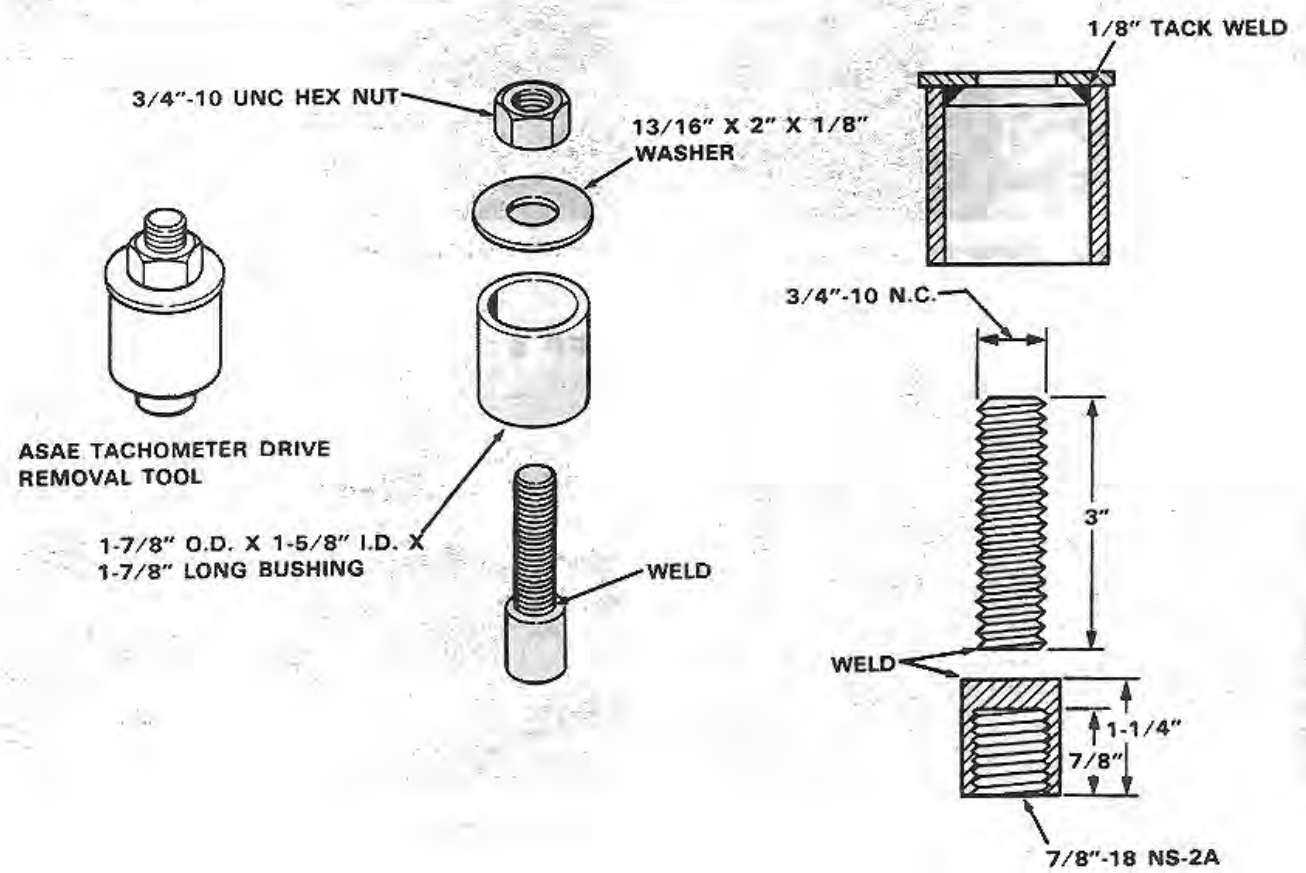


SPRING TESTER

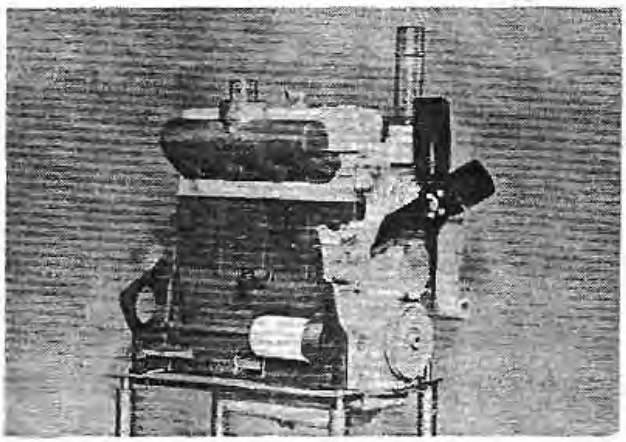
SPECIFICATIONS FOR TOOLS WHICH MUST BE MADE

Tachometer Drive Removal Tool

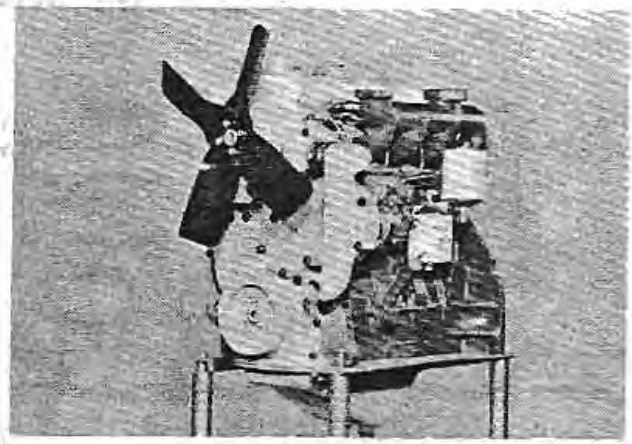




CYLINDER HEAD RECONDITIONING



188 DIESEL ENGINE



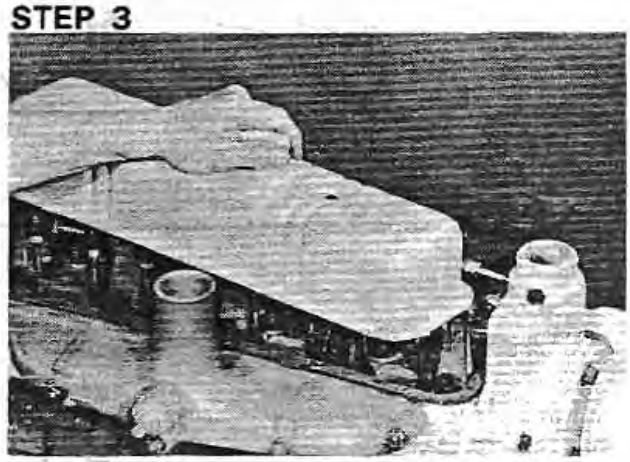
207 DIESEL ENGINE

Removal

STEP 1

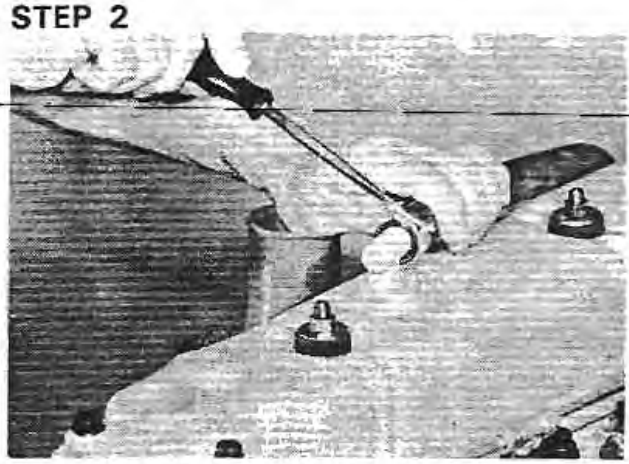
Remove fuel injectors. Refer to Section 3013.

STEP 3



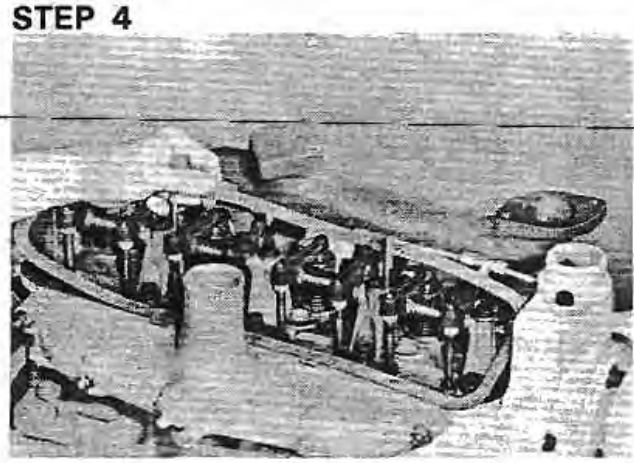
Remove valve cover.

STEP 2



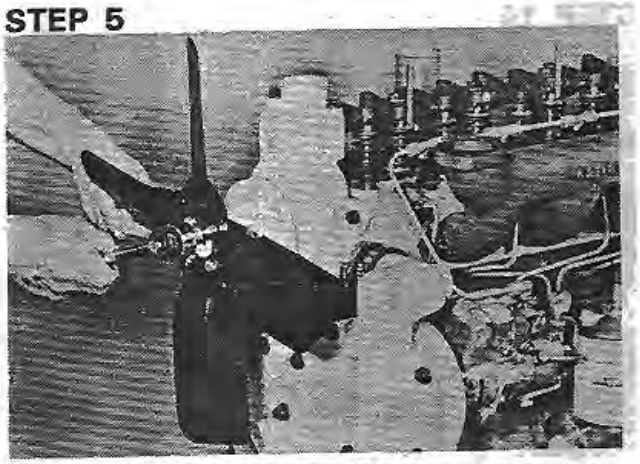
Remove breather tube.

STEP 4



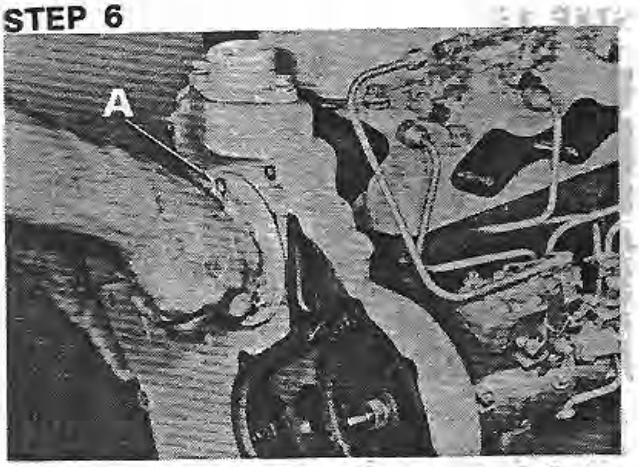
Remove valve cover gasket.

STEP 5



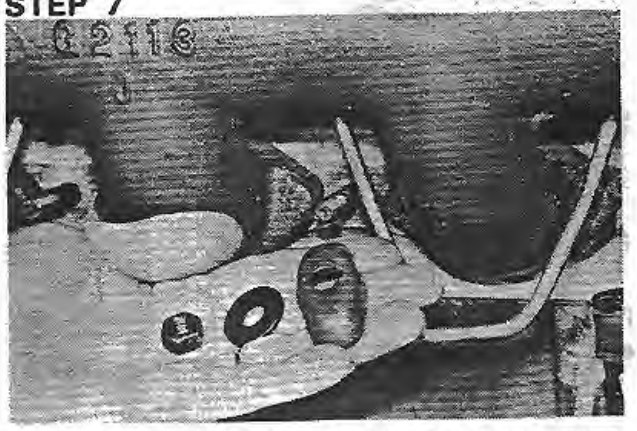
Remove fan, fan spacer (if equipped) and fan pulley.

STEP 6



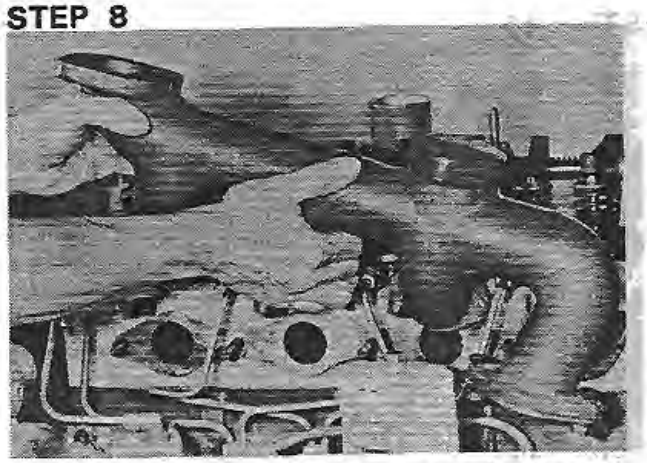
If engine is equipped with one piece timing cover, remove outer bolts secured to cylinder head. *NOTE:* If a stud and nut is located at point "A", the water pump must be removed to remove the inner socket hd. bolt in the housing.

STEP 7



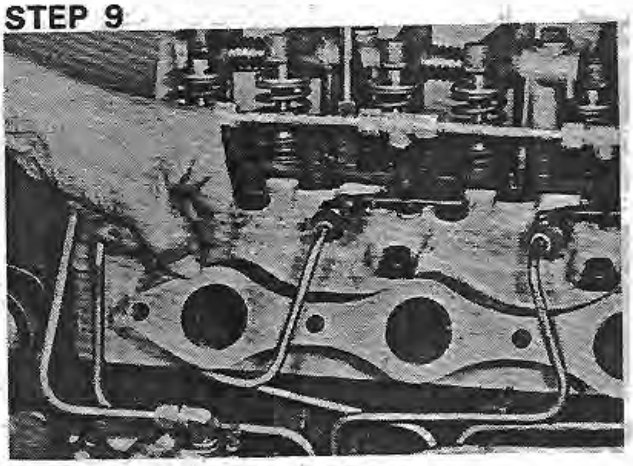
Remove the exhaust manifold retaining nuts, washers and clamps.

STEP 8



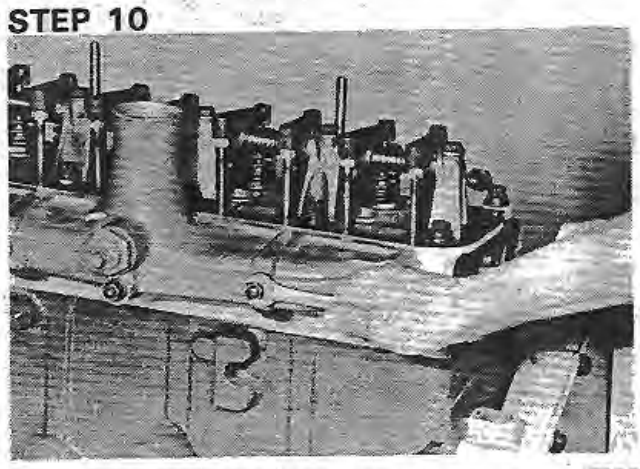
Pull the front of manifold from the front stud, swing the manifold upward and pull manifold off of rear stud and away from engine.

STEP 9



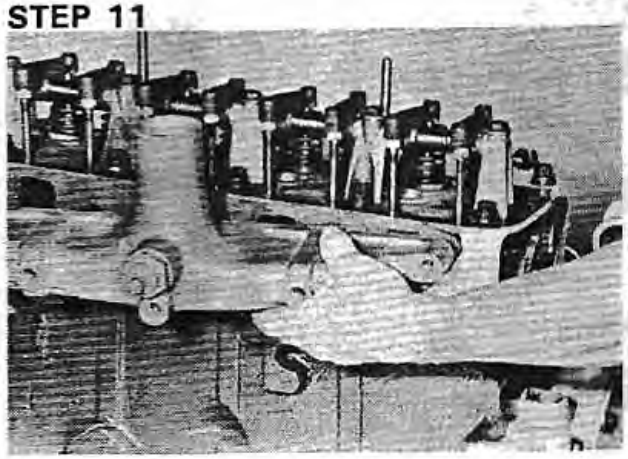
Remove exhaust manifold gasket.

STEP 10



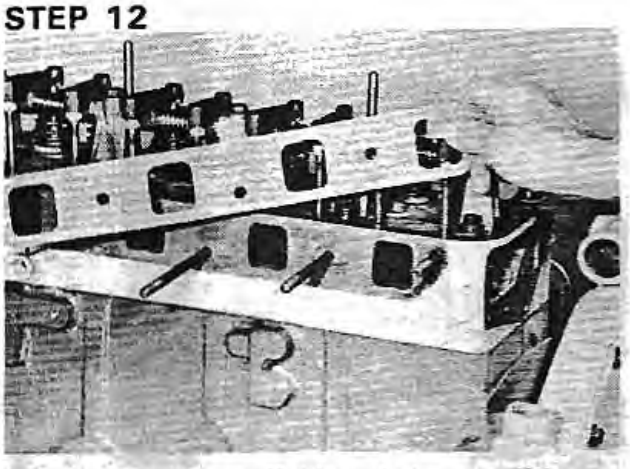
Remove intake manifold retaining nuts.

STEP 11



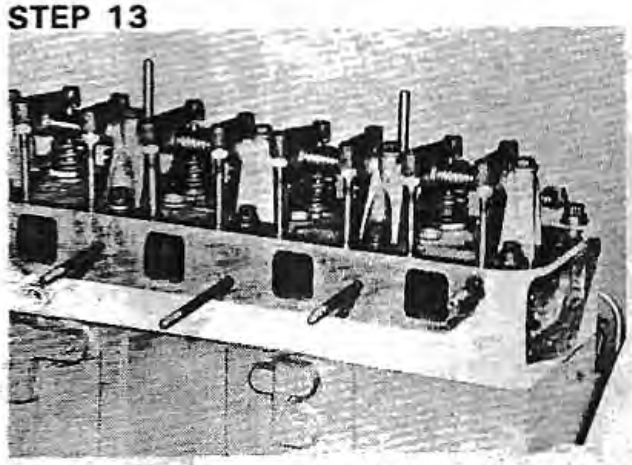
Remove intake manifold.

STEP 12



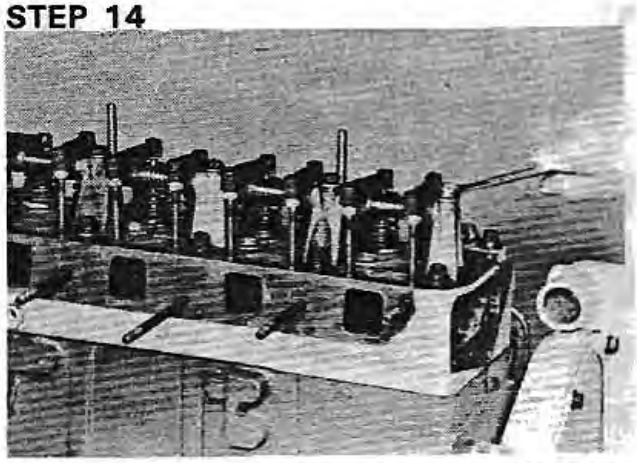
Remove intake manifold gasket.

STEP 13



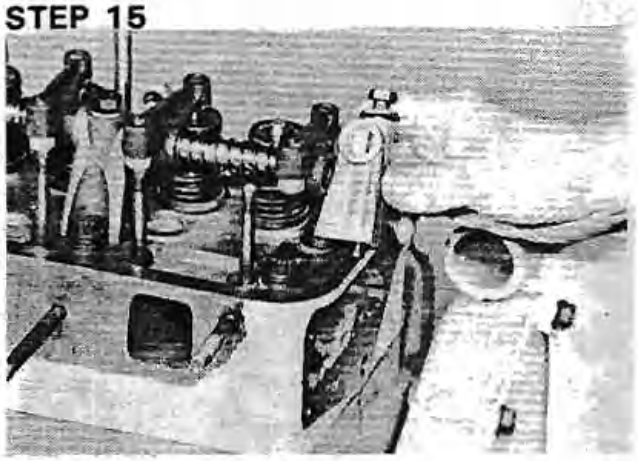
Cylinder head ready for rocker arm disassembly.

STEP 14



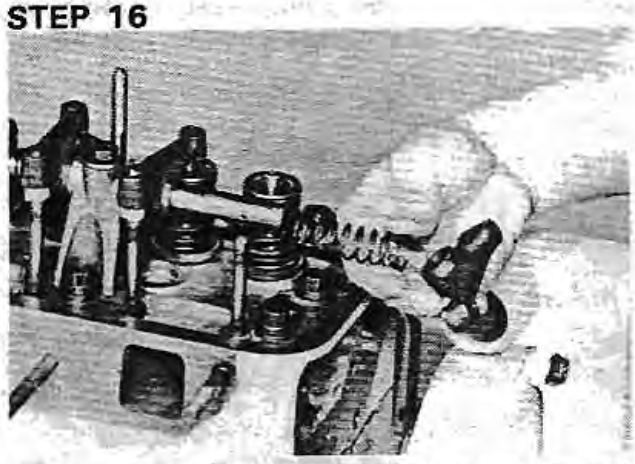
Loosen front and rear rocker arm assembly bracket bolts.

STEP 15



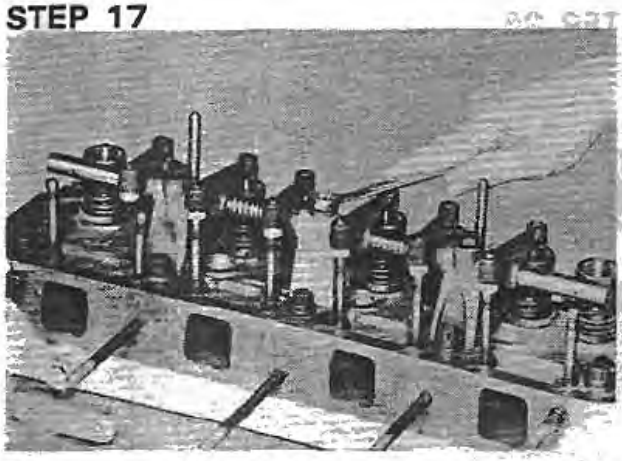
Remove brackets and bolts.

STEP 16



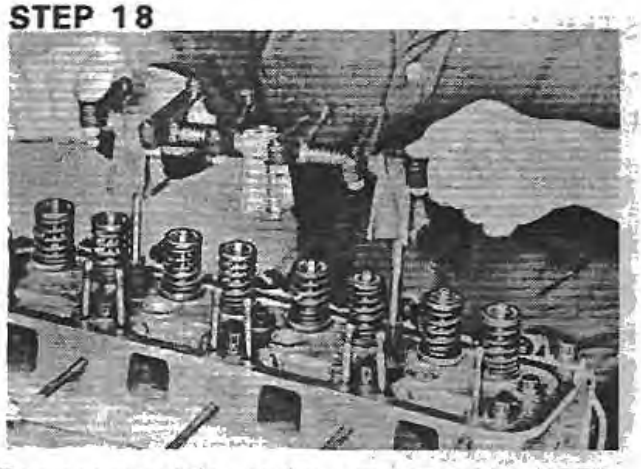
Rocker arm and spring will fall off each end due to spring pressure.

STEP 17



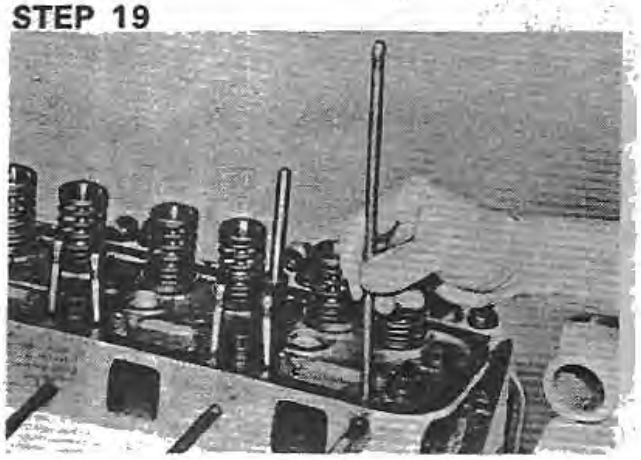
Remove remaining three rocker arm assembly bracket bolts.

STEP 18



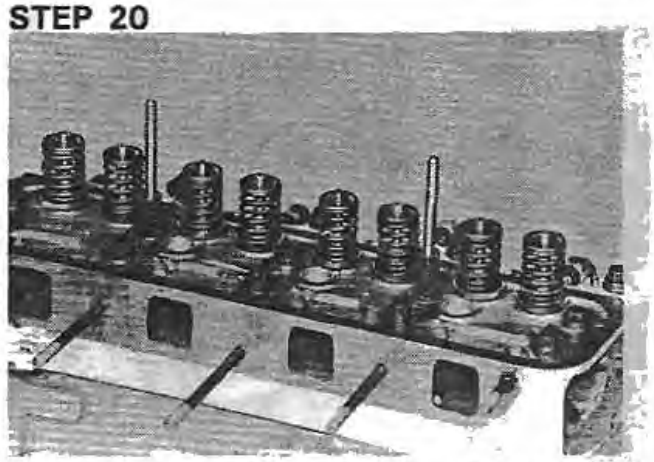
Remove remaining rocker arm assembly. *NOTE:* Tie the assembly together to prevent parts from falling apart.

STEP 19



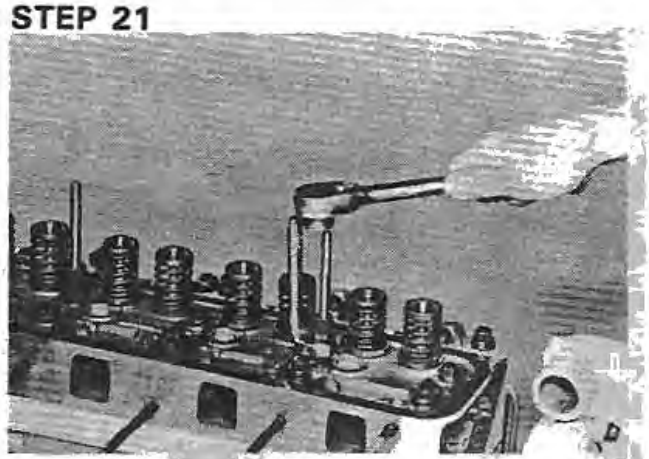
Remove push rods.

STEP 20



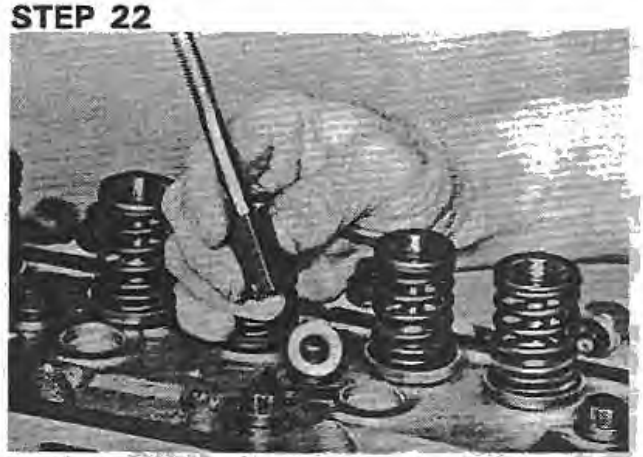
Rocker arm assembly and push rods removed.

STEP 21



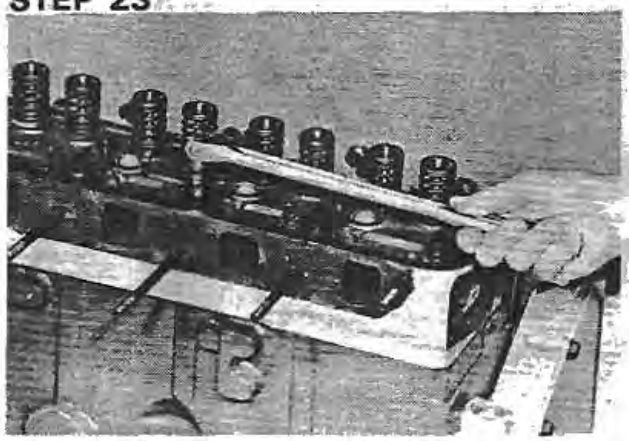
Loosen valve cover stud and nut assemblies using M20419 cylinder head wrench.

STEP 22



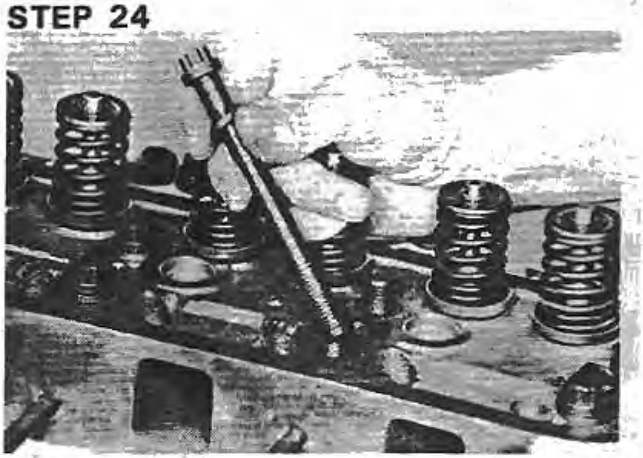
Remove valve cover mounting stud and nut assemblies and washers.

STEP 23



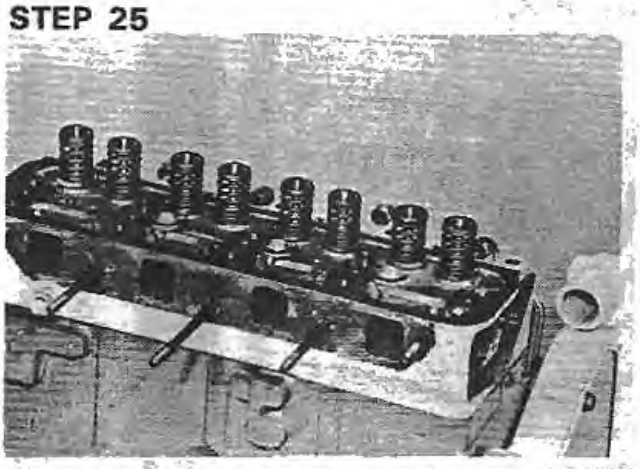
Loosen cylinder head mounting bolts.

STEP 24



Remove cylinder head mounting bolts and washers.

STEP 25

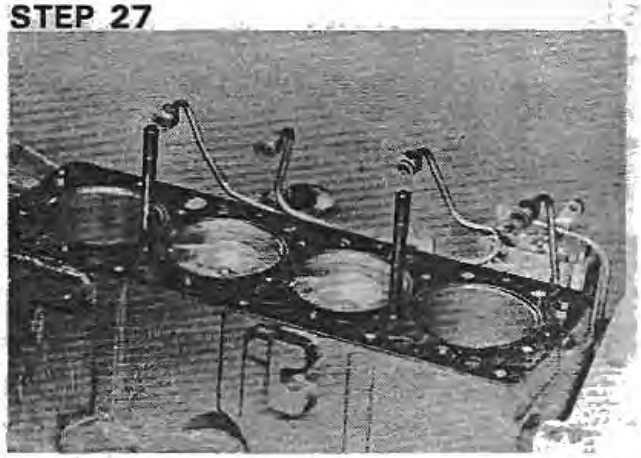


Cylinder head ready for removal.

STEP 26

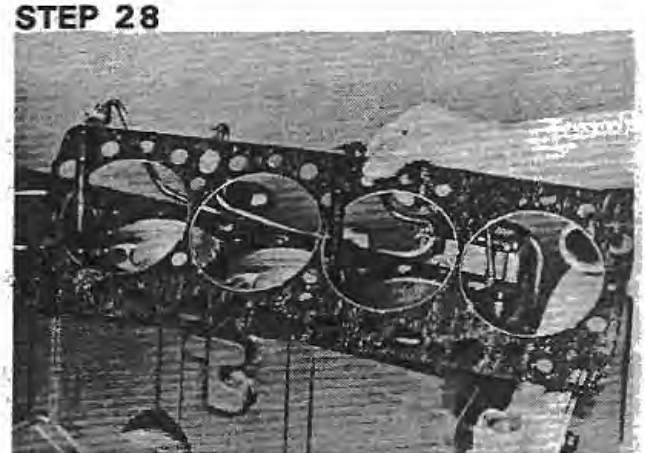
Remove cylinder head and place on work bench.

STEP 27



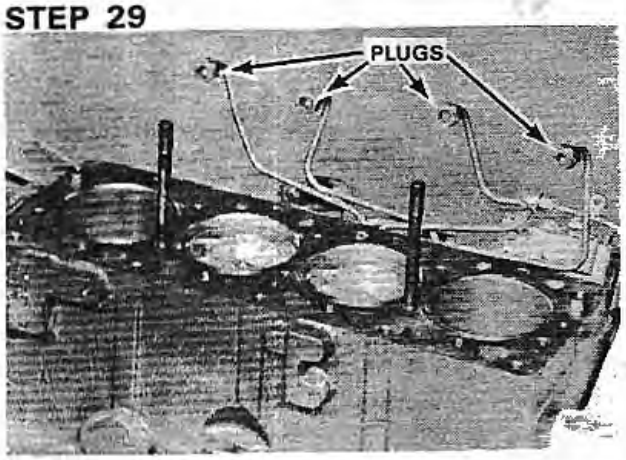
Cylinder head removed.

STEP 28



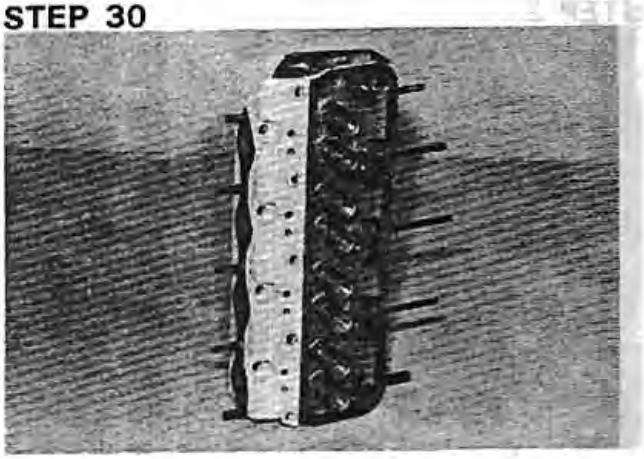
Remove cylinder head gasket.

STEP 29



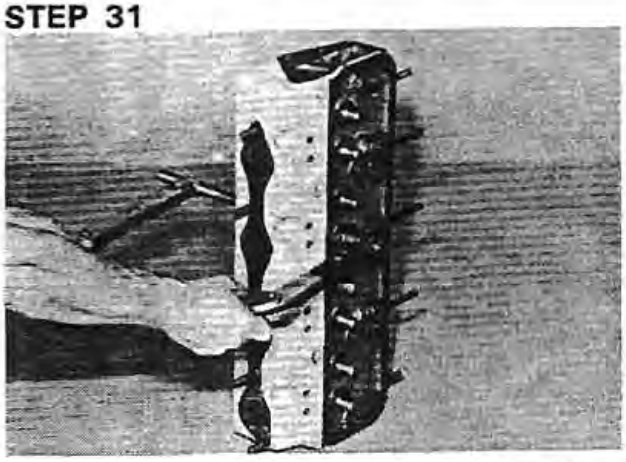
Cap the ends of fuel lines.

STEP 30



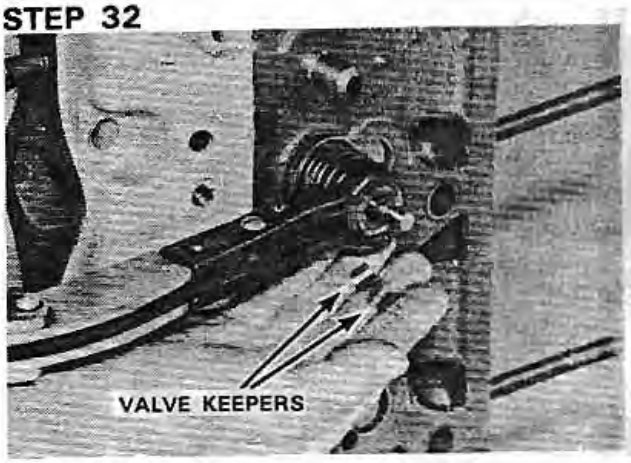
Cylinder head on work bench.

STEP 31



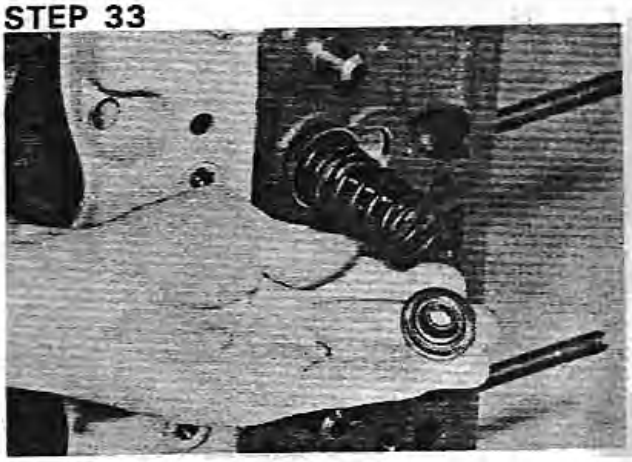
Compress valve springs with a spring compressor.

STEP 32



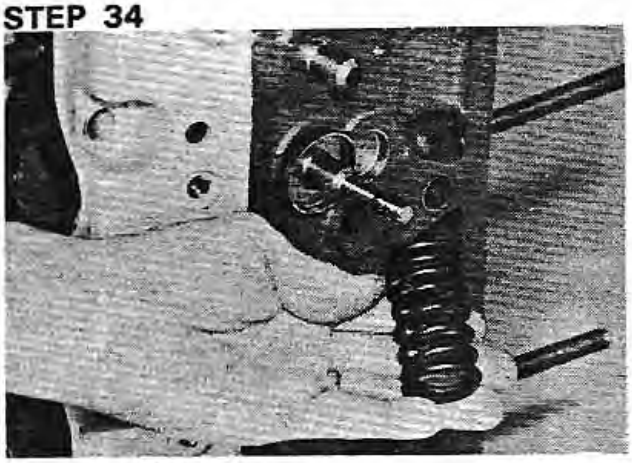
Remove valve keepers.

STEP 33



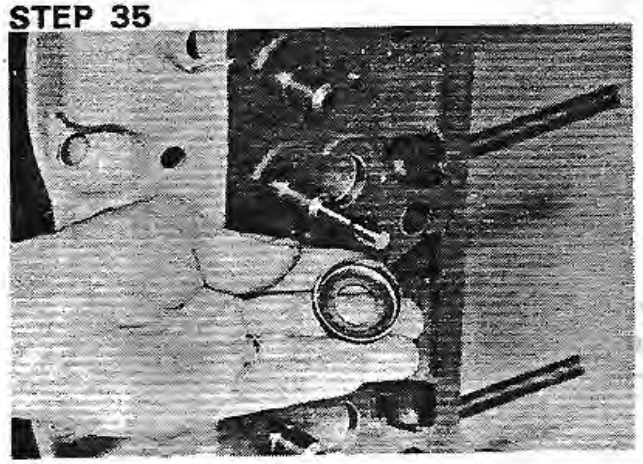
Remove spring retainer.

STEP 34



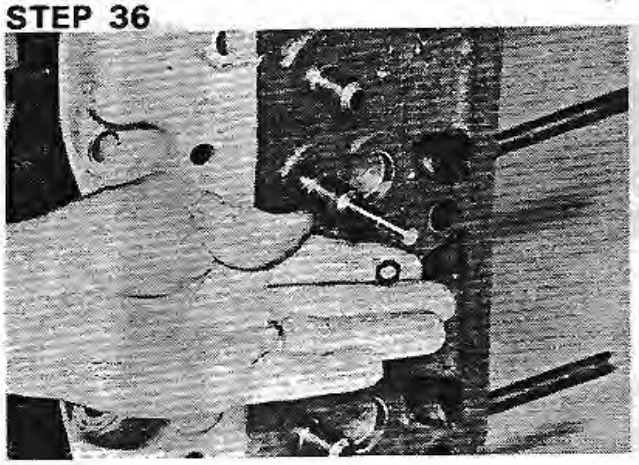
Remove valve spring.

STEP 35



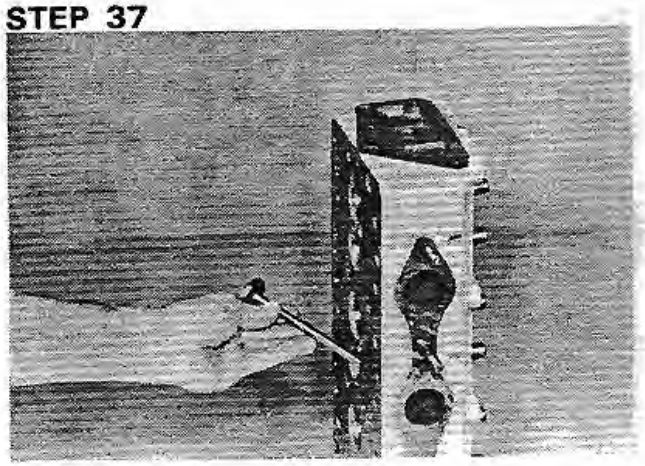
Remove spring seat.

STEP 36



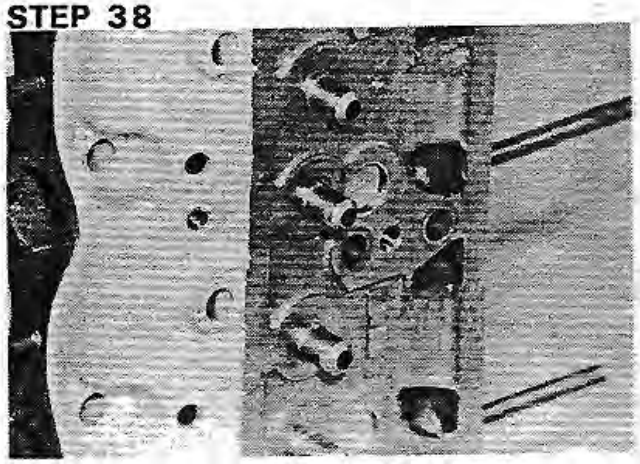
Remove valve stem seals.

STEP 37



Remove valve.

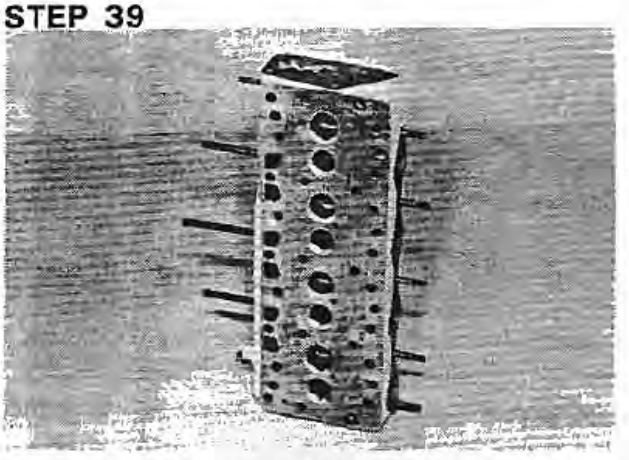
STEP 38



Valve assemblies removed.

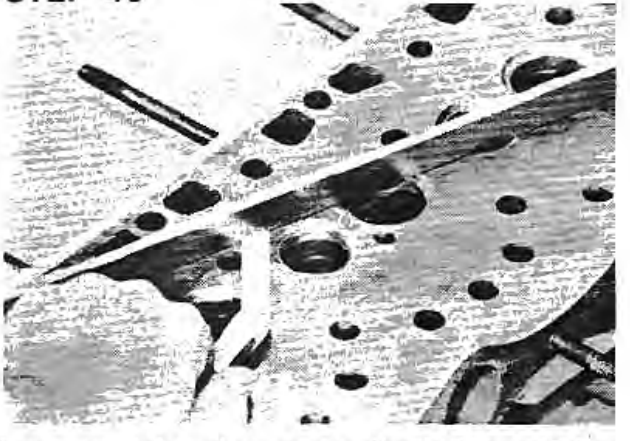
Cylinder Head Inspection

STEP 39



Wash, clean and inspect cylinder head. Use rotary wire brush to clean around and down into the valve ports. Clean carefully all machined surface areas with emery cloth, removing all gasket material, carbon and rust from cylinder head.

STEP 40

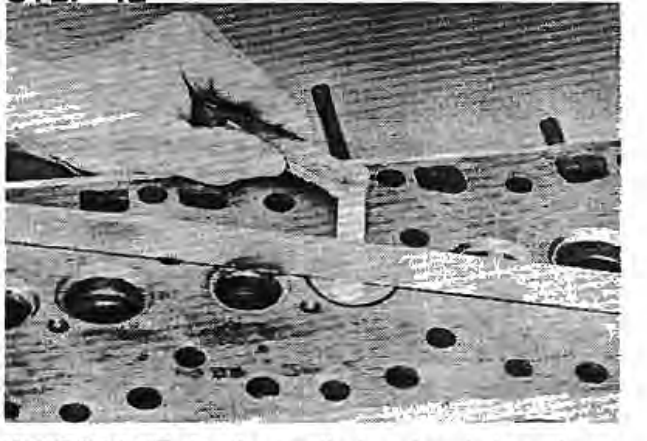


Lay a straight edge across the bottom of the cylinder head from corner to corner. Try to get a .006" feeler gauge under the straight edge. The maximum limit for head warpage is .006". If warpage is greater than .006", the cylinder head must be replaced or resurfaced. A minimum head thickness of 3.968" must be maintained if cylinder head is resurfaced.

STEP 41

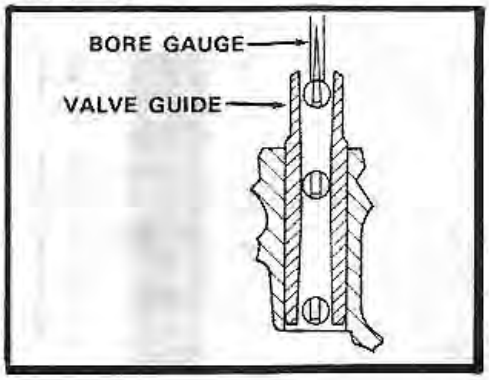
IMPORTANT: If the cylinder head has been resurfaced, the valve protrusion must be checked so as to prevent piston and valve contact. Refer to Steps 65 and 66.

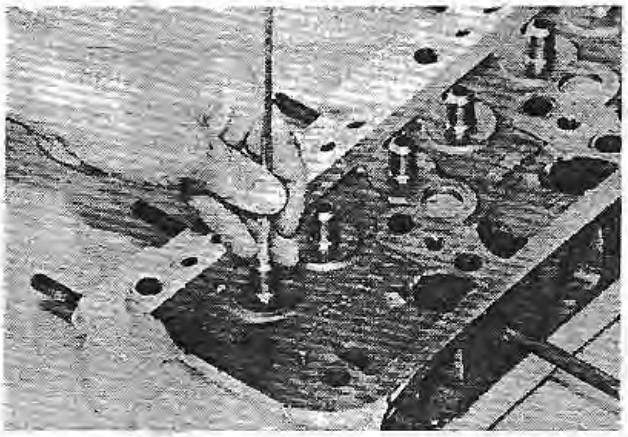
STEP 42



IMPORTANT: If the cylinder head has been resurfaced, the valve recession must be checked also. Refer to Steps 65 and 66.

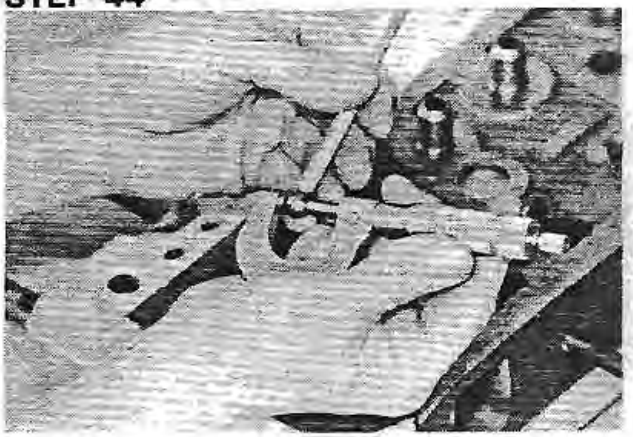
STEP 43





Check valve guides with an expandable bore gauge in three places as illustrated in the inset.

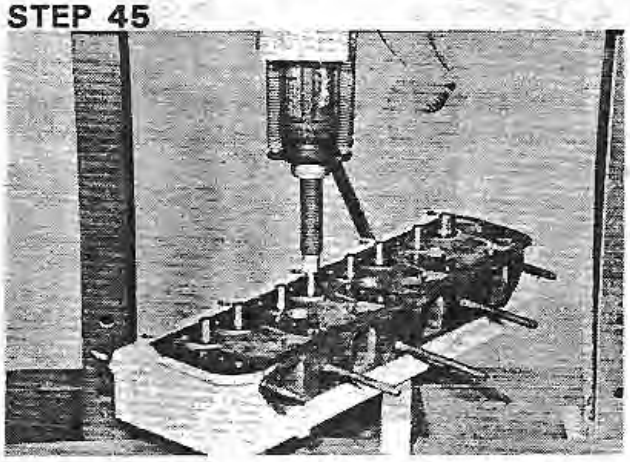
STEP 44



Check bore gauge with a micrometer. If the diameter is greater than .3449" at any point, replace the valve guide. If the inside diameter of the valve guides is less than .3449", proceed to valve and seat inspection. Refer to Step 53.

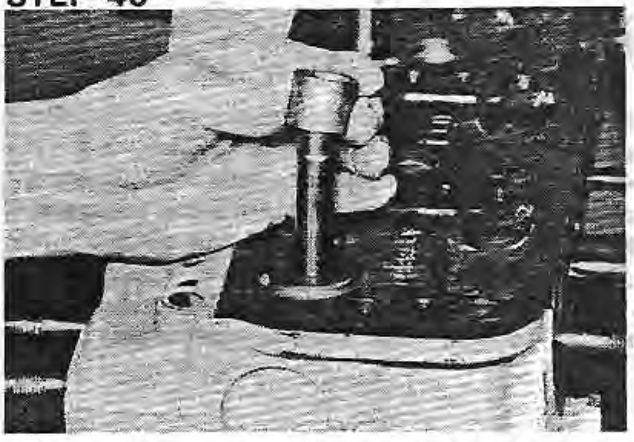
Valve Guide Replacement

STEP 45



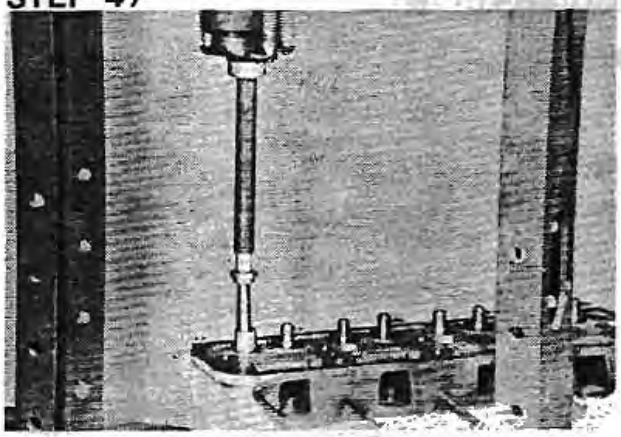
To replace valve guides, place the cylinder head in a hydraulic press. *NOTE:* Always press guides from the top, through the head.

STEP 46



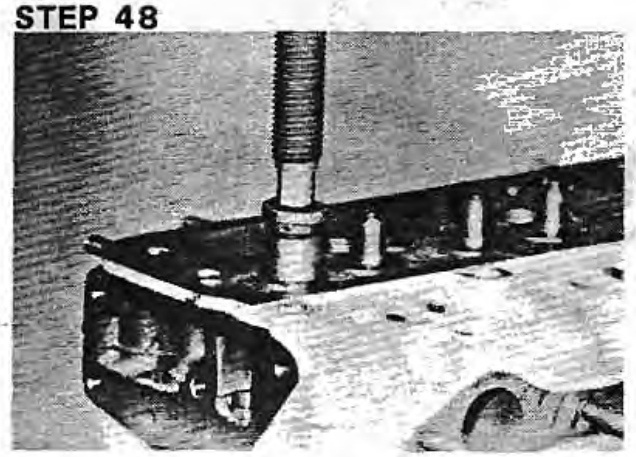
Valve guides must protrude .875" above the cylinder head. Fabricate a bushing (.688" minimum I.D. x .875" long) and place over the valve guide. The bushing will aid in obtaining correct guide protrusion.

STEP 47



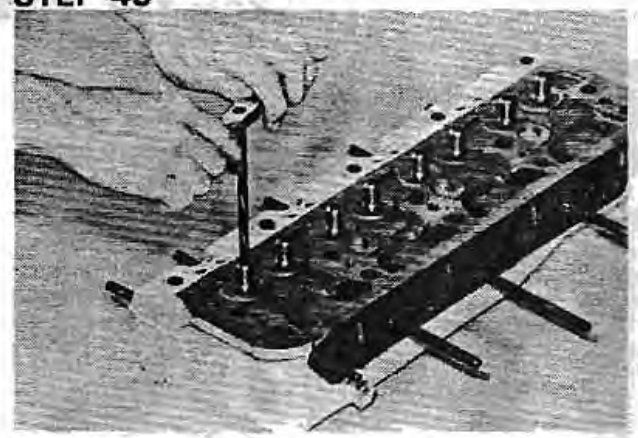
Use a hydraulic press to push valve guides into head.

STEP 48



Press valve guides into head until hydraulic press makes contact with fabricated bushing.

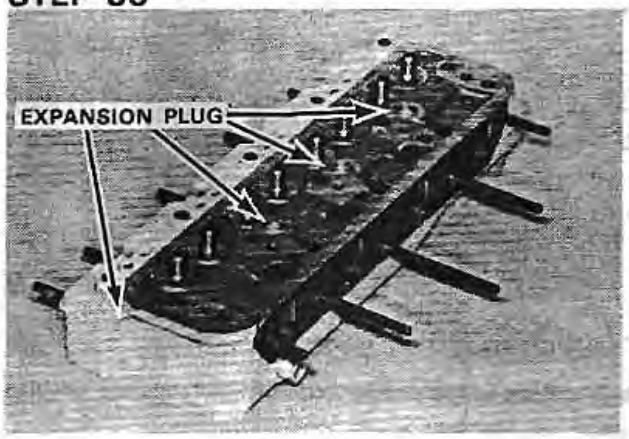
STEP 49



Ream new valve guides to .3429/.3439" using A43112 reamer.

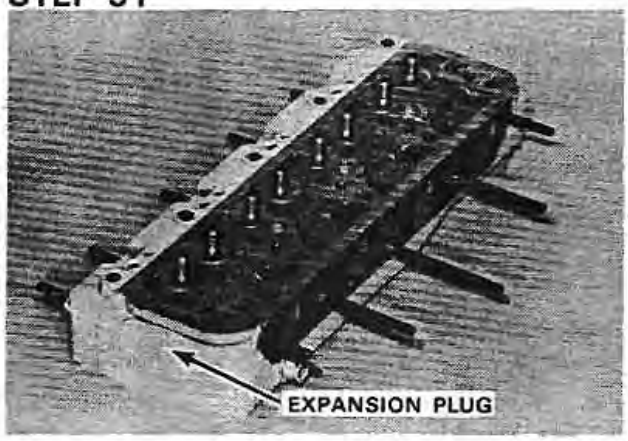
Expansion Plugs Replacement

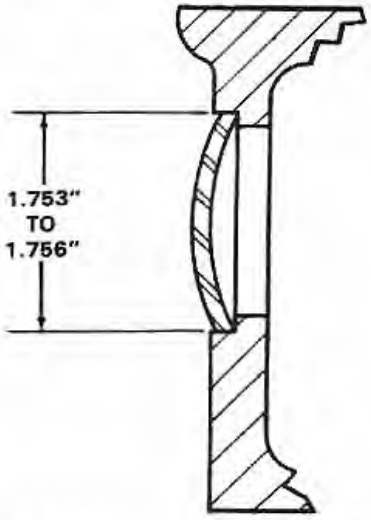
STEP 50



If the expansion plugs need replacing, they must be drilled and pryed out.

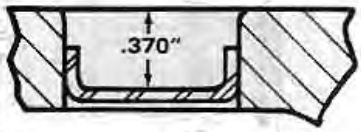
STEP 51

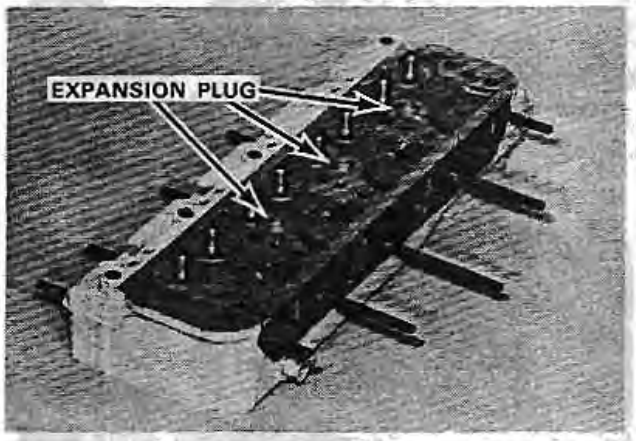




Install a new end expansion plug until it is seated and then strike a blow with a hammer to cause expansion.

STEP 52





Install a new top expansion plug to depth shown.

Valves and Valve Seats Inspection

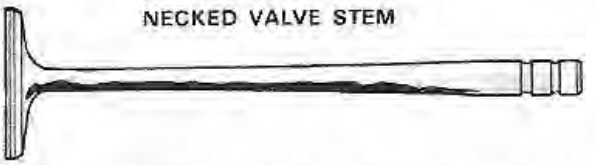
STEP 53

Clean valves with a fine power driven wire brush, being careful not to scratch valve stems.

STEP 54

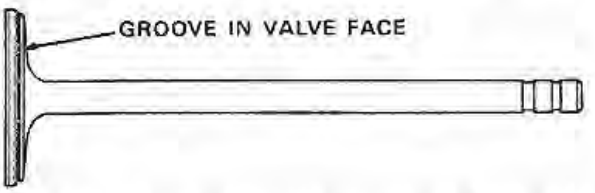
INSPECT THE VALVES FOR THE FOLLOWING CONDITIONS.

NECKED VALVE STEM



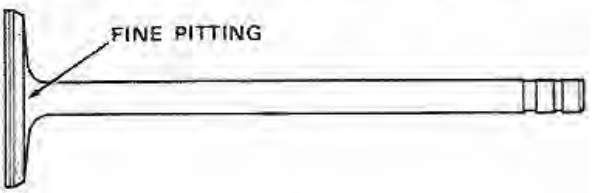
NOTE: REPLACE VALVE IF THIS CONDITION EXISTS.

This condition can be caused by lack of lubrication, plugged water passages or operating the engine under continuous overload at excessive RPM.



NOTE: REFACE OR REPLACE VALVE IF THIS CONDITION EXISTS.

This condition can be caused by abrasives entering the engine through the intake system or not servicing the air intake system regularly.



NOTE: THIS IS A NORMAL CONDITION

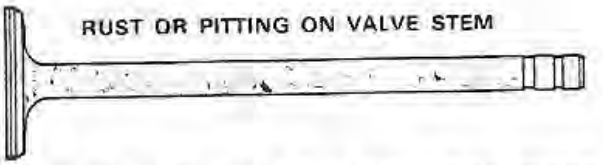
Small amounts of very fine pitting may be found on the surfaces of the valve face or seat after the valves are cleaned. This condition is normal and will not affect engine performance. This fine pitting is caused by a normal oxidation process and can happen on any engine during the run-in period. It is not necessary to grind valves or seats if this fine pitting is found, since pitting will generally recur after the engine is run for a few hours.

HEAVY CARBON AND VARNISH DEPOSITS

NOTE: CLEAN AND REFACE VALVES IF THIS CONDITION EXISTS OR REPLACE VALVES.

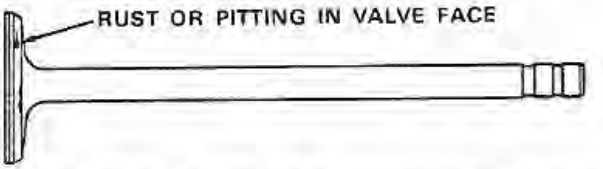
This condition is usually caused by worn valve guides or bad seals on the valves, allowing oil to pass by the valves. Low operating temperature is still another cause or worn piston rings and sleeves will allow too much oil to reach the combustion chamber.

RUST OR PITTING ON VALVE STEM



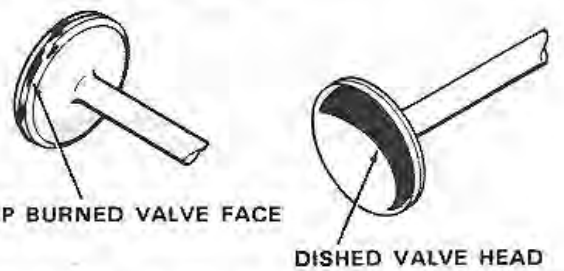
NOTE: REPLACE VALVE IF THIS CONDITION EXISTS.

This condition can be caused by using poor quality engine oil or fuel and by improper engine storage.



NOTE: REFACE OR REPLACE VALVE IF THIS CONDITION EXISTS.

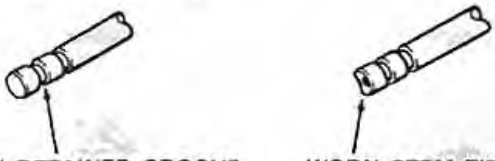
This condition can be caused by using poor quality engine oil or fuel.



NOTE: IF EITHER OF THESE CONDITIONS EXIST, REPLACE THE VALVES.

These conditions are usually caused by running the engine under excessive loads at high engine temperature, grinding valve face too thin or improper valve grinding.

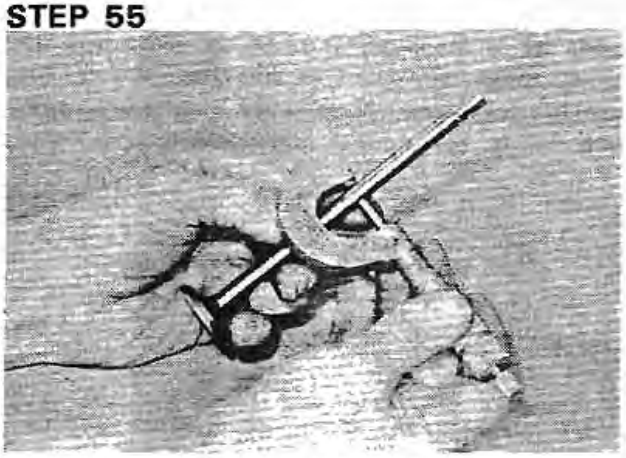
STEP 54 (CONT)



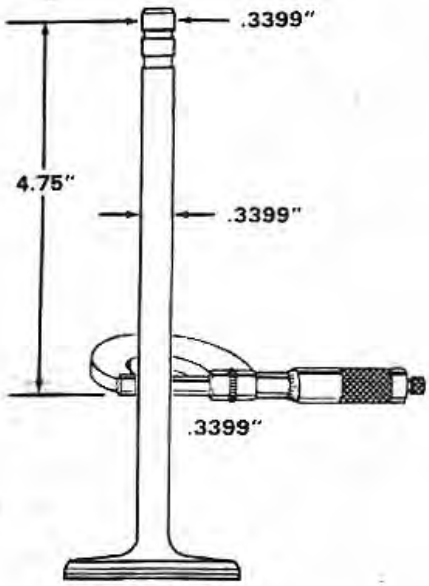
WORN RETAINER GROOVE WORN STEM TIP

NOTE: IF EITHER OF THESE CONDITIONS EXIST, REPLACE THE VALVES.

STEP 55

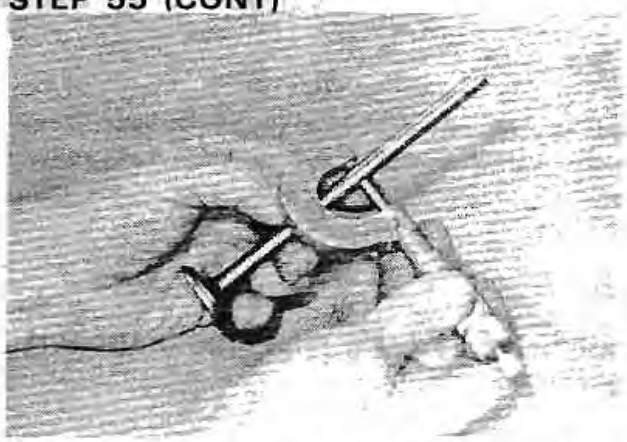


Check intake valve stem diameter at three points along the stem. If stem diameter is less than .3399", the valve must be replaced.

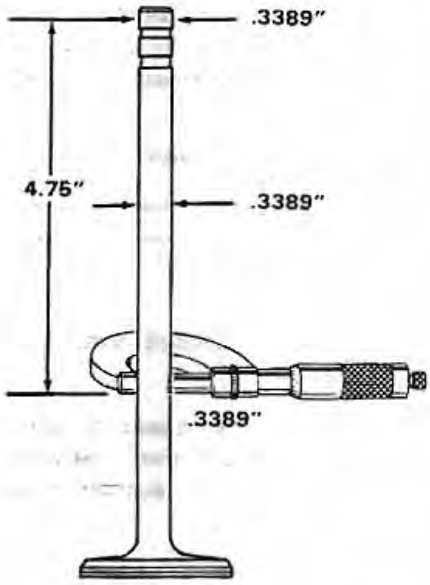


INTAKE VALVE

STEP 55 (CONT)

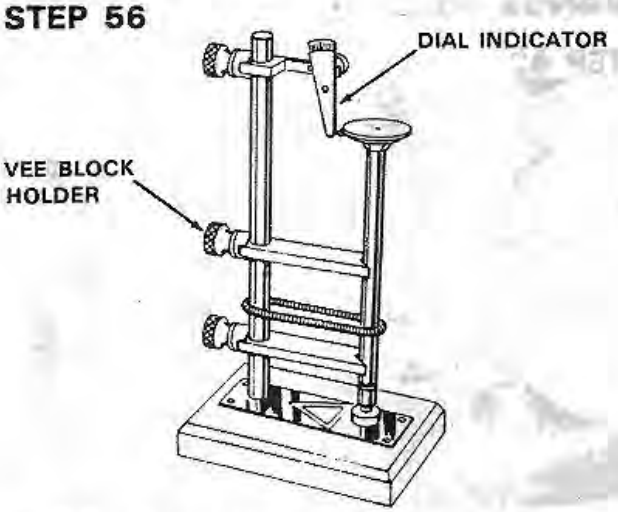


Check exhaust valve stem diameter at three points along the stem. If stem diameter is less than .3389", the valve must be replaced.



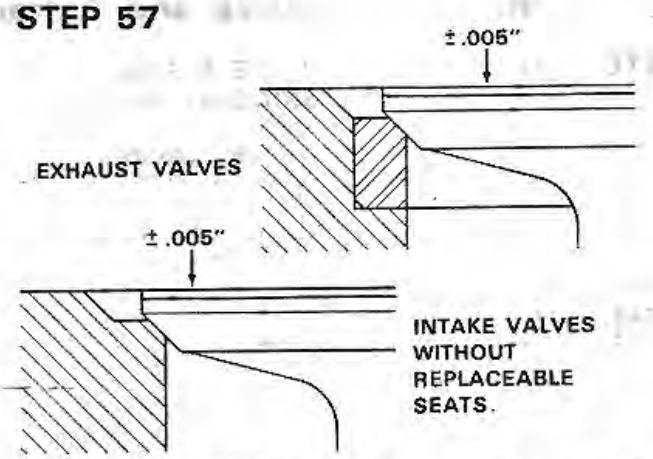
EXHAUST VALVE

STEP 56



Place the valves in a "Vee" block type holder with a dial indicator. Check valve face and stem run-out. Run-out must not exceed .002" on either the valve face or stem. Replace valves if run-out exceeds .002".

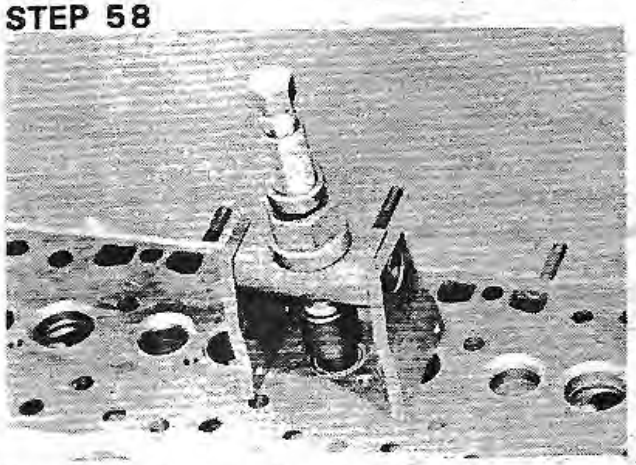
STEP 57



Place the valves in the cylinder head and check valve head recession. If the valve head has receded more than .005" below head surface, the valve and/or valve insert must be replaced to insure equal compression ratio between cylinders.

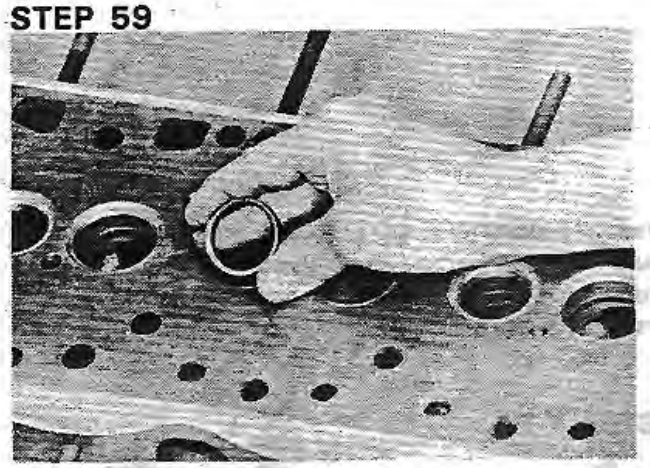
Valve Seat Replacement

STEP 58



Remove exhaust valve seats with a seat removal tool or have the seats machined out. *NOTE:* Never attempt to remove valve seats with a center punch, cold chisel or pry bar.

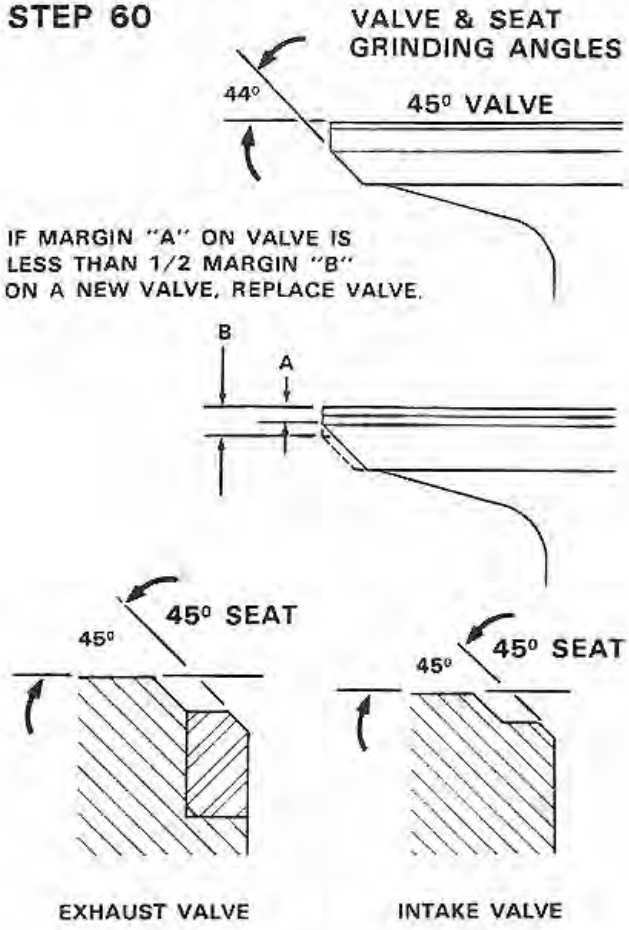
STEP 59



Clean the recess in the cylinder head. Place new valve seats in dry ice to shrink them for ease of installation.

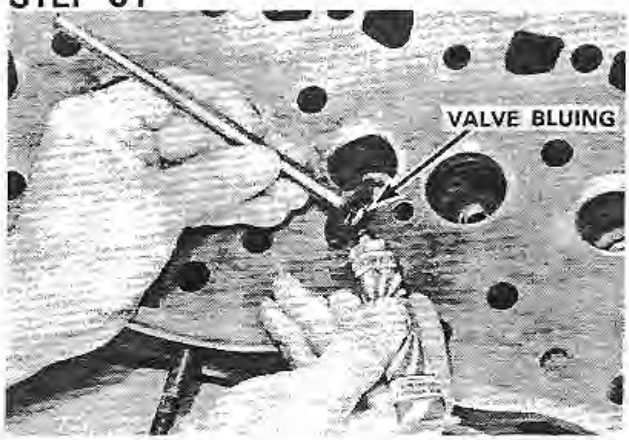
Refacing Intake and Exhaust Valves and Valve Seats

STEP 60



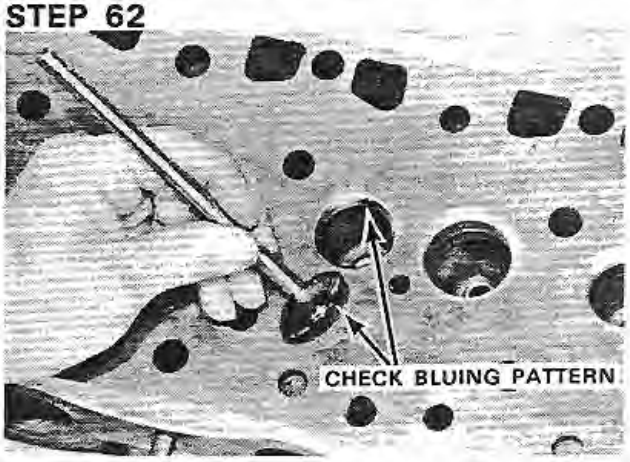
Use a precision seat grinder. Take very light cuts with the grinding stones so that just enough metal is removed to end up with a good smooth seat finish.

STEP 61



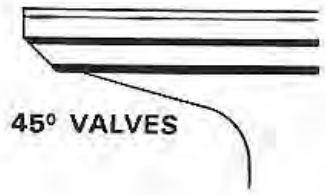
Apply a small amount of valve bluing (Prussian Blue) on the valve face. Install the valve in the head and rotate the valve on its seat.

STEP 62



Remove the valve and inspect the contact area on the valve face and seat. The bluing will have been removed from the valve face where it made contact with the seat.

STEP 63

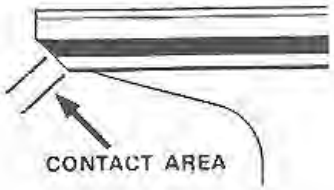


Correct refacing of valves and seats will provide a bluing pattern as shown. If bluing pattern is other than the pattern shown, refer to diagnosis of various bluing patterns on Pages 21 thru 23.

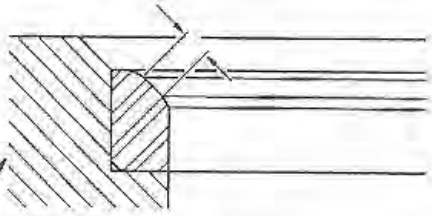
Diagnosis of Various Bluing Patterns

45° INTAKE OR EXHAUST VALVES

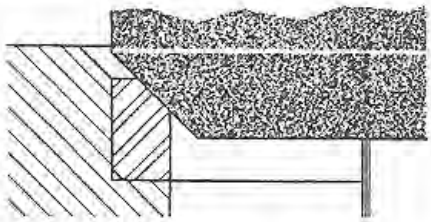
SEAT CONTACT AREA ON VALVE TOO LOW



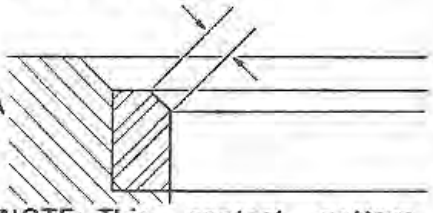
If valve contact area on seat looks like this (previously ground seat).



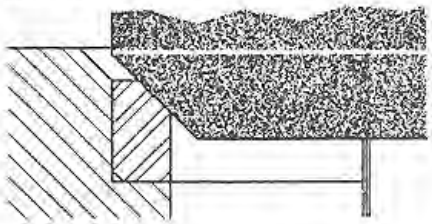
→ Use a 45° stone to raise and widen contact area →



If valve contact area on seat looks like this.

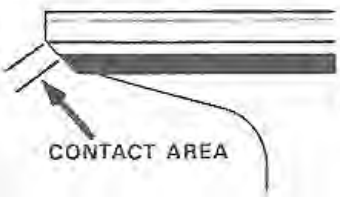


→ Use a 45° stone to raise contact area. →

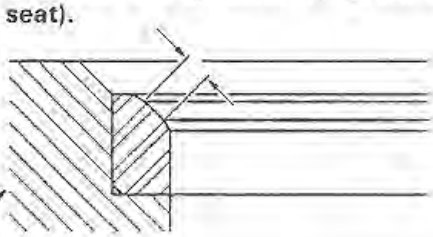


NOTE: This contact pattern will also be found on intake valves without replaceable seats.

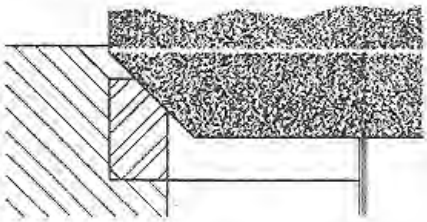
SEAT CONTACT AREA ON VALVE TOO HIGH



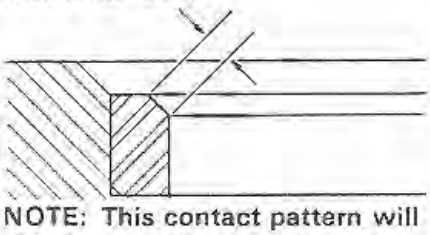
If valve contact area on seat looks like this (previously ground seat).



→ Use a 45° stone to lower and widen contact area →



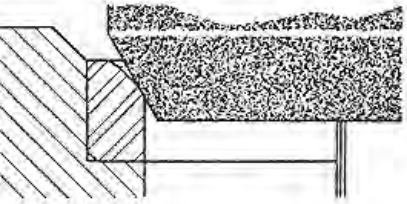
If valve contact area on seat looks like this.



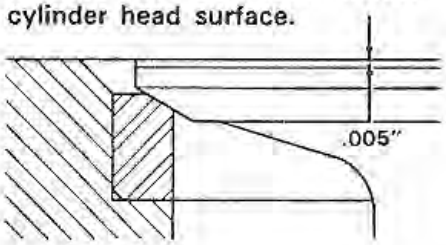
→ The valve and valve seat must be replaced since additional grinding will not alter the lower contact point.

NOTE: This contact pattern will also be found on intake valves without replaceable seats.

se a 60° narrowing stone to
arrow lower contact area in-
eased by 45° stone.

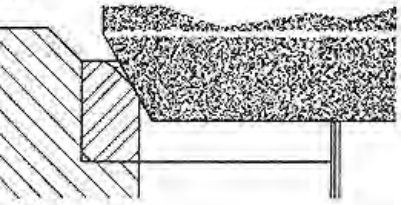


→ Check that valve head has not receded more than .005" below cylinder head surface.

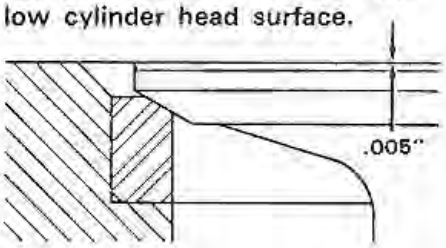


→ If valve head recedes or protrudes more than .005", refer to Steps 65 and 66.

se a 60° narrowing stone to
ise and narrow lower contact
ea.



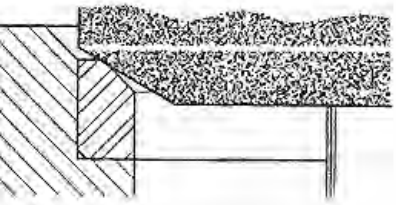
→ Check that valve head has not receded more than .005" below cylinder head surface.



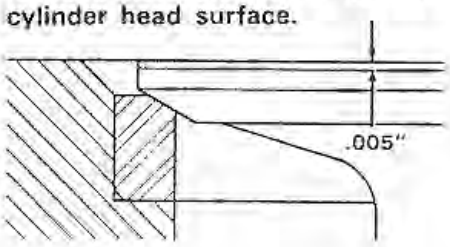
→ If valve head recedes or protrudes more than .005", refer to Steps 65 and 66.

---

se a 30° narrowing stone to
arrow upper contact area in-
eased by 45° stone

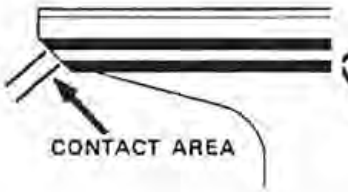


→ Check that valve head has not receded more than .005" below cylinder head surface.

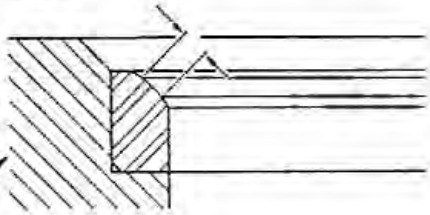


→ If valve head recedes or protrudes more than .005", refer to Steps 65 and 66.

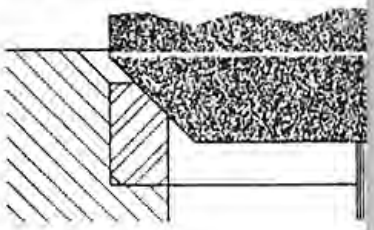
SEAT CONTACT AREA ON VALVE TOO NARROW



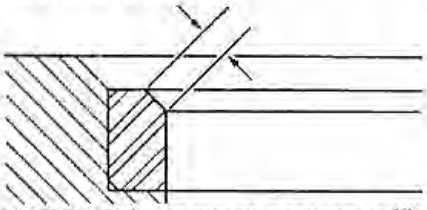
If valve contact area on seat looks like this (previously ground seat).



→ Use a 45° stone to increase tact area.



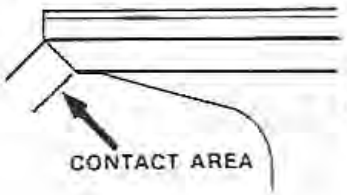
If valve contact area on seat looks like this



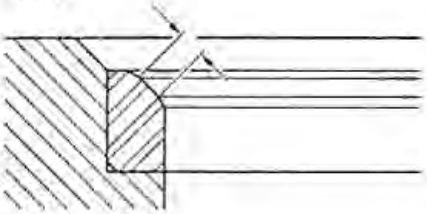
→ The valve and valve seat be replaced since addit grinding will not alter the wer contact point.

NOTE: This contact pattern will also be found on intake valves without replaceable seats.

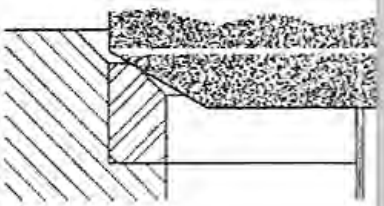
SEAT CONTACT AREA ON VALVE TOO WIDE



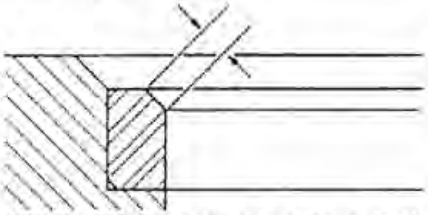
If valve contact area on seat looks like this (previously ground seat).



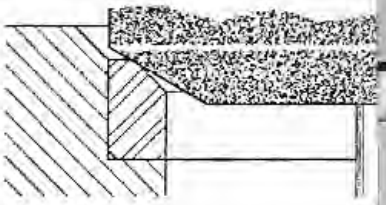
→ Use a 30° narrowing ston lower upper contact area.



If valve contact area on seat looks like this

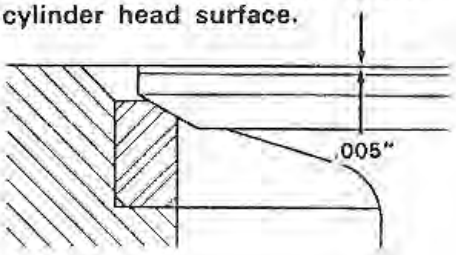


→ Use a 30° narrowing ston lower upper contact area.



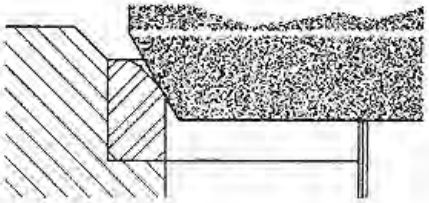
NOTE: This contact pattern will also be found on intake valves without replaceable seats.

Check that valve head has not receded more than .005" below cylinder head surface.

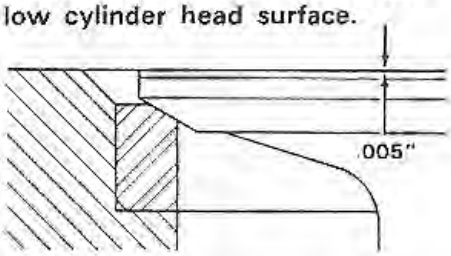


If valve head recedes or protrudes more than .005", refer to Steps 65 and 66.

Use a 60° narrowing stone to raise lower contact area.

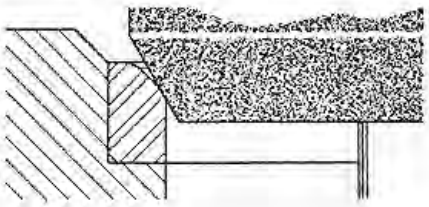


Check that valve head has not receded more than .005" below cylinder head surface.

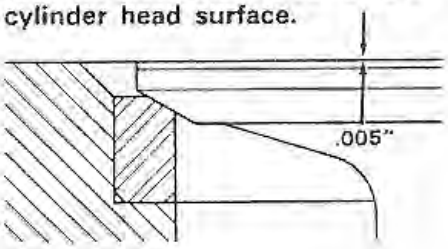


If valve head recedes or protrudes more than .005", refer to Steps 65 and 66.

Use a 60° narrowing stone to raise lower contact area.

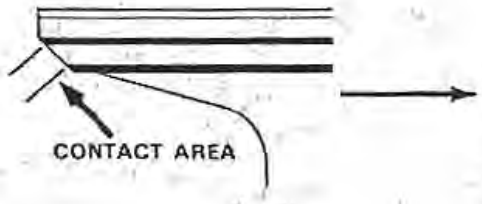


Check that valve head has not receded more than .005" below cylinder head surface.

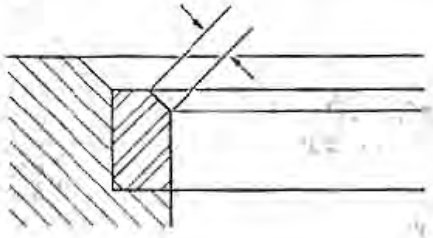


If valve head recedes or protrudes more than .005", refer to Steps 65 and 66.

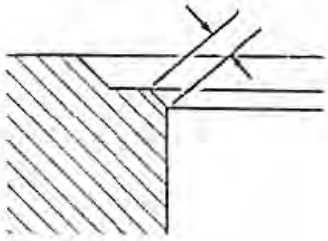
THIS IS THE CORRECT SEAT CONTACT AREA ON VALVE



The correct exhaust valve contact area on seat will provide a seat width of .0608" to .0962"

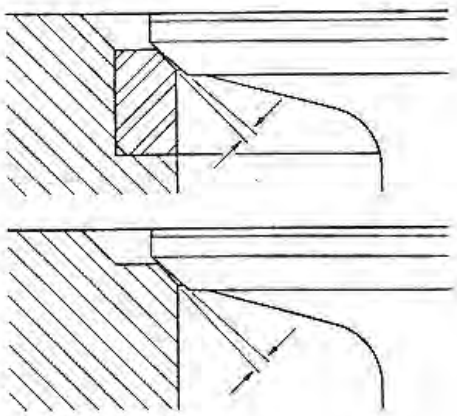


The correct intake valv
tact area will provide
width of .0704" to .1057



con-
seat

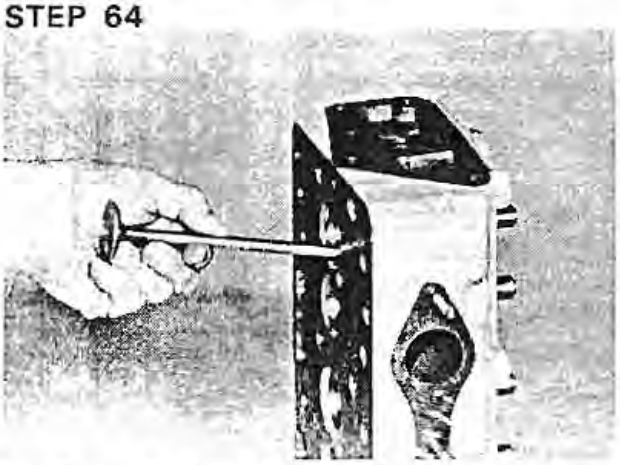
→ 1° interference angle



→ Correct refacing of intake and exhaust valves and valve seats will provide a 1° interference angle. This angle is important since it aids in cutting carbon and helps seat the valves.

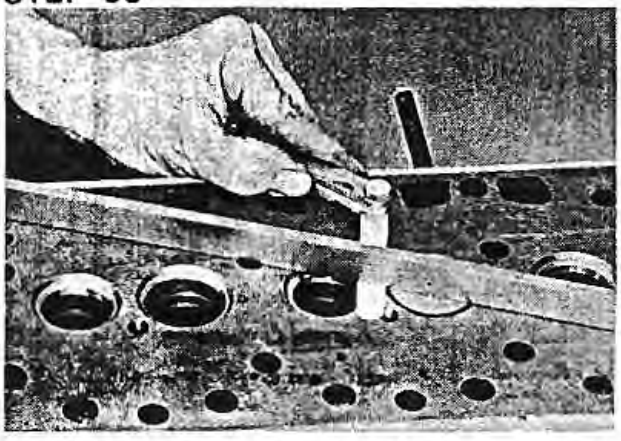
Cylinder Head Assembly and Installation

STEP 64



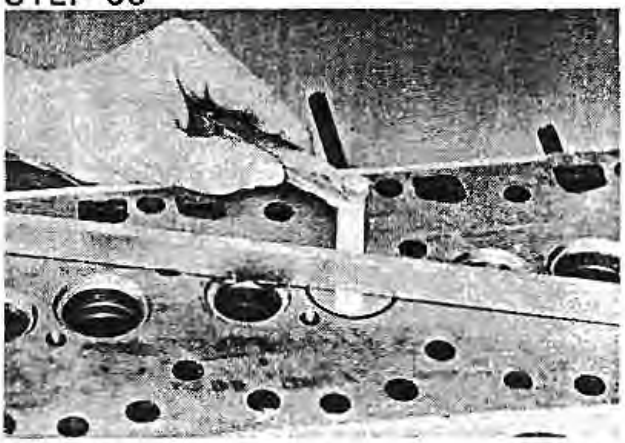
Install a valve into the cylinder head one at a time and perform steps 65 and/or 66.

STEP 65



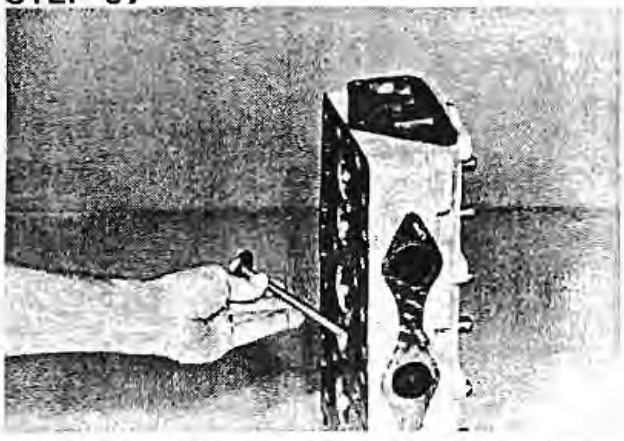
Check for valve protrusion. Place a straight edge on the valve and measure the distance between the straight edge and the cylinder head, using a feeler gauge. If protrusion is more than .005", refer to pages 21, 22 and 23 for proper valve and seat grinding.

STEP 66



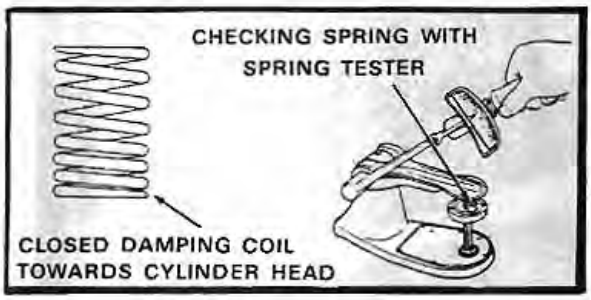
Check for valve recession. Place a straight edge over the valve and measure the distance between the straight edge and the valve head, using a feeler gauge. If recession is more than .005", replace the valve and/or valve seat.

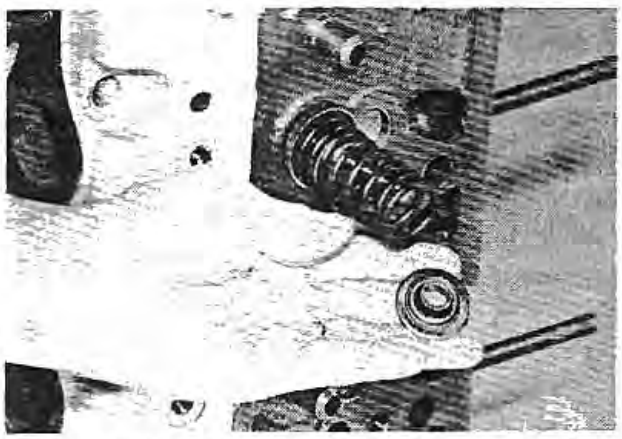
STEP 67



After valve protrusion and recession have been checked and corrected, lubricate valve stems with HDM #30 oil before installing into cylinder head.

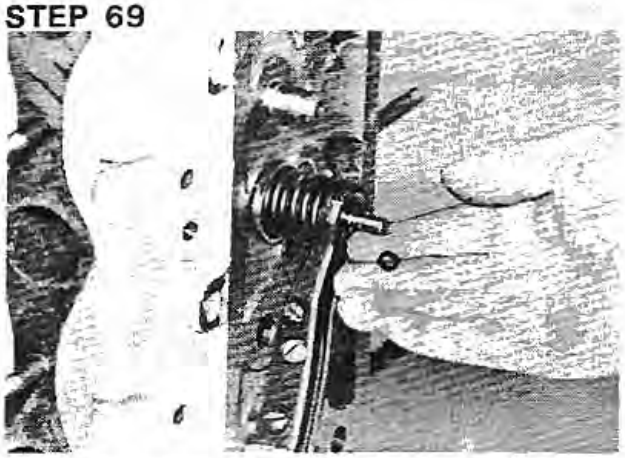
STEP 68





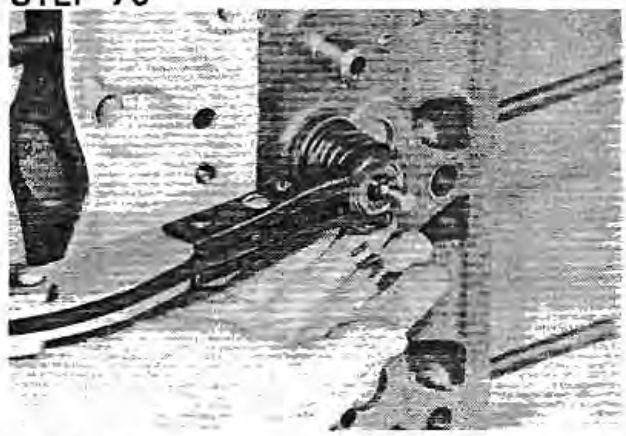
Install spring seat, spring (damping coils towards cylinder head) and spring retainer. *NOTE:* Check spring for broken coils and for proper specifications listed in Section 1026 or 1027, using a spring tester.

STEP 69



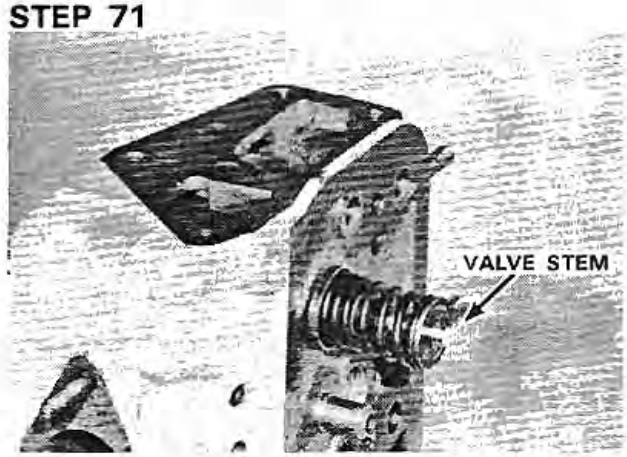
Compress valve spring with a spring compressor and install valve stem seal in lower stem groove.

STEP 70



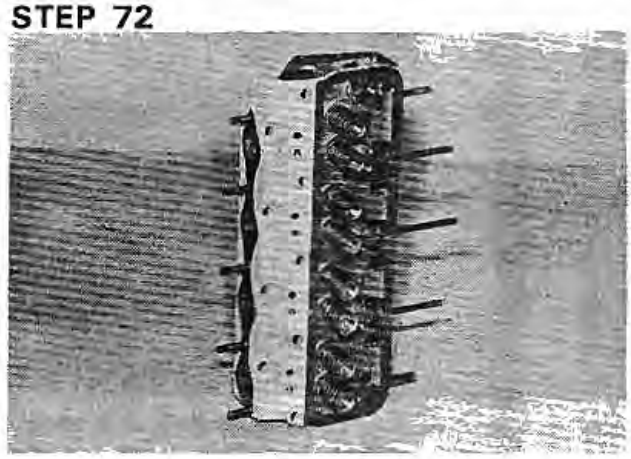
Install valve keepers on the top valve stem groove. *NOTE:* Always install new valve keepers when new valves are installed.

STEP 71



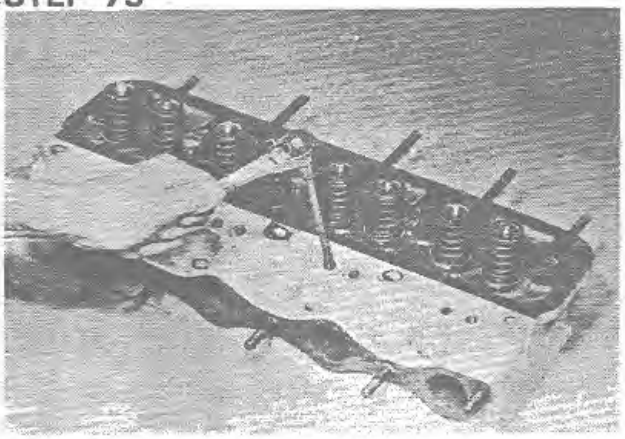
Remove the spring compressor and tap valve stem to seat keepers.

STEP 72



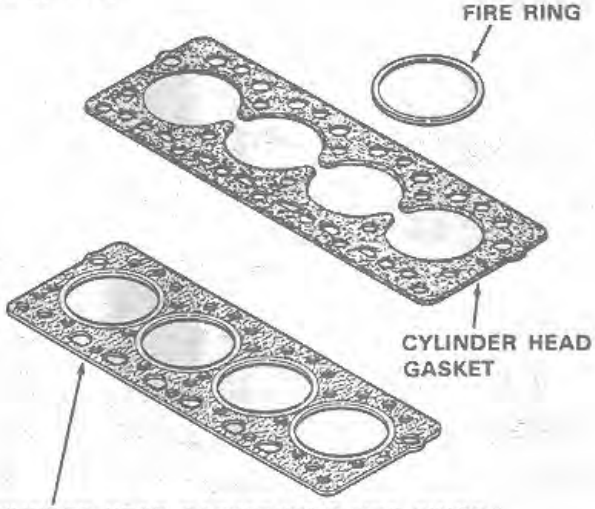
Install the other intake and exhaust valves, following the preceding procedure.

STEP 73

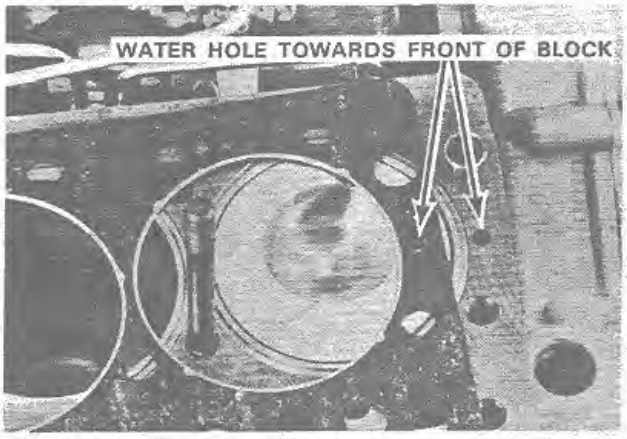


Before installing cylinder head on block, clean the injector bores using A43277 reamer.

STEP 74

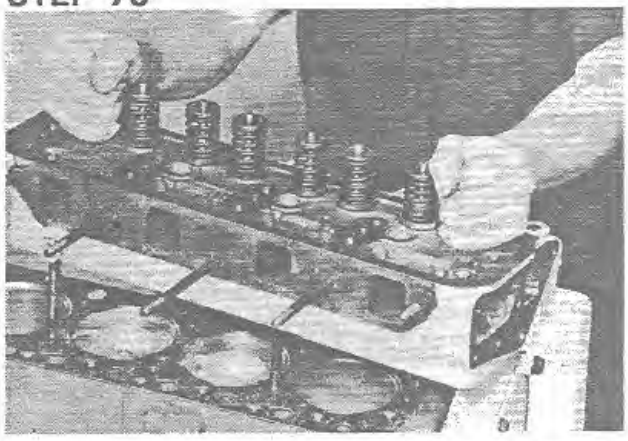


CYLINDER HEAD GASKET WITH FIRE RINGS PART OF GASKET



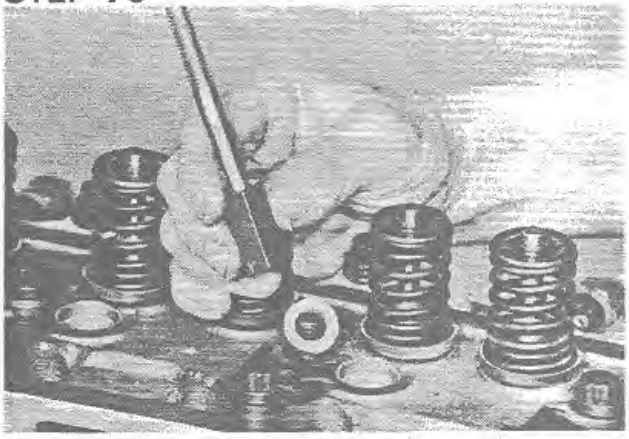
Install a new cylinder head gasket and check to see that all gasket holes align with block holes and especially that the 1/4" water hole of gasket is towards the front of the block. *NOTE:* Refer to Sections 2025 or 2125, sleeve protrusion, if you are experiencing head gasket leakage problems.

STEP 75



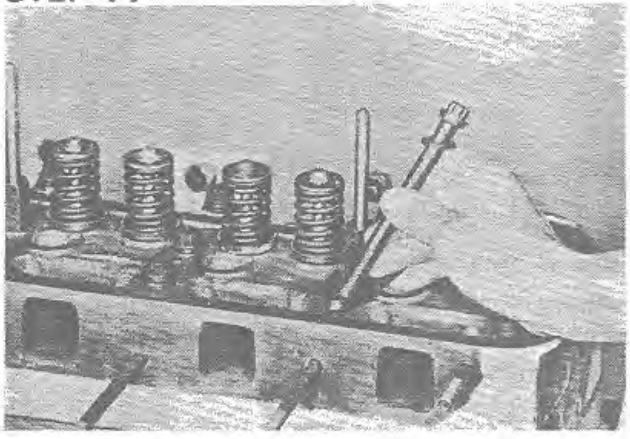
Carefully slide the cylinder head over the cylinder block and valve cover studs, down on the aligning dowels until resting on the block.

STEP 76



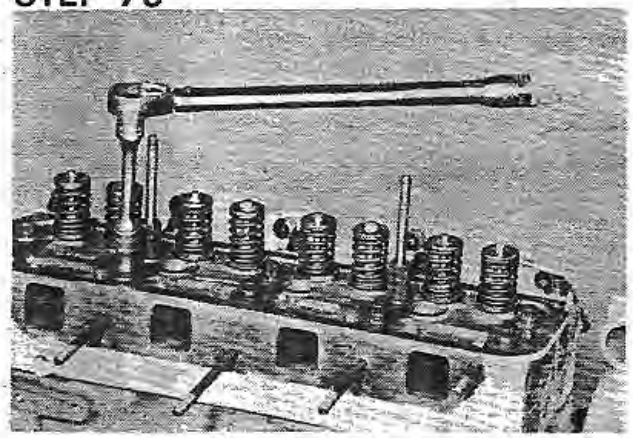
Install washers and valve cover mounting nut and stud assembly over the valve cover studs.

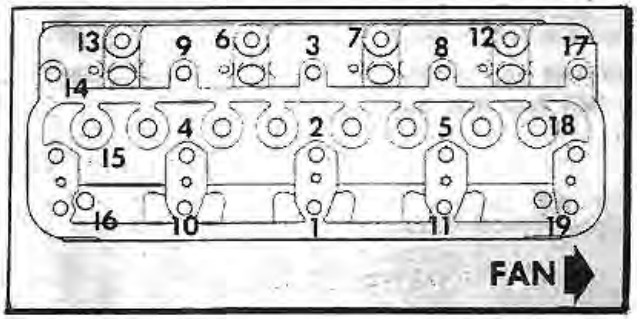
STEP 77

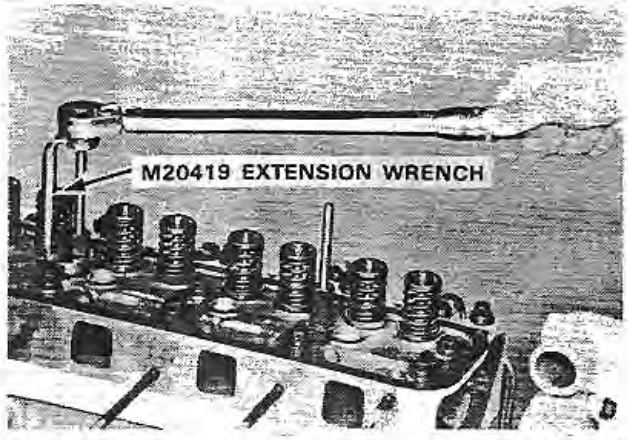


Install cylinder head bolts and washers or nuts.

STEP 78



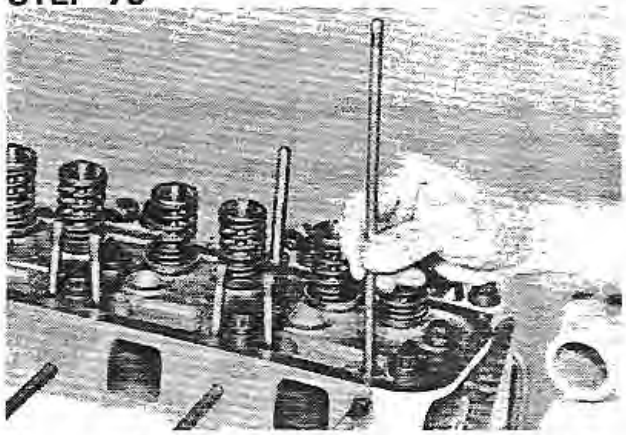




Coat bolt threads, washers and underside of bolt heads or nuts (where used) with HDM #30 oil. Torque all cylinder head bolts and nuts (on to stud) using a torque of 50% to 70% of final torque listed below and in a sequence as shown in inset. Repeat torquing sequence and bring nuts or bolts to full torque.

1. Nuts w/hardened washers-torque 95-105 ft. lbs.
2. Grade 8, 12 pt. hd. bolts - torque 110-115 ft. lbs.
3. Flanged nuts - torque 90-100 ft. lbs.

STEP 79



Check push rods for wear and straightness before installing into cylinder head. Coat push rods with HDM #30 oil.

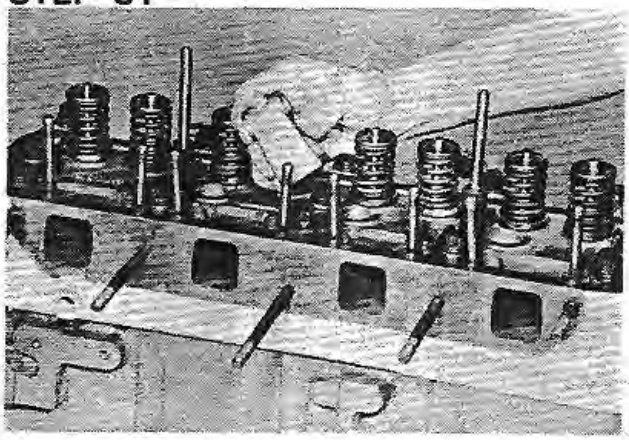
Rocker Arm Assembly

STEP 80

Flush the rocker arm shafts to remove any residual material. Inspect shafts for worn spots on the bottom side of shaft. Replace the shafts if a worn condition exists. Coat all parts with HDM #30 oil.

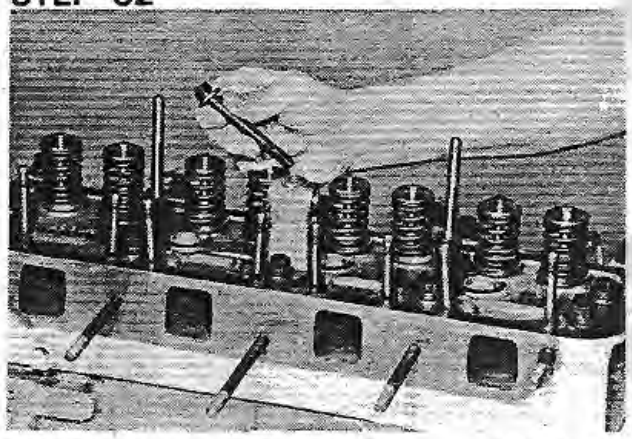
IMPORTANT: Before installing the rocker arm assembly on the cylinder head, the location of the special drilled bolt must be determined for rocker arm lubrication. Prior to engine serial number 2072089, the drilled bolt must be located in the center rocker arm mounting bracket. After engine serial number 2072089, the drilled bolt must be located in the rear rocker arm mounting bracket.

STEP 81



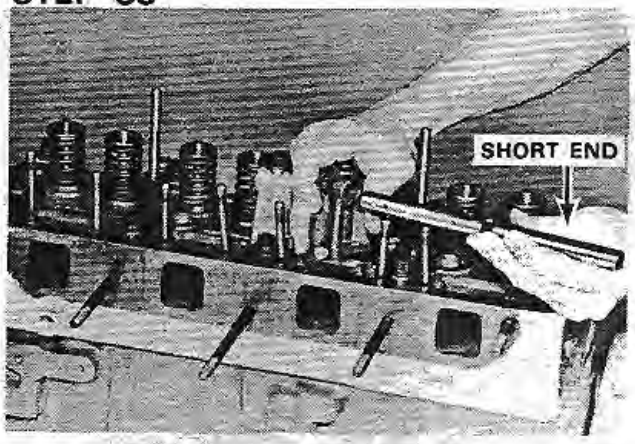
Install center rocker arm bracket on cylinder head.

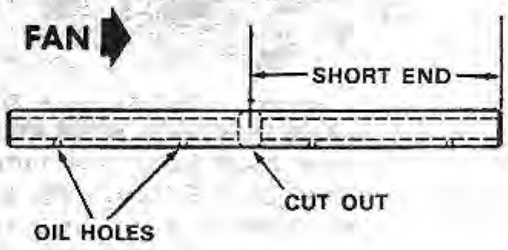
STEP 82



Install bolt and washer (drilled or undrilled, see Step 80) into the center bracket.

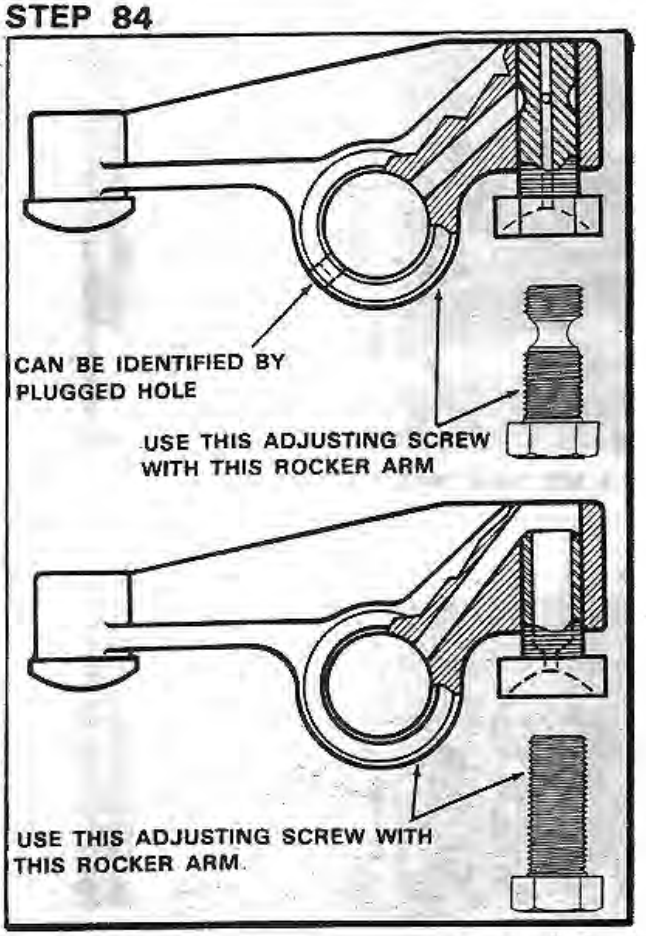
STEP 83

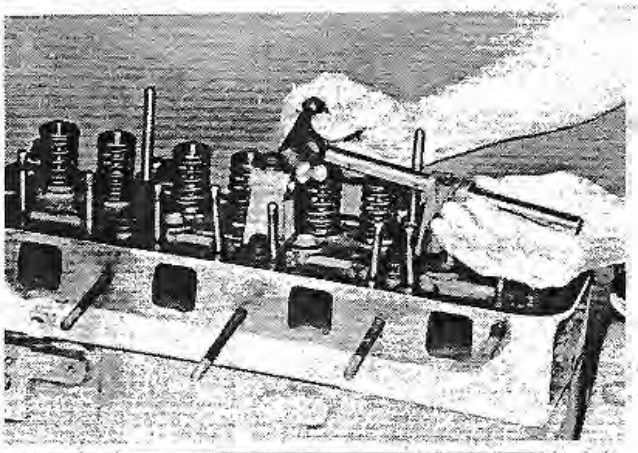


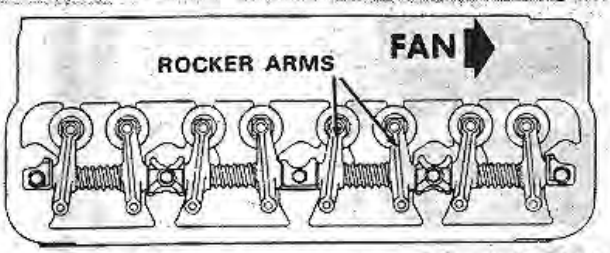


Install the front rocker arm shaft into the intermediate bracket. *NOTE:* The front shaft is installed with the short end of the shaft (from the cut-out) towards the front of the engine. The rear shaft is installed with the short end of the shaft (from the cut-out) towards the rear of the engine. On shafts with oil holes drilled only on one side, point the oil holes downward and on shafts with oil holes drilled on both sides, align the holes in a horizontal plane.

STEP 84

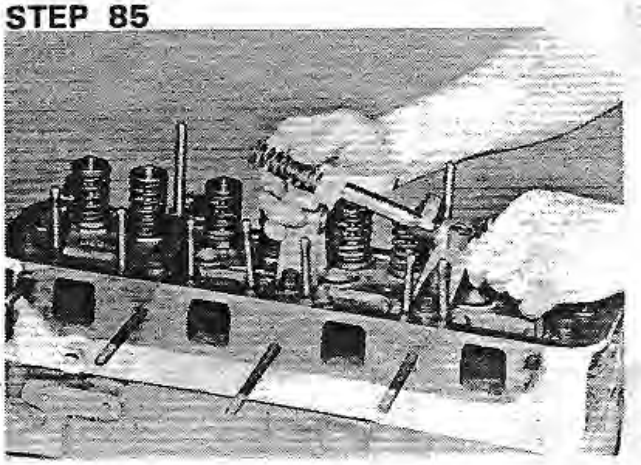






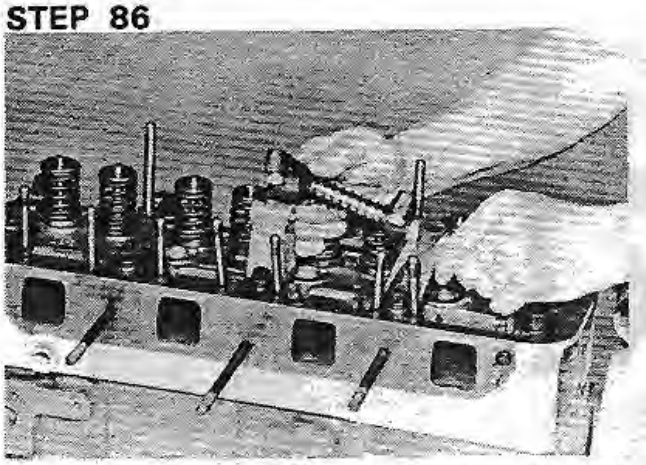
Install a right hand rocker arm on shaft with correct slant of arm in correct position as shown. *NOTE:* Failure to use the correct adjusting screw with designated rocker arm, will result in lack of lubrication to the valve train. Rocker arms are completely interchangeable. See above inset.

STEP 85



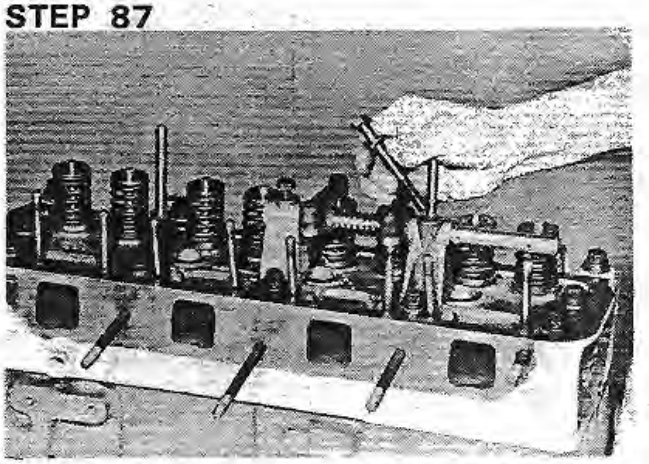
Install spring.

STEP 86



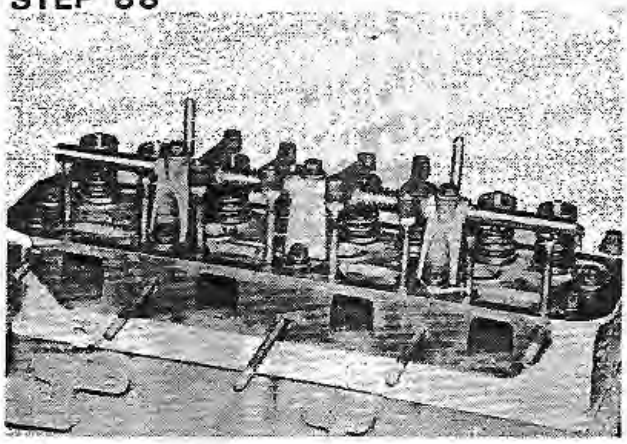
Install a left hand rocker arm. *NOTE:* Left hand is determined in this manner: when standing on the push rod side of the cylinder head, the rocker arm will slant away from the valve towards the left.

STEP 87



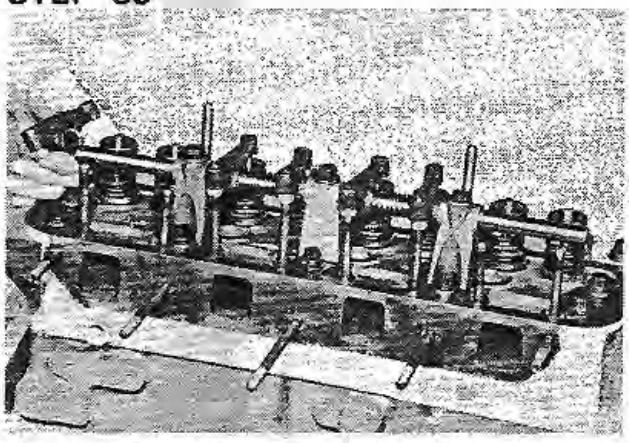
Install end of shaft assembly into the center bracket and install bolt and washer into the intermediate bracket.

STEP 88



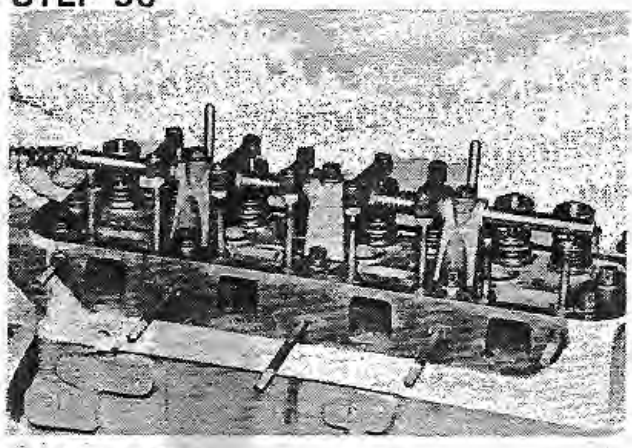
Assemble and install the rear intermediate shaft assembly following steps 83 thru 87.

STEP 89



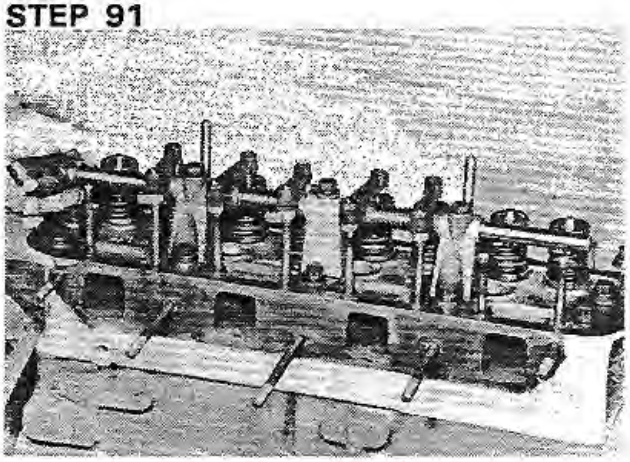
Install a right hand rocker arm on shaft.

STEP 90



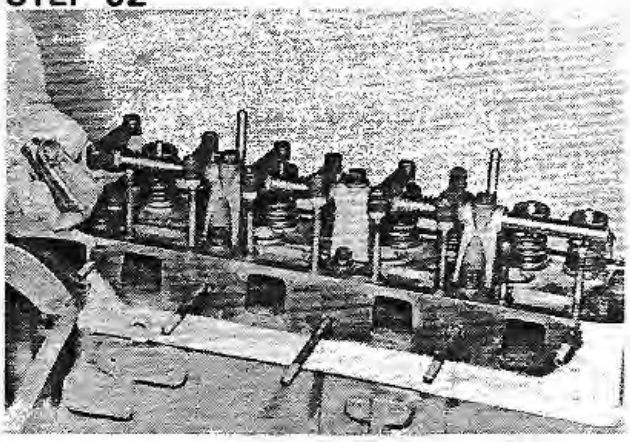
Install a spring.

STEP 91



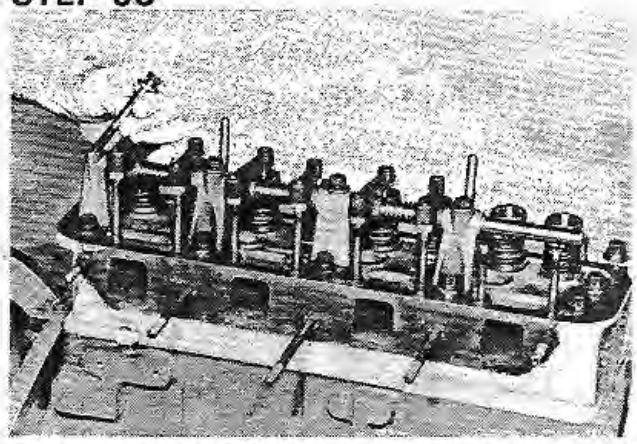
Install a left hand rocker arm.

STEP 92



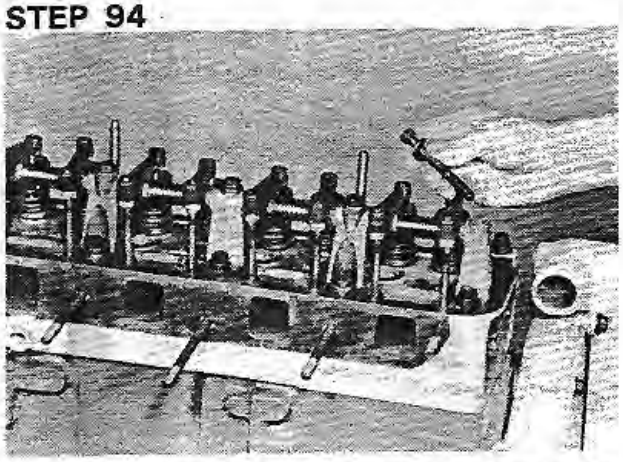
Install rear bracket on shaft.

STEP 93



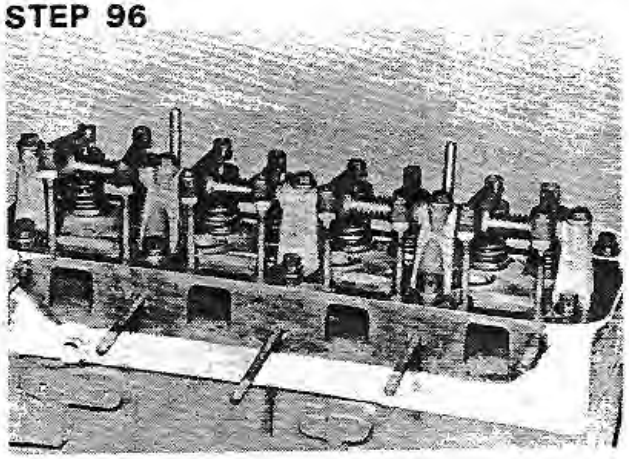
Install bolt (drilled or undrilled, see Step 80) and washer into the rear bracket.

STEP 94



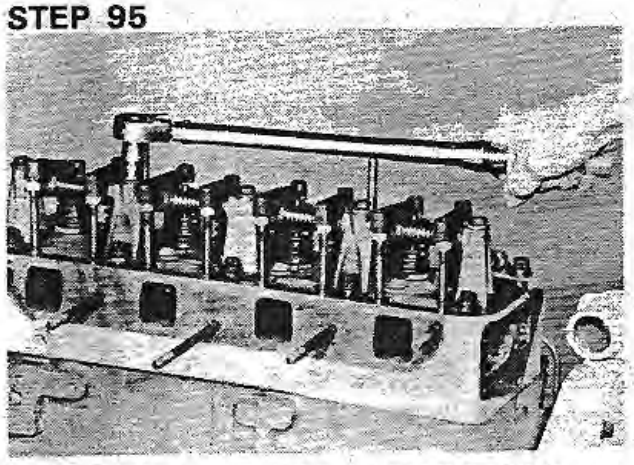
Assemble and install the front rocker arm assembly, following steps 89 thru 93. *NOTE:* The front bracket mounting bolt is always undrilled.

STEP 96



Completed rocker arm assembly.

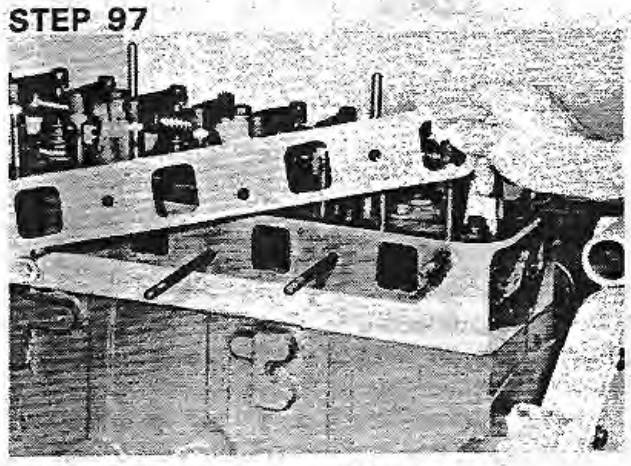
STEP 95



Torque rocker arm bracket bolts 25 to 30 ft. lbs.

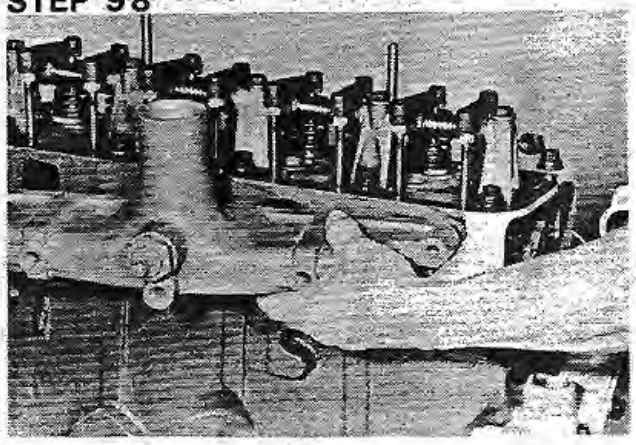
Manifolds, Water Pump & Fuel Injectors Installation

STEP 97



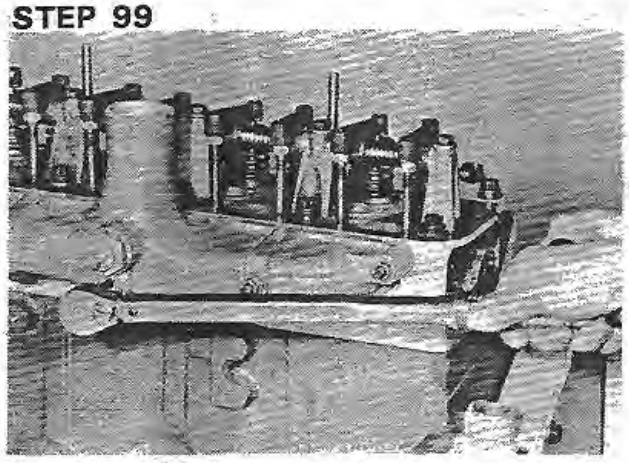
Install a new intake manifold gasket.

STEP 98



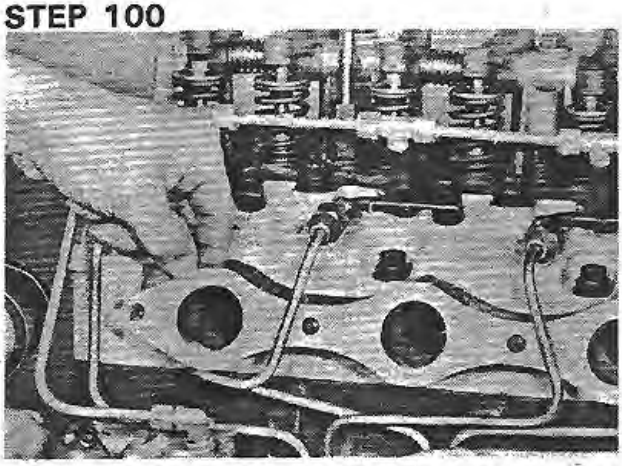
Install the intake manifold.

STEP 99



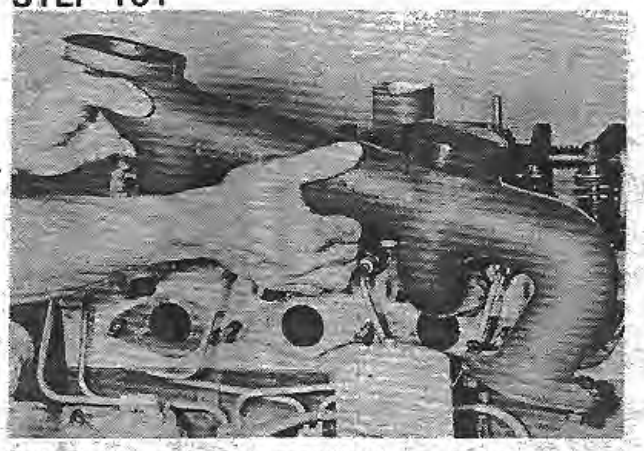
Torque the intake manifold nuts and washers accordingly: on aluminum manifold, torque nuts 30 to 35 ft. lbs., on cast iron manifold, torque nuts 25 to 30 ft. lbs.

STEP 100



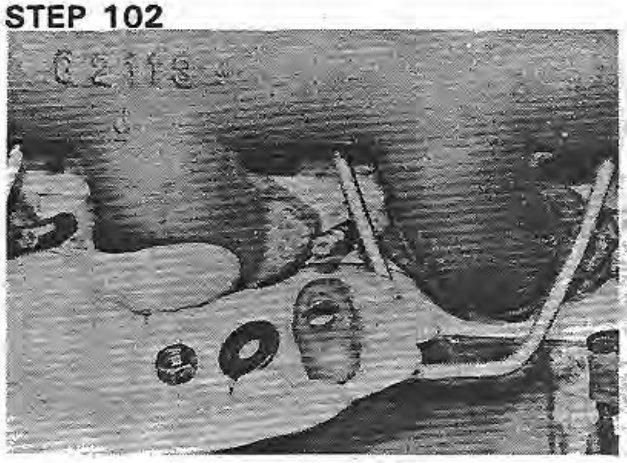
Install a new exhaust manifold gasket.

STEP 101



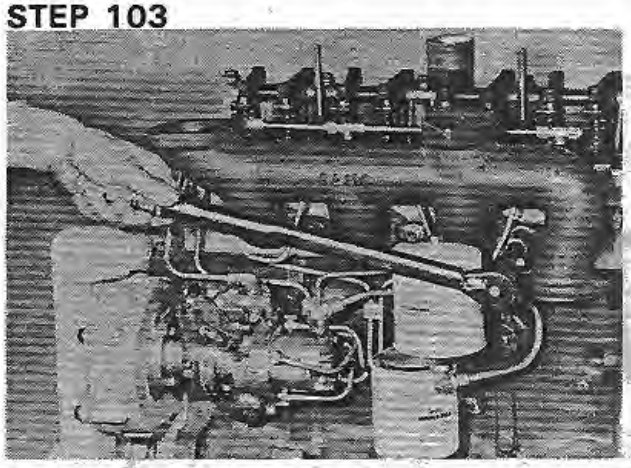
Install the exhaust manifold by holding front in raised position and installing rear of manifold on rear stud. Lower front of manifold down and install on front stud.

STEP 102



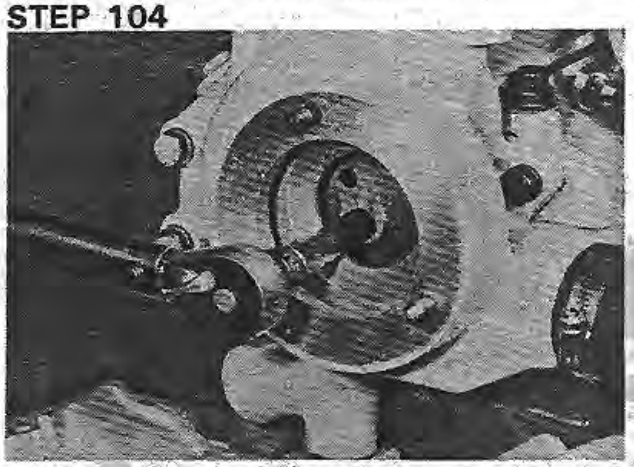
Install retaining clamps, washers and nuts.

STEP 103



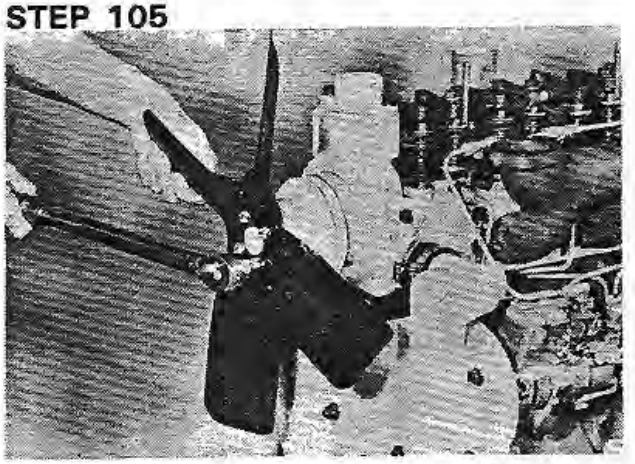
Torque nuts 25 to 30 ft. lbs.

STEP 104



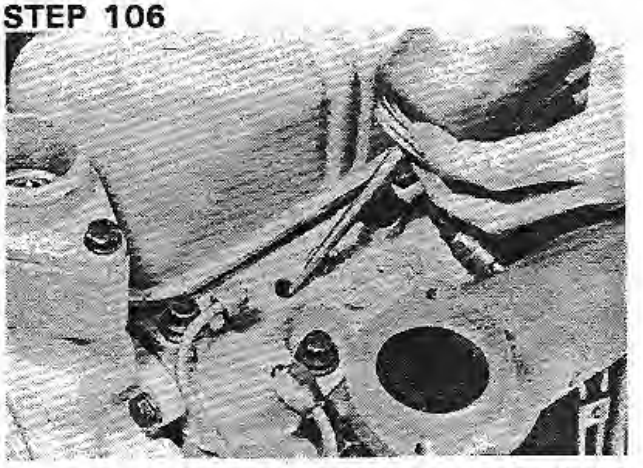
IMPORTANT: Apply Loctite Primer "T" and Loctite #271 (Case B17429 and B17423) on water pump housing inner socket hd.capscrew threads to prevent capscrew backing out into impeller. Install capscrew and torque 35 to 42 ft. lbs.

STEP 105



Install water pump, pulley, spacer (if equipped) and fan. Refer to Section 2055 for installation.

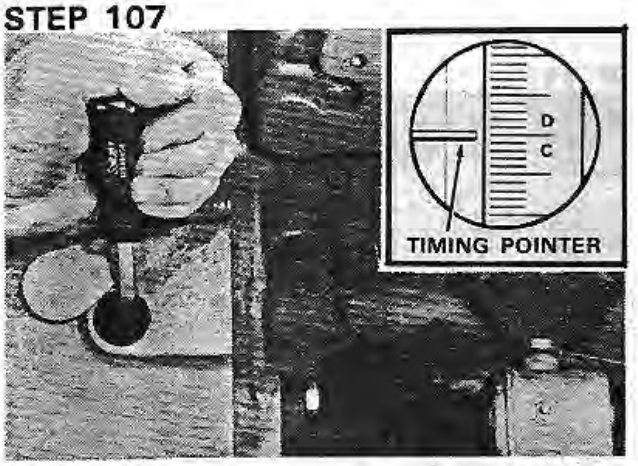
STEP 106



Install the fuel injectors. Refer to section 3013 for injector installation. *NOTE:* Squirt a few drops of HDM #30 oil in each cylinder head injector hole to provide lubricant for carbon dam at lower end of injector.

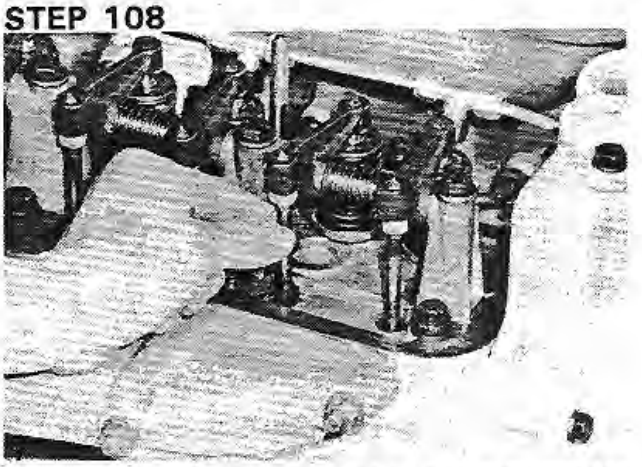
Locating Top Dead Center

STEP 107



Crank the engine by inserting a screwdriver into the timing hole in the flywheel housing or torque tube and by engaging the ring gear teeth with the screwdriver. align the timing pointer with the TDC timing mark on the flywheel.

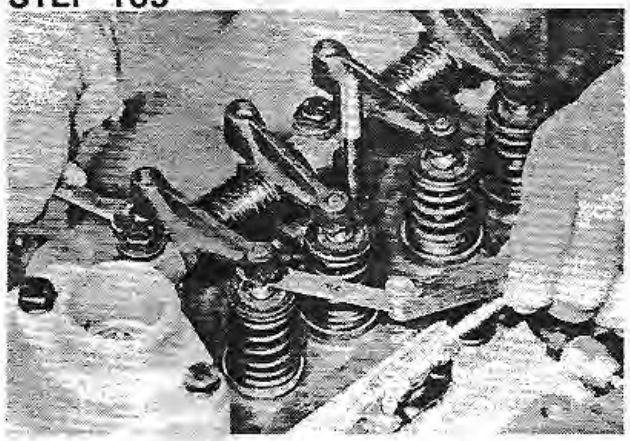
STEP 108



Check push rods on the number one cylinder for looseness. If push rods are loose, the number one cylinder is at TDC on the compression stroke. If push rods are tight, crank engine one complete revolution and align timing pointer with TDC mark on the flywheel.

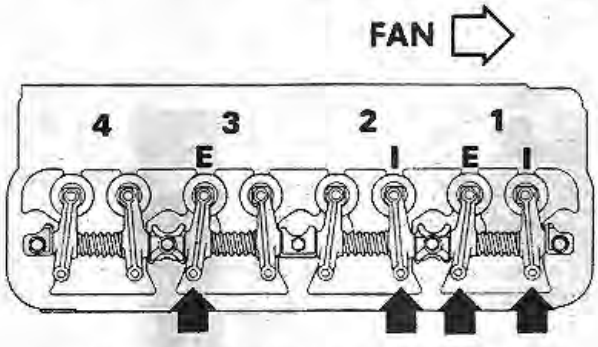
Valve Tappet Adjustment-Cold Setting

STEP 109



Check and adjust the intake and exhaust valves as pointed out by the arrows below.

Tappet Clearance Cold - Intake Valves .012"
Exhaust Valves .014"

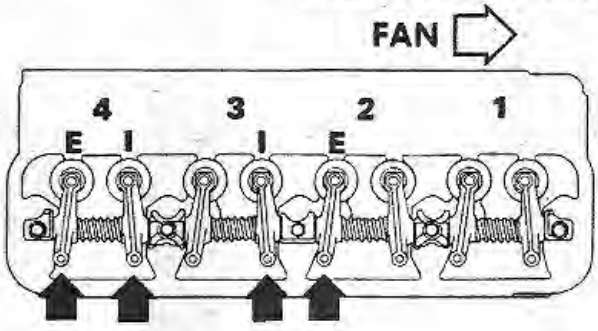


NO. 1 TDC COMPRESSION STROKE

STEP 110

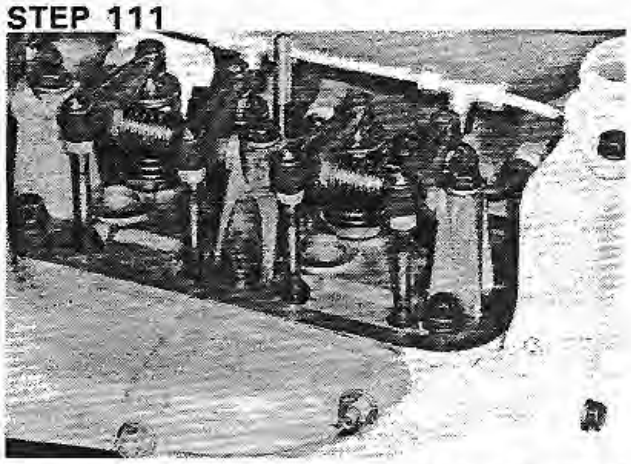
Crank the engine one complete revolution and align the timing pointer with the TDC mark on the flywheel. Check and adjust the intake and exhaust valves as pointed out by the arrows below.

Tappet Clearance Cold - Intake Valves .012"
Exhaust Valves - .014"



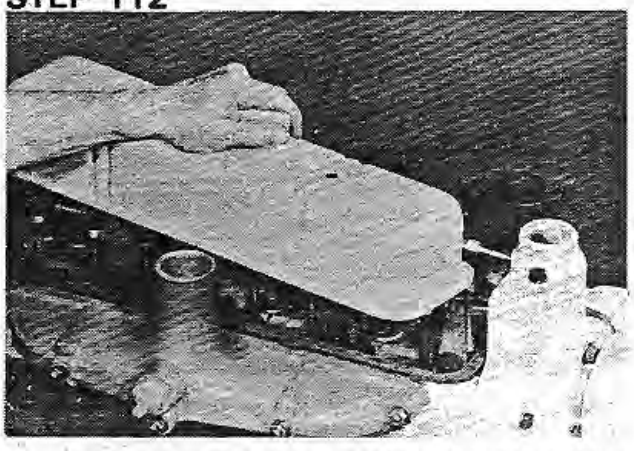
NO. 4 TDC COMPRESSION STROKE

STEP 111



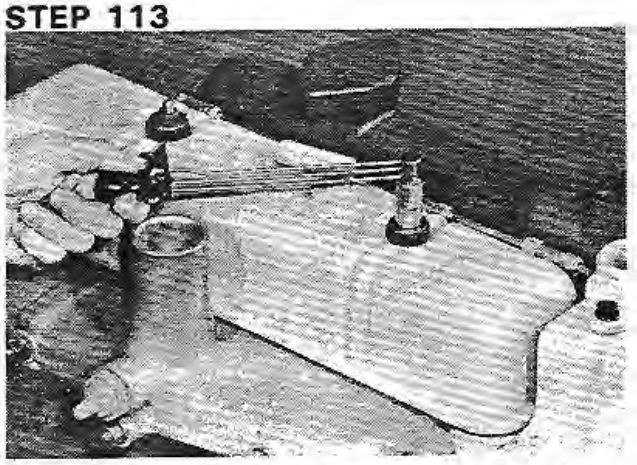
After the valve tappet adjustment (cold setting) is complete, start and run the engine. Check that the engine oil pressure gauge is registering in the green zone. Check the rocker arms to insure that they are receiving oil. *NOTE:* Squirt HDM #30 oil through valve springs to lubricate valve stems before starting the engine.

STEP 112



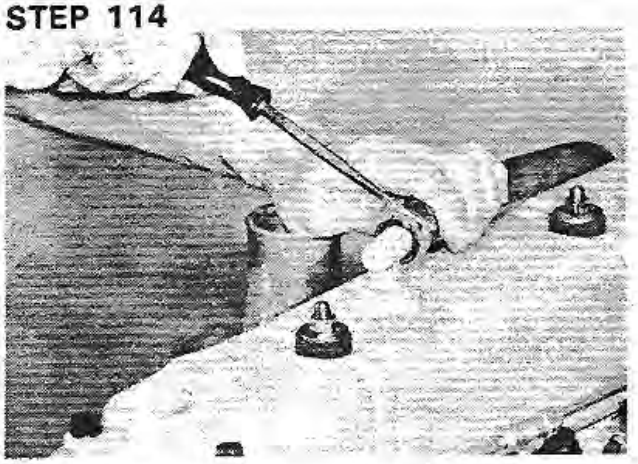
Shut the engine off and install valve cover gasket and valve cover.

STEP 113



Torque the valve cover nuts 4 to 6 ft. lbs.

STEP 114



Install breather tube.

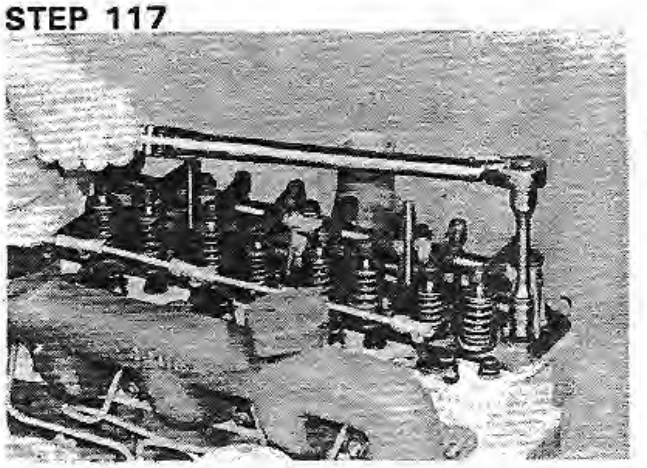
STEP 115

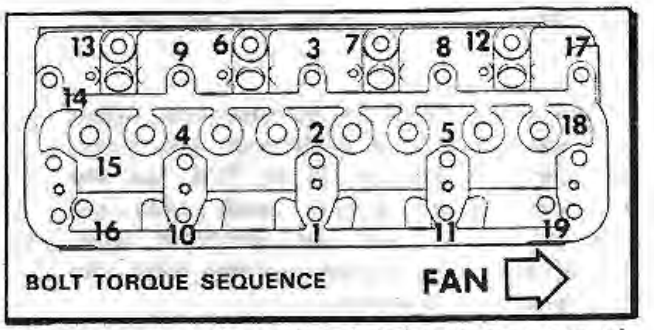
Start and run the engine approximately one hour (under load if possible), to thoroughly warm up the engine and seat the head gasket. Refer to Run-In-Procedure, section 1022.

STEP 116

After the engine has run for one hour, remove the breather tube and cylinder head valve cover. The cylinder head bolts (or nuts) and rocker arm mounting bracket bolts must be retorqued. Also the valve tappets must be readjusted. These functions must be performed while the engine is hot.

STEP 117

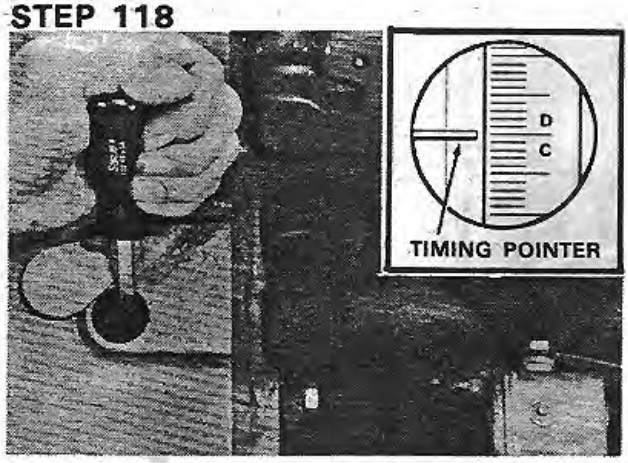




Loosen each cylinder head bolt or nut approximately 1/4 turn and then tighten it to the specified torquing procedure as listed in step 78 and in sequence as shown in inset. Do not loosen all nuts or bolts simultaneously, but loosen and tighten each individual nut and bolt in prescribed sequence. The nut or bolt is backed off 1/4 turn to break the set of the threads caused by heat, high stress and oxidation. If this is not done a false reading is obtained.

Retorque rocker arm mounting bracket bolts to insure they have retained 25 to 30 ft. lbs. torque.

STEP 118

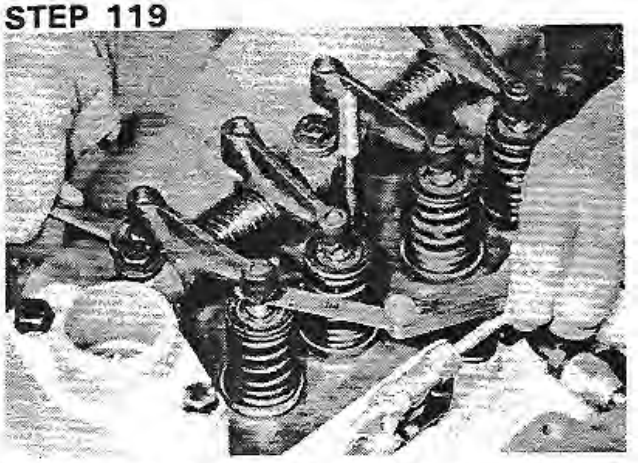


Crank the engine until the timing pointer is aligned with the TDC timing mark on the flywheel.

Check the push rods on number one cylinder for looseness. If the push rods are loose, the number one cylinder is at TDC on the compression stroke. If the push rods are tight, crank the engine one complete revolution and align the timing pointer with the TDC mark on the flywheel.

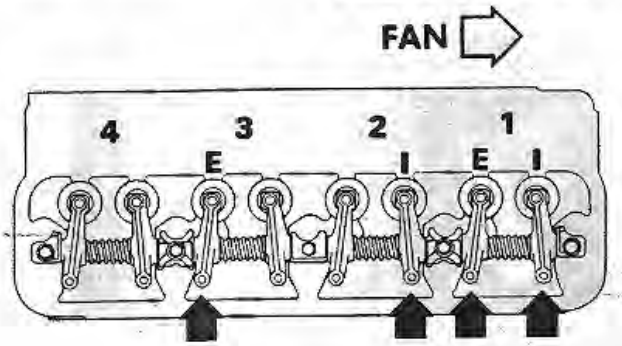
Valve Tappet Adjustment - Hot Setting With Engine Stopped

STEP 119



Check and adjust the intake and exhaust valves as pointed out by the arrows below.

Tappet Clearance Hot - Intake Valves .012"
Exhaust Valves .014"

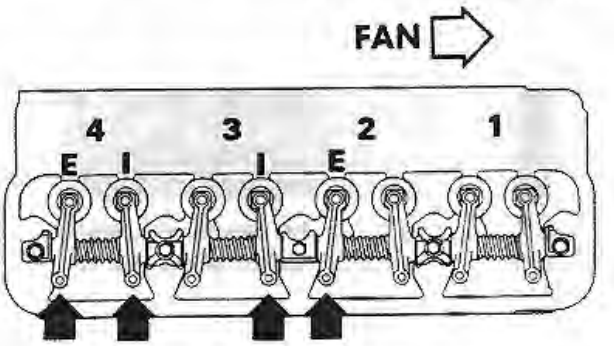


NO. 1 TDC COMPRESSION STROKE

STEP 120

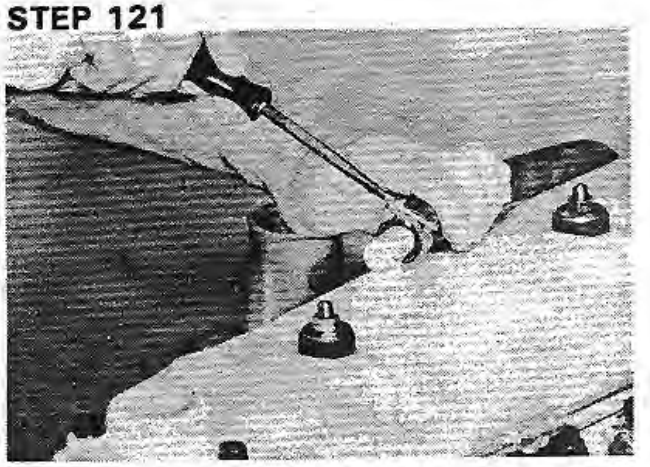
Crank the engine one complete revolution and align the timing pointer with the TDC mark on the flywheel. Check and adjust the intake and exhaust valves as pointed out by the arrows below.

Tappet Clearance Hot - Intake Valves .012"
Exhaust Valves .014"



NO. 4 TDC COMPRESSION STROKE

STEP 121

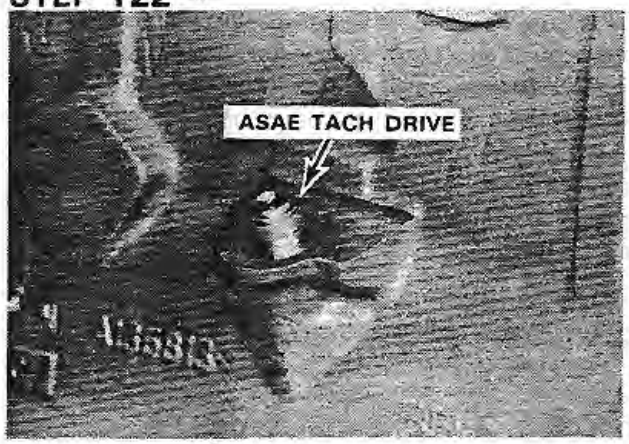


Install the cylinder head gasket and cover, torque cover nuts 4 to 6 ft. lbs. Reinstall breather tube.

Camshaft, Valve Train and Backlash

REMOVAL

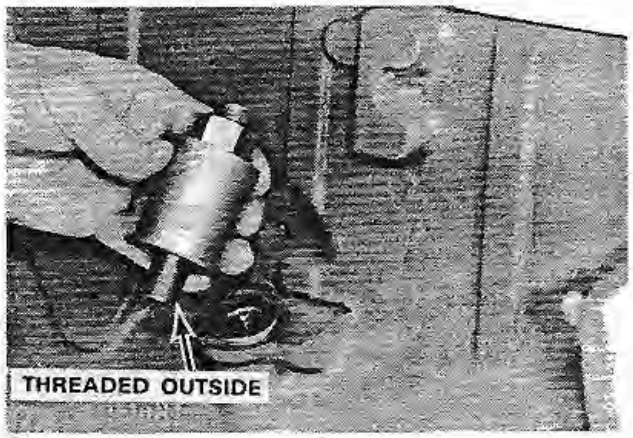
STEP 122



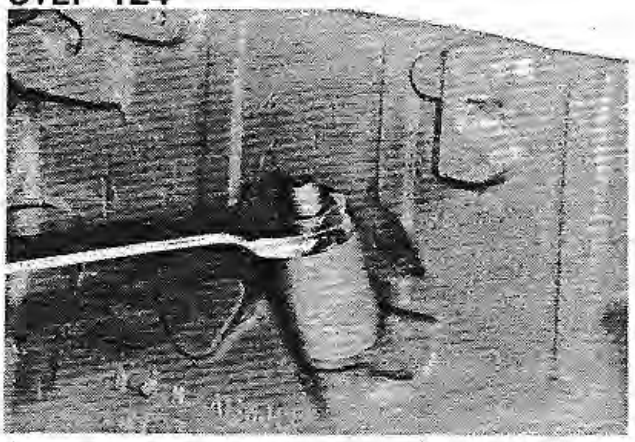
Before the camshaft can be removed from the engine, the tachometer drive must be removed.

STEP 123

To remove the tachometer drive, a special tool must be made. Refer to specifications for making special tools, found on page 5.

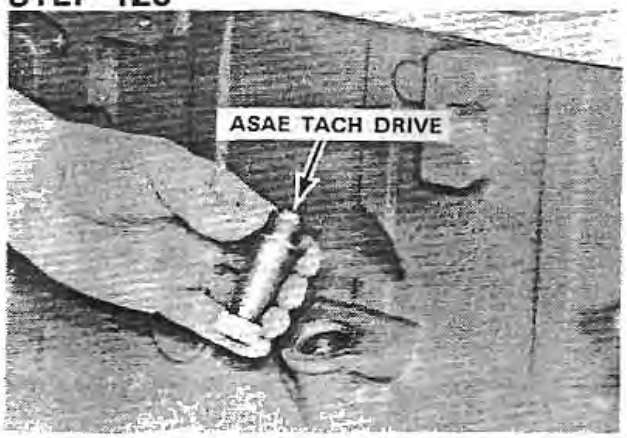


STEP 124

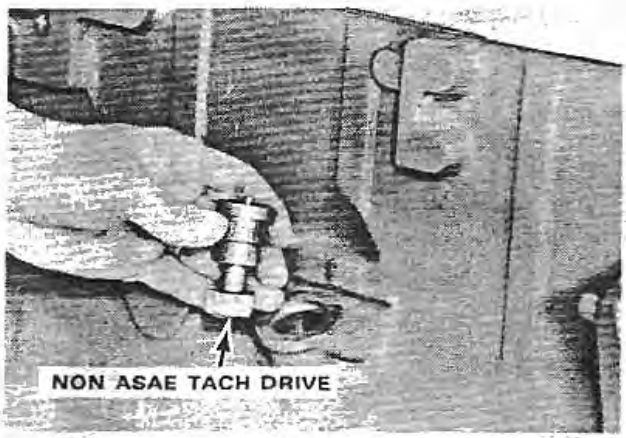


Screw the tool into or onto the tachometer drive and pull drive from engine.

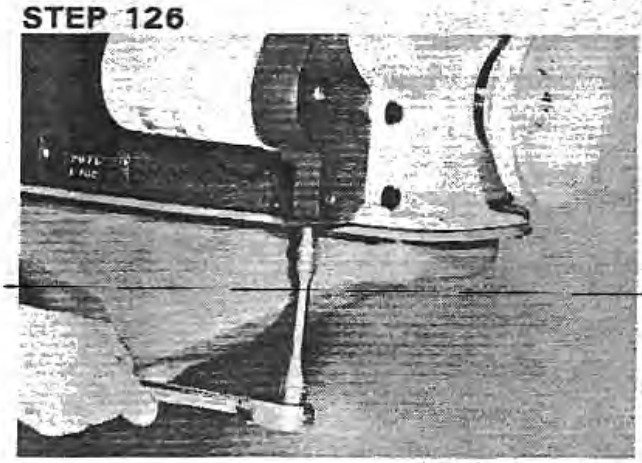
STEP 125



Remove the tachometer drive from the special tool.

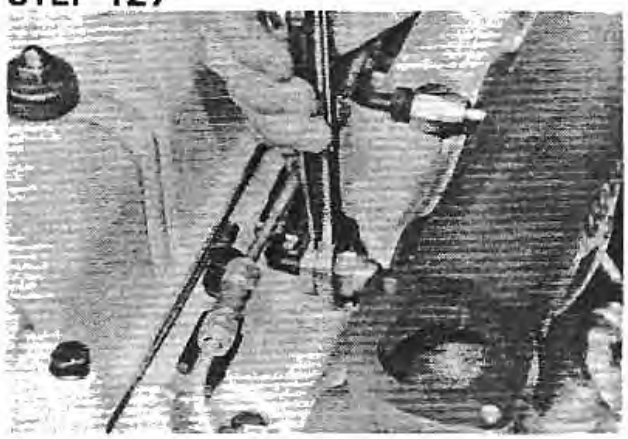


STEP 126



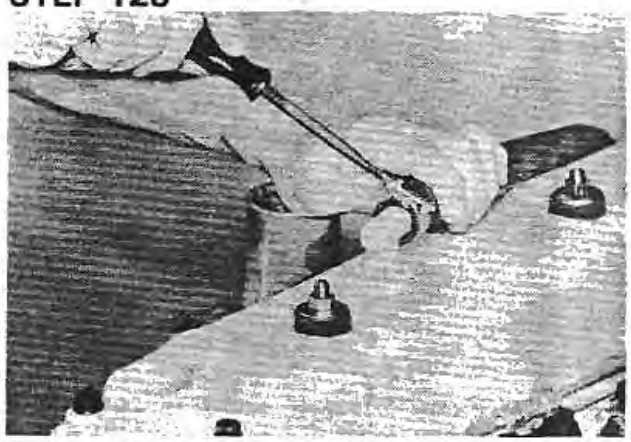
Remove the engine oil pan.

STEP 127



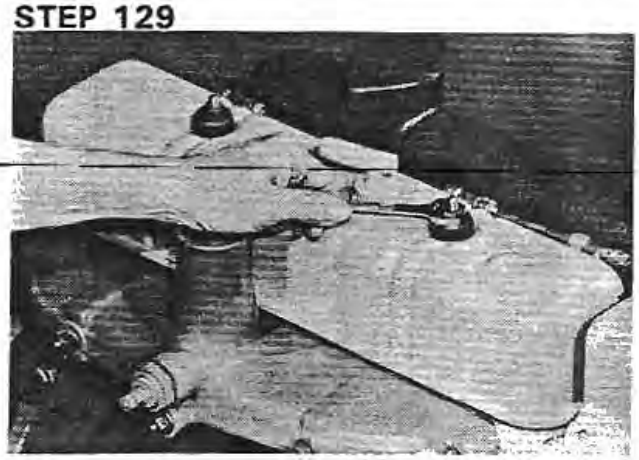
Disconnect fuel injectors inlet fitting using the one-hand, two wrench method to minimize damage.

STEP 128



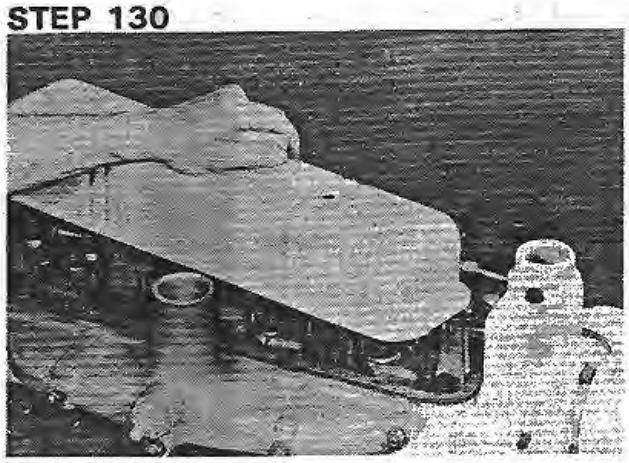
Remove breather tube.

STEP 129



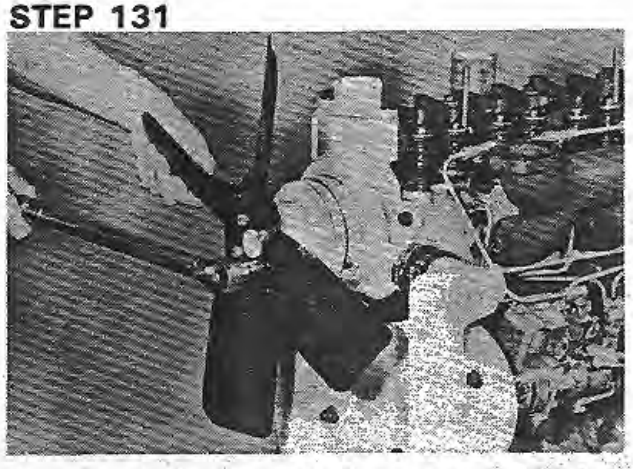
Remove valve cover nuts and gaskets.

STEP 130



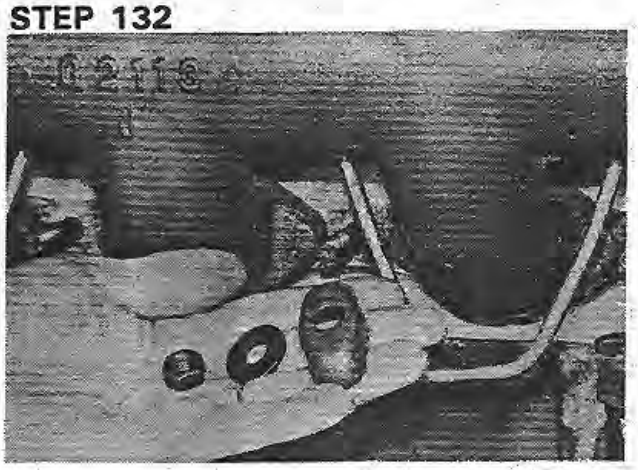
Remove valve cover.

STEP 131



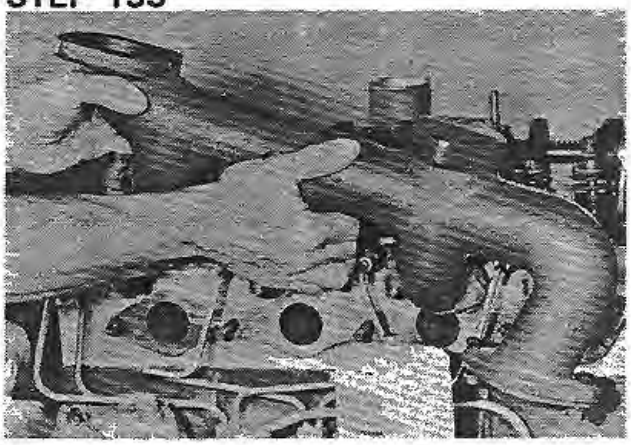
Remove water pump & water pump housing. Refer to Section 2055.

STEP 132



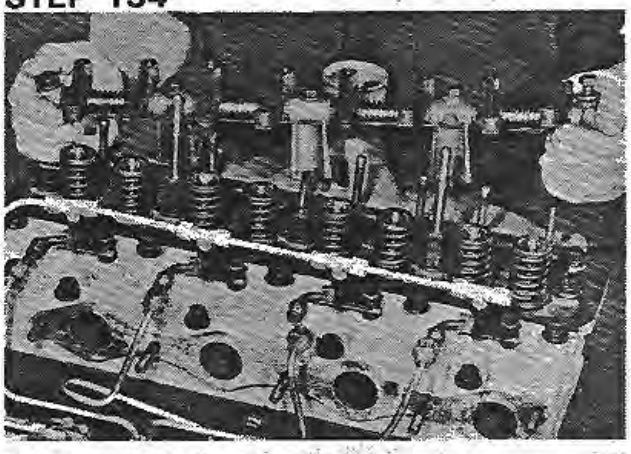
Remove exhaust manifold retaining clamps, washers and nuts.

STEP 133



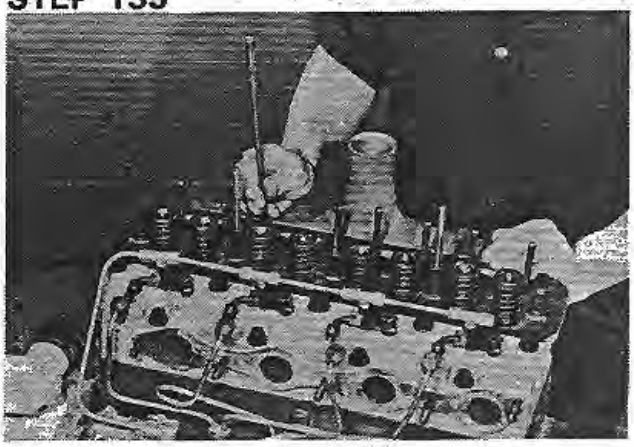
Remove exhaust manifold by removing front of manifold from front stud, swing manifold upward and remove manifold from rear stud and away from engine.

STEP 134



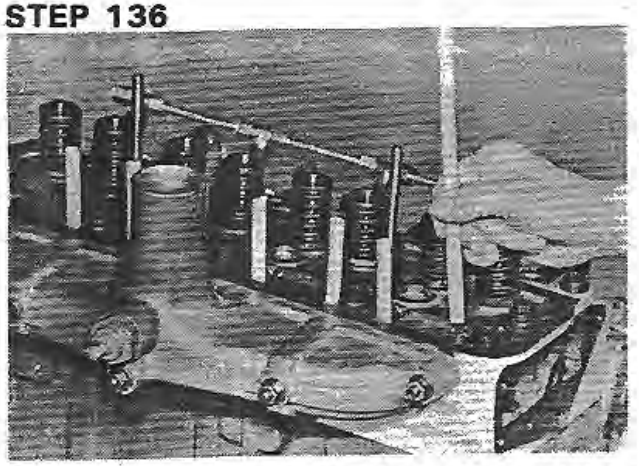
Remove rocker arm assembly.

STEP 135



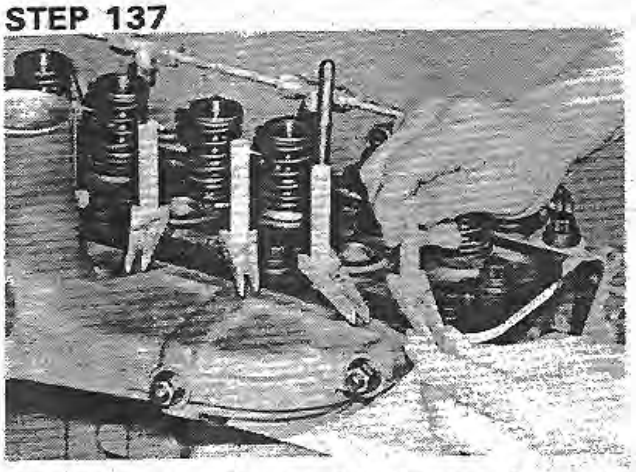
Remove push rods.

STEP 136



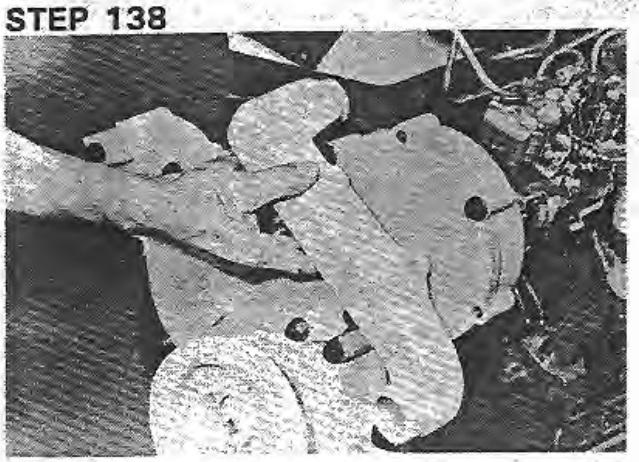
The valve lifters must be lifted off cam lobes and retained in place in order to remove the camshaft. Cut 8 wood dowels (approximately 3/8" dia. x 1' long) and insert into push rod openings in cylinder head. Push the dowels into the valve lifters hole.

STEP 137



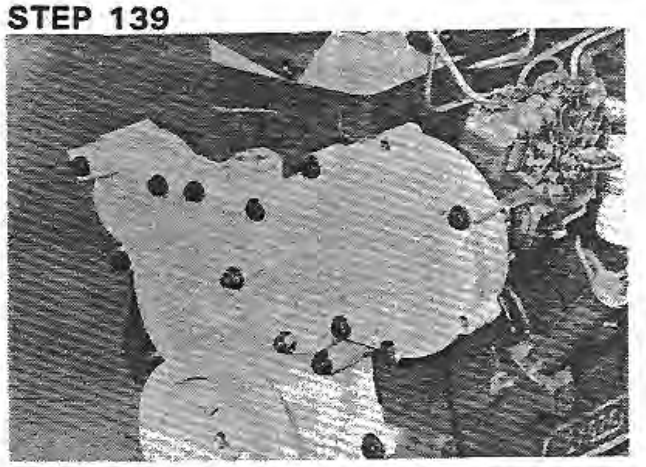
Raise the valve lifters with the wood dowels and retain in place with clothespins.

STEP 138

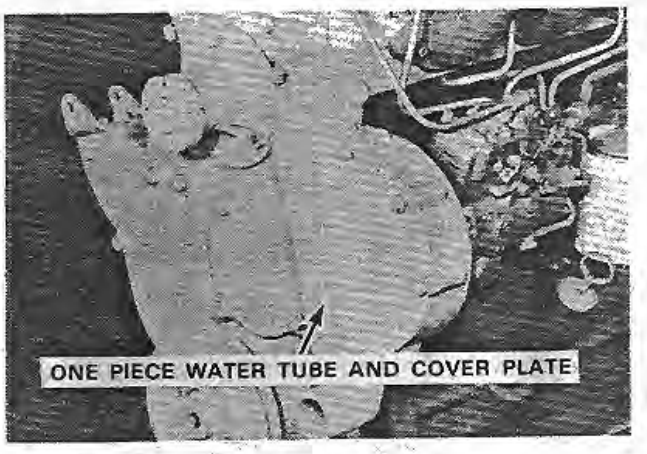


Remove water tube.

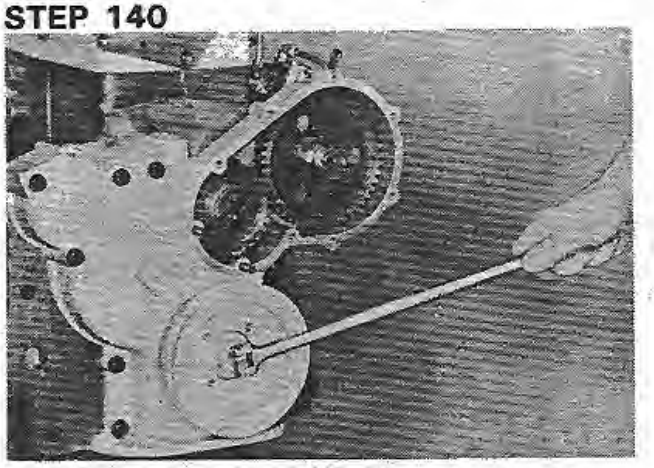
STEP 139



Remove cover plate. *NOTE:* If equipped with one piece water tube and cover plate, remove.

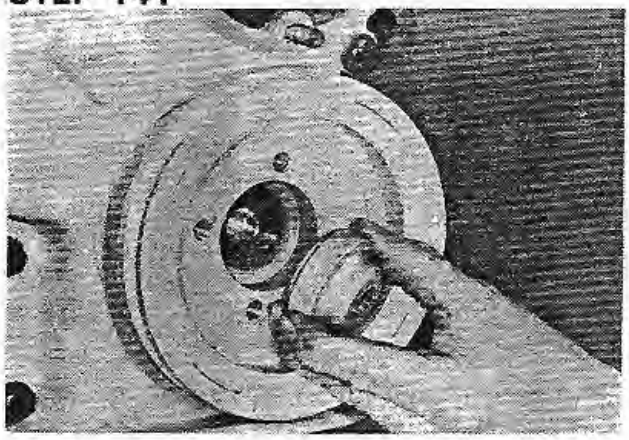


STEP 140



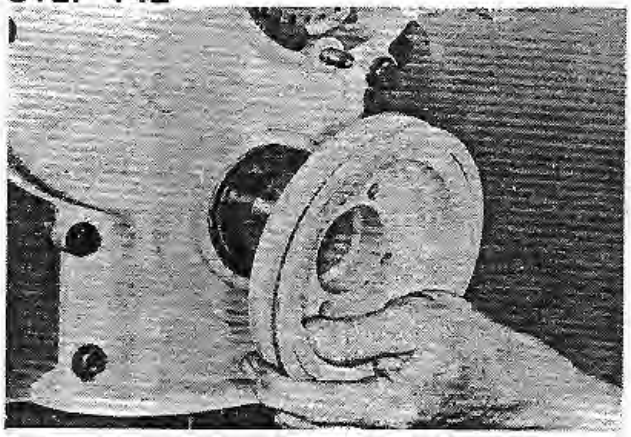
Loosen crankshaft pulley mounting nut.

STEP 141



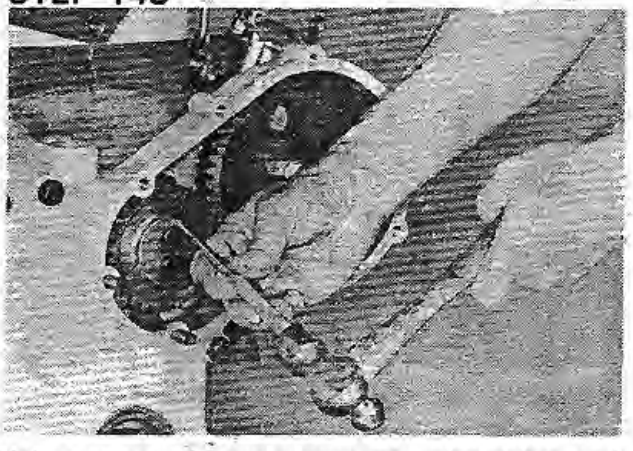
Remove crankshaft pulley mounting nut.

STEP 142



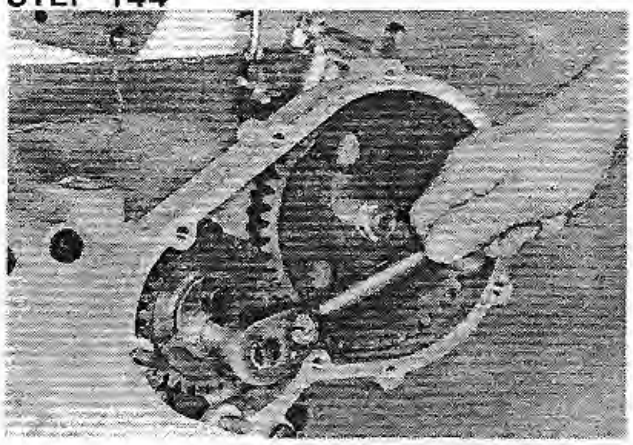
Remove crankshaft pulley.

STEP 143



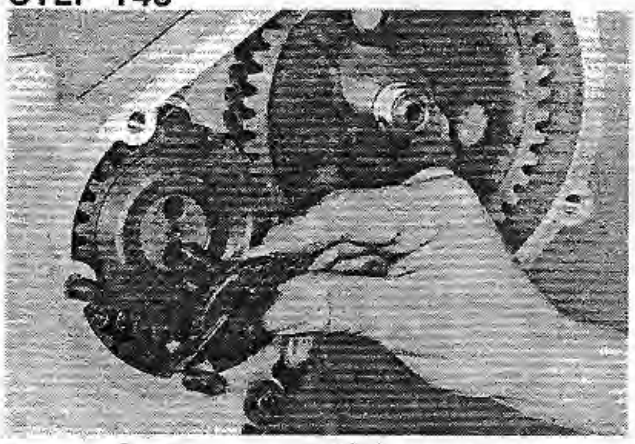
Using a punch and hammer, straighten out lock tab on the idler gear lock plate.

STEP 144



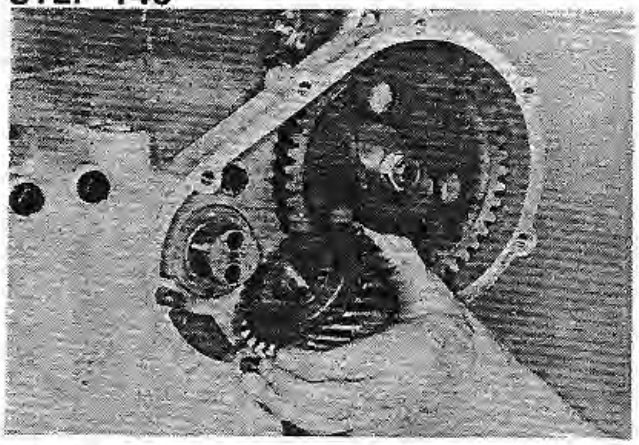
Loosen idler gear mounting bolts.

STEP 145



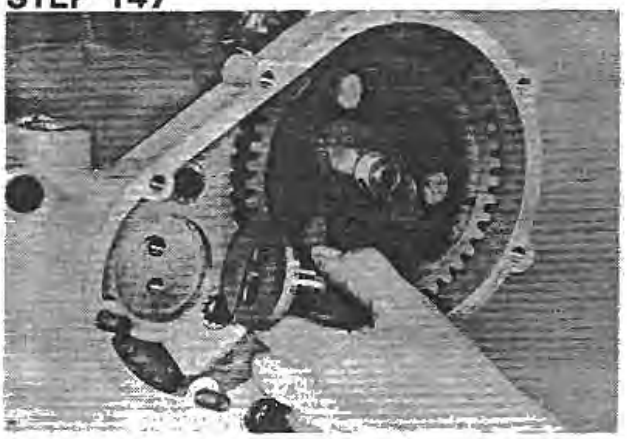
Remove bolts, lock plate, thrust plate and shims.

STEP 146



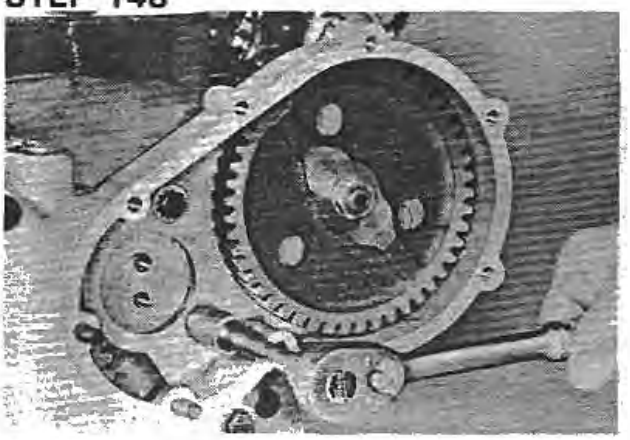
Remove idler gear.

STEP 147



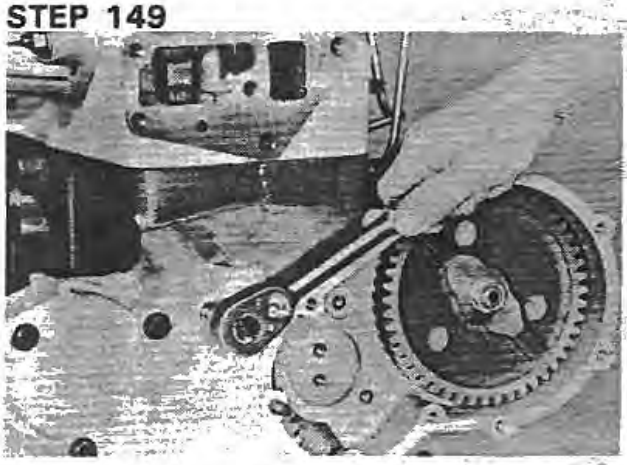
Remove the idler gear hub shaft.

STEP 148



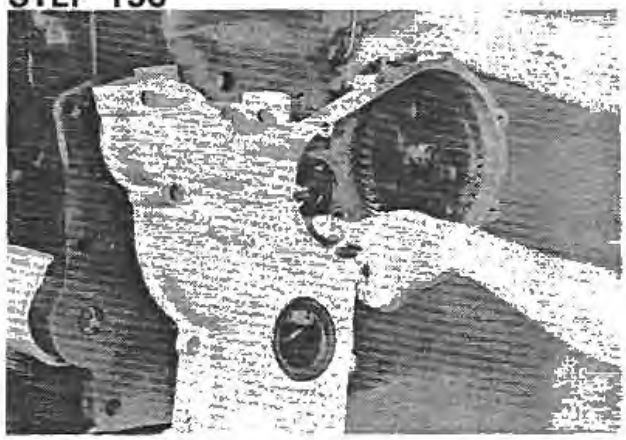
Remove two inside bolts from timing gear cover.

STEP 149



Remove timing gear cover mounting bolts.

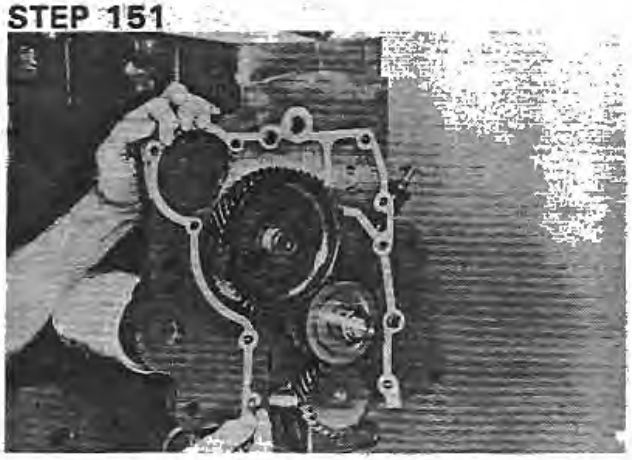
STEP 150



Remove timing gear cover with attached fuel pump.

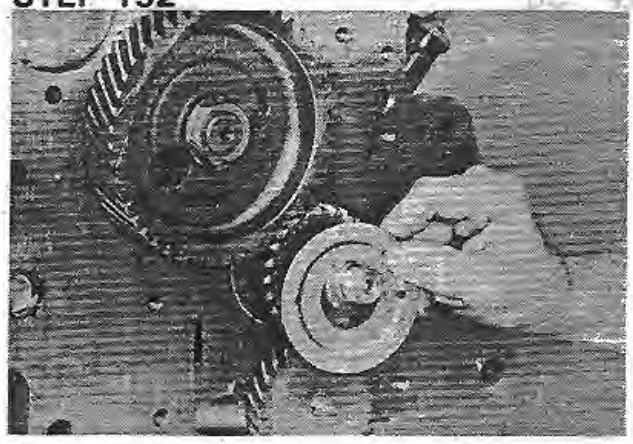
If equipped, remove the one piece water pump and timing gear housing assembly. *NOTE:* If a stud and nut is located in place of a bolt at point "A", the water pump must be removed and the inner socket hd. capscrew must be removed in order to remove the timing gear housing.

STEP 151



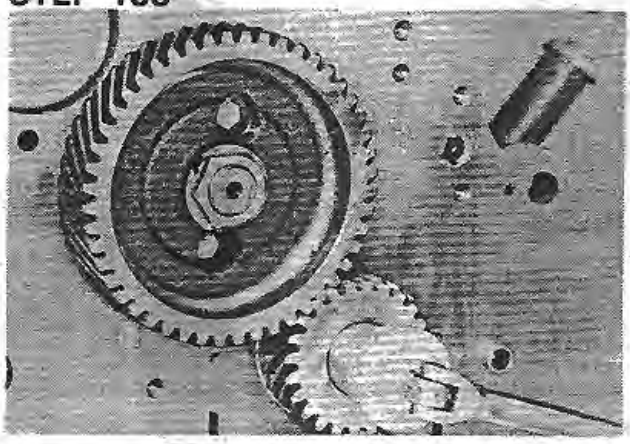
Remove timing gear housing gasket.

STEP 152



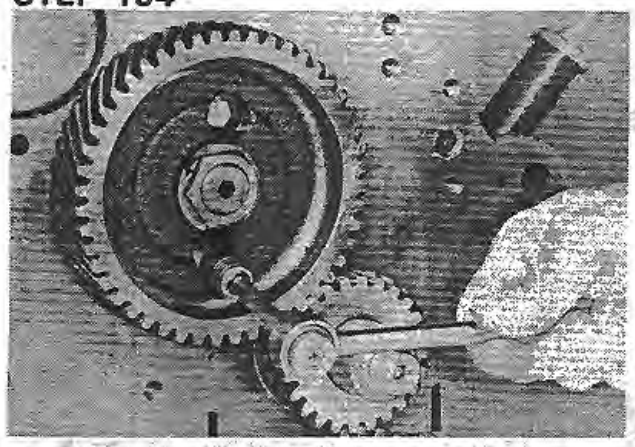
Remove oil slinger from crankshaft.

STEP 153



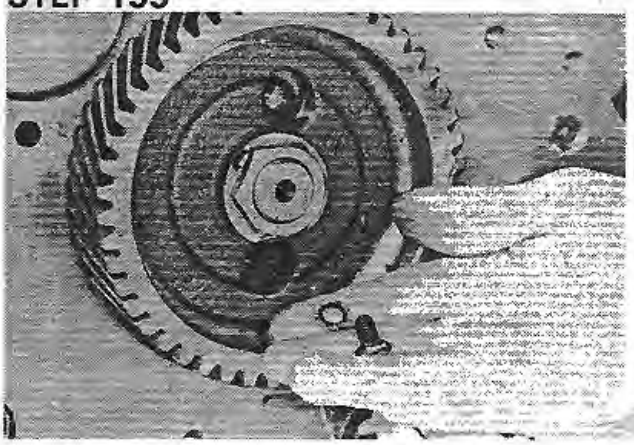
Align holes in cam gear with thrust plate mounting bolts.

STEP 154



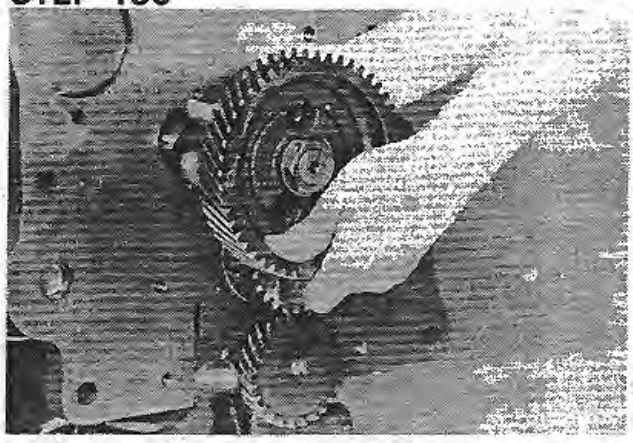
Loosen thrust plate mounting bolts.

STEP 155



Remove bolts and external tooth washers.

STEP 156



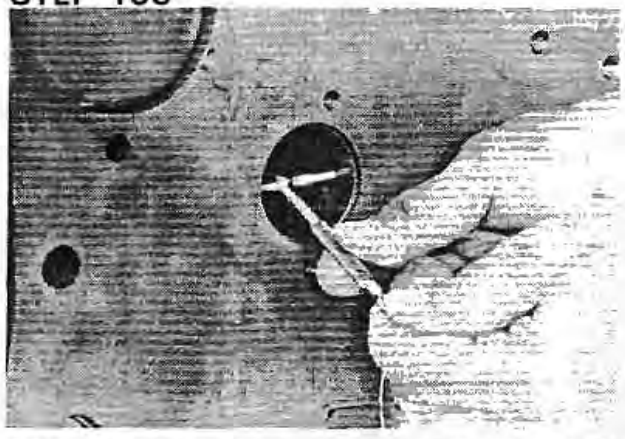
Remove camshaft from the block.

STEP 157

Camshaft removed from block.

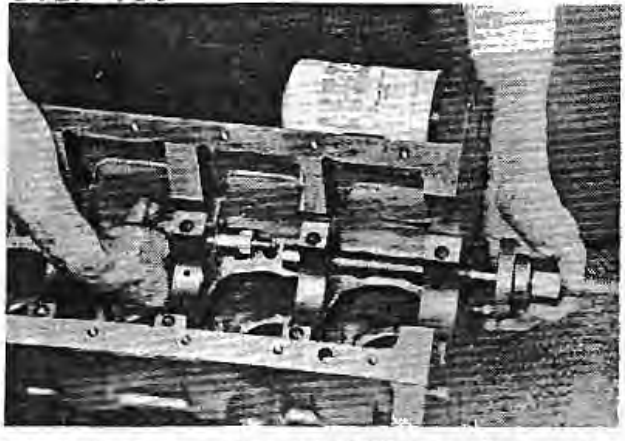
Front, Intermediate And Center Camshaft Bushing Replacement

STEP 158



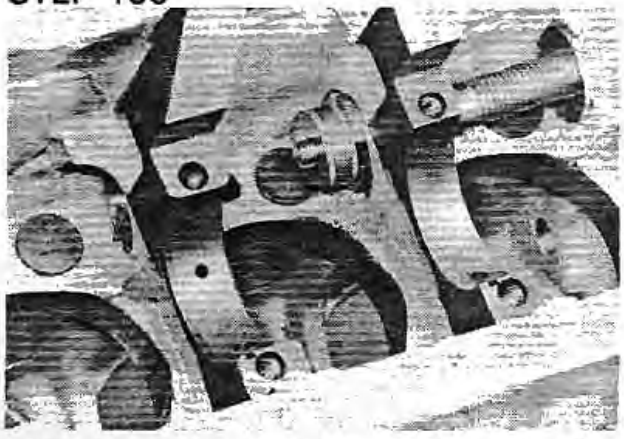
Using a bore gauge, measure the camshaft bushings. The bushing must be measured in two places. Take the second measurement 90° from the first measurement. *NOTE:* If bushing I.D. is greater than 1.755", replace the bushing.

STEP 159



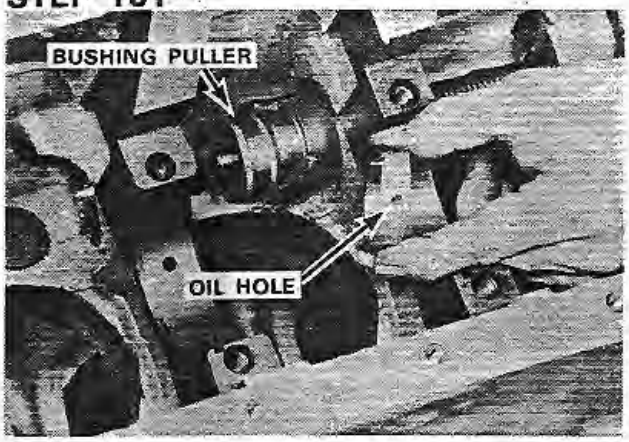
Insert bushing puller A41103 into the engine block to remove camshaft bushings. *NOTE:* The crankshaft, cylinder sleeves and pistons have been removed for photographic purposes only. These parts need not be removed when servicing camshaft.

STEP 160

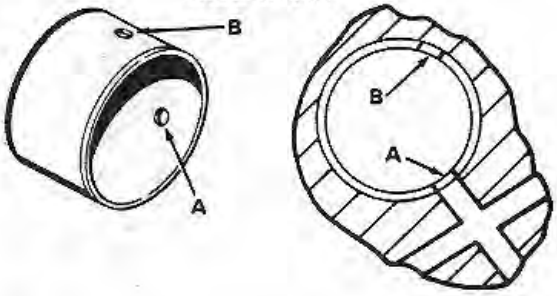


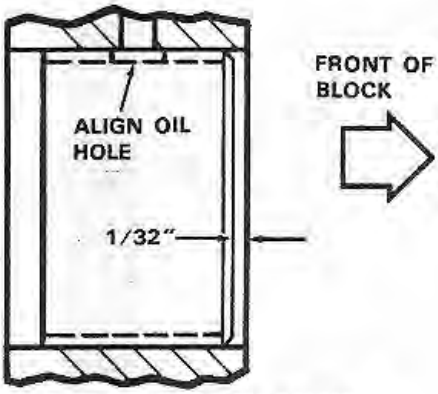
Puller installed in bushing to be removed.

STEP 161



FRONT BUSHING
WIDE WIDTH



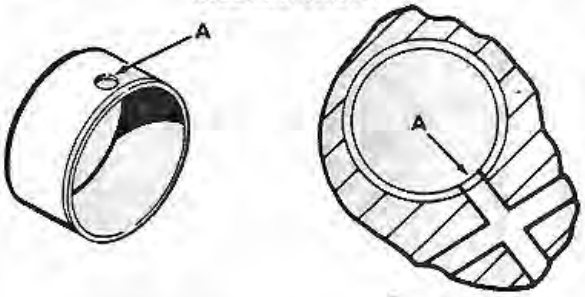


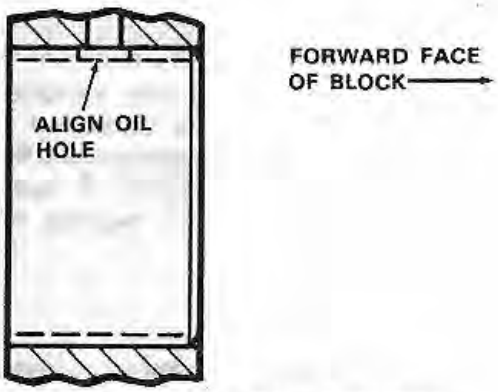
PRESS FRONT BUSHING 1/32" BELOW FRONT FACE OF BLOCK.

The camshaft bushing kit includes a 1-7/32" wide front camshaft bushing. The two oil holes are offset to one side and should face towards the front of the engine when installed. Press the front bushing 1/32" below front face of block and align holes "A" with oil passages in the block. Hole "B" is against blank surface in the block.

STEP 161 (CONT.)

INTERMEDIATE & CENTER BUSHINGS
MEDIUM WIDTH

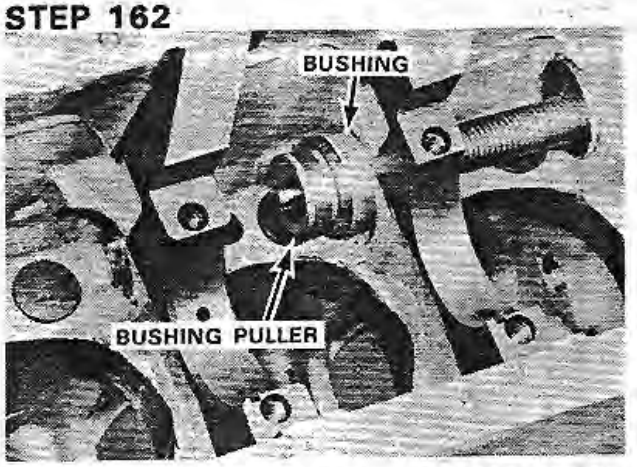




PRESS CENTER & INTERMEDIATE BUSHINGS FLUSH WITH FORWARD FACE OF BLOCK.

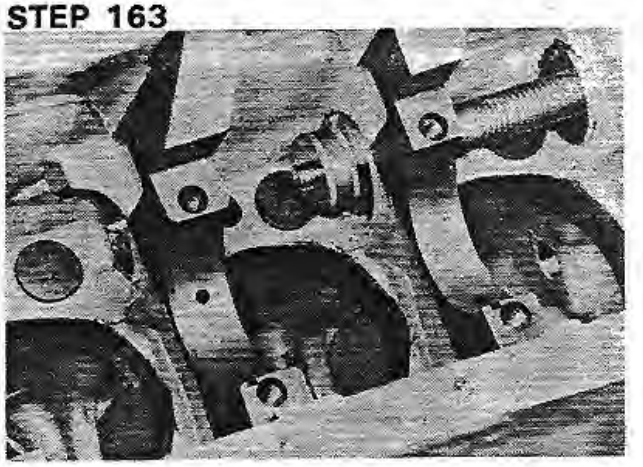
The camshaft bushing kit includes three 1/2" medium width intermediate & center camshaft bushings. The one oil hole is offset to one side and should face towards the front of the engine when installed. Press the intermediate and center bushings flush with forward face of block and align holes "A" with oil passages in the block.

STEP 162



Install the bushing on the puller (with oil holes aligned) and pull bushing into place.

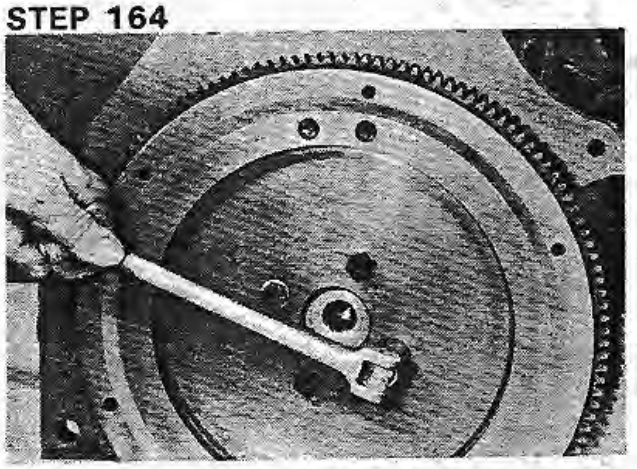
STEP 163



Pull the bushing into block bore. Remove bushing tool.

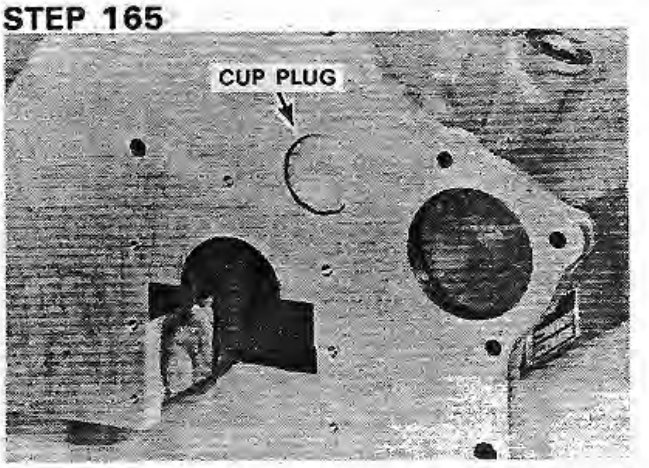
Rear Camshaft Bushing Replacement

STEP 164



To replace the rear camshaft bushing, the engine must be removed from the machine and then the flywheel must be removed.

STEP 165

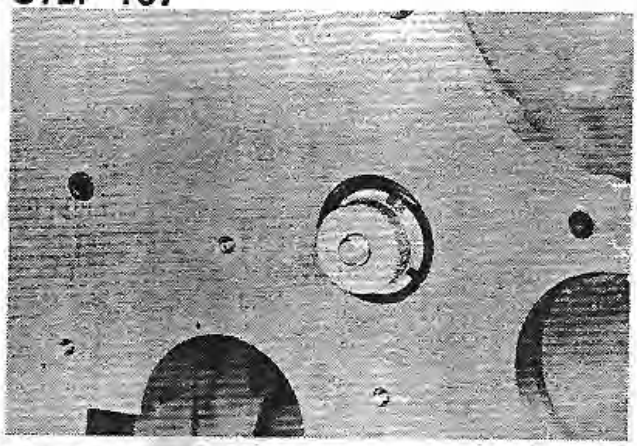


The rear camshaft cup plug must be removed before the rear camshaft bearing can be removed from the engine block.

STEP 166

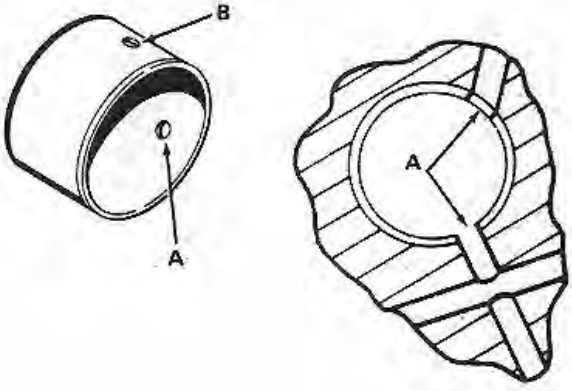
Remove cup plug from engine block by inserting a rod into the block and then tap plug out.

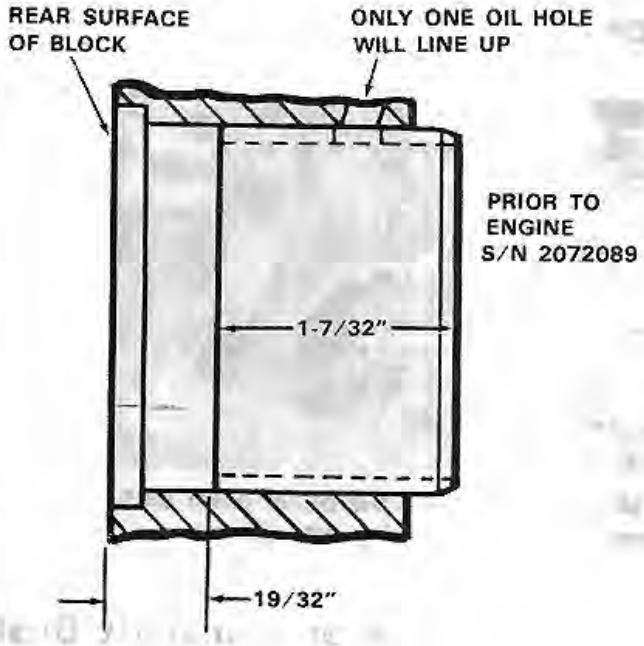
STEP 167

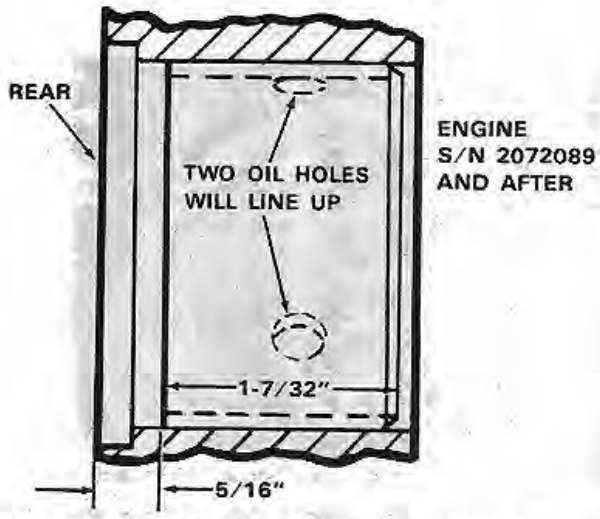


Install the rear bushing on the puller (with oil holes aligned) and pull bushing into the block. The camshaft bushing kit includes a 1-7/32" wide width rear camshaft bushing.

REAR BUSHING
WIDE WIDTH



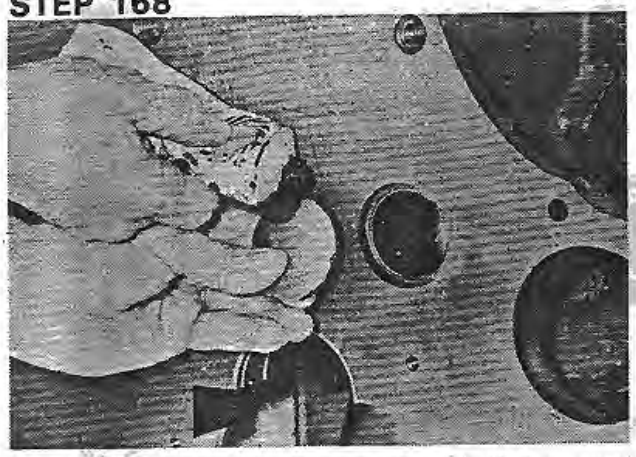




The 1-7/32 wide width rear bushing is used in place of the 15/16" wide rear bushing prior to serial number 2072089. The two oil holes are offset to one side and should face towards the front of the engine when installed. On engines prior to serial number 2072089, only one of the rear bushing oil holes must line up with the oil hole in the block when the bushing is installed to a depth of 19/32". The other rear bushing oil hole will not line up as it is not required for engine lubrication. On engines prior to serial number 2072089, the 1-7/32" wide width rear bushing will protrude inside the block approximately 1/4" when installed. THIS IS NORMAL.

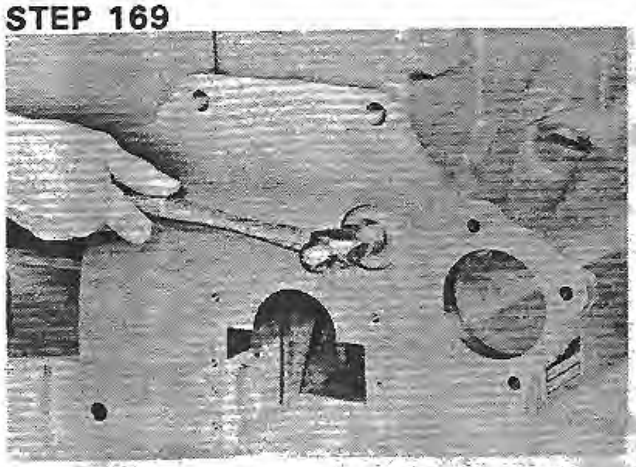
On engines, serial number 2072089 and after, the two oil holes in the rear bushing must line up with the two oil holes in the block when the bushing is installed to a depth of 5/16".

STEP 168



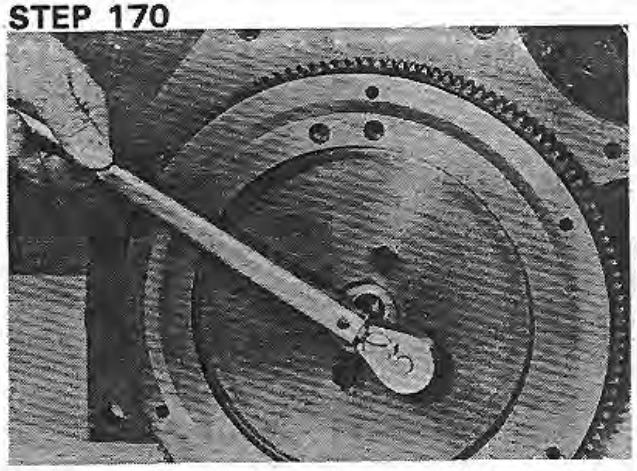
Apply #2 Permatex to a new cup plug.

STEP 169



Tap cup plug into engine block until plug bottoms out against seat.

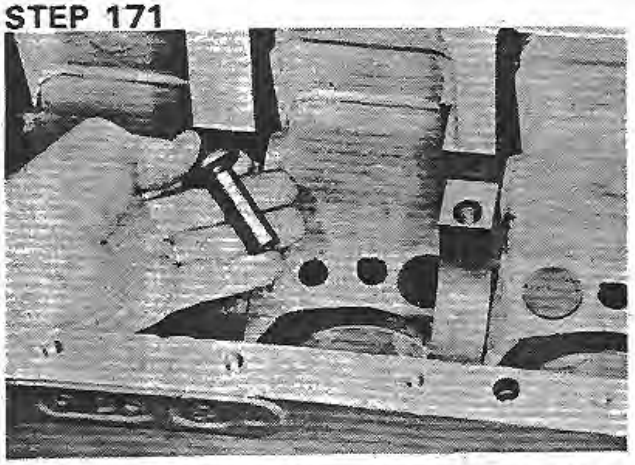
STEP 170



Install the flywheel on the crankshaft and torque bolts 65 to 70 ft. lbs.

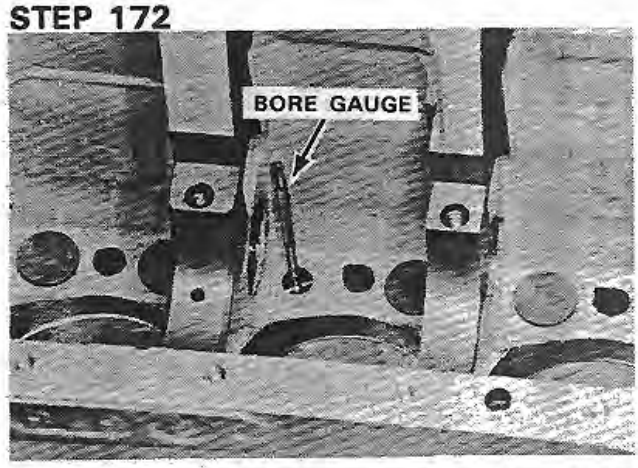
Valve Lifter Inspection & Replacement

STEP 171



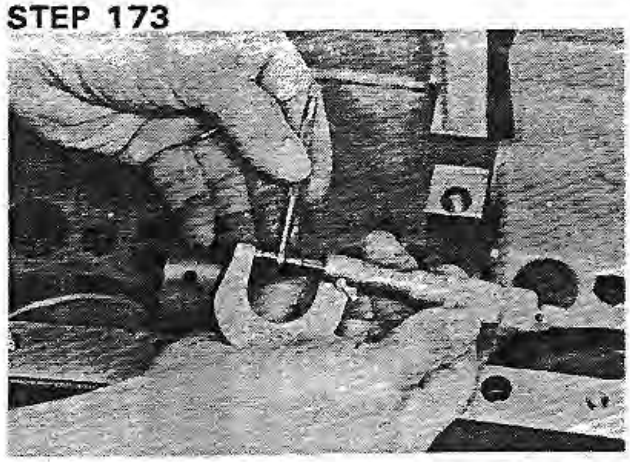
Remove the lifters from the engine block. Number the lifters and the holes that they came out of to insure proper re-assembly.

STEP 172



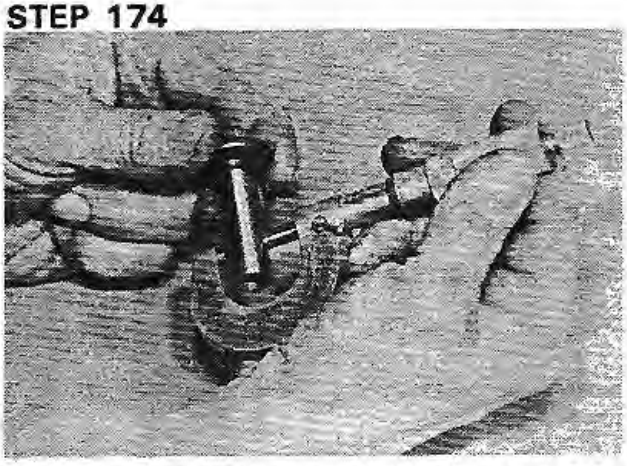
With an expandable bore gauge, measure the lifter bores.

STEP 173



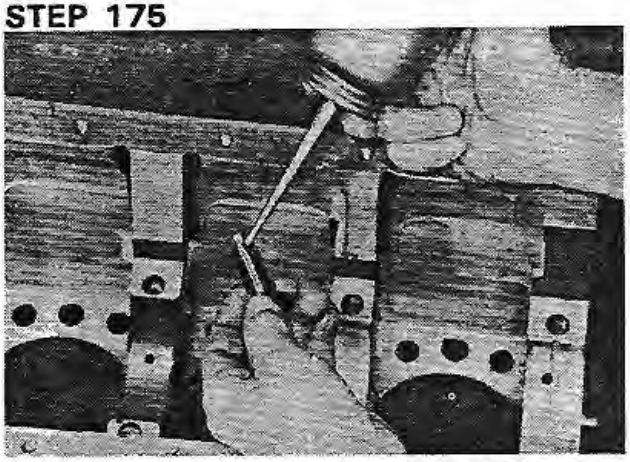
Using a micrometer, measure the bore gauge setting. If the lifter bores exceed .5650" diameter at any point, the engine block must be replaced.

STEP 174



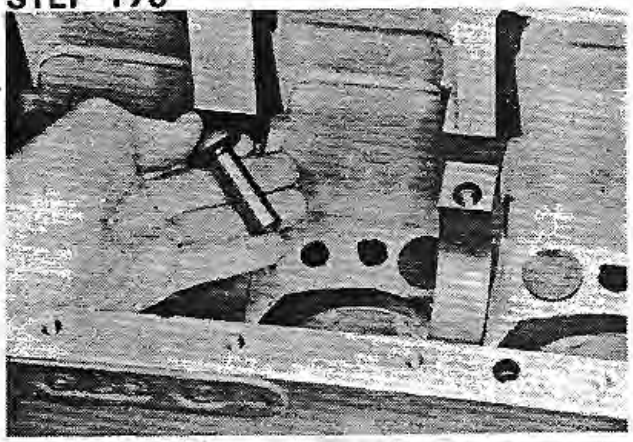
Mike the valve lifters. If lifter stem O.D. is less than .5605", replace the valve lifters.

STEP 175



Lubricate valve lifter stems with HDM #30 oil before installing lifters.

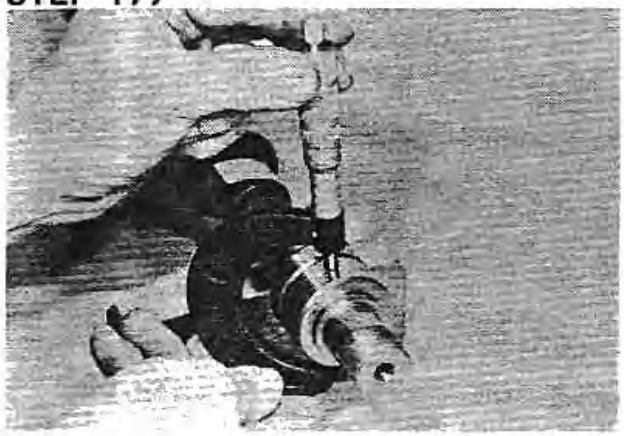
STEP 176



Install the lifters into the block and secure in place using the wood dowels (See Step 136).

Camshaft Assembly And Installation

STEP 177



With a micrometer, measure the front and rear of each bearing surface on the camshaft.

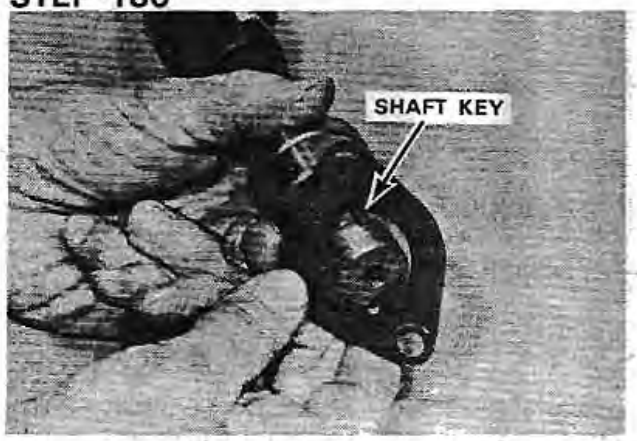
STEP 178

Each bearing surface must be measured in four places. Measure front and rear bearing surfaces again, 90° from first measurement. If the O.D. of any bearing surface is less than 1.748", the camshaft must be replaced.

STEP 179

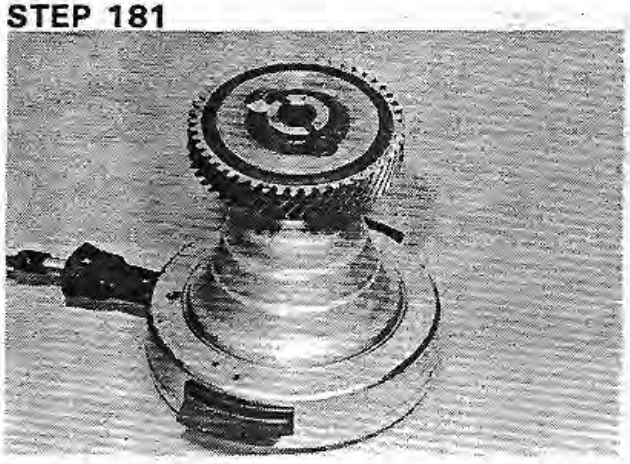
Check the thickness of the thrust washer. If thickness is less than .147", replace the thrust washer.

STEP 180



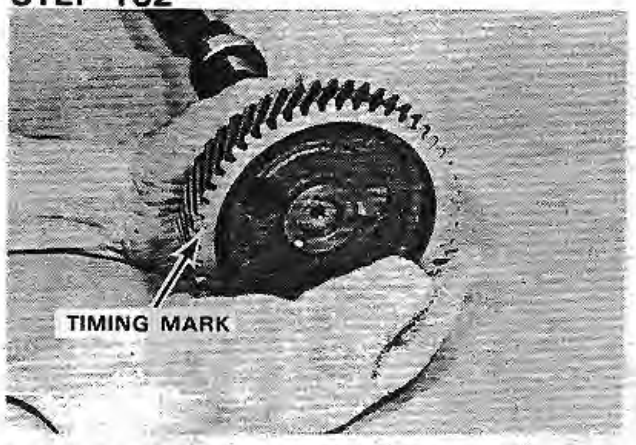
Clean the camshaft thoroughly and blow out the oil holes with compressed air. Place the thrust washer on the camshaft and install the shaft key.

STEP 181



Heat the camshaft gear, using a gear and bearing heater, to facilitate assembling the gear on camshaft.

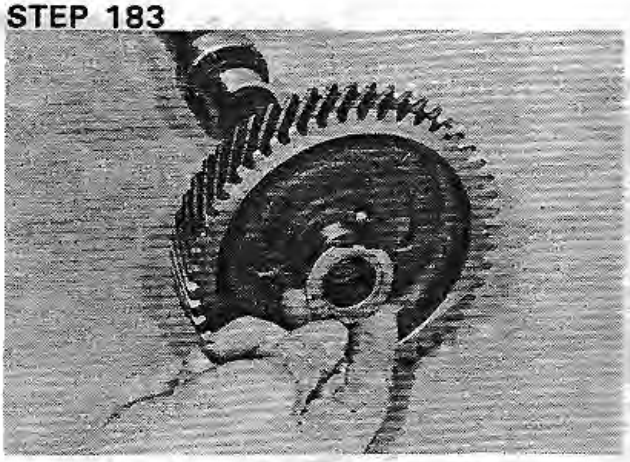
STEP 182



Install the heated camshaft gear on the camshaft, making sure the timing marks are outward.

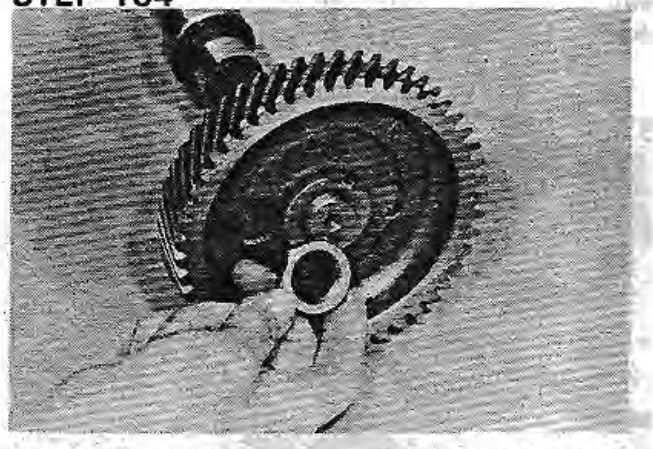
CAUTION: *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*

STEP 183



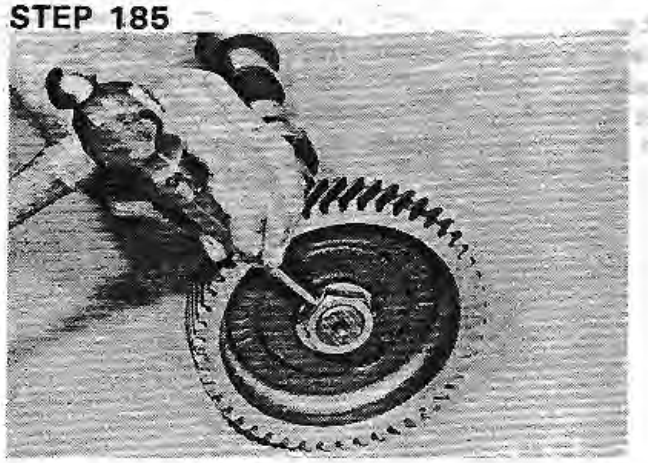
Install the tab washer on the camshaft gear.

STEP 184



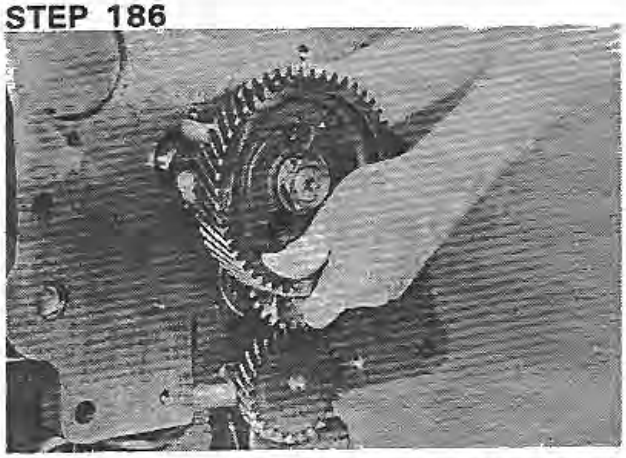
Install the retaining nut and torque 80 to 90 ft. lbs.

STEP 185



Bend the lip of the lockwasher over one of the flats on the retaining nut.

STEP 186

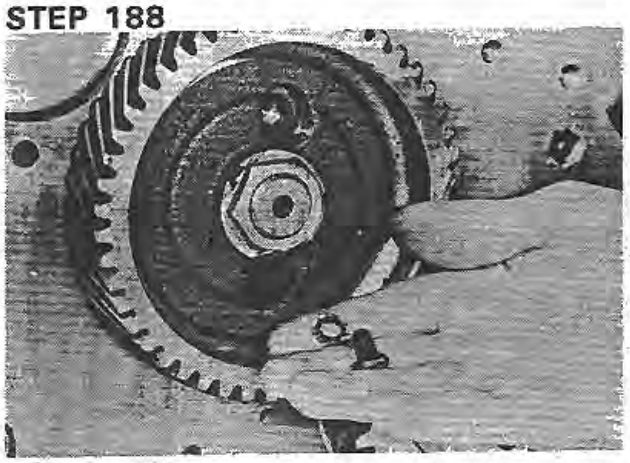


Install the camshaft part way into the engine block.

STEP 187

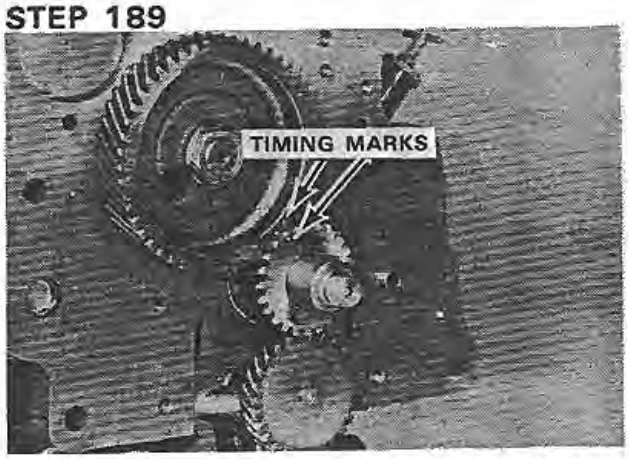
Lubricate the thrust washer, all bearing surfaces and lifter cams with HDM #30 oil.

STEP 188



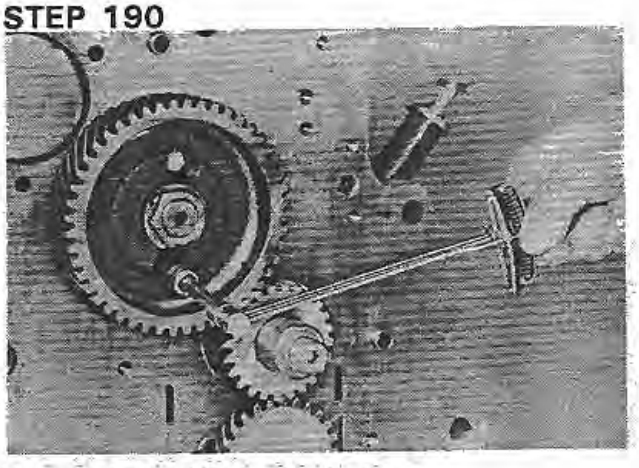
Push camshaft all the way into the engine block and align holes in camshaft gear with holes in thrust plate. Install external tooth lockwashers and bolts.

STEP 189



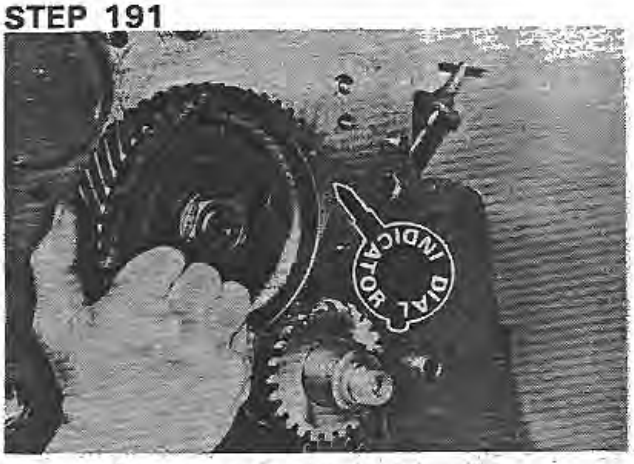
Align the timing marks on the camshaft gear with the timing mark on the crankshaft.

STEP 190



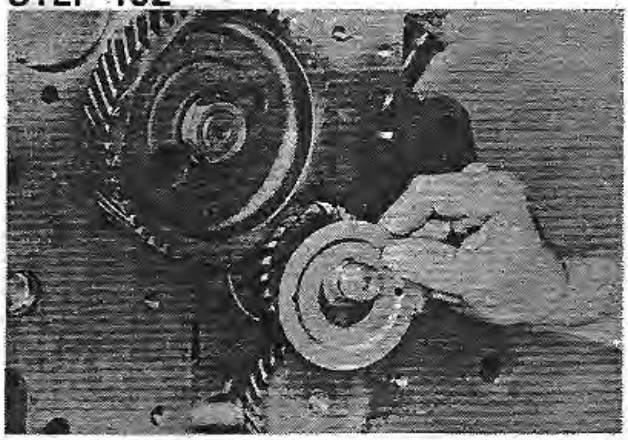
Torque bolts 17 to 20 ft. lbs.

STEP 191



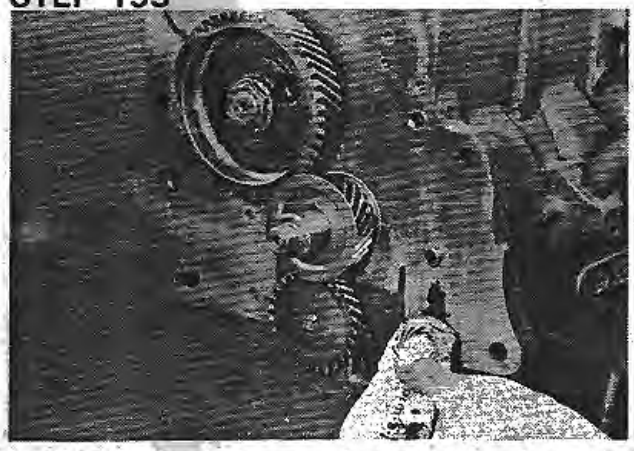
Place a dial indicator on the camshaft gear and check backlash between camshaft gear and crankshaft gear. Backlash must be .0002" to .006". If backlash exceeds .006", the gears must be replaced. *NOTE:* Excess backlash could also be caused by worn camshaft bushings.

STEP 192



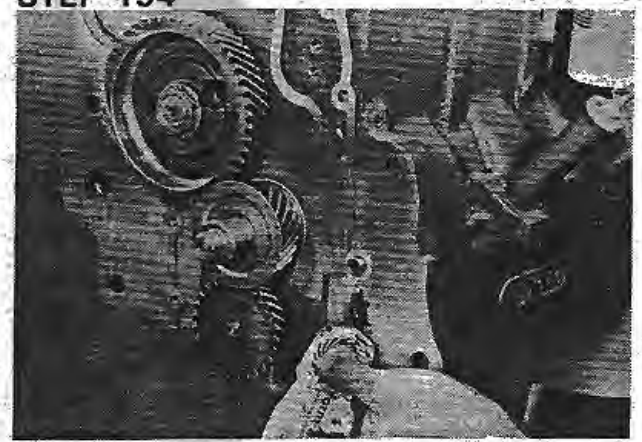
Install oil slinger ring over end of crankshaft with cupped face toward crank gear and notch aligned with key way on crankshaft.

STEP 193



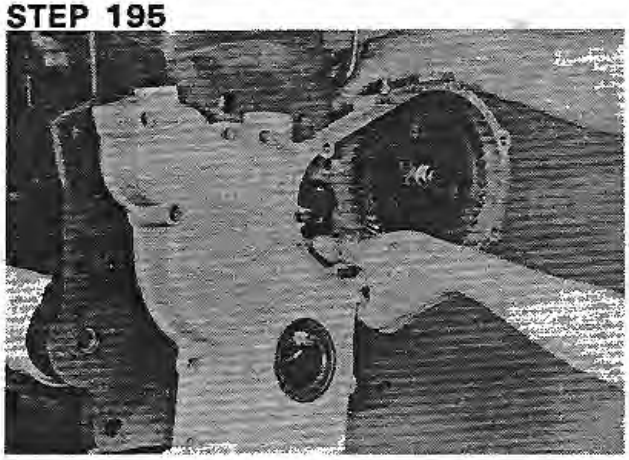
Apply #2 Permatex on both sides of engine block from lower mounting hole, downwards.

STEP 194

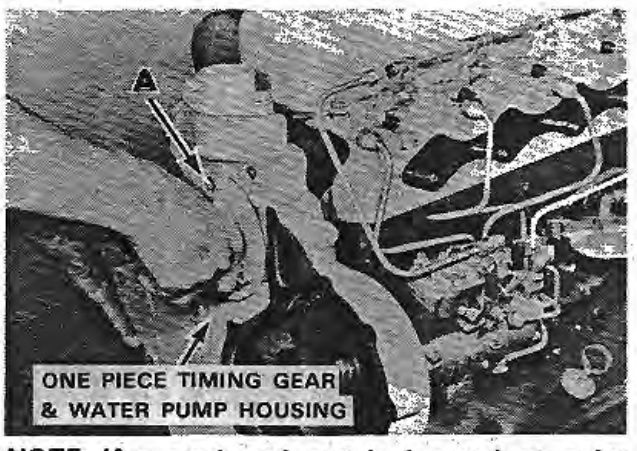


Install new timing gear cover gasket over aligning dowels. Apply #2 Permatex to open face of gasket from lower mounting hole, downwards.

STEP 195

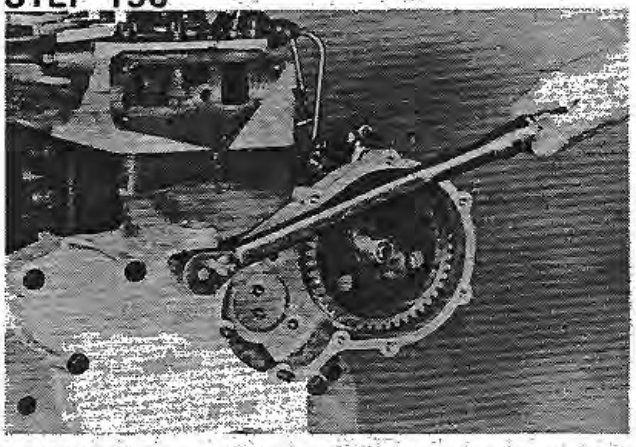


Set timing gear cover with fuel pump on engine block aligning dowels to position cover. *If equipped,* install one piece timing gear cover & water pump housing with fuel pump. Refer to section 2035 for front pulley seal replacement.



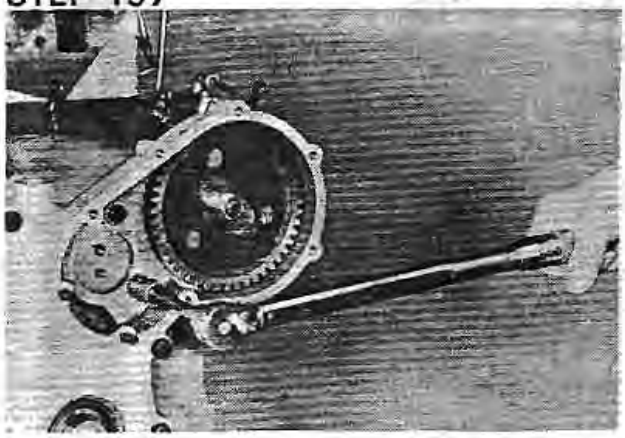
NOTE: If a stud and nut is located at point "A", the pump must be removed to install a hex. socket capscrew inside of pump housing.

STEP 196



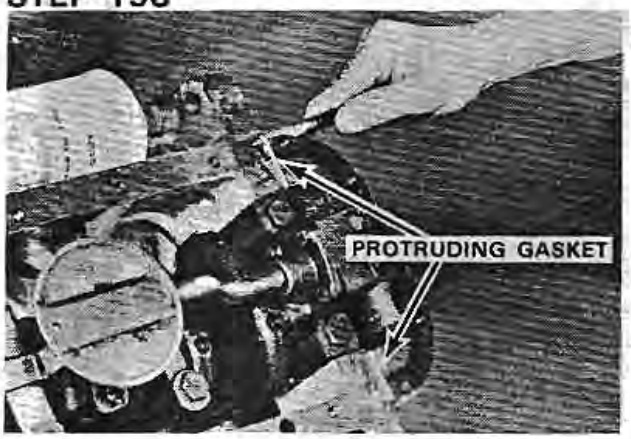
Install all external bolts and torque 25 to 30 ft. lbs. on aluminum covers and 35 to 42 ft. lbs. on cast iron covers.

STEP 197



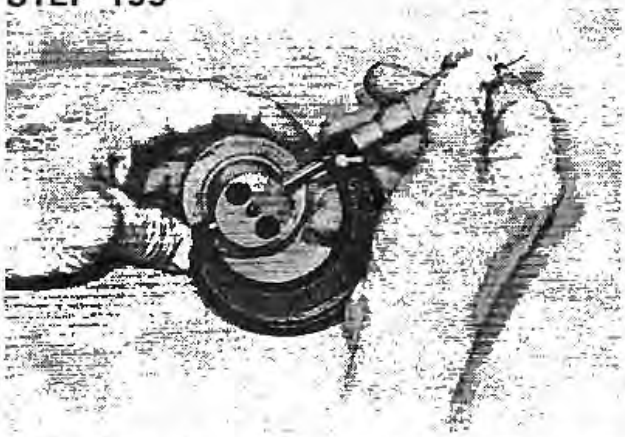
Install the two internal bolts and torque 25 to 30 ft. lbs. on aluminum covers and 35 to 42 ft. lbs. on cast iron covers.

STEP 198



Cut off protruding gasket flush with housing.

STEP 199

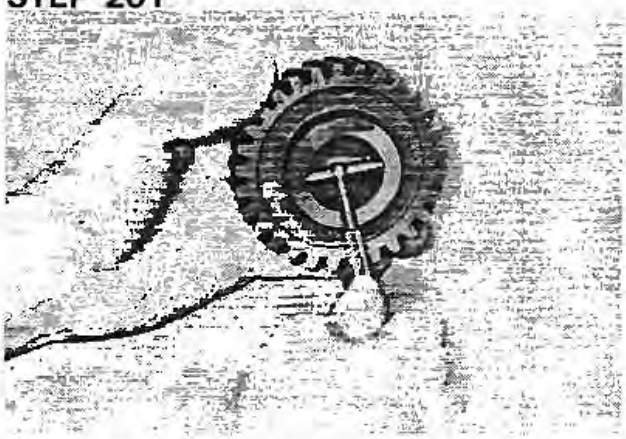


Measure the O.D. of the idler gear shaft with a micrometer. If O.D. is less than 1.3740", replace idler gear shaft.

STEP 200

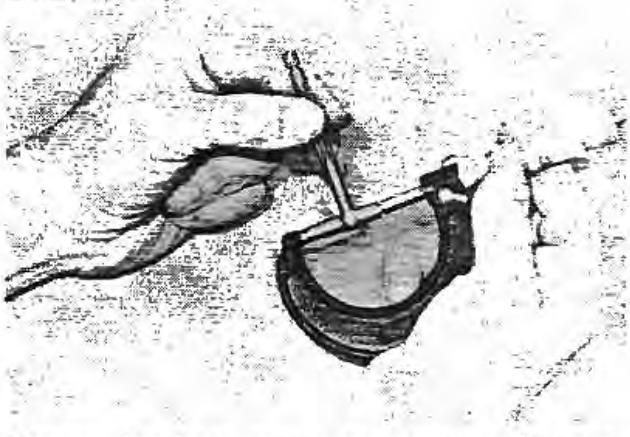
Install the idler gear shaft on the engine block aligning the open end of the oil slot in the idler gear shaft with the opening in the circumference of the seat in the engine block.

STEP 201



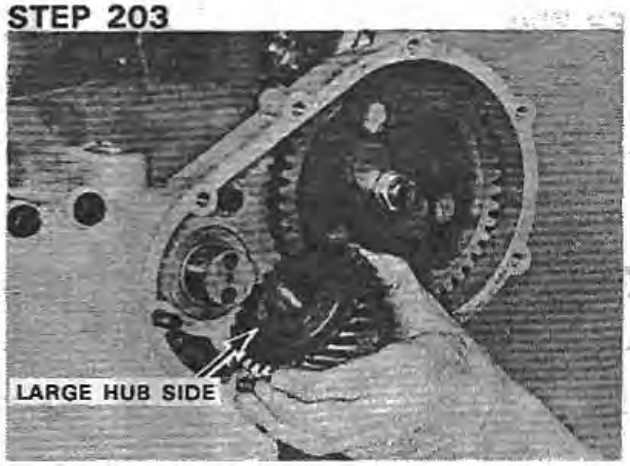
With a bore gauge, measure the I.D. of the idler gear bushing.

STEP 202



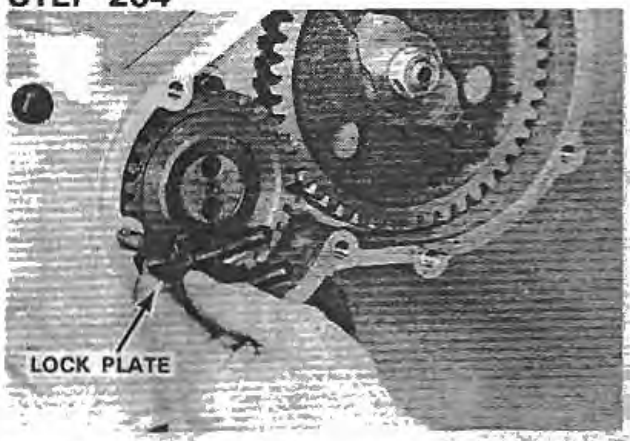
Measure the bore gauge dimension with a micrometer. If the I.D. of the gear bushing is more than 1.377", replace the gear.

STEP 203



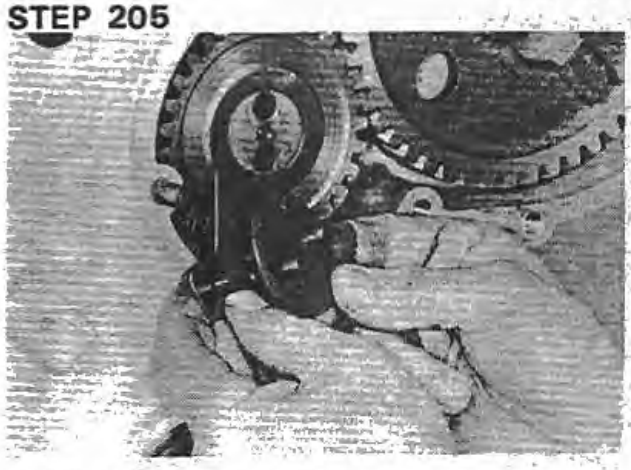
Install idler gear with large hub side towards the engine block, on the idler shaft.

STEP 204



Install lock plate on idler gear bolts.

STEP 205



Install thrust plate next.

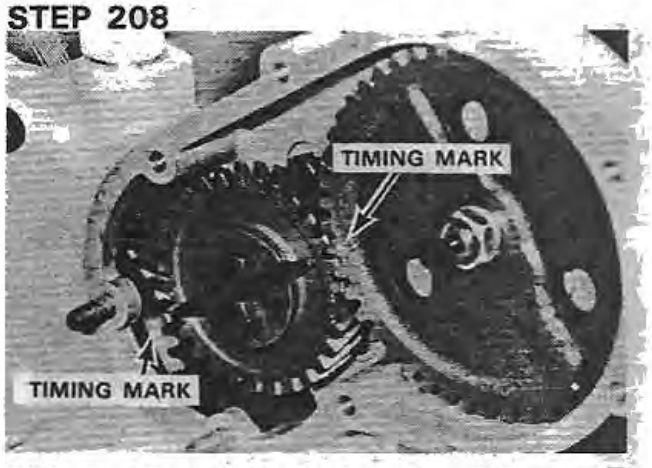
STEP 206

Install enough number of shims to maintain a running clearance between thrust plate and idler gear.

STEP 207

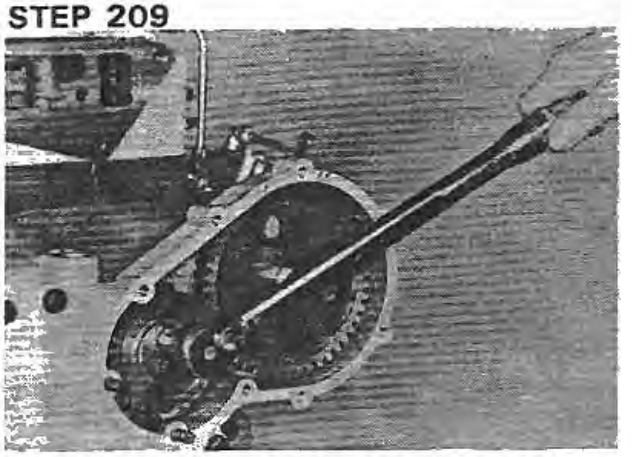
Install assembly into idler gear.

STEP 208



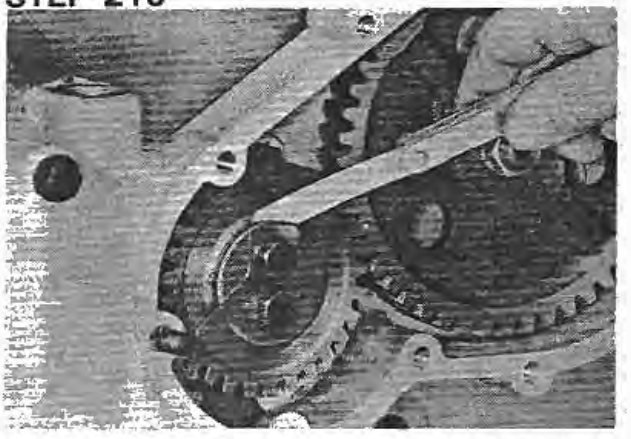
With engine on top dead center with number one cylinder on compression stroke, there will be a timing mark on the camshaft gear lined up with idler gear pointer. Be sure injection pump drive gear timing mark is aligned with other end of idler gear pointer.

STEP 209



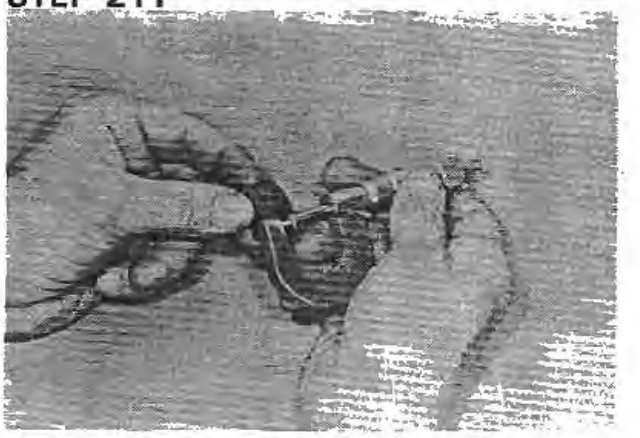
Torque idler gear retaining bolts 35 to 42 ft. lbs.

STEP 210



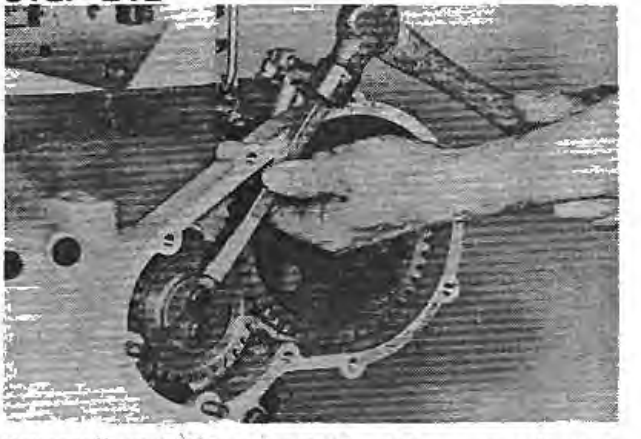
With a feeler gauge check the running clearance between thrust washer and idler gear. The running clearance should be .003".

STEP 211



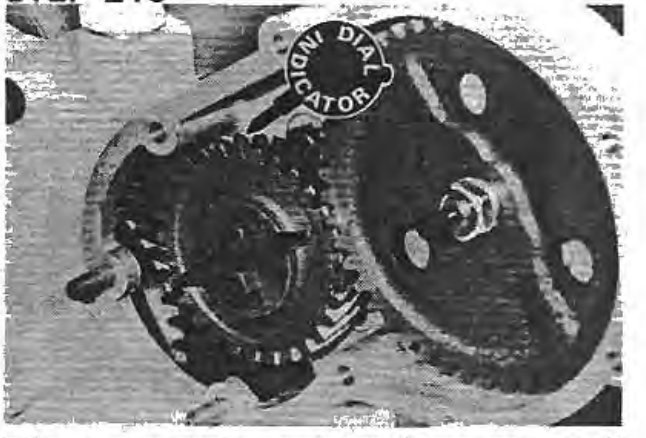
Remove mounting bolts and by measuring the thickness of the shims with a micrometer, add or deduct shims to obtain correct clearance.

STEP 212



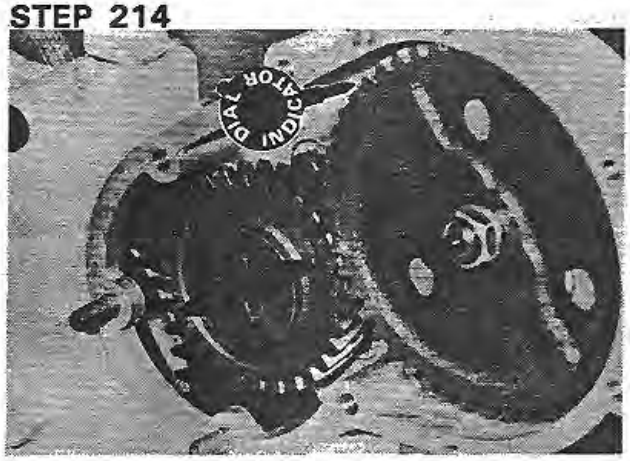
Reinstall mounting bolts in idler gear, torque 35 to 42 ft. lbs. Then bend lock plate over retaining bolts.

STEP 213



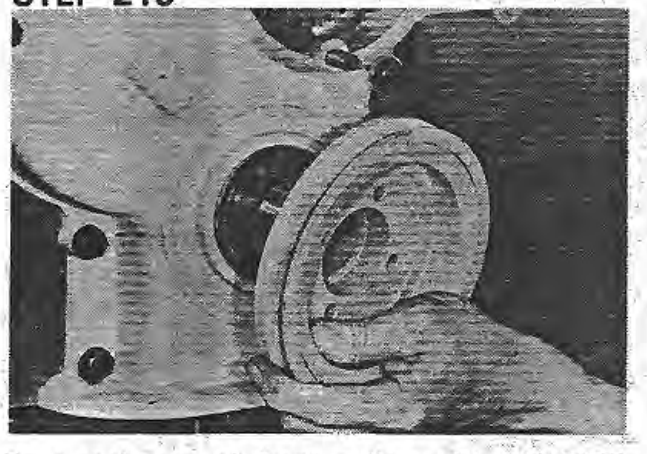
Take a screwdriver and hold cam gear so it can't move. Install a dial indicator to check back lash. Backlash must not exceed .006". If backlash exceeds .006", replace the gears.

STEP 214



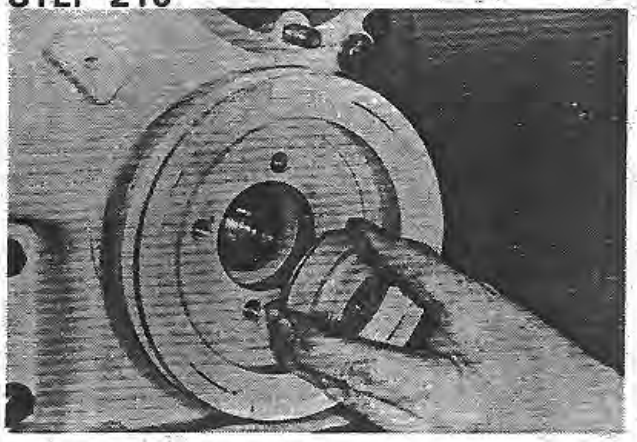
Holding idler gear with a screw driver, check injection pump drive gear back lash. Backlash must not exceed .007". If backlash exceeds .007", replace the gears.

STEP 215



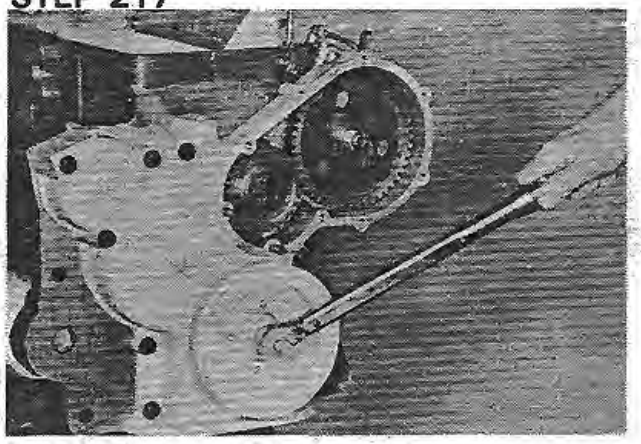
Coat seal area of front pulley with HDM#30 oil, align crankshaft key way and start pulley on crankshaft.

STEP 216



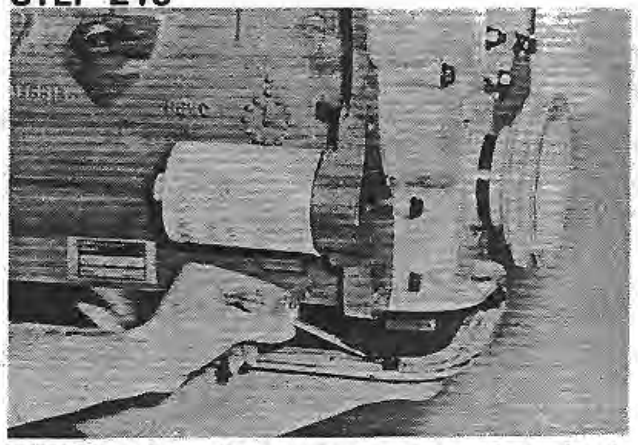
Install pulley retaining nut.

STEP 217



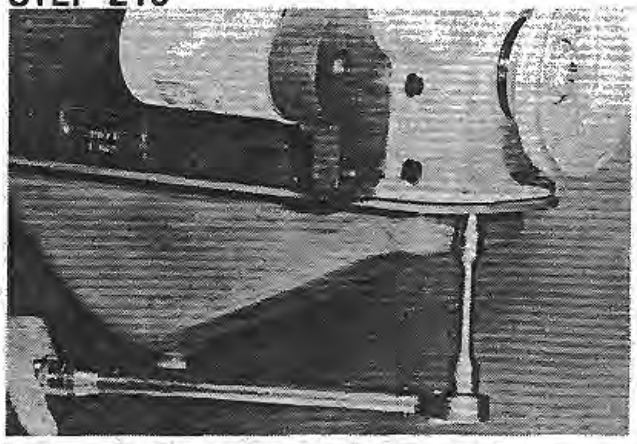
Draw pulley on crankshaft with pulley nut and final torque nut 125 to 135 ft. lbs.

STEP 218



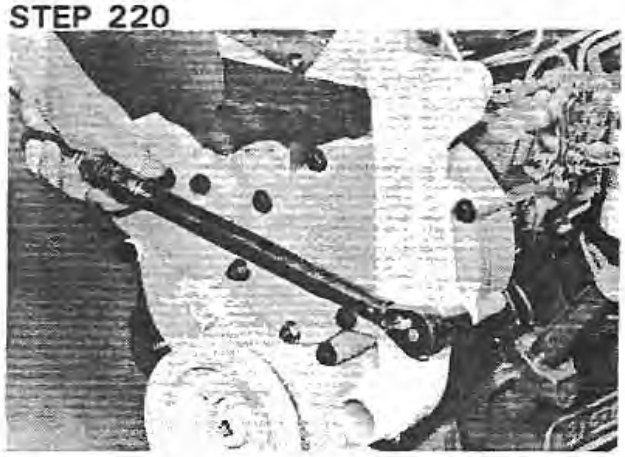
Install engine oil pan and new gasket. Apply #2 Permatex on both sides of gasket at the front and rear portions only.

STEP 219



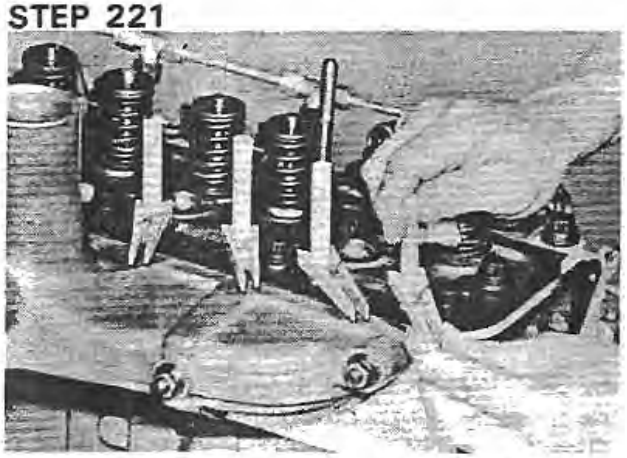
Torque retaining bolts 10 to 12 ft. lbs. on the stamped steel oil pan. On the cast iron oil pan, torque the long rear bolts 15 to 20 ft. lbs. and the remaining bolts, 24 to 28 ft. lbs.

STEP 220



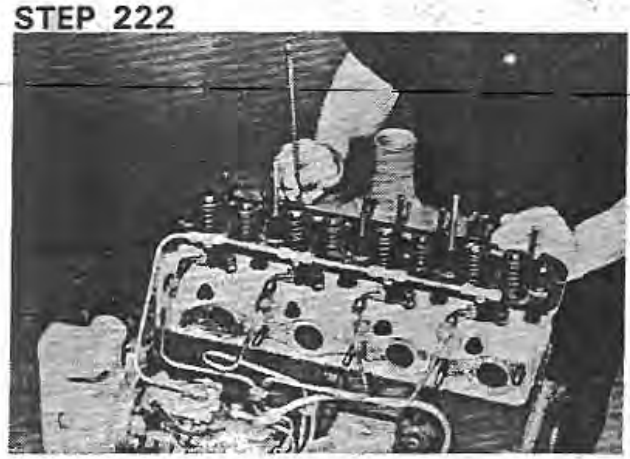
Install a new cover plate gasket, cover plate and water tube. Torque bolts 25 to 30 ft. lbs. on aluminum covers and 35 to 42 ft. lbs. on cast iron covers.

STEP 221



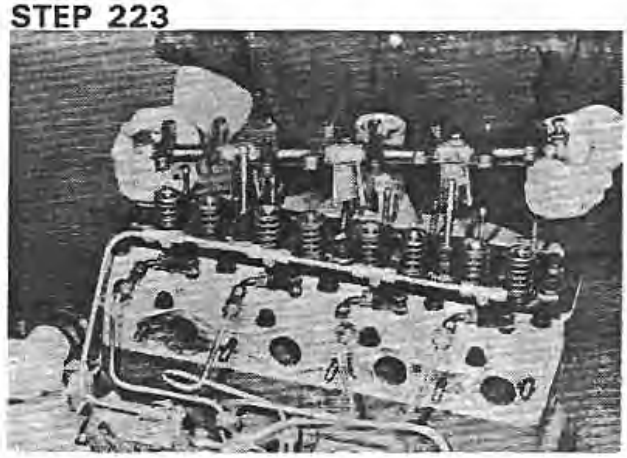
Remove clothespins & wood dowels from cylinder head.

STEP 222



Install push rods.

STEP 223



Install rocker arm assembly. Refer to Steps 80 thru 96.

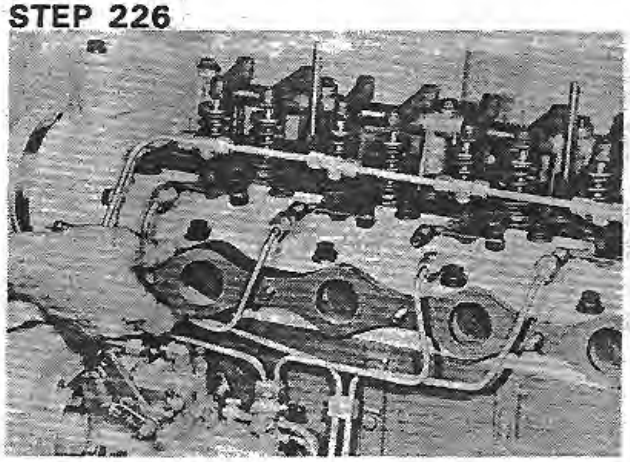
STEP 224

Adjust the valve tappets. Refer to Steps 109 thru 118.

STEP 225

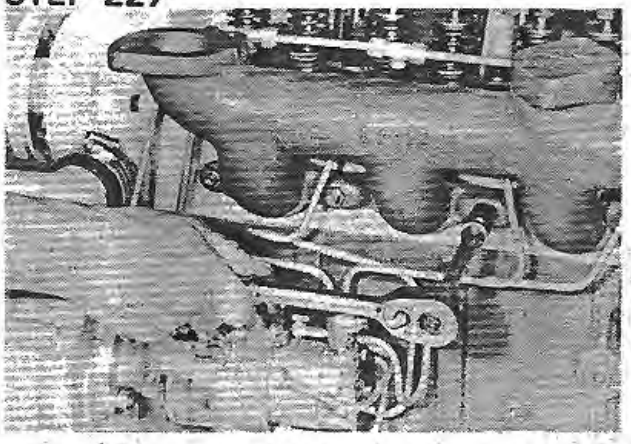
Install water pump & water pump housing. Refer to section 2055.

STEP 226



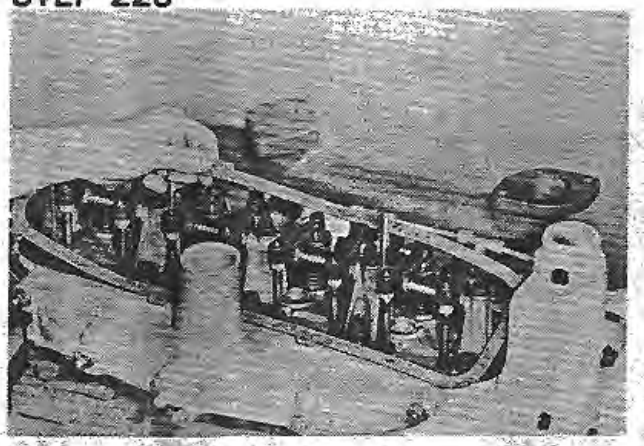
Install a new exhaust manifold gasket.

STEP 227



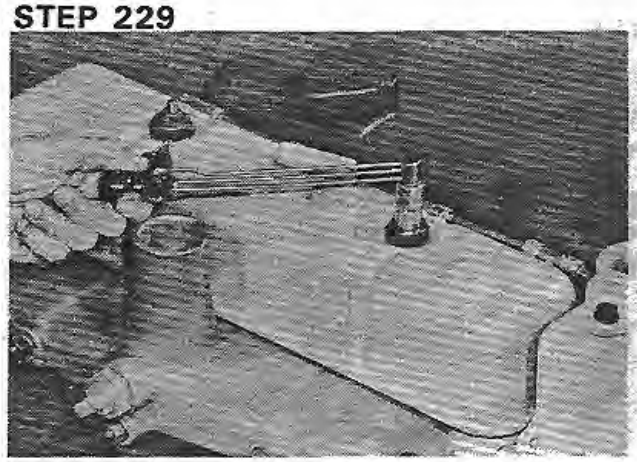
Install exhaust manifold and torque nuts 25 to 30 ft. lbs.

STEP 228



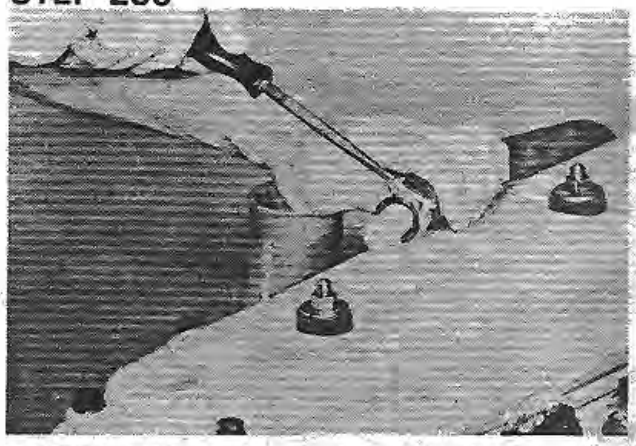
Install new valve cover gasket.

STEP 229



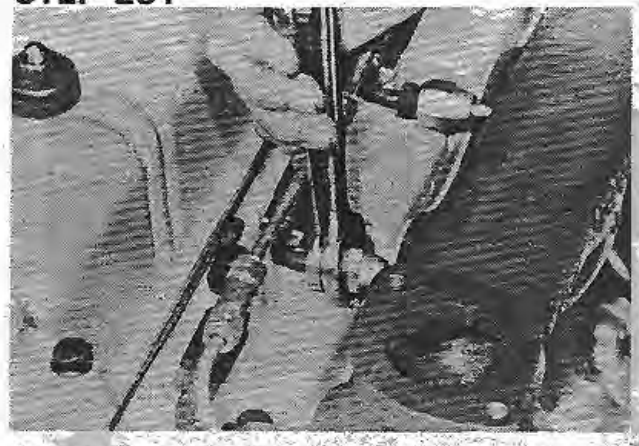
Install valve cover and torque retaining nuts 4 to 6 ft. lbs.

STEP 230



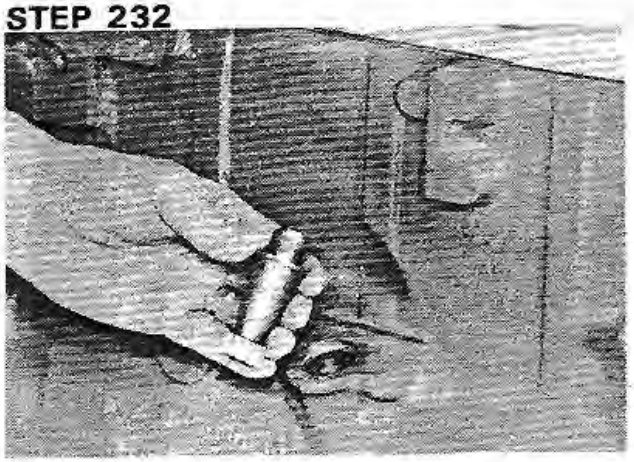
Install breather tube.

STEP 231



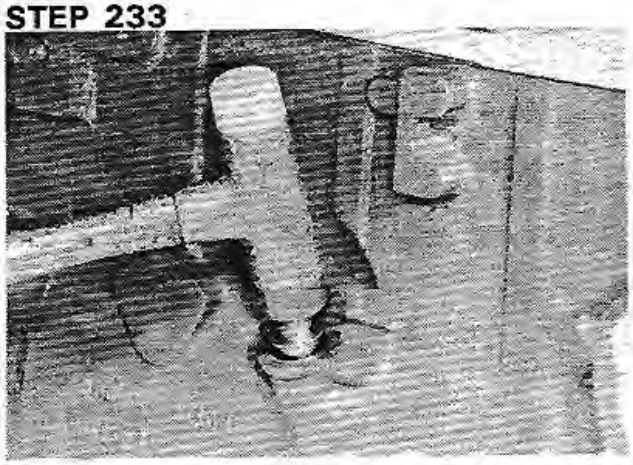
Connect fuel injectors inlet fittings using the one-hand, two wrench method to prevent any damage to fittings and tubes.

STEP 232

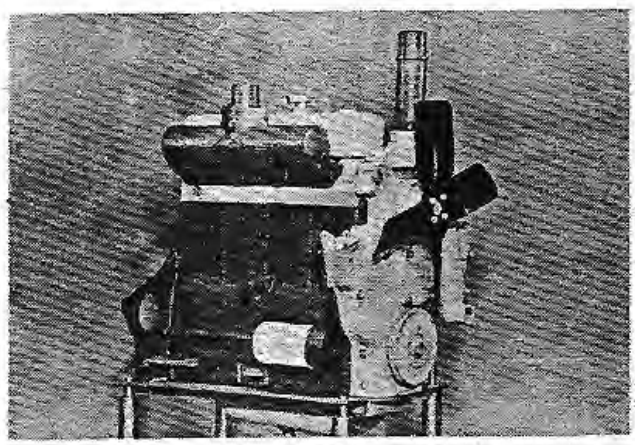


Install tachometer drive, if equipped.

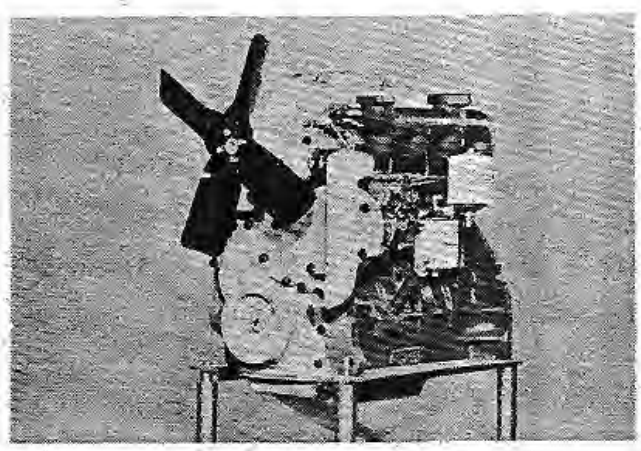
STEP 233



Carefully tap drive into engine block until top of drive is flush with block.



188 DIESEL ENGINE



207 DIESEL ENGINE

Section 2035

CRANKSHAFT, MAIN BEARINGS, FLYWHEEL AND OIL SEAL REPLACEMENT

188 and 207 Diesel Engines

J I Case
A Tenneco Company

Rac 9-78866

PRINTED IN U.S.A.

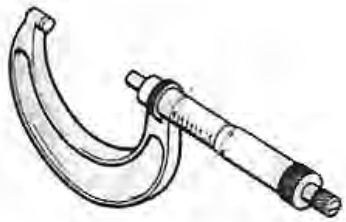
TABLE OF CONTENTS

THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

SPECIAL TOOLS

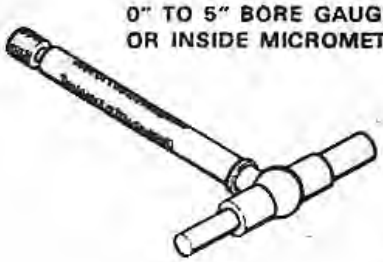
G13506 REAR SEAL
ALIGNING TOOL

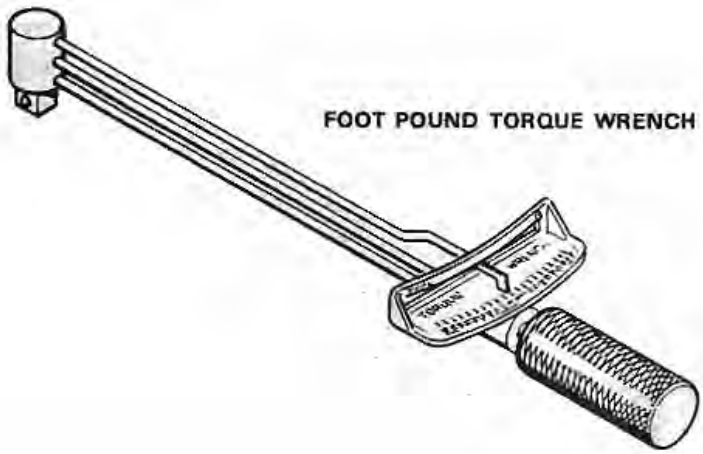
G15028 SLEEVE
REAR SEAL INSTALLATION



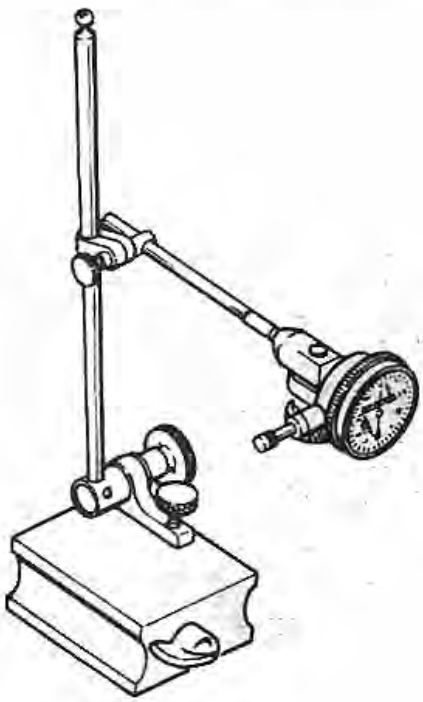
0" TO 5" MICROMETERS

0" TO 5" BORE GAUGES
OR INSIDE MICROMETERS

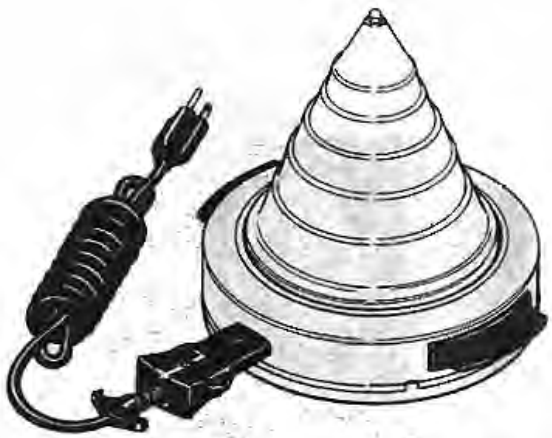




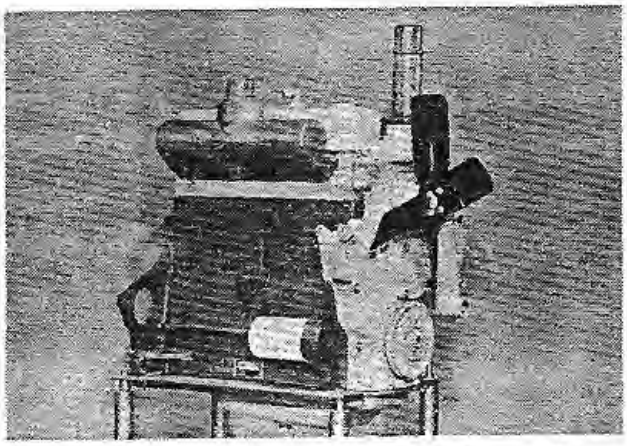
FOOT POUND TORQUE WRENCH



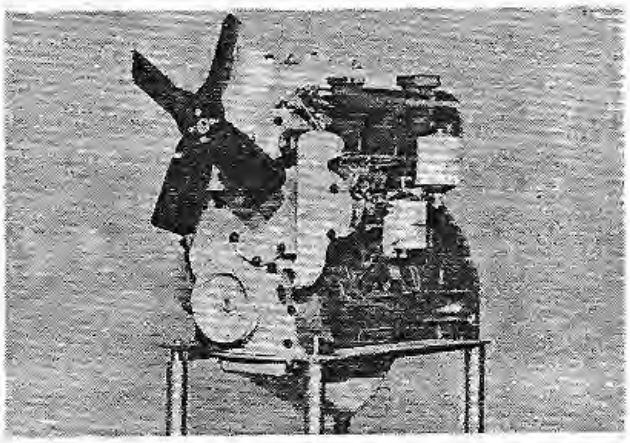
DIAL INDICATOR



THERMO MOUNTER- MODEL "C"
ELECTRONIC DESIGNS, INC.
5164 N. 62ND STREET
MILWAUKEE, WIS. 53218



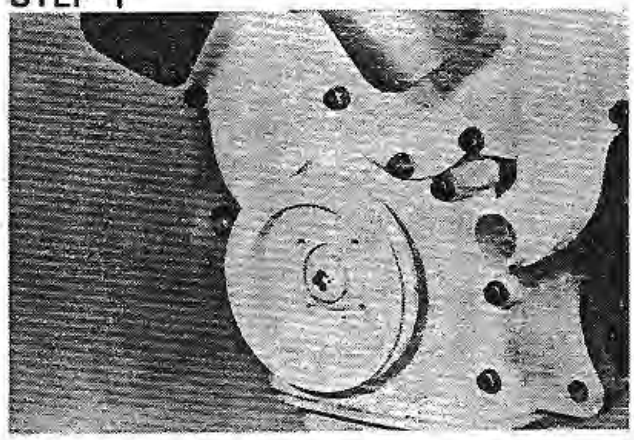
188 DIESEL ENGINE



207 DIESEL ENGINE

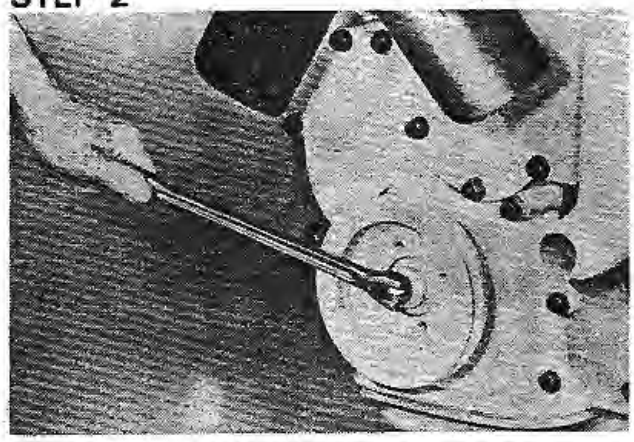
FRONT OIL SEAL REPLACEMENT

STEP 1



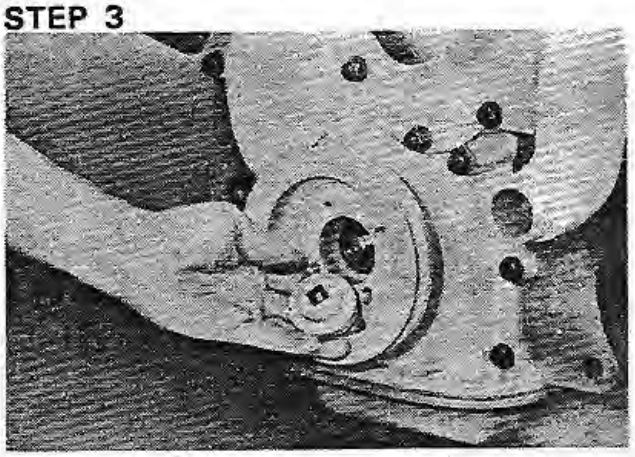
Before the front oil seal can be replaced, the crankshaft pulley must be removed. Remove belt from pulley.

STEP 2



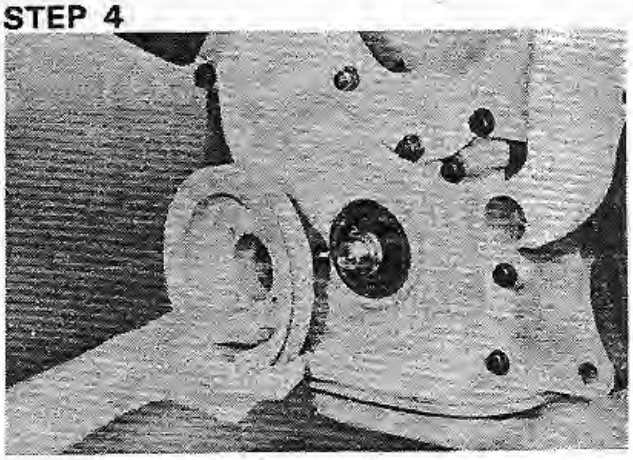
Loosen crankshaft pulley retaining nut.

STEP 3



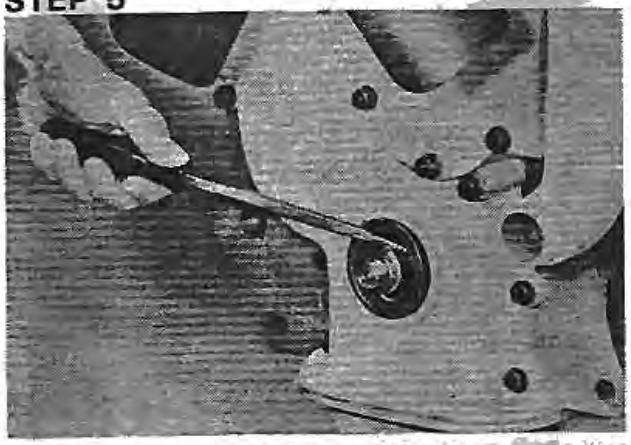
Remove crankshaft pulley retaining nut.

STEP 4



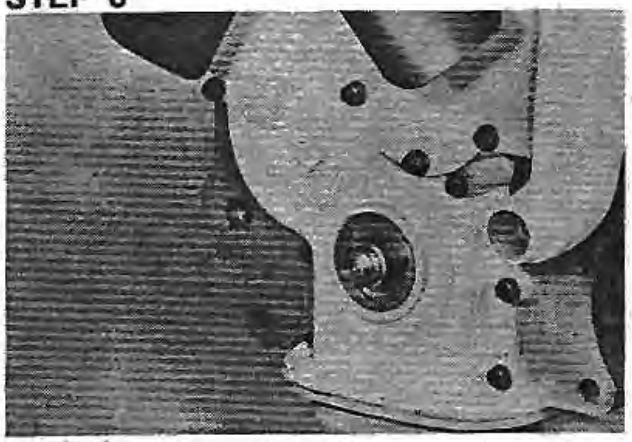
Remove crankshaft pulley from crankshaft.

STEP 5



Remove front oil seal from timing gear cover.

STEP 6

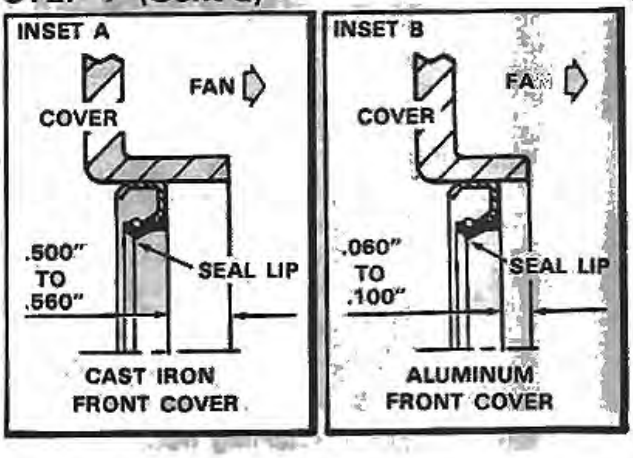


Front oil seal removed.

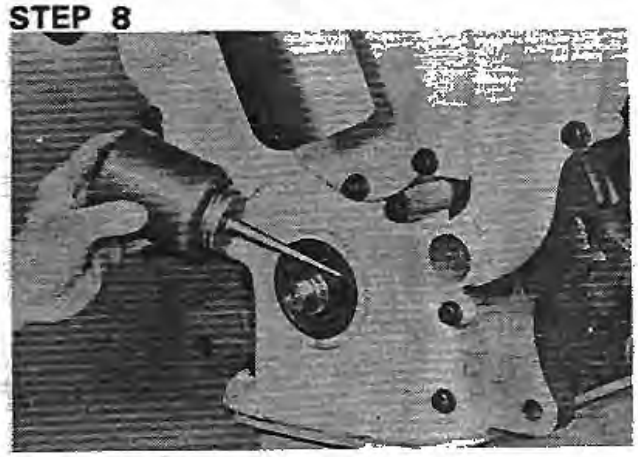
STEP 7

Install a new seal in the timing gear cover, with the seal lip inward, to a depth from the outer edge as shown in Inset A or B.

STEP 7 (Cont'd)

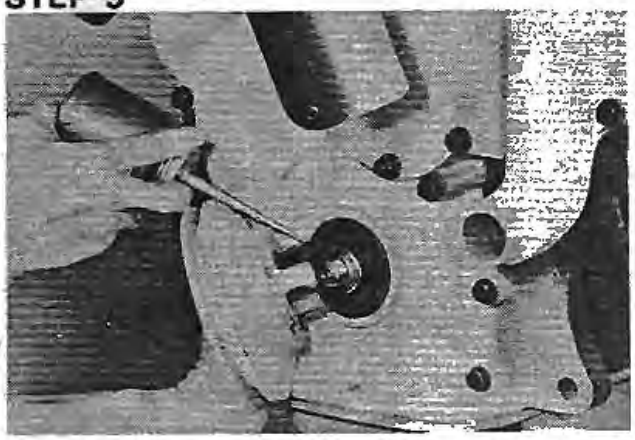


STEP 8



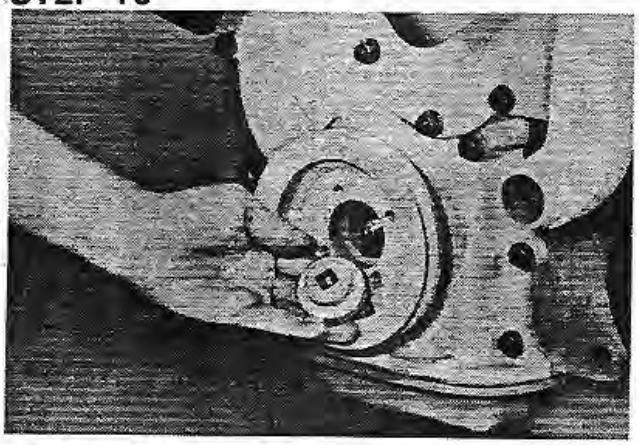
Apply HDM No. 30 oil to front oil seal.

STEP 9



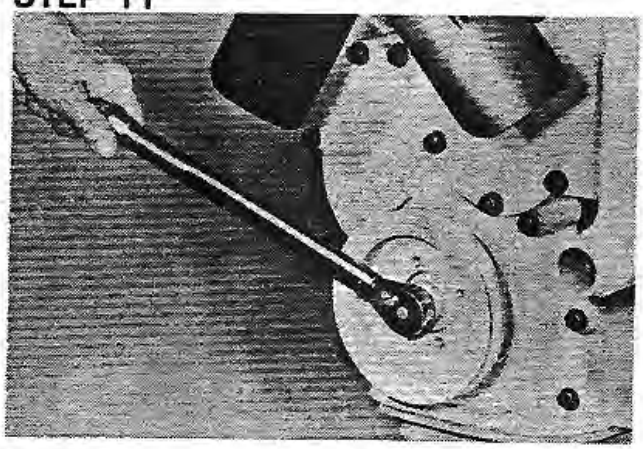
Apply HDM No. 30 oil to shaft of crankshaft pulley. Install pulley on crankshaft.

STEP 10



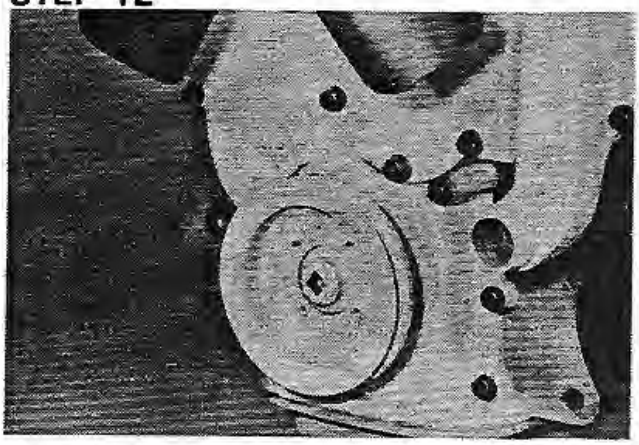
Install crankshaft pulley retaining nut.

STEP 11



Torque crankshaft pulley retaining nut 125 to 135 ft. lbs.

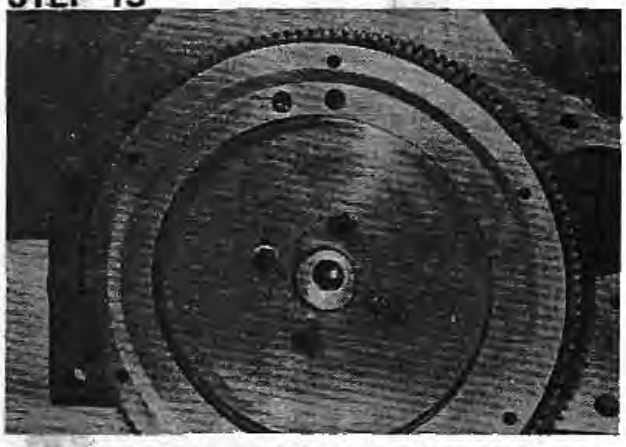
STEP 12



Crankshaft pulley installed on engine. Connect belt to pulley.

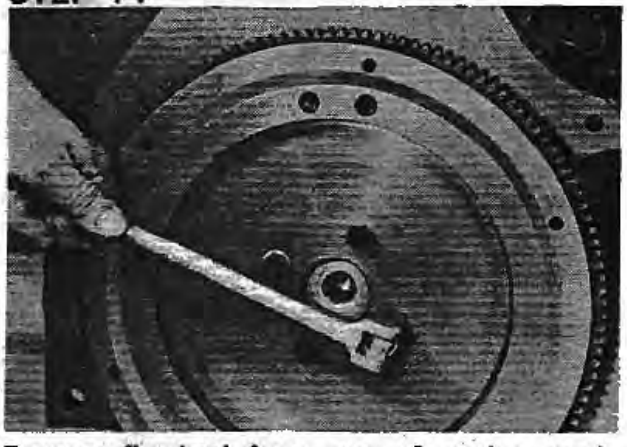
REAR OIL SEAL REPLACEMENT

STEP 13



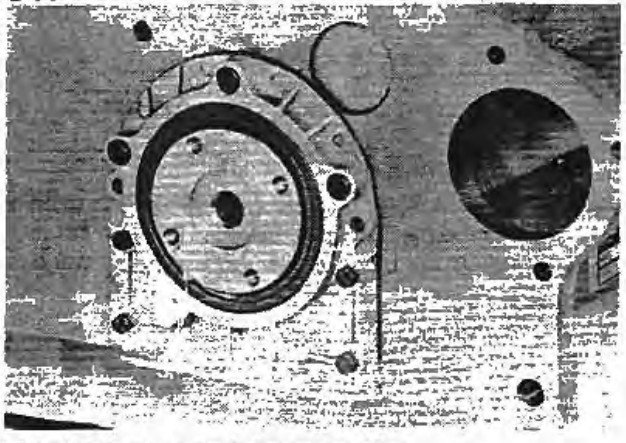
In order to replace the rear oil seal, the engine must be removed from the machine.

STEP 14



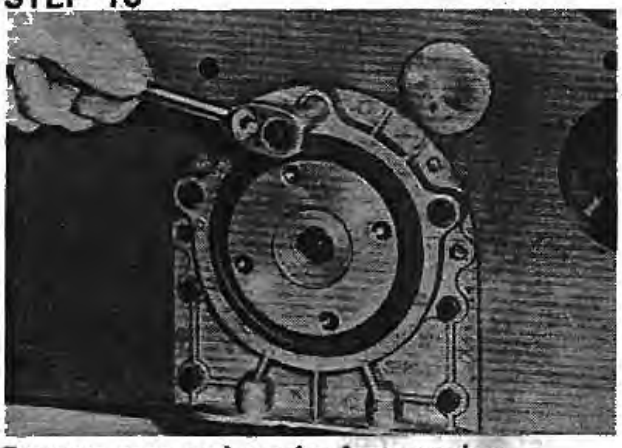
Remove flywheel from rear of engine crankshaft.

STEP 15



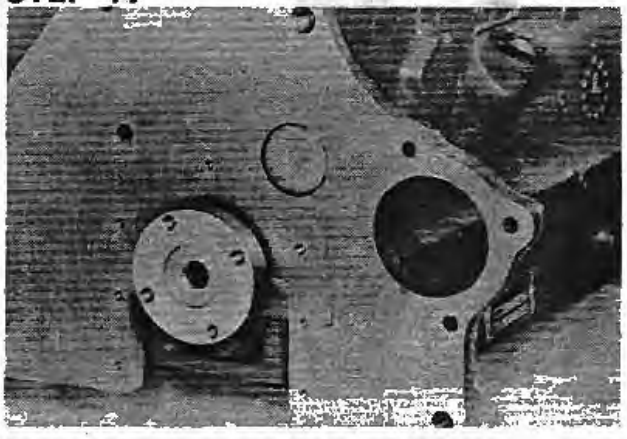
Flywheel removed from engine.

STEP 16



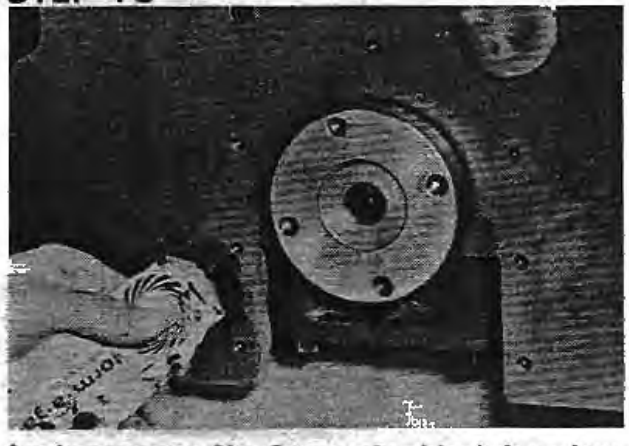
Remove rear seal carrier from engine.

STEP 17



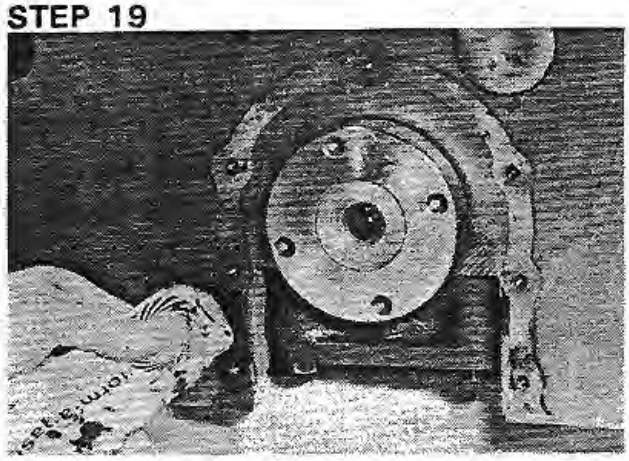
Seal carrier removed from engine.

STEP 18



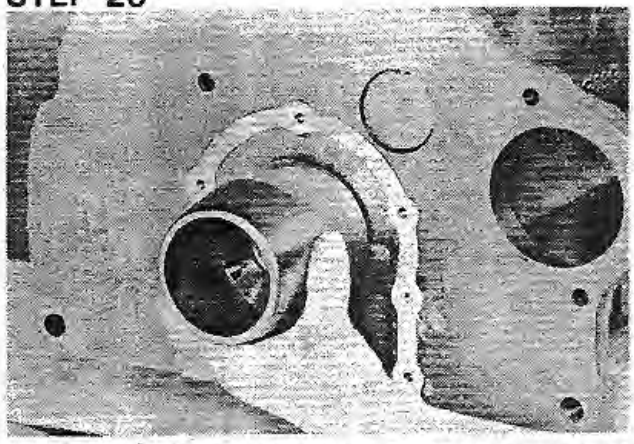
Apply permatex No. 2 to engine block from lower bolt holes to bottom of block.

STEP 19



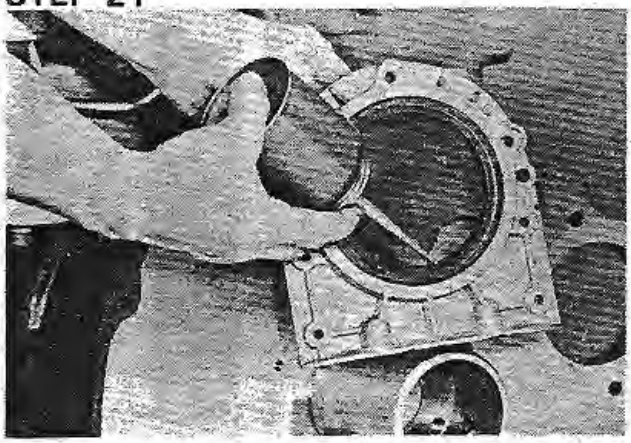
Install new seal carrier gasket on engine block. Apply Permatex No. 2 from lower bolt holes to bottom of gasket. Trim excess gasket material.

STEP 20



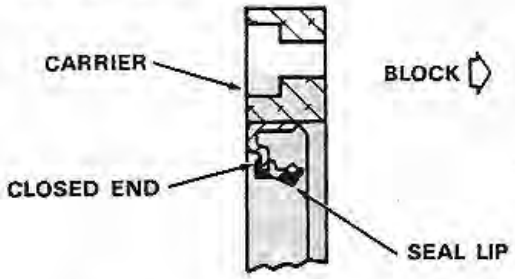
Install sleeve, Case Part No. G15028 on end of crankshaft.

STEP 21

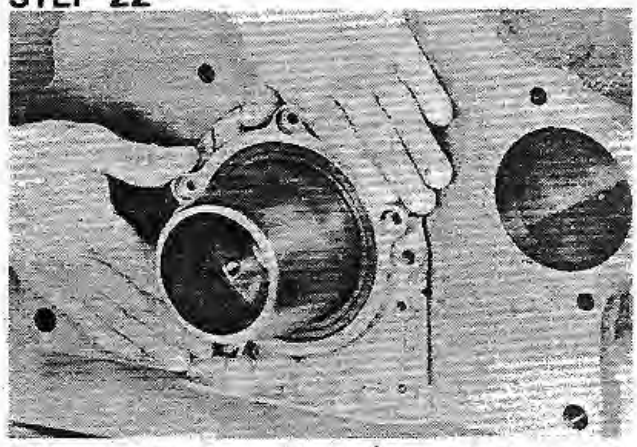


Press new rear oil seal into the carrier with seal lip inward, until seal is flush with rear of carrier. Apply HDM No. 30 oil to rear oil seal.

STEP 21 (Cont'd)

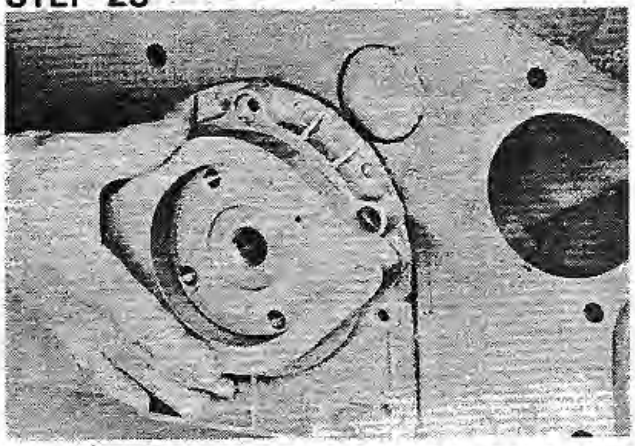


STEP 22



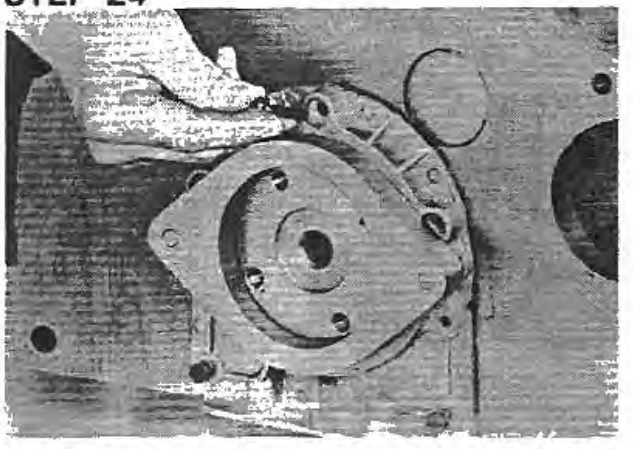
Slide seal on sleeve tool until carrier is against gasket on engine block. Remove sleeve tool.

STEP 23



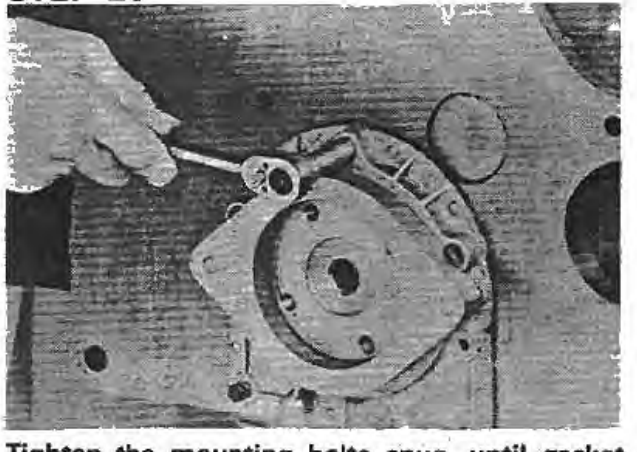
Install Case Aligning Tool, G13506 with the tool pins in aligning holes of carrier. The tool must be installed over the flange of the crankshaft.

STEP 24



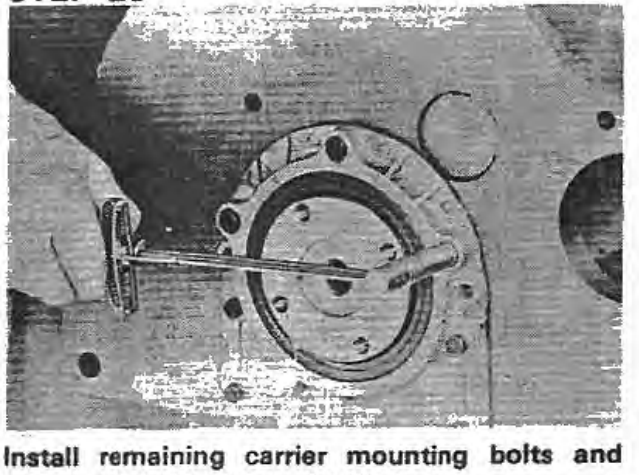
Install the top carrier mounting bolt and the two bottom mounting bolts.

STEP 25



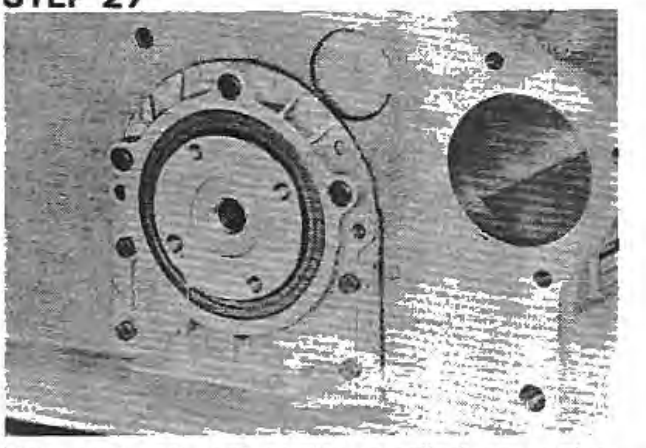
Tighten the mounting bolts snug, until gasket and carrier is against engine block, then remove the aligning tool.

STEP 26



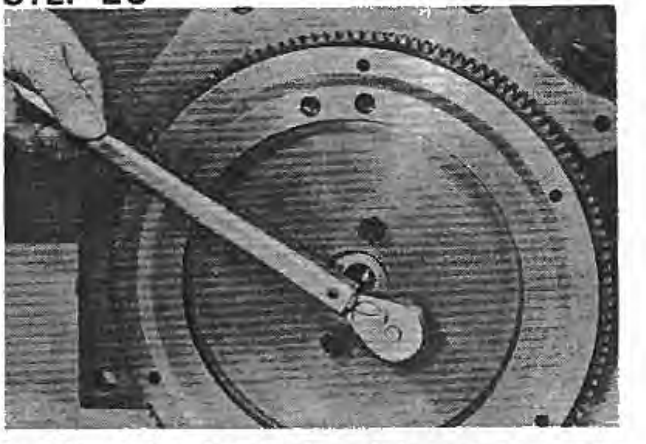
Install remaining carrier mounting bolts and torque all bolts 12 to 15 ft. lbs.

STEP 27



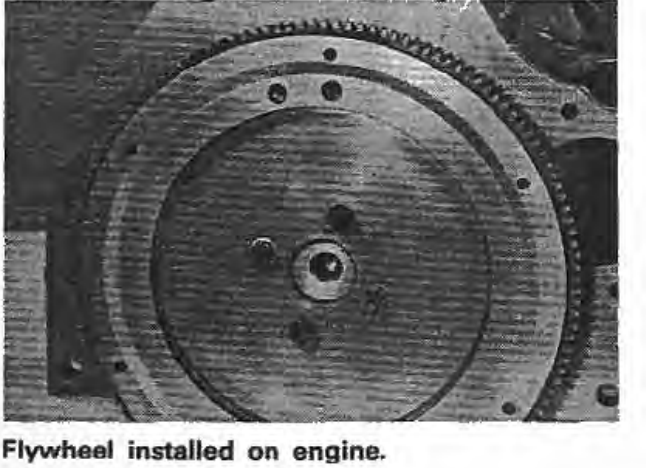
New seal and seal carrier installed on engine.

STEP 28



Install engine flywheel and torque mounting bolts 65 to 70 ft. lbs.

STEP 29

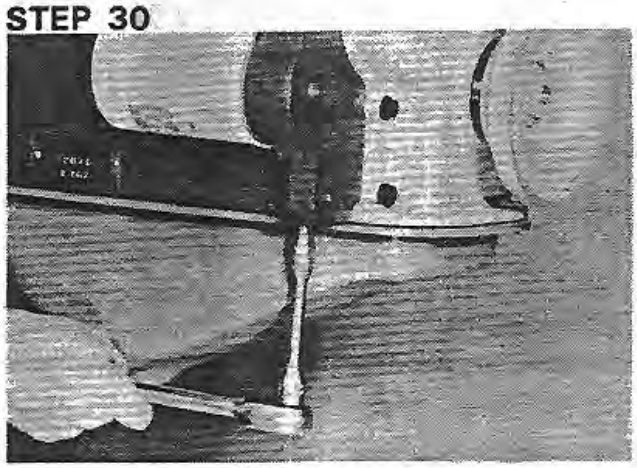


Flywheel installed on engine.

CRANKSHAFT AND MAIN BEARINGS

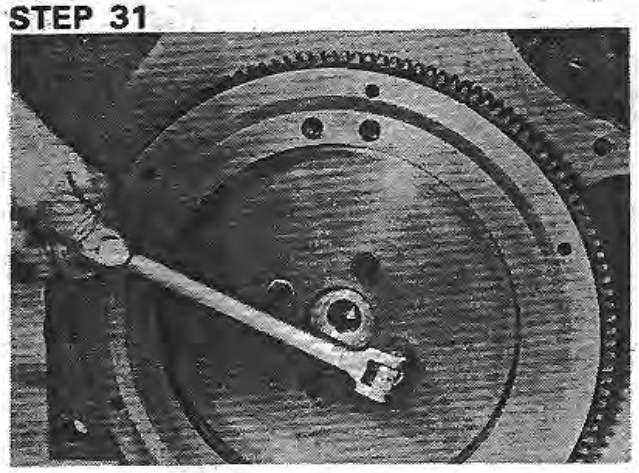
Removal

STEP 30



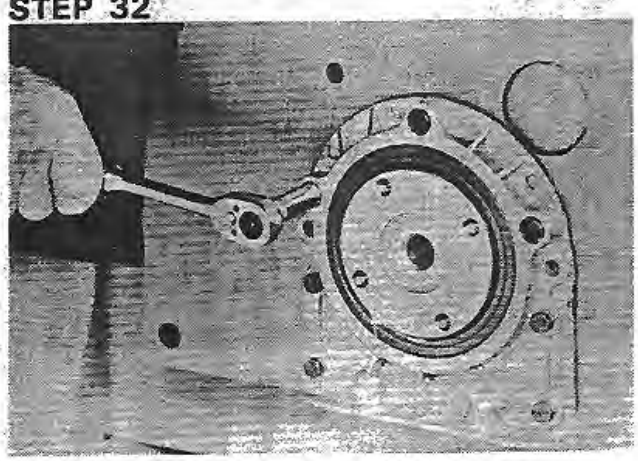
Remove the engine oil pan.

STEP 31



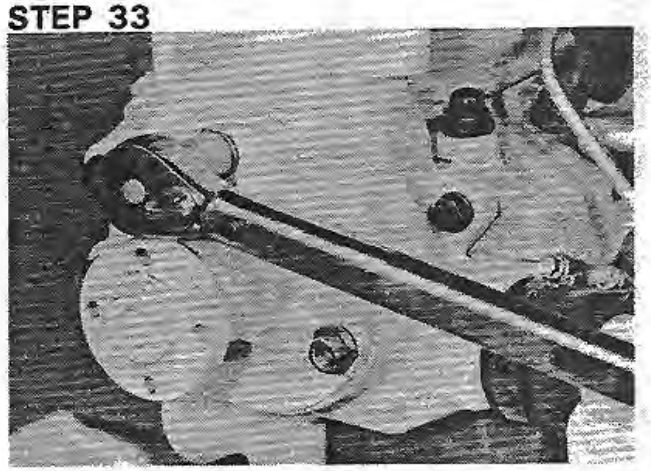
Remove the engine flywheel.

STEP 32



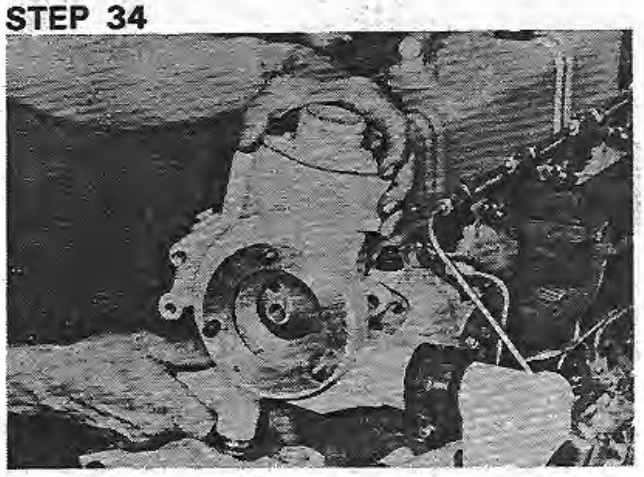
Remove the rear seal and seal carrier.

STEP 33



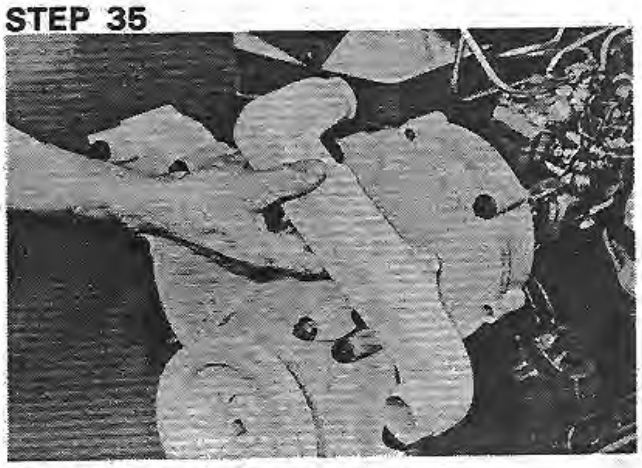
Remove the water pump.

STEP 34



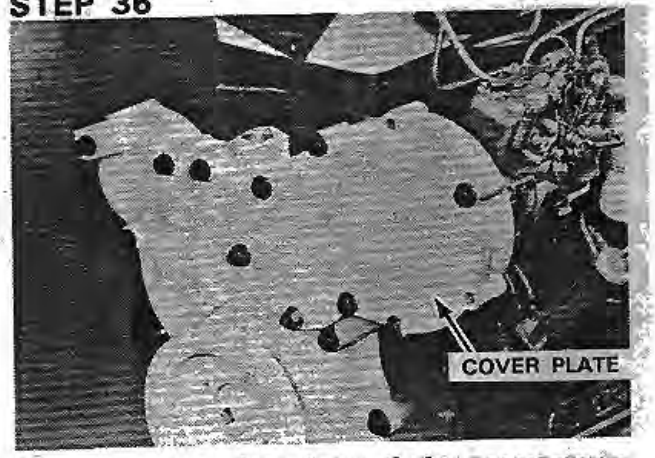
Remove the water pump housing.

STEP 35

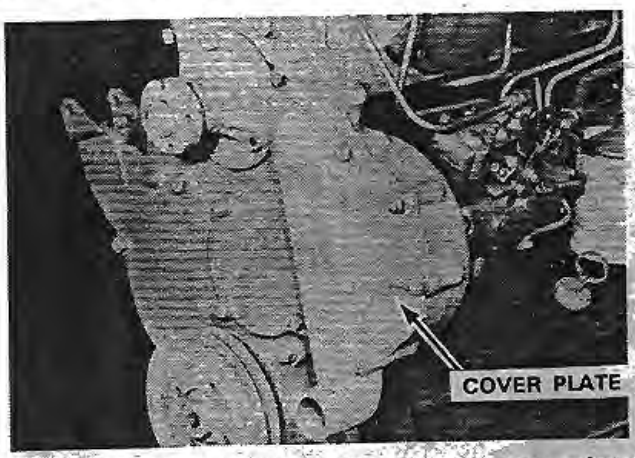


Remove the water tube.

STEP 36

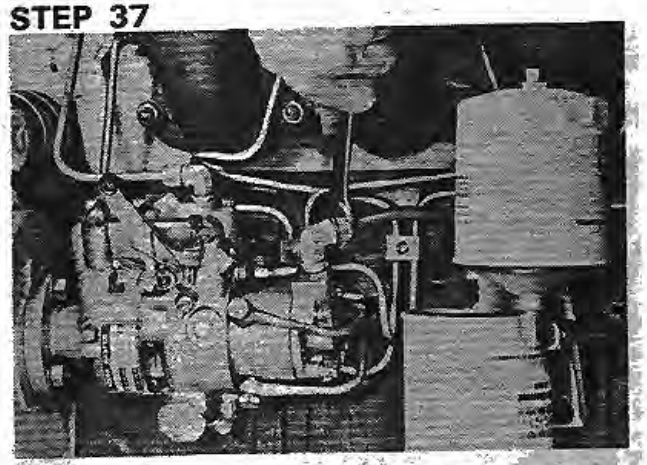


Remove cover plate from timing gear cover.



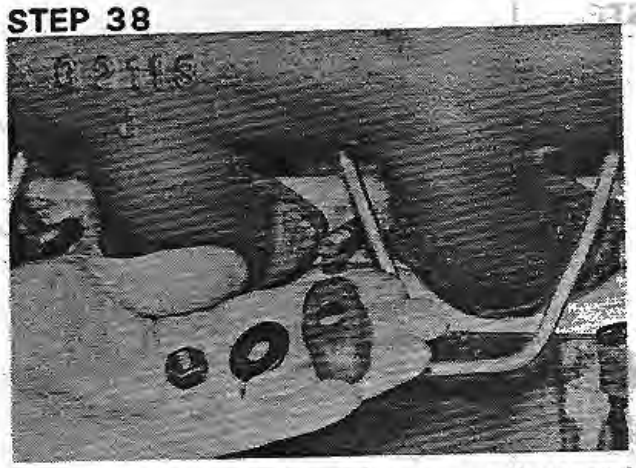
If equipped, remove timing gear cover plate with integral water tube.

STEP 37



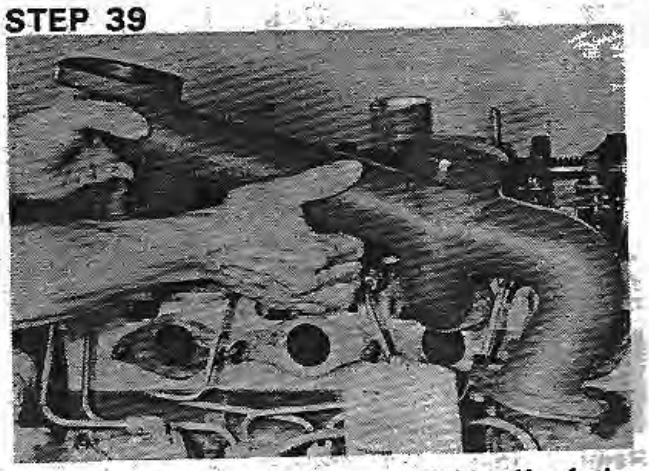
Disconnect the inlet fitting, leakoff line, throttle control and governor control from fuel injection pump. Disconnect the high pressure lines from the fuel injectors.

STEP 38



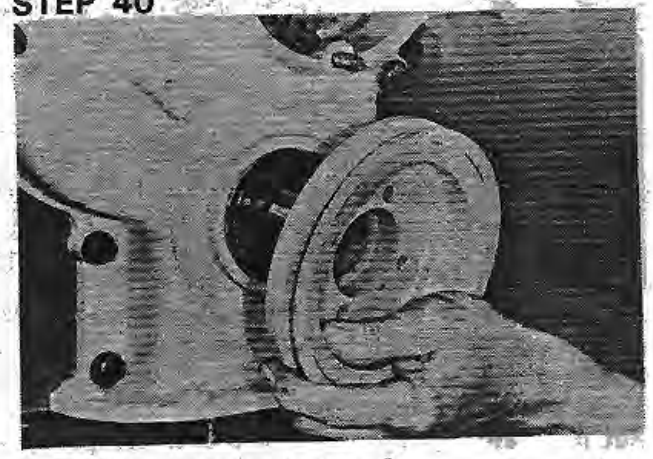
Remove the manifold stud nuts, washers and retaining clamps.

STEP 39



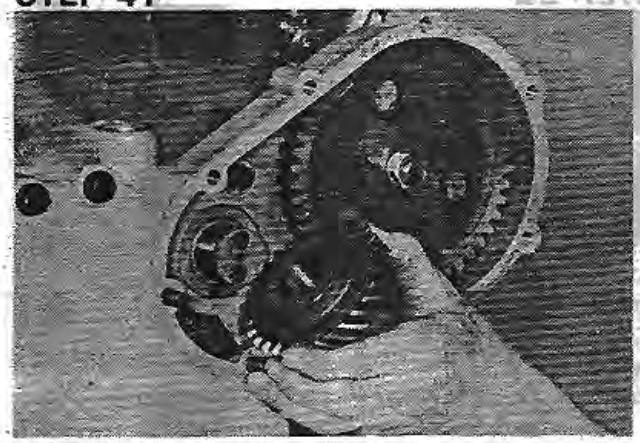
Remove the front of the manifold off of the front stud. Swing manifold upward and remove the manifold from the rear stud.

STEP 40



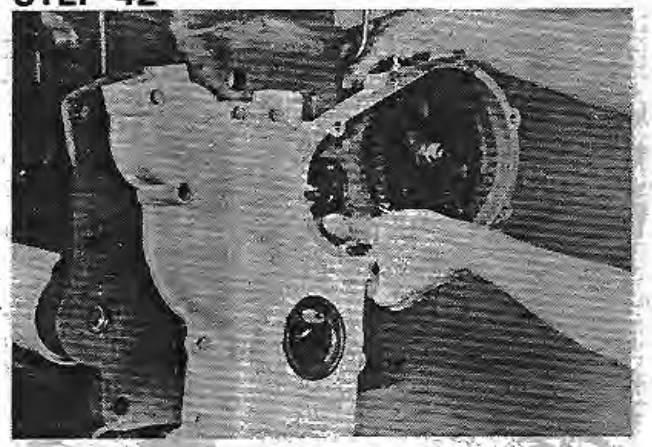
Remove crankshaft pulley.

STEP 41

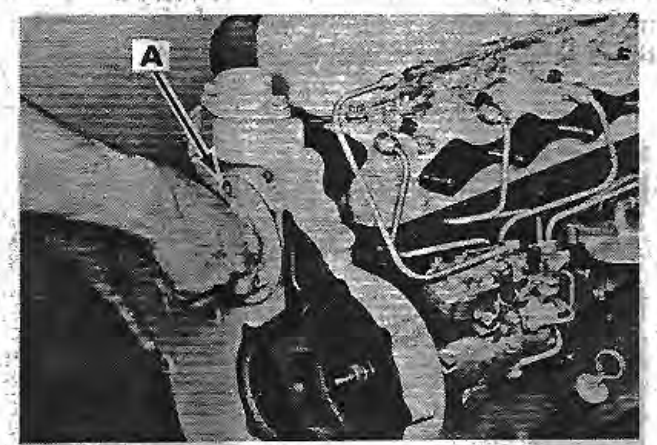


Remove idler gear and shaft.

STEP 42

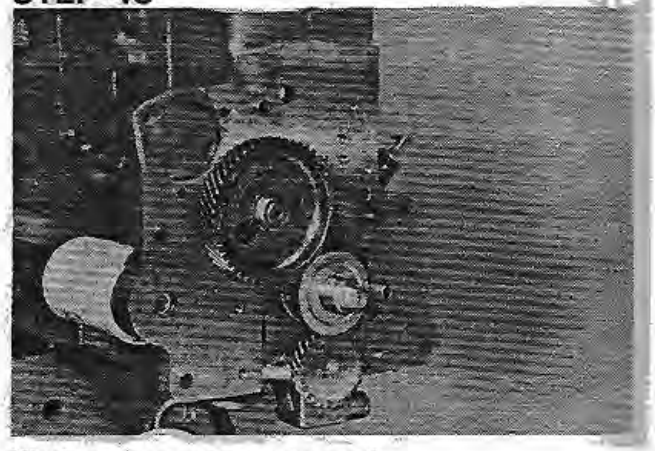


Remove timing gear cover.



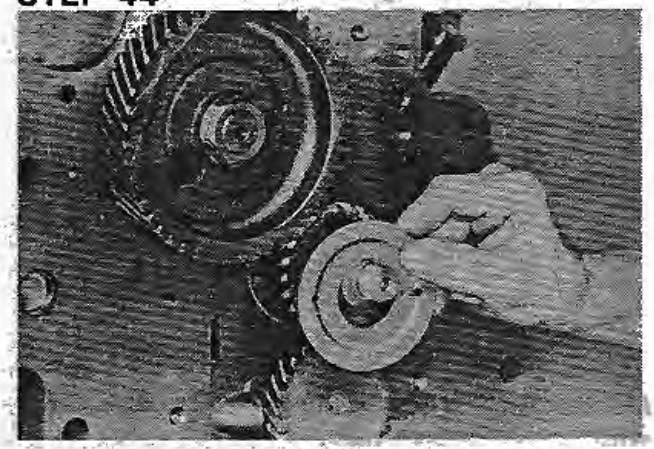
If equipped, remove the one piece timing gear cover and water pump housing. *NOTE:* If a hex. bolt is located at point "A", the water pump is not required to be removed. If stud and nut is located at point "A", the water pump and the inner socket hd. bolt must be removed, so that the one piece cover may be removed.

STEP 43



Timing gear cover removed.

STEP 44

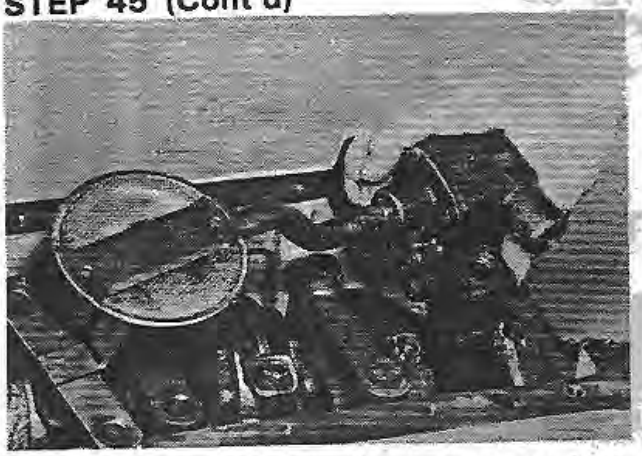


Remove oil slinger from end of crankshaft.

STEP 45

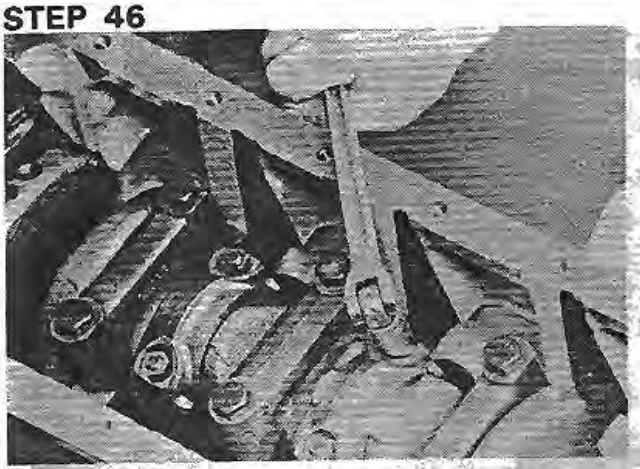
Remove the oil pump and shims from front main bearing.

STEP 45 (Cont'd)



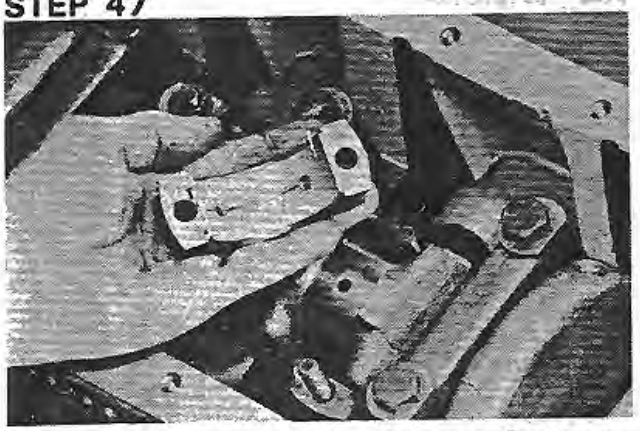
If equipped, disconnect oil pump screen bracket from 3rd main bearing cap and remove oil pump and shims from front main bearing.

STEP 46



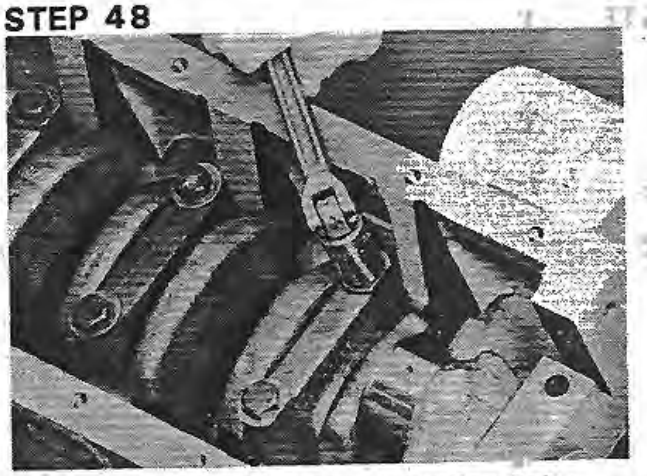
Remove connecting rod bearing cap nuts.

STEP 47



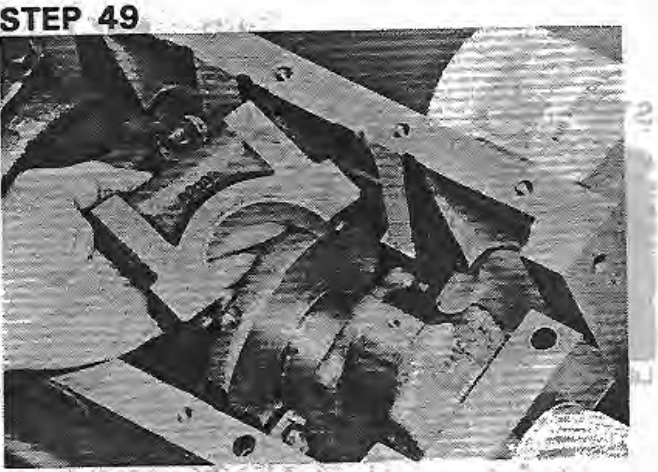
Remove connecting rod bearing caps from connecting rods. Check to be sure that the rods and caps are numbered as to their location in the block. If not, they must be identified for reinstallation in their same locations.

STEP 48



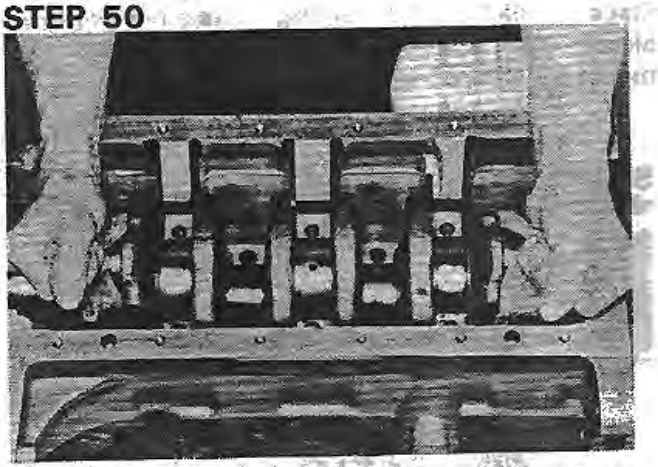
Remove main bearing cap mounting bolts.

STEP 49



Remove main bearing caps from engine.

STEP 50

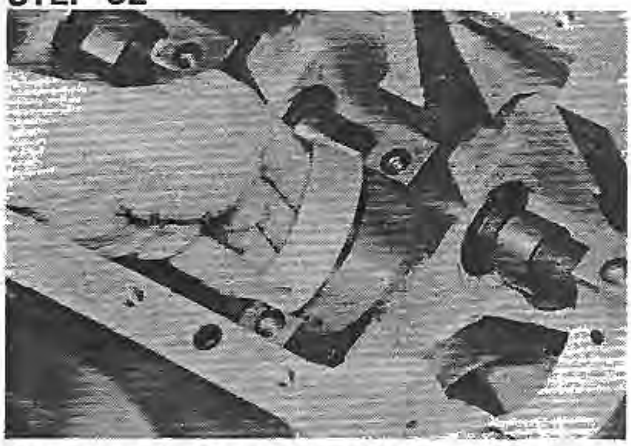


Lift the crankshaft out from the engine block.

STEP 51

Crankshaft removed from engine.

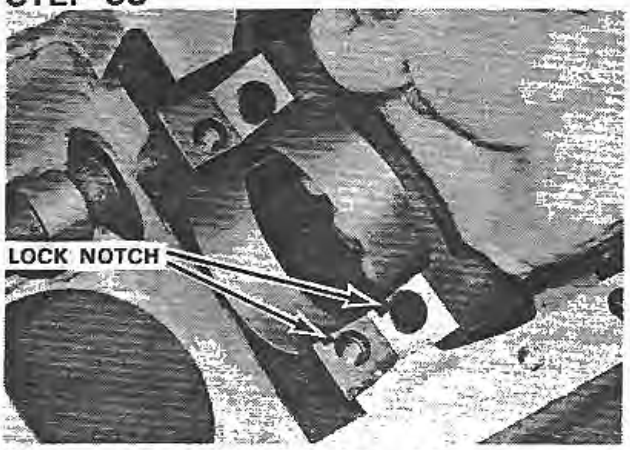
STEP 52



Remove main bearing liners from engine block.

Main Bearing Cap Replacement

STEP 53

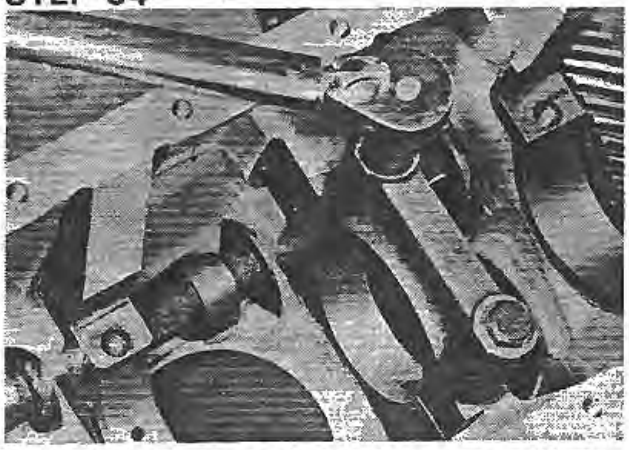


Place replacement bearing cap in engine block. *NOTE:* Lock notches must be on the same side of bearing.

STEP 55

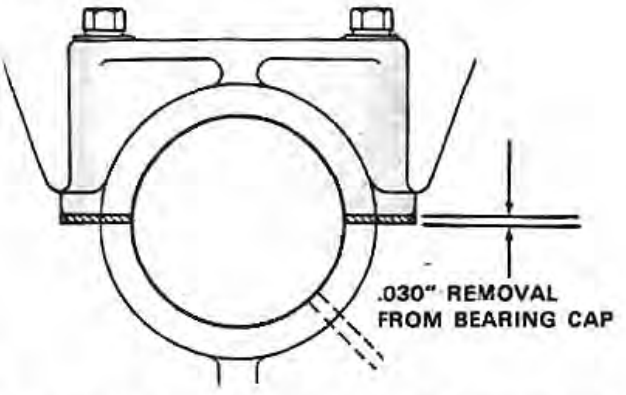
Check bore diameter at three angular locations indicated. Inside dimension must be 3.066" to 3.067"

STEP 54



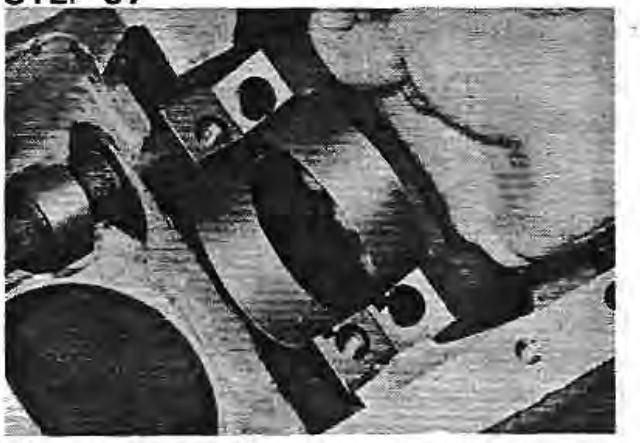
Install replacement main bearing caps and bolts. Torque bolts 90 to 100 ft. lbs.

STEP 56



If vertical dimension is out of tolerance or cap is shifted side-wise, rework cap by removing .030" stock from mating surface and then bore out to meet tolerance as specified in Step 55. *IMPORTANT:* If .030" stock was required to be removed, the same amount must be machined from the lock groove, to prevent interference when installing liners.

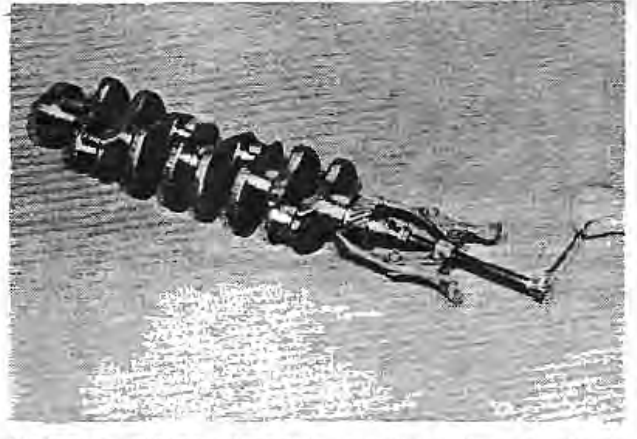
STEP 57



Be sure to machine new mounting surface flat, so that cap will set solid without wobbling in block.

Crankshaft Inspection and Installation

STEP 58



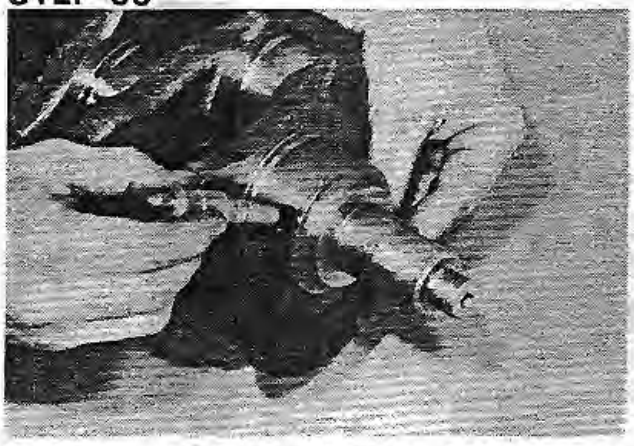
Using a puller, remove crankshaft gear from crankshaft.

STEP 59

Measure the main bearing journals for wear. Measure front and rear of each journal. If diameters are smaller than 2.8730", undersize bearing liners (.002") must be used.

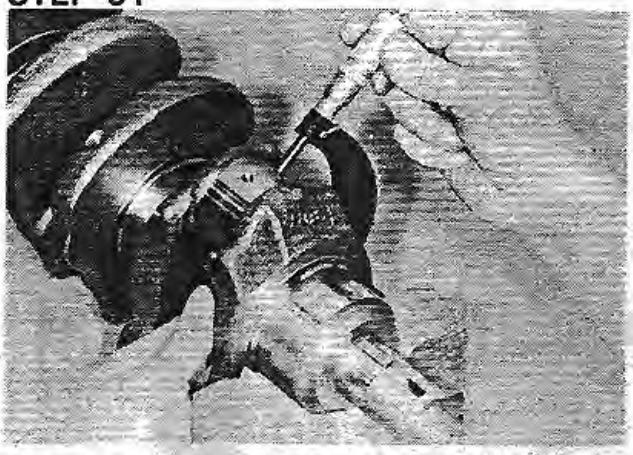
NOTE: When journals are worn more than .002", the crankshaft must be ground undersize .010",020" or .030". Refer to Specifications, Sections 1026 or 1027 for grinding dimensions.

STEP 60



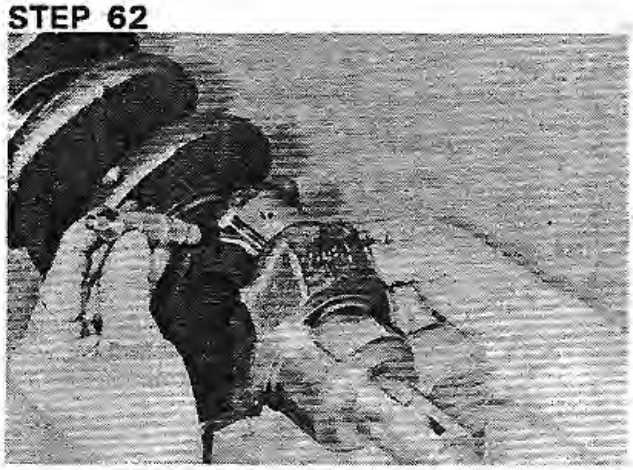
Recheck main bearing journals 90° from the first measurements for out-of-roundness. If out-of-roundness exceeds .0005", the journals must be reground and undersize liners used.

STEP 61



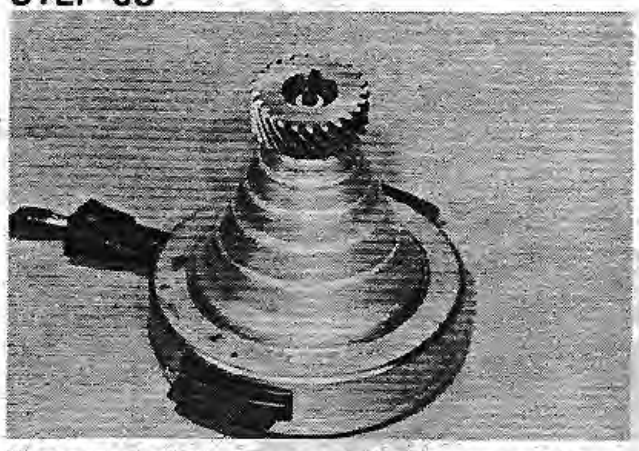
Measure the connecting rod journals. Measure front and rear of each journal, checking taper. If taper exceeds .001", the journals must be refinished.

STEP 62



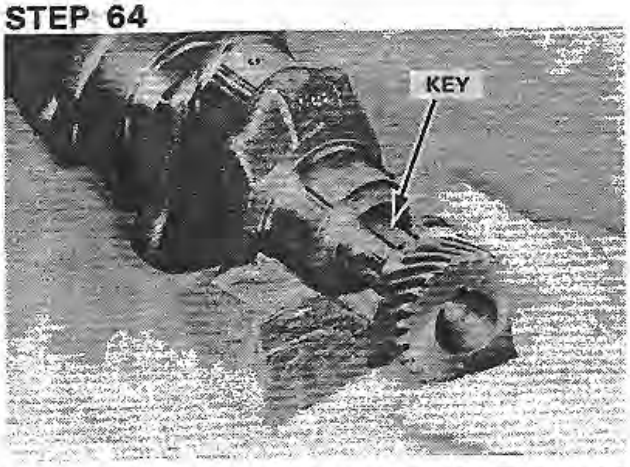
Recheck rod journals 90° from the first measurements for out-of-roundness. If out-of-roundness exceeds .0005", the journals must be refinished.

STEP 63



Heat crankshaft gear, using a gear and bearing heater, to facilitate assembling gear on crankshaft.

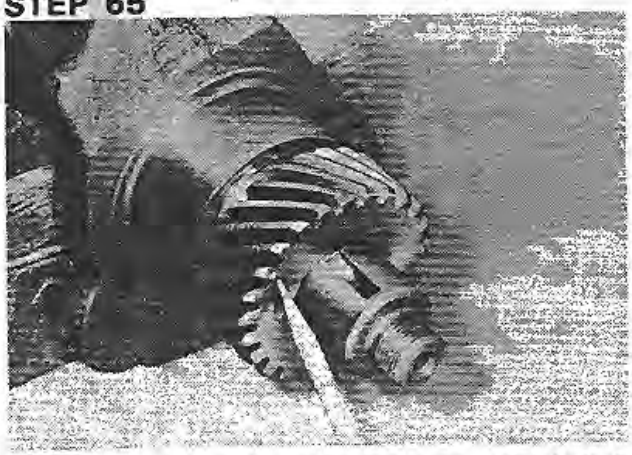
STEP 64



Install key and heated crankshaft gear with timing mark outward, on crankshaft.

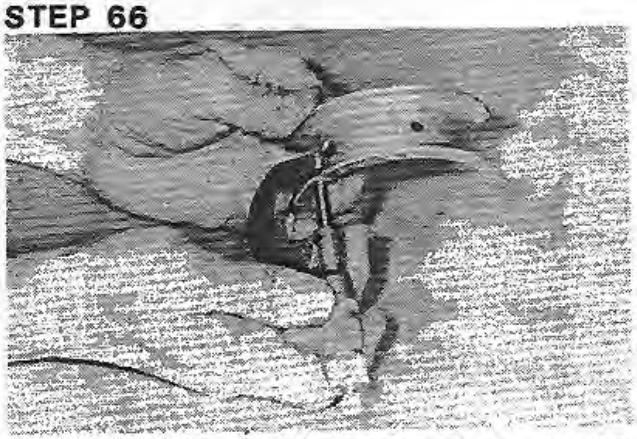
CAUTION: *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*

STEP 65



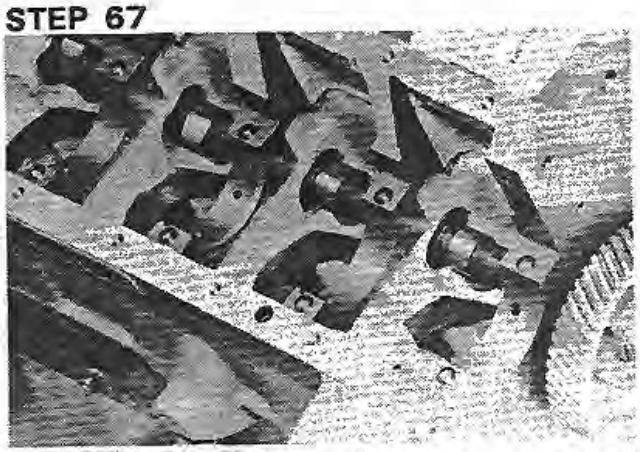
Make sure the timing mark on crankshaft gear is outward.

STEP 66



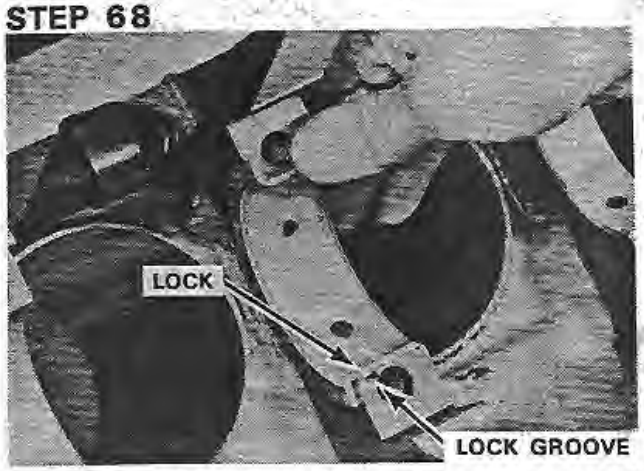
Measure thickness of thrust surface of center main bearing liner. Minimum thickness of thrust surface is .1025". Replace liner if dimension is less than specified.

STEP 67



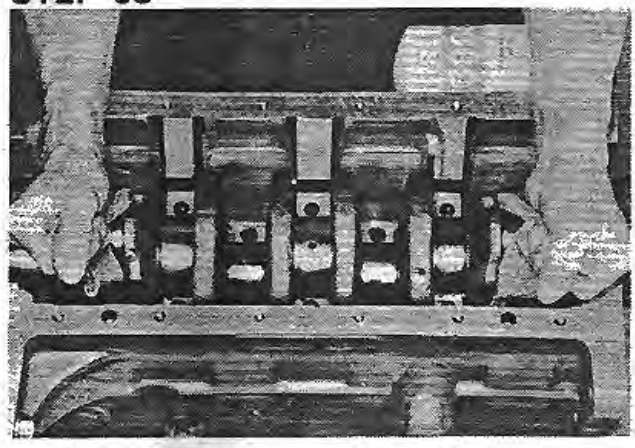
IMPORTANT: The bearing bore in the block and the bearing caps must be absolutely clean and free of dirt or grease. Any dirt left behind the bearing liners will interfere with the lube cooling of the bearing liners and will result in "hot spots" and premature failure.

STEP 68



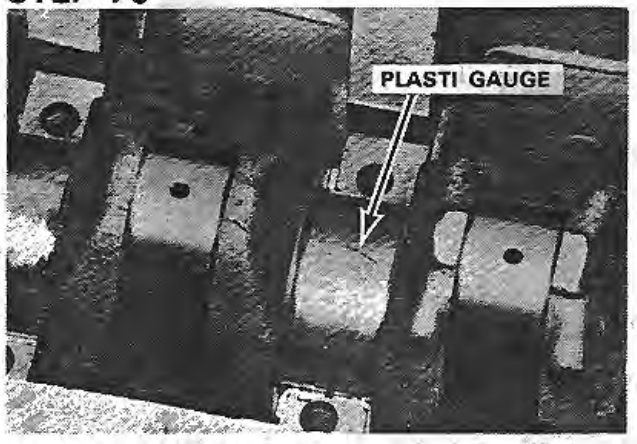
Install bearing liners in engine block, with lock of liner engaging lock groove in block.

STEP 69



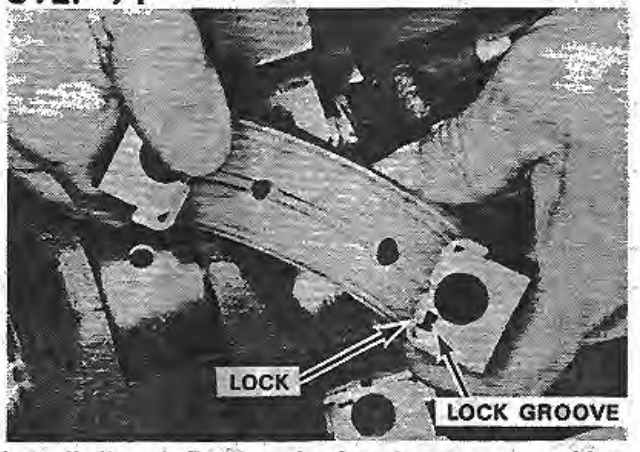
Install crankshaft in engine block.

STEP 70



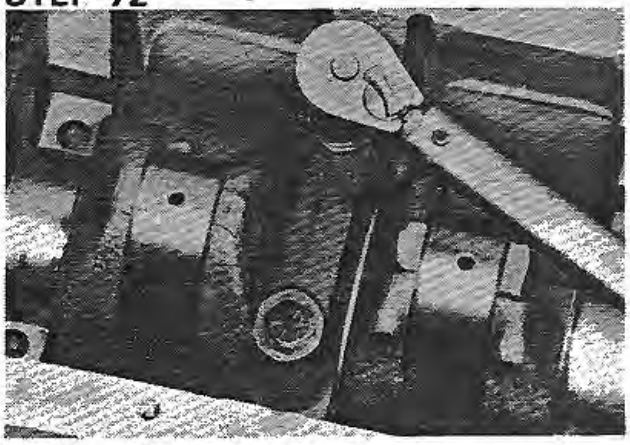
Wipe clean the main bearing journals and place a piece of plasti gauge on the journals.

STEP 71



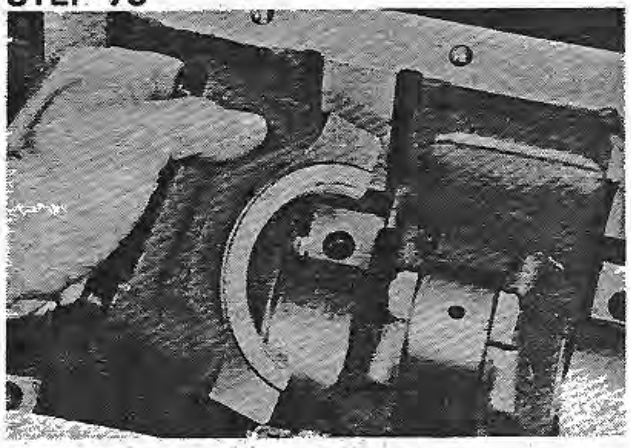
Install liners into main bearing caps making sure liner lock aligns with lock groove in cap. Use a sliding type movement when installing liners, never press on center of liners.

STEP 72



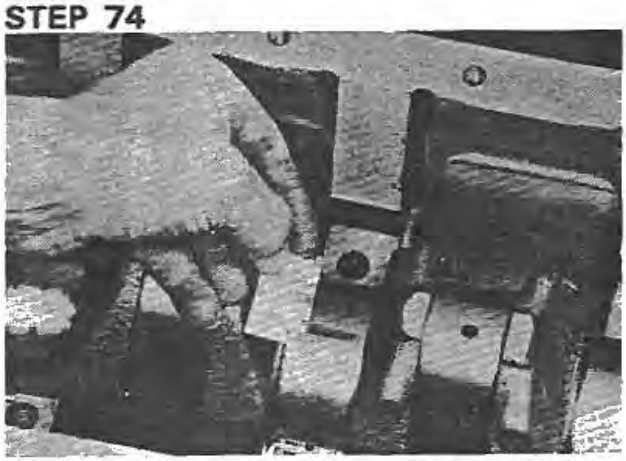
Install main bearing caps and torque cap mounting bolts 90 to 100 ft. lbs.

STEP 73



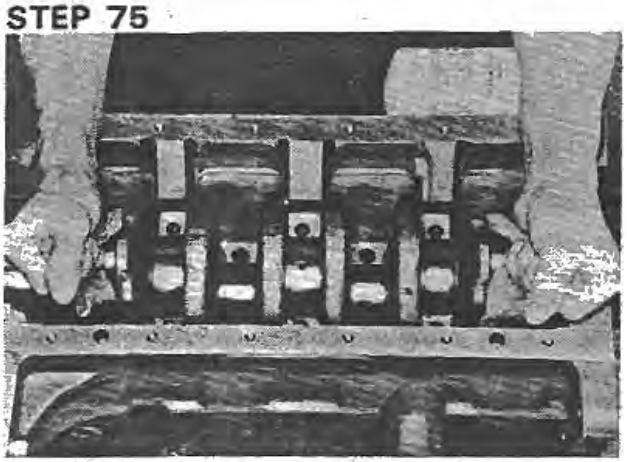
Remove the main bearing caps.

STEP 74



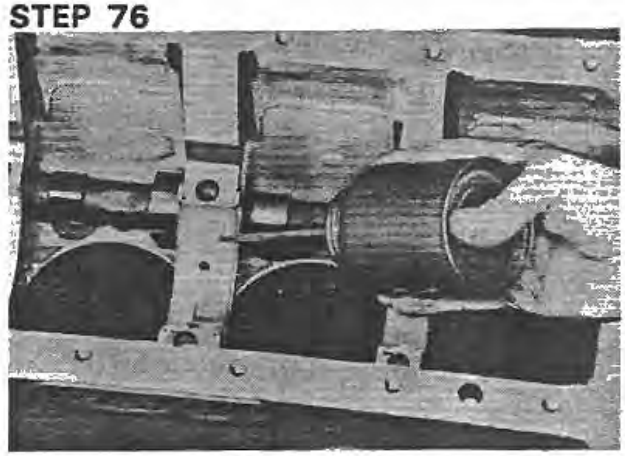
The flattened plasti gauge will be found on either the bearing shell or crankshaft. Compare the flattened gauge material at its widest point with the scale that is furnished. The number within the graduation indicates clearance in thousandths of an inch. Bearing oil clearance should be .0012" to .0042". *NOTE:* Undersize liners are available. If it is necessary to grind down one or more journals, it is advisable to grind all the journals.

STEP 75



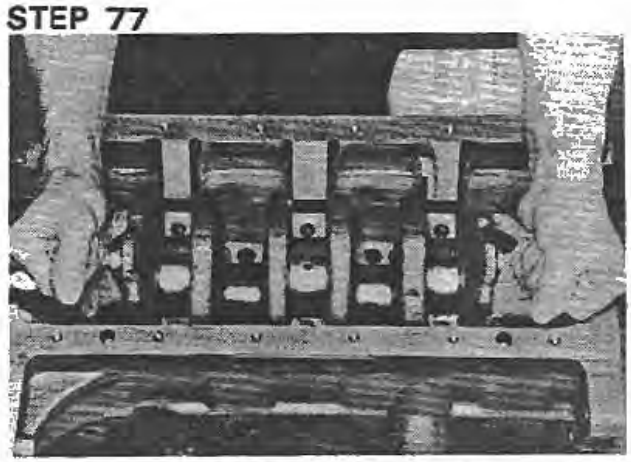
Lift crankshaft from the engine.

STEP 76



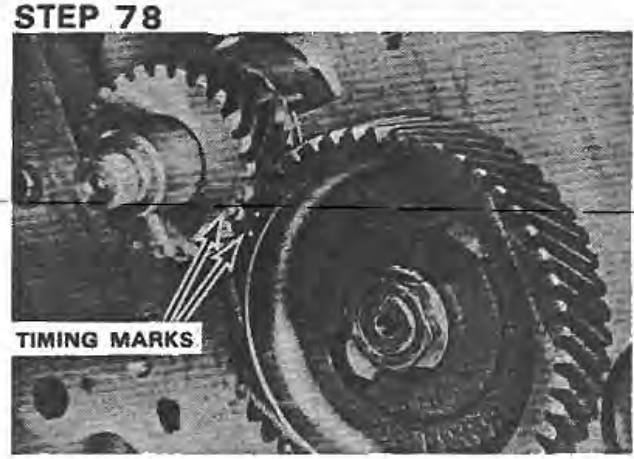
Lubricate the bearing liners with clean HDM No. 30 oil.

STEP 77



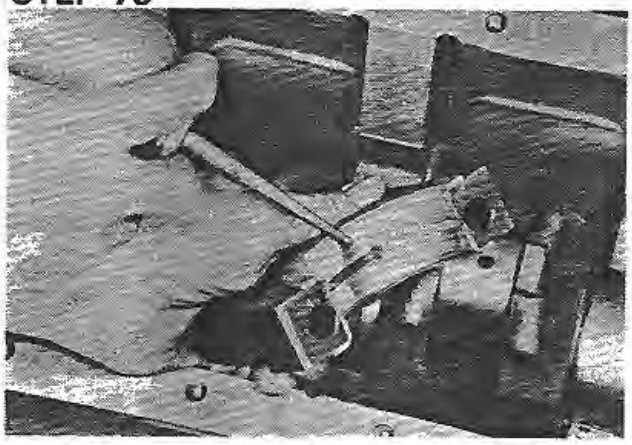
Install the crankshaft into the engine.

STEP 78



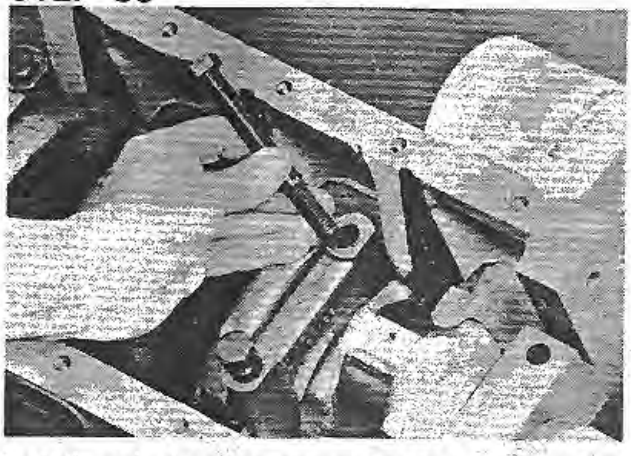
Make sure the timing marks on the crankshaft gear and the double marks on the camshaft gear are aligned.

STEP 79



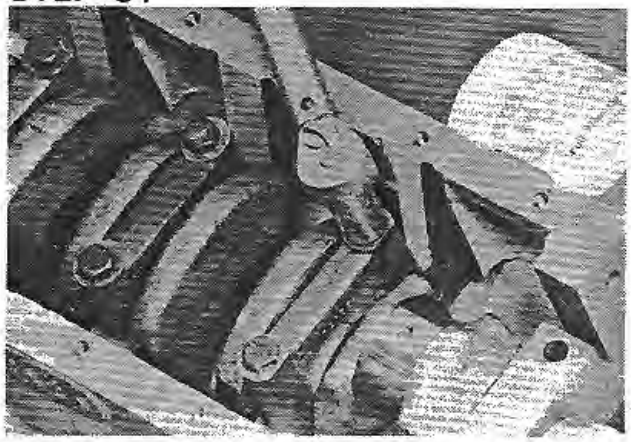
Lubricate bearing liners and crankshaft journals with clean HDM No. 30 oil. Install the main bearing caps in the engine. The numbered side of the main bearing caps must be toward the camshaft. *IMPORTANT:* The main bearings are numbered from 1 thru 5, starting at the pulley end of the crankshaft. Make sure the main bearing caps are installed in the correct numbered location.

STEP 80



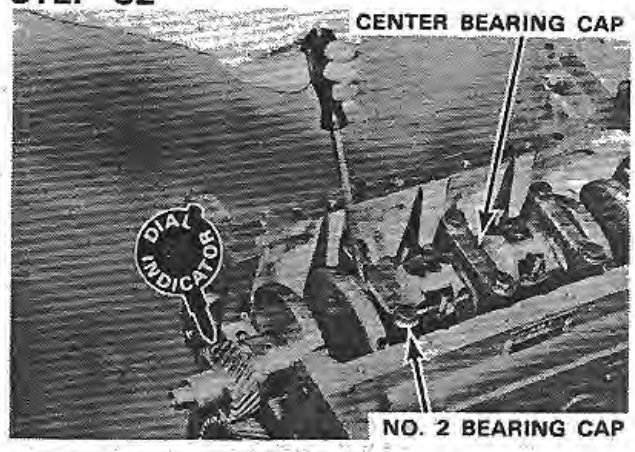
Install main bearing cap mounting bolts.

STEP 81



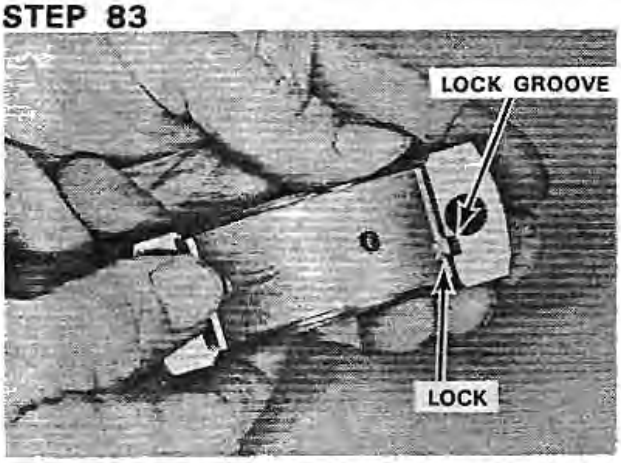
Torque main bearing cap mounting bolts 90 to 100 ft. lbs.

STEP 82



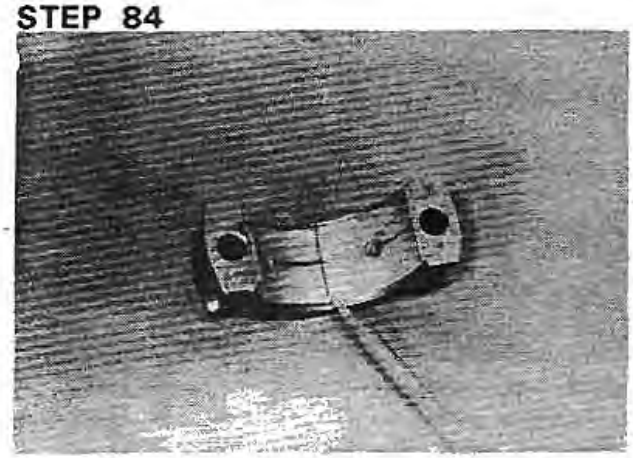
Check the crankshaft end play. The crankshaft end thrust is taken up by the center bearing liner flange. To obtain an accurate reading, place a dial indicator on the crankshaft gear and use a pry bar between the crank throw and No. 2 main bearing cap. Take up all the end play and check indicator reading. Maximum end play is .015". If excessive end play cannot be taken up by a new center main bearing liner, the crankshaft must be replaced.

STEP 83



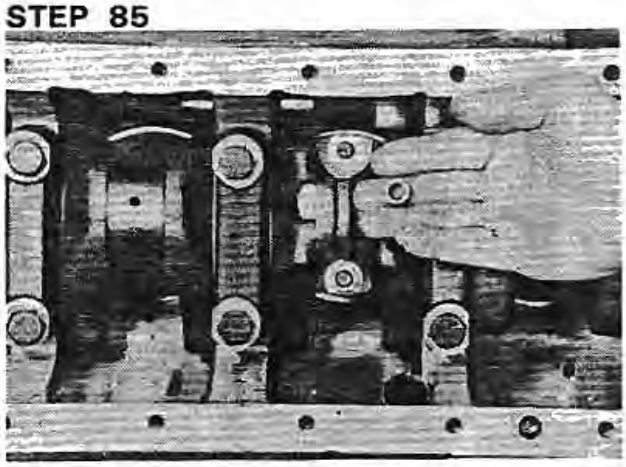
Install bearing liners into connecting rod bearing caps. *NOTE:* Make sure liner lock aligns with lock groove in bearing cap. Use a sliding movement when installing liners; never press on center of liner.

STEP 84



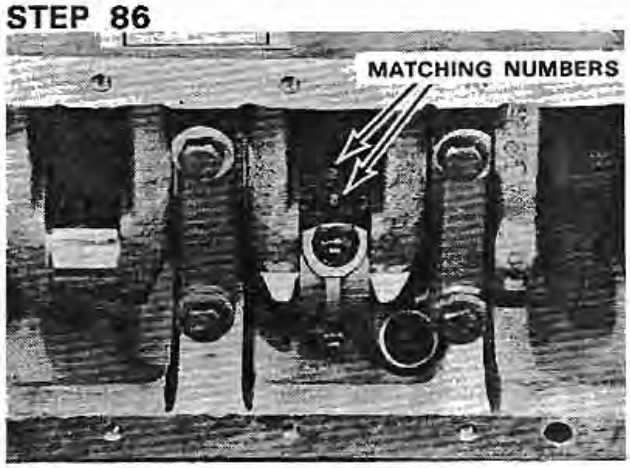
Wipe clean the connecting rod journals and bearing liners. Place a piece of plasti gauge on the connecting rod cap liner.

STEP 85



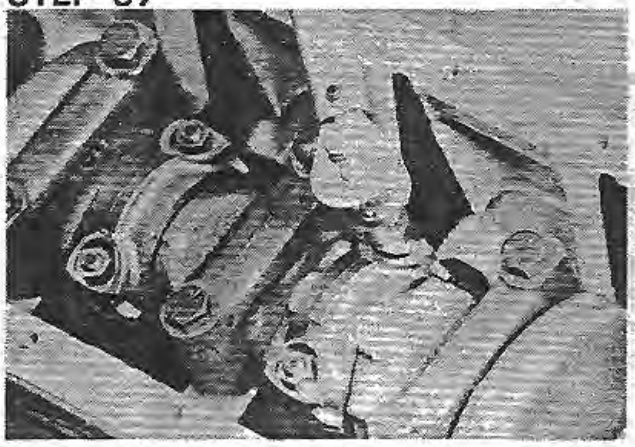
Install the connecting rod cap with corresponding number as connecting rod toward the camshaft side of engine with plasti gauge on the connecting rod. Retain in place with mounting nuts.

STEP 86



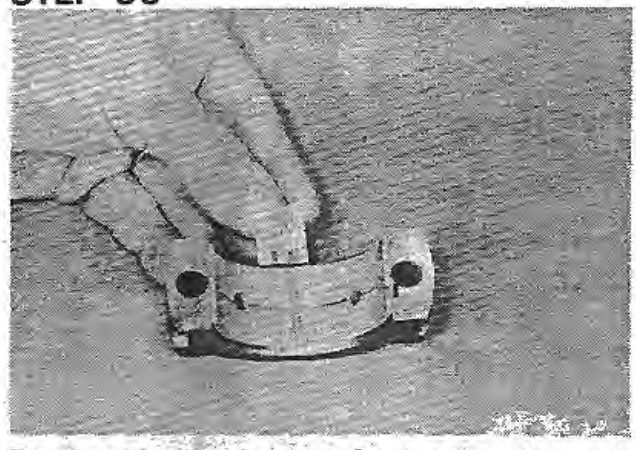
When installing connecting rod bearing caps, make sure the number matches the number on the connecting rod and is toward the camshaft side of the engine.

STEP 87



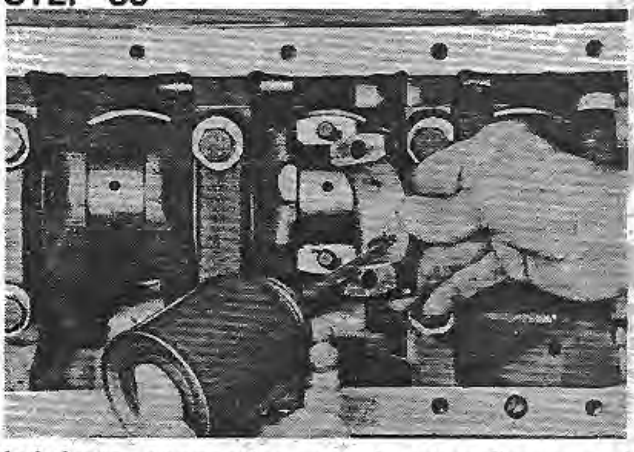
Torque the connecting rod bearing cap mounting nuts 45 to 50 ft. lbs.

STEP 88



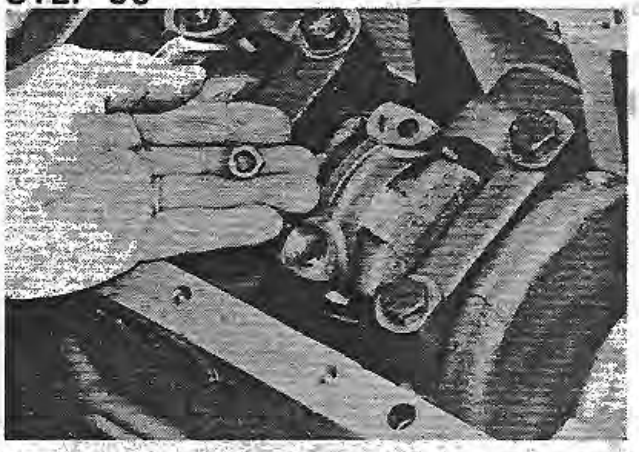
Remove the bearing cap from connecting rod. The flattened plasti gauge will be found on either the rod bearing cap or crankshaft. Compare the flattened gauge material at its widest point with the scale that is furnished. The number within the graduation indicates the clearance in thousandths of an inch. The oil clearance must be .0010" to .0040". If the clearance exceeds these limits, undersize bearing liners must be installed to provide the proper clearance.

STEP 89



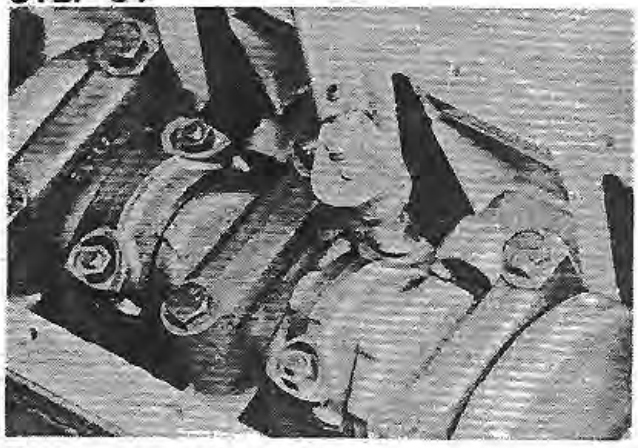
Lubricate connecting rod bearing liners and rod journals with HDM No. 30 oil.

STEP 90



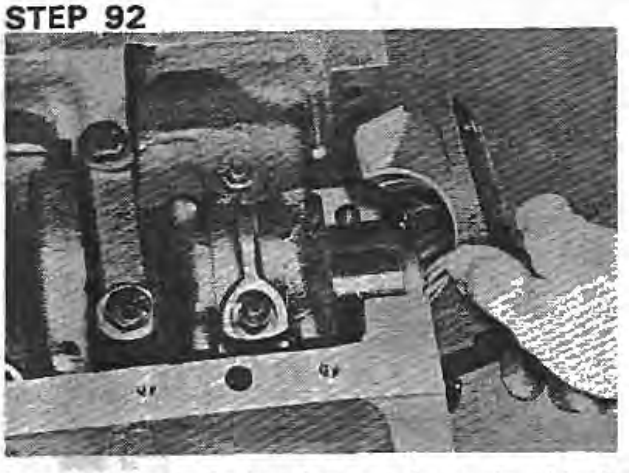
Re-install connecting rod bearing caps and mounting nuts, with numbers matching on bearing caps and rods, towards the camshaft.

STEP 91



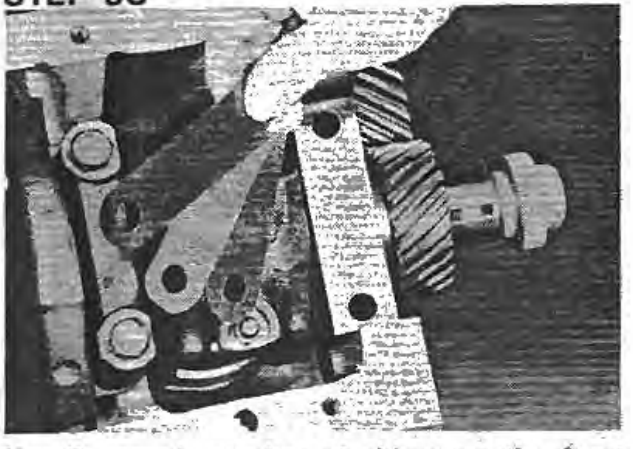
Torque connecting rod bearing cap mounting nuts 45 to 50 ft. lbs.

STEP 92



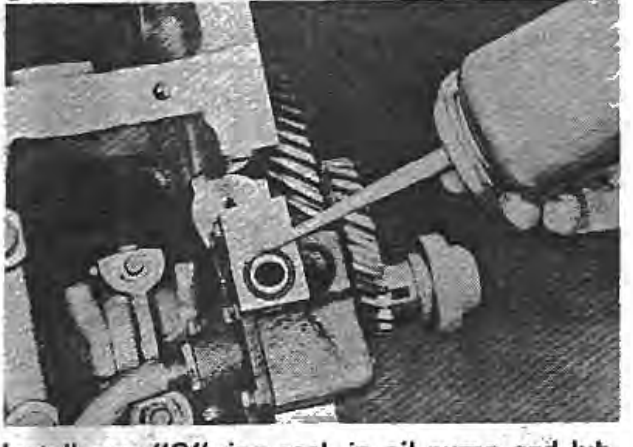
Install front main bearing cap in engine block.

STEP 93



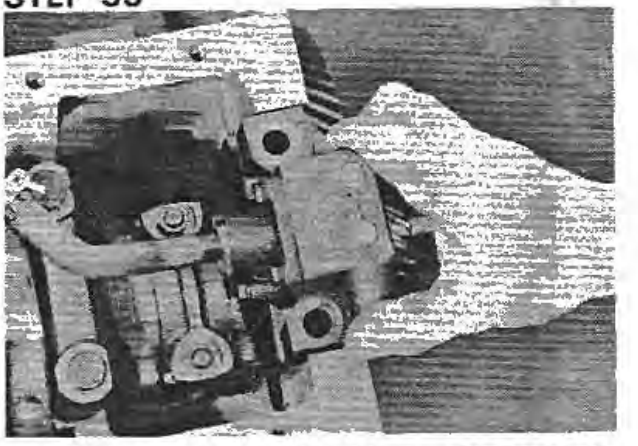
Install enough number of shims on the front main bearing cap to maintain backlash between pump gear and crankshaft gear when mounting bolts are torqued, or damage to the oil pump may result.

STEP 94



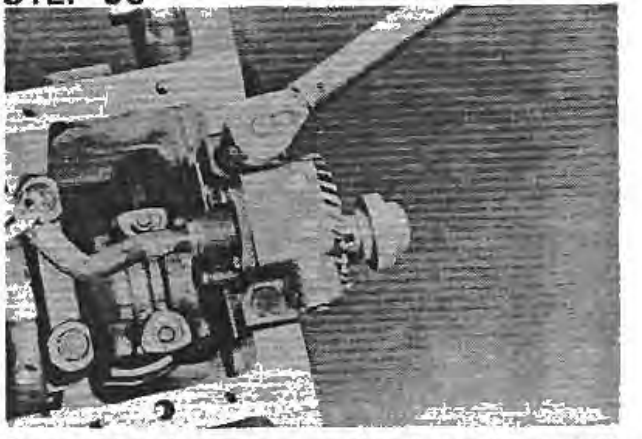
Install new "O" ring seal, in oil pump and lubricate with clean HDM No. 30 oil.

STEP 95

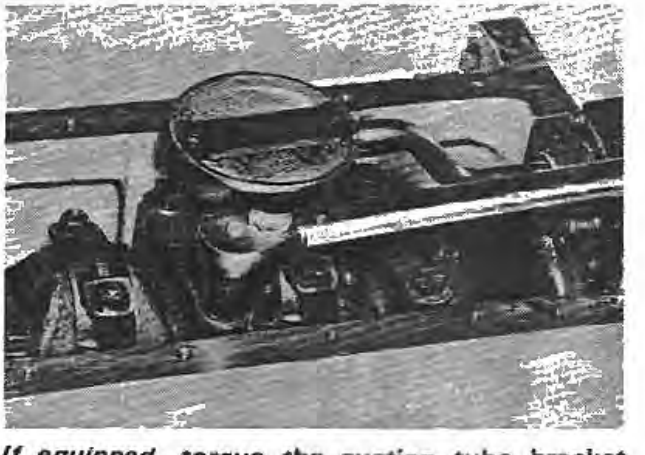


Install oil pump in engine block. *IMPORTANT:* Care must be taken not to cut "O" ring when installing pump to engine.

STEP 96

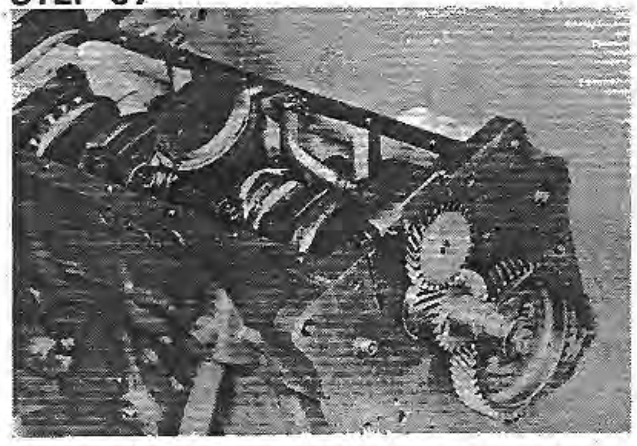


Torque the oil pump mounting bolts 90 to 100 ft. lbs. *IMPORTANT:* A repeated check for backlash between the pump gear and crankshaft gear should be taken when bolts are torqued, or damage to the oil pump may result.



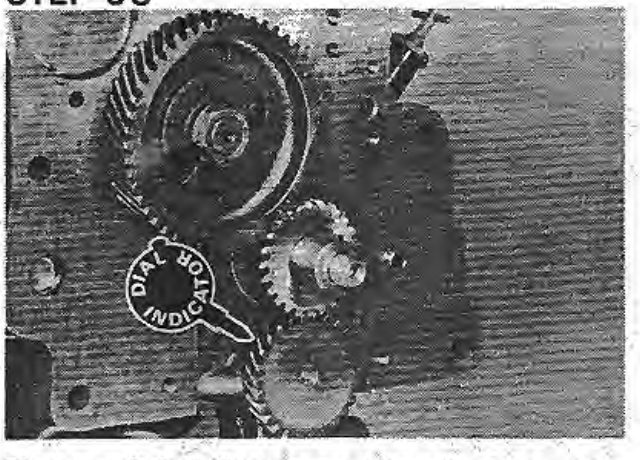
If equipped, torque the suction tube bracket mounting bolts 90 to 100 ft. lbs.

STEP 97



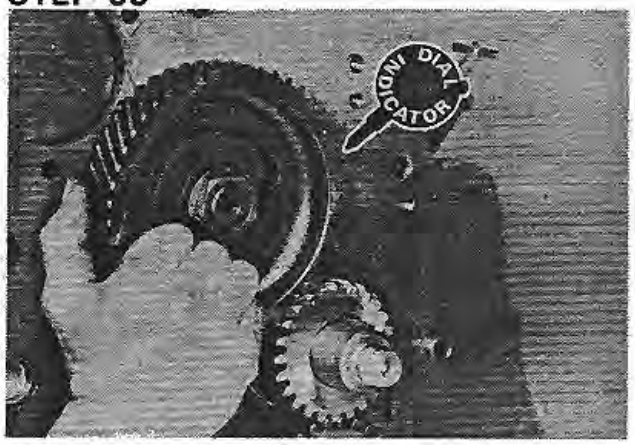
Crankshaft, connecting rods and oil pump installed.

STEP 98



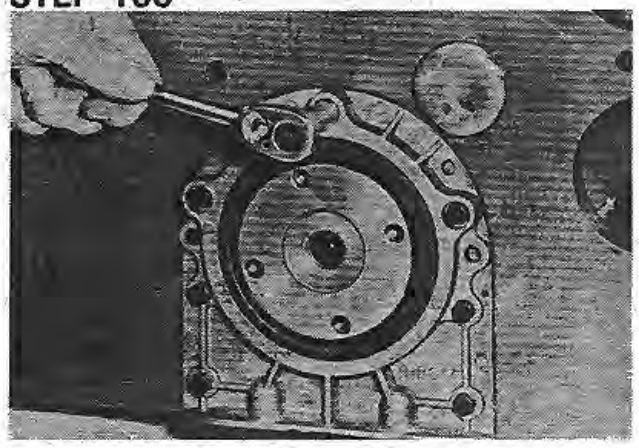
Place a dial indicator on the oil pump drive gear and check backlash between pump drive gear and crankshaft gear. Backlash must be .002" to .008". If backlash exceeds or is less than specified, add or delete shims between oil pump and front main bearing cap to obtain correct backlash, See Step 93.

STEP 99



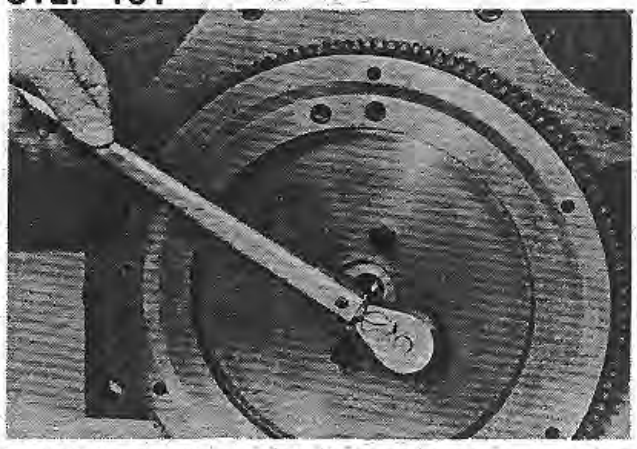
Place a dial indicator on the camshaft gear and check backlash between camshaft gear and crankshaft gear. Backlash must be .0002" to .006". If backlash exceeds .006", the gears must be replaced. *NOTE:* Excessive backlash could also be caused by worn camshaft bushings.

STEP 100



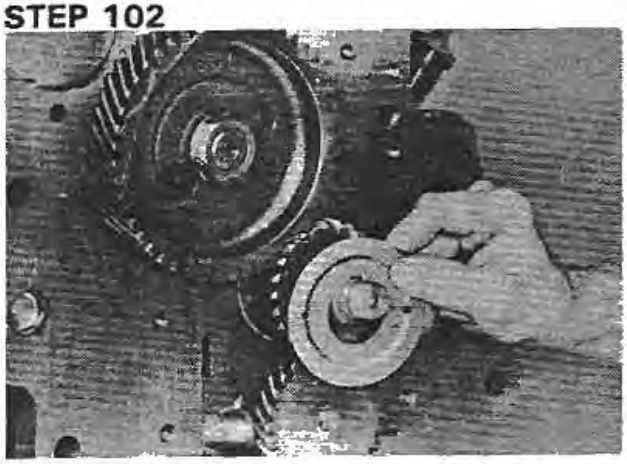
Install rear oil seal and seal carrier. See Steps 18 to 25.

STEP 101



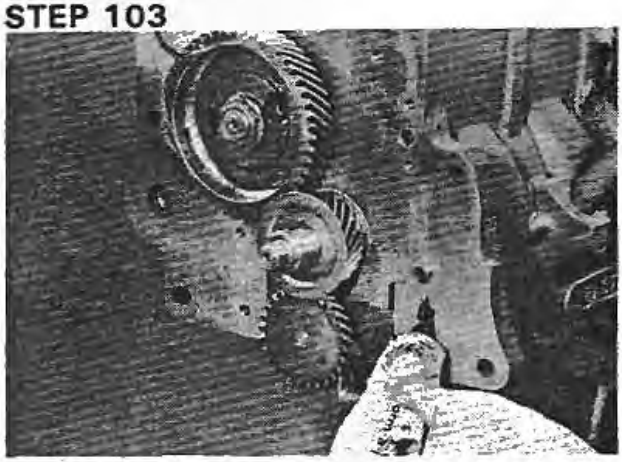
Install flywheel on end of crankshaft and torque mounting bolts 65 to 70 ft. lbs.

STEP 102



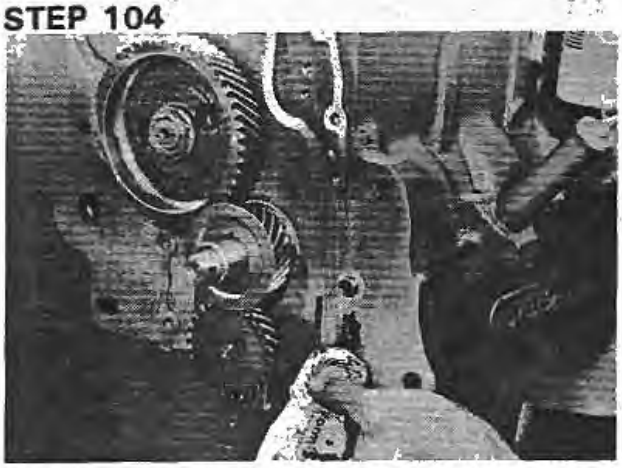
Install oil slinger on crankshaft with concave side facing outward.

STEP 103



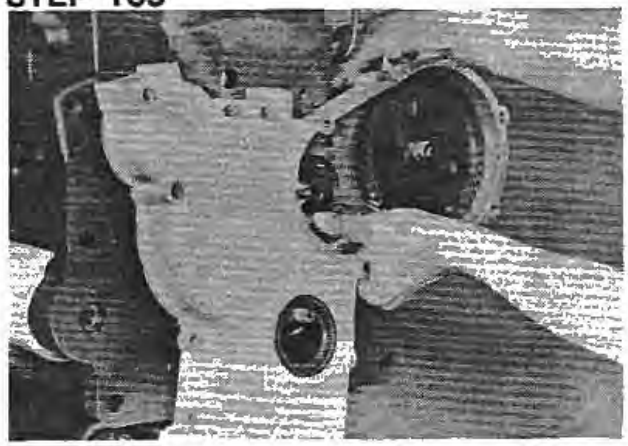
Apply Permatex No. 2 to engine block from bottom timing gear cover mounting hole to bottom of engine block.

STEP 104

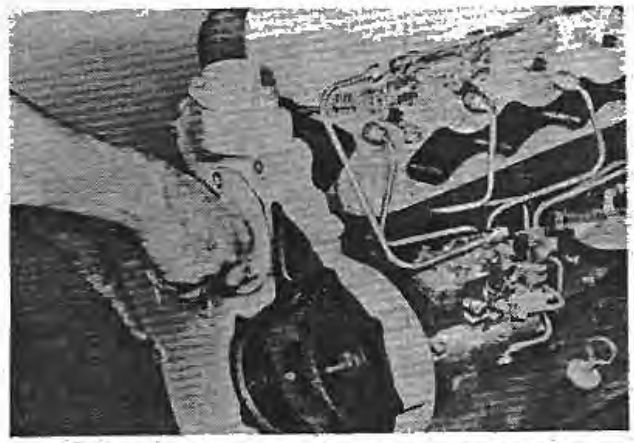


Install new timing gear cover gasket on engine block. Apply Permatex No. 2 to gasket from bottom timing gear cover mounting hole to bottom of engine block.

STEP 105

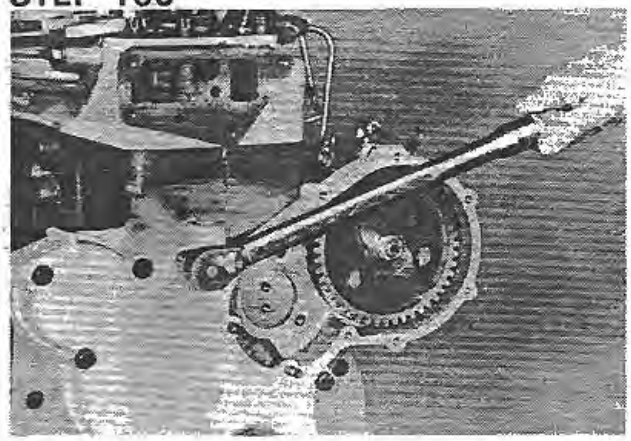


Install timing gear cover on engine block.

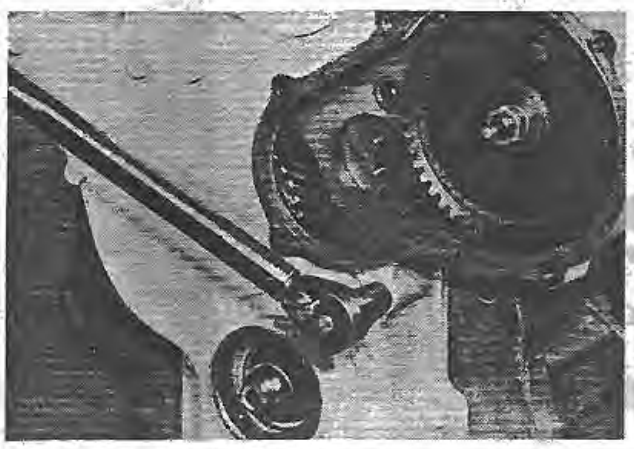


If equipped, install one piece timing gear cover and water pump housing.

STEP 106

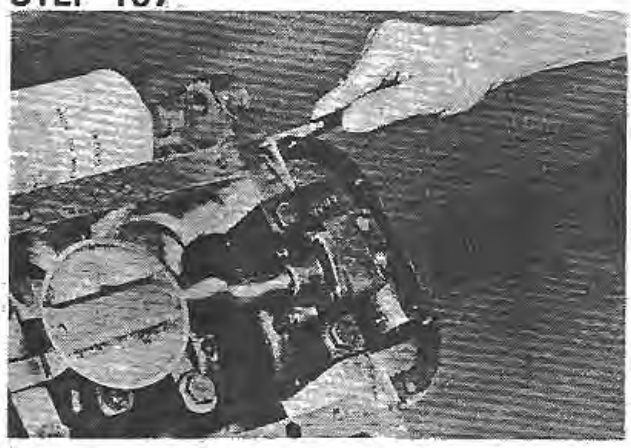


Torque aluminum timing gear cover mounting bolts, 25 to 30 ft. lbs.



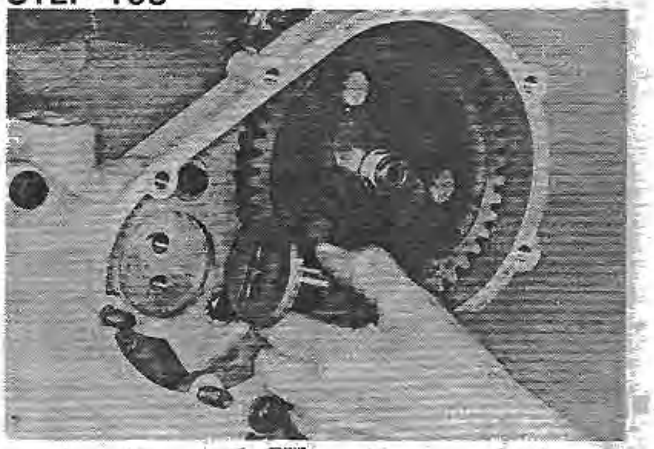
Torque cast iron timing gear cover mounting bolts, 35 to 42 ft. lbs.

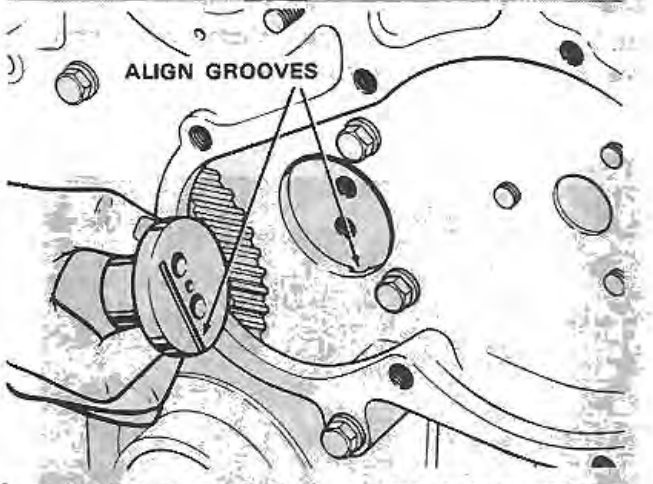
STEP 107



Cut off excess gasket material from bottom of timing gear cover gasket.

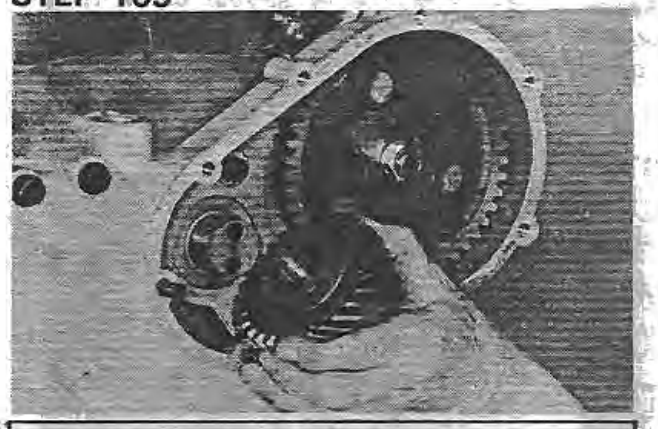
STEP 108

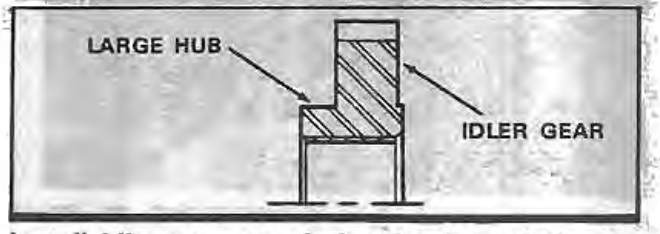




Install idler gear shaft in engine block with oil groove aligned with groove in block.

STEP 109



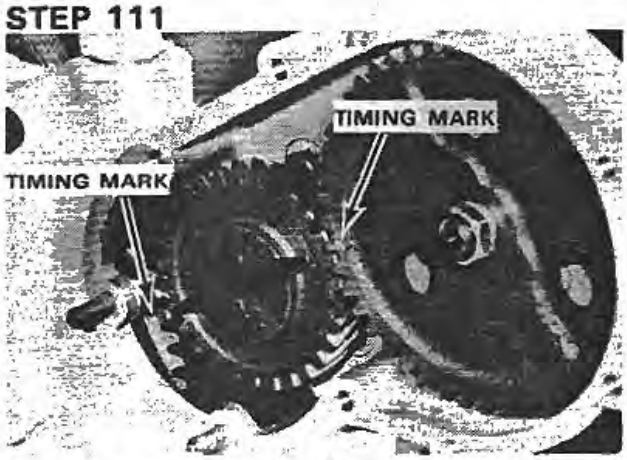


Install idler gear on shaft with large hub side toward engine block.

STEP 110

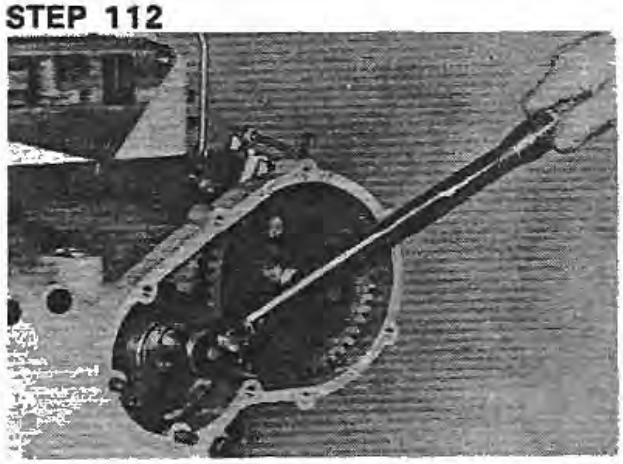
Install idler gear mounting bolts, thrust plate, pointer and enough shims to maintain a running clearance between thrust plate and idler gear.

STEP 111



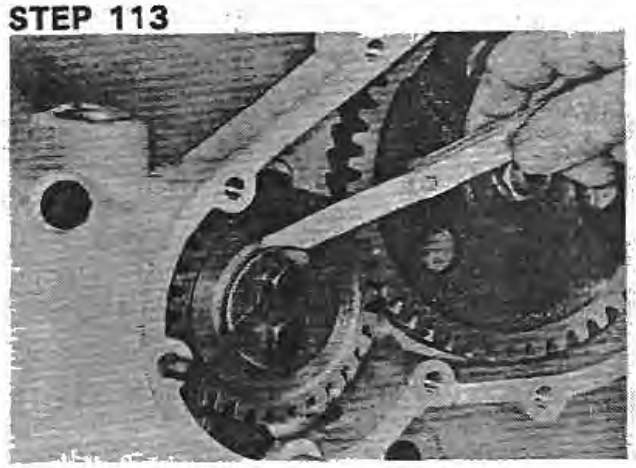
With the engine on top dead center and number one cylinder on compression stroke, the idler gear pointer must be lined up with timing mark on the camshaft gear and timing mark on the injection pump drive gear.

STEP 112



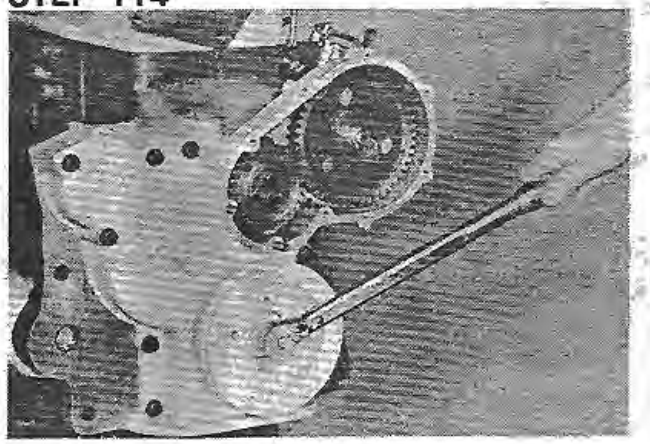
Torque idler gear mounting bolts 35 to 42 ft. lbs. Bend tabs of pointer to lock mounting bolts.

STEP 113



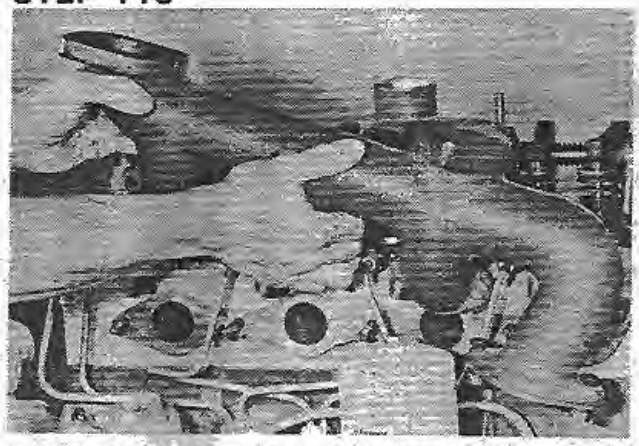
With a feeler gauge, check the running clearance between thrust washer and idler gear. The running clearance should be .003". If clearance is incorrect, add or delete shims as required.

STEP 114



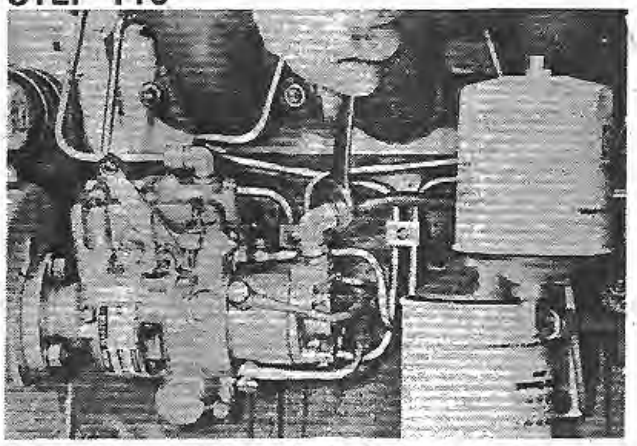
Install crankshaft pulley and mounting nut. Torque mounting nut 125 to 135 ft. lbs.

STEP 115



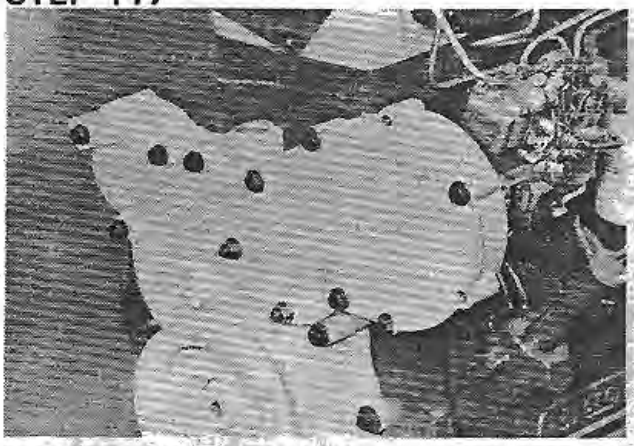
Install the exhaust manifold by holding manifold front in upward position and installing to rear stud first. Lower manifold and install on front stud. Retain with clamps and nuts. Torque mounting nuts 25 to 30 ft. lbs.

STEP 116



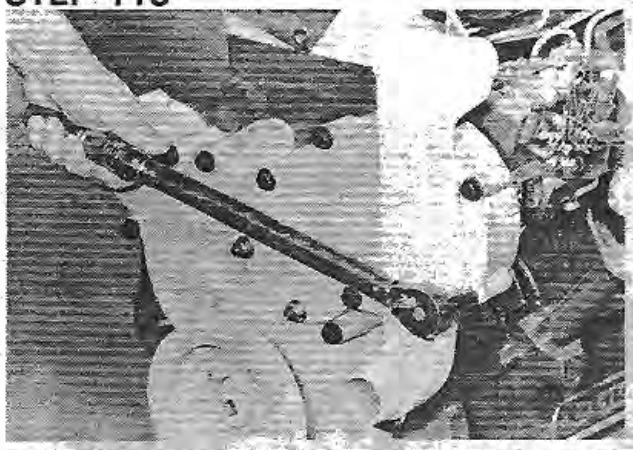
Connect inlet fitting, leakoff line, throttle control and governor control to fuel injection pump.

STEP 117

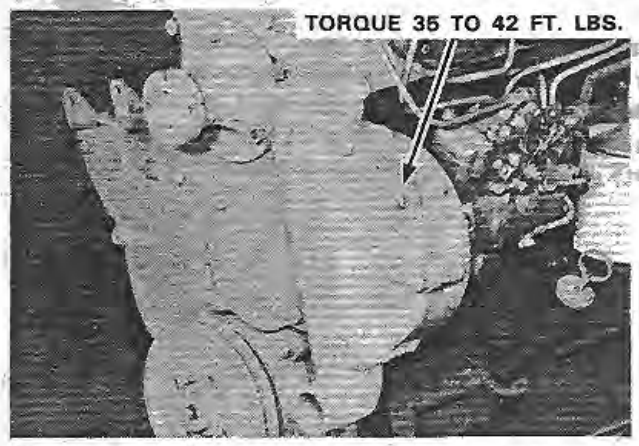


Install cover plate on timing gear cover.

STEP 118

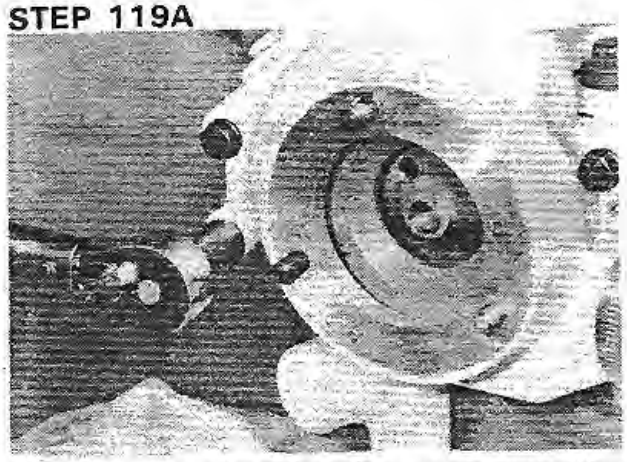


Install the water tube. Torque mounting bolts 25 to 30 ft. lbs.



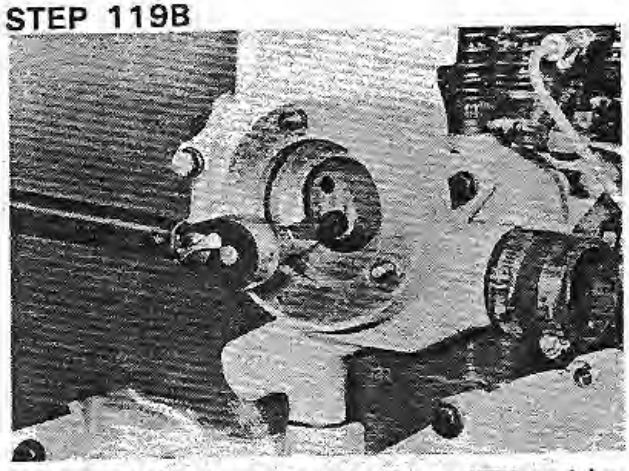
If equipped, install one piece cover plate on timing gear cover. Torque mounting bolts 35 to 42 ft. lbs.

STEP 119A



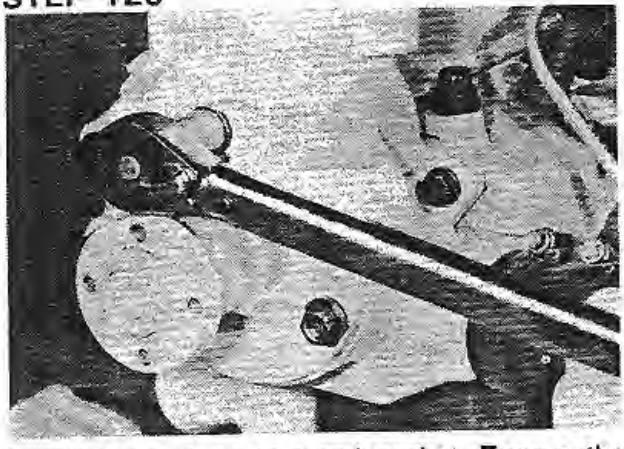
Install water pump housing outer mounting bolts and torque 35 to 42 ft. lbs.

STEP 119B



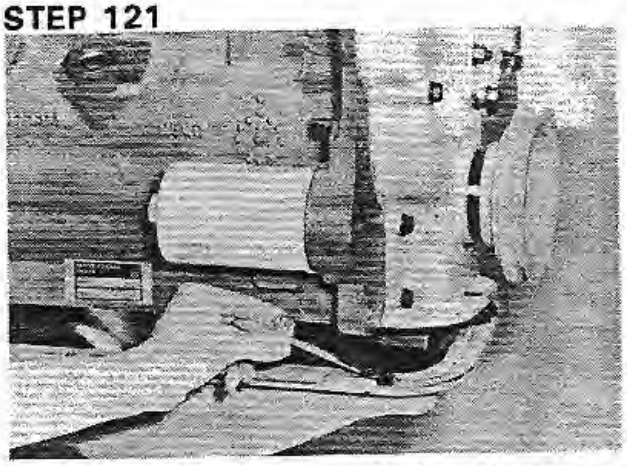
IMPORTANT: Apply Loctite Primer"T" and Loctite #271 (Case B17429 and B17423) on water pump housing inner socket hd.capscrew threads to prevent capscrew backing out into impeller. Install capscrew and torque 35 to 42 ft. lbs.

STEP 120



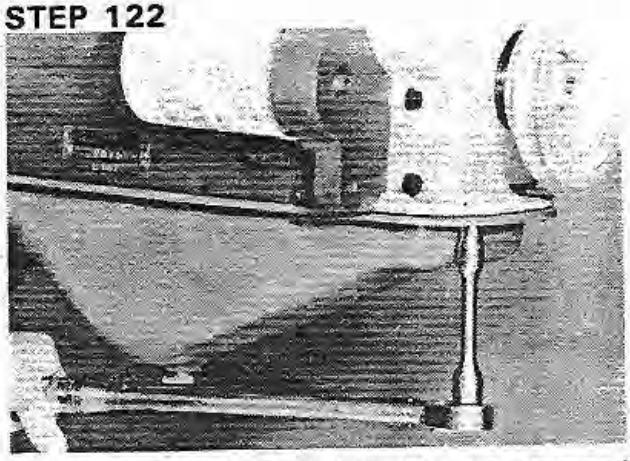
Install the water pump and gasket. Torque the pump mounting nuts 25 to 30 ft. lbs.

STEP 121

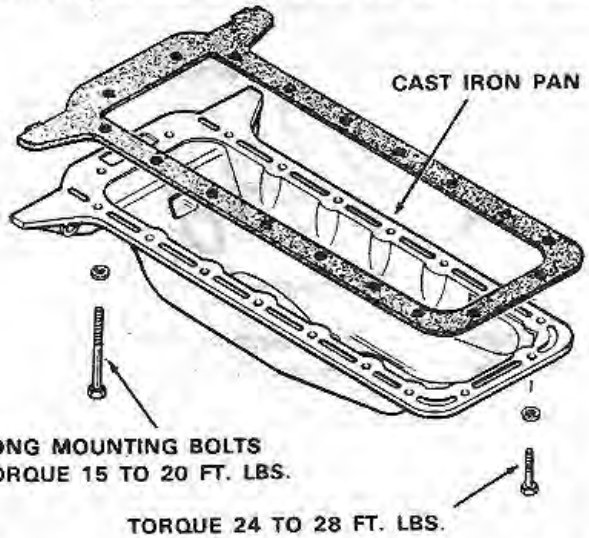


Apply No. 2 Permatex on both sides of new oil pan gasket at the front and rear portions only.

STEP 122



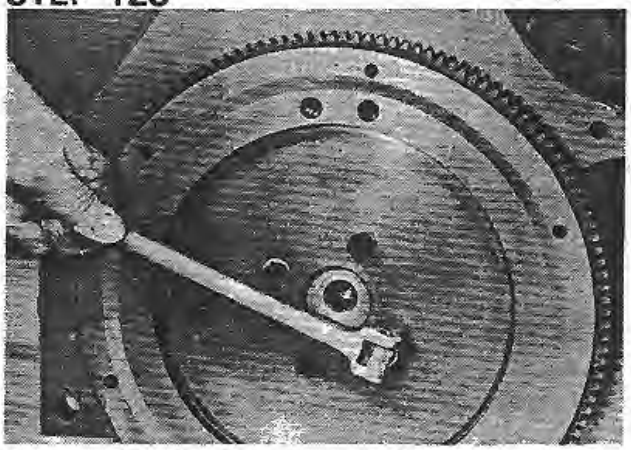
Install oil pan and gasket. Torque stamped steel oil pan mounting bolts 10 to 12 ft. lbs.



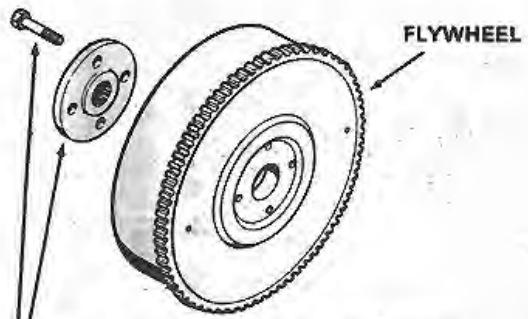
If equipped with cast iron oil pan, install long bolts to the rear of the engine and torque 15 to 20 ft. lbs. Torque remaining mounting bolts 24 to 28 ft. lbs.

FLYWHEEL

STEP 123

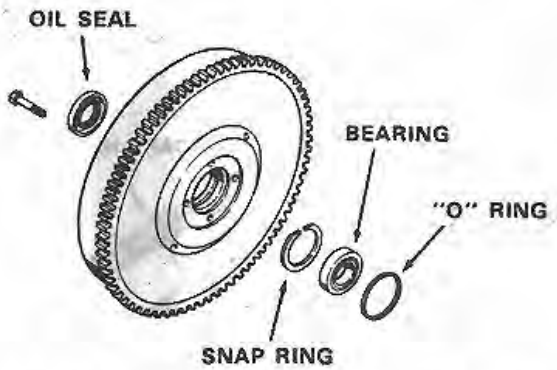


Remove flywheel from end of crankshaft.



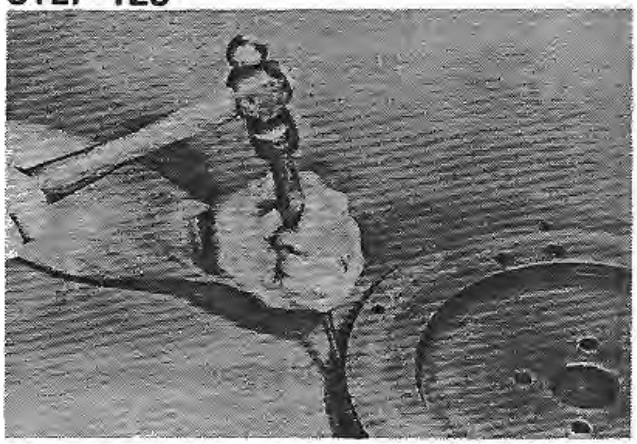
REMOVE SPECIAL OUTPUT HUB IF EQUIPPED

STEP 124



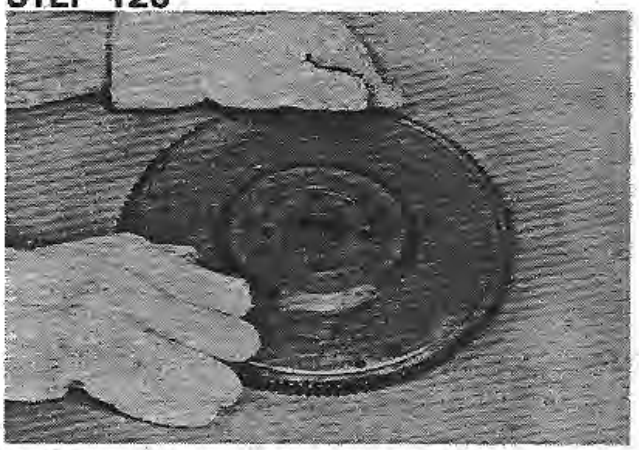
If equipped with a dry clutch tractor flywheel, disassemble flywheel components.

STEP 125



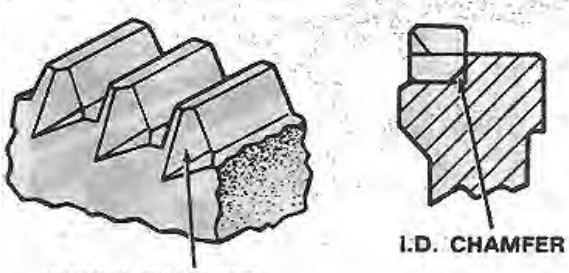
Using a drift, drive ring gear off flywheel.

STEP 126



Preheat new flywheel ring gear 400° to 450° F. in oil or in an oven. Do not use a torch to heat ring gear. Install ring gear with chamfer side of gear teeth outward and larger I.D. chamfer toward flywheel.

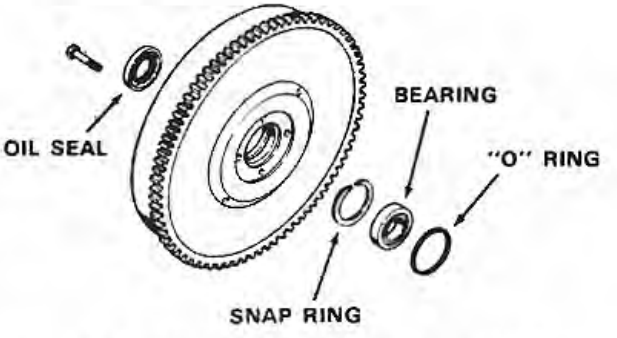
CAUTION: *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*



STEP 127

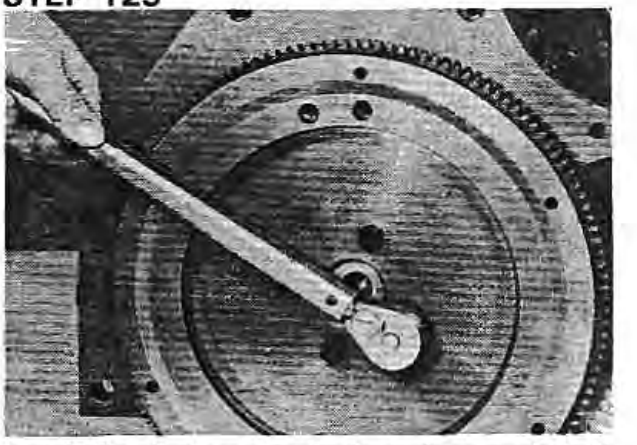
Ring gear installed on flywheel.

STEP 128



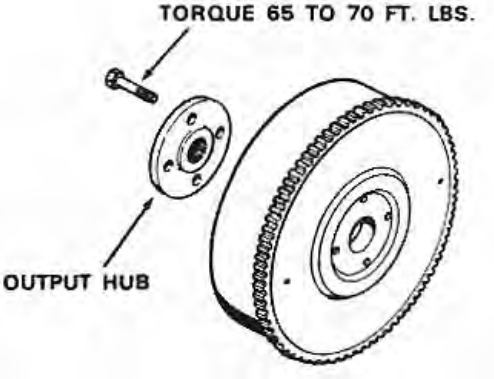
On dry clutch tractor flywheel, install snap ring in groove of flywheel. Press bearing in until seated against snap ring from the gear side of flywheel. Install new oil seal from rear side until seated against the snap ring. Install new "O"-ring. Lubricate oil seal and "O" ring with drive-away oil.

STEP 129

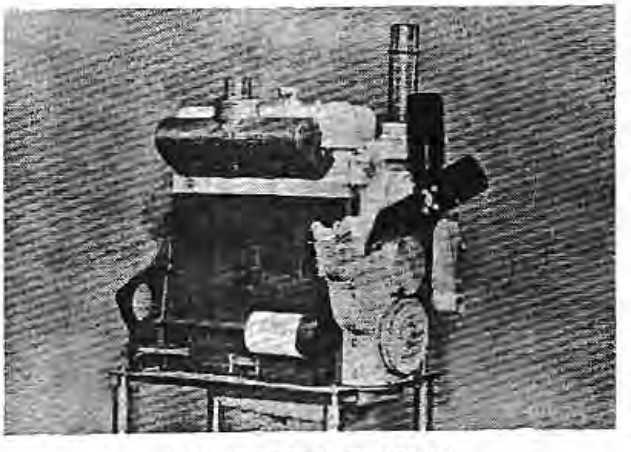


Install flywheel on end of engine crankshaft. Torque flywheel mounting bolts 65 to 70 ft.lbs.

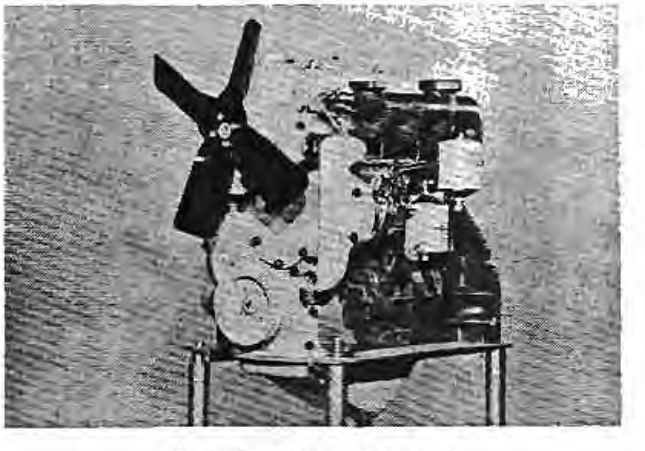
STEP 130



On hydrostatic tractors, lubricate the spline hole and face of hub liberally with No. 2 Moly Disulfide grease. Install flywheel and output hub. Torque retaining bolts 65 to 70 ft. lbs.



188 DIESEL ENGINE



207 DIESEL ENGINE

Section 2045

OIL PUMP
188 and 207 Diesel Engines

J I Case
A Tenneco Company

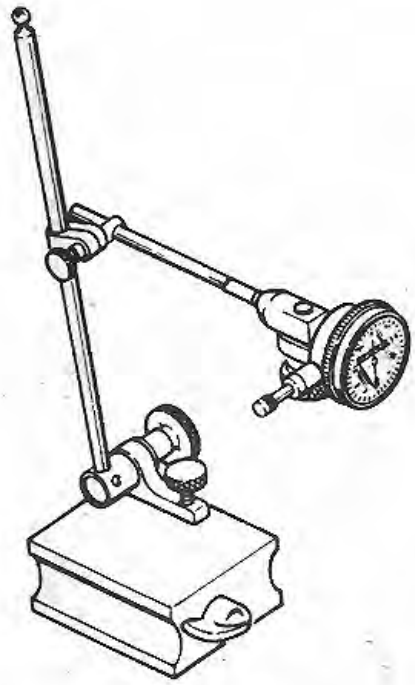
TENNECO

Rac. 9-78885

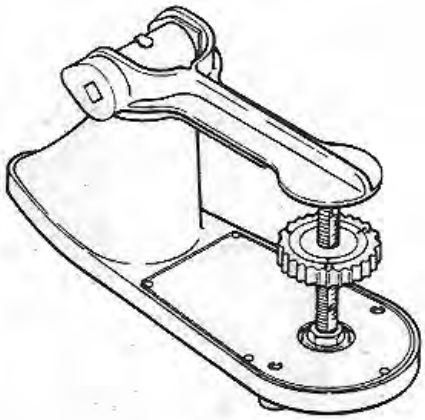
PRINTED IN U.S.A.

TABLE OF CONTENTS

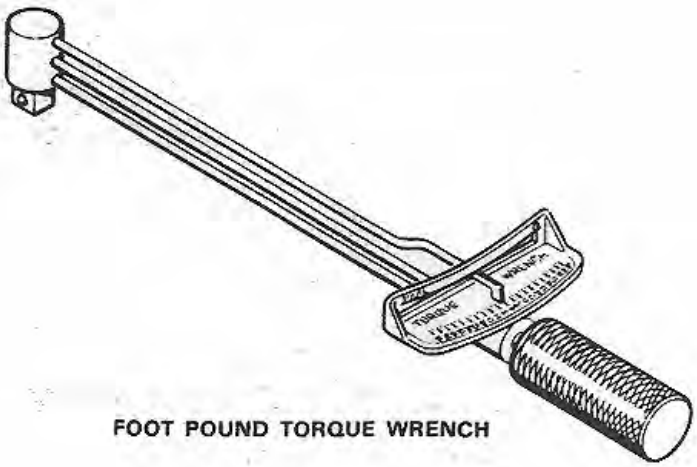
SPECIAL TOOLS



DIAL INDICATOR

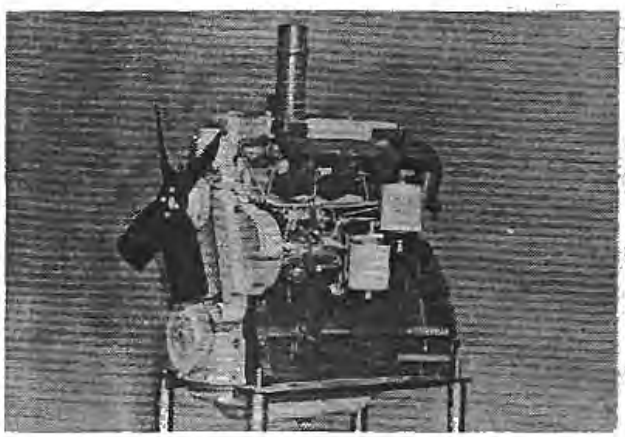


SPRING TESTER

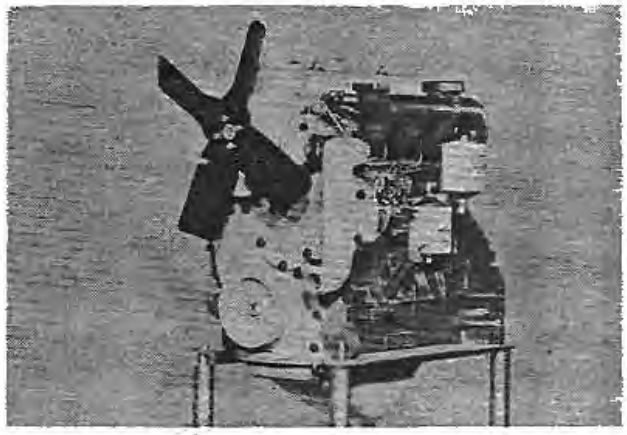


FOOT POUND TORQUE WRENCH

OIL PUMP



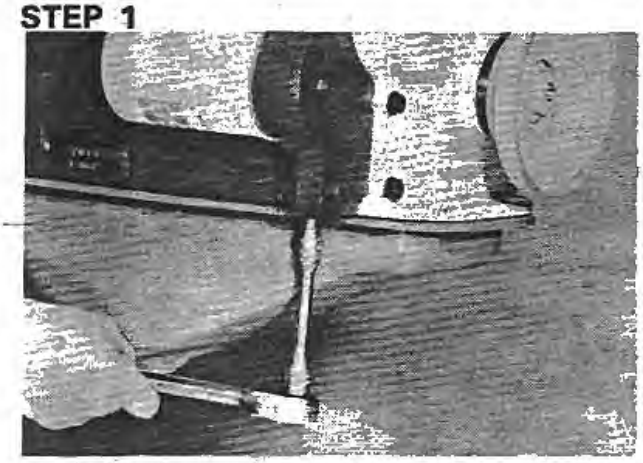
188 DIESEL ENGINE



207 DIESEL ENGINE

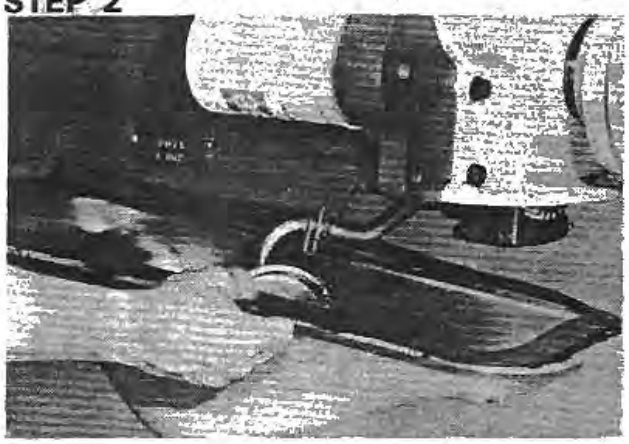
Oil Pump Removal

STEP 1



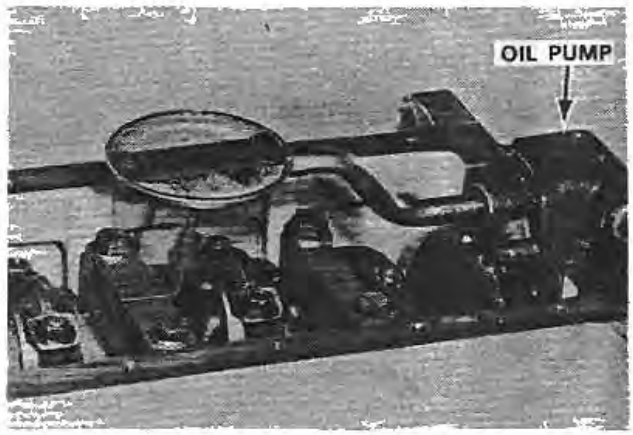
Remove oil pan drain plug and drain oil from engine. Remove oil pan mounting bolts.

STEP 2



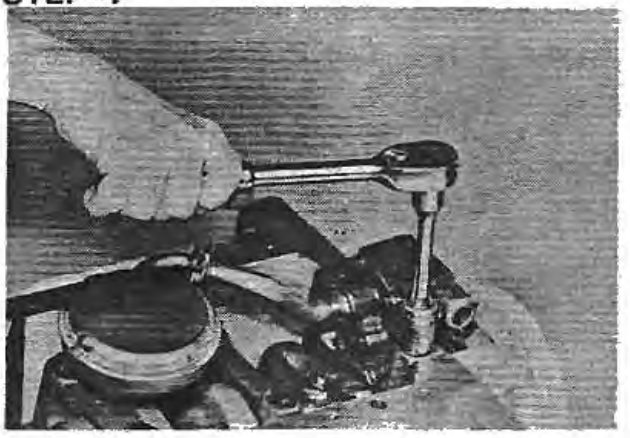
Remove oil pan and gasket from engine.

STEP 3

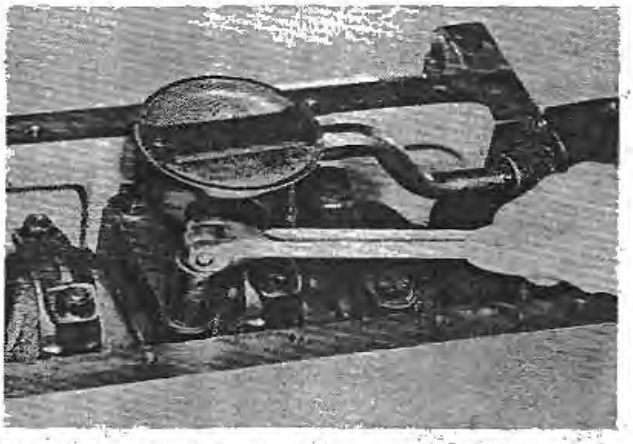


Oil pan removed from engine.

STEP 4

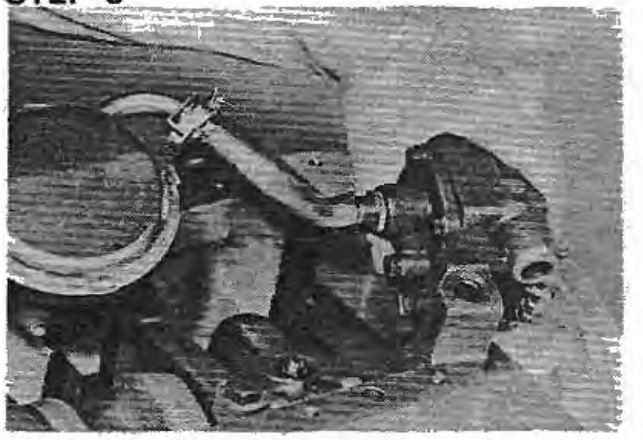


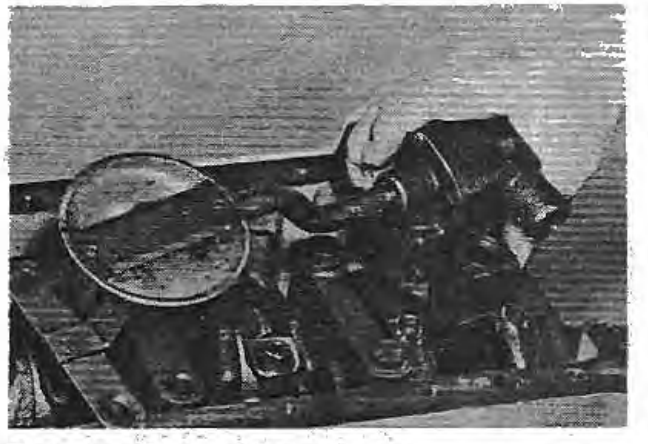
Remove oil pump mounting bolts.



If equipped, **loosen oil pump suction tube bracket bolts from main bearing cap and then remove oil pump mounting bolts.**

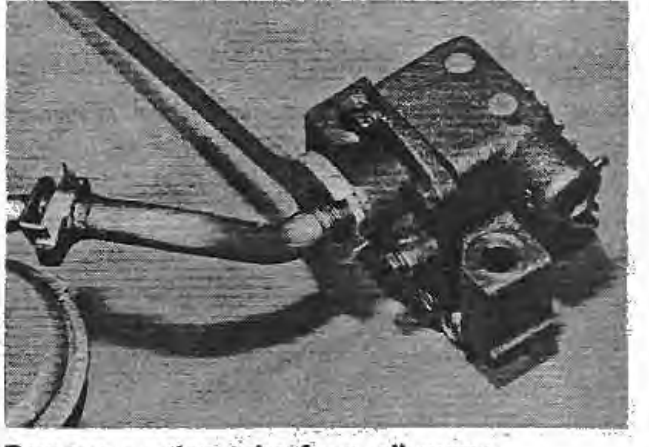
STEP 5





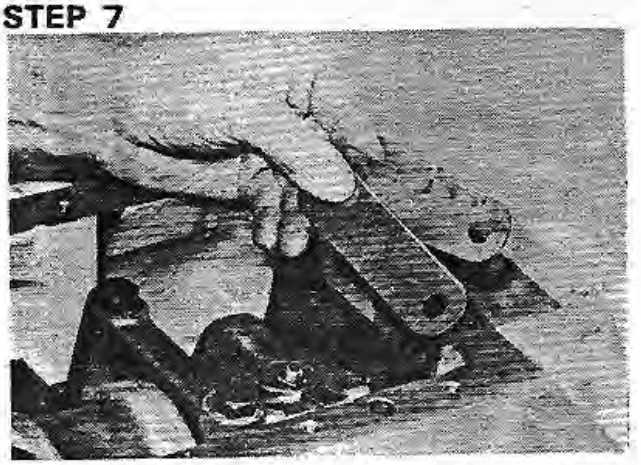
Remove oil pump from engine.

STEP 6



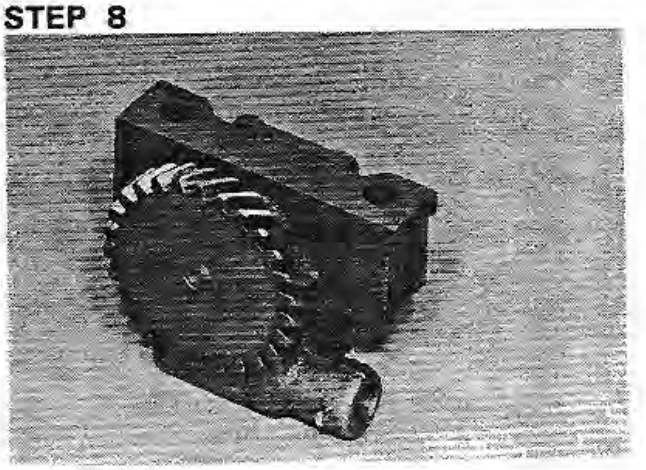
Remove suction tube from oil pump.

STEP 7



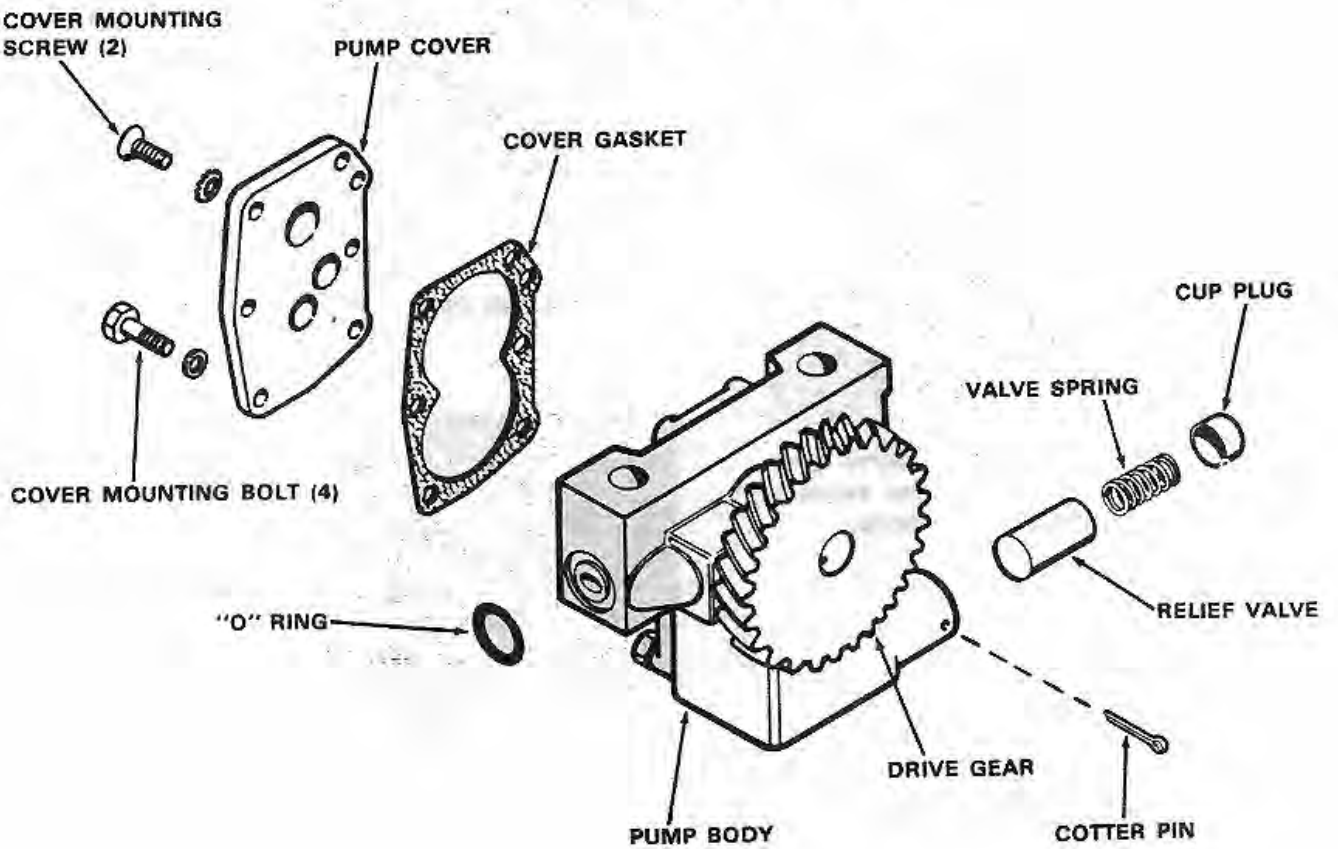
Remove shims from top of front main bearing.

STEP 8

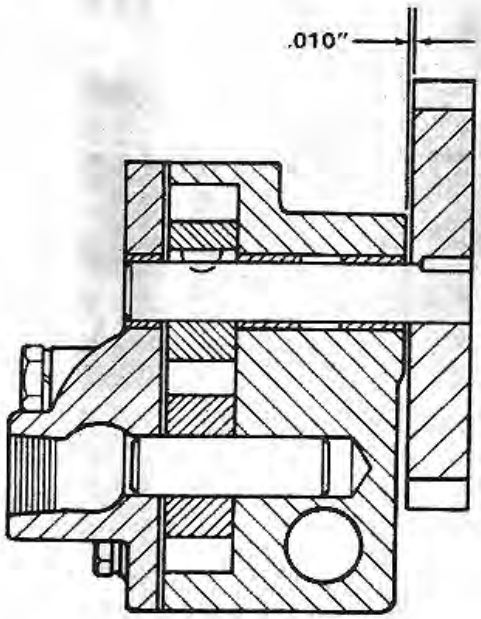


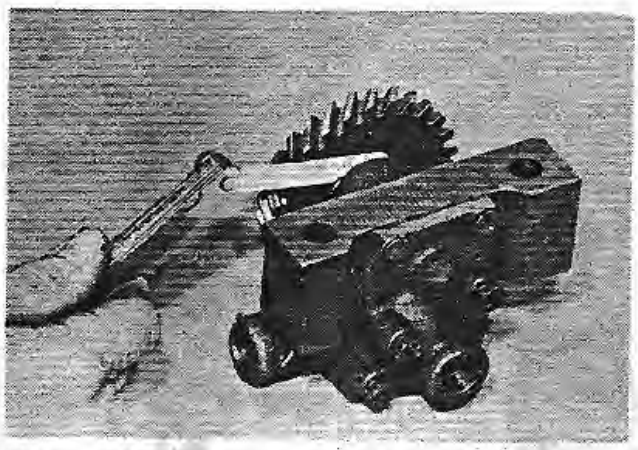
Engine oil pump removed.

Oil Pump Inspection



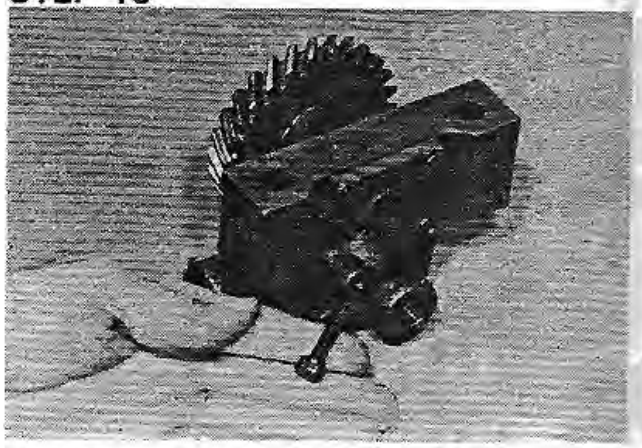
STEP 9





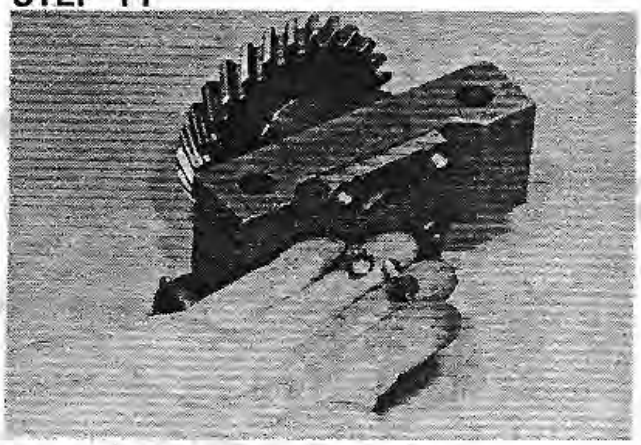
Using a feeler gauge, check pump drive gear to pump body clearance. If clearance exceeds .010 inch, the pump must be replaced.

STEP 10



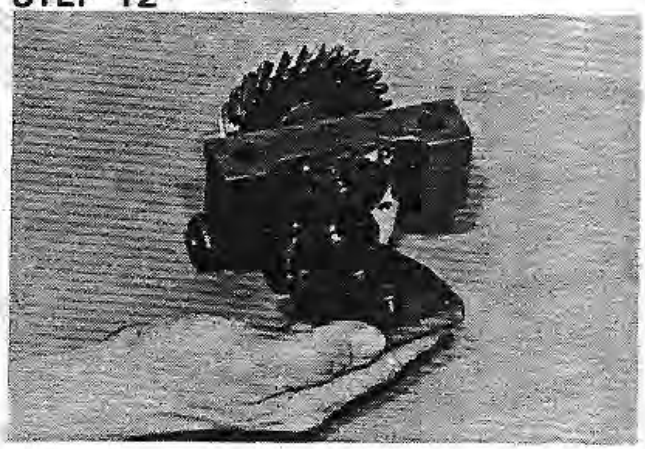
Remove pump cover mounting bolts.

STEP 11



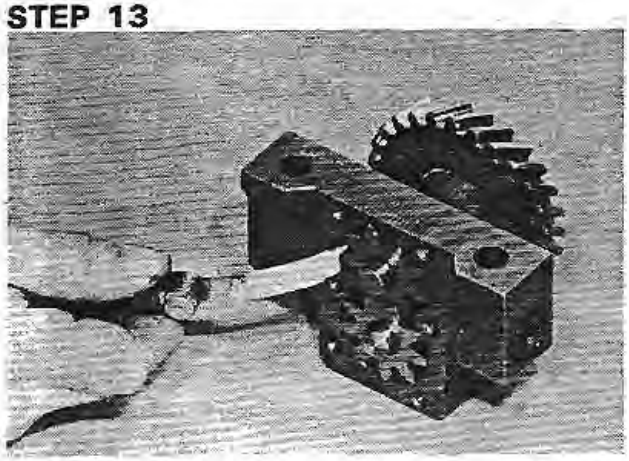
Remove pump cover mounting screws.

STEP 12



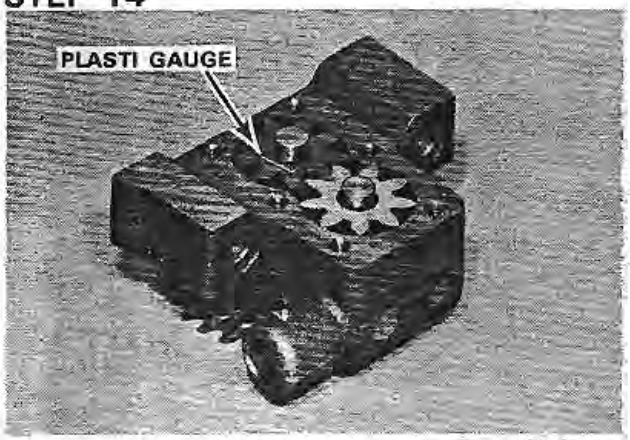
Remove pump cover and gasket from pump body.

STEP 13



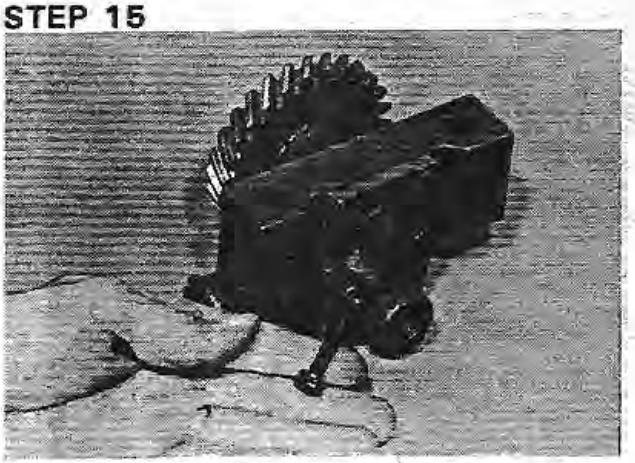
Using a feeler gauge, check pump gears to body radial clearance. If clearance is greater than .008 inch, the pump must be replaced.

STEP 14



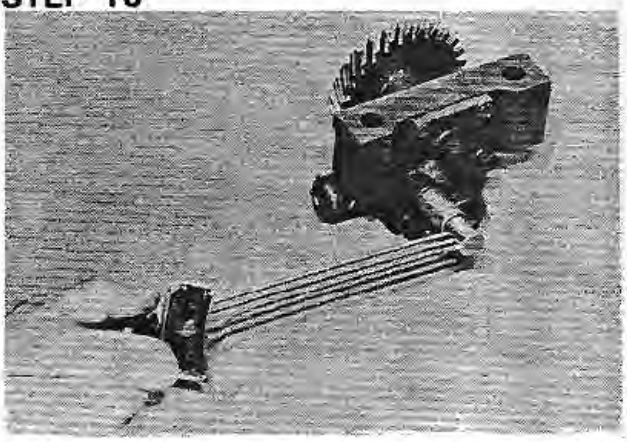
Place a piece of plasti gauge on one of the pump gears.

STEP 15



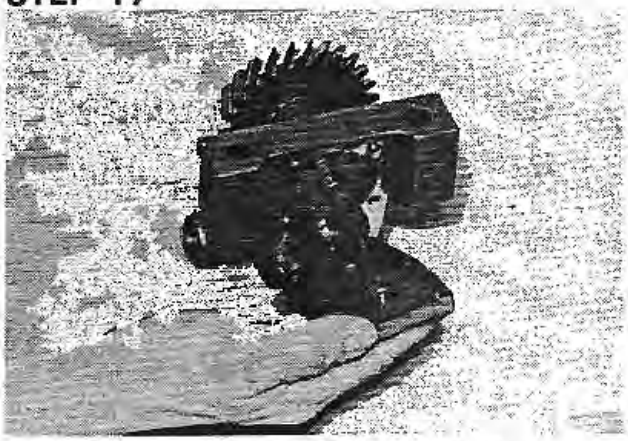
Install pump cover and gasket on pump body.

STEP 16



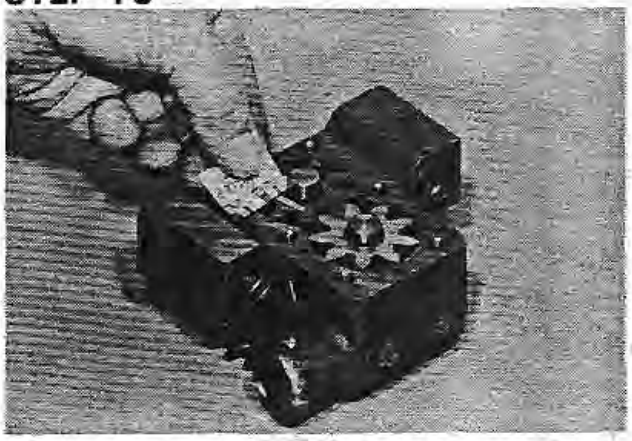
Torque pump cover mounting bolts 6 to 8 ft. lbs.

STEP 17



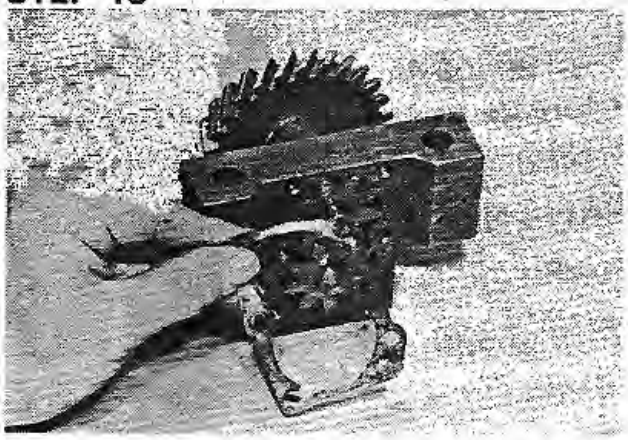
Remove pump cover from pump body.

STEP 18



Measure plasti gauge to obtain gear-to-pump cover clearance. If clearance exceeds .008 inch, the pump must be replaced.

STEP 19

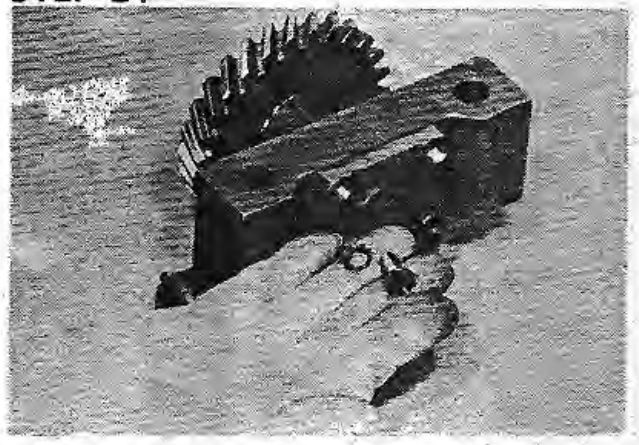


Install new pump cover gasket on pump body.

STEP 20

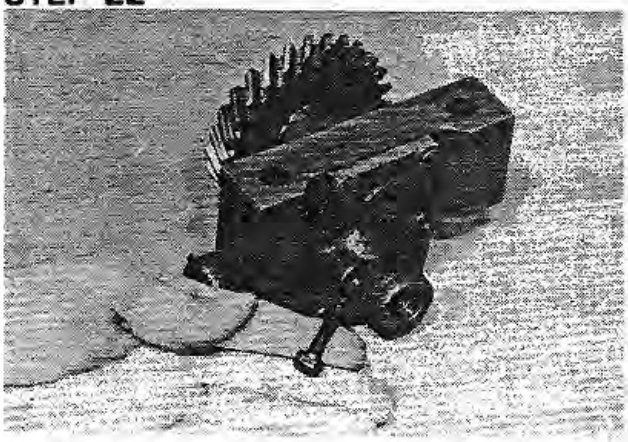
Install pump cover on pump body.

STEP 21



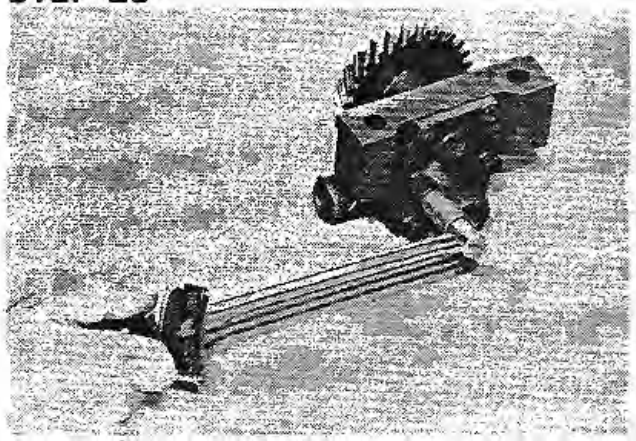
Install pump cover mounting screws.

STEP 22



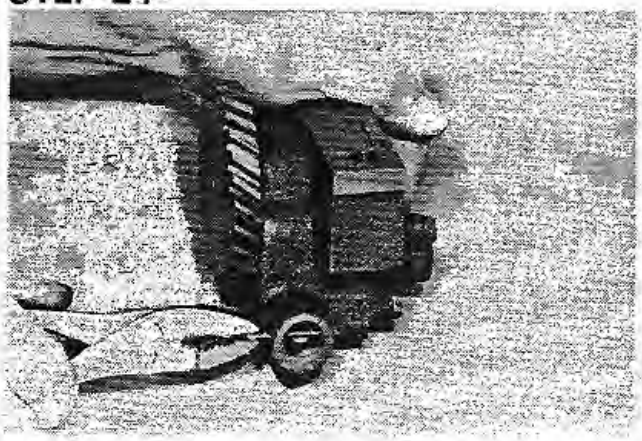
Install pump cover mounting bolts.

STEP 23



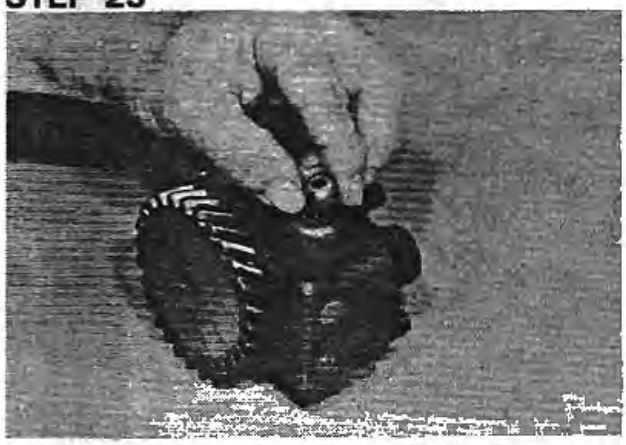
Torque pump cover mounting bolts 6 to 8 ft. lbs. *NOTE:* While tightening bolts and screws, position the cover to provide free rotation of shaft and gears.

STEP 24



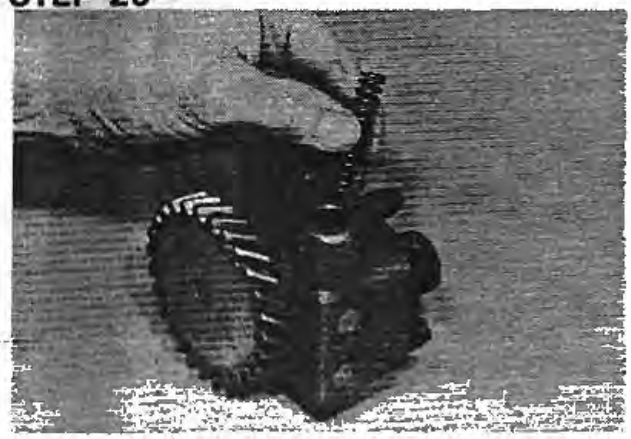
Remove cotter pin retaining relief valve and spring.

STEP 25



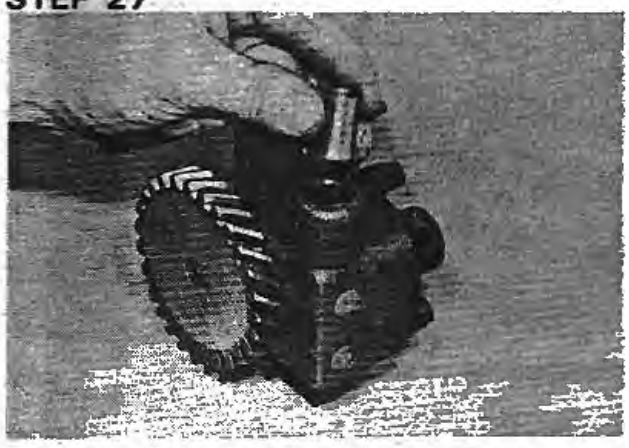
Remove cup plug from body.

STEP 26



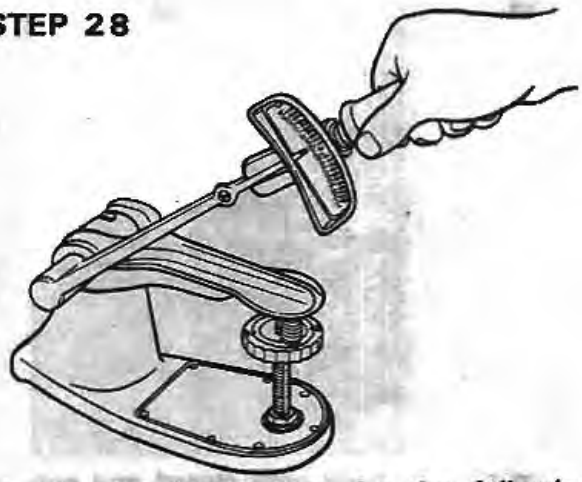
Remove relief valve spring from body.

STEP 27



Remove relief valve from body.

STEP 28

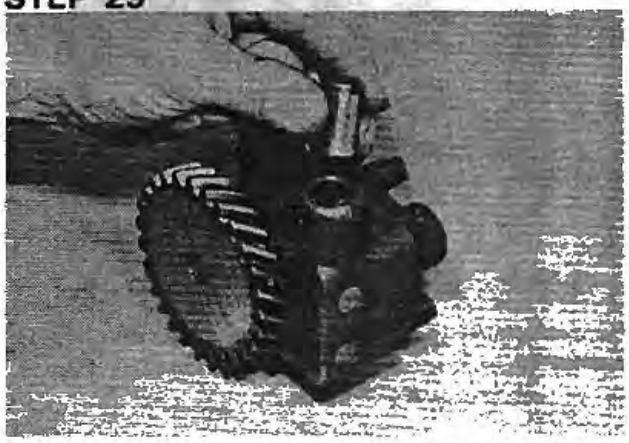


Check relief valve spring for the following:

Free length ..... 2.125"

Load at 1.44" ..... 18 to 19 lbs.

STEP 29

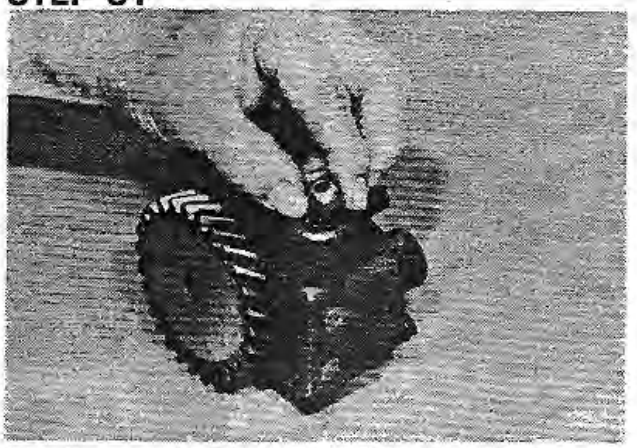


Install relief valve in body with closed end toward pump.

STEP 30

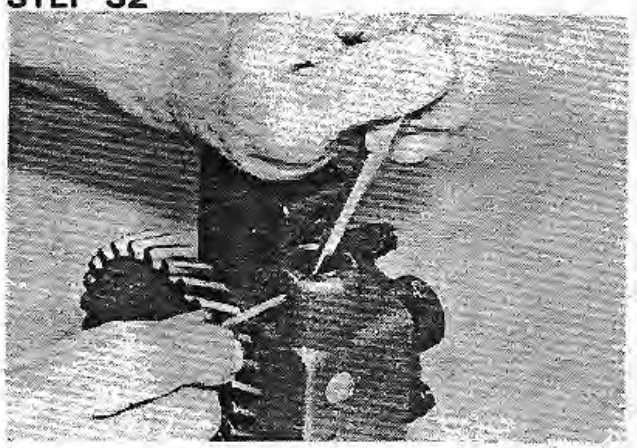
Install relief valve spring in body.

STEP 31



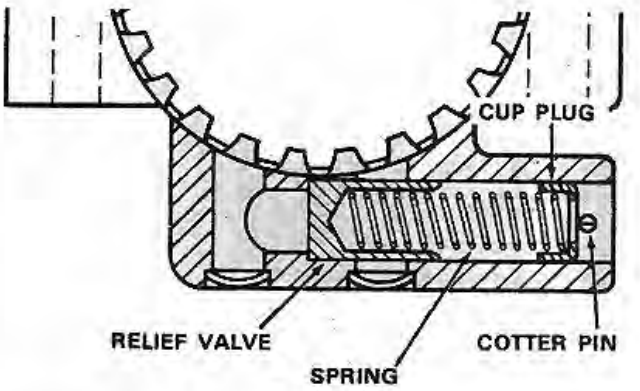
Install cup plug in body with closed end outward.

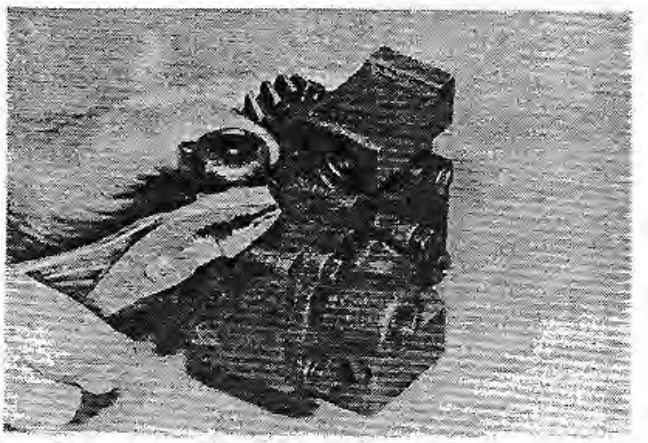
STEP 32



Compress relief valve spring and cup plug until plug is below cotter pin hole. Insert new cotter pin through hole in body.

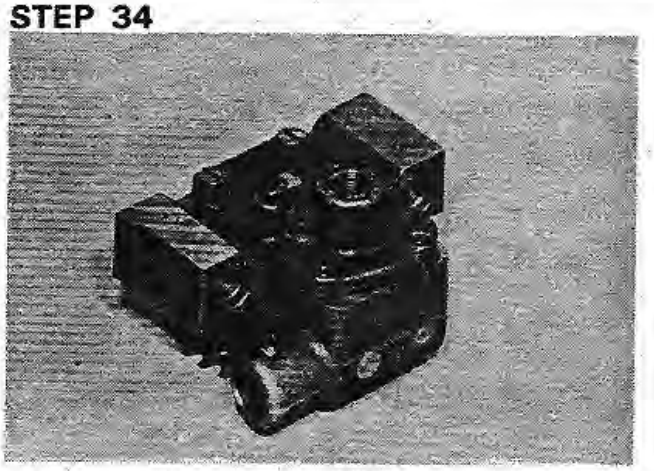
STEP 33





Bend cotter pin to retain in place.

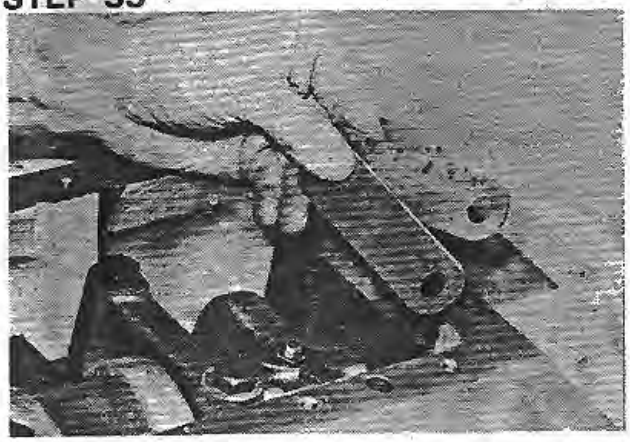
STEP 34



Engine oil pump assembled.

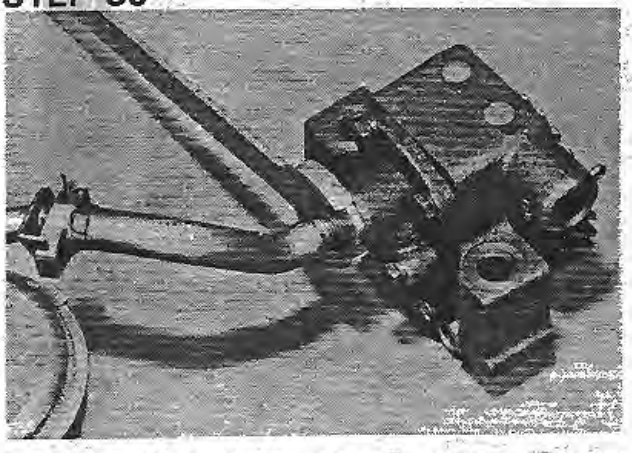
Oil Pump Installation

STEP 35



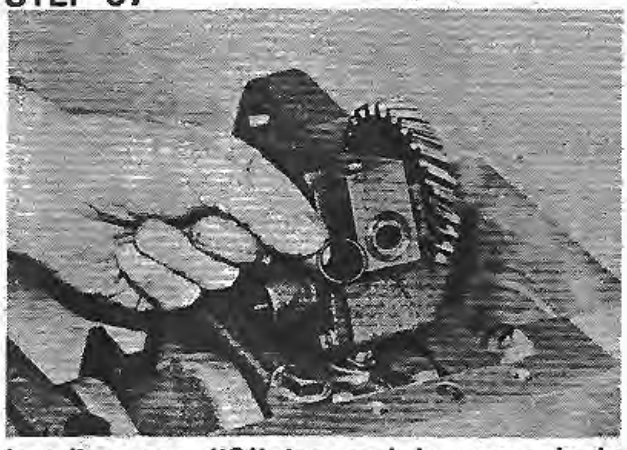
Install shims on top of front main bearing.Install a shim pack with a minimum of .015" thickness so that pump gear and crankshaft gear are not jammed together. Refer to Step 43.

STEP 36



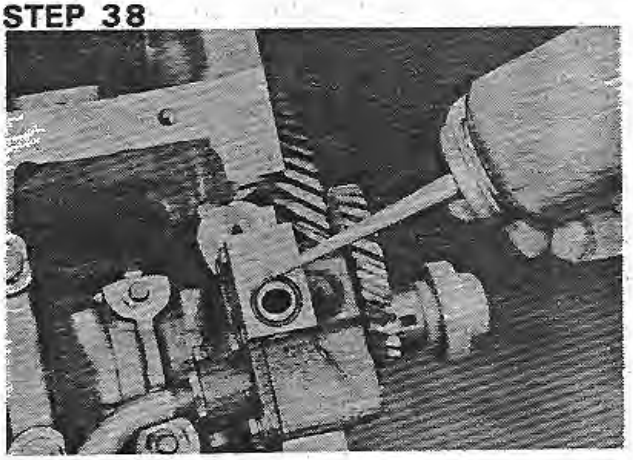
Install suction tube on oil pump. Torque suction tube nut 95 to 105 ft. lbs.

STEP 37



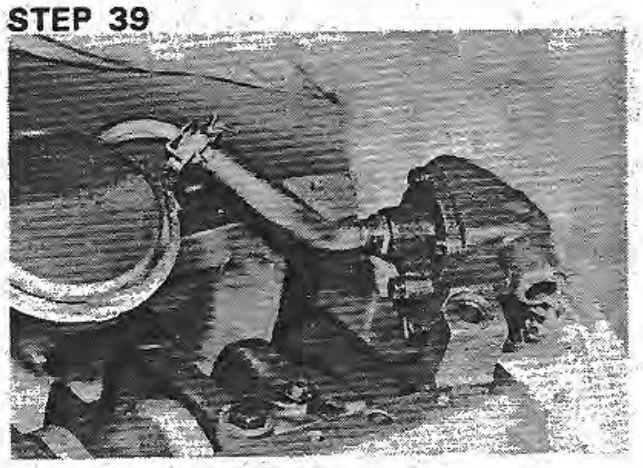
Install a new "O" ring seal in pump body.

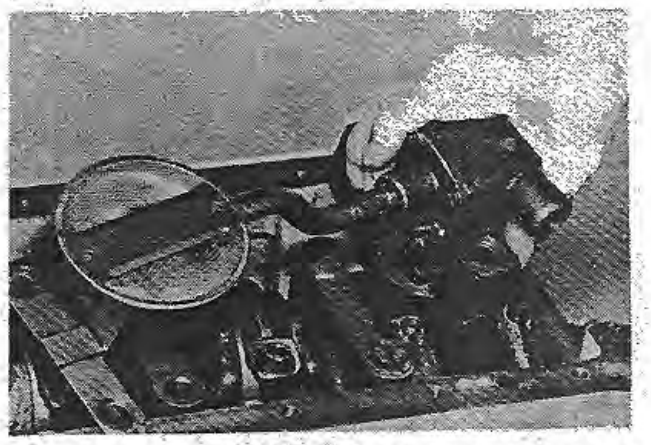
STEP 38



Lubricate "O" ring seal with clean engine oil.

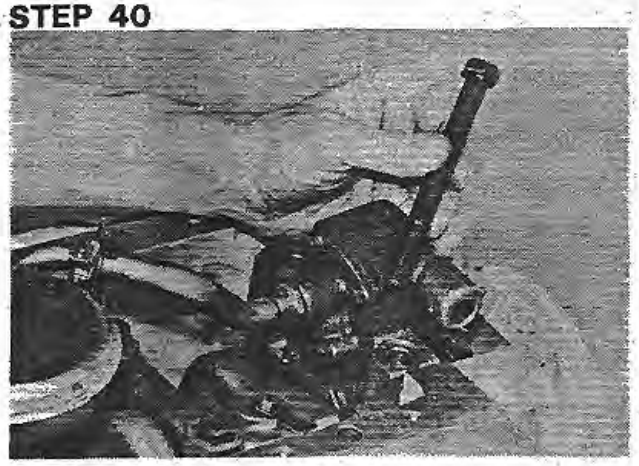
STEP 39





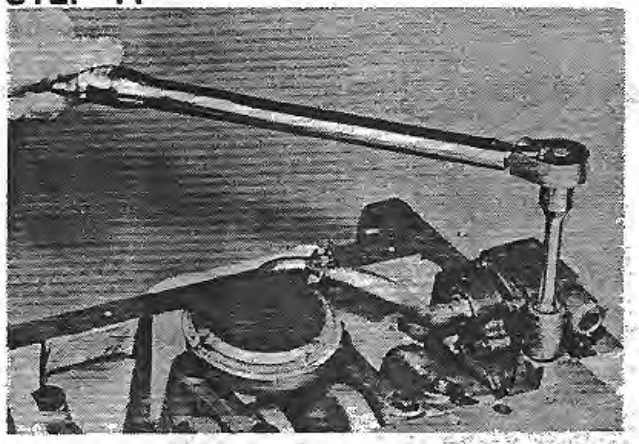
Install oil pump in engine on top of shims and front main bearing. *IMPORTANT:* Use care not to cut "o-ring on sharp edge of block during pump installation.

STEP 40

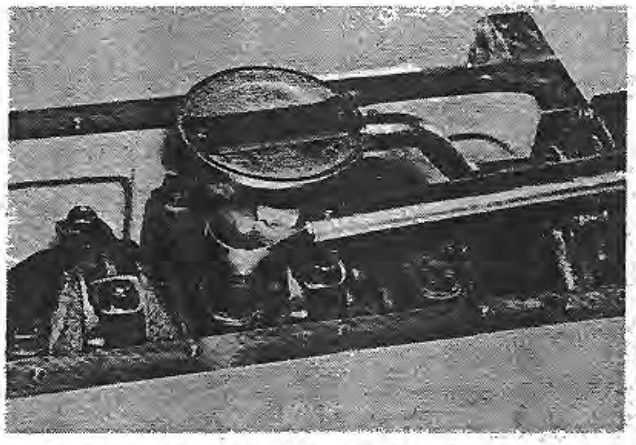


Install oil pump mounting bolts.

STEP 41



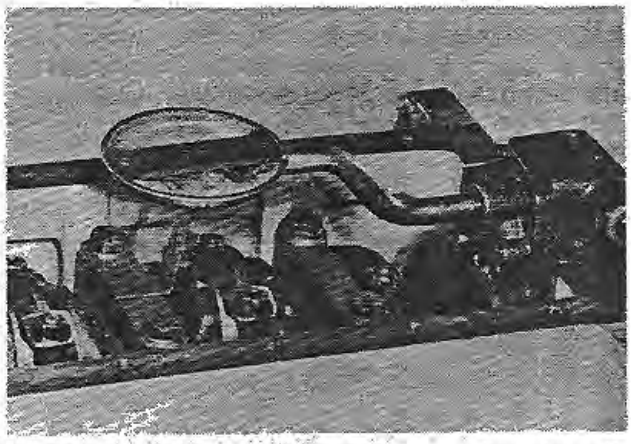
Torque oil pump mounting bolts 90 to 100 ft. lbs.



If equipped, torque pump mounting bolts and suction tube bracket mounting bolts 90 to 100 ft. lbs.

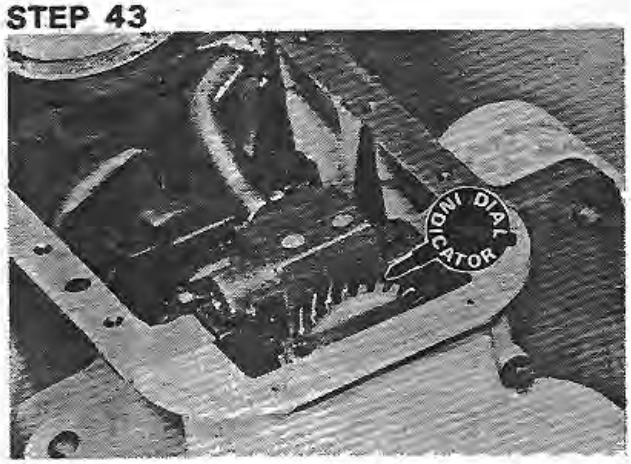
STEP 42

Oil pump installed.



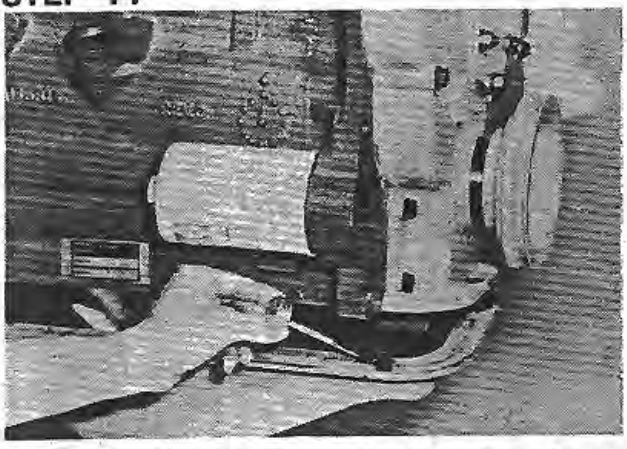
Oil pump with suction tube bracket installed.

STEP 43



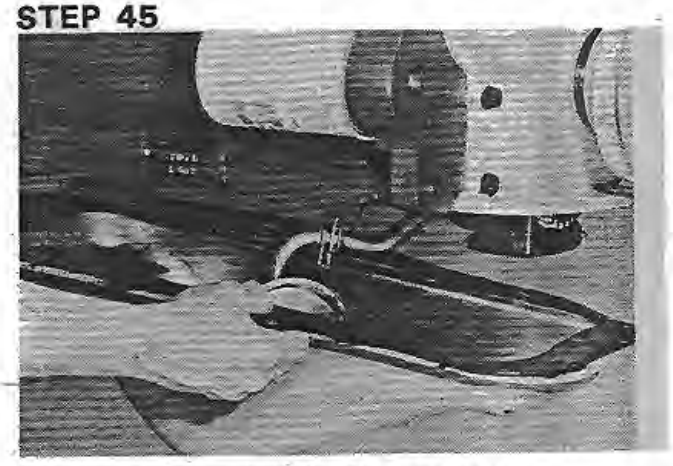
Place a dial indicator on the oil pump drive gear and check backlash between drive gear and crankshaft gear. Backlash must be .002 to .008 inch. If backlash exceeds or is under the above range, add or delete shims between oil pump and No. 1 main bearing cap to obtain correct backlash. See Step 35. *NOTE:* Oil pump shims are .002 and .005 inch thick.

STEP 44



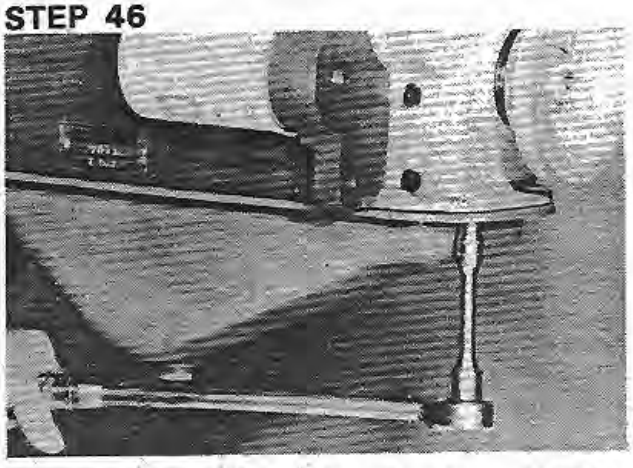
Apply No. 2 Permatex on both sides of new oil pan gasket at the front and rear portions only.

STEP 45

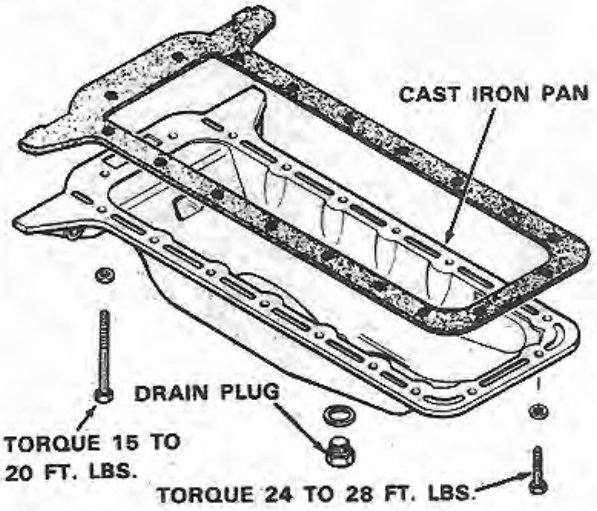


Install oil pan and gasket on engine.

STEP 46

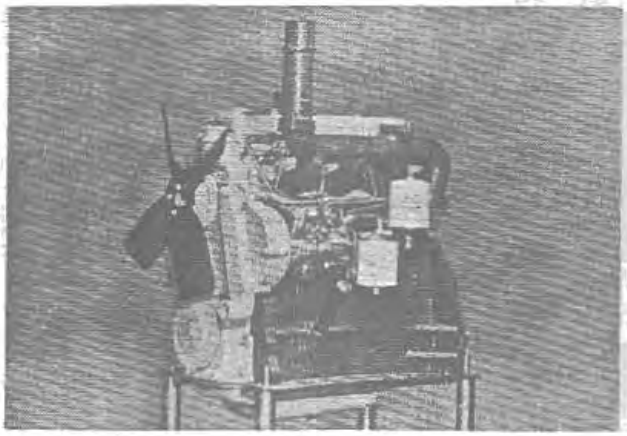


Torque stamped steel oil pan mounting bolts 10 to 12 ft. lbs.

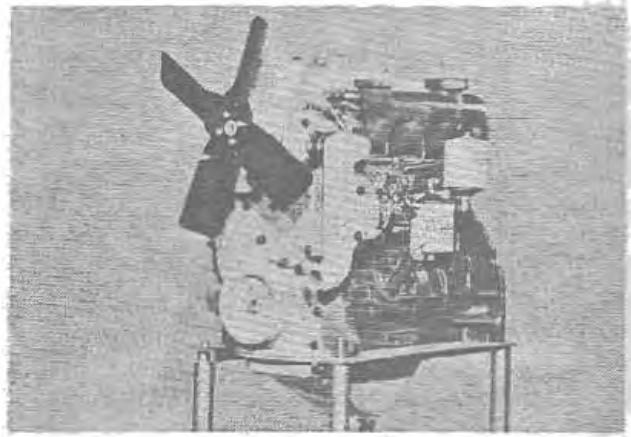


If equipped with cast iron oil pan, install long bolts to the rear of the engine and torque 15 to 20 ft. lbs. Torque remaining mounting bolts 24 to 28 ft. lbs.

NOTE: Torque drain plug 29 to 31 ft. lbs. Refill crankcase with proper amount and type of oil. Refer to Operator's Manual.



188 DIESEL ENGINE



207 DIESEL ENGINE

Section 2050

STALL CHECKS, ENGINE REMOVAL AND INSTALLATION, AND RADIATOR

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

STALL CHECKS

During these tests engine stall speed will be recorded at full throttle with the engine working against the torque converter and/or the hydraulic system on machines with a power shuttle or against the hydraulic system only on machines equipped with a mechanical shuttle.

Test Specifications

	Power shuttle	Mechanical shuttle
Idle speed	700-750 rpm (r/min)	700-750 rpm (r/min)
Maximum no load speed	2230-2270 rpm (r/min)	2230-2270 rpm (r/min)
Hydraulic stall speed	2100 rpm (r/min)	2050 rpm (r/min)
Converter stall speed	1890 rpm (4/min)	NA
Combined converter and hydraulic stall speed	Engine must continue to run	NA
Converter/transmission oil temperature	Temperature gauge needle in middle of green zone	NA
		NA
Hydraulic oil temperature	125-175° F (51-79° C)	125-175° F (51-79° C)

WARNING: Before performing the stall checks on a power shuttle machine, check to be sure the parking brake will hold the machine with the engine running at full throttle and the transmission in fourth (4th) gear. If the machine moves, adjust or repair the brakes as required to hold the machine, or park the machine against an immovable object such as a wall, post or another piece of heavy equipment. 39-3

Oil Heating Procedure

Converter/Transmission Oil

1. Apply parking brake and start engine.
2. Shift transmission to fourth (4th) gear and place power shuttle lever in Forward. Accelerate to full throttle and hold for 15 seconds then shift to Neutral and run at full throttle for 15 seconds.
3. Repeat step 2 until needle on transmission oil temperature gauge is in middle of green zone on gauge.

Hydraulic Oil

Run engine at full throttle, hold control lever in Rollback for 15 seconds then return control lever to Neutral for 30 seconds. Repeat cycle until oil is at specified temperature. If a thermometer is not available, the inlet tube to the loader control valve will be very warm to the touch at the specified temperature.

Test 1 - Combined Converter and Hydraulic Stall

1. Apply parking brake and start engine. Shift transmission to fourth (4th) gear and power shuttle to Forward.
2. Increase engine speed to half throttle and roll the bucket back. Hold control lever in power position and accelerate to wide open throttle. The engine must continue to run.

Test Summary

1. If engine speed is below the specified rpm or quits it may be due to:
   a. A worn or damaged engine, or worn or damaged injection pump, or improper adjustments.
   b. Excessive hydraulic system pressure or damaged or worn parts in the power shuttle or converter.

2. If engine speed is above 1200 rpm (r/min) it indicates inefficiency in the converter, power shuttle or hydraulic system. Possible causes are:

   a. Internal leakage in the power shuttle.

   b. Worn charging or hydraulic pump.

   c. Low main relief valve setting.

3. To identify the problem area, conduct Tests 2 and 3. If both tests are unsatisfactory, the cause of trouble is very likely the engine. Refer to Section 2001 Engine Diagnosis and Section 2002 Engine Tune-Up.

Test 2 - Converter Stall

1. Apply parking brake and start engine.

2. Shift transmission to fourth (4th) gear and place power shuttle in Forward. Accelerate to wide open throttle and record engine speed.

Test Summary

1. If engine speed is as specified the converter and power shuttle are working properly; proceed to Test 3.

2. If engine speed is below the specified rpm, the problem is in the engine or converter.

   a. If engine speed is 600-700 rpm (r/min) below the specified speed, the problem is the one way clutch in the converter. To correct the problem, replace the converter.

   b. If engine speed is 200-300 rpm (r/min) below the specified speed the engine is at fault. Refer to Section 2001 Engine Diagnosis and Section 2002 Engine Tune-Up.

3. If engine speed is above the specified rpm (r/min) the problem is in the converter or power shuttle.

   a. Refer to Section 6012 for power shuttle trouble shooting information.

   b. A tinny sound from the converter indicates damaged converter blading and replacement of the converter.

Test 3 - Hydraulic Stall

1. Start engine and run at half throttle.

2. Roll the bucket back and hold control lever in power position. Accelerate to full throttle and record engine speed.

Test Summary

1. If engine speed is below the specified rpm (r/min) it indicates engine wear or excessive pressure or restriction in the hydraulic system. Check main relief valve setting as instructed in Section 4002, and possible restriction between the hydraulic pump and loader control valve inlet. Repeat test; if engine speed is still low, the engine is likely at fault.

2. If engine speed is above the specified rpm the hydraulic system is at fault. Refer to Section 4002 for trouble shooting and hydraulic system test information.

ENGINE REMOVAL

This procedure is written to cover machines equipped with a power shuttle or a mechanical shuttle. The power or mechanical shuttle remains in the machine when the engine is removed.

1. Remove engine side panels if so equipped and hood and muffler. Disconnect battery ground cable at battery.

2. Remove radiator grille and drain cooling system.

3. Disconnect tubes to power shuttle oil cooler at hose connections. Catch oil from cooler in a drain pan.

4. Remove the lower guard or if equipped with a counterweight, remove plate behind counterweight.

5. Remove the upper and lower radiator hoses.

6. Remove bottom radiator support to frame nuts, washers and bolts.

7. Remove rear mounting bolt on each side of radiator shroud.

8. Remove air intake tube if so equipped.

9. Attach chain hoist to shroud. Move shroud forward to clear the fan blades and lift the radiator/shroud assembly from the machine.

10. Close shutoff valve on bottom of fuel tank.

11. Remove air cleaner and mounting bracket as an assembly.

12. Disconnect or remove from left side of engine:

    a. Return fuel line from rear fuel injector and fuel supply line at fuel filter.

    b. Throttle rod and fuel shutoff cable at fuel injection pump. Loosen cable clamp on the block and place cable out of way.

    c. Wire from oil pressure sender.

13. Disconnect or remove from right side of engine:

    a. Battery cable from starter mounting bolt. If equipped with power shuttle, remove fill tube bracket.

    b. Battery cable and wiring from starter solenoid.

    c. Hoses at power steering pump.

    d. Wiring from alternator, air cleaner restriction switch, engine temperature sender, circuit breaker, and horn if so equipped. Remove wiring harness clamp and place harness out of way.

    e. Tachometer cable.

    f. Tube to ether injector if so equipped.

14. Disconnect outlet hose from hydraulic pump. Install plug in hose and cap pump fitting.

15. Loosen a hose clamp on each lower suction tube hose. Remove the pump mounting cap screws. Pull pump forward to disengage drive coupling and pivot pump forward.

16. Remove flywheel housing to engine mounting bolts and nuts, and cover on front of flywheel housing. The washers are hardened. If a washer is to be replaced it must be replaced with the part listed in the parts catalog.

17. If equipped with a mechanical shuttle place a jack under rear of shuttle for support.

18. Remove front engine mounting bolt.

19. Attach lifting sling to engine and chain hoist to sling.

20. Remove engine from machine checking to make sure all wires, tubes, etc. are disconnected.

ENGINE INSTALLATION

The engine is installed in the reverse order of removal.

If the torque converter was removed, it MUST be centered on the flywheel within .004" (0.102 mm) when it is reinstalled or a new converter is installed. Place dial indicator against converter hub to check for proper installation.

Before installing the starter on the engine (or before installing engine) disassemble the starter and inspect the brushes, starter drive, bearings, etc. and repair as required. Also saturate the lubrication wicks with 10 weight engine oil. Refer to Section 8006 for starter information.

Refer to the various sections in this manual to make sure connections are correct.

When the engine has been installed, service all filters and install coolant and engine oil as specified in Section 1050. If antifreeze is not used in the cooling system, be sure to add a rust inhibitor and water pump lubricant. Anticavitation inhibitor (part no. 331-508) must be added to all cooling systems.

INSTALLATION OF FRONT ENGINE MOUNT/HYDRAULIC PUMP MOUNTING BRACKET

Whenever a new engine or engine mount is installed, the engine mount must be properly installed so the hydraulic pump and pump drive coupling will be properly aligned.

Special tools required to properly install the engine mount are (1) a dial indicator capable of indicating .100" (2.5 mm), (2) the indicator adapter illustrated in Figure 1, (3) a No. 5 taper, straight fluted reamer and (4) a 1/4" drill bit and electric drill.

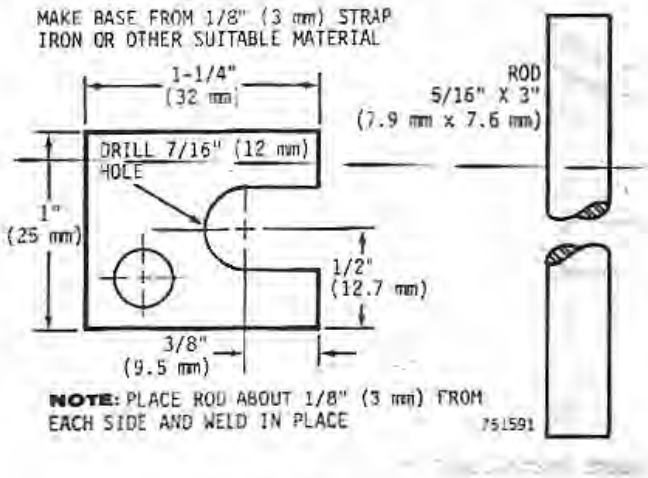


Figure 1 - Dial Indicator Adapter

1. Secure engine mount to engine with bolts, lock washers and nuts.

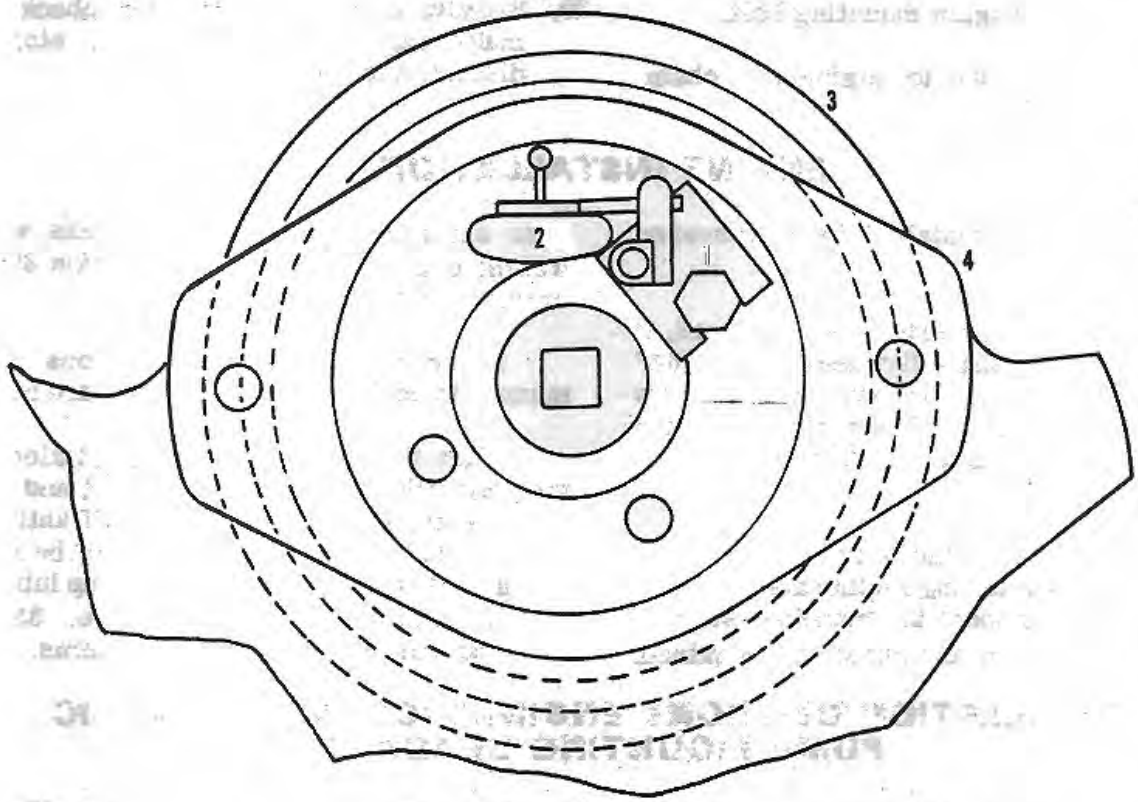
2. Wipe off pump pilot bore in engine mount. Remove pump drive coupling from crankshaft pulley. Attach dial indicator to pulley using a 7/16" - NC x 3/4" cap screw as illustrated in Figure 2. Attach dial indicator to adapter so its stem is touching the pump pilot bore.

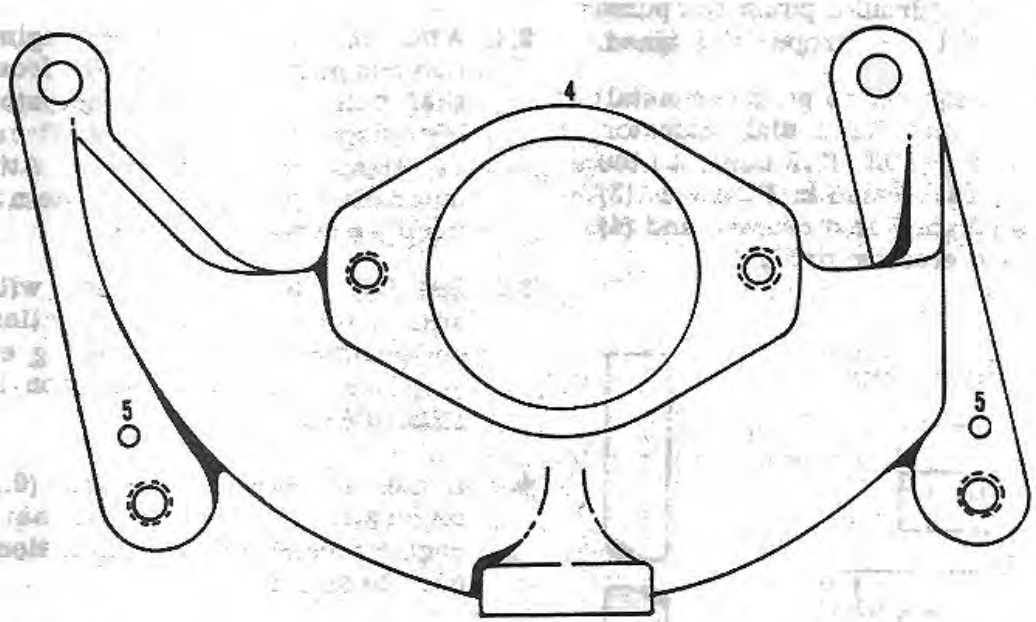
3. Set dial indicator at zero with ample stem movement in both directions. Turn engine over and take reading every 90° until one complete revolution is made. Record each reading.

4. If the readings varied .005" (0.127 mm) or less in either direction from zero the engine mount is properly positioned. Proceed to step 6.

5. If the readings varied .006" (0.15 mm) or more in either direction from zero the engine mount must be repositioned.

6. After the engine mount is properly positioned, drill a 1/4" hole all the way through engine block flange at the pilot holes in the engine mount.





1. DIAL INDICATOR ADAPTER
2. DIAL INDICATOR
3. CRANKSHAFT PULLEY
4. ENGINE MOUNT
5. DOWEL PIN HOLE

751592

Figure 2 - Engine Mount Installation

NOTE: If a new engine mount is being installed on a used engine or a used engine mount is being used on a new engine, drill the 1/4" holes 1/2" above the engine mount pilot holes.

7. Using the No. 5 tapered straight fluted reamer, ream the 1/4" holes to fit a No. 5 x 1-1/2" pin (part no. 139-64). The fit must be snug enough so the pin must be driven into place with a hammer.

8. Drive new pins into place.

RADIATOR REMOVAL AND INSTALLATION

1. Remove grille and drain radiator.

2. Remove lower guard (or cover plate if equipped with a counterweight).

3. Disconnect oil cooler lines at hose connections. Plug oil cooler to prevent oil loss and keep machine clean. Plug cooling lines to prevent entry of dirt.

4. Remove bottom radiator support to frame nuts, washers and bolts.

5. Remove the upper and lower radiator hoses.

6. Remove air cleaner intake tube if so equipped.

7. Remove the rear mounting bolt on each side of shroud.

8. Attach chain hoist to shroud. Move shroud forward to clear the fan blades and lift shroud from machine. Set shroud on blocks.

9. Remove nuts and lock washers from studs on bottom of radiator.

10. Remove the radiator mounting strap to shroud nuts, washers and bolts on each side. Then remove radiator from shroud.

11. If radiator is being sent to a repair shop, use a sharp putty knife and remove the foam rubber baffles from the radiator. Also remove the oil cooler.

12. Radiator installation is the reverse of removal.

13. Use a good grade of contact cement according to the manufacturer's instructions and cement baffles to radiator. The baffles must not be left off.

14. If permanent antifreeze is not used in the cooling system be sure to use a rust inhibitor and water pump lubricant. Also add anticavitation inhibitor, part number 331-508.

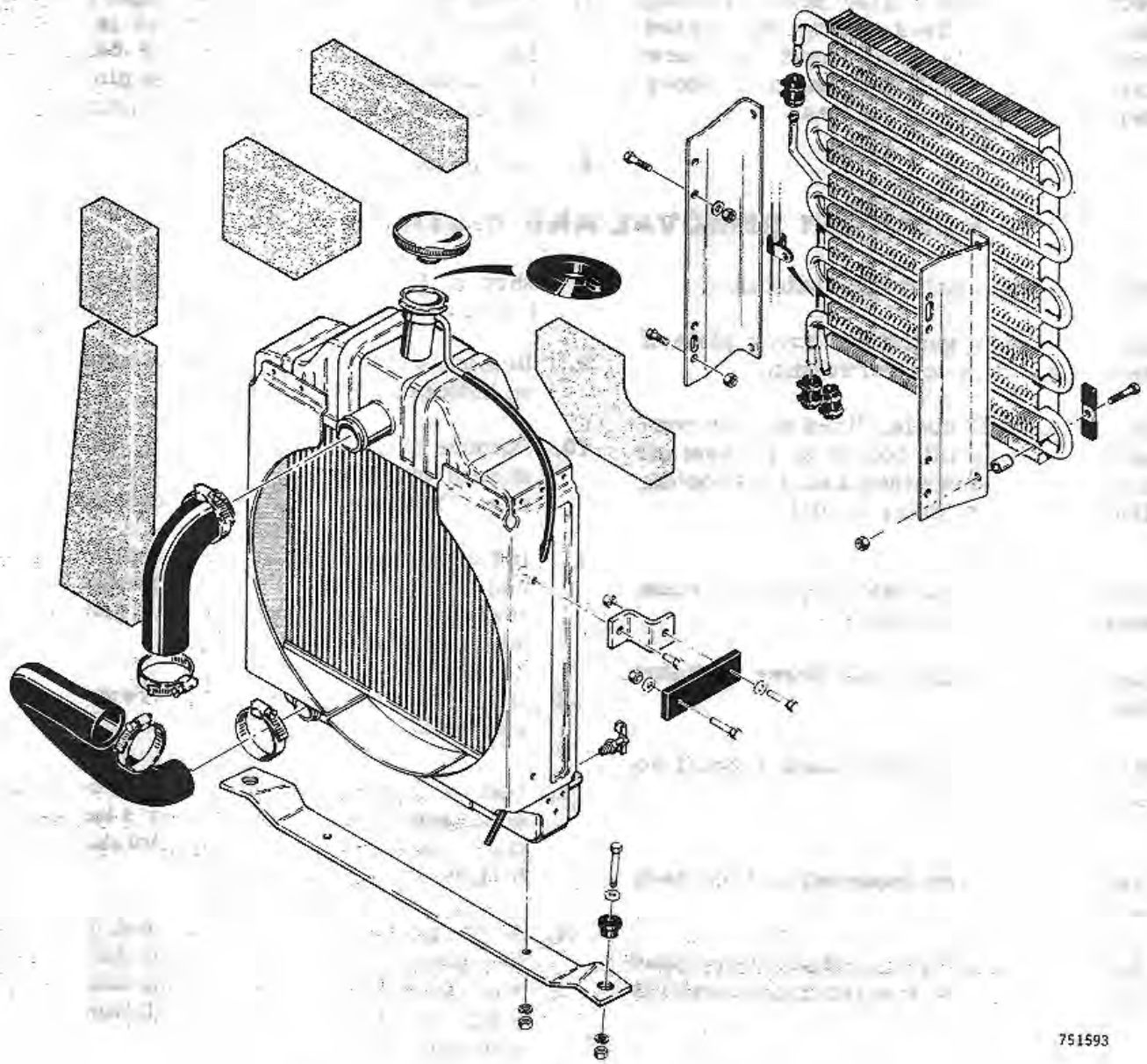


Figure 3 - Radiator and Oil Cooler Installation

Section 2051

AIR CLEANER

AND

SPARK ARRESTING MUFFLER

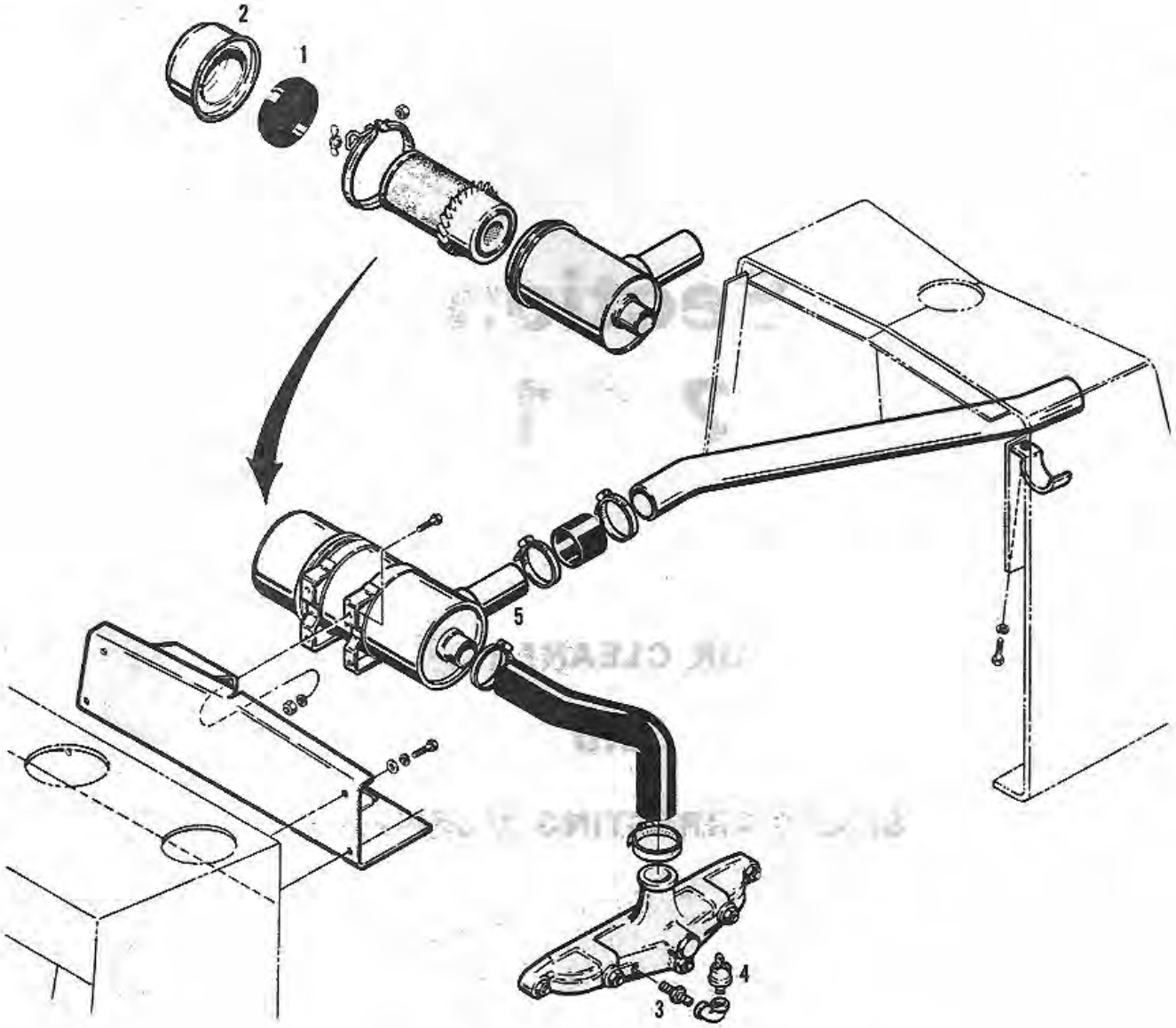
J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.



1. BAFFLE
2. DUST CUP
3. SAFETY FILTER
4. FILTER RESTRICTION LIGHT SWITCH
5. FILTER BODY INTAKE TUBE

751621

Figure 1 - Air Cleaner Installation

AIR CLEANER SERVICE

Service Interval

The air cleaner filter element must be serviced when the filter restriction warning light remains on with engine running at full throttle. In addition to filter service the dust cup should be cleaned daily or more often as conditions warrant.

Filter Element Service

Washing is the preferred method of cleaning the element as it removes more dust and soot, thus restoring the element to an almost new condition.

Wash the filter in Case Filter Element Cleaner, Part No. A40910. Mix according to instructions on container. Do not use water pressure over 40 psi (275 kPa) at the nozzle. Let the element dry completely before installing. Do not use compressed air to dry the element.

Use of compressed air to clean the element is permissible but not recommended as it does not remove carbon and soot. When using compressed air, use no more than 30 psi (206 kPa) at the nozzle and keep the nozzle a reasonable distance (no closer than 1" (25 mm) away from the filter. Move the nozzle up and down each pleat, blowing from the inside only.

Inspect the filter after it is clean and dry. Place a light inside the filter and inspect for holes, tears, and dented or bent metal covering. If metal covering is dented or bent, inspect filter paper for holes or rub spots in that area. If holes or rub spots are noted, discard the filter and install a new filter element.

Figure 2 – Inspecting the Element

NOTE: Inspect new filter element in the same manner. Do not accept a defective filter.

The element must be replaced after it has been cleaned six times or once a year, whichever occurs first.

SAFETY FILTER (FILTERED FITTING)

The filtered fitting is installed in the air intake manifold, Figure 1. The filter prevents unfiltered air from entering the engine if the filter restriction light switch is damaged.

The safety filter will plug up with continued operation if a leak occurs. If the filter becomes plugged the switch will fail to operate.

Checking for Plugged Safety Filter

1. Place the shuttle and transmission in Neutral and apply the parking brake.
2. Refer to Figure 1. Expose the filter body intake tube.
3. Start the engine. Block off the intake tube. If the filter restriction warning light on the instrument panel does not light, the filter is plugged or warning light switch is inoperative.
4. Remove the fitting from the manifold. Soak fitting in cleaning solvent and blow moisture free compressed air through the filter.
5. Install fitting and switch and repeat step 3. If filter is still plugged, replace the fitting.

FILTER RESTRICTION LIGHT SWITCH

The filter restriction light switch can be checked for proper operation using a manometer (usually found on ignition distributor tester) and an ohmmeter.

To check the switch, connect an ohmmeter lead to the switch terminal and the other ohmmeter lead to the switch body. Connect hose from manometer to the switch and slowly increase the vacuum. The ohmmeter should show continuity (switch closed) at 2.2 ± .3 inches of mercury (7 ± 1 kPa). If the switch does not function as specified the switch must be replaced.

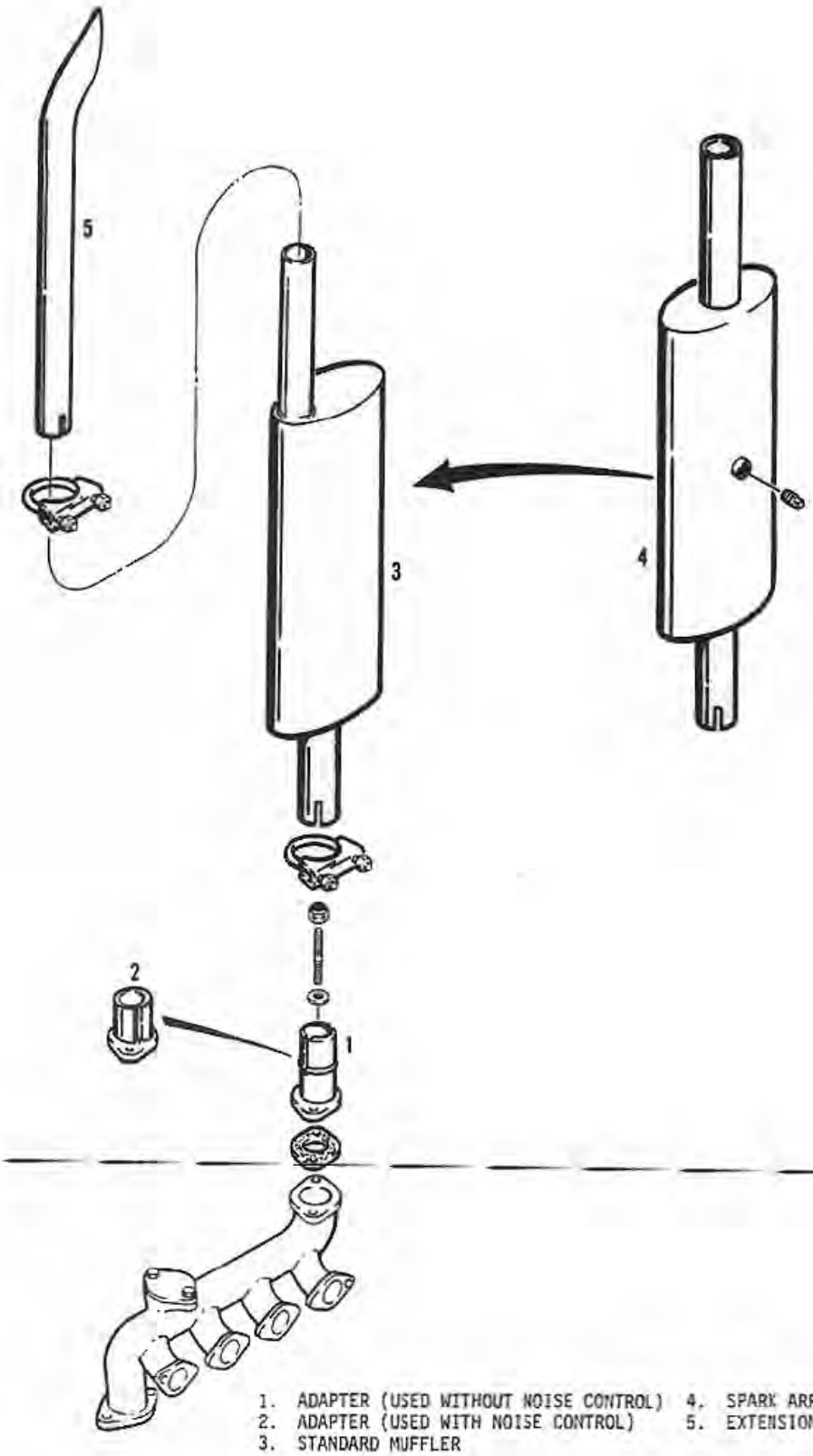
SPARK ARRESTING MUFFLER

Laws of some states or provinces may require that this machine be equipped with a spark arrester or spark arresting muffler. If machine is equipped with a spark arresting muffler, a pipe plug will be found on the side of the muffler, Figure 3.

If the machine is equipped with a spark arresting muffler, any replacement muffler must also be of the spark arresting type.

The spark arresting muffler must be cleaned (loose carbon removed) after every 100 hours of operation.

1. Remove plug from side of muffler. This is a brass plug; if it requires replacement it MUST be replaced with another brass plug.
2. Have a second person available to block the outlet pipe.
3. Pull fuel shutoff control out.
4. Apply parking brake. Turn switch on and crank engine for 30 seconds while helper blocks the outlet pipe.
5. Reinstall plug in muffler.



1. ADAPTER (USED WITHOUT NOISE CONTROL)
2. ADAPTER (USED WITH NOISE CONTROL)
3. STANDARD MUFFLER
4. SPARK ARRESTING MUFFLER
5. EXTENSION (USED WITH BOTH MUFFLERS)

751622

Figure 3 - Muffler Installation

Section 2053

ETHER INJECTION

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

Operation

The ether injection system injects a measured amount of ether into the intake manifold whenever the control knob is pulled all the way out and pushed back in. Actuate the ether injector as the engine is being turned over with the starter. If the engine starts but fails to continue to run, actuate the injector again as instructed. DO NOT actuate the ether injector with the engine running.

Control Cable Adjustment

When the control cable is pushed all the way in, there should be 1/8" (3 mm) clearance between the knob and the cable housing end.

To adjust control knob position:

1. Loosen cable clamp at injector valve.
2. Hold injector valve lever down and push cable housing up and tighten clamp.
3. Check control knob position and readjust as required.

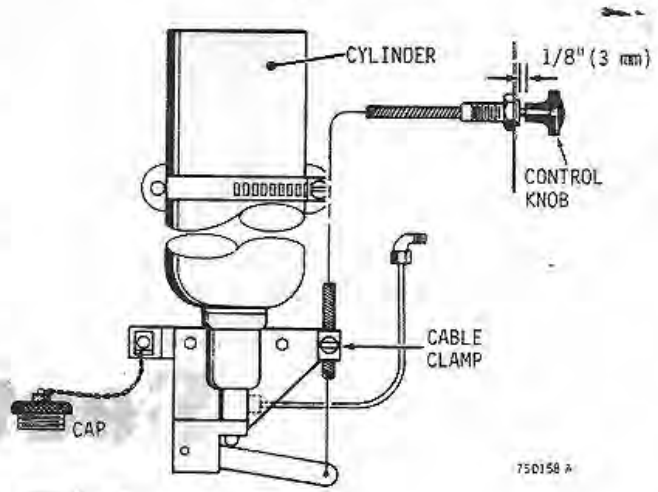
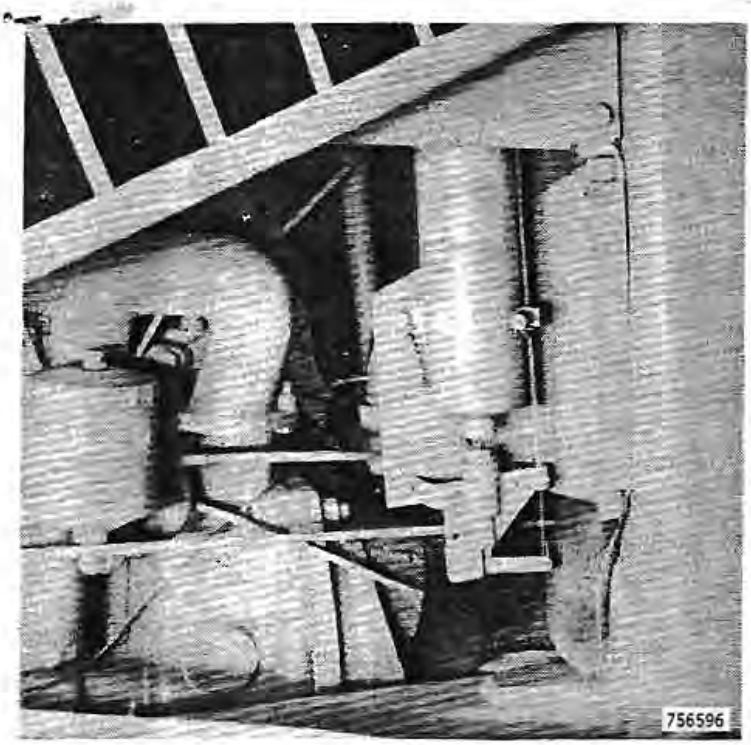


Figure 1

Cylinder Replacement

1. Be sure control cable is pushed all the way in.
2. Loosen cylinder mounting clamp and unscrew cylinder. Discard cylinder according to instructions on the cylinder.
3. If O-ring remained in injector valve, remove O-ring and discard.
4. Install new cylinder using a new O-ring.



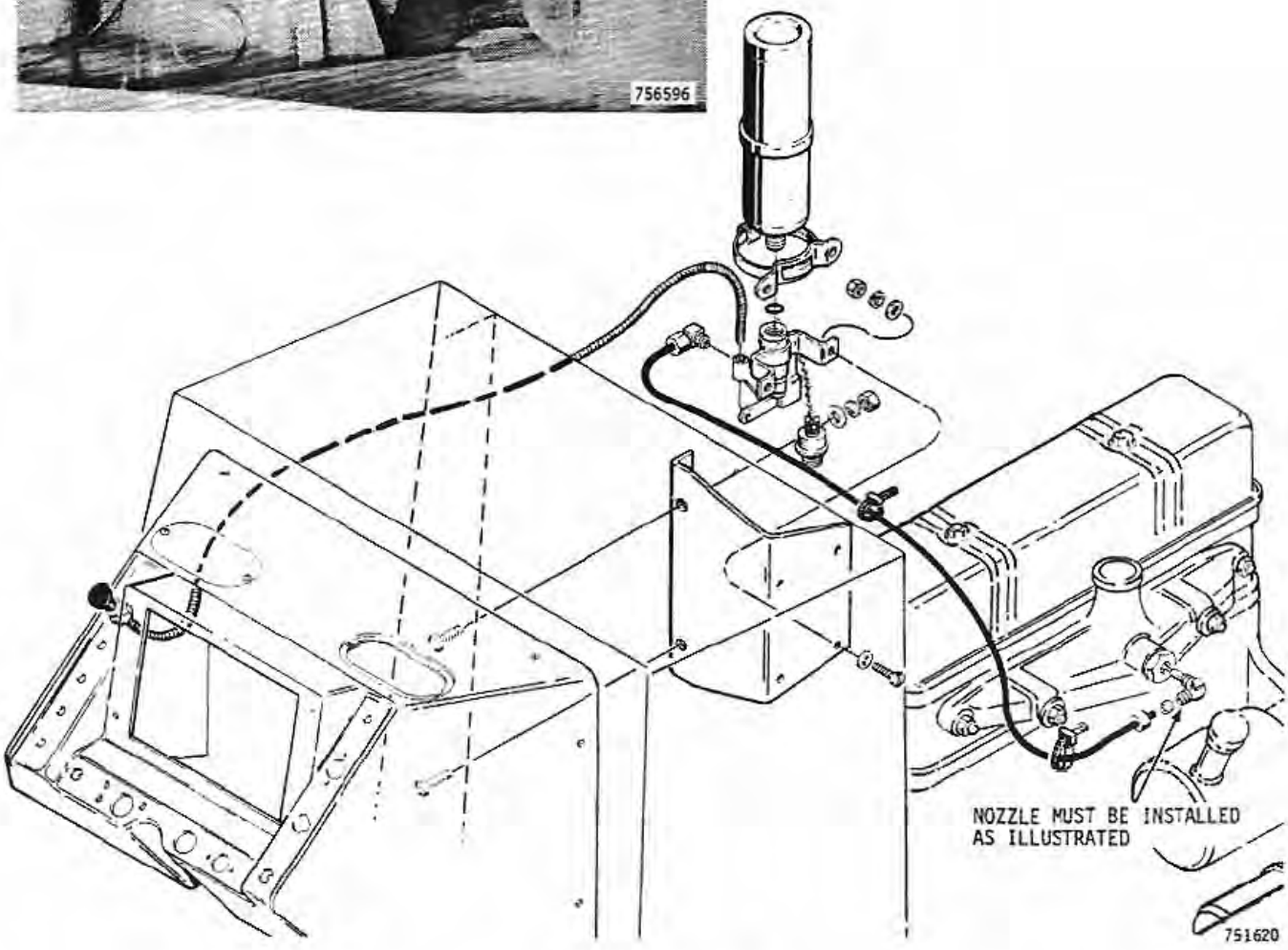


Figure 2 - Ether Injector Installation

Section
2055

COOLING SYSTEM

188 and 207 Diesel Engines

Thermostat and Water Pump

J I Case
A Tenneco Company

TENNECO

Rac 9-78816

PRINTED IN U.S.A.

THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

SAFETY PRECAUTIONS

CAUTION *Add coolant to the radiator only when the engine is stopped or slowly idling. To avoid being scalded when the pressure-type filler cap is being removed, turn the cap slowly to the first stop position to relieve pressure before removing the cap.*

Relieve the system pressure by turning the radiator cap counter-clockwise to the FIRST stop. This will allow a gradual reduction in pressure and minimize coolant loss.

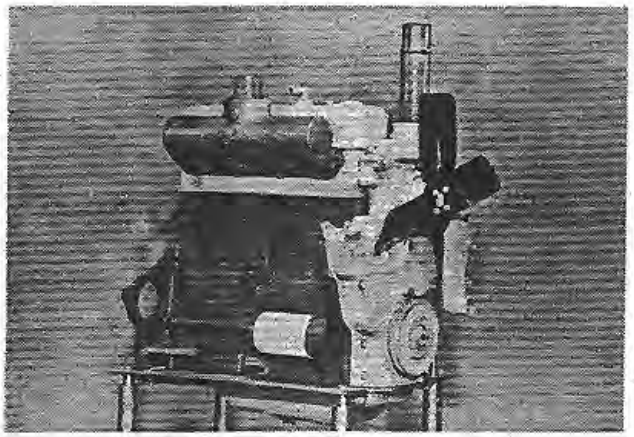
NEVER pour cold coolant into a hot engine. The engine block or the cylinder head may crack by the sudden contraction caused by the difference in temperature between the metal and the coolant.

CLEANING THE COOLING SYSTEM

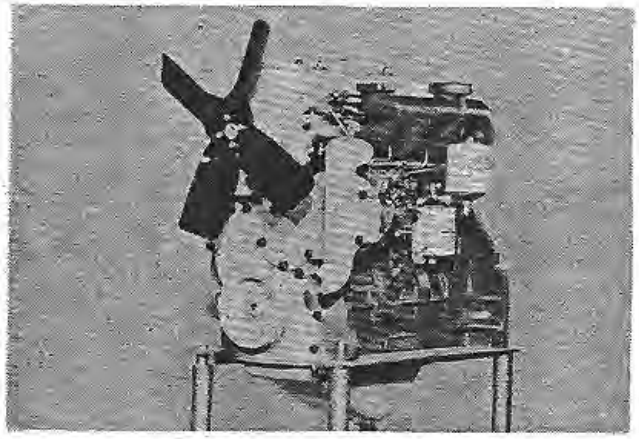
It is recommended that the cooling system be cleaned at least once a year. In areas where water containing scale forming minerals is all that is available, clean the system more often.

1. **While the coolant is still hot, open the radiator drain valve and the engine block drain valve.**
2. **Add any nationally known commercial brand cleaner marketed by a reputable manufacturer. Follow the directions provided with the cleaner.**
3. **After draining the cleaning solution, flush the system with clean water before refilling for operation.**

NOTE: **Always use only a nationally recognized brand of High Boiling Point Ethylene base anti-freeze, that does not contain a stop-leak additive.**



188 DIESEL ENGINE



207 DIESEL ENGINE

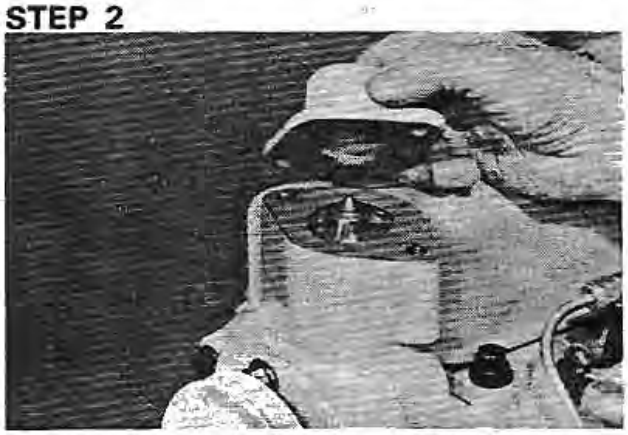
THERMOSTAT REPLACEMENT

Removal

STEP 1

Disconnect and remove hose from thermostat housing. Remove thermostat housing bolts.

STEP 2

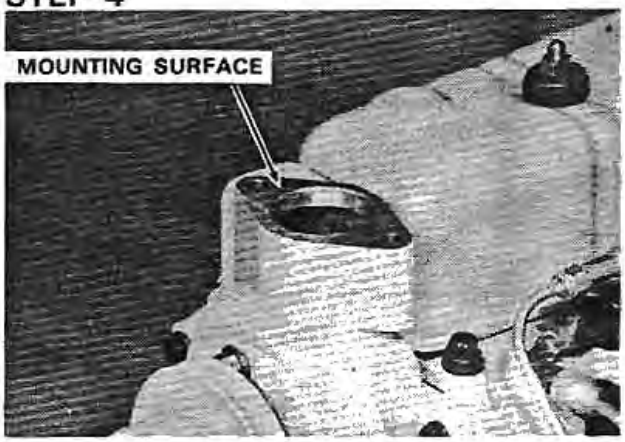


Remove thermostat housing and gasket.

STEP 3

Lift thermostat out of water pump housing

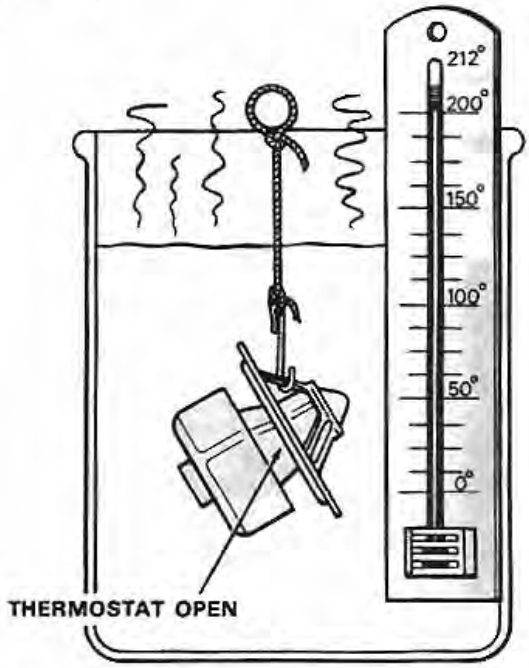
STEP 4



Remove all old gasket material from mounting surfaces.

Inspection

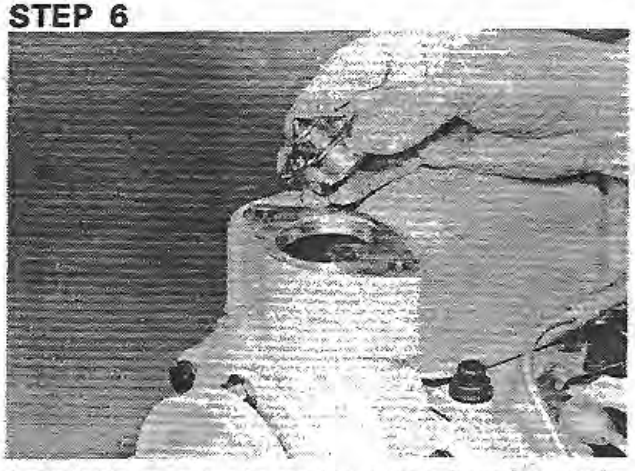
STEP 5



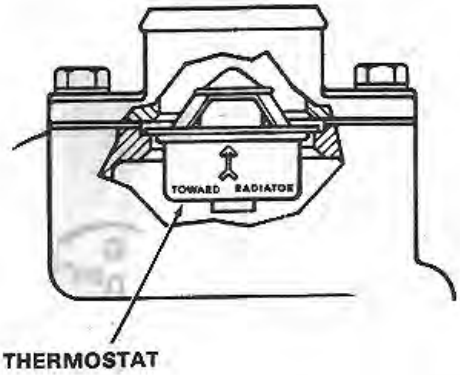
Check thermostat for proper operation by submerging in a container of hot (approximately 175°F) water. The thermostat should be completely open at 202°F. Replace the thermostat if it does not meet the above specification.

Installation

STEP 6



Install thermostat in water pump housing making sure that the thermostat points upward and toward the radiator.



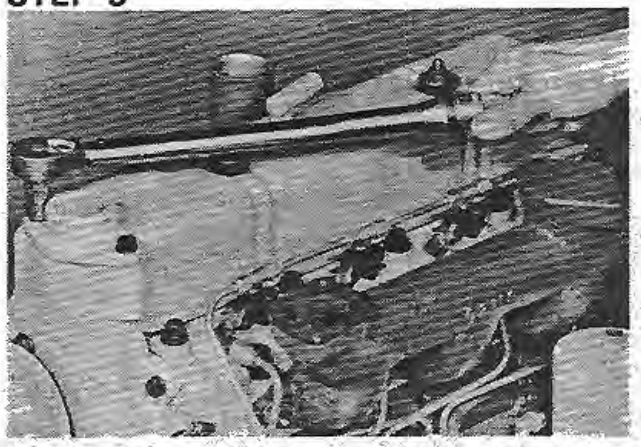
STEP 7

Install new thermostat housing gasket.

STEP 8

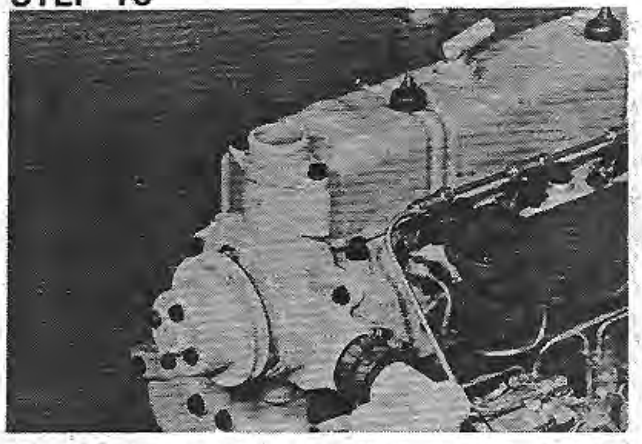
Install thermostat housing.

STEP 9



Install thermostat housing bolts. Torque retaining bolts 35 to 42 ft. lbs.

STEP 10

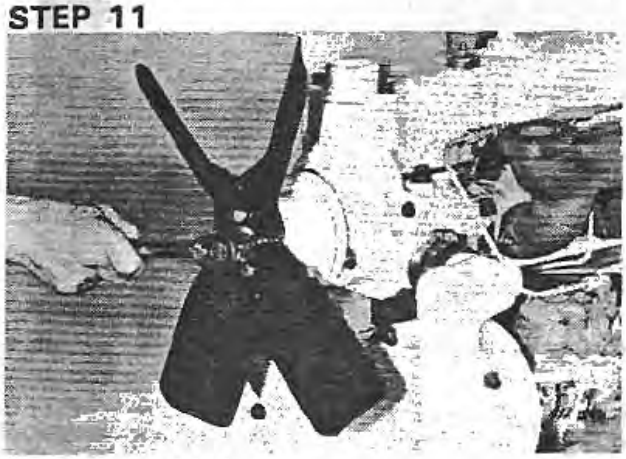


Thermostat housing installed. Install radiator hose to thermostat housing.

WATER PUMP REPLACEMENT

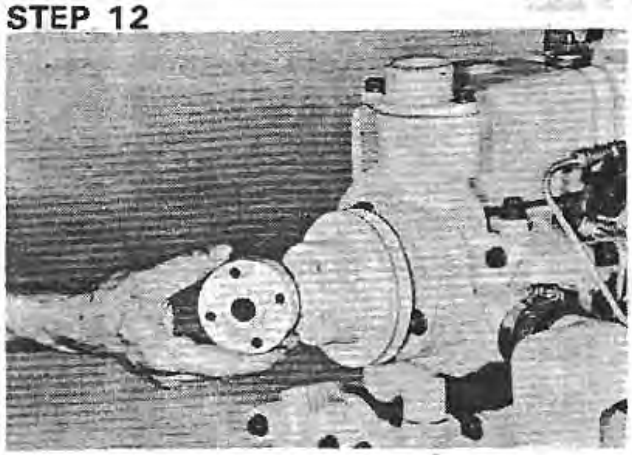
Removal

STEP 11



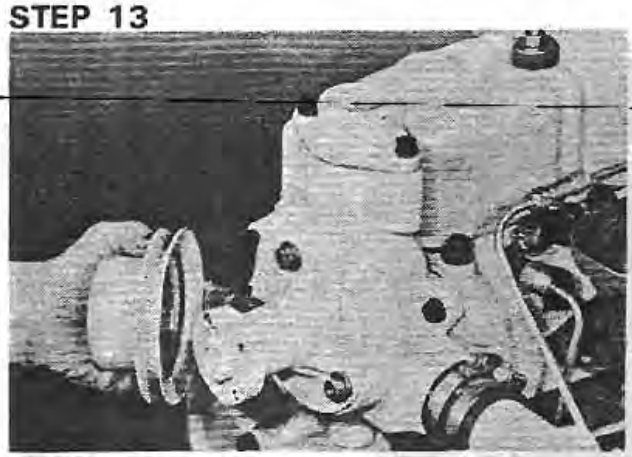
Remove fan blade.

STEP 12



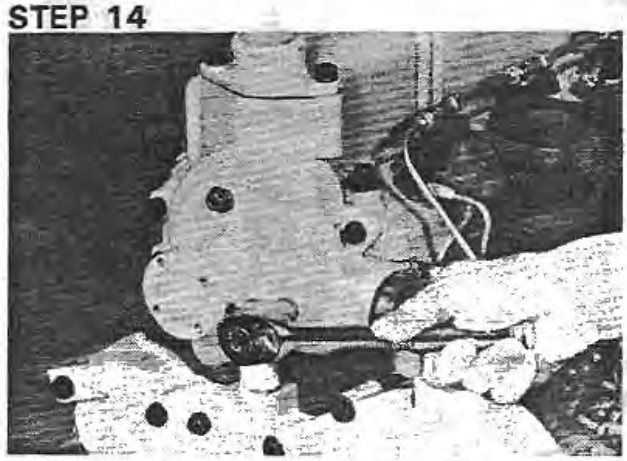
Remove fan hub-spacer, if equipped.

STEP 13



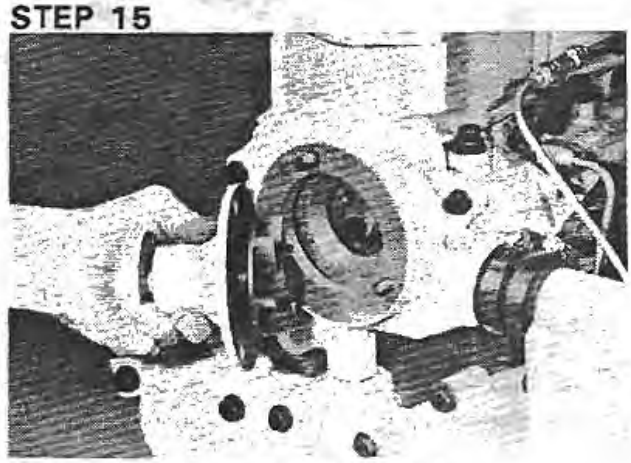
Remove fan drive pulley.

STEP 14



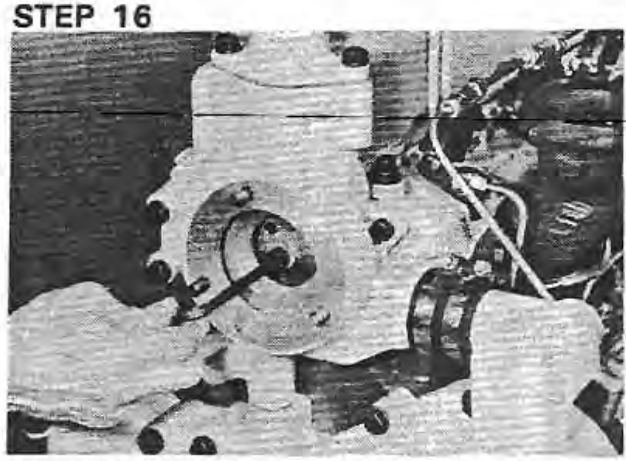
Remove water pump mounting nuts.

STEP 15



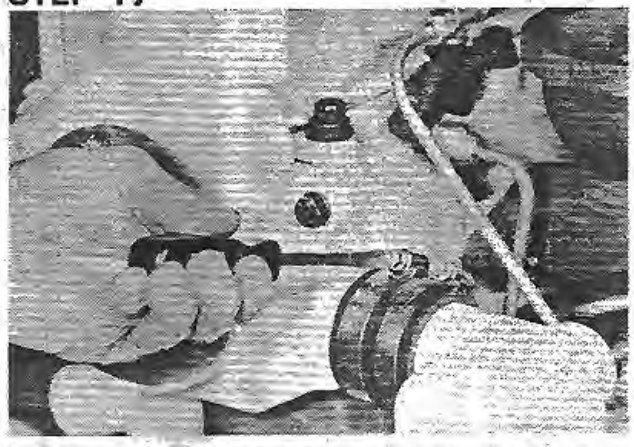
Remove water pump and gasket.

STEP 16



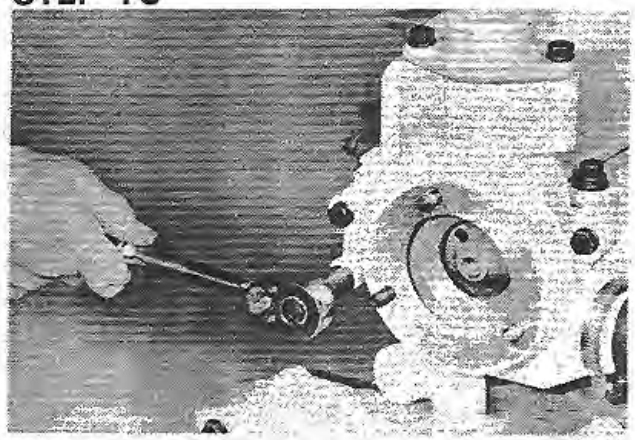
Remove inner mounting bolt.

STEP 17



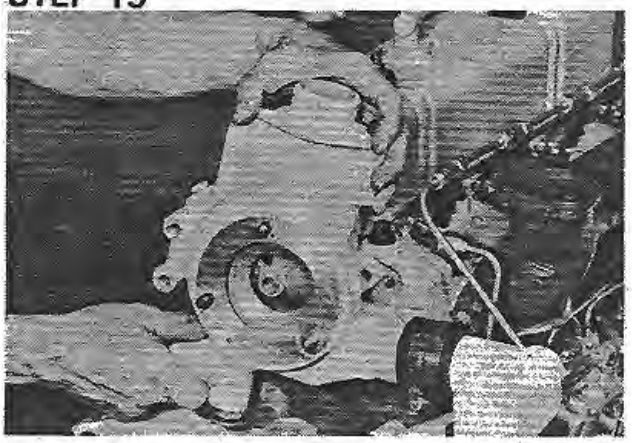
Loosen water tube to water pump housing hose clamps.

STEP 18

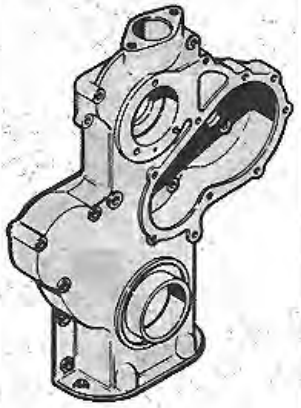


Remove water pump housing bolts.

STEP 19

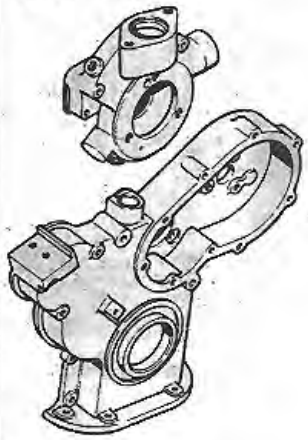


Remove water pump housing and gasket from cylinder head. Check housing for cracks at mounting flanges and replace if necessary. *NOTE:* If equipped with a one piece water pump and timing gear housing and replacement is required, you will receive a separate water pump housing and timing gear housing, refer to Section 2015.



ONE PIECE WATER PUMP AND TIMING GEAR HOUSING

SEPARATE WATER PUMP HOUSING AND TIMING GEAR HOUSING

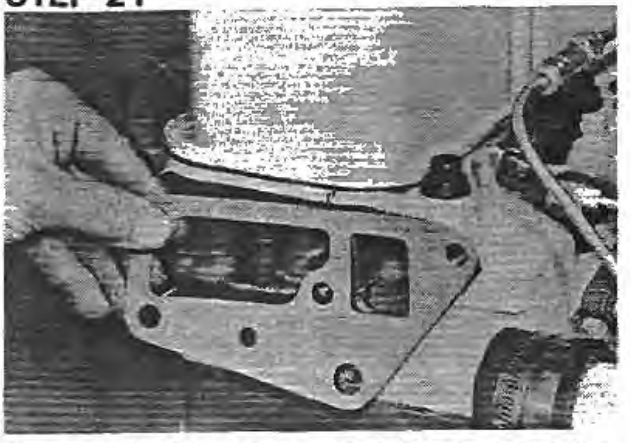


STEP 20

Water pump housing and gasket removed from cylinder head.

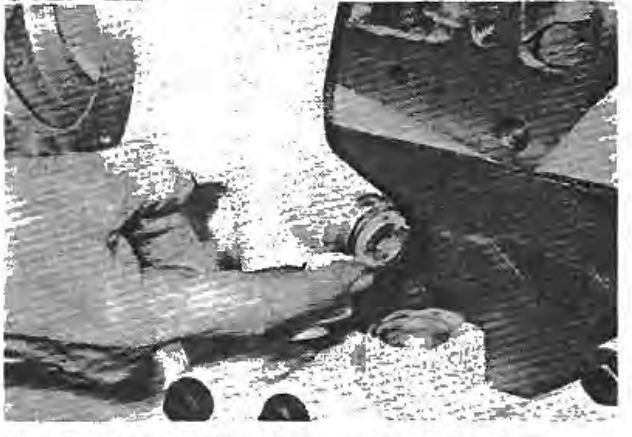
Installation

STEP 21



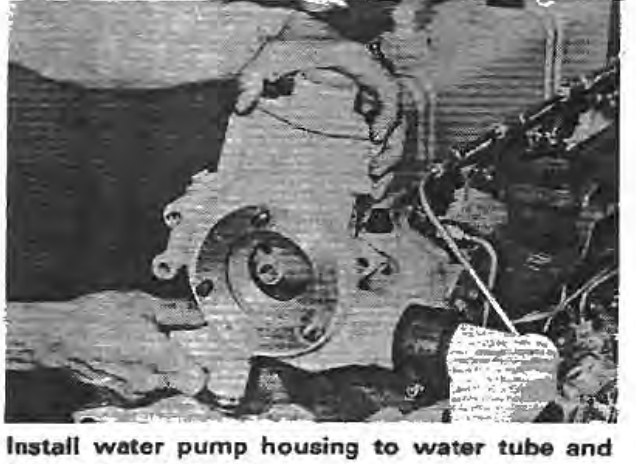
Remove all old gasket material from mounting surface. Install a new water pump housing to cylinder head gasket.

STEP 22



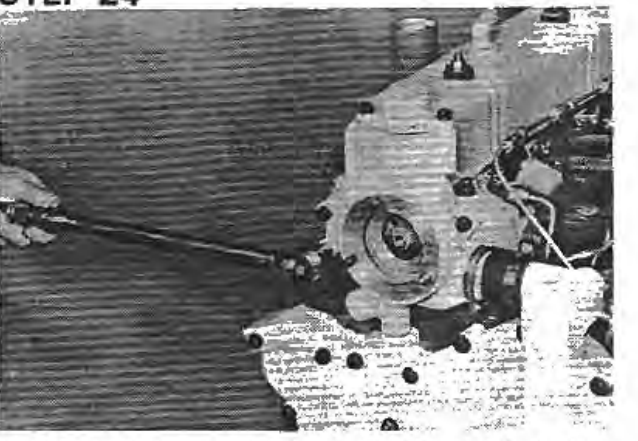
Install a new "O" ring, using lubriplate.

STEP 23



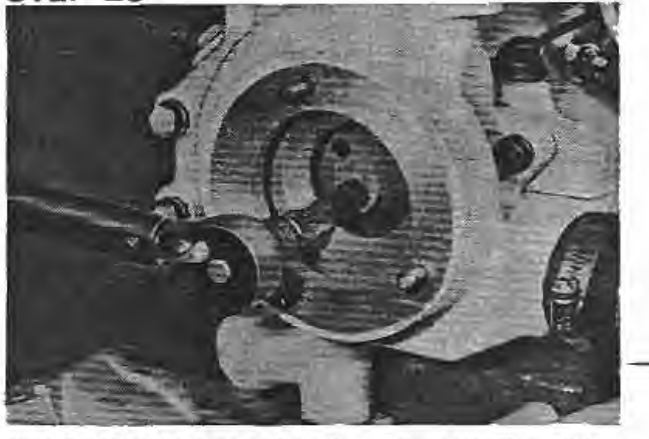
Install water pump housing to water tube and timing gear housing.

STEP 24



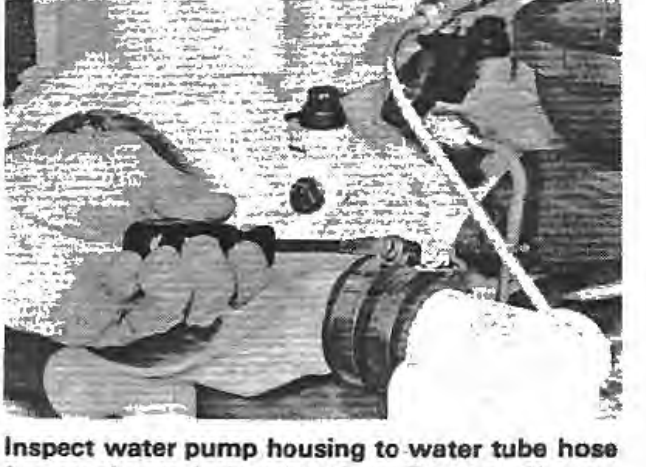
Install outer bolts, and torque 35 to 42 ft. lbs.

STEP 25



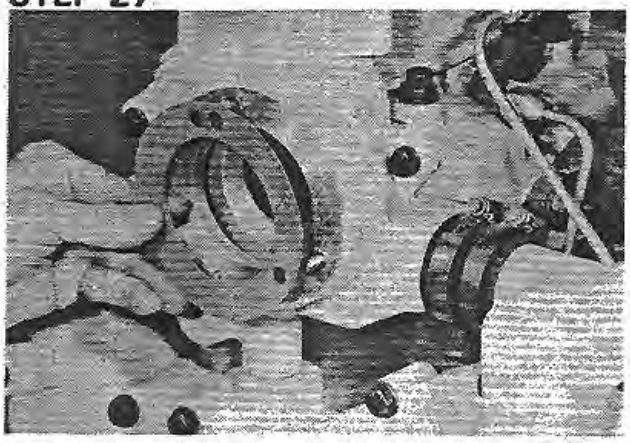
IMPORTANT: Apply Loctite Primer"T" and Loctite #271 (Case B17429 and B17423) on water pump housing inner socket hd.capscrew threads to prevent capscrew backing out into impeller. Install capscrew and torque 35 to 42 ft. lbs.

STEP 26



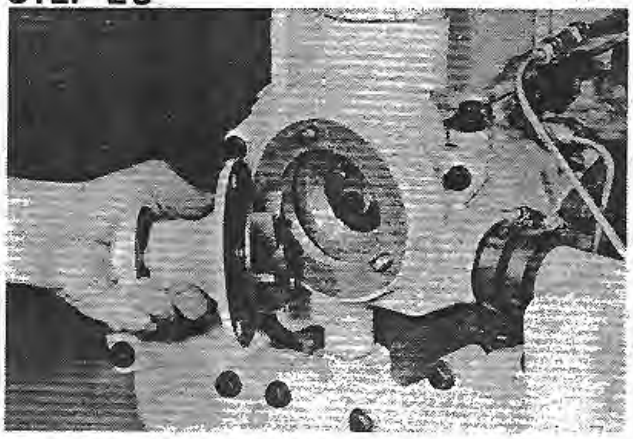
Inspect water pump housing to water tube hose for cracks and deterioration. Replace if necessary. Install hose on water pump housing and on water tube. Secure with clamps.

STEP 27



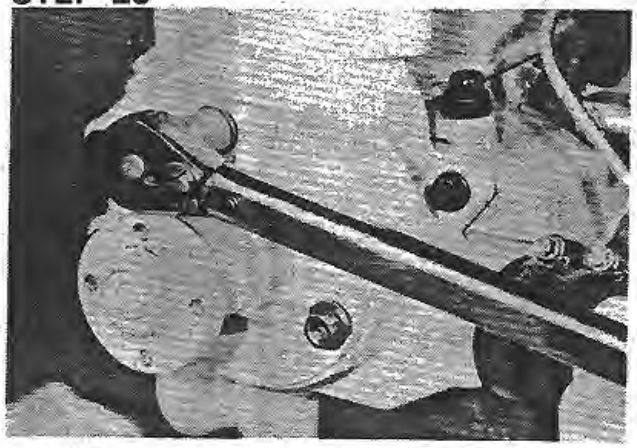
Remove all old gasket material from mounting surface. Install a new pump to housing gasket.

STEP 28



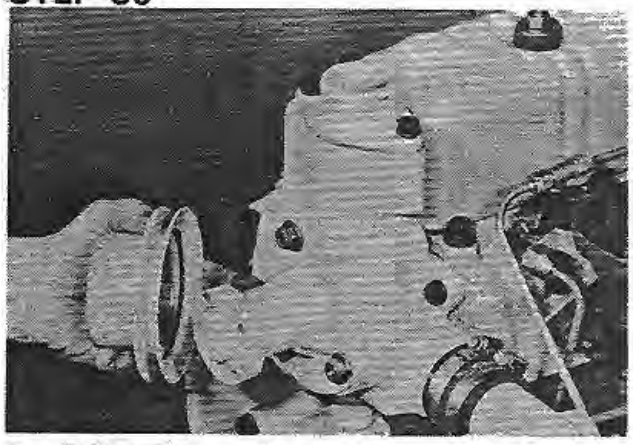
Install water pump on pump housing studs. *NOTE:* The water pump is serviced as a unit. If pump is leaking or malfunctioning, replace the unit.

STEP 29



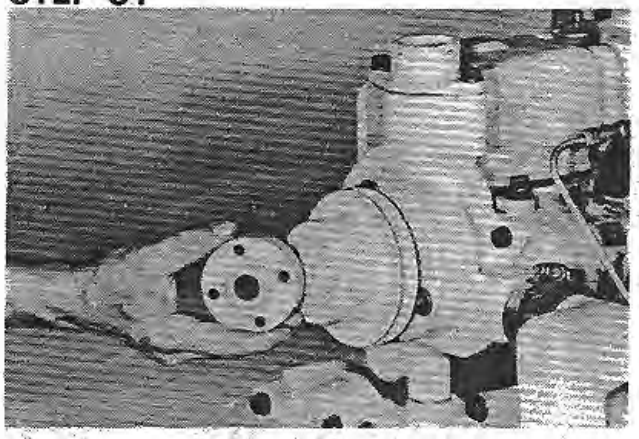
Install nuts and torque 35 to 42 ft. lbs.

STEP 30



Install fan drive pulley.

STEP 31



Install fan hub spacer, if equipped.

STEP 32

Check fan for damage or loose blades. Replace fan if required. Install fan on pulley and spacer, if required, and torque retaining bolts 17 to 21 ft. lbs.

Section 2125

CYLINDER BLOCK, SLEEVES, PISTONS AND RODS

207 Diesel Engines

J I Case
A Tenneco Company

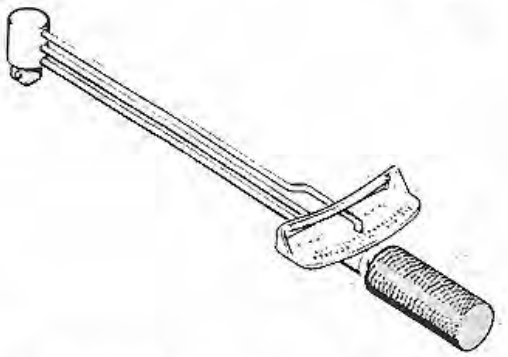
TENNECO

Rac. 9-78845

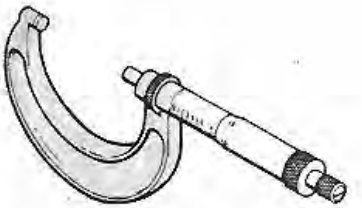
PRINTED IN U.S.A

TABLE OF CONTENTS

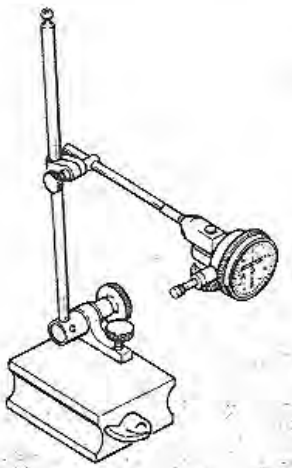
SPECIAL TOOLS



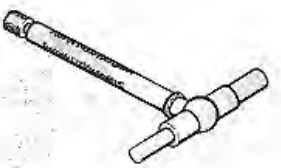
FOOT POUND TORQUE WRENCH



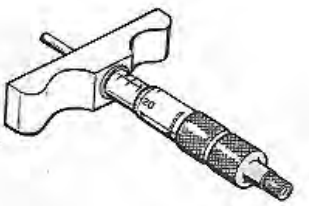
0" TO 5" MICROMETER



DIAL INDICATOR

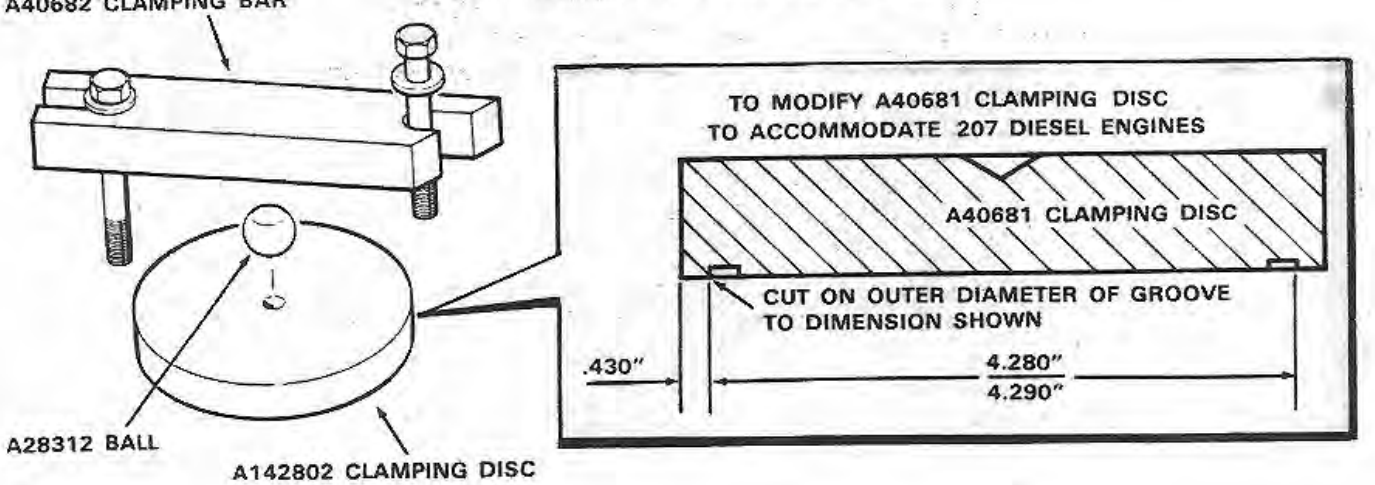


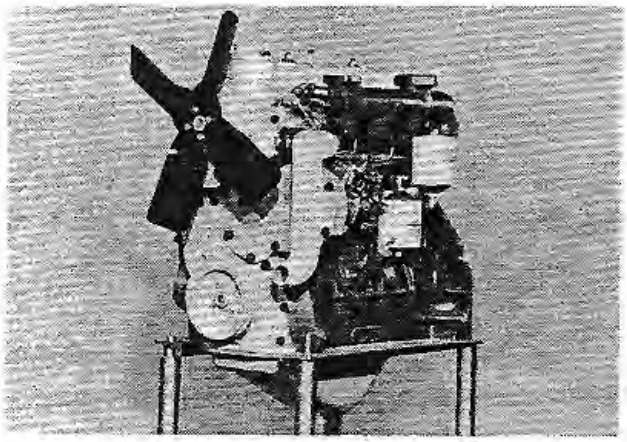
0" TO 5" BORE GAUGE
OR INSIDE MICROMETER



DEPTH MICROMETER

TOOLS FOR CHECKING SLEEVE PROTRUSION



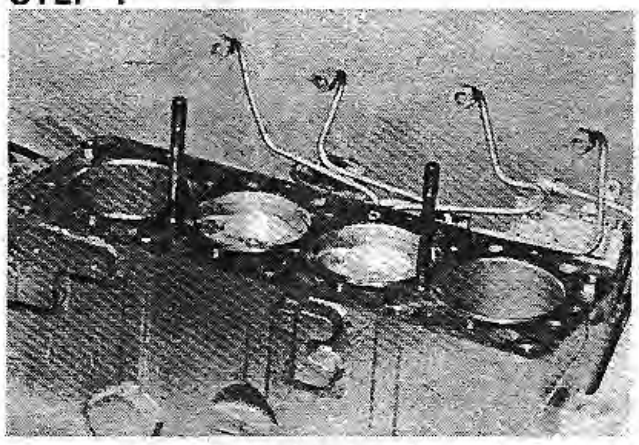


207 DIESEL ENGINE

CYLINDER BLOCK, SLEEVES, PISTONS AND RODS

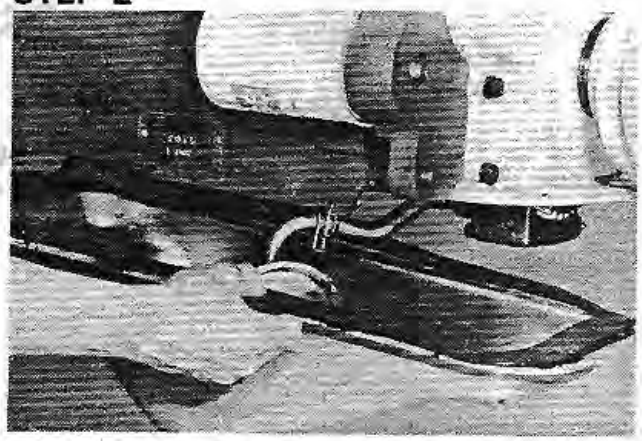
Removal

STEP 1



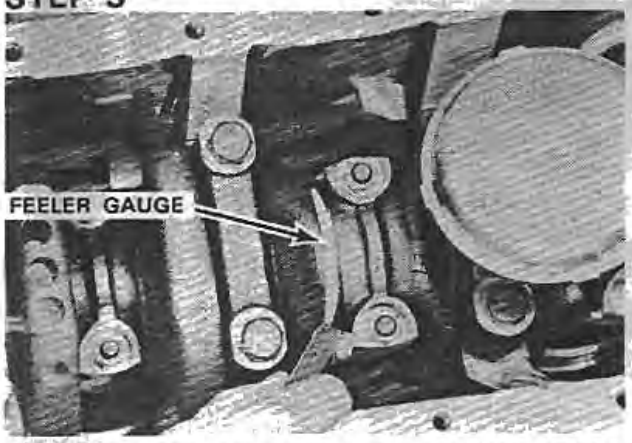
Remove the cylinder head and manifolds from the engine block. Refer to section 2015 for removal.

STEP 2



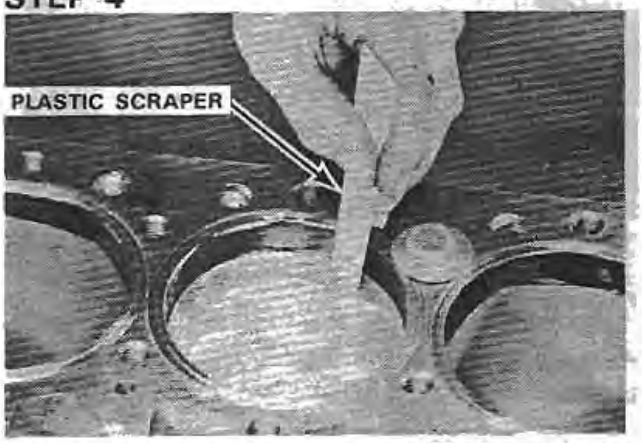
Remove drain plug from oil pan and drain engine crankcase oil. Remove oil pan.

STEP 3



Check the connecting rod side clearance with a feeler gauge. If side clearance exceeds .011", the connecting rod must be replaced.

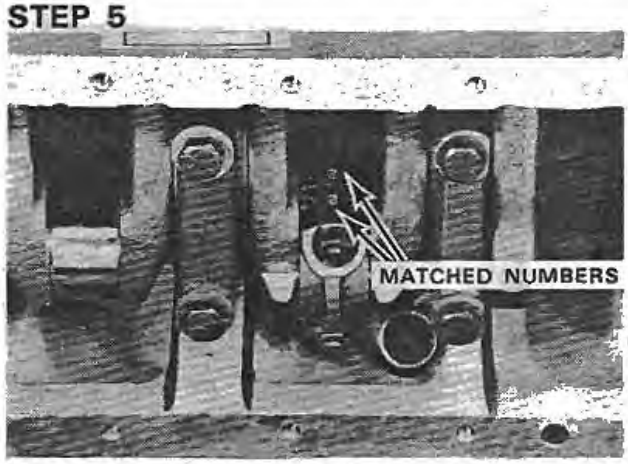
STEP 4



Check the piston sleeves for a carbon or a metal ridge at the top of the ring travel. If a ridge is present, it must be removed before the pistons can be removed. Use a plastic scraper to remove carbon ridges using the top of the piston as a guide for scraping.

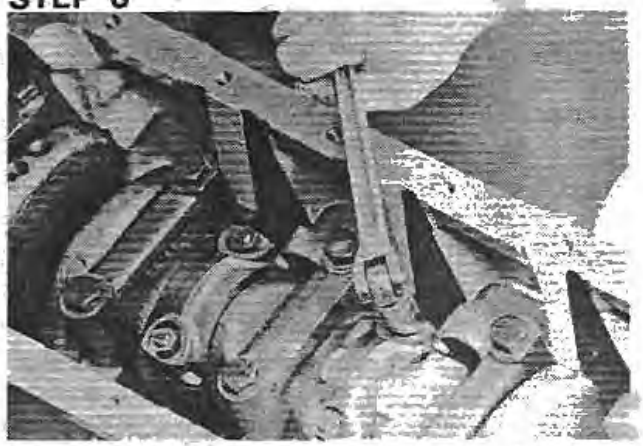
IMPORTANT The piston sleeves are chrome plated. Sharp instruments must not be used to remove carbon from piston sleeves because there is a possibility of scratching through the chrome surface and exposing the iron, which in turn will have a tendency to rust. Never use a ridge reamer to remove a ridge due to metal build-up. If a metal ridge has formed, replace the piston sleeve or damage to the piston rings and lands will result.

STEP 5



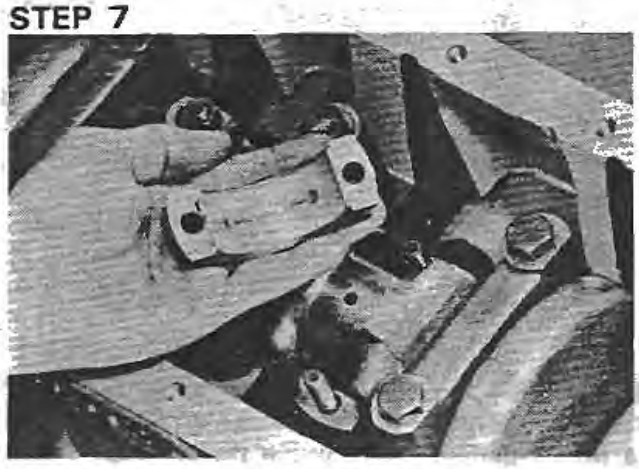
Check the connecting rods and caps to see if they are numbered as to their location in the engine block. If not, they must be numbered for reinstallation in their original location on the camshaft side of the engine.

STEP 6



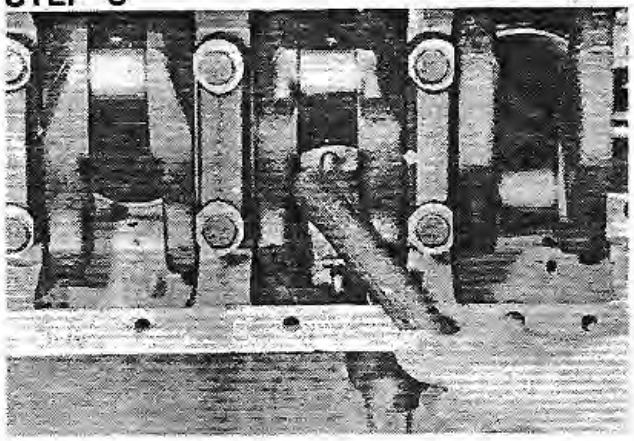
Remove the connecting rod cap mounting nuts.

STEP 7



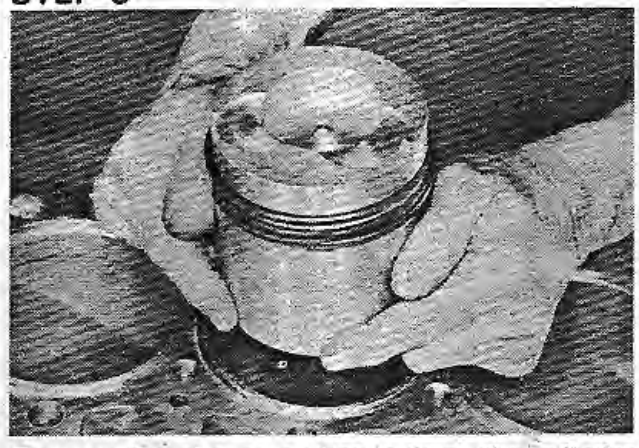
Remove the connecting rod caps.

STEP 8



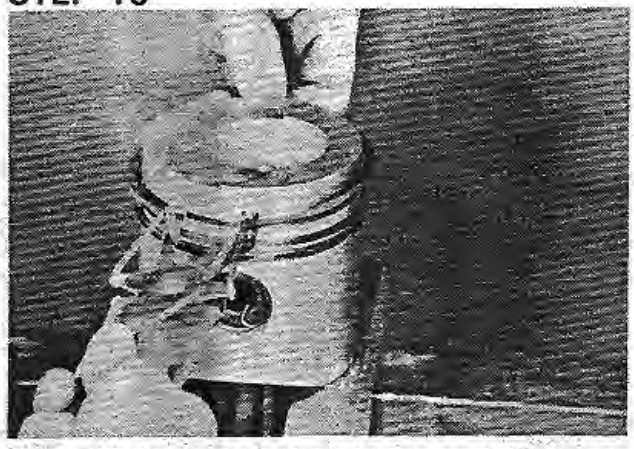
Push the connecting rod up through the engine block.

STEP 9



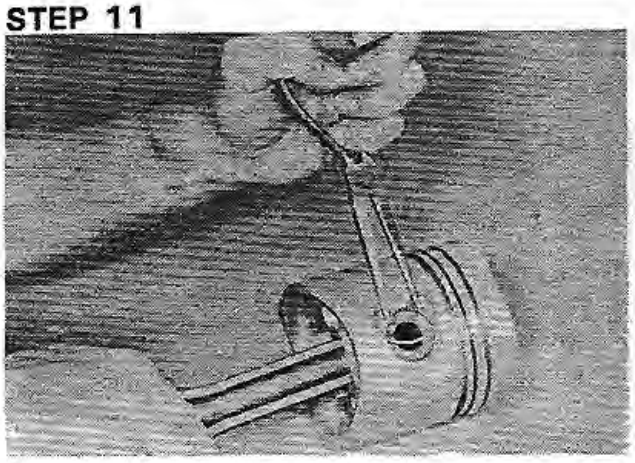
Remove the pistons and rods from the cylinder block. Reinstall rod caps on corresponding connecting rods to avoid mixing of the caps.

STEP 10



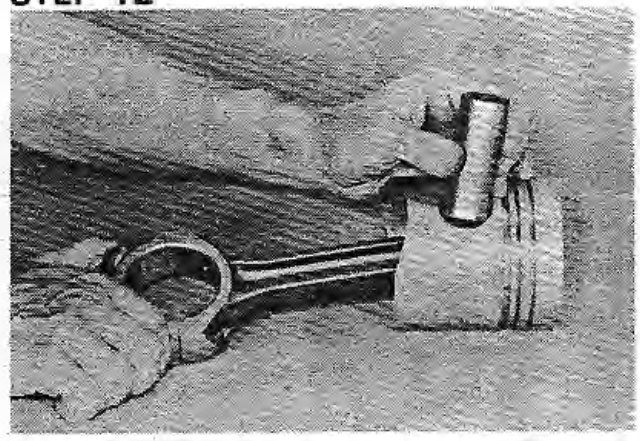
To avoid damage to the pistons and rings, use a ring expander and remove piston rings from piston.

STEP 11



Remove piston pin retaining rings from piston.

STEP 12



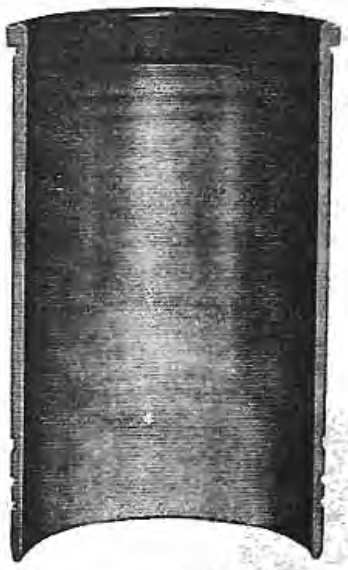
Remove piston pin from connecting rod and piston.

Cylinder Sleeve Inspection

STEP 13

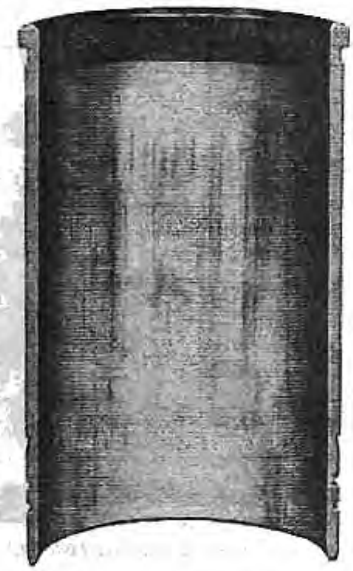
Inspect the cylinder sleeves for the following conditions.

NORMAL WEAR



A smooth shiny surface along the complete length of the cylinder sleeve indicates a worn out sleeve due to normal wear and it should be replaced.

SCUFFED CYLINDER WALLS

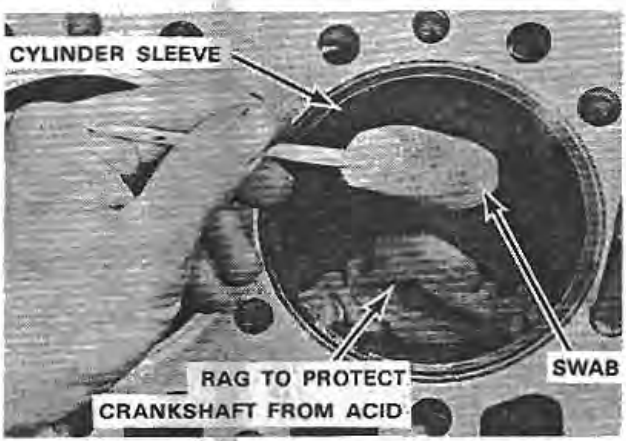


Heavy vertical lines fringed by a discolored band caused by metal transferring from one spot to another indicates scuffed cylinder walls. The vertical scuff marks are caused by metal coming in contact with the piston. The scuffing may be in one particular area or it may occur the entire length of the piston travel. If this condition exists, replace the cylinder sleeve.

CHROME PLATED LINERS

The chrome plated liners must not be honed or re-surfaced in any way and only the recommended piston rings must be used. However, new piston rings may be installed in used cylinder sleeves as long as the chrome plating is still intact and not physically damaged.

CHECKING CHROME PLATED LINERS



The method for determining whether chrome plating is intact over steel or iron cylinder sleeves is as follows:

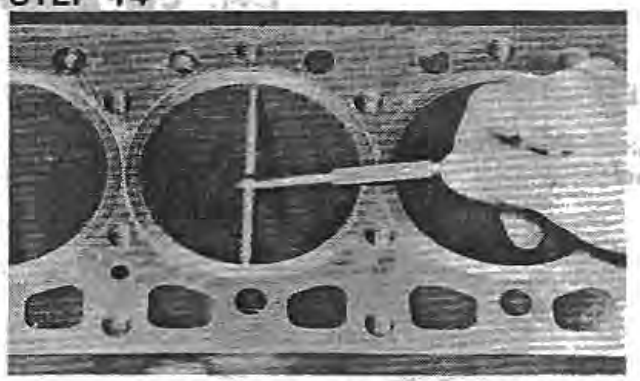
1. Remove all soil and oil from inside of cylinder sleeves. Clean with detergents and/or solvents to assure complete removal of oil film.
2. With a cotton swab or clean cloth rag, wet the inside of cylinder sleeves with Blue Vitriol Solution.
3. Exposed steel or iron surfaces will be plated a bright copper color. All surfaces that have the chrome plating intact will not be copper plated.
4. Rinse tested surface with water after test.

WARNING: *Blue Vitriol contains acid. Avoid prolonged exposure to skin. Wash off with water. Protect eyes from accidental splashing.*

If Blue Vitriol Solution can't be obtained from the druggist then proceed to make a satisfactory test solution from copper sulfate crystals which are available at hobby stores and pharmacies. Prepare solution as follows:

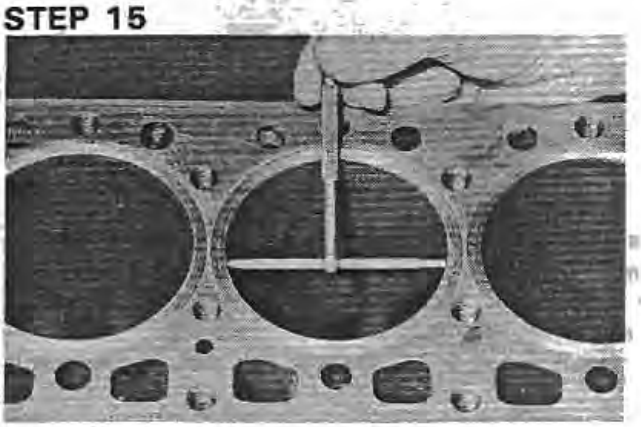
1. Add 1 tablespoon of fresh battery acid to 1 cup water.
2. Add 1/2 level teaspoon copper sulfate crystals to the solution.
3. Stir with plastic spoon until crystals are dissolved.

STEP 14



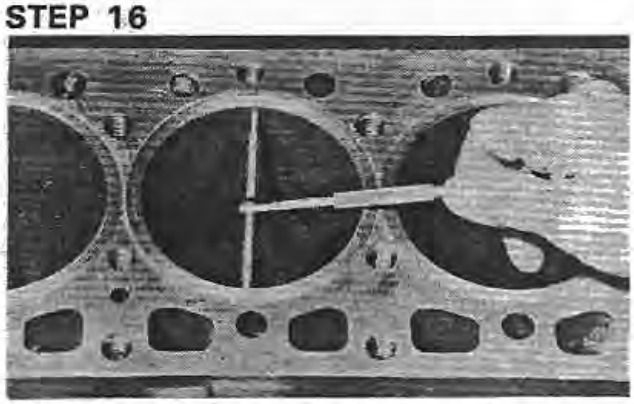
Using an inside micrometer, bore gauge or a taper gauge, check the sleeve diameter just below the top ring location and at several points down the length of the sleeve to check taper. If taper is more than .002", replace the sleeve.

STEP 15



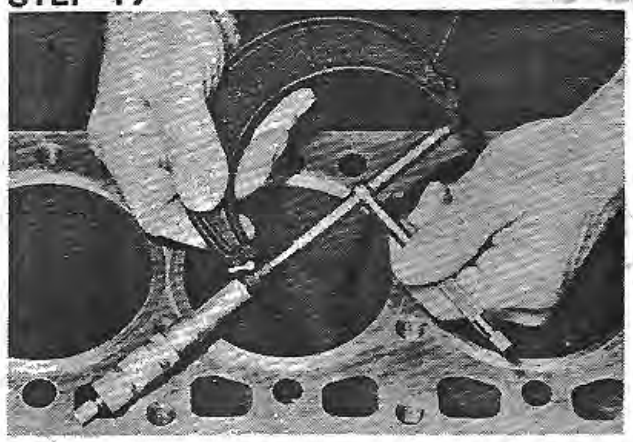
Check the cylinder sleeve for out of roundness with a bore gauge. Measure the sleeve lengthwise starting just below the top ring location.

STEP 16



Check the cylinder sleeve again for out-of-roundness, this time checking points 90° from points checked in step 15.

STEP 17



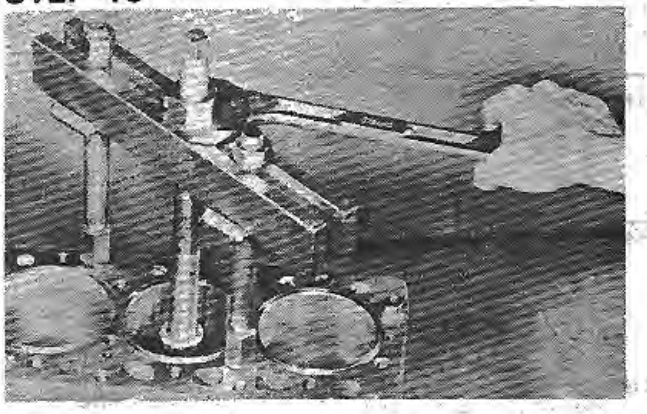
Check bore gauge with a micrometer. If out of roundness exceeds .001", the cylinder sleeve must be replaced.

Cylinder Sleeve Removal and Installation

STEP 18

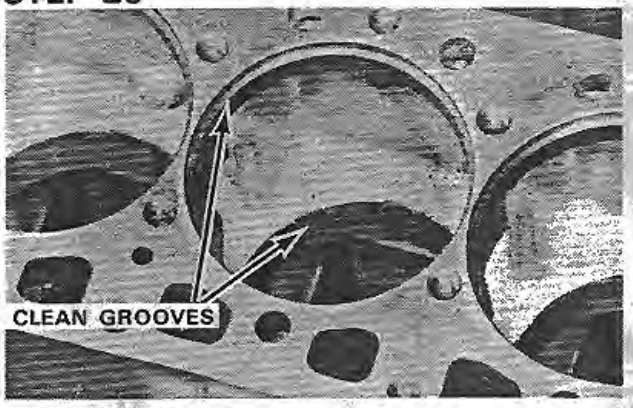
Number the cylinder sleeves & also mark them for position with paint in relation to the block, if the same sleeves are going to be re-installed. Use a sleeve puller to remove cylinder sleeves.

STEP 19



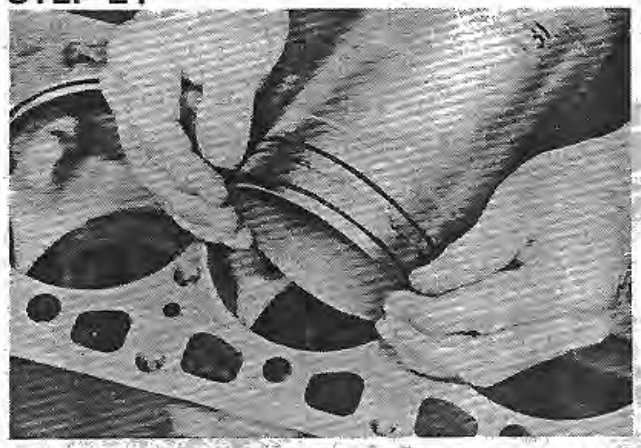
IMPORTANT: Before removing cylinder sleeves, cover the crankshaft and main bearings to prevent sediment from the block, damaging these parts.

STEP 20



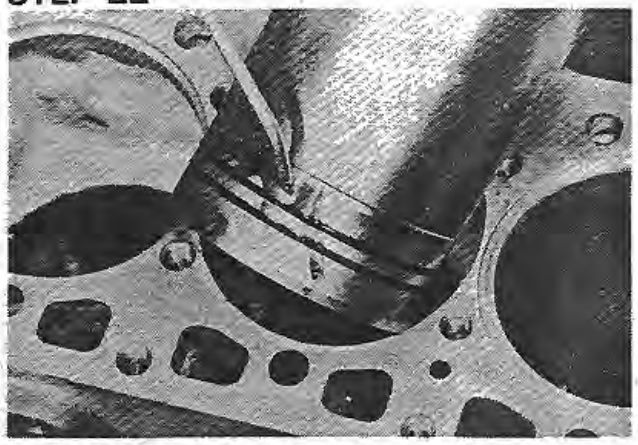
Clean the upper and lower grooves in the block.

STEP 21



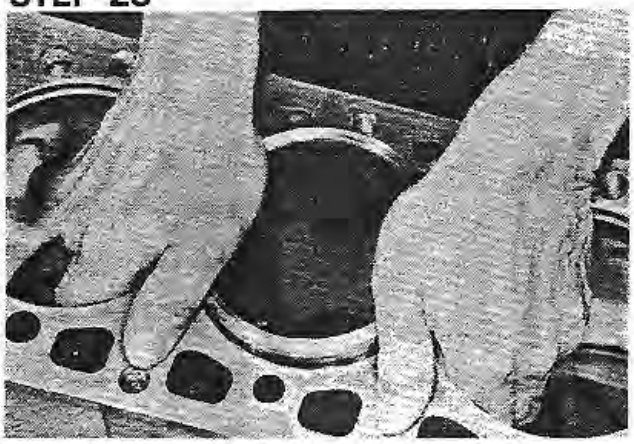
Install new "O" rings into grooves on the bottom of the cylinder sleeves.

STEP 22



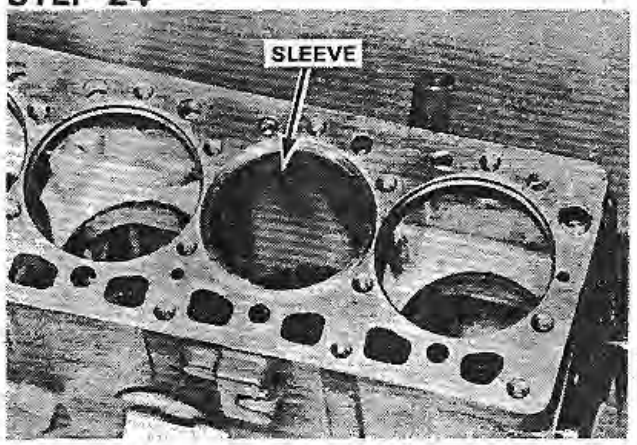
Lubricate the "O" rings with HDM #30 oil before installing sleeve into engine block.

STEP 23



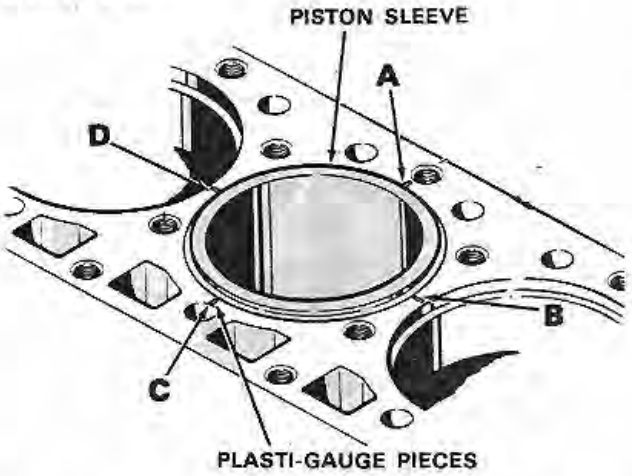
Press the sleeves into the block being careful not to damage the "O" rings. Do not rotate the sleeves during installation. Old sleeves must be installed in the same position and location as they were prior to removal.

STEP 24



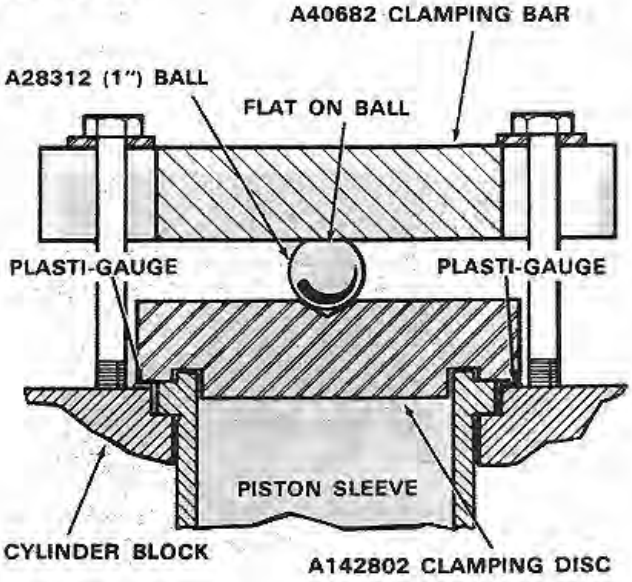
Cylinder sleeve installed.

STEP 25



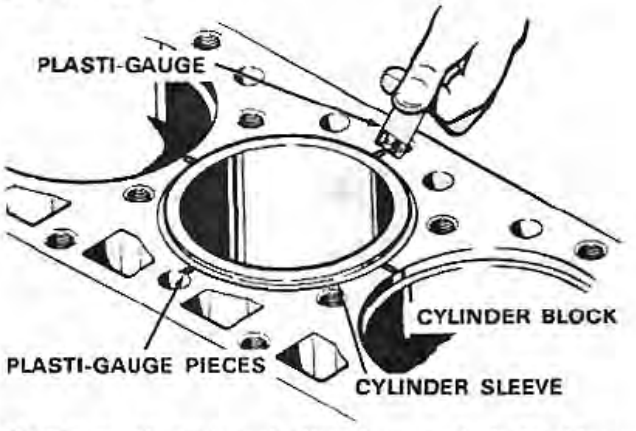
Measure sleeve protrusion at points A,B,C and D, using plasti-gauge. Place a .001" to .003" plasti-gauge in four positions on the cylinder block as shown. *NOTE:* The plasti-gauge must not protrude onto the cylinder sleeve flange.

STEP 26



Install clamping disc A142802 carefully over the cylinder sleeve. Install 1" ball A28312 (with flat side up) and clamping bar A40682. Torque the hold down bolts evenly to 50 ft. lbs.

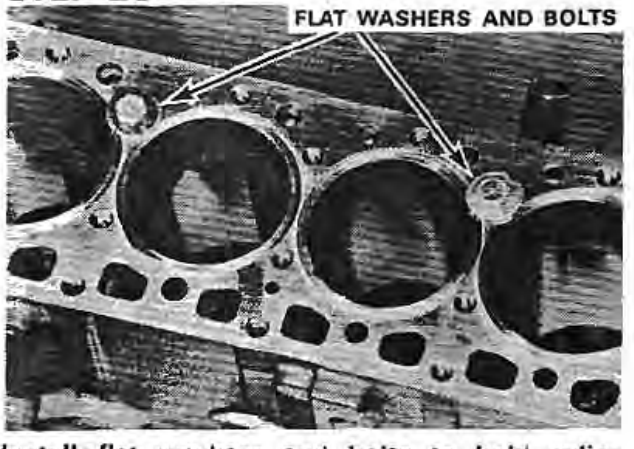
STEP 27



Remove clamping bolts, bar and ball. Very carefully remove clamping disc being careful not to disturb plasti-gauge pieces. *NOTE:* Plasti-gauge pieces will stick to either the clamping disc or cylinder block. Before disturbing the plasti-gauge pieces, they should be measured and recorded. Sleeve protrusion must not exceed .005". If sleeve protrusion varies more than .005" around circumference, change that sleeve and check again.

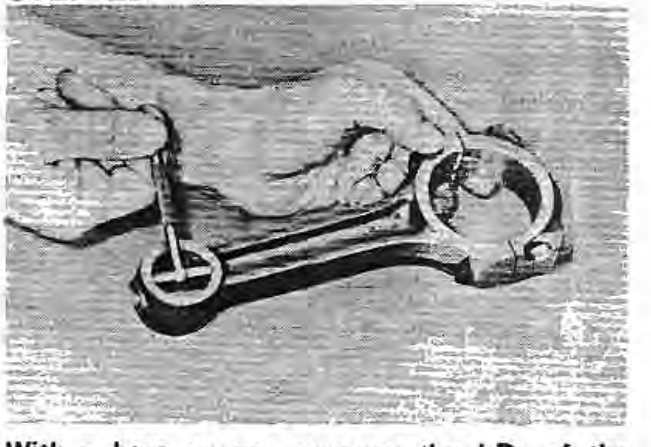
Piston and Connecting Rod Inspection and Installation

STEP 28



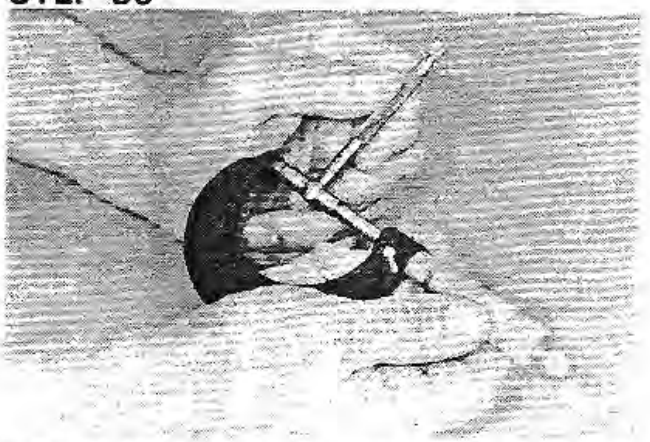
Install flat washers and bolts to hold cylinder sleeves in position.

STEP 29



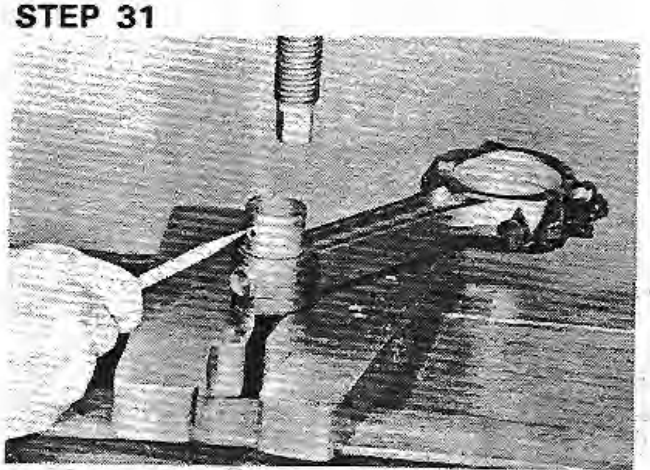
With a bore gauge, measure the I.D. of the connecting rod bushing for wear and out-of-roundness.

STEP 30



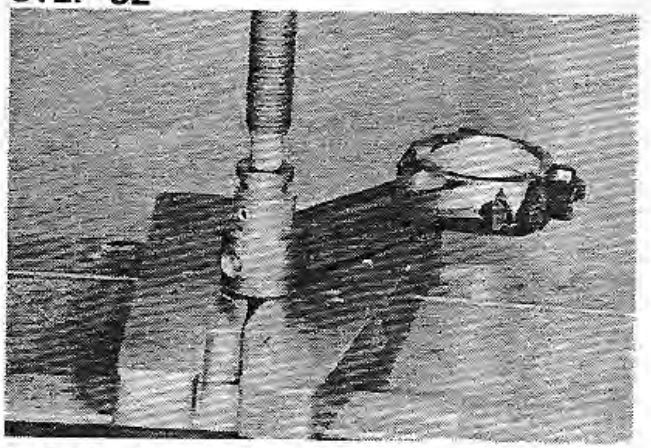
Measure the bore gauge with a micrometer. If the bushing I.D. measurement is greater than 1.2510", the bushing must be replaced.

STEP 31



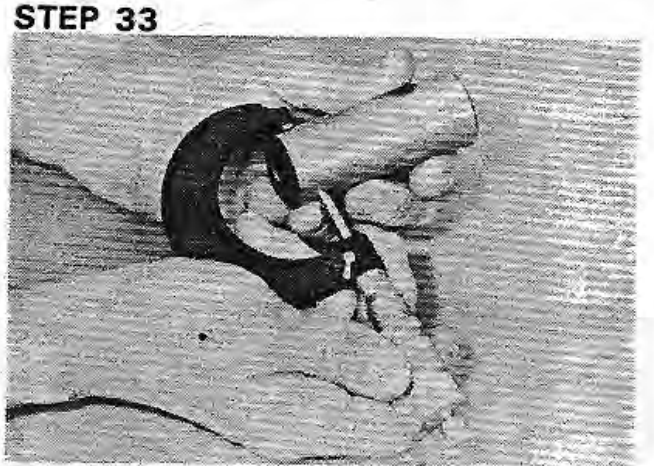
Align the oil hole in bushing with oil hole in connecting rod before pressing in new bushing.

STEP 32



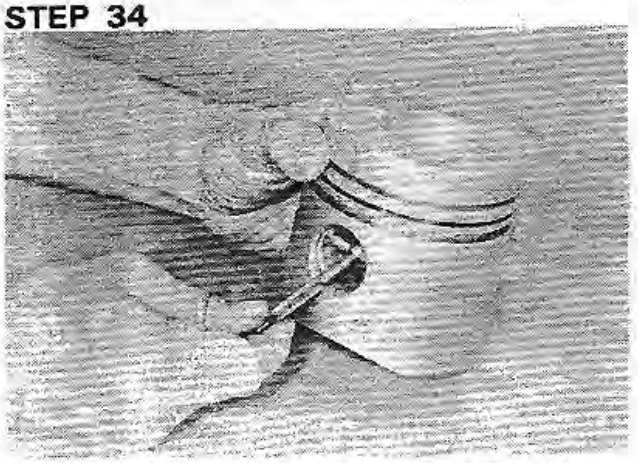
Press bushing into connecting rod until it is flush with rod. Ream bushing 1.2502" to 1.2504" if new piston pins are to be installed. *NOTE:* If a new piston pin is not being installed, ream the bushing .0004" to .0015" larger than piston pin diameter.

STEP 33



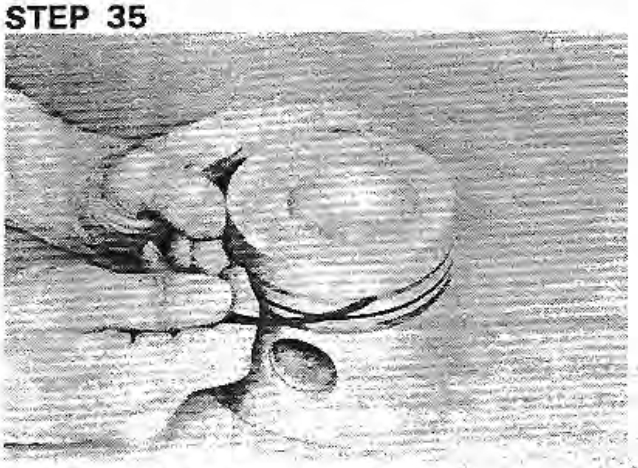
Using a micrometer, measure the piston pin diameter. If outside diameter of pin is less than 1.2495", replace the piston pin.

STEP 34



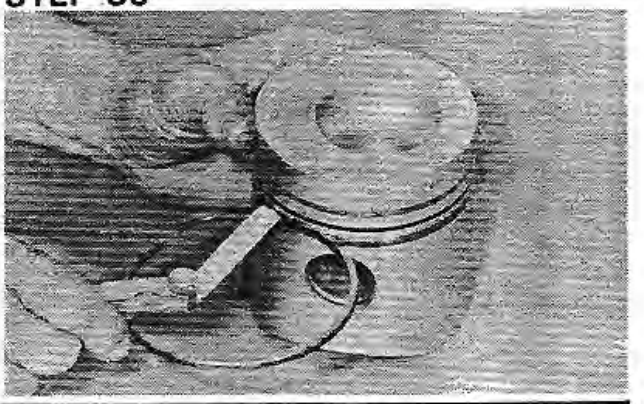
Measure the piston pin bore in the piston in two places, 90° apart, using a bore gauge. If the bore I.D. is greater than 1.2508", the piston must be replaced.

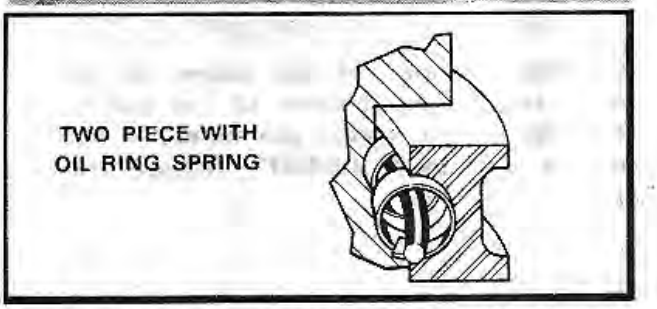
STEP 35



Break an old piston ring in half and clean the piston ring grooves.

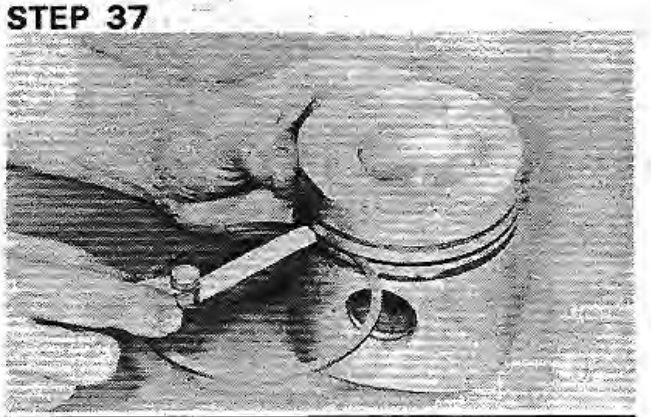
STEP 36

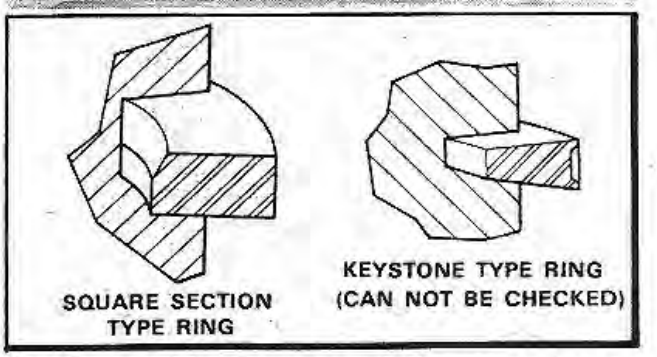




Check the side clearance of the oil ring in the piston with a feeler gauge. If side clearance exceeds .005", replace the piston.

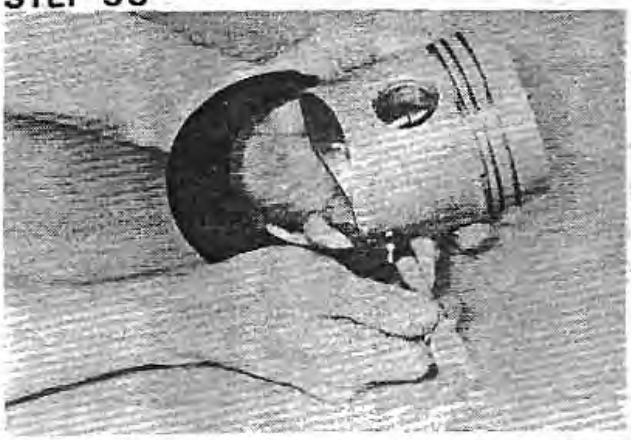
STEP 37





Check the side clearance of the second compression ring using a feeler gauge. If the side clearance exceeds .008", replace the piston. *NOTE:* The top ring is a keystone type ring and cannot be checked for side clearance.

STEP 38

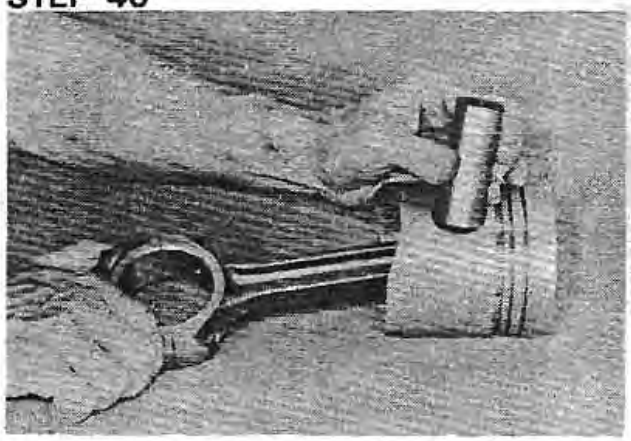


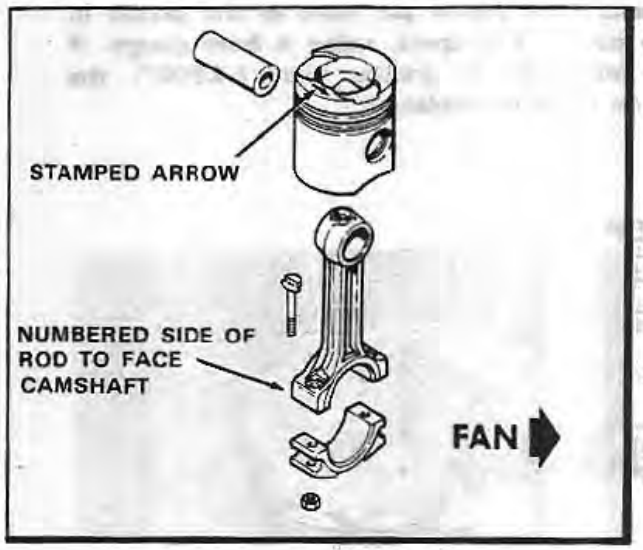
Measure the diameter of the piston across the thrust face at the bottom of the piston, perpendicular to the piston pin holes. If the diameter is less than 3.9940", replace the piston.

STEP 39

Clean the piston oil holes with a small drill or fine wire.

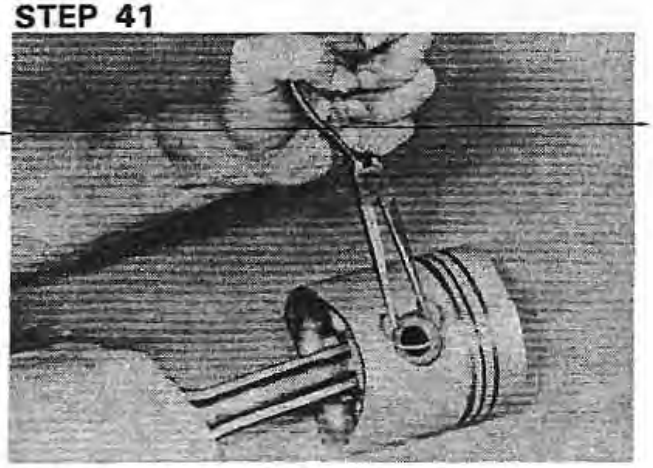
STEP 40





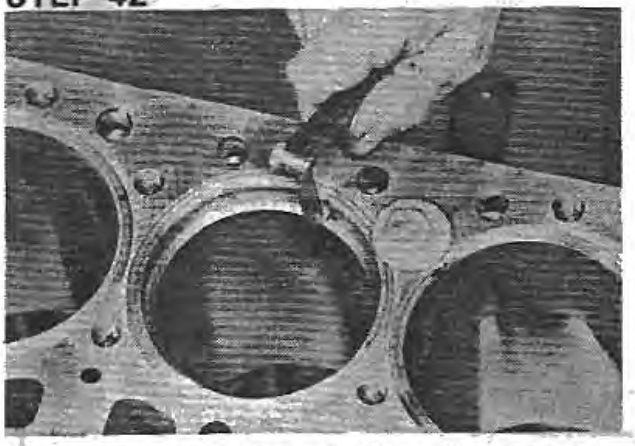
Assemble the connecting rod to the piston. Make sure the numbered side of rod is towards the arrow side of piston. Use hand pressure only to install the piston pin.

STEP 41



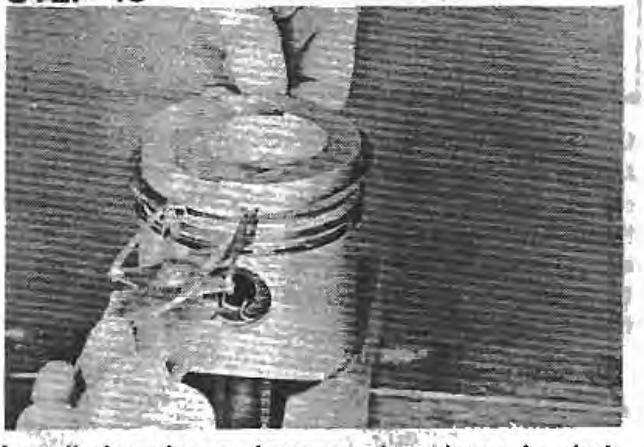
Install the piston pin retaining rings.

STEP 42



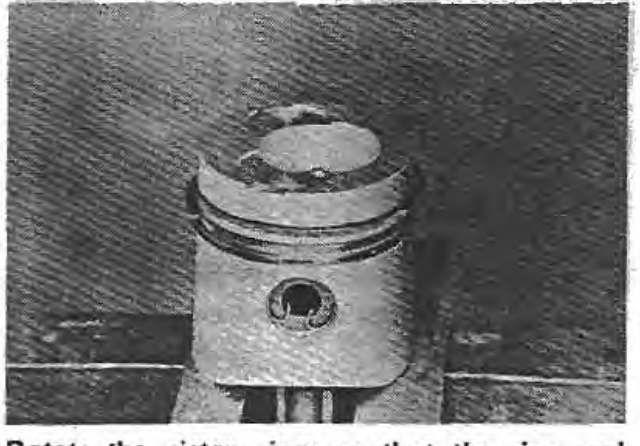
Place the piston rings in the cylinder sleeve and check the end gap by using a feeler gauge. If the end gap of the No. 1 compression rings is more than .035", replace the rings. If the end gap of the No. 2 compression rings and of the No. 3 oil control rings is more than .033", replace the rings.

STEP 43



Install the piston rings on the piston in their respective grooves, using a ring expander.

STEP 44

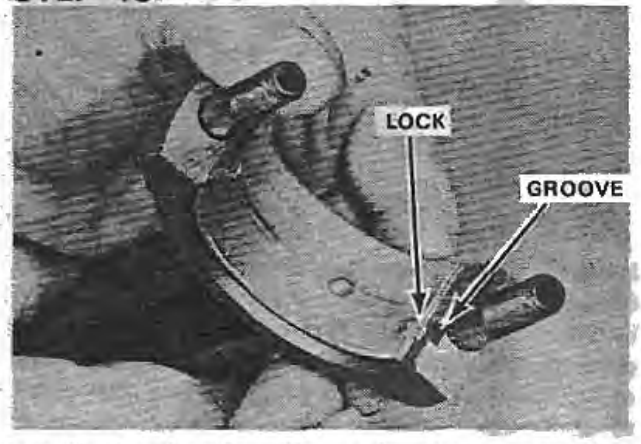


Rotate the piston rings so that the ring end gaps are 120° apart.

STEP 45

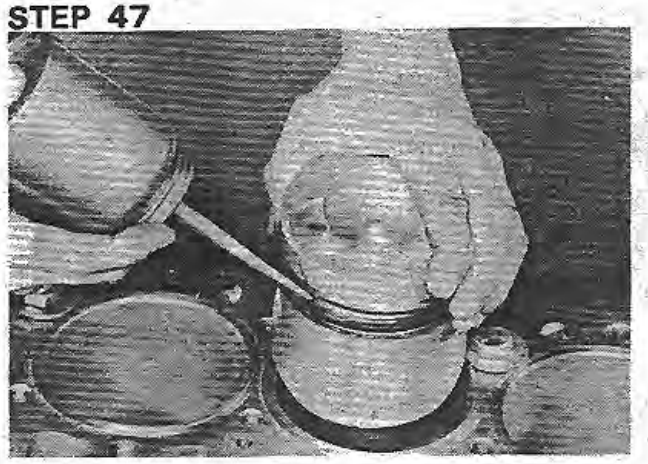
Measure the connecting rod journals on the crankshaft with a micrometer. Measure the front and rear of each journal, checking the taper. If taper exceeds .001", the journals must be refinished. Recheck the rod journals, 90° from the first measurements for out-of-roundness. If out-of-roundness exceeds .0005", the journals must be refinished.

STEP 46



Install the bearing liners in the connecting rods. Make sure that the lock of the bearing liner engages the lock groove of the connecting rod. Slide liner into place, do not push in on center of liner.

STEP 47

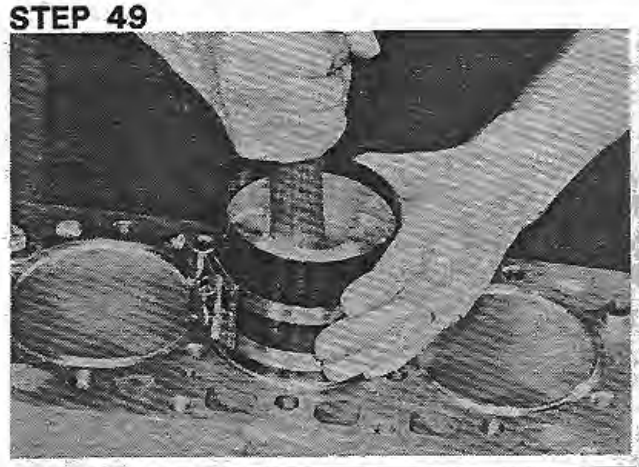


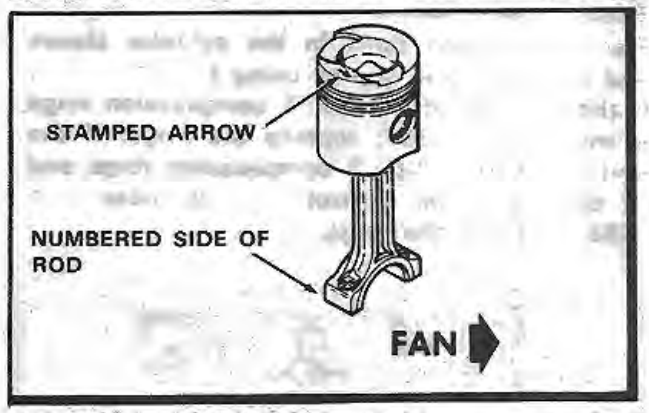
Lubricate cylinder sleeves and piston assemblies with HDM #30 oil.

STEP 48

Install a ring compressor on the piston. *NOTE:* Make sure the piston rings are seated fully in the grooves before tightening the ring compressor. Tighten the ring compressor a little at a time, making sure the rings are free to compress.

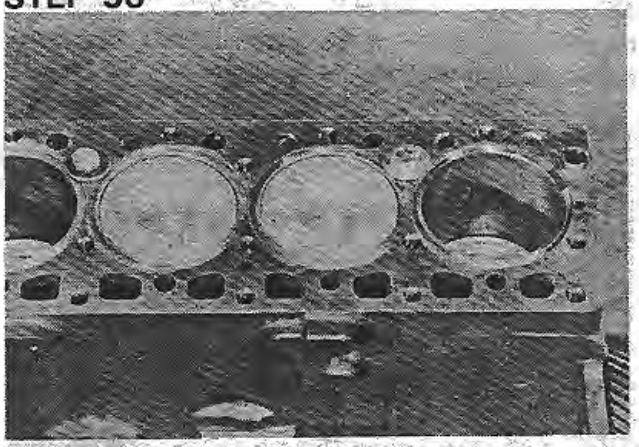
STEP 49





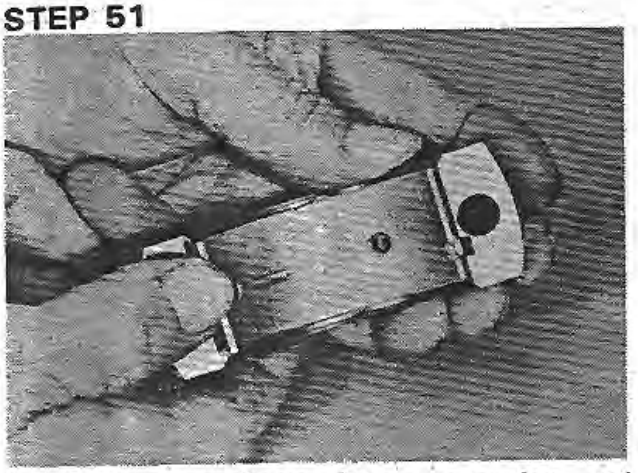
Gently tap the piston down into the block. *IMPORTANT:* Make sure the stamped arrow on top of the piston is pointed towards the front of the engine. The connecting rods are numbered consecutively 1 through 4 on the bearing end of the rods. The numbers must face the camshaft.

STEP 50



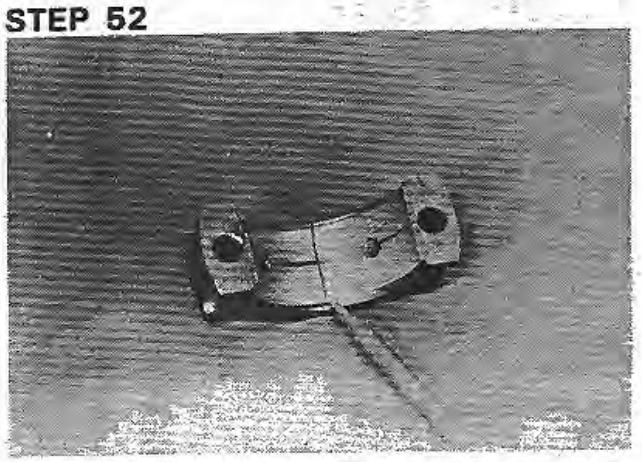
Pistons installed in engine block.

STEP 51



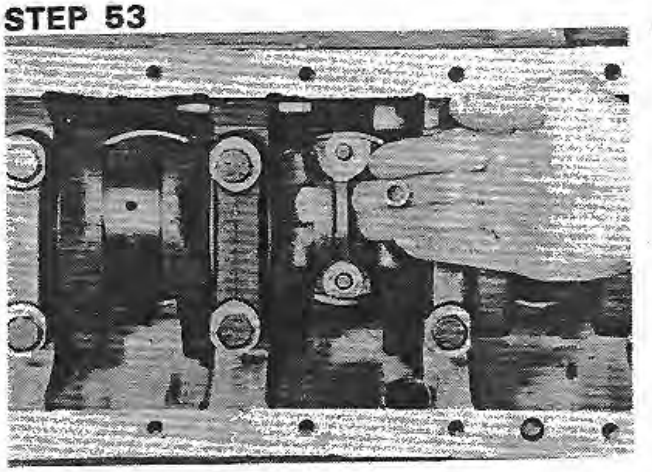
Install bearing liners into connecting rod bearing caps. *NOTE:* Make sure the bearing liner lock aligns with the lock groove in the bearing cap. Use a sliding type movement when installing liners; never press on center of liners.

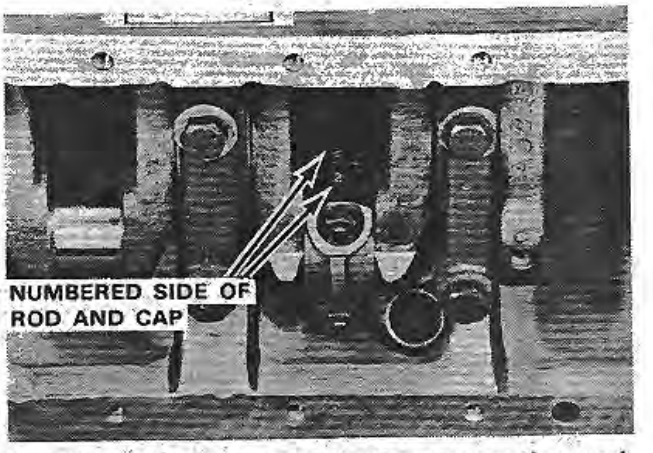
STEP 52



Clean the connecting rod journals and the bearing liners in the bearing caps. Place a piece of plasti-gauge on the bearing cap liner.

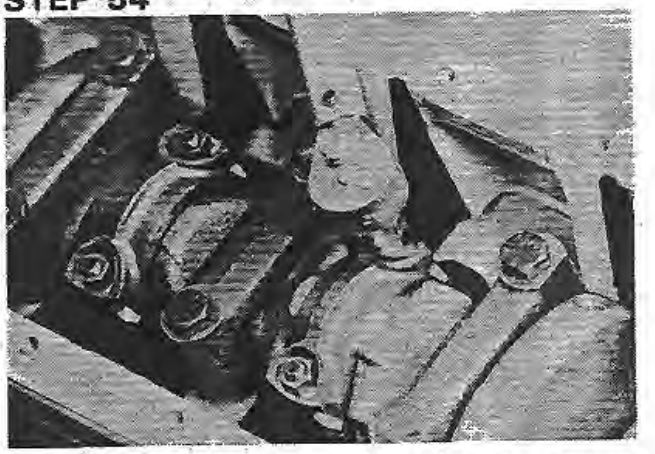
STEP 53





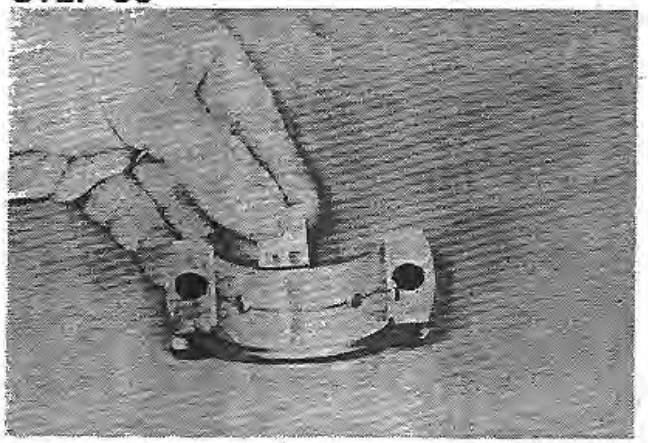
Install bearing liner cap to the connecting rod. Retain in place with mounting nuts. *NOTE:* Make sure the number on the bearing cap matches the number on the connecting rods.

STEP 54



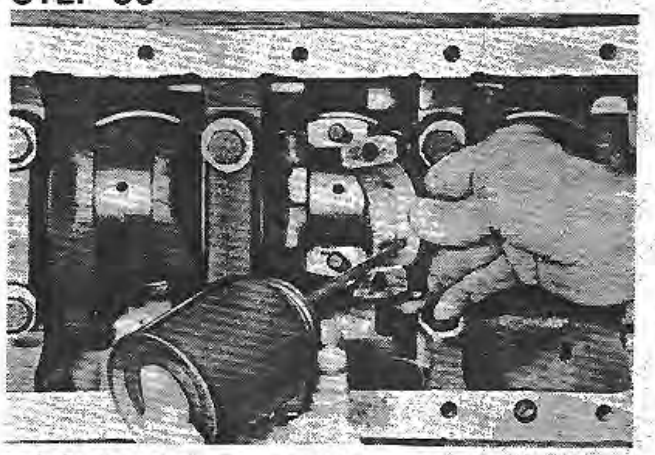
Torque the connecting rod bearing cap mounting nuts 45 to 50 ft. lbs.

STEP 55



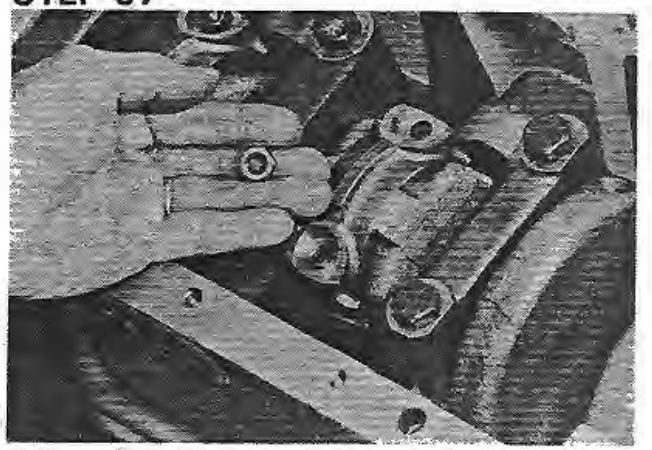
Remove the bearing caps and measure the spread out plasti-gauge which will be found either on the cap or the crank journal. Clearance must be between .0010" to .0040". If clearance exceeds .0040", undersize bearing liners must be installed and bearing journals must be reground.

STEP 56



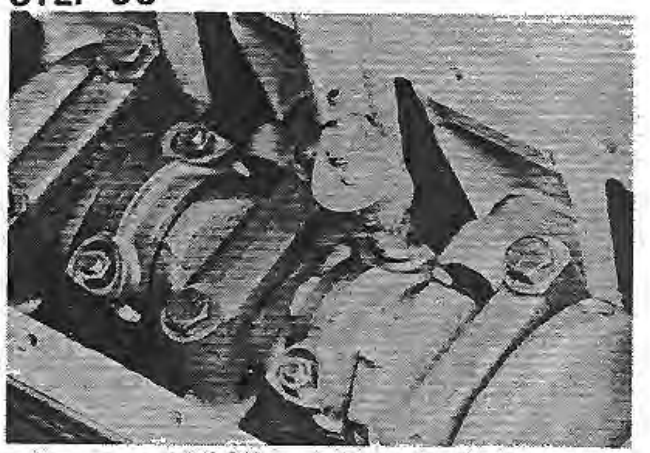
Lubricate the connecting rod bearing cap liners and rod journals with HDM#30 oil.

STEP 57



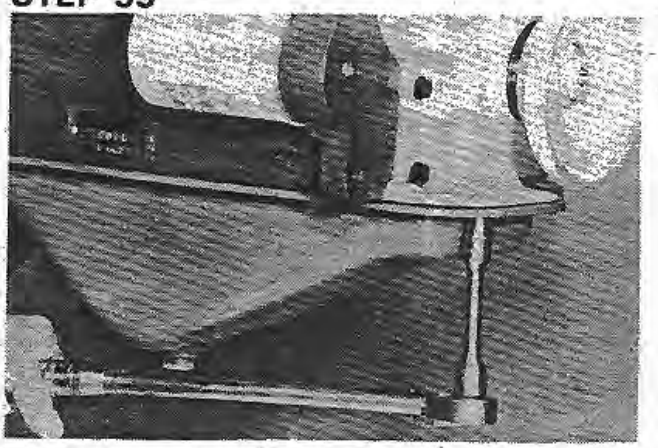
Reinstall bearing caps with matched numbers on rods toward camshaft and secure with mounting nuts.

STEP 58



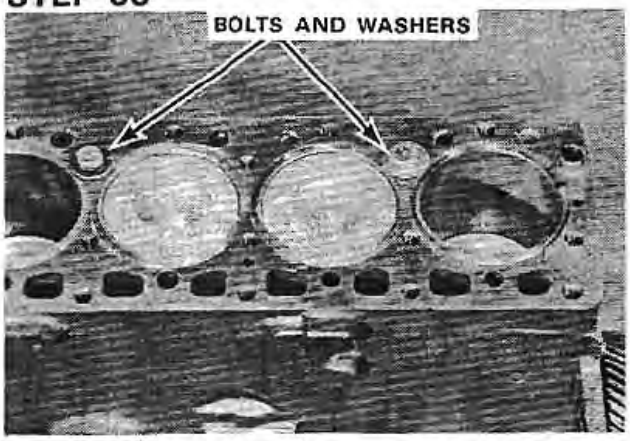
Torque mounting nuts 45 to 50 ft. lbs.

STEP 59



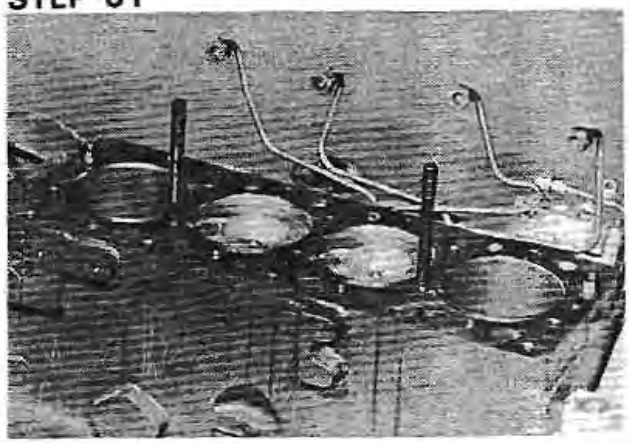
Install the engine oil pan and new gasket. Torque retaining bolts 10 to 12 ft. lbs.

STEP 60

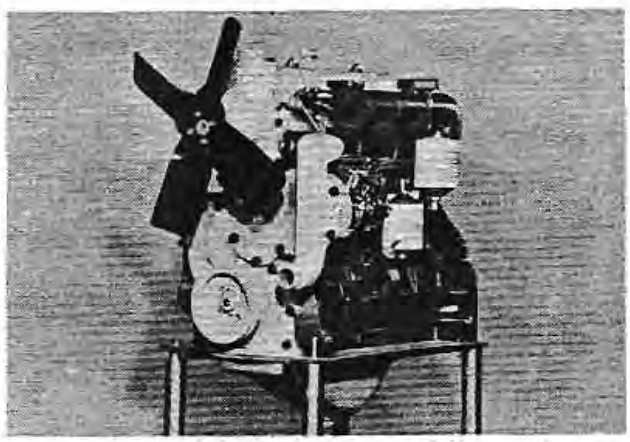


Remove the bolts and washers retaining the cylinder sleeves in place.

STEP 61



Install cylinder head and manifolds. Refer to Section 2015.



207 DIESEL ENGINE

Section 2555

ENGINE LUBRICATION

188 and 207 Diesel Engines

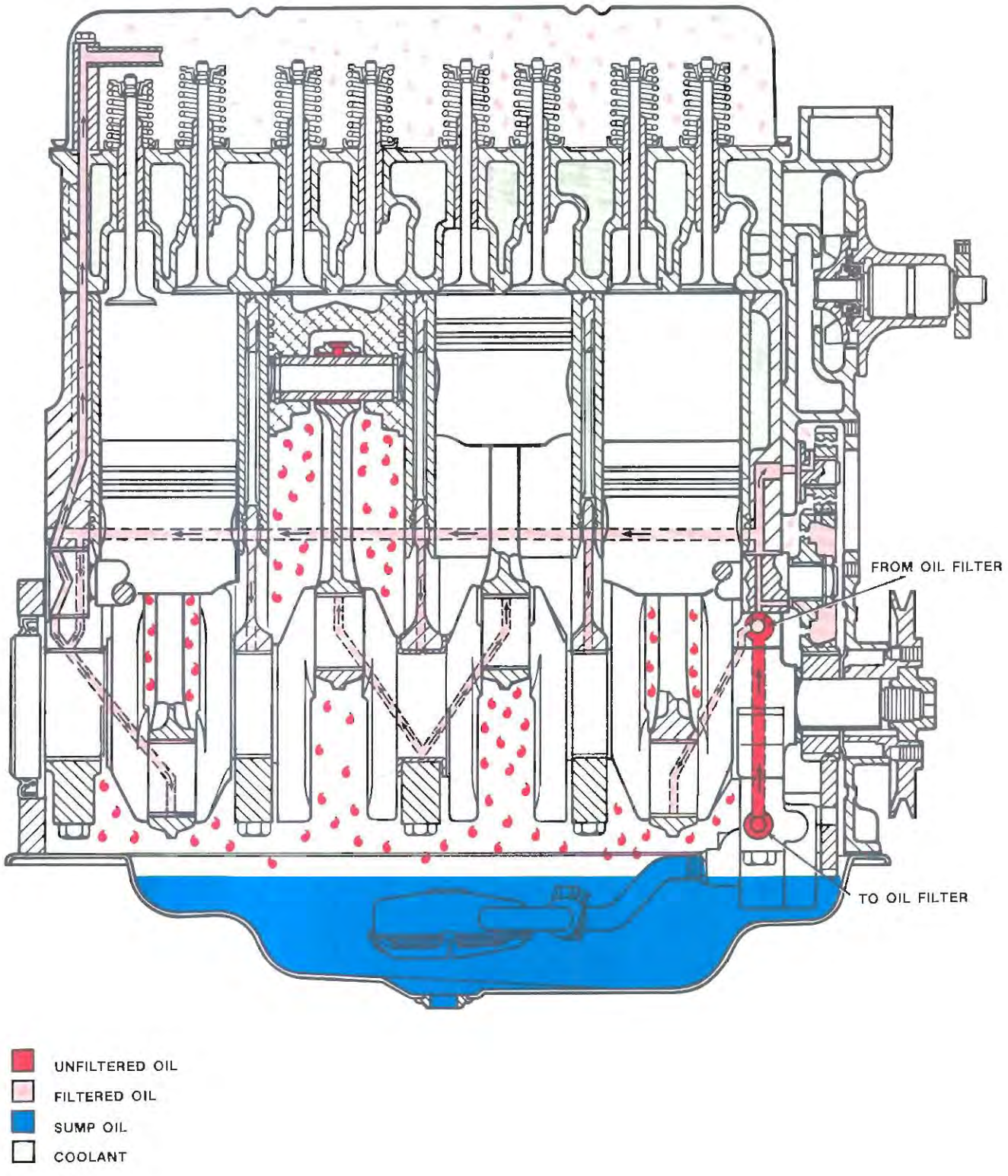
J I Case
A Tenneco Company

TENNECO

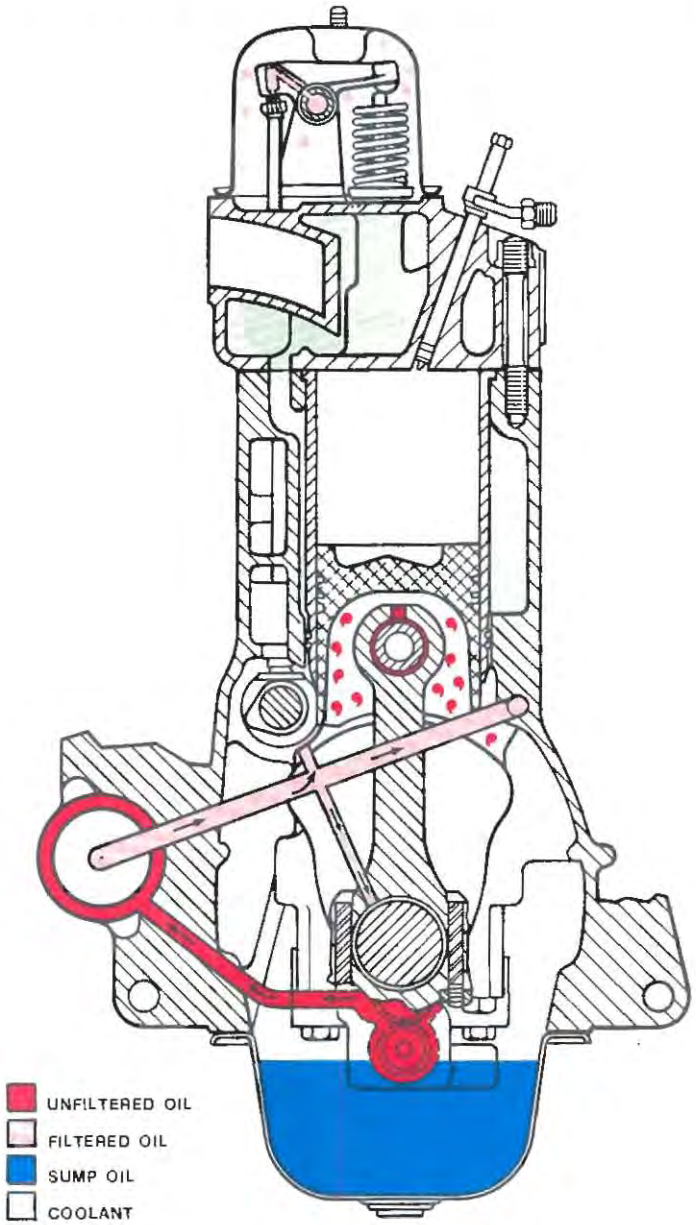
Rac. 9-78985

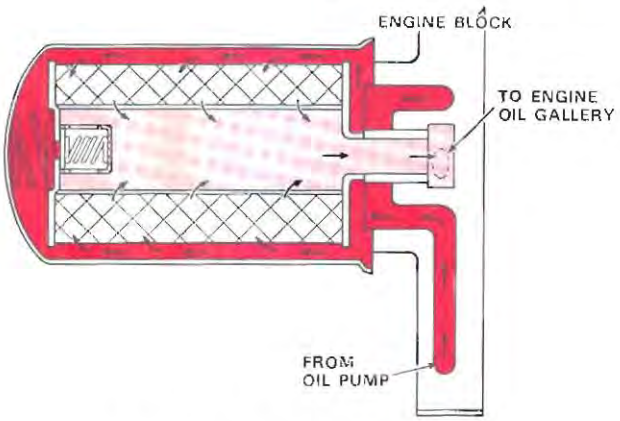
PRINTED IN U.S.A.

ENGINE LUBRICATING OIL AND COOLANT SYSTEM

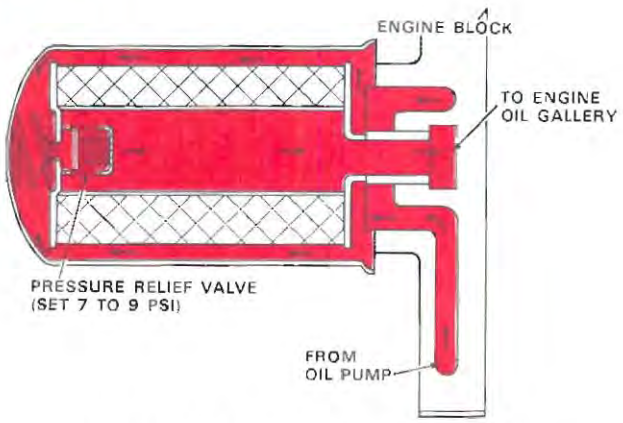


ENGINE LUBRICATING OIL AND COOLANT SYSTEM





CLEAN OIL FILTER

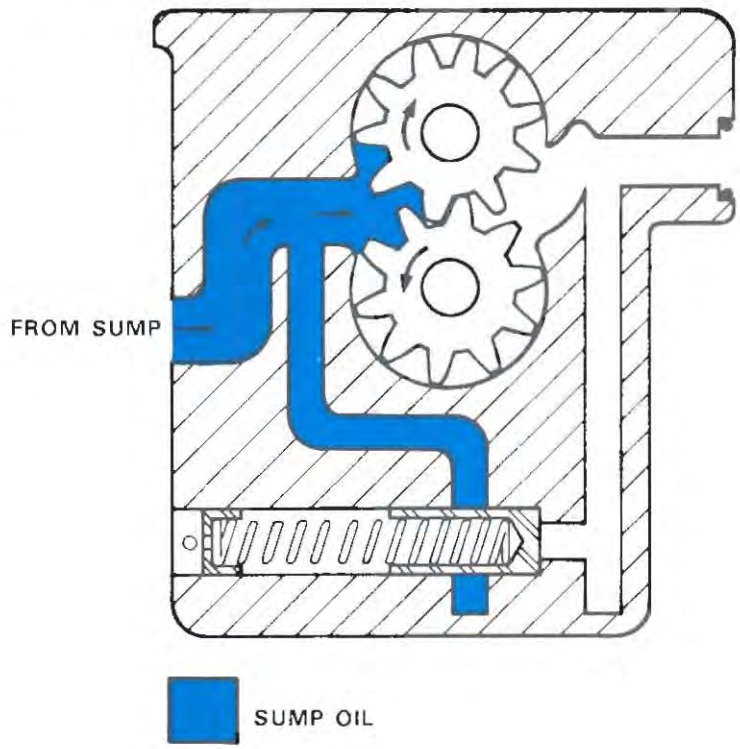


PLUGGED OIL FILTER

ENGINE OIL PUMP FLOW

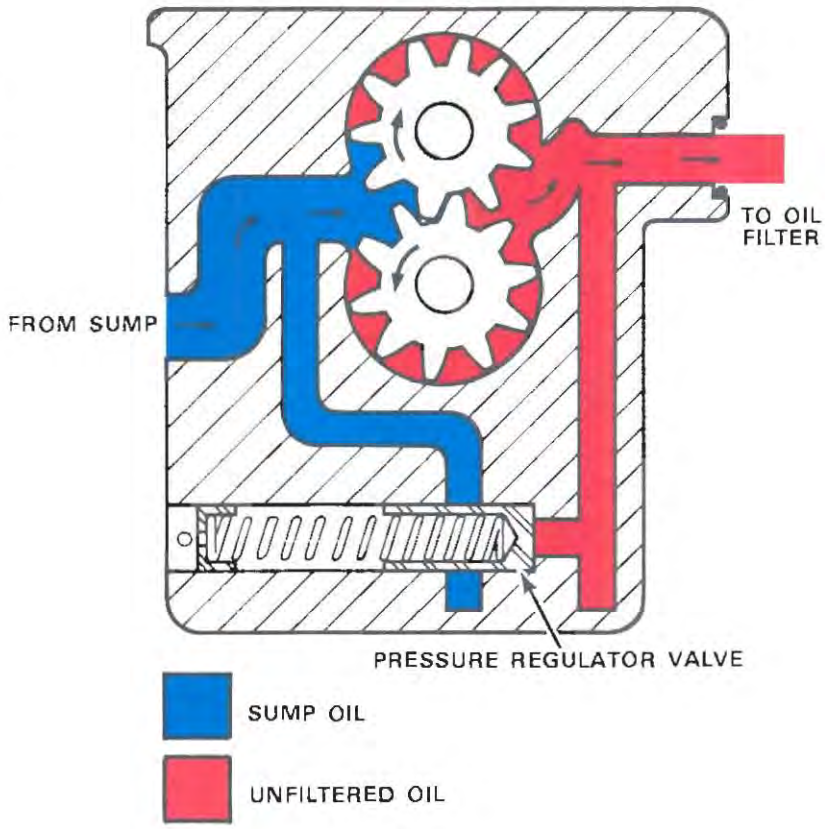
STEP 1

Oil is drawn from the engine oil sump by the pump gears through the suction pickup tube and enters the pump cavity.



STEP 2

The oil is forced by the pump gears through internal passages to the pressure relief valve where it dead heads. The oil then flows to the engine oil filter.

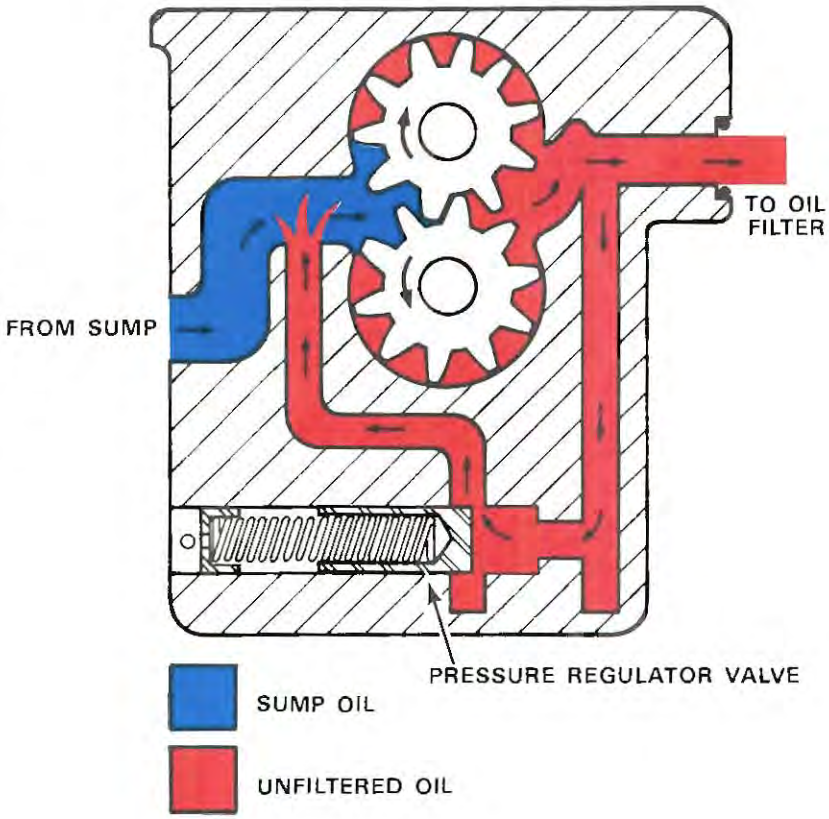


ENGINE OIL PUMP FLOW

STEP 3

As the oil pressure builds up within the engine oil galleries, the pressure is sensed at the pump. This pressure is then exerted on the back side of the pressure regulator sleeve. As pressure builds up to 50 to 75 PSI, the regulator sleeve is moved, opening an internal passage to the inlet side of the pump cavity.

Should the oil pressure drop below 50 to 75 PSI, the regulator spring moves the sleeve back, closing off the passage to the inlet side the pump cavity.



Section
3010

FUEL SYSTEM AND FILTERS
188 AND 207 DIESEL ENGINES

J I Case
A Tenneco Company

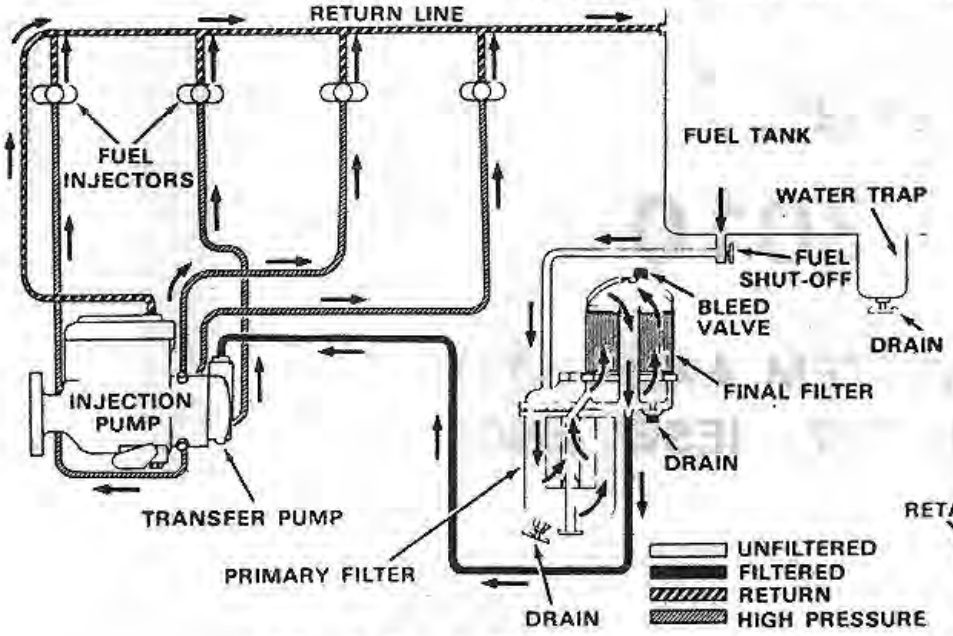
TENNECO

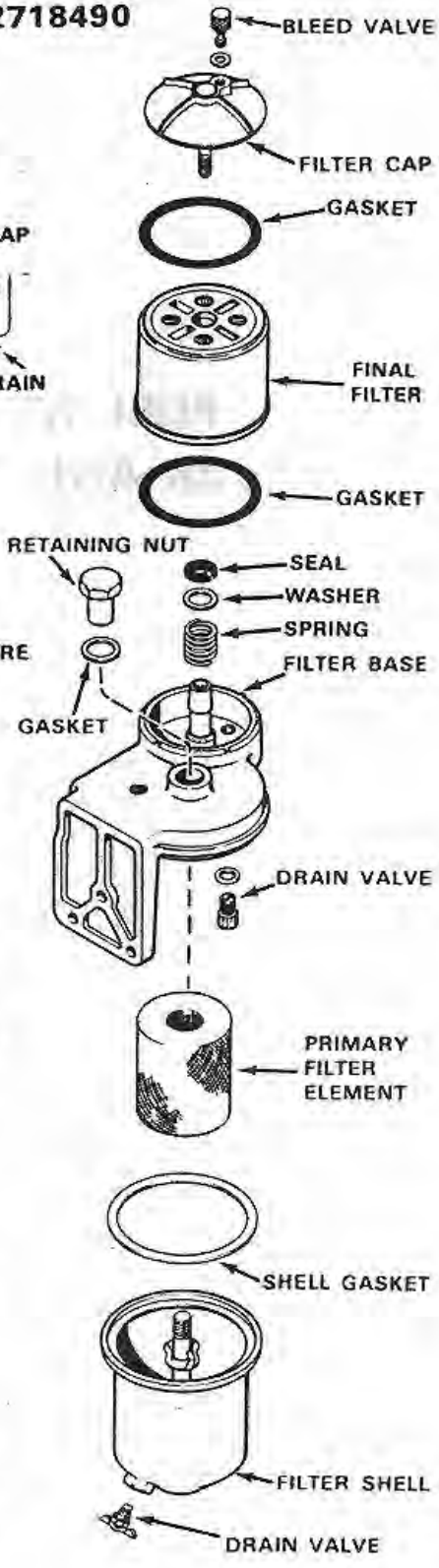
Rac. 9-78785

PRINTED IN U.S.A.

SERVICING THE DIESEL FUEL FILTERS

PRIOR TO ENGINE SERIAL NO. 2718490





Final Fuel Filter

Filter Replacement (Final and Primary) ..... Every 500 Hours or earlier when loss of engine horsepower is indicated.

Clean the filter side of the engine thoroughly. Be sure no dirt is left on the filter bodies.

Close the fuel shut-off valve on the fuel tank. Open the drain valves on the primary filter shell and final filter base.

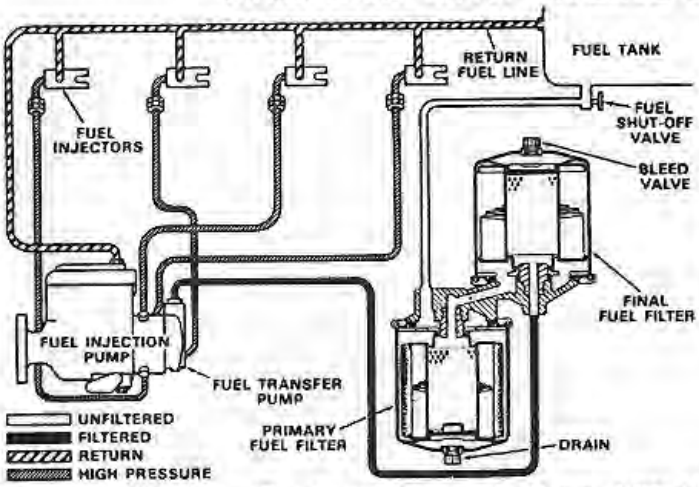
1. Loosen the filter cap until the element and cap can be removed.
2. Install a new Genuine Case Filter, new gaskets and place with the 3/4" hole in the filter down onto the filter base.
3. Install and tighten cap.
4. Close the drain valve.

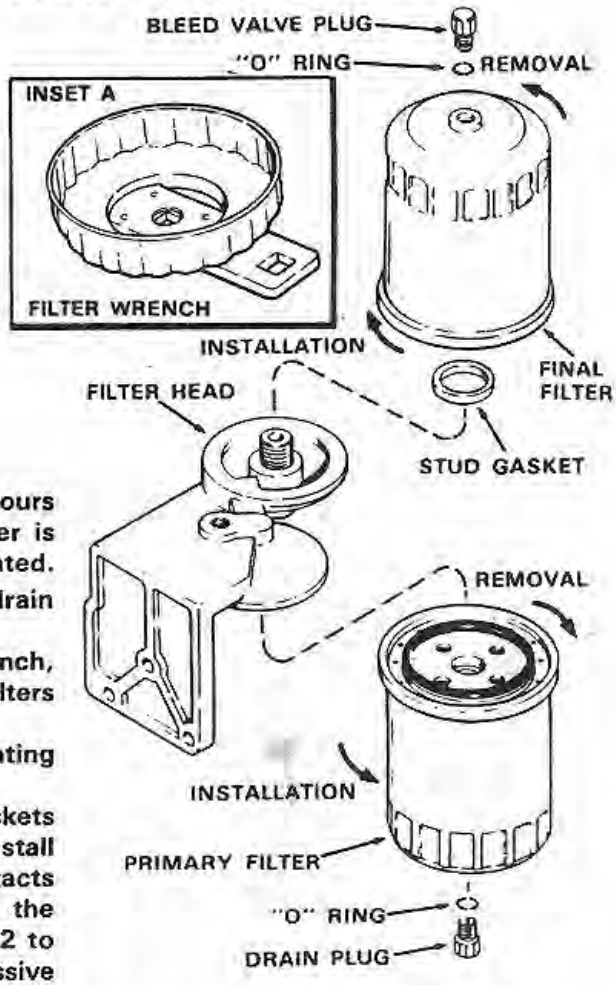
Primary Fuel Filter

1. Loosen the filter shell retaining nut until the filter shell can be removed.
2. Lift the contaminated element out of the filter shell and discard it.
3. Wash the filter shell in clean diesel fuel.
4. Install a new Genuine Case Filter Element in the shell and new shell gasket. Check the filter shell retaining nut gasket. Replace if necessary.
5. Install shell assembly on filter base and tighten the retaining nut.
6. Close the drain valve.
7. Bleed the system and check for leaks.

SERVICING THE DIESEL FUEL FILTERS

STARTING WITH ENGINE SERIAL NO. 2718490

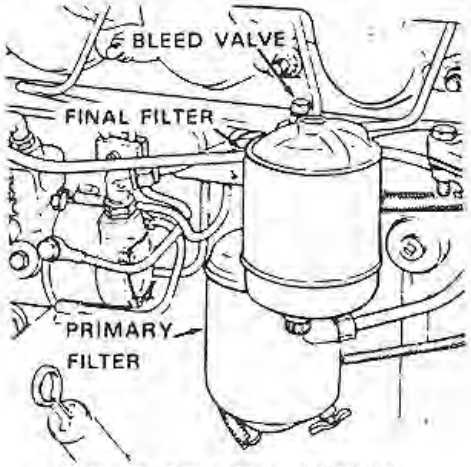




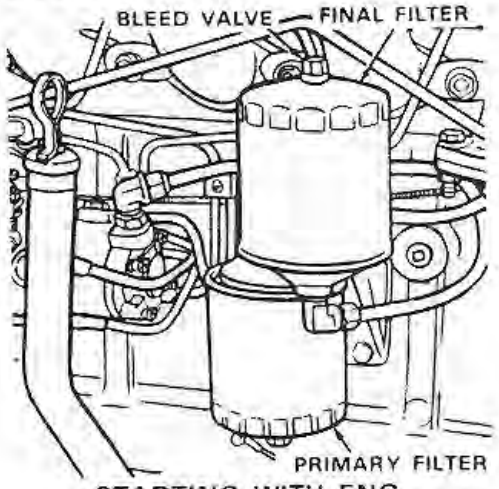
Filter Replacement (Final and Primary) - Every 500 Hours or earlier when loss of engine horsepower is indicated.

1. Close the fuel tank shut-off valve and remove the drain plug from the primary fuel filter.
2. Use a clamp type filter wrench or the filter wrench, A64761 Inset A, to remove the filters. Turn the filters counter-clockwise for removal.
3. Remove the stud gasket from the final filter mounting stud and install a new gasket.
4. Apply a thin film of clean oil or grease to the gaskets on the new primary and final stage Case filters. Install the filters by turning clockwise until the gasket contacts the filter head. Hand tighten 1/2 of a turn. Loosen the filters and retighten after gasket contact is made, 1/2 to 3/4 of a turn to obtain a proper seal. *NOTE:* Excessive final tightening will damage the gaskets and filters.

SEQUENCE FOR BLEEDING THE DIESEL FUEL SYSTEM



PRIOR TO ENG. SERIAL NO. 2718490



STARTING WITH ENG. SERIAL NO. 2718490

1. Fill the fuel tank and open the fuel tank shut-off valve.
2. Wipe the top of the final filter clean.
3. Open the bleed valve on the final filter allowing the air to bleed out of both of the filters. When fuel, free of bubbles, starts to flow, close the bleed valve and wipe the parts free of diesel fuel.

Section 3012

ROOSA MASTER
MODEL DB FUEL INJECTION PUMPS
AND
PUMP DRIVE GEAR

188 and 207 Diesel Engines

J I Case
A Tenneco Company

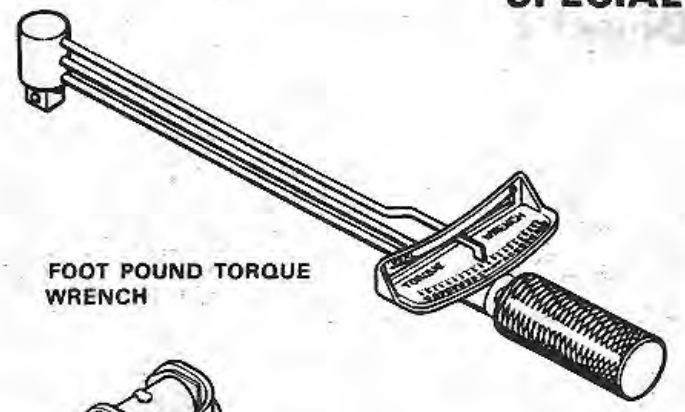
TENNECO

Rac. 9-78795

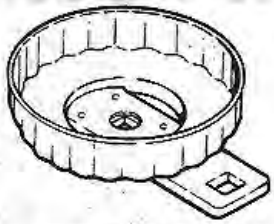
PRINTED IN U.S.A.

TABLE OF CONTENTS

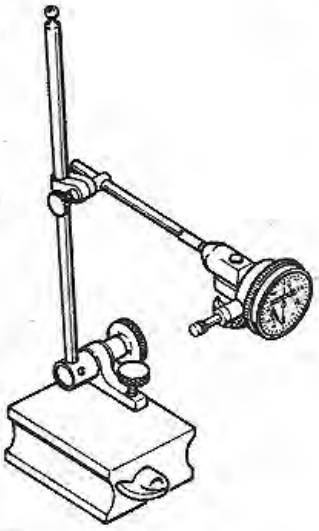
SPECIAL TOOLS



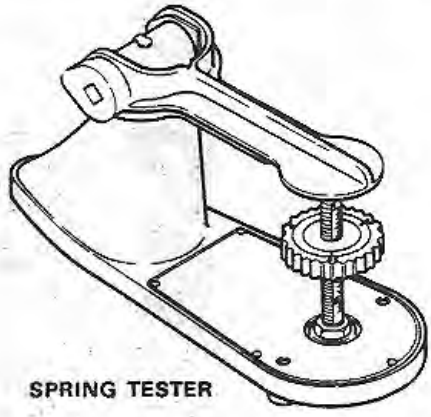
FOOT POUND TORQUE WRENCH



FILTER WRENCH A64761

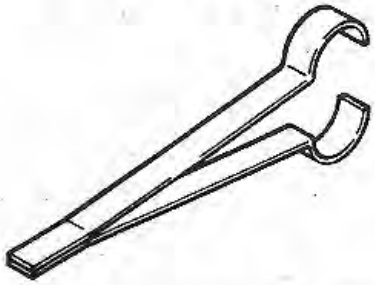


DIAL INDICATOR



SPRING TESTER

SLEEVE TOOL CD322



SEAL COMPRESSION TOOL CD331

SPECIFICATIONS

Fuel Injection Pump

	U.S. Value	Metric Value
Type	Roosa Master Model DB	
Rotation	Counterclockwise	
Mounting	Left hand side of engine	
Drive	Gear driven at 1/2 engine speed	
Governor	Centrifugal type, variable speed, flyweight, integral part of pump	
Backlash idler gear to fuel pump gear	.0005 to .007"	.013 to .178mm
Lubrication	Self lubricated by fuel	

Thrust Spring

Free length	1.22"	30.990mm
Compress to .950" (24.13mm)	6 lbs. 4 oz.	2.72 kg 113.4g

Timing

Timing marks	Located on flywheel
Timing pointer	Located on flywheel housing

SPECIAL TORQUES

Fuel pump drive gear nut	40 to 50 ft. lbs.	54 to 68 Nm
Fuel pump inlet nut	20 ft. lbs.	27 Nm
Fuel pump mounting nuts	35 to 42 ft. lbs.	47 to 57 Nm
Fuel pump high pressure line connector screws	35 ft. lbs.	47 Nm
Gear cover plate mounting bolts	25 to 30 ft. lbs.	34 to 41 Nm
Valve cover mounting nuts	4 to 6 ft. lbs.	5 to 8 Nm

GENERAL INFORMATION

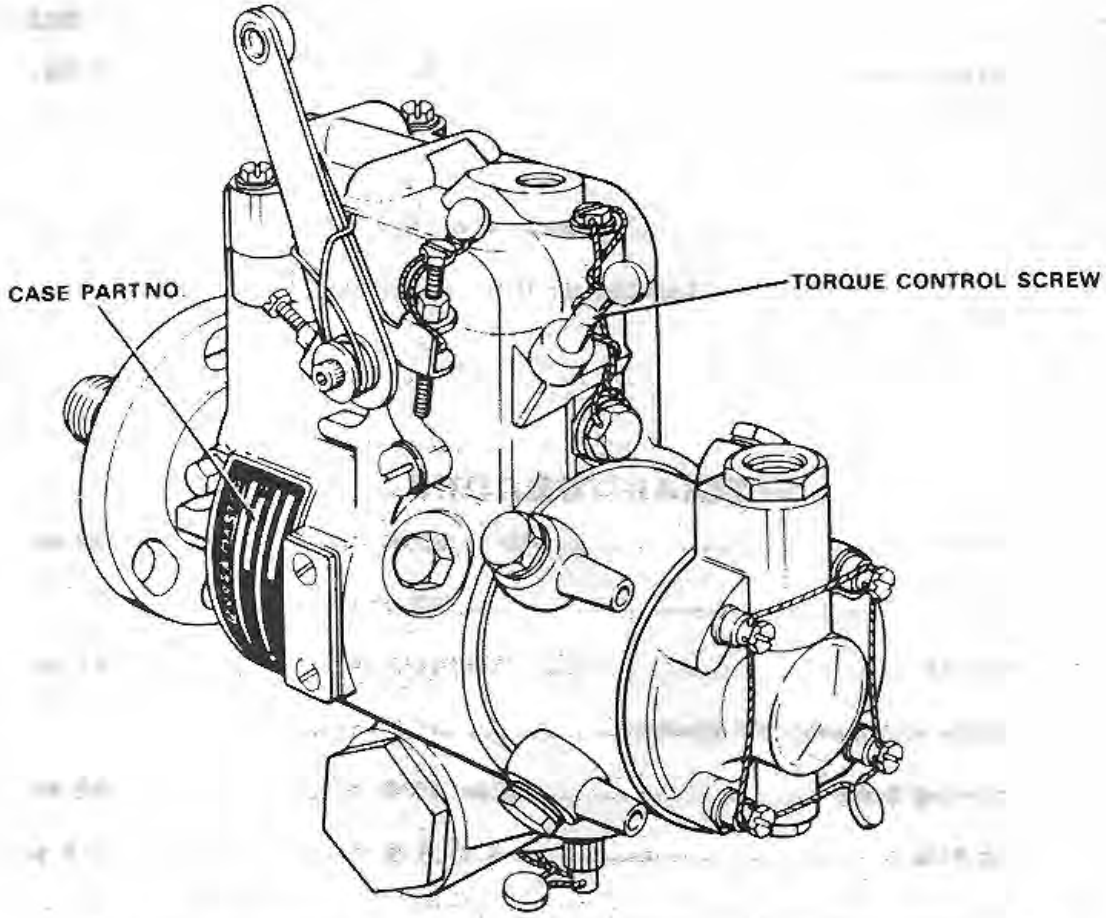
The Roosa Master Model DB fuel injection pump is an extremely compact and precision unit incorporating a high pressure injection pump, a mechanical variable speed centrifugal type governor, vane type fuel transfer pump and is self-lubricated by the fuel.

The function of the fuel pump is to deliver accurately metered quantities of fuel under high pressure to the fuel injectors. This delivery must be accomplished with accurate timing in relation to the engine firing order and for a very definite period of time in relation to load and engine speed requirements.

To meet these rigid requirements, the Model DB Injection Pump is manufactured to unusually close tolerances. While the pump cannot be considered delicate, the precision with which it is manufactured can be compared to that of a fine watch.

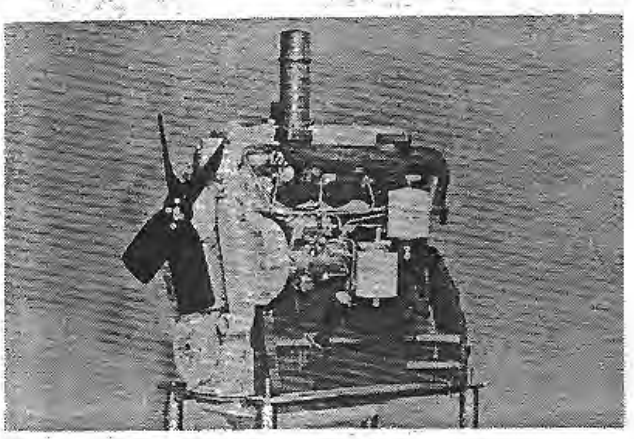
It is therefore doubly important that you take extra precautions to prevent the entry of dust or similar abrasives when you perform service work that involves the fuel injection pump or other components of the fuel system.

Some pumps are equipped with an external factory adjusted torque control screw. This screw, which is wired and sealed to prevent unauthorized changes, provides improved engine lugging ability by delivering maximum torque from rated speed down through peak torque speed.

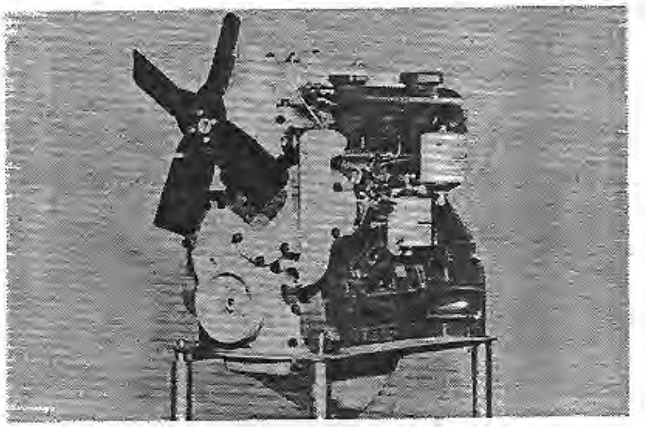


THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

FUEL PUMP REMOVAL

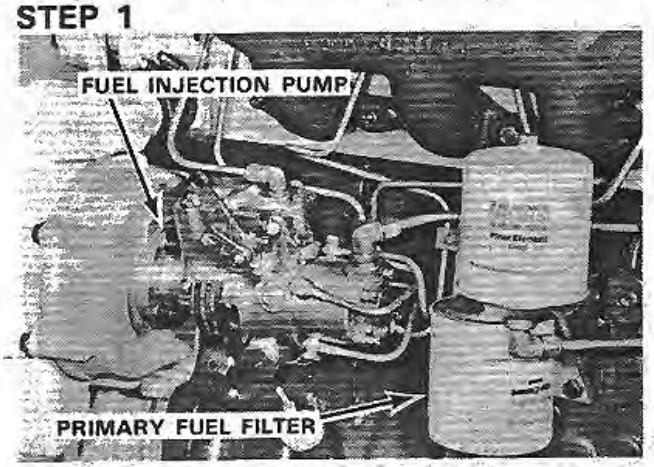


188 DIESEL ENGINE



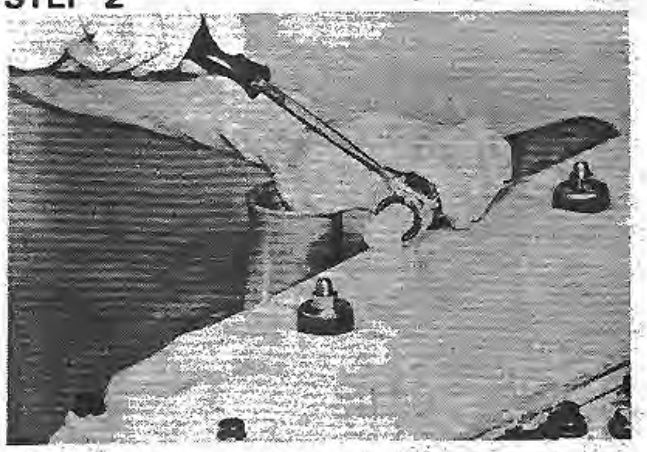
207 DIESEL ENGINE

STEP 1



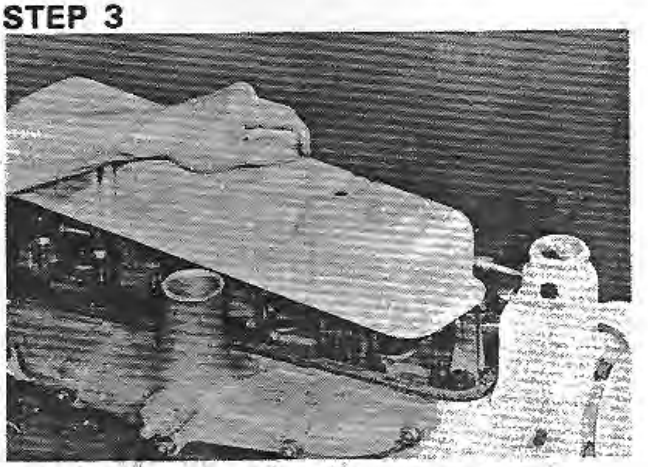
Prior to performing any service work, steam clean the engine thoroughly in the area of the fuel injection pump and lines. Close the fuel tank shutoff valve. Remove the drain plug from the primary fuel filter to drain the filters.

STEP 2



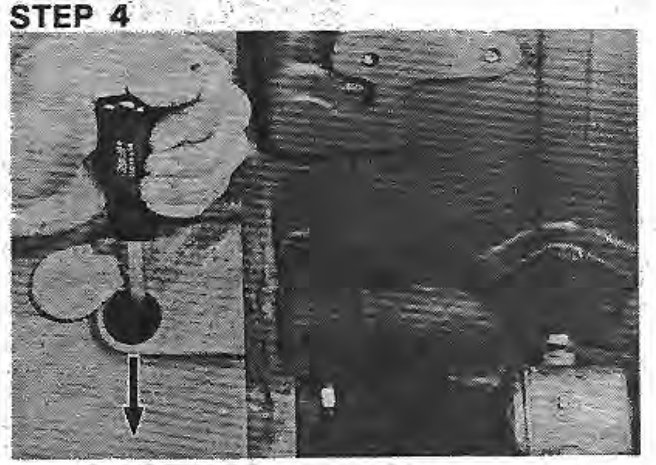
Remove the breather hose.

STEP 3



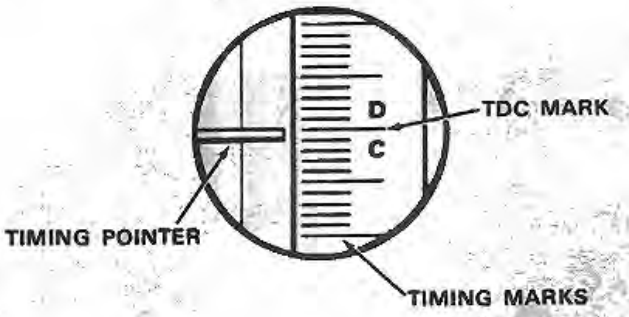
Remove valve cover from cylinder head.

STEP 4

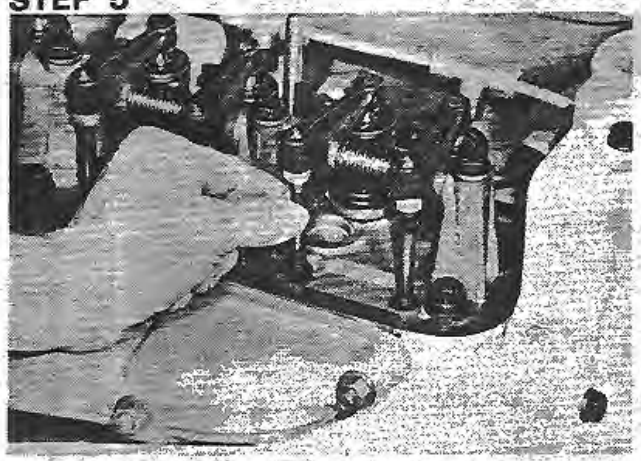


Crank engine clockwise until TDC mark on flywheel is in line with timing pointer as seen through the flywheel housing timing hole.

STEP 4 (CONT)

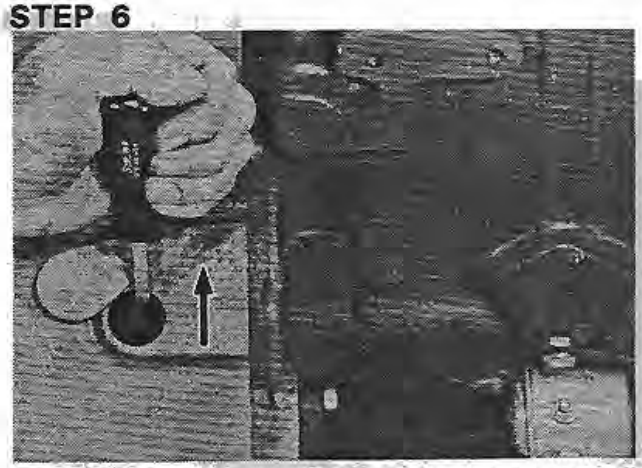


STEP 5



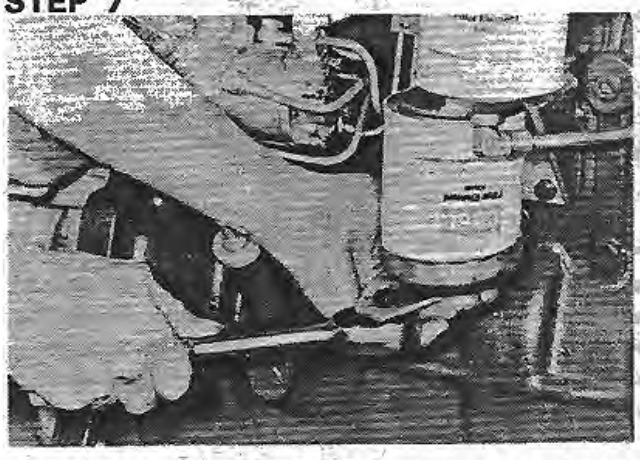
Both push rods of No. 1 cylinder should be loose when No. 1 cylinder is on TDC of compression stroke. If both push rods are tight, crank engine 360° and again check push rods.

STEP 6



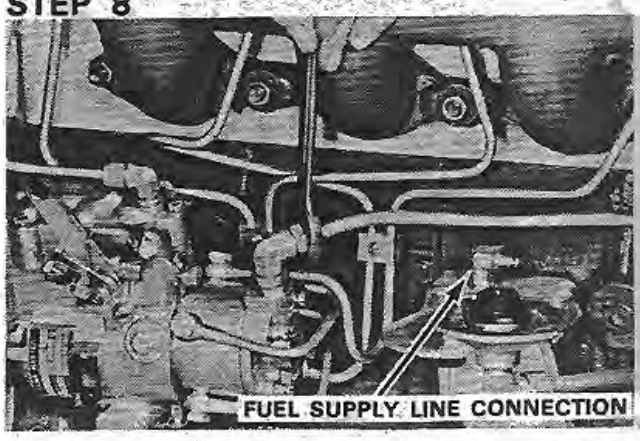
Crank engine counterclockwise (as viewed from the Operator's seat) past the specified pump timing then, crank engine clockwise until timing pointer is in line with the specified pump timing mark on flywheel. This procedure will remove slack from valve train and insure correct pump timing. *NOTE:* Refer to engine data decal on engine valve cover or to Operator's Manual for specified fuel pump timing.

STEP 7



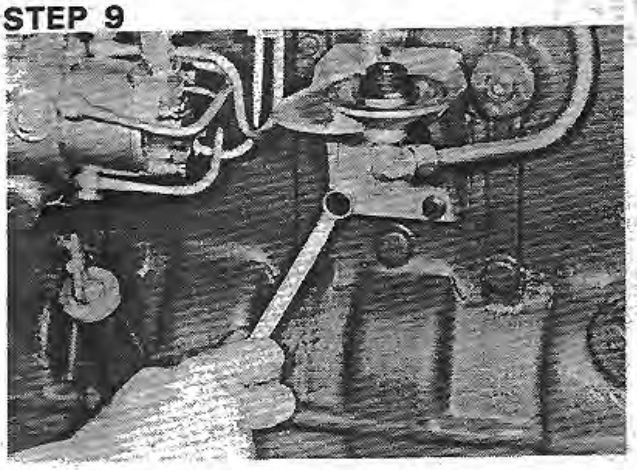
Using filter wrench A64761, remove primary and final fuel filters from filter head.

STEP 8



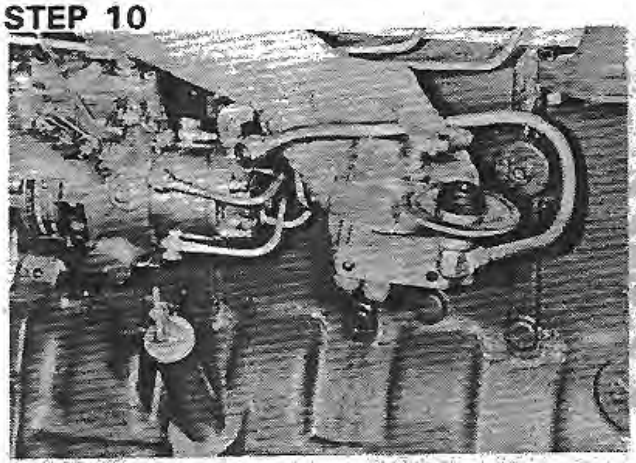
Disconnect fuel inlet line from fuel pump. Disconnect fuel tank supply line from filter head.

STEP 9



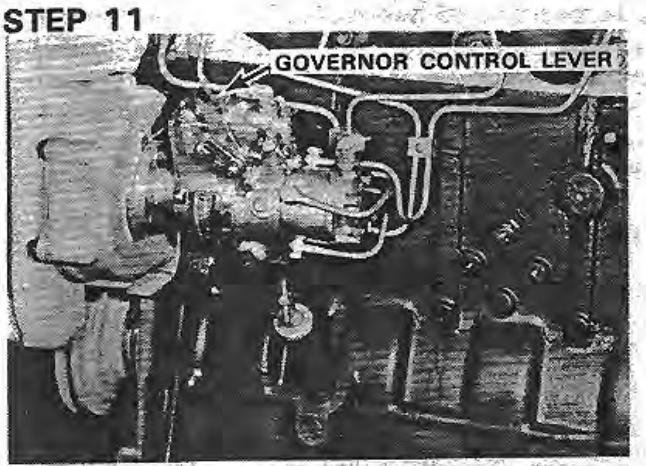
Remove filter head mounting bolts.

STEP 10



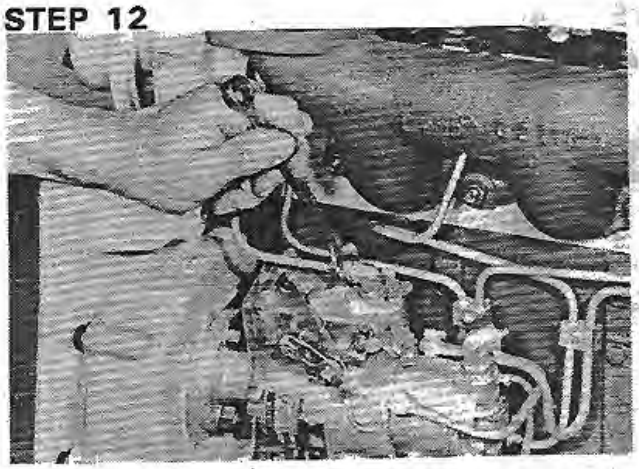
Remove filter head from engine block.

STEP 11



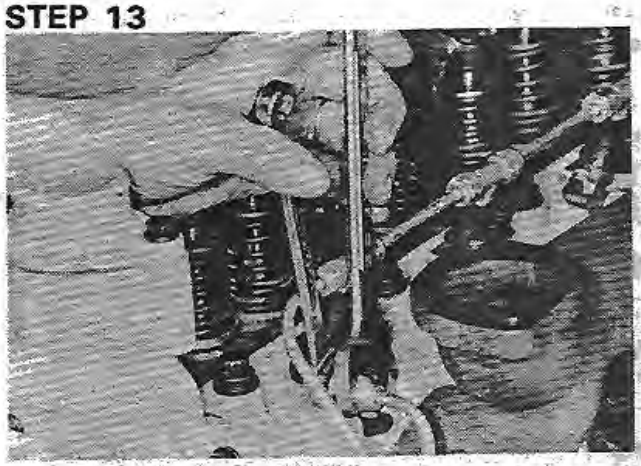
Disconnect the throttle rod from the governor control lever and the fuel shutoff cable from the shutoff lever.

STEP 12



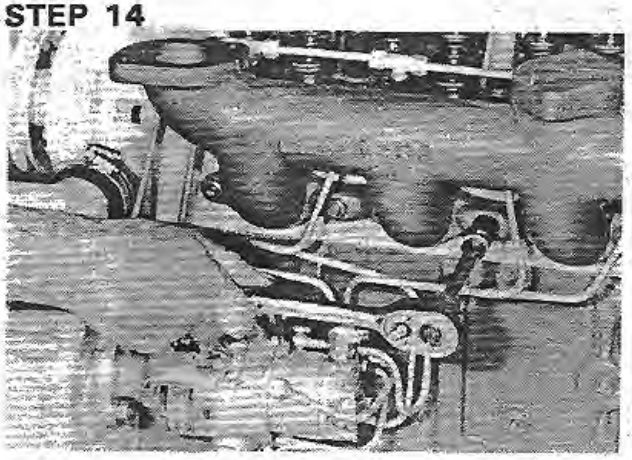
Disconnect leakoff return line from pump.

STEP 13



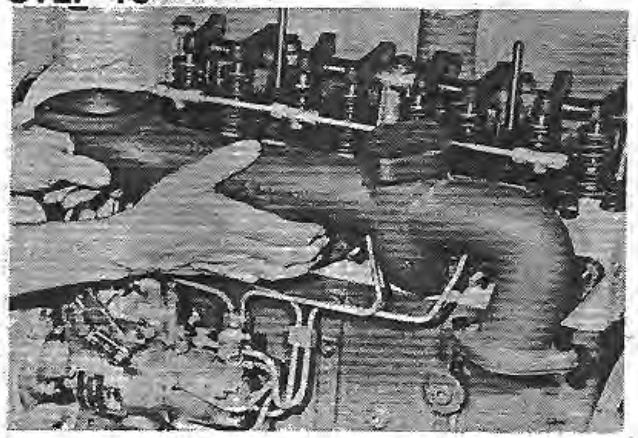
Disconnect high pressure lines from fuel injectors using the one hand-two wrench method.

STEP 14



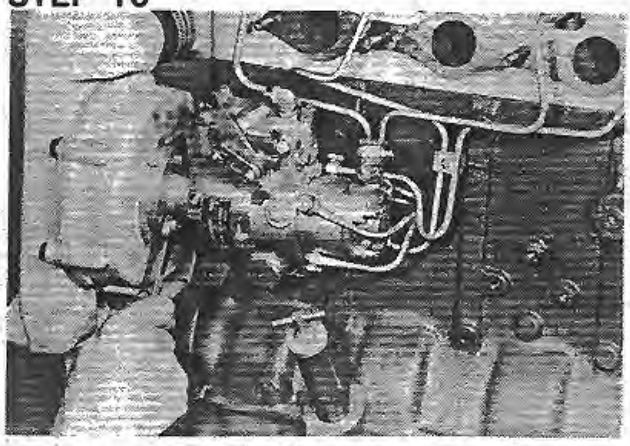
To obtain the necessary clearance for the fuel pump high pressure fuel lines when withdrawing the pump from the drive shaft, it is necessary to remove the exhaust manifold. Remove exhaust manifold mounting nuts.

STEP 15



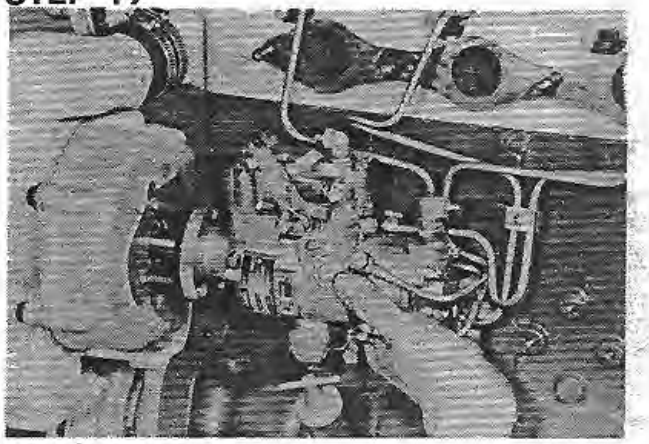
Remove exhaust manifold and gasket from engine.

STEP 16



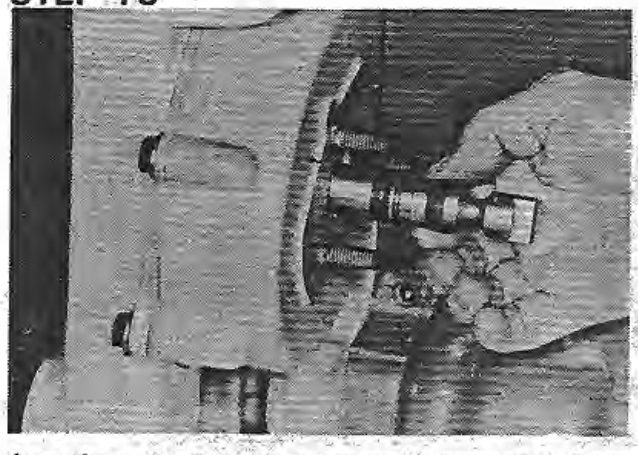
Remove pump mounting nuts and washers.

STEP 17



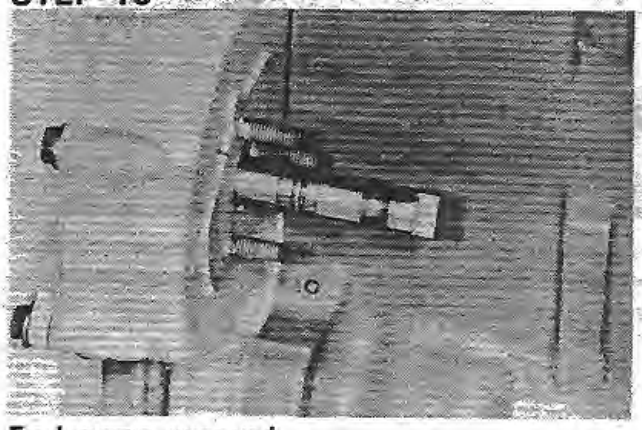
Carefully pull the fuel pump rearward, off the pump drive shaft.

STEP 18



Any time the injection pump is removed from the engine for any reason, the two drive shaft seals and the pilot tube "O" ring seal must be replaced. *NOTE:* If fuel pump is being returned to an authorized Roosa-Master service station, be sure it is complete with drive shaft. Replacement pumps are complete with drive shaft and necessary pump mounting parts.

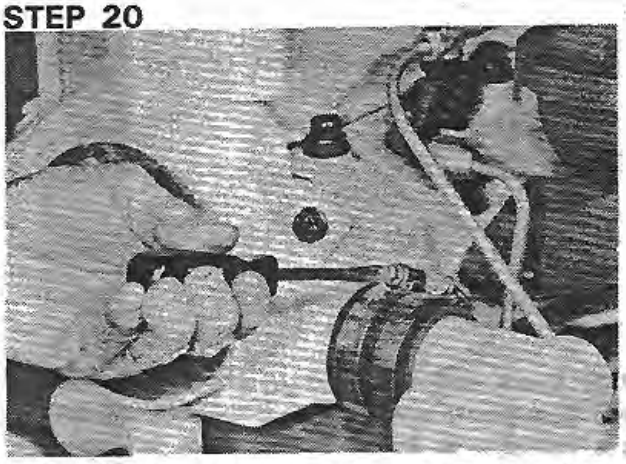
STEP 19



Fuel pump removed.

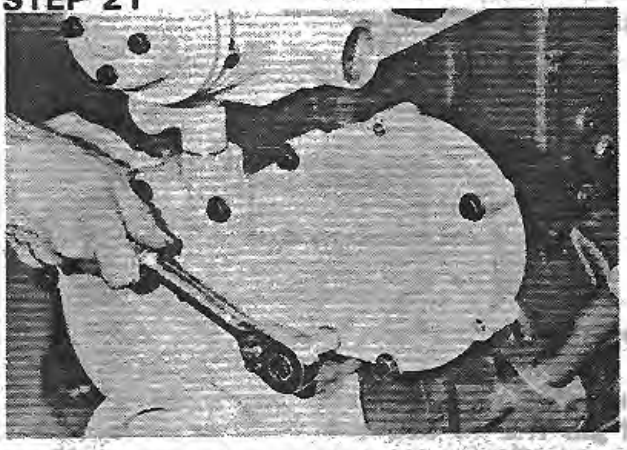
Pump Drive Shaft Removal

STEP 20



Drain cooling system and disconnect hose from water tube. Remove the water tube.

STEP 21



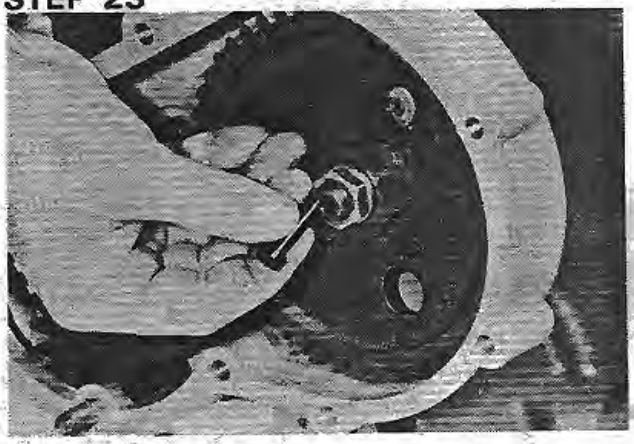
Remove cover plate mounting bolts.

NOTE: On some engines the water tube and cover plate are one piece. Disconnect hose from cover plate and remove cover plate and gasket.

STEP 22

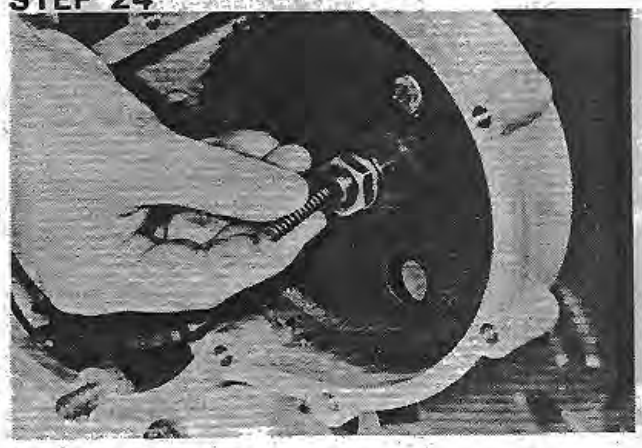
Remove the cover plate and gasket.

STEP 23



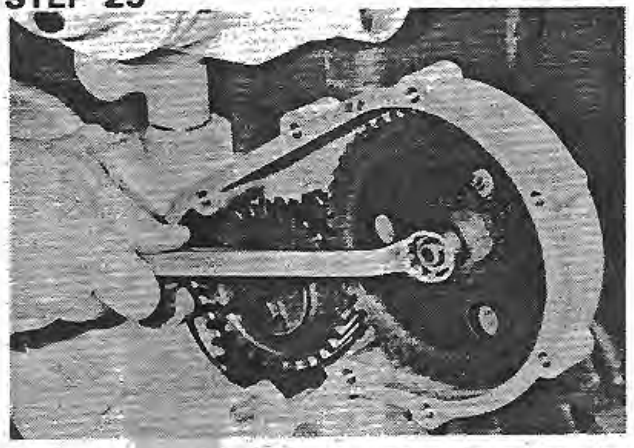
Remove thrust plunger.

STEP 24



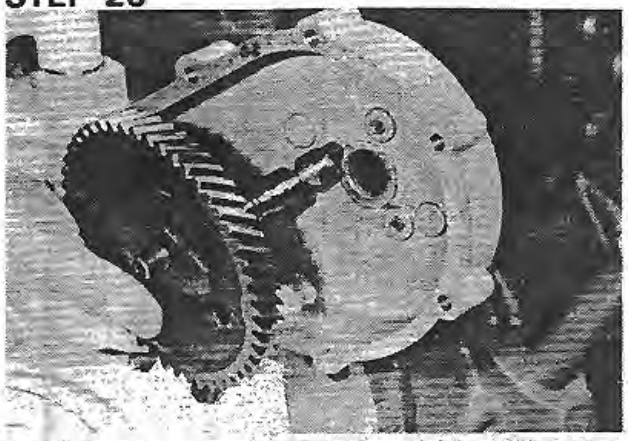
Remove thrust plunger spring.

STEP 25



Remove pump drive gear mounting nut and washer.

STEP 26

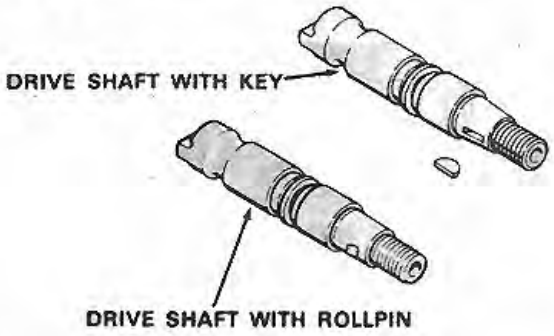


Remove pump drive gear and shaft.

STEP 27

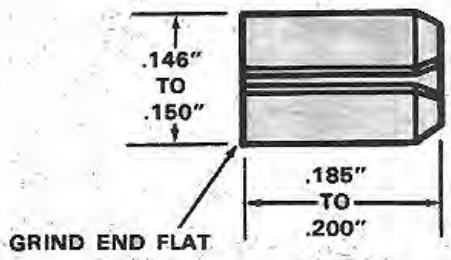
Pump drive gear and shaft removed from engine.

STEP 28

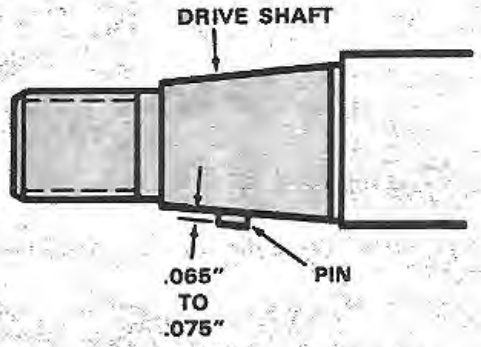


NOTE: There are two types of pump drive shaft. One has a woodruff key while the other has a roll pin. In event the shaft is replaced, the replacement shaft will contain the roll pin.

If the drive pin has sheared but the shaft is not otherwise damaged, remove roll pin using a 5/64" Easy-Out Extractor or a 3/32" Carbide Tipped Drill.



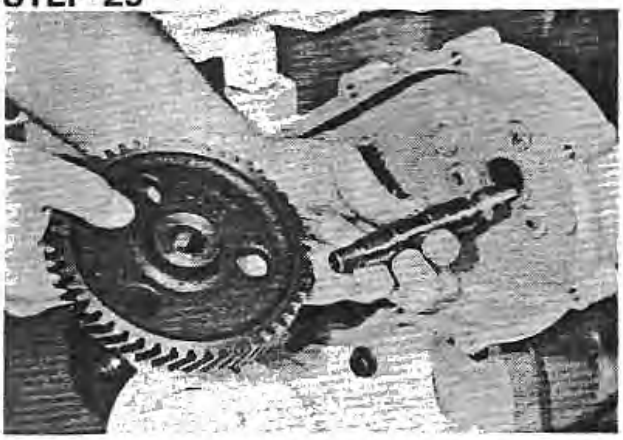
A new drive pin can be made from an Esna roll pin No. 59-028-140-.0375 or Case Part No. 138-275, .150" to .146" diameter by 3/8" long. Grind the roll pin flat on one end to the overall dimension shown.



Press roll pin into shaft chamfered end first to the dimension shown.

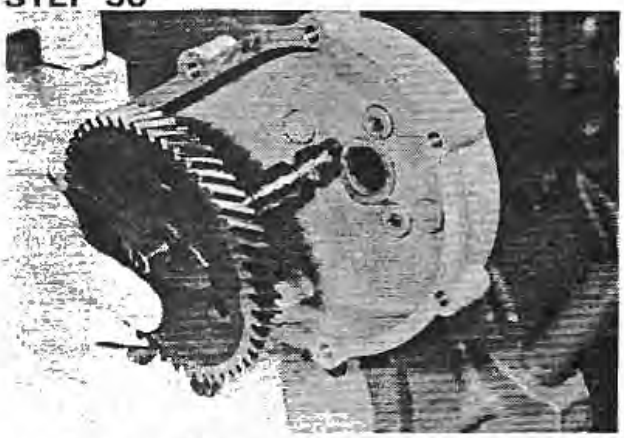
Pump Drive Shaft Installation

STEP 29



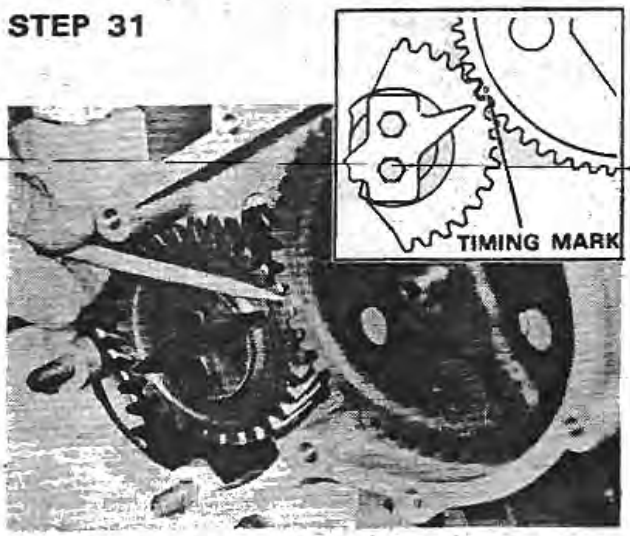
Insert pump drive shaft into pump drive gear.

STEP 30



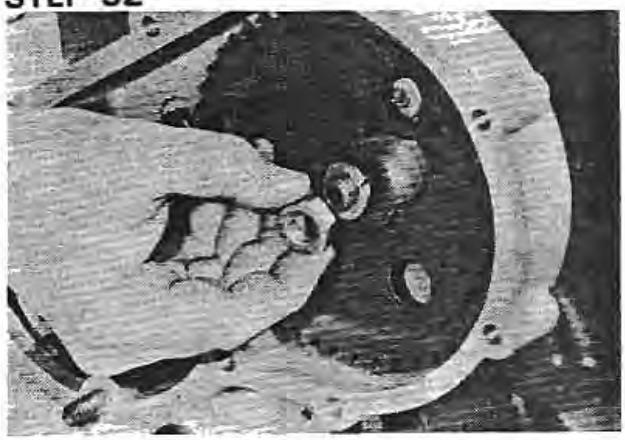
Install pump drive gear and shaft.

STEP 31



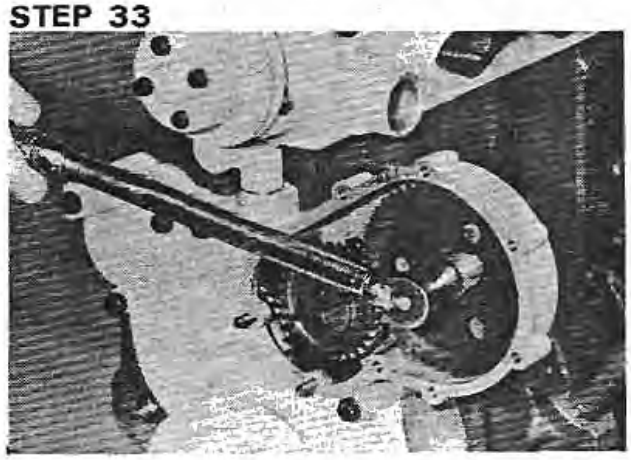
The timing mark on the pump drive gear must be aligned with the timing pointer on the idler gear.

STEP 32



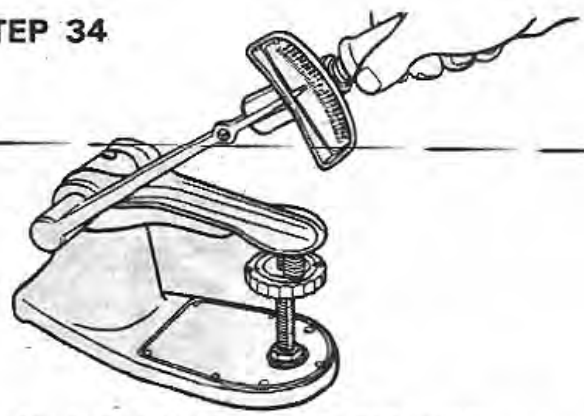
Install lockwasher and nut on fuel pump drive shaft.

STEP 33



Torque fuel pump drive gear mounting nut 40 to 50 ft. lbs.

STEP 34

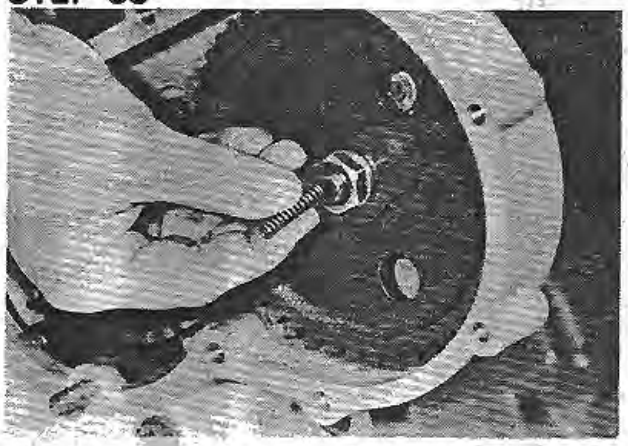


Inspect thrust spring for the following:

Free length ..... 1.22"

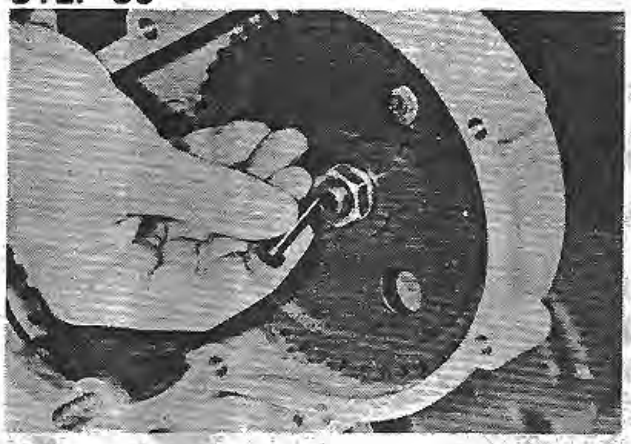
Compressed to .950" ..... 6 lbs. 4 oz.

STEP 35



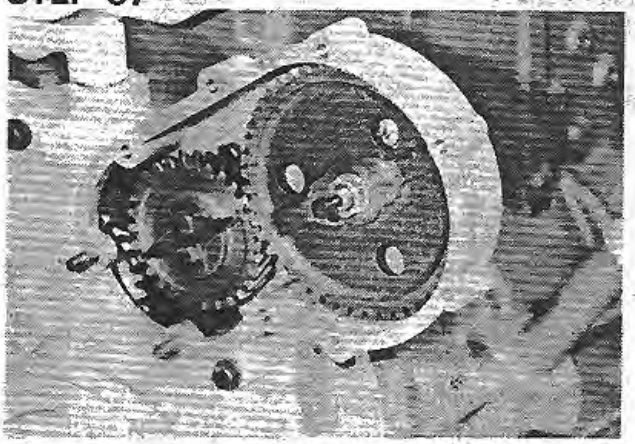
Install thrust spring into drive shaft.

STEP 36



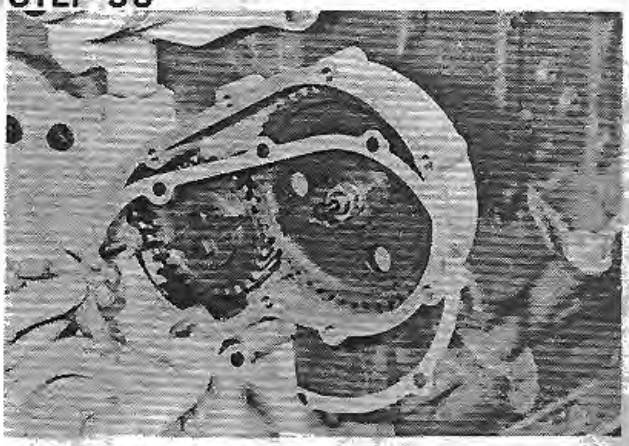
Install thrust plunger.

STEP 37



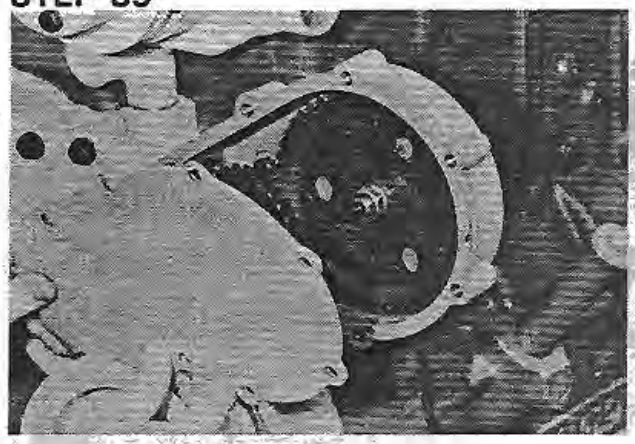
Fuel pump drive gear and shaft installed.

STEP 38



Install cover plate gasket.

STEP 39



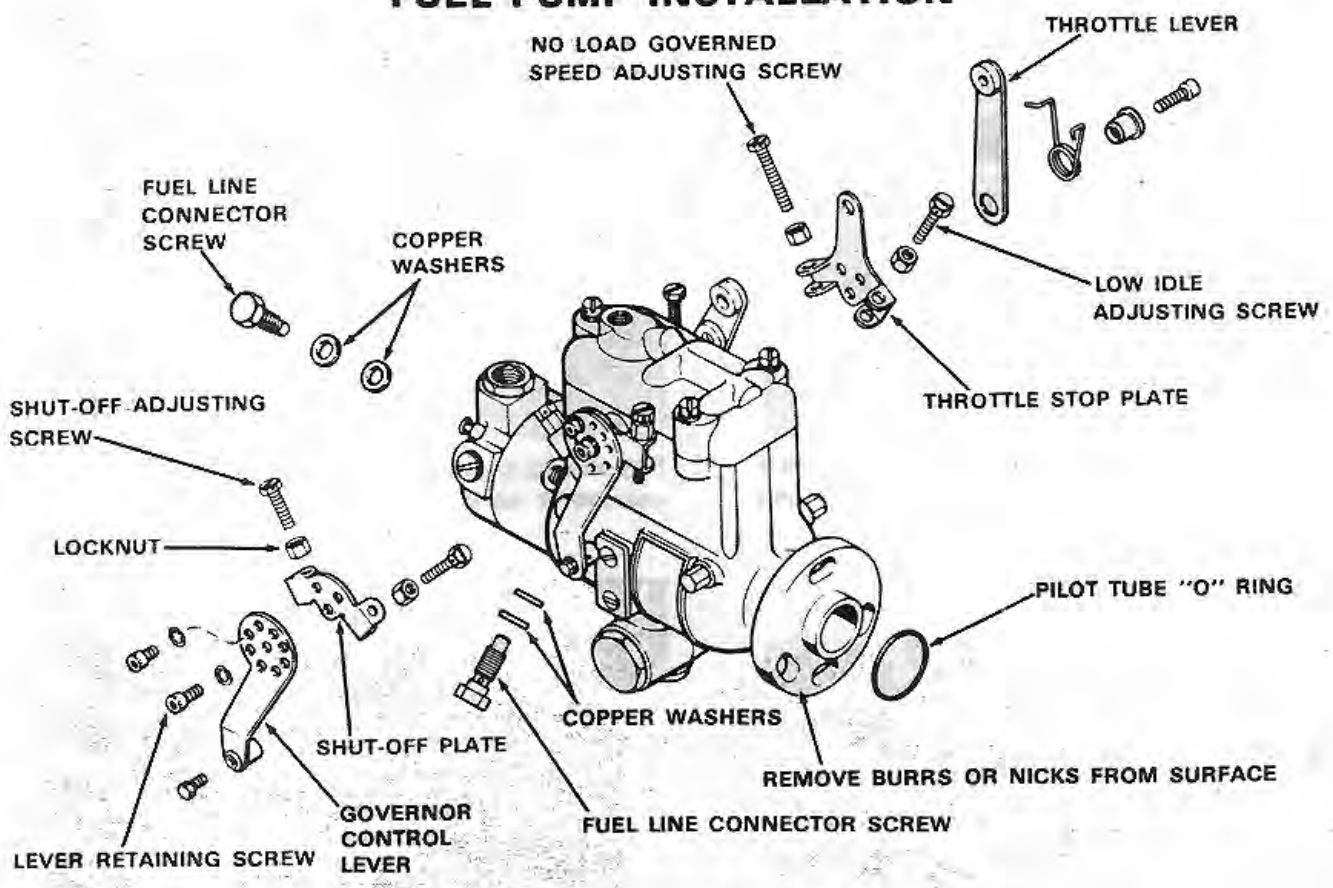
Install cover plate.

STEP 40

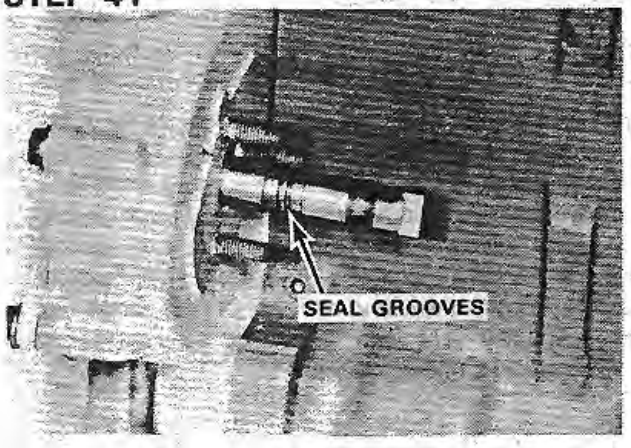
Install water tube and torque the tube and cover bolts and nuts 25 to 30 ft. lbs.

NOTE: If equipped with cast iron front cover plate, torque mounting bolts and nuts 35 to 42 ft. lbs.

FUEL PUMP INSTALLATION

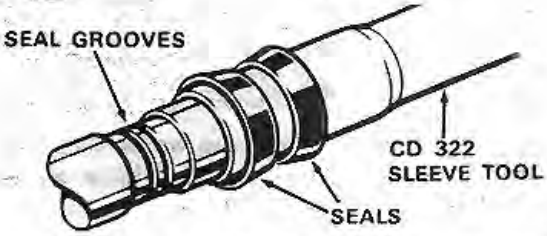


STEP 41



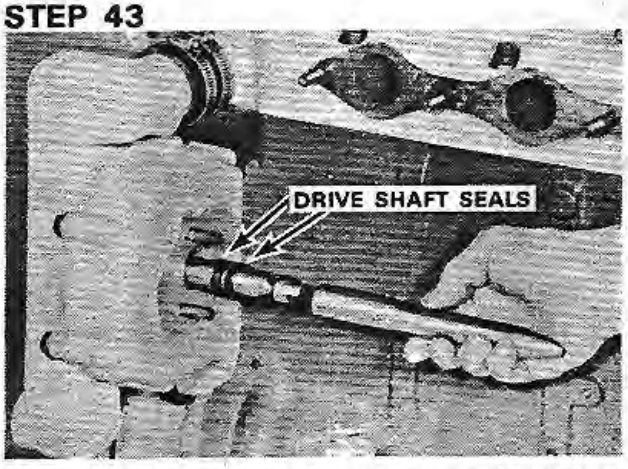
Fuel pump drive shaft.

STEP 42



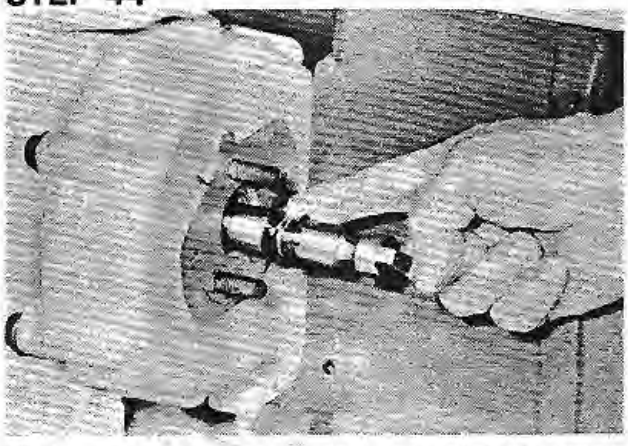
Freely lubricate two new drive shaft seals with lubriplate. Install the seals on sleeve tool CD322 with lips of seals outward. (seals back-to-back).

STEP 43



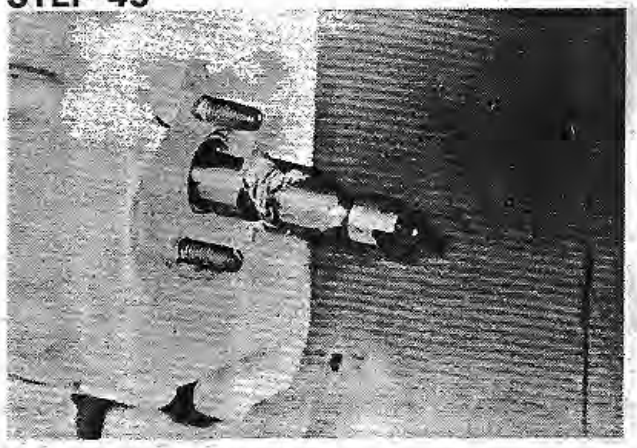
Slide sleeve tool CD322 over pump drive shaft and install seals in their respective grooves on the shaft.

STEP 44



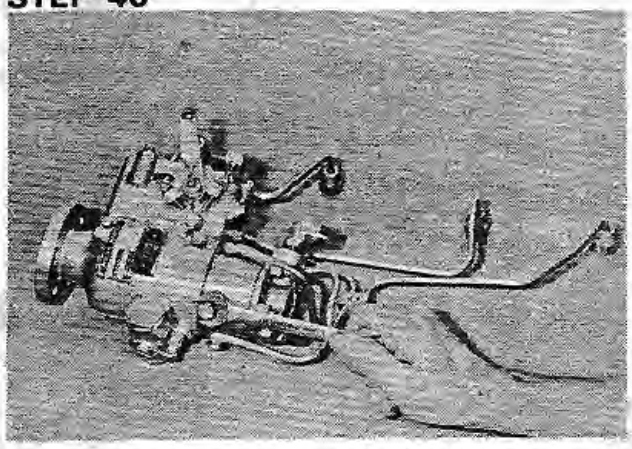
Thoroughly lubricate the two seals with lubriplate to avoid damage and facilitate ease of installation.

STEP 45



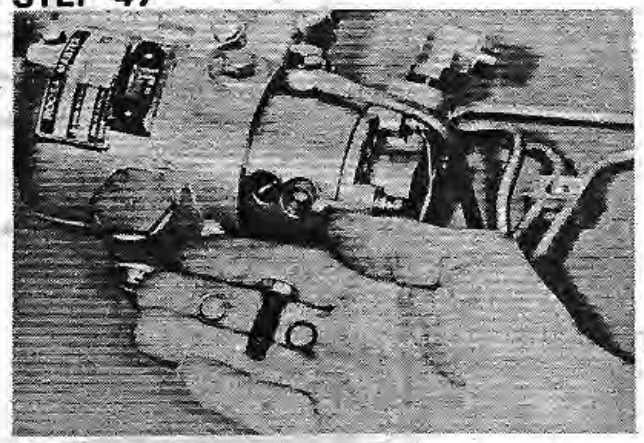
Drive shaft seals installed.

STEP 46



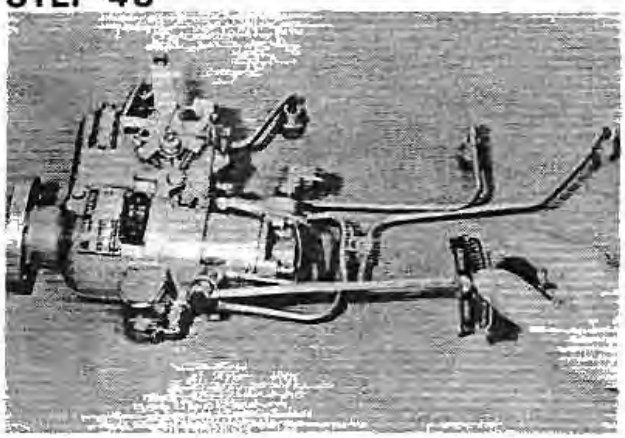
If replacing pump, remove the high pressure line connector bolts and lines from the pump.

STEP 47



When installing fuel line connector bolts into the high pressure fuel lines, be sure that two new copper washers are used on each connection. Make sure washers are in place on each side of connector before tightening connector bolts. *IMPORTANT: Do not tighten connector bolts without the washers in place because pump seizure could result due to connector bolt going too deep into pump body.*

STEP 48

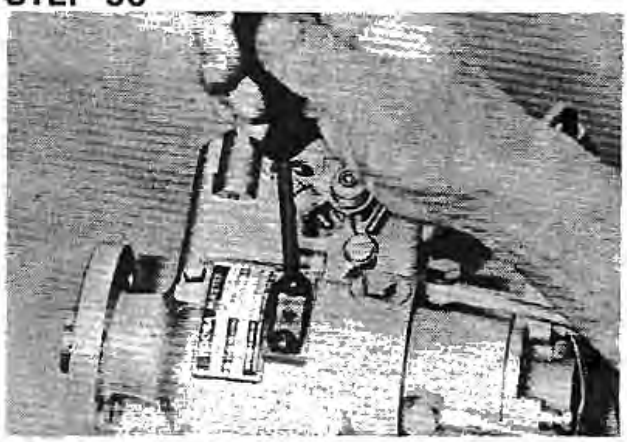


Torque connector bolts to 35 ft. lbs.

STEP 49

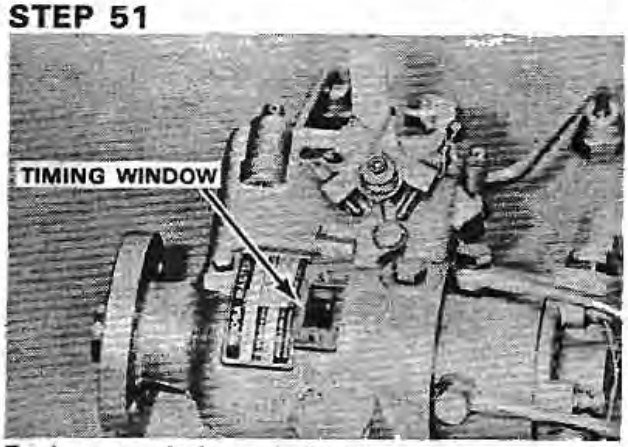
IMPORTANT: If engine has been cranked after pump was removed, repeat steps 4 thru 6 to assure correct timing.

STEP 50



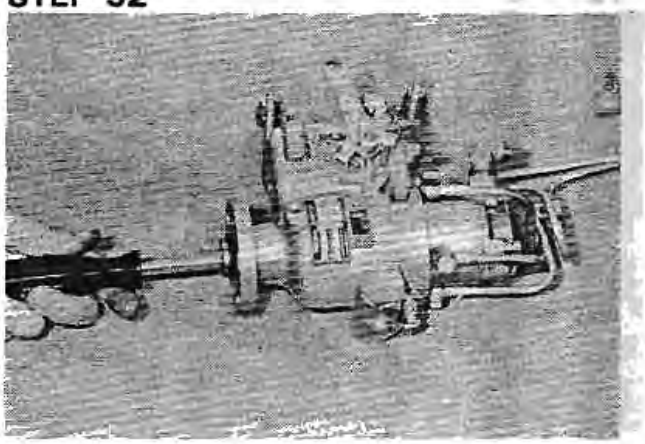
Remove the timing window cover from injection pump.

STEP 51

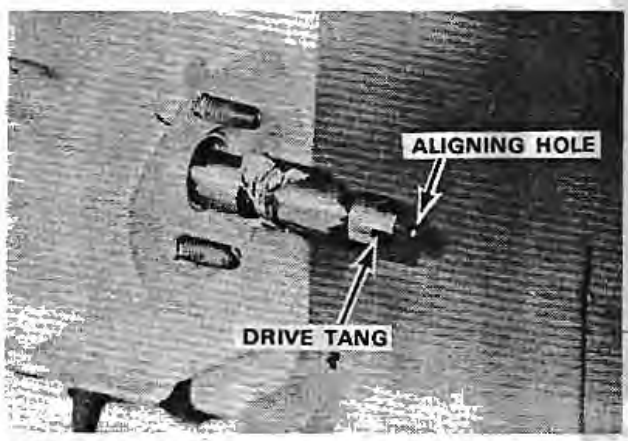


Fuel pump timing window.

STEP 52

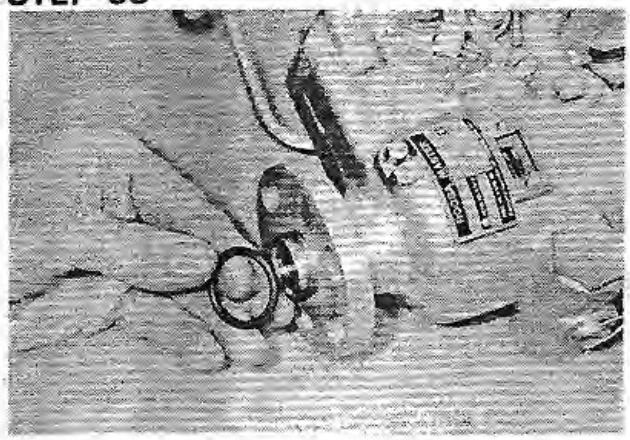


Using a *clean,* wide bladed screwdriver inserted into the drive end of the pump, rotate the distributor rotor until the timing lines in the timing window are aligned.



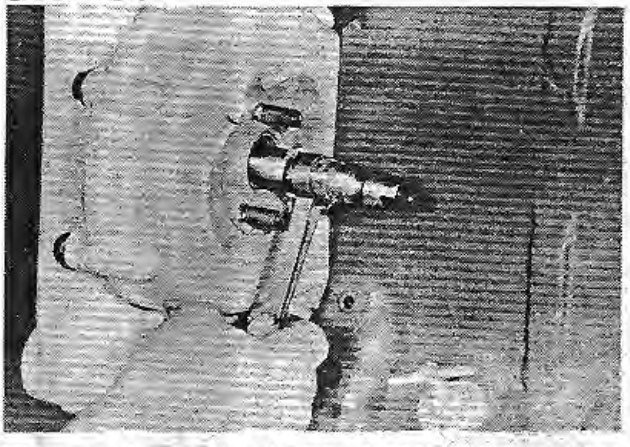
IMPORTANT: The rear end of drive shaft is equipped with a drive tang which has a hole in one side. This hole must line up with a hole located internally in pump on the distributor rotor. Turn pump rotor to approximately the position as tang on end of drive shaft so holes correspond with each other. If holes are not aligned, pump would be 180° out of time.

STEP 53



Apply clean engine oil to new pilot tube "O"-ring seal and install seal on pump.

STEP 54

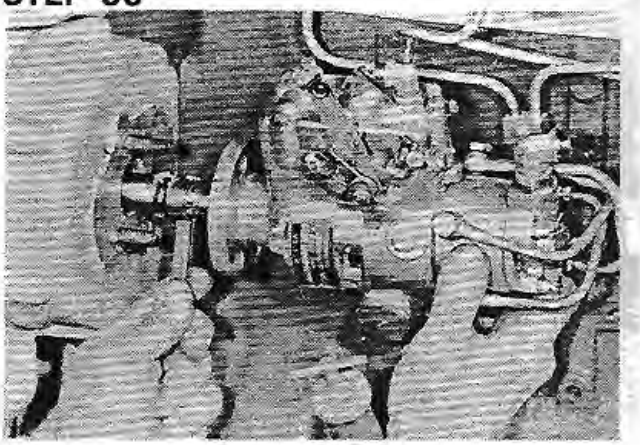


Using seal compression tool CD331, compress the seals on drive shaft.

STEP 55

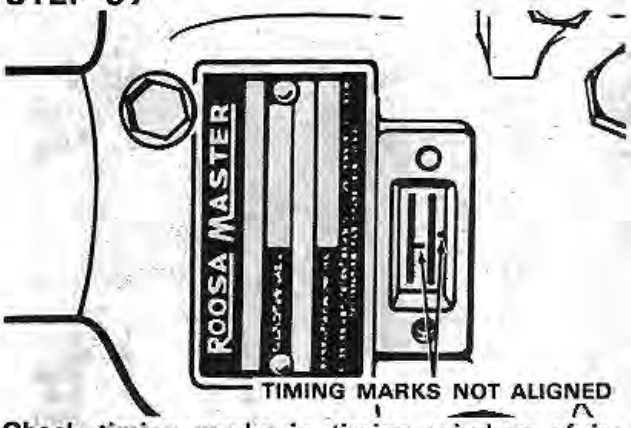
NOTE: When replacing an injection pump, be sure the replacement pump is for the correct full load RPM of the engine. The full RPM is stamped on the serial plate of the pump. It would be possible to install an incorrect pump, therefore, always refer to the parts catalog when ordering a replacement pump.

STEP 56



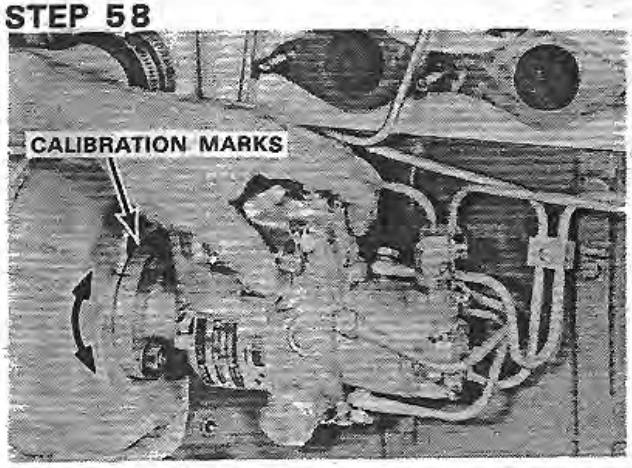
Slide the pump onto shaft being careful not to damage seals during assembly. If rear seal is rolled over on shaft during assembly, remove the pump and replace rear seal even though no visual damage is apparent. *Do not force* After pump is moved forward, it may be necessary to rotate pump slightly to permit tang of shaft to engage slot in pump.

STEP 57



Check timing marks in timing window of injection pump. If marks are not aligned, proceed to next step. If marks are aligned, proceed to Step 59.

STEP 58

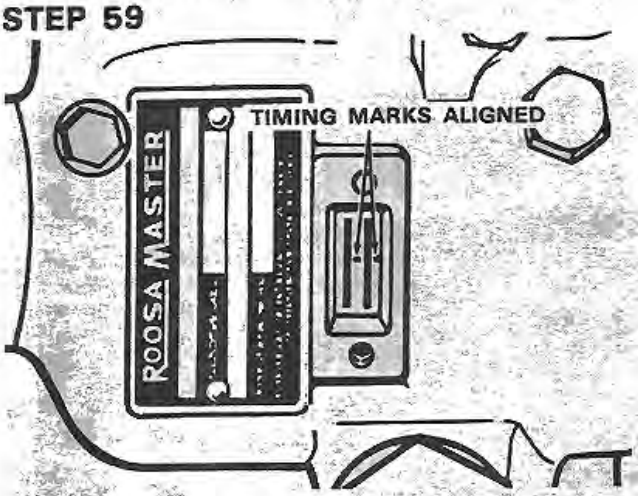


In the event that timing marks are not in alignment, rotate pump toward or away from engine until timing marks are aligned. To advance timing, move top of pump away from engine. To retard pump timing, move top of pump toward engine.

NOTE: **There are 0-12° marks on top side of pump flange. They are calibration marks for Service Station use only.**

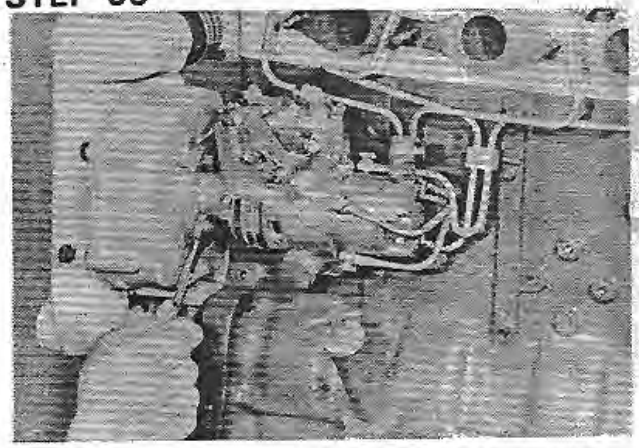
WARNING: *Never attempt to adjust timing with the engine running. This could result in serious injury to the mechanic or damage to injection pump.*

STEP 59



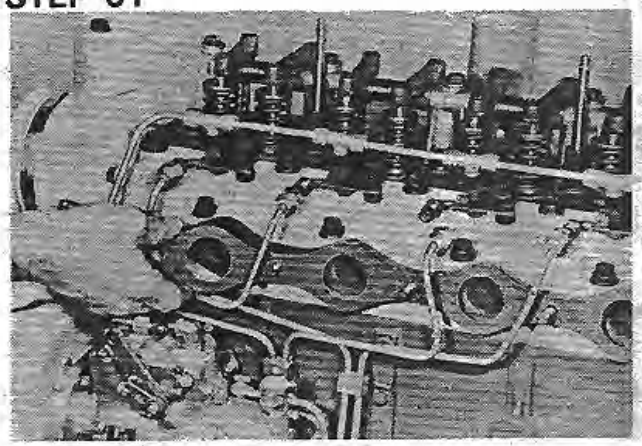
Timing marks aligned for proper timing.

STEP 60



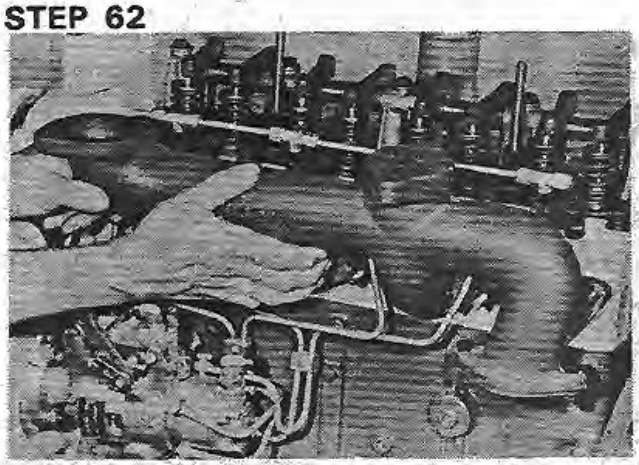
Install fuel pump mounting nuts and torque 35 to 42 ft. lbs.

STEP 61



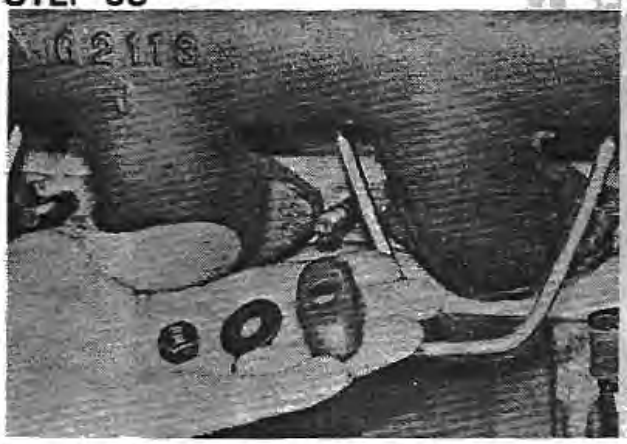
Install a new exhaust manifold gasket.

STEP 62



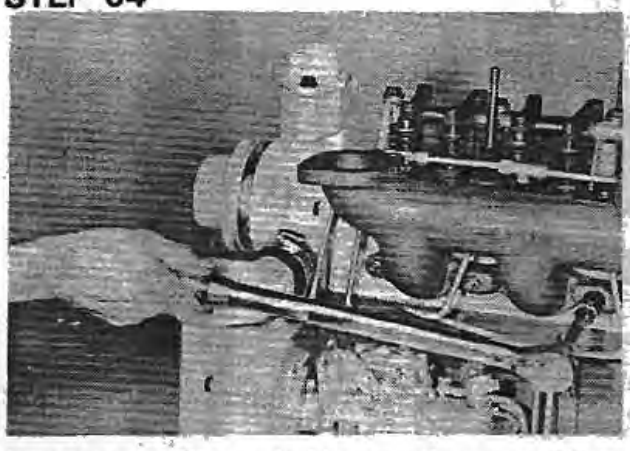
Install exhaust manifold on studs of cylinder head.

STEP 63



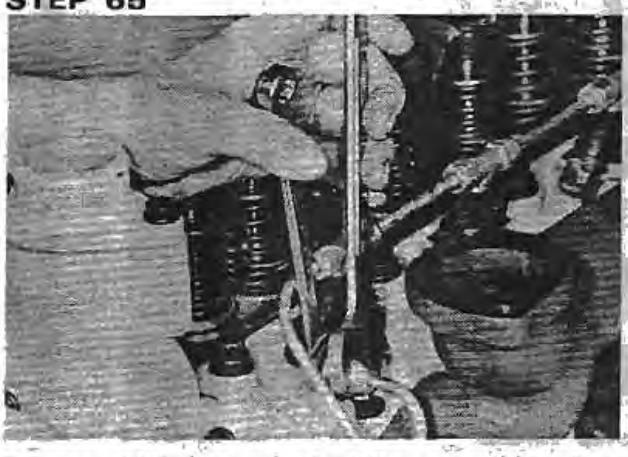
Install exhaust manifold mounting clamps, washers and nuts.

STEP 64



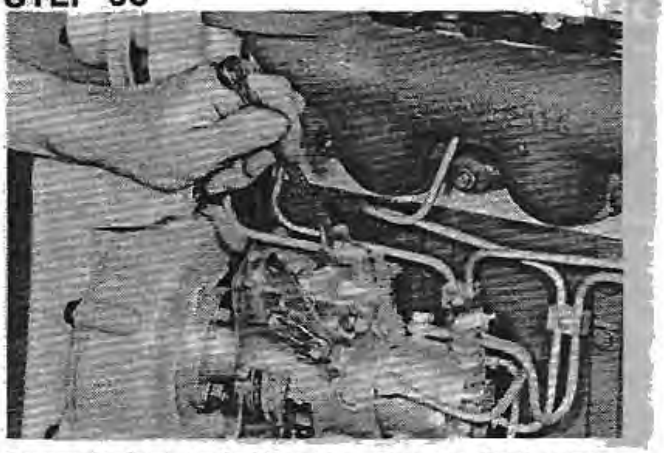
Torque exhaust manifold mounting nuts 25 to 30 ft. lbs.

STEP 65



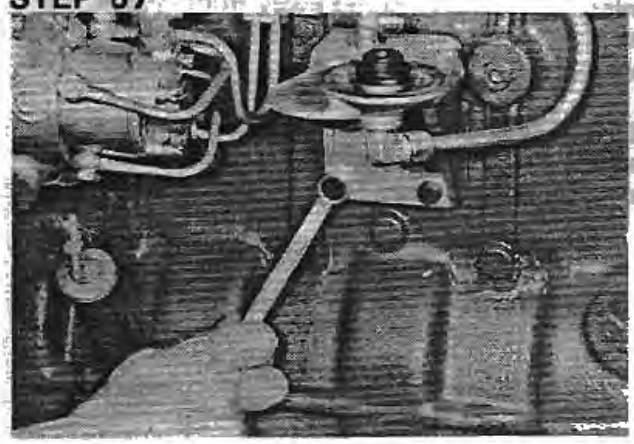
Connect high pressure fuel lines to fuel injectors using the one hand-two wrench method.

STEP 66



Connect fuel leakoff return line to fuel pump.

STEP 67



Install fuel filter head on engine block.

STEP 68

Connect fuel inlet line to fuel pump. Connect fuel tank supply line to elbow of filter head.

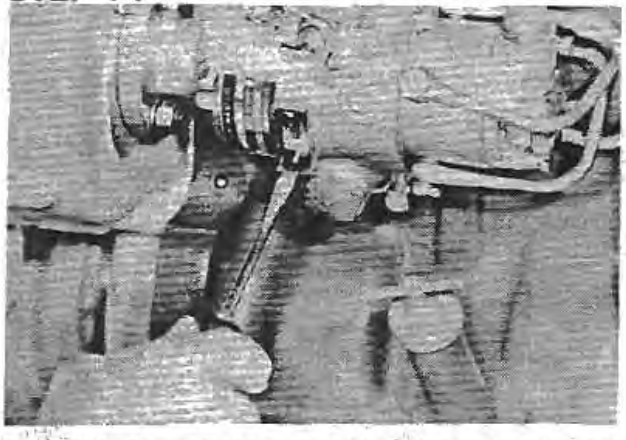
STEP 69

Install primary and final fuel filters on filter head. Refer to Section 3010.

STEP 70

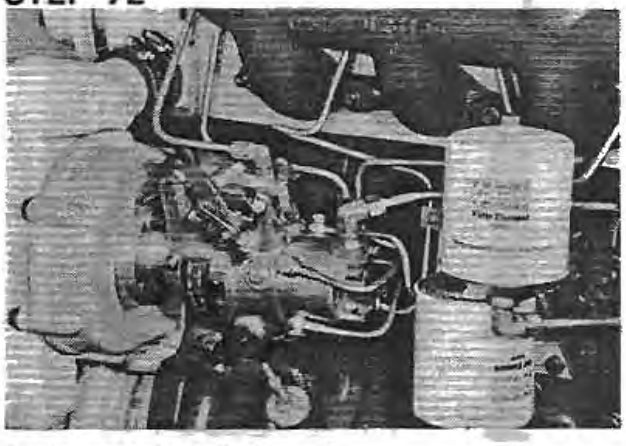
Connect the throttle rod to the governor control lever and the fuel shutoff cable to the shutoff lever.

STEP 71



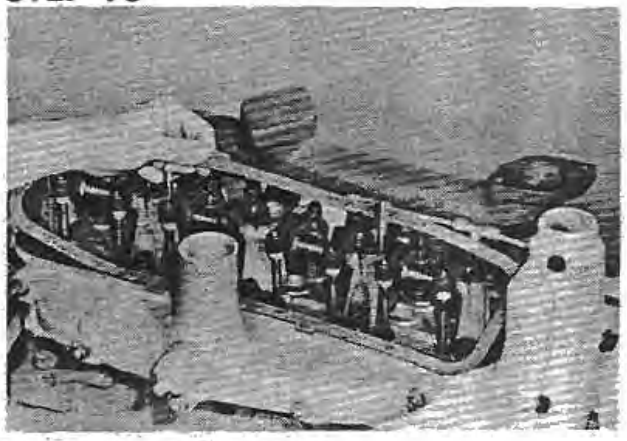
Install timing window cover on injection pump. Refer to Page 21 and check pump gear to idler gear backlash.

STEP 72



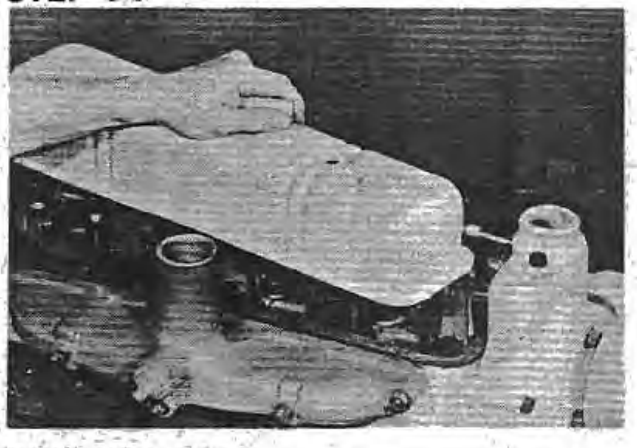
Fuel pump installed.

STEP 73



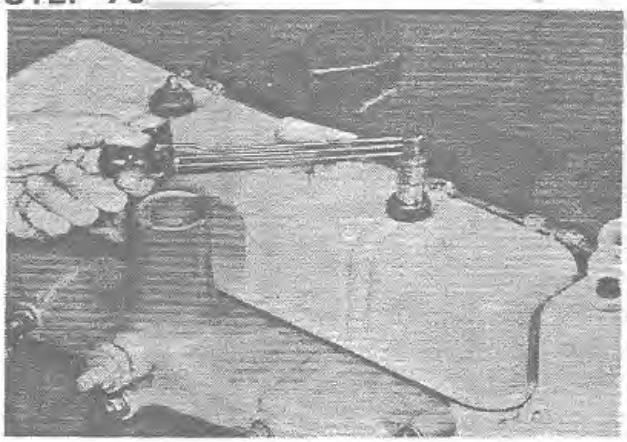
Install valve cover gasket.

STEP 74



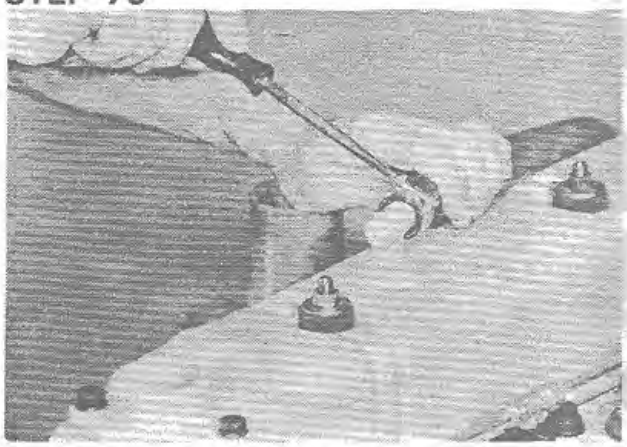
Install valve cover.

STEP 75



Torque valve cover nuts 4 to 6 ft. lbs.

STEP 76



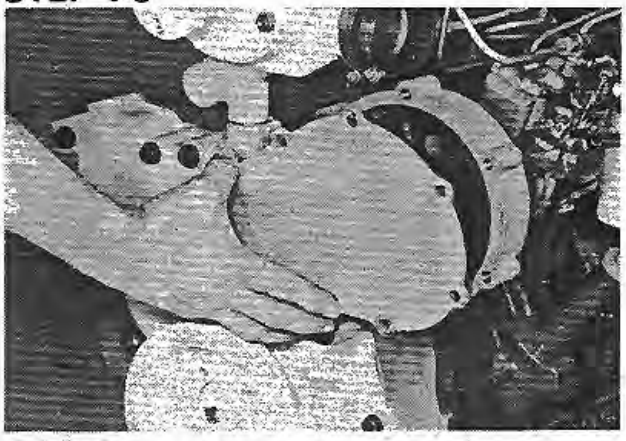
Install the breather hose.

Checking Pump Gear Backlash

STEP 77

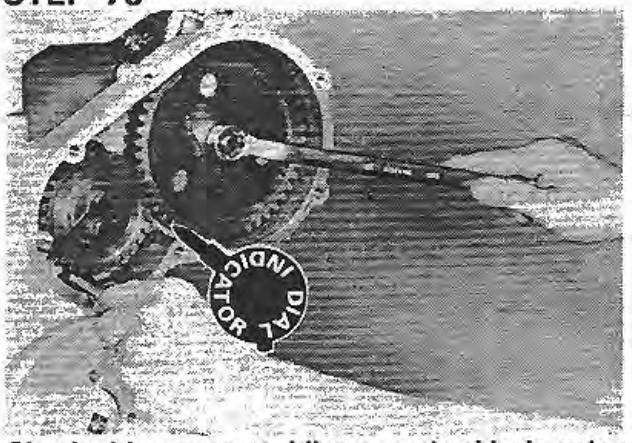
Remove water tube.

STEP 78



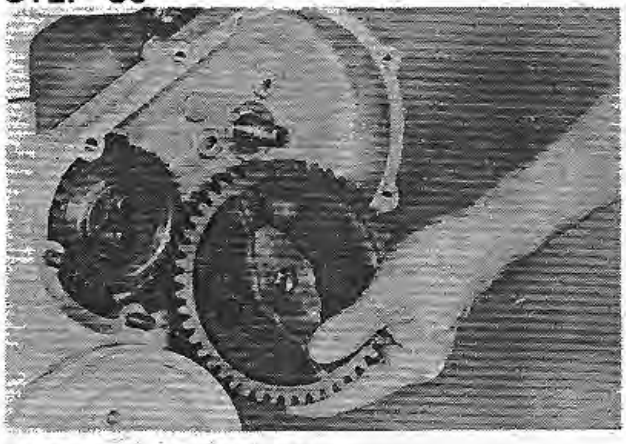
Remove cover plate and gasket.

STEP 79



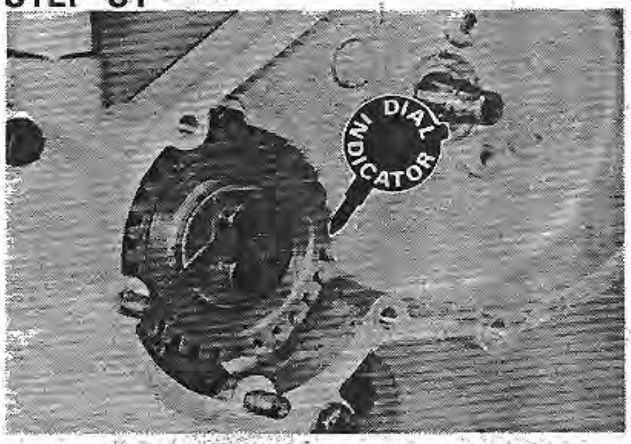
Check drive gear to idler gear backlash using a dial indicator. Maximum backlash .007 inch. Excessive backlash will cause erratic pump action.

STEP 80



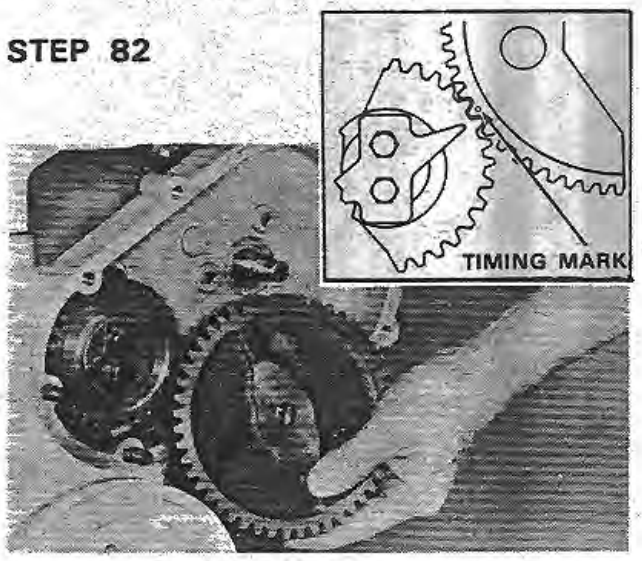
Remove pump drive gear.

STEP 81



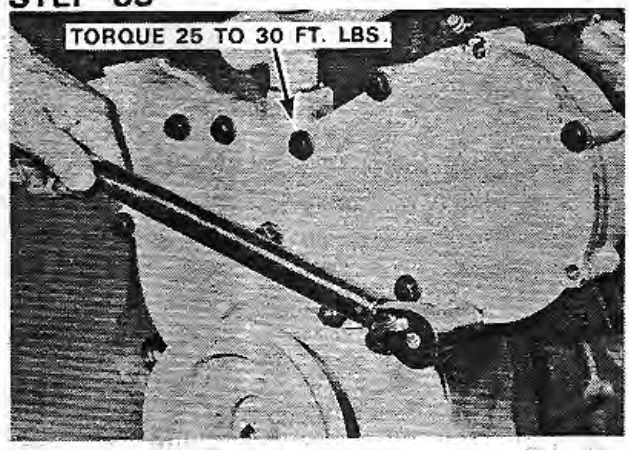
Check idler gear to camshaft gear backlash. Maximum backlash .006 inch.

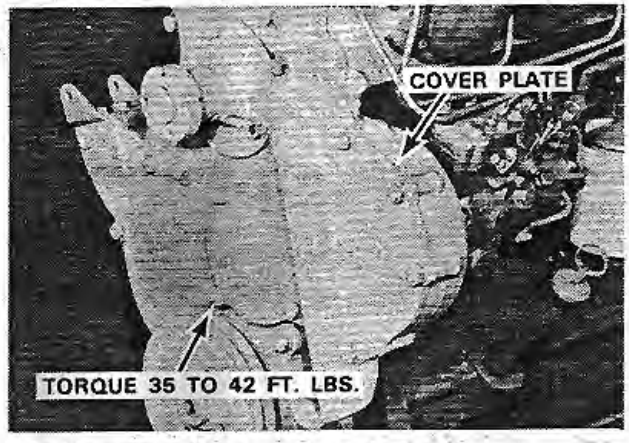
STEP 82



Install pump drive gear. Be sure timing mark on gear aligns with timing pointer of idler gear.

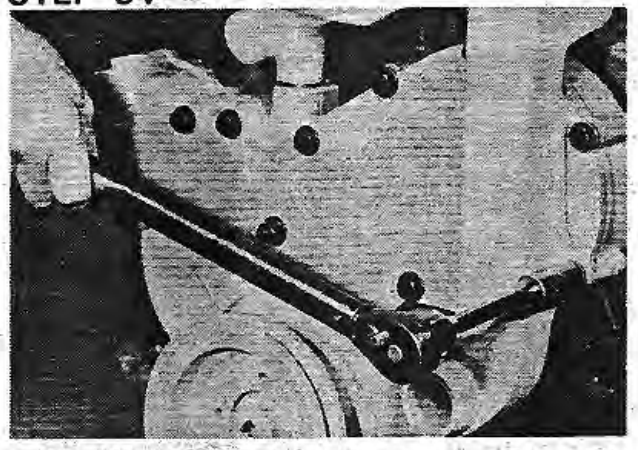
STEP 83





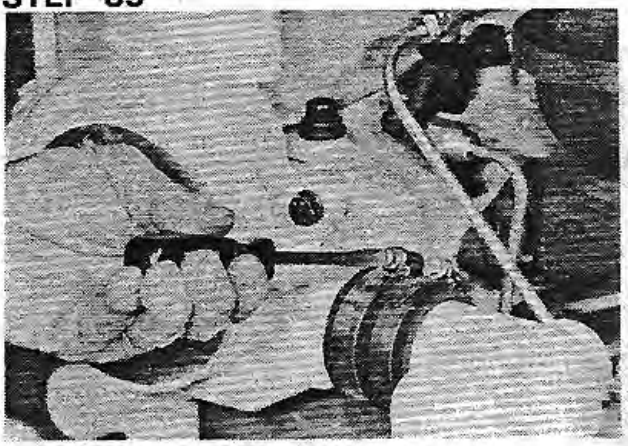
Install cover plate and gasket.

STEP 84



Install the water tube. Torque mounting bolts 25 to 30 ft. lbs.

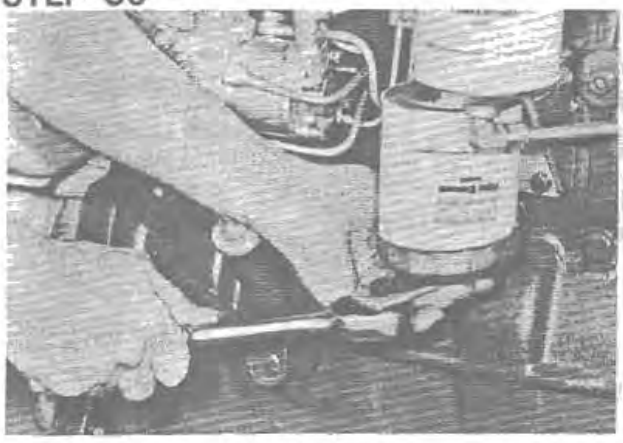
STEP 85



Connect hoses to water tube. Fill cooling system.

Replacing Pump Inlet Filter

STEP 86

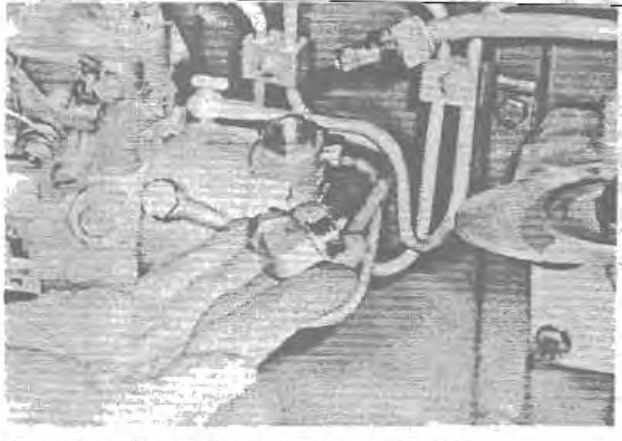


When servicing the fuel pump inlet filter, it is good practive to also change the primary and final fuel filters. Remove primary and final fuel filters from filter head.

STEP 87

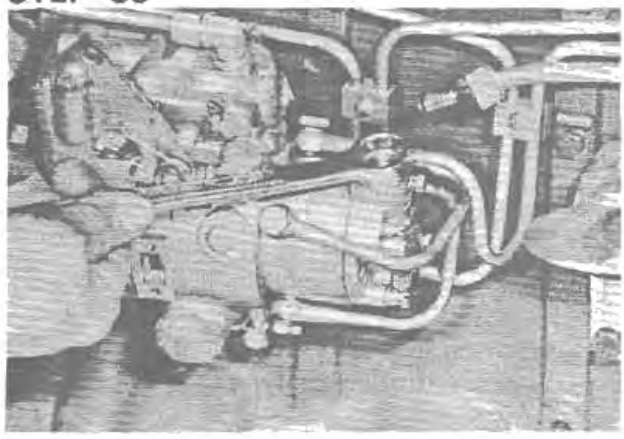
Disconnect fuel inlet line from fuel pump.

STEP 88



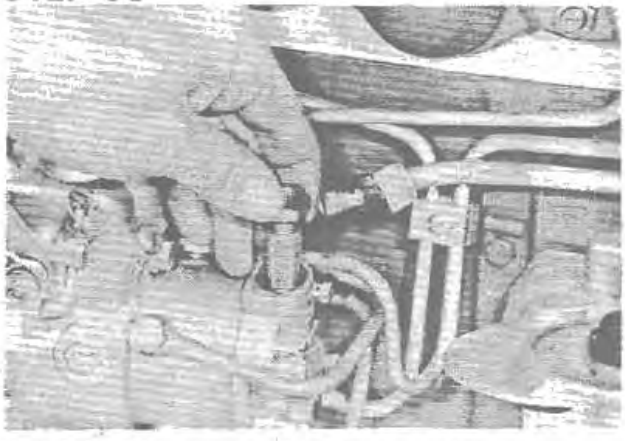
Remove elbow from fuel pump inlet.

STEP 89



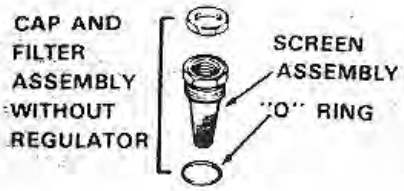
Unscrew inlet filter from fuel pump.

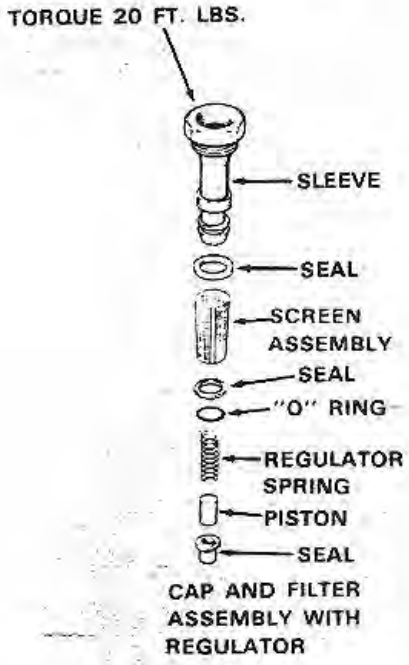
STEP 90

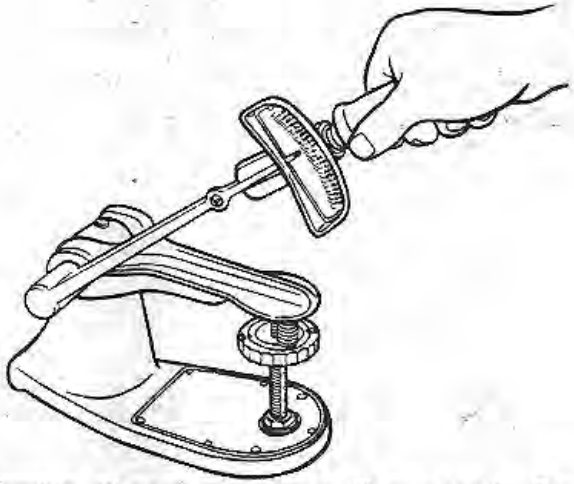


Pull inlet filter assembly from fuel pump.

STEP 91



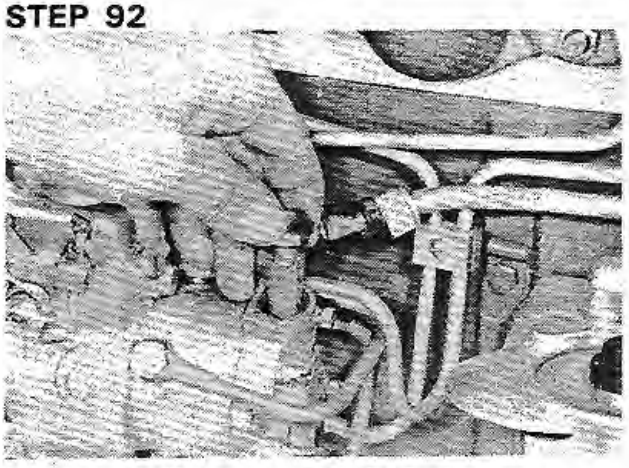




Assemble filter components if removed. Replace damaged parts. Inspect regulator spring for the following:

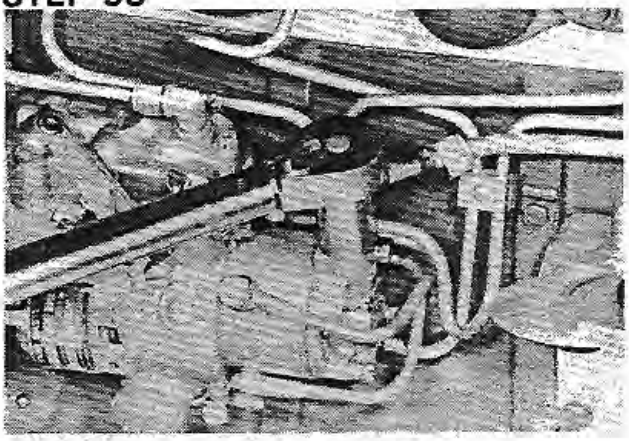
Free Length ..... .633" to .667"
Rate ..... 10 lbs./inch
Color Ident. ..... One end red; one end green

STEP 92



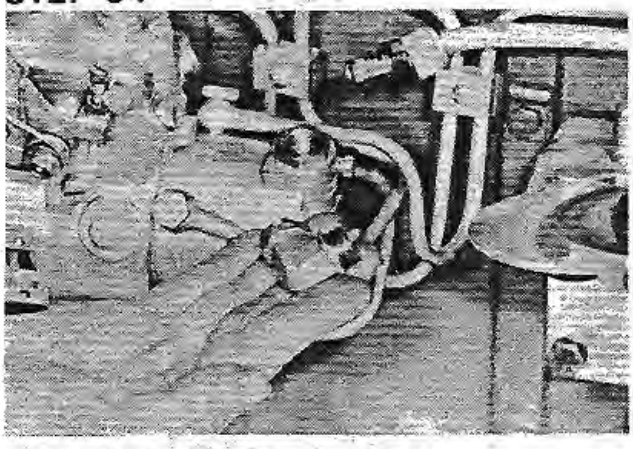
Install inlet filter assembly in fuel pump.

STEP 93



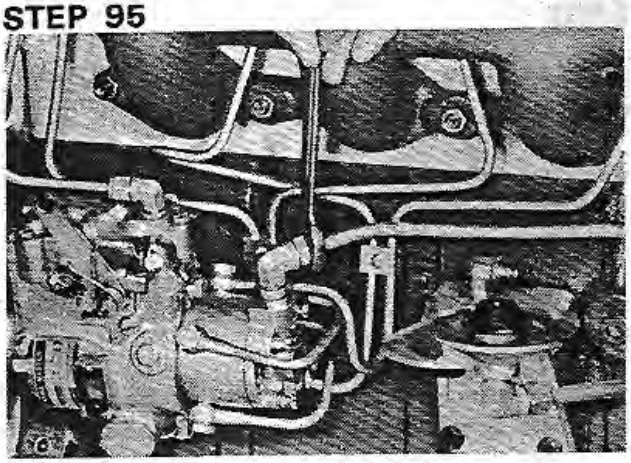
Torque inlet filter assembly 20 ft. lbs.

STEP 94



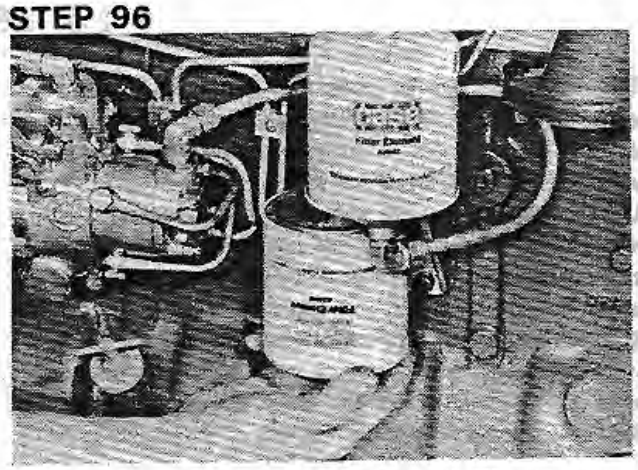
Install elbow in fuel pump inlet.

STEP 95

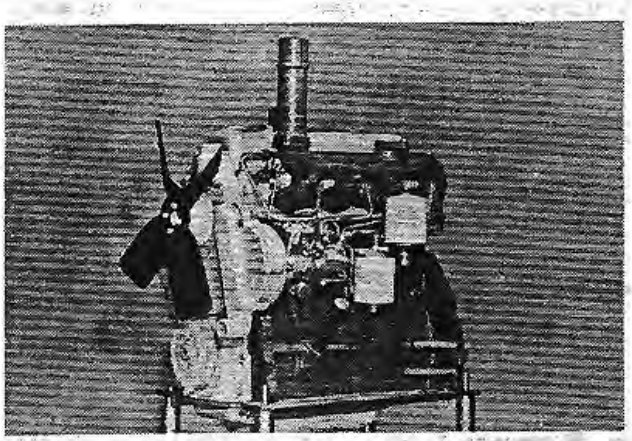


Connect fuel filter line to fuel pump.

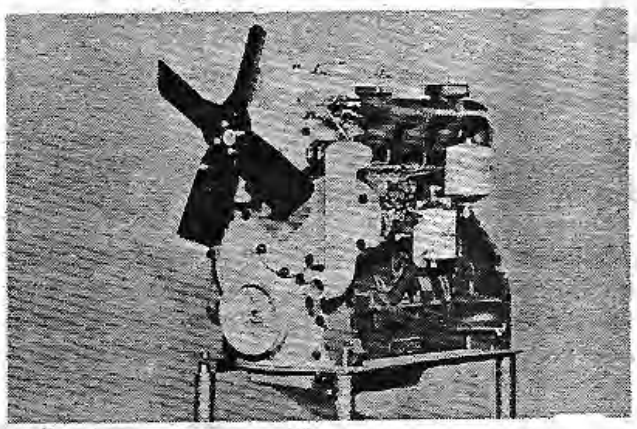
STEP 96



Install new primary and final fuel filters.



188 DIESEL ENGINE



207 DIESEL ENGINE

ENGINE SPEED

The Authorized Engine Speed Adjustments described in the following paragraphs of this section are for the information and use of *Authorized Case Dealers only.*

Unauthorized changes in the governed engine speed of the Case Diesel Engine will automatically void and waive any Warranty whatsoever by the J. I. Case Company.

Before making any changes in the no load governed engine speed, check that the engine speed is not affected by one or more of the following conditions:

1. Check to be sure the engine is equipped with the correct injection pump. The pump can be identified by the number stamped on the serial number plate on the pump housing.
2. Engine must be carefully "Run-In".
3. Engine lubricating oil viscosity not according to recommendations.
4. Incorrect oil viscosity in the transmission or the hydraulic system. *NOTE:* The transmission and hydraulic oil must be at normal operating temperature before attempting to take an accurate engine speed reading.
5. Fuel does not meet the required specifications for Number 2 Diesel Fuel.
6. Plugged air cleaner.
7. Fuel tank breather partially plugged.
8. Fuel filter bleed by-pass valve not closed completely.
9. Lack of fuel to the injectors due to plugged fuel filters, air or water in the fuel system.
10. Fuel injection pump not timed as described in this section.
11. Valve tappet clearance not adjusted and set correctly. Refer to Cylinder Head Section.
12. One or more faulty injectors.
13. Loss of compression in one or more cylinders.
14. Fuel shut-off out of adjustment.

Checking Engine Speed

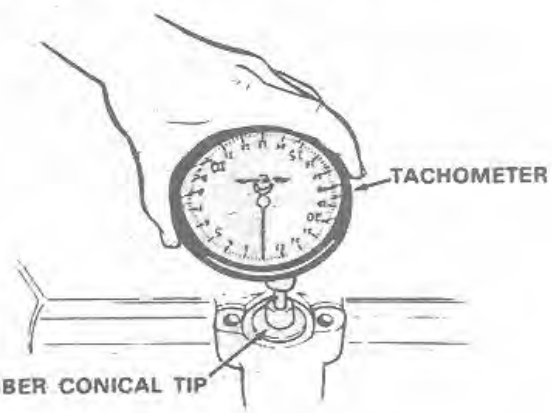
WARNING: *Make sure the power train is in neutral before checking engine speed.*

Checking engine speeds is critical and can only be made with a tachometer that is known to be accurate. Revolution counters of any type, or tachometers that have been in use for a long time without being checked for accuracy *must not be used.*

NOTE: Refer to the engine data decal on the engine valve cover or to the Operator's Manual for the engine no load governed speed and rated speed.

Allow the engine to run until the temperature gauge is in the normal operating zone.

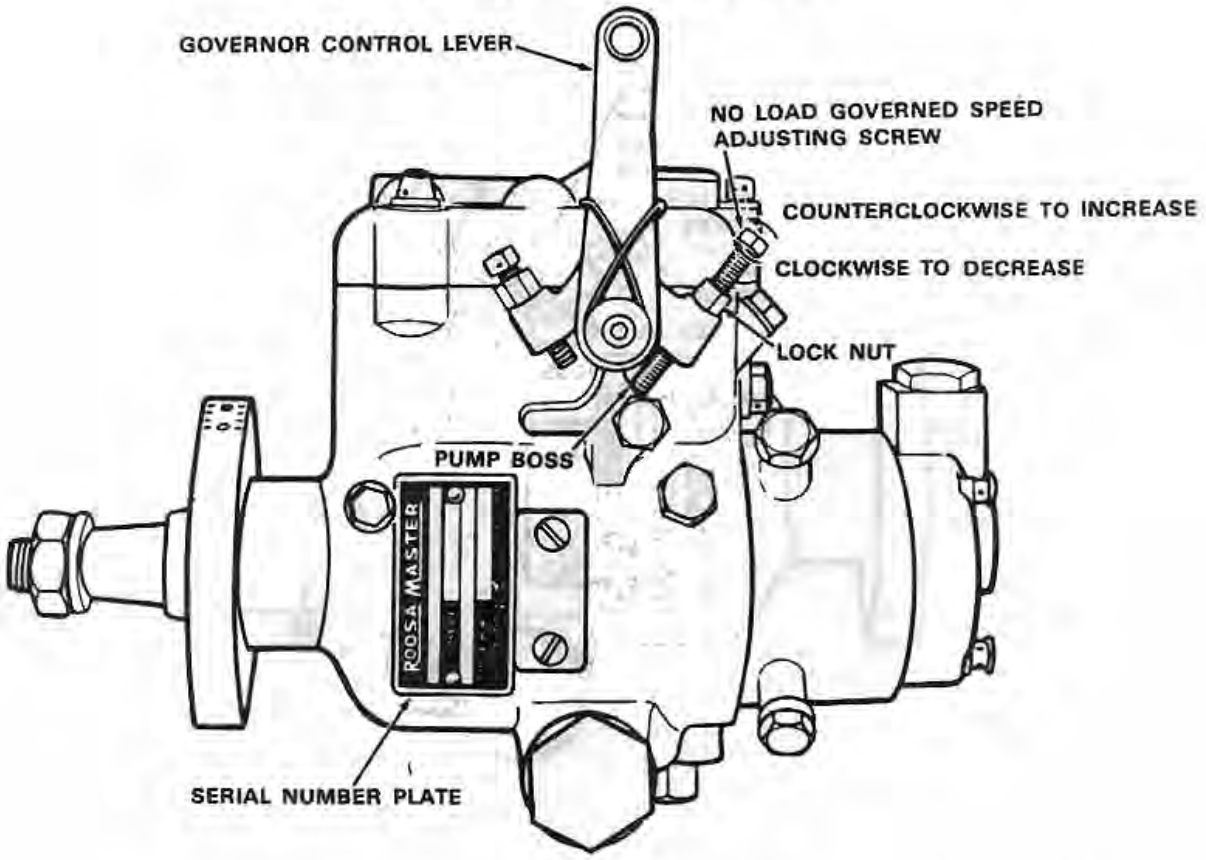
1. Take the speed reading from the tachometer drive shaft which runs at one half the engine speed. Hold the conical rubber tip against the tachometer drive shaft.
2. Hold the tachometer in position until the hand stops moving. Take the reading and double it to arrive at the no load governed engine speed.



3. To eliminate the possibility of error, check the engine speed with the tachometer at least three times.

ENGINE SPEED ADJUSTMENTS

No Load Governed Speed



IMPORTANT: Before changing or adjusting the No Load Governed Speed, make sure the engine is operating with the correct injection pump. The pump can be identified by the number stamped on the Serial Number Plate located on the side of the pump housing.

1. Set the engine throttle in the No Load Governed Speed position. The No Load Governed speed adjusting screw should be against the pump boss.

2. If the No Load Governed Speed adjusting screw is not against the pump boss, adjust the throttle linkage until it holds the pump control lever against the pump boss.

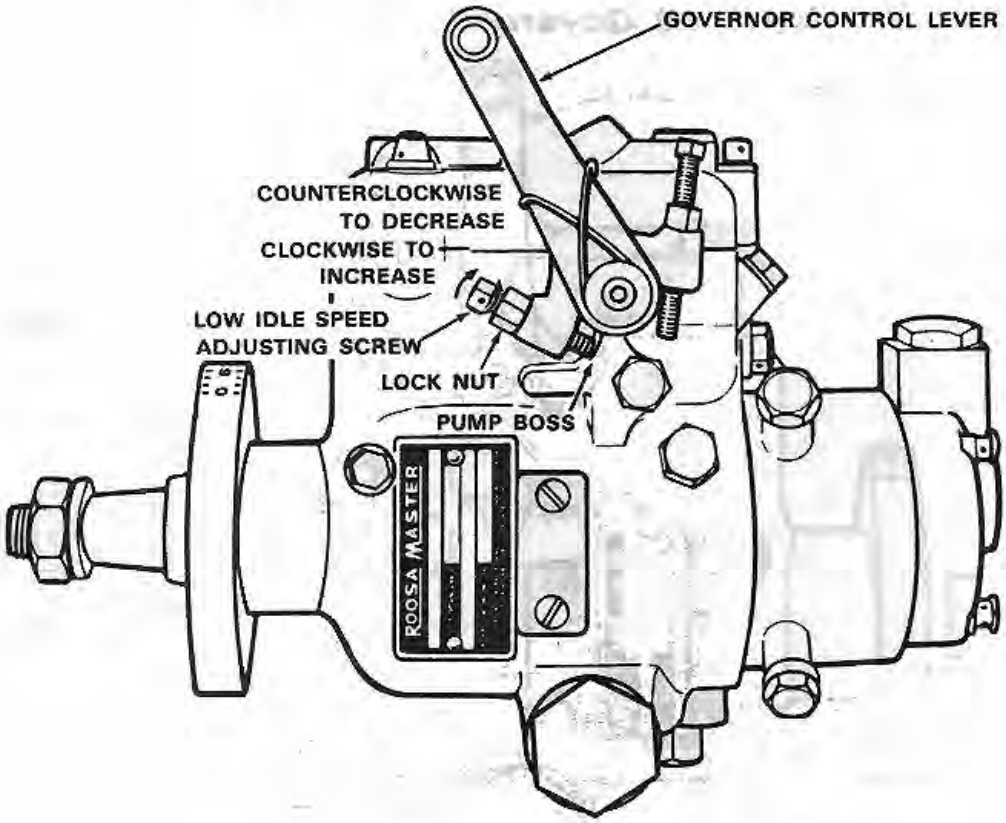
3. If the No Load Governed speed adjusting screw is against the pump boss but the No Load Governed Speed is still low, the speed can be increased a limited amount by means of the No Load Governed Speed adjusting screw.

4. *To increase* the engine No Load Governed speed by means of the No Load Governed Speed adjusting screw, loosen the Lock nut and turn the adjusting screw out (counterclockwise) 1/2 turn at a time and then tighten lock nut. Check the No Load Governed engine speed with the tachometer after each 1/2 turn.

5. *To decrease* the engine No Load Governed speed, set the engine throttle lever in the No Load Governed Speed position. Loosen the lock nut on the adjusting screw and turn the screw in (clockwise) 1/2 turn at a time until the correct No Load Governed engine speed is obtained. Check the No Load Governed engine speed with a tachometer after each 1/2 turn.

IMPORTANT: The No Load Governed Speed adjusting screw is sealed with a wire and lead seal. You must have the necessary equipment to reseal the adjusting screw when the adjustment is complete. Always make a record of the date you broke the seal, the serial number of the machine or engine and the reason why you broke the seal.

Low Idle Speed Adjustment



Set the engine throttle in the Low Idle Speed position. Check the position of the governor control lever. The Low Idle Speed screw should be against the pump boss.

If the Low Idle Speed screw is not against the pump boss, adjust the throttle linkage rod until it holds the control lever against the boss.

If the Low Idle Speed screw is against the pump boss but the engine speed is not correct, the engine speed can be increased or decreased a limited amount by means of the Low Idle Speed adjusting screw.

1. *To decrease* the engine speed by means of the Low Idle Speed adjusting screw, loosen the lock nut and turn the screw out (counterclockwise) 1/2 turn at a time until the correct engine speed is obtained. Check the engine speed with a tachometer after each 1/2 turn of the adjusting screw.

2. *To increase* the engine speed by means of the Low Idle Speed adjusting screw, loosen the lock nut and turn the adjusting screw in (clockwise) 1/2 turn at a time. Check the engine speed with a tachometer after each 1/2 turn of the adjusting screw.

3. After the correct engine speed is set, tighten the lock nut while holding the adjusting screw setting.

IMPORTANT: The Low Idle Speed adjusting screw is sealed with a wire and lead seal. You must have the necessary equipment to reseal the adjusting screw when the adjustment is complete. Always make a record of the date you broke the seal, the serial number of the engine and the reason why you broke the seal.

Section

3013

ROOSA MASTER FUEL INJECTORS

188 and 207 Diesel Engines

APPLICATION

Part Numbers		Color	Engine Application
Case	Roosa Master	Code Band	
A37836	17206, 18054	No Color	188
A50970	20552	No Color	207
A51234	19993,20348	No Color	188
A140827	20674	White & Blue	207
A140828	20673	White & Yellow	188
A140829	20671	White	188

SPECIFICATIONS

Part Numbers		Spray Angle	Spray Orifice Size	Sac Hole Length	Sac Hole Size	Opening Pressure	
Case	Roosa Master					New	Used
A37836	17206,18054	160°	.011" (.279mm)	.195" (4.953mm)	.042" (1.066mm)	2750 to 2850 (18 958.5kPa) to (19 647.9kPa)	2550 to 2650 (17 579.7kPa) to (18 269.1kPa)
A50970	20552	150°	.011" (.279mm)	.095" (2.413mm)	.042" (1.066mm)		
A140827	20674	150°	.011" (.279mm)	.095" (2.413mm)	.042" (1.066mm)		
A51234	19993,20348	160°	.011" (.279mm)	.095" (2.413mm)	.042" (1.066mm)	3150 to 3250 (21 716.1kPa) to (22 405.5kPa)	2950 to 3050 (20 337.3kPa) to (21 026.7kPa)
A140829	20671	160°	.011" (.279mm)	.095" (2.413mm)	.042" (1.066mm)		
A140828	20673	150°	.010" (.254mm)	.095" (2.413mm)	.042" (1.066mm)	2750 to 2850 (18 958.5kPa) to (19 647.9kPa)	to 2650 (17 579.7kPa) to (18 269.1kPa)

THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

WARNING *When testing or adjusting fuel injectors, do not place your hands or arms in front of the injector nozzle.*

The fuel spray from an injector has sufficient penetrating power to puncture the flesh and destroy tissue. Should the fuel enter the blood stream, it may cause blood poisoning.

In the event the skin is punctured from the discharge of an injector, apply the following first aid immediately and then have the injury examined by a physician as quickly as possible.

Wash the injured part with boric acid solution, support the injured finger or hand with a splint and sling so the injured part will remain absolutely at rest until a physician can examine it.

TABLE OF CONTENTS

SPECIAL TOOLS

SAC HOLE DRILLS SET OF 5 .010" 66-0151

TIP SEAT SCRAPER 66-0149

COMPRESSION GAUGE ADAPTER 70-314 (D558)

TORQUE WRENCH ADAPTER 66-0146

VALVE RETRACTOR 66-0148

ORIFICE CLEANING WIRES 66-0035

SEAL TOOL CASE PART A42449

TEST PUMP ADAPTER 65-878 (N49)

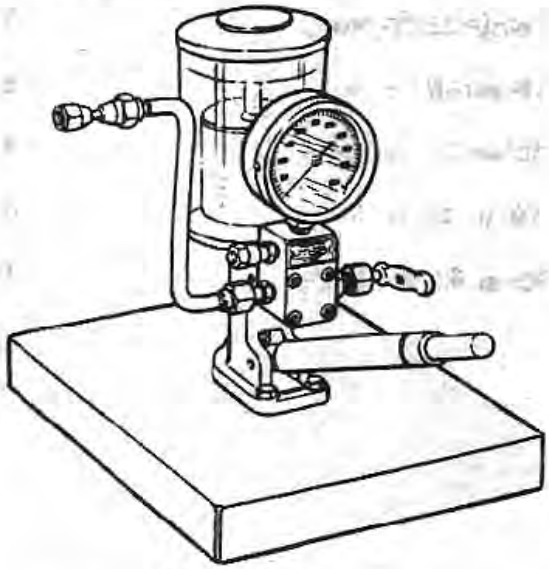
LAPPING COMPOUND 66-0145

INJECTOR HOLDING TOOL 66-0147

MAGNIFYING GLASS 66-0135

TOOLS IN CASE KIT NO. M20520

The individual parts can be ordered from the Bacharach Inst. Co. 200 N. Braddock Ave., Pittsburgh, Pa. 15208.



TEST STAND
CASE PART NO. M20322
BACHARACH PART NO. 65-934D

NOZZLE PULLING TOOL
CASE PART NO. A43278

BORE CLEANING TOOL
CASE PART NO. A43277

NOTE: Injector Tool Kit, Case Part No. M20520, Bacharach Part No. 60-0010. This kit is used in conjunction with the Case Diesel Tool Kits, Case Part No. M20247 (CD-800) and Case Part No. M20246 (CD-350).

SPECIFICATIONS

	U.S. Value	Metric Value
No. of orifices	4	
Valve lift	.009" or 1/2 turn off valve seat.	.229 mm
Nozzle leakoff rate	3 to 10 drops in 30 seconds at 1500 PSI after first drop appears (serviced injector).	10 341 kPa
Maximum opening pressure between cylinders	100 PSI	689.5 kPa

Opening pressure control spring:

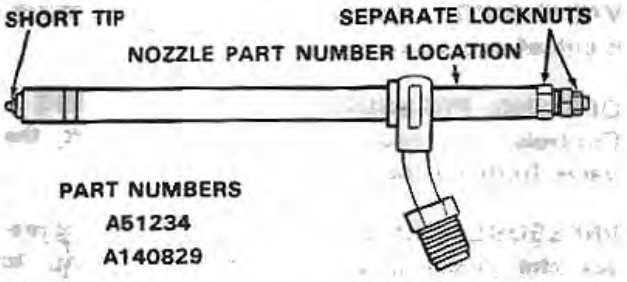
INJECTOR NO.	COLOR CODE	FREE LENGTH	NO. COILS	WIRE DIA.	SPRING O.D.	COMPRESSED
A50970 A51234 A140827 A140828 A140829	RED	.563" (14.3mm)	7.5	.058" (1.47mm)	.276" (7.01mm)	.456" to .478" at 29 lbs. (11.58mm to 12.14mm at 13.2 kg.)
A37836	NO COLOR	.536" (13.61mm)	7	.056" (1.42mm)	.272" (6.91mm)	.435" to .457" at 27 lbs. (11.05 to 11.61mm at 12.3 kg.)

SPECIAL TORQUES

Fuel injector clamp capscrews	18 to 22 ft. lbs.	24 to 30 Nm
Fuel injector leakoff nuts	35 to 45 in. lbs.	4 to 5 Nm
Fuel injector pressure adjusting screw locknut	70 to 75 in. lbs.	7.8 to 8.4 Nm
Fuel injector tube nuts	18 to 22 ft. lbs.	24 to 30 Nm
Fuel injector valve lift adjusting screw locknut	40 to 45 in. lbs.	4.5 to 5.0 Nm

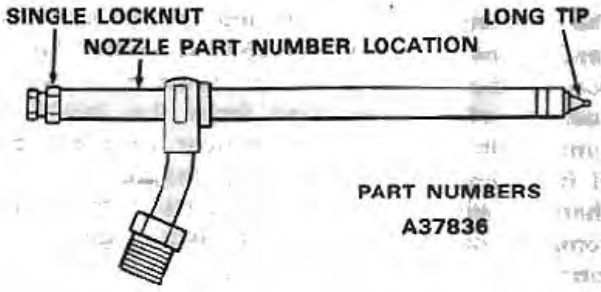
NOZZLE IDENTIFICATION

3200 PSI OPENING PRESSURE



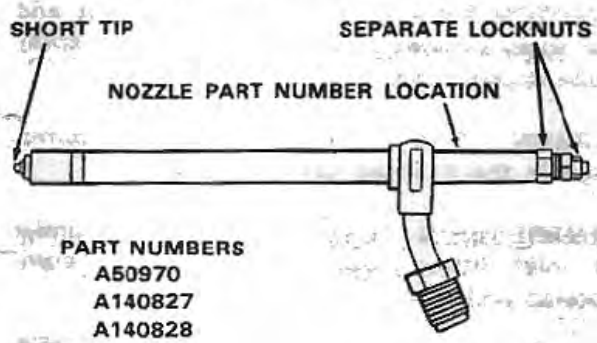
PART NUMBERS
A51234
A140829

2800 PSI OPENING PRESSURE



PART NUMBERS
A37836

2800 PSI OPENING PRESSURE



PART NUMBERS
A50970
A140827
A140828

GENERAL INFORMATION

The fuel injector is a closed end (injector valve does not project through an opening in the injector tip) differential pressure, hydraulically operated hole type injector.

The fuel injectors are located in the cylinder head - one for each cylinder. It is the function of the fuel injector to direct a metered quantity of fuel received from the injection pump to the combustion chamber. Each charge of fuel must be delivered into the combustion chamber with a definite spray pattern to insure complete combustion and efficient engine performance.

IMPORTANT: The injector body and valve is a mated assembly, accurately lapped to a very close fit for precise metering of fuel to each cylinder. The body or valve cannot be installed individually for service. If it is necessary to replace either the valve or body, replace the complete assembly.

IMPORTANT: Do not mix valves and bodies while disassembling the injector.

INJECTOR BODY - Houses the injector parts in their correct position in the cylinder head. The part of the injector body which projects into the cylinder head is Teflon coated to prevent sticking.

INJECTOR VALVE - Controls the flow of fuel from the injector.

VALVE GUIDE - Supports and guides the movement of the valve in the body.

OPENING PRESSURE CONTROL SPRING - Controls fuel pressure necessary to lift the valve from its' seat.

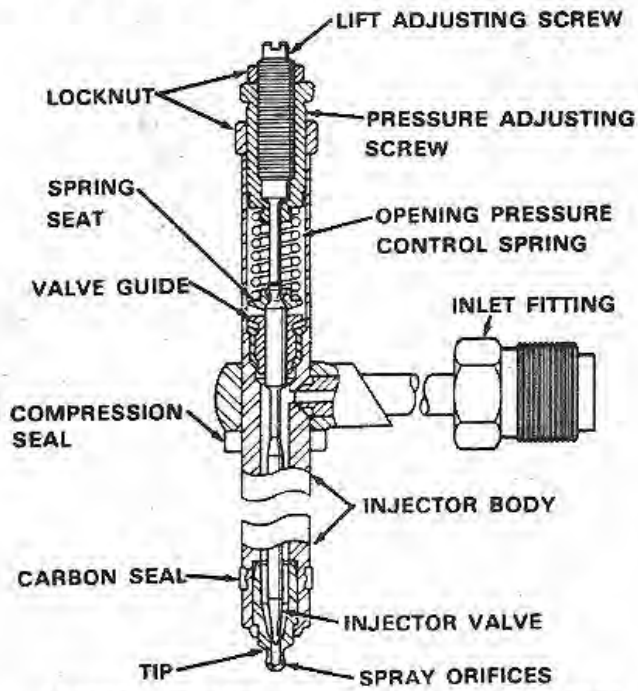
PRESSURE ADJUSTING SCREW - Compresses the opening pressure control spring to maintain a predetermined spring pressure on the valve.

LIFT ADJUSTING SCREW - Controls the valve travel distance.

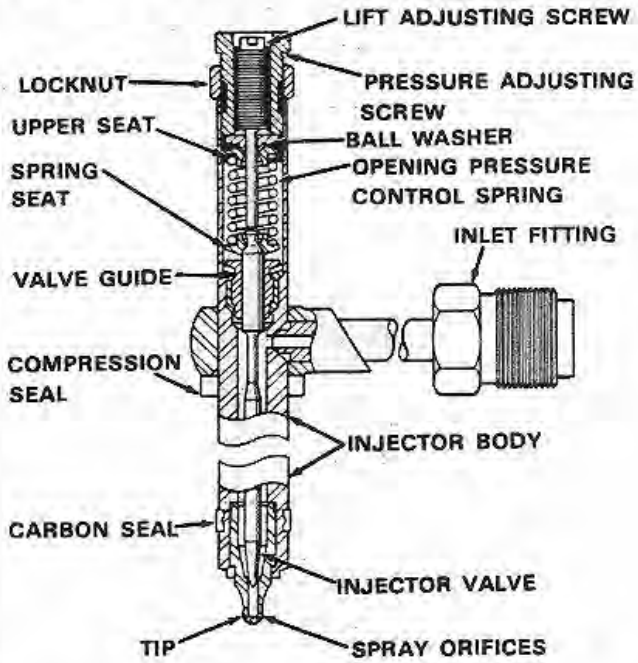
INJECTOR TIP - Contains the valve seat and four spray orifices which direct the fuel spray in the combustion chamber.

CARBON SEAL - Prevents carbon accumulation in the cylinder head openings.

COMPRESSION SEAL - A nylon seal under the inlet fitting that prevents engine compression leakage.



A51234 A50970 A140827 A140828 A140829



A37836

OPERATING PRINCIPLES

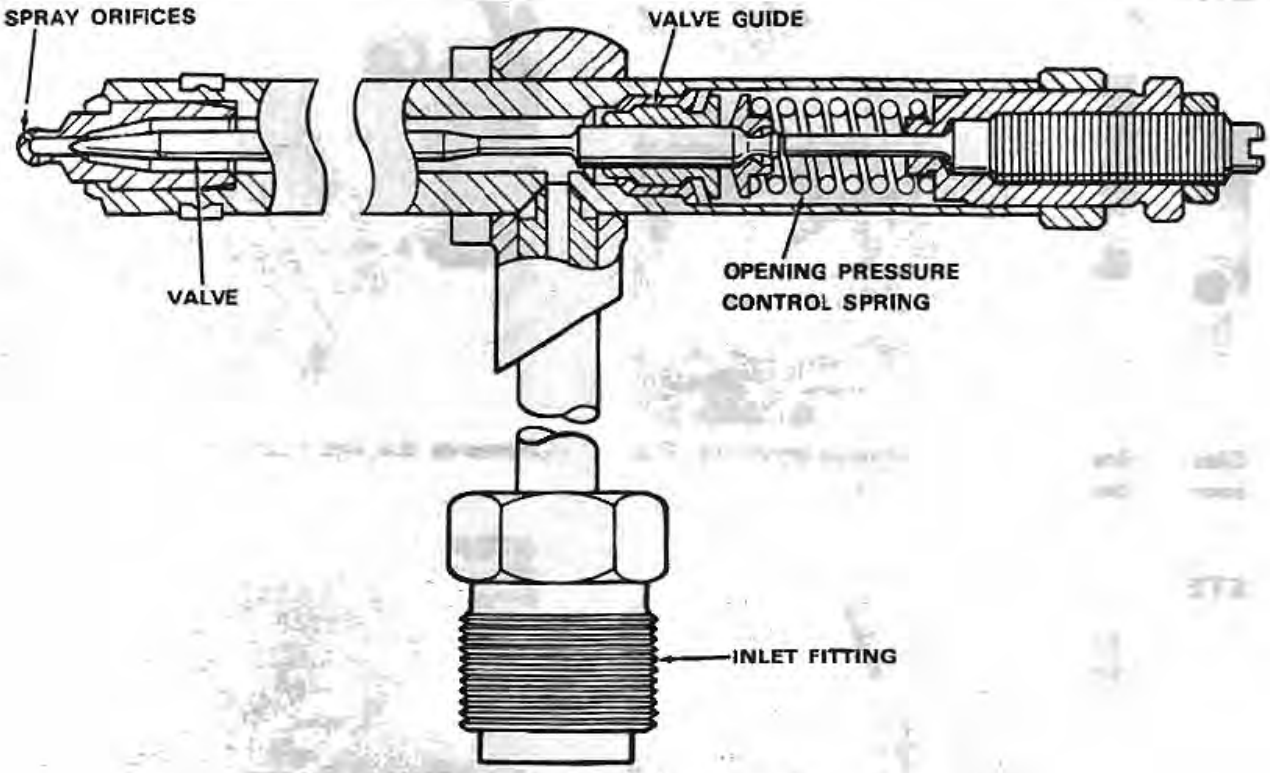
The operation of the injector is simple and positive.

A metered quantity of fuel under high pressure from the injection pump flows through the inlet line of the injector around the injector valve.

At the instant the pressure of the fuel against the valve exceeds the predetermined spring force, the valve is forced from its' seat allowing fuel under high pressure to flow through the four spray orifices to the combustion chamber.

The instant the fuel delivery ceases, the pressure against the valve is reduced and the control spring snaps the valve to its' seat. This eliminates any possibility of dripping after the metered amount of fuel has been delivered. In actual operation, the valve opens and closes very rapidly with a distinct chatter.

During injection, a small amount of fuel leaks through the closely controlled clearance at the guide, lubricating all the moving parts in the injector. This fuel then flows off through leak-off lines at the top of the injector and returns to the fuel tank.

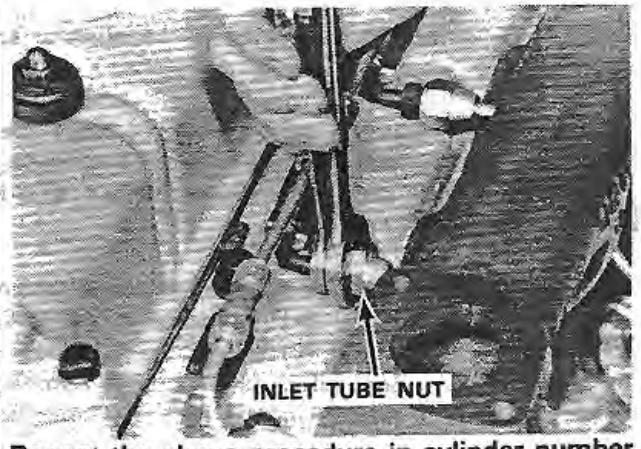


ISOLATING FAULTY INJECTORS

STEP 1

If the engine is misfiring and one or more of the injectors is suspected, the following procedures can be utilized to isolate the faulty injectors. *NOTE:* The engine should be run at a speed where the misfiring is most apparent.

Using the one-hand, two-wrench method, loosen the fuel inlet tube nut for the number one cylinder injector. If the injector is faulty, there should be no noticeable affect on engine performing. Tighten the inlet tube nut using the one-hand, two-wrench method.



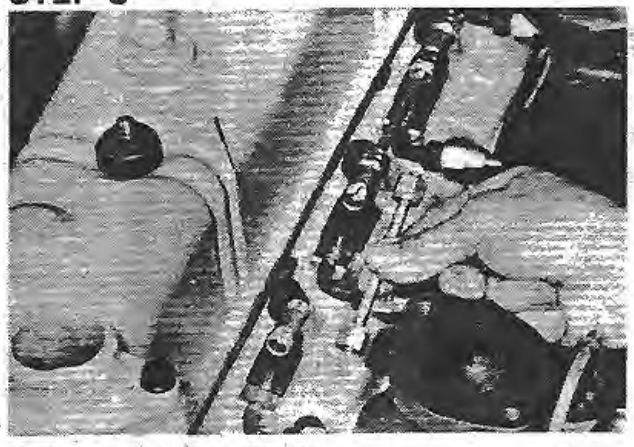
Repeat the above procedure in cylinder number sequence for the remaining injectors.

REMOVING INJECTORS

STEP 2

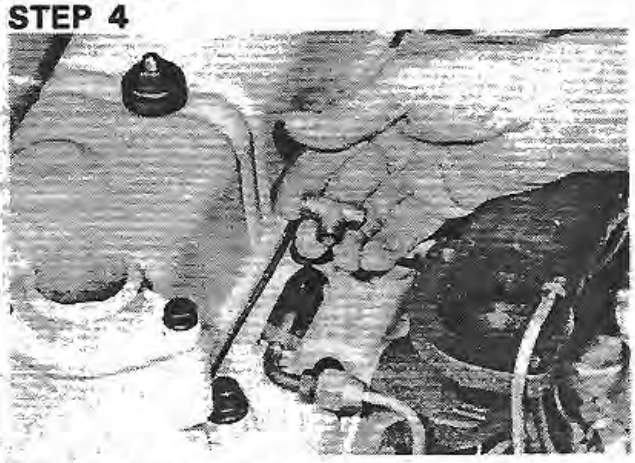
Clean cylinder head area around injectors. Disconnect the leak-off line nuts.

STEP 3



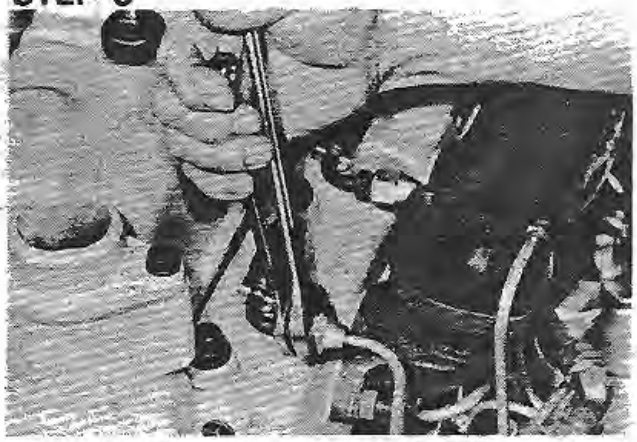
Remove the leak-off lines.

STEP 4



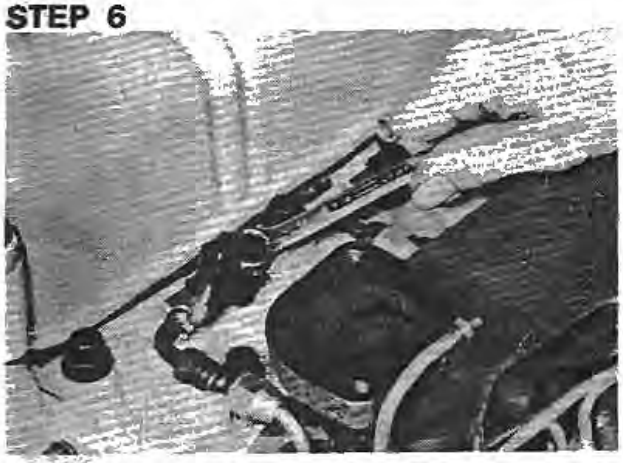
Remove the injector tees.

STEP 5



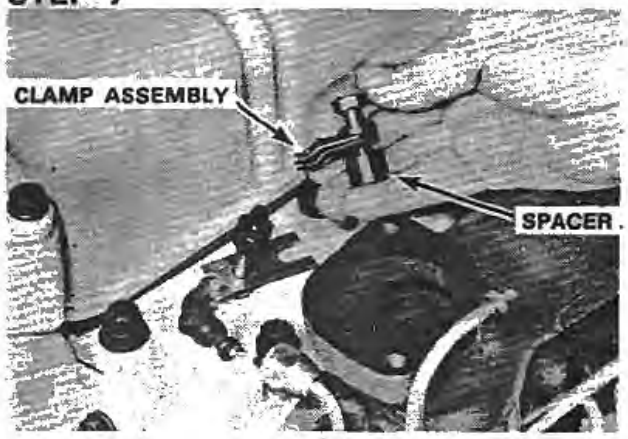
Disconnect the inlet fittings using the one hand, two-wrench method.

STEP 6



Loosen injector clamp assemblies.

STEP 7



Remove the clamp assemblies and spacers.

STEP 8

Remove the tee nuts from the injectors.

STEP 9

Remove the injectors by pulling upward and turning. *IMPORTANT:* Never attempt to remove an injector by prying with a screwdriver or similar tool. If an injector cannot be easily removed by hand, proceed to Step 10.

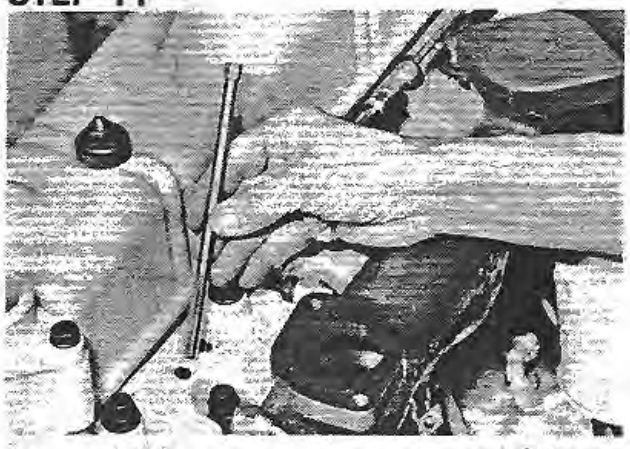
STEP 10

Remove the injectors using nozzle puller, Case Part No. A43278.

INSTALLING INJECTORS

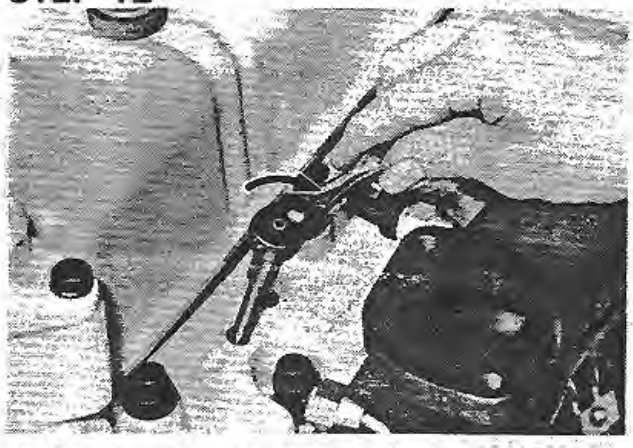
Clean and inspect the cylinder head, injector inlet fittings and seal surfaces. Dirt or burrs on the sealing surfaces can cause injector distortion when clamping injector in place, resulting in a sticking valve.

STEP 11



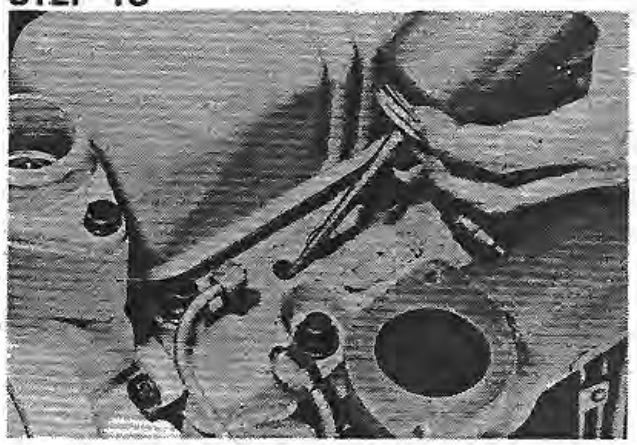
Clean cylinder head injector bore using bore cleaner, Case Part No. A43277.

STEP 12



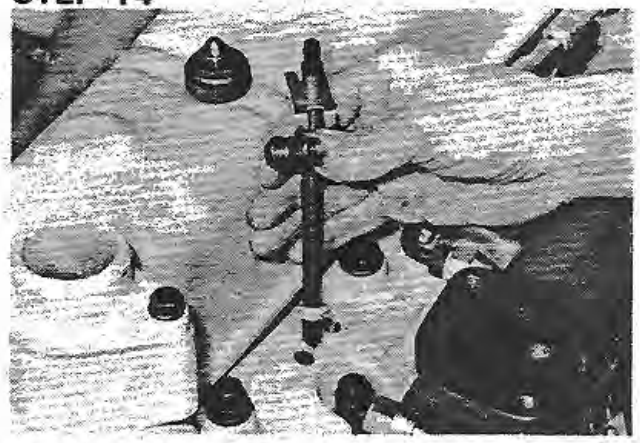
Always turn tool clockwise. Counter-clockwise rotation dulls the tool. Blow out with compressed air.

STEP 13



Squirt a few drops of clean engine oil in eac cylinder head injector hole to provide lubricant for carbon dam at lower end of injector when being installed.

STEP 14



Install injectors into cylinder head bores using a twisting motion.

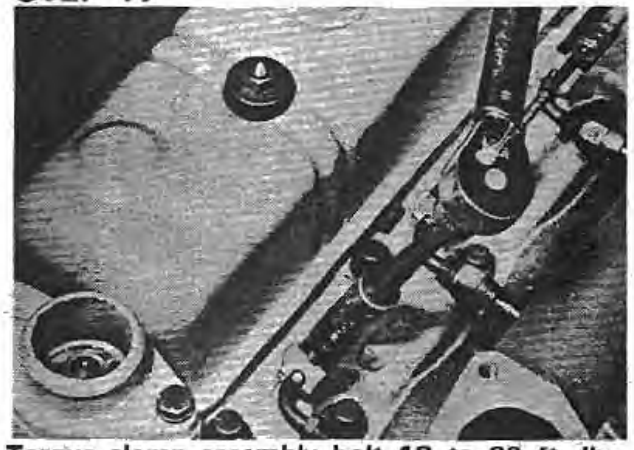
STEP 15

Install injector tee nut.

STEP 16

Install spacer and clamp assembly, engaging lock plate.

STEP 17

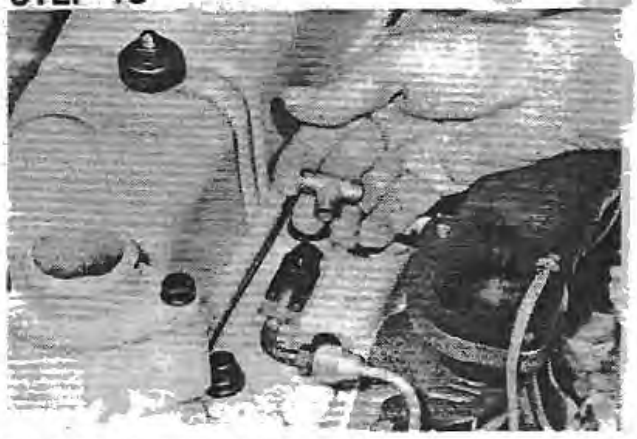


Torque clamp assembly bolt 18 to 22 ft. lbs.

STEP 18

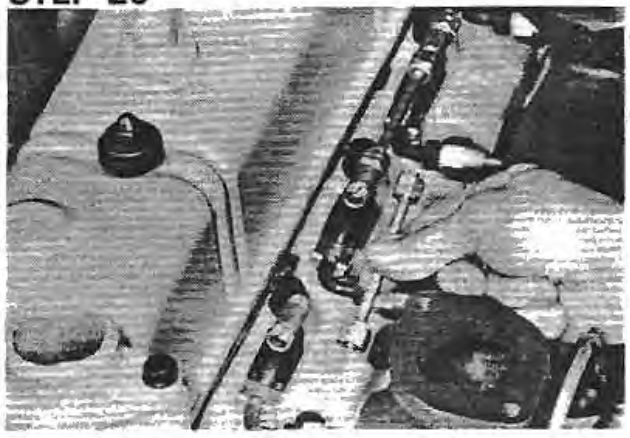
Connect and hand tighten inlet connection to tube.

STEP 19



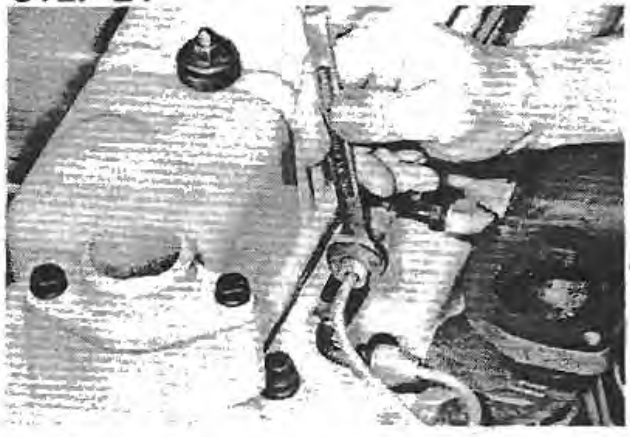
Install injector tee.

STEP 20



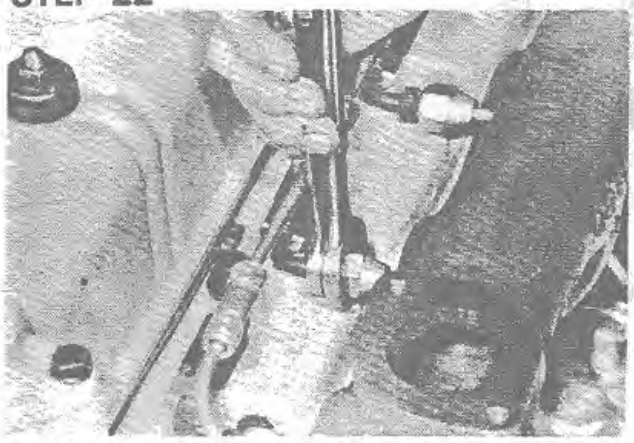
Install leak-off lines.

STEP 21



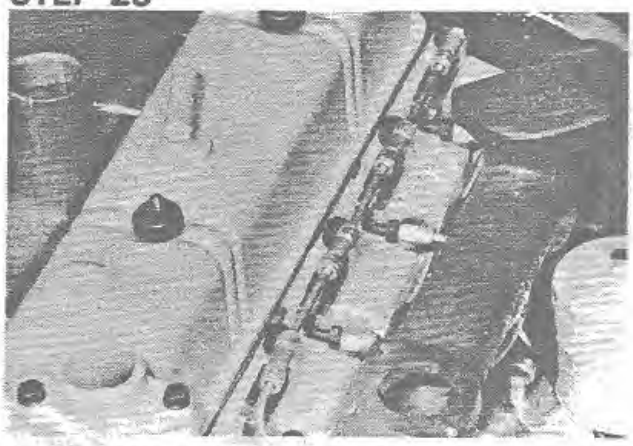
Tighten the leak-off line nuts.

STEP 22



To bleed the air from injection tubes, loosen the inlet fittings and crank engine until fuel flows from the inlet fitting. Then tighten the inlet fitting using the one-hand two-wrench method.

STEP 23

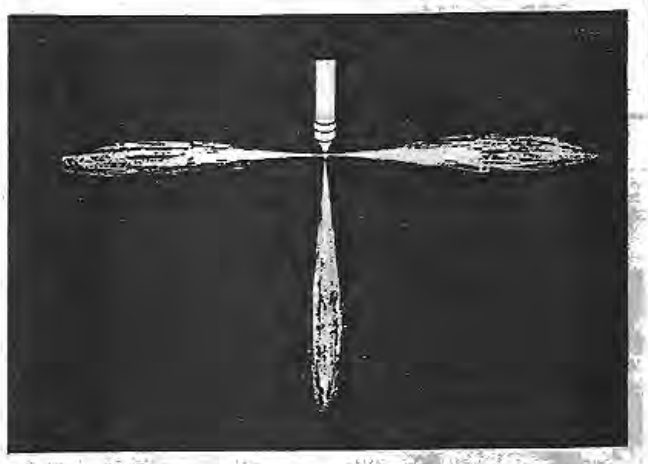


Start engine and check for leaks.

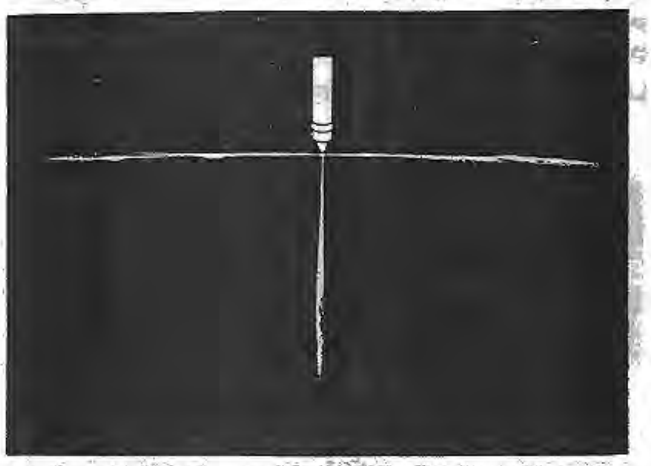
TESTING INJECTORS (Continued)

Spray Pattern

Close the pressure gauge. Operate the tester at 60 strokes per minute and observe the spray pattern. Fuel should be finely atomized and not a solid irregular spray pattern.



Fine Atomized Spray Pattern



olid Type Irregular Spray Pattern

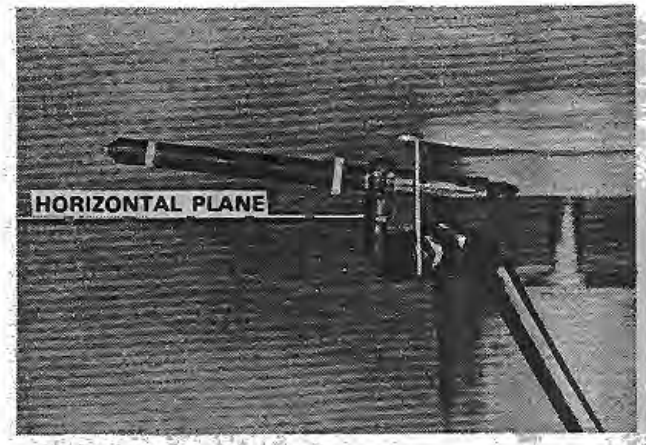
The injector will chatter when the tester is operated rapidly. Although this chatter may not occur in operation of the injector in the engine, it is an indication of valve freedom and will improve atomization. Chatter is generally an indication of good seat width and interference angle conditions.

If the injector produces a solid type irregular spray pattern, proceed as follows:

1. Check for eroded, clogged or chipped orifices. See Page 18.
2. Disassemble and clean injector, See pages 16 thru 21.
3. Lap the valve to guide area. See pages 18 and 19.
4. Check for pitted or eroded valve or seat, valve interference angle worn, bent valve and distorted body. These conditions would require replacement of the complete injector assembly.

Injector Leak-Off

Loosen connector nuts and reposition injector tip slightly above a horizontal plane. Tighten connector nuts and raise pressure to 1500 PSI. Observe leakage from the return end of the injector. After one drop falls, leak-off should be 3 to 10 drops in 30 seconds with No. 2 diesel fuel at room temperature (65°-75°F.).



If the leak-off does not meet this specification, proceed as follows:

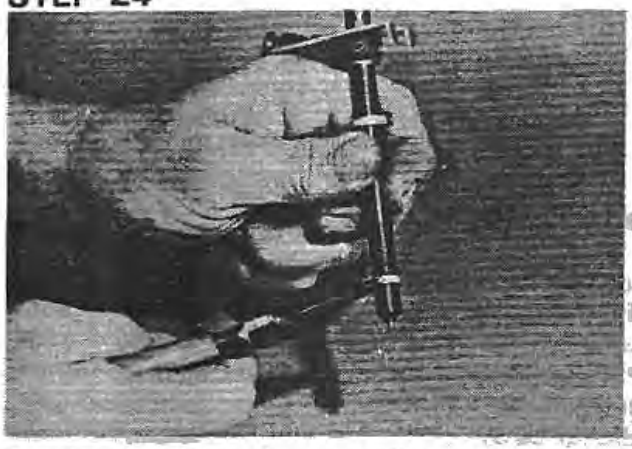
1. If excessive leak-off is noted, injector must be replaced.
2. If low leak-off is noted, disassemble and clean injector. See Pages 16 thru 18.
3. Lap the valve to guide area to increase the nozzle leak-off. See pages 18 and 19.

SERVICING INJECTORS

Disassembly

Because the injector contains closely fitted parts which are precision ground and finished, dirt is its' greatest enemy. Exercise utmost care in keeping the work area and tools clean. Handle all parts carefully to avoid damage.

STEP 24



Remove and discard carbon dam seal.

STEP 25

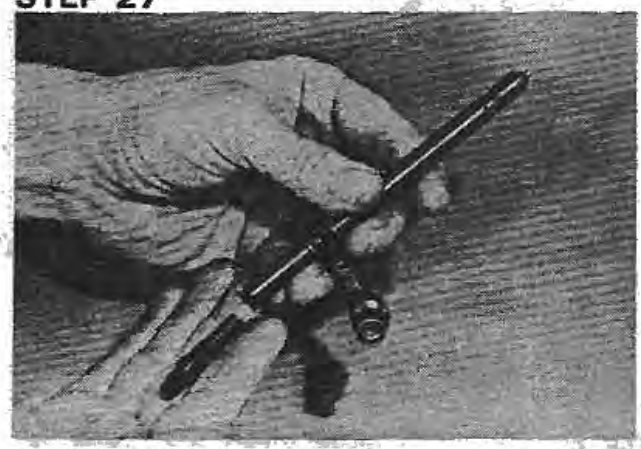
Remove and discard compression seal.

STEP 26

INJECTOR HOLDING TOOL 66-0147

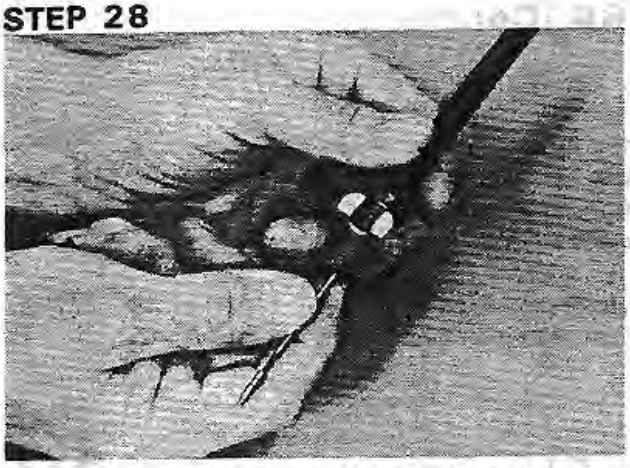
Place injector in the holding tool Bacharach Part No. 66-0147 and secure the tool in a vise. Loosen the pressure adjusting screw locknut.

STEP 27



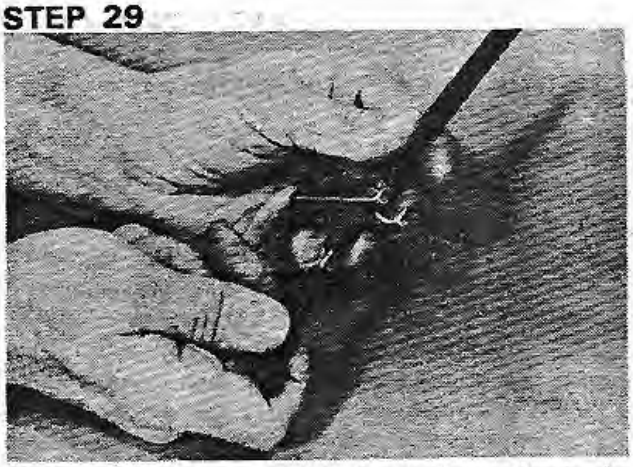
While holding the injector body in one hand, invert it and back out the pressure adjusting screw, allowing the spring and spring seat to fall into your other hand.

STEP 28

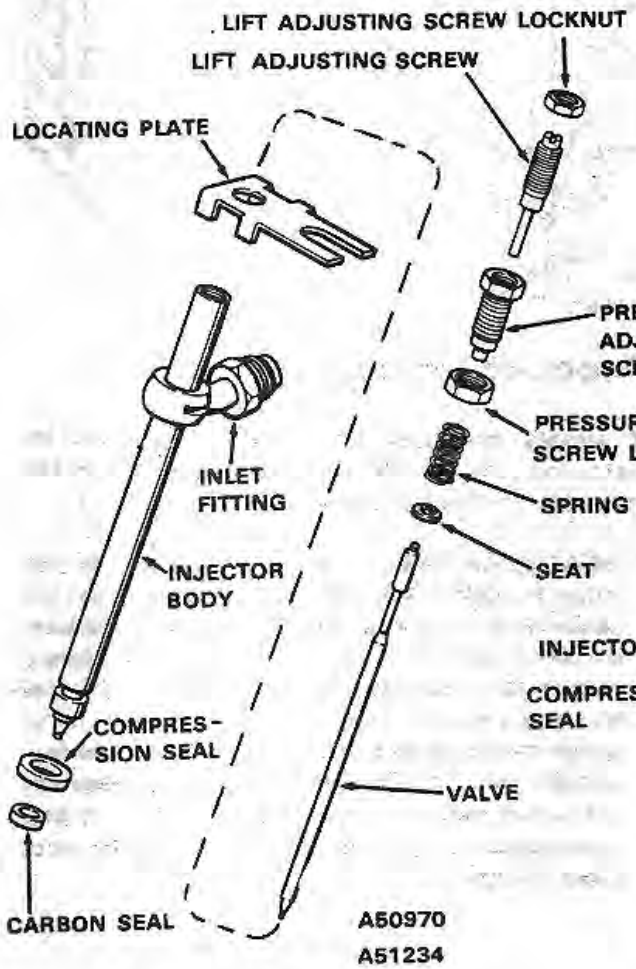


The valve may slide out of the body at this time and should be handled carefully by its' stem.

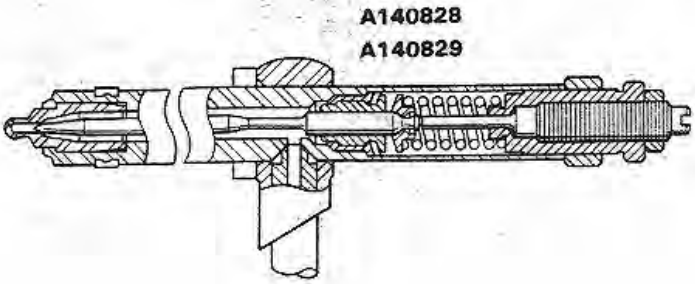
STEP 29

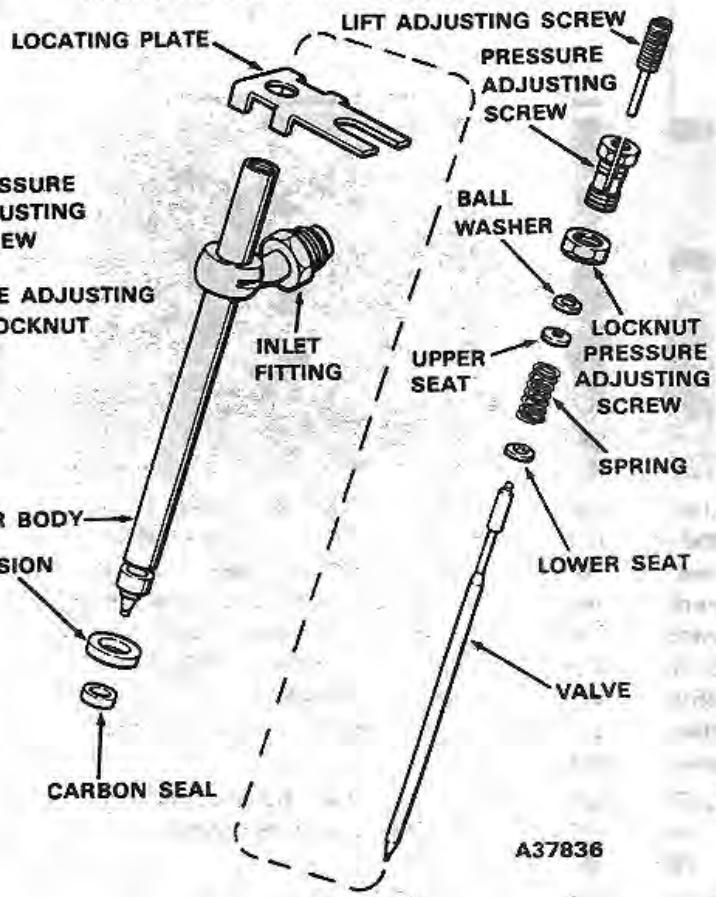


If the valve does not slide freely from the body, use valve retractor Bacharach Part No. 56-0148, to remove the valve. To prevent bending the valve, bottom it in the body with the retractor. Push down on the retractor body to mount the collet. Turn the knurled nut counterclockwise to secure the collet and withdraw the valve.

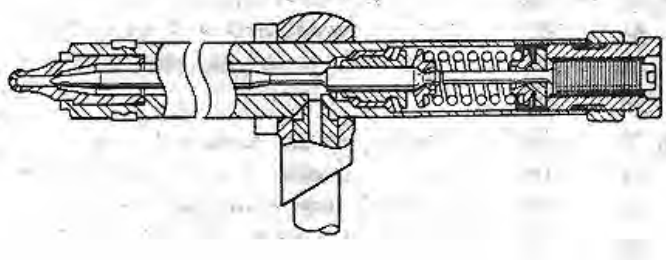


A50970
A51234
A140827
A140828
A140829





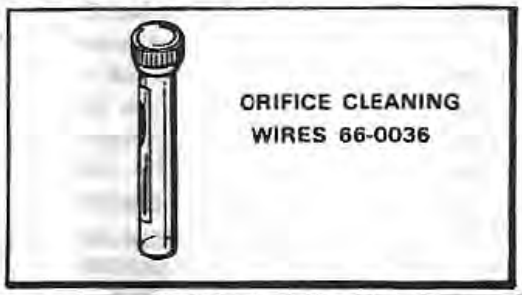
A37836

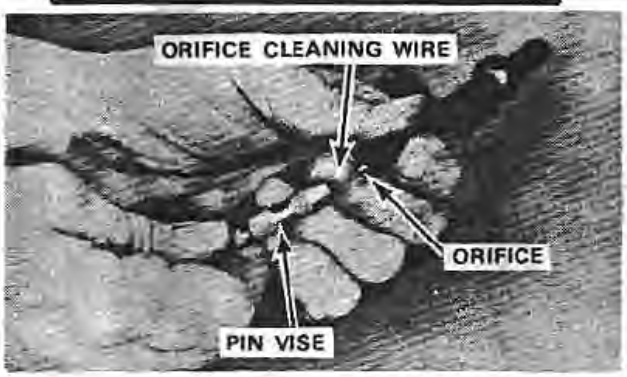


SERVICING INJECTORS (Continued)

Cleaning and Inspection

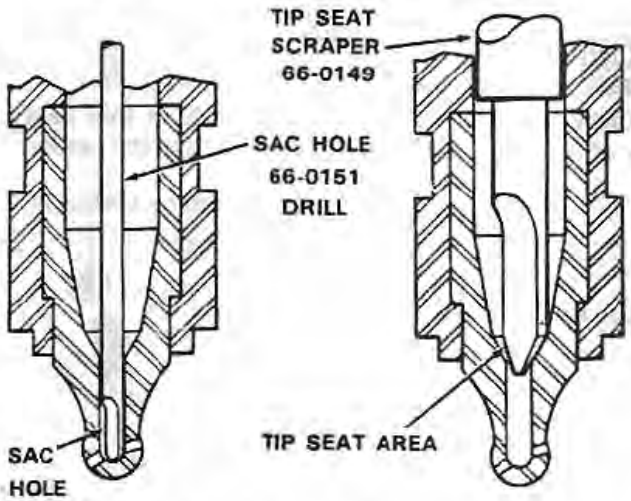
1. All parts should be placed in a solvent to loosen carbon deposits.
2. A brass wire brush should be used to clean the tip and body exterior. To clean carbon from spray orifices, use cleaning wires Bacharach Part No. 66-0036 in .010", .011", and .012" diameter. Secure the wire in a pin vise with the end protruding 1/32". A longer length of wire will bottom on the opposite wall of the sac hole and tends to break easily.





Use a stone to remove cutting burrs from the end of the wire. If a small flat is stoned on one side of the wire it will facilitate cutting carbon from the orifice. Insert the cleaning wire and rotate it until it is free. Flush the body and inspect the tip. If any orifices are chipped at the edges or eroded to an extent that spray pattern is affected, the injector should be replaced.

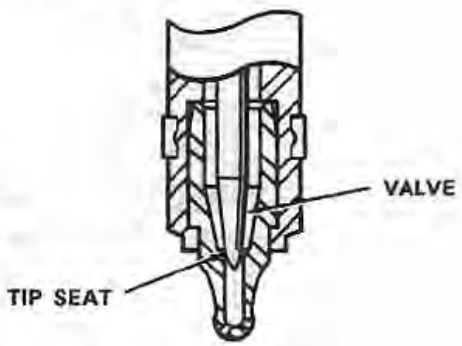
3. The seat area in the tip can be cleaned using the tip seat scraper tool Bacharach Part No. 66-0149.
4. Insert sac hole drill Bacharach Part No. 66-0151 into the sac hole, rotate it to clean deposits from the sac hole; repeat orifice cleaning.
5. The injector valve may be cleaned with a brush to remove deposits from the seat area. Varnish should be removed with a solvent and felt cleaning pad. Do not chuck the valve in a motor driven lapping lathe for cleaning, as this technique will bend the valve. Inspect the valve for pitting or erosion which could cause leakage.
6. Inspect the adjusting screws for thread damage and replace if necessary.



Reconditioning Injectors

If simple cleaning does not restore an injector to proper operating condition, use the methods outlined below:

1. SEAT LEAKAGE - If lack of freedom of the valve movement has been ruled out as the cause of seat leakage, the valve may be cleaned up by lapping it to the tip seat. Use lapping compound Bacharach Part No. 66-0145, for this purpose. The purpose of lapping is to polish the seats of both valve and tip to obtain a tight seal. Excessive lapping will destroy the interference angle between the seat and valve, causing a loss of chatter with poor atomization.



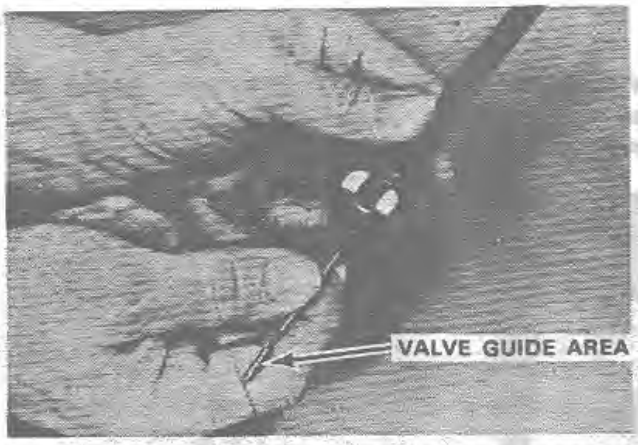
SERVICING INJECTORS (Continued)

Place a small amount of lapping compound Bacharach Part No. 66-0145 on the valve seat and insert valve into the body. Grip the top of the valve with the retractor Bacharach Part No. 66-0148.

Rotate the valve by hand, first clockwise then counterclockwise for a total of 3 - 5 revolutions. *IMPORTANT:* Never attempt to use motor driven chucks of any kind for this purpose. Flush the body thoroughly. Wash the valve and reassemble injector.

The injector may be then retested. If the valve and seat is worn, the seat may be tight, but chatter may be lost in the lapping process. In such case, the injector must be replaced.

2. VALVE GUIDE SERVICING: Low return leak-off is an indication of varnish accumulation between the guide and valve. Insufficient clearance can cause sticking and loss of chatter. If return leak-off is found to be below specified quantities, the valve guide clearance may be increased by lapping.



Place a small amount of lapping compound Bacharach Part No. 66-0145 on the guide area of the valve. Bottom the valve in the body and grasp with the retractor as previously described. Rotate the valve ten revolutions while raising and lowering it very slightly. Flush and wash compound from both components. Assemble and recheck return leak-off. If leak-off is still low, lap the guide until correct leakage is obtained. Always flush the injector thoroughly after lapping.

IMPORTANT: The required amount of material removed is usually only a few millionths of an inch. Never use motorized chucks for this operation.

SERVICING INJECTORS (Continued)

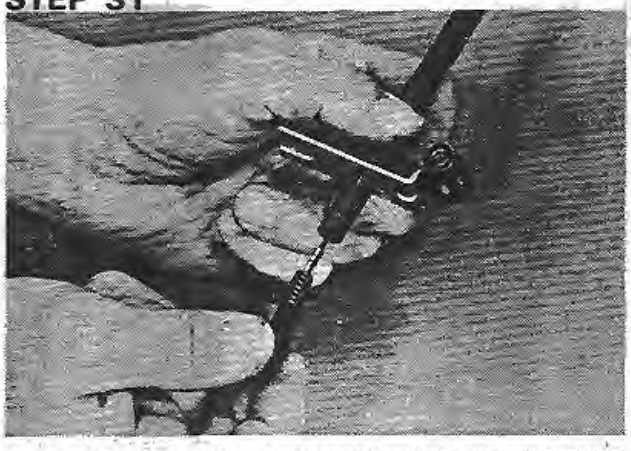
Assembly

Wash and flush all parts thoroughly before assembly. Wet all injector parts and hands with clean fuel during assembly.

STEP 30

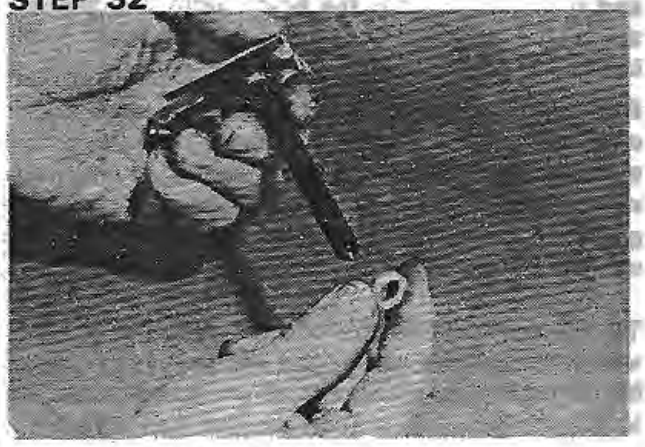
Handle the valve by its' shank and slide it partially into the body. Install the locating plate on the body before assembling the pressure adjusting screw and locknut.

STEP 31



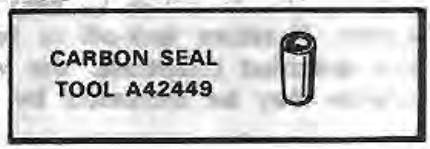
Assemble the spring and seat (on injector A37836 assemble spring, ball washer and upper spring seat) on the lift and pressure adjusting screw assembly. Tilt the injector body and with the spring seat contacting the valve top, push the valve and spring components into the body. Exercise care not to dislodge the spring seat during this assembly. Thread the pressure adjusting screw into the body by hand until the spring is compressed sufficiently to hold all parts in place.

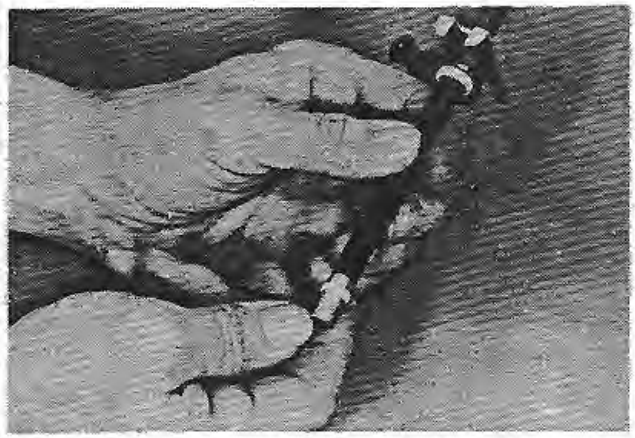
STEP 32



Install a new compression seal.

STEP 33



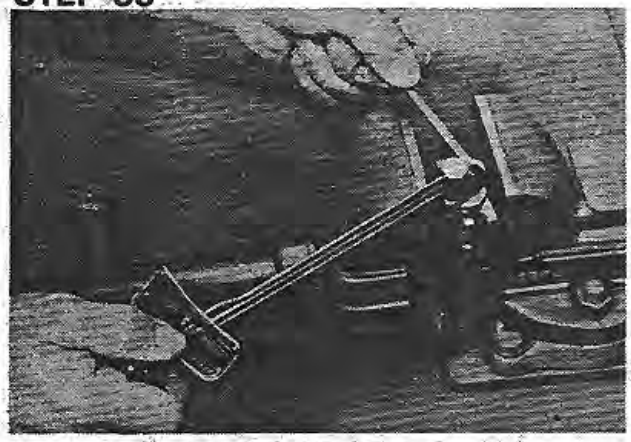


Install a new carbon dam seal using the carbon seal tool, Case Part No. A42449.

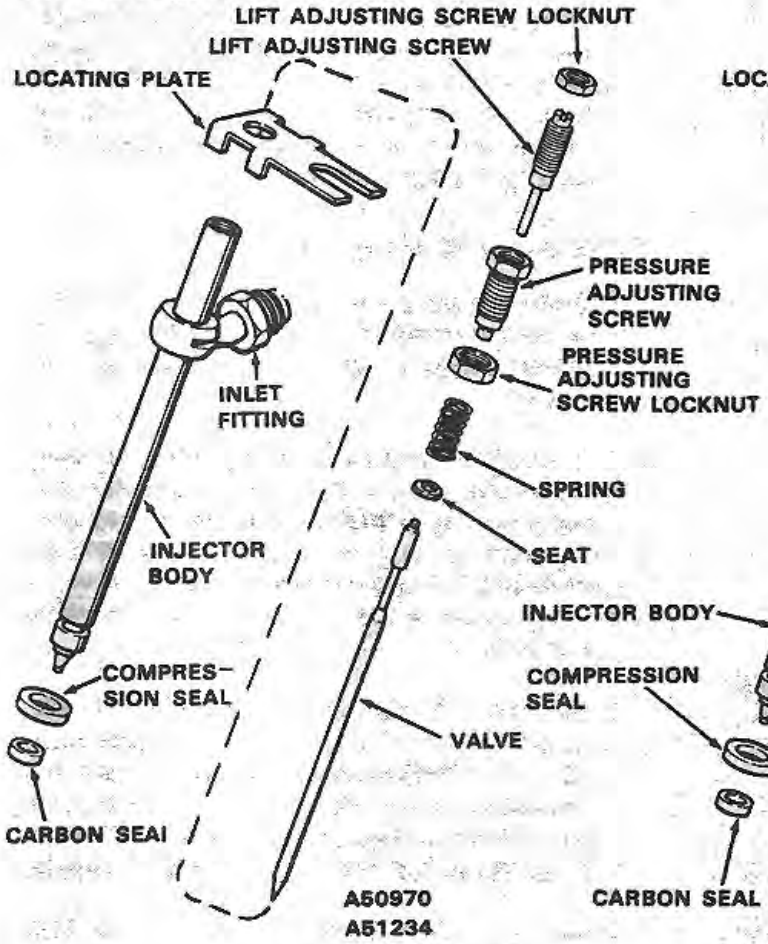
STEP 34

Install injector assembly on the test stand. Test and adjust opening pressure valve lift and leak-off. See Page 22 for injector adjustments.

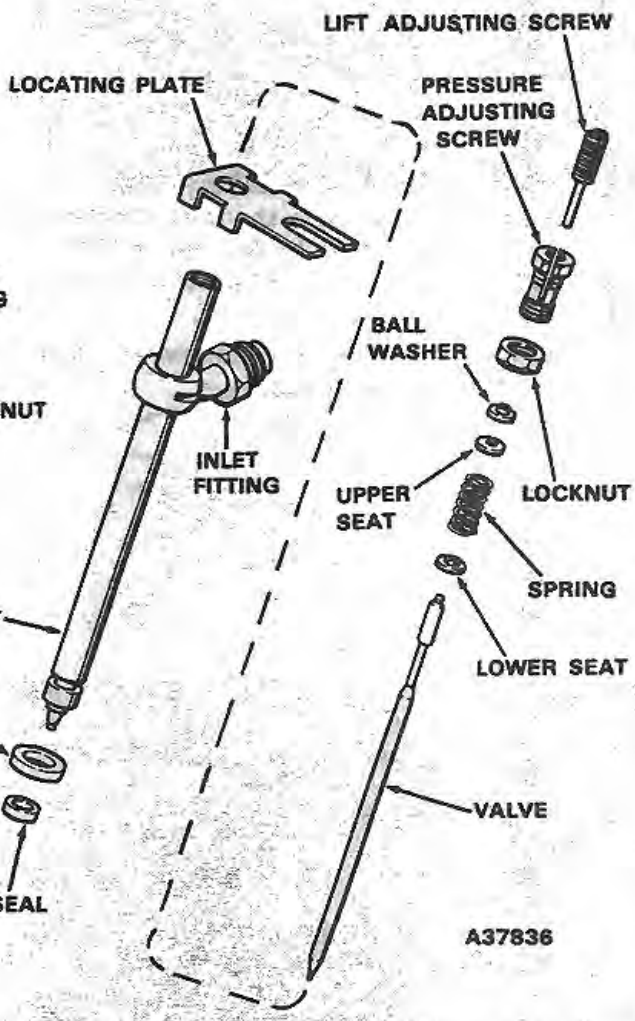
STEP 35



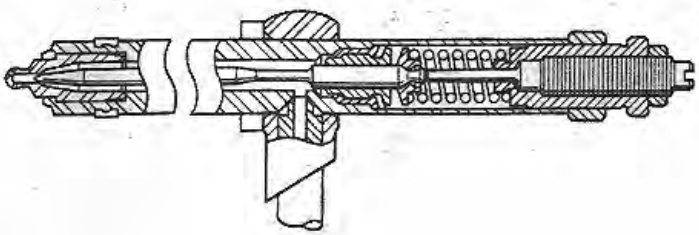
Tighten locknut 70 to 75 inch lbs.

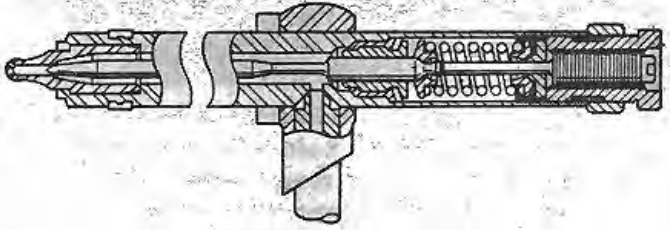


A50970
A51234
A140827
A140828
A140829



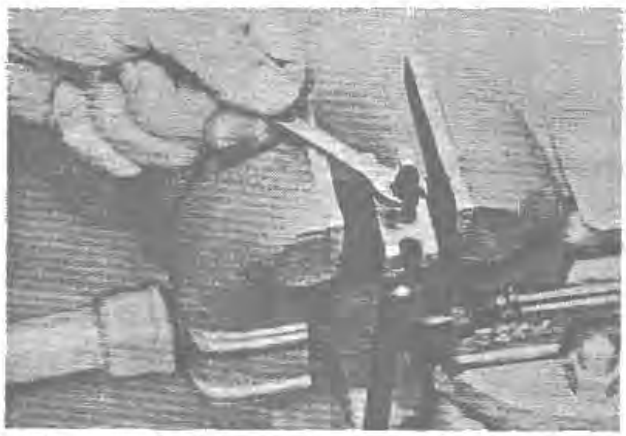
A37836



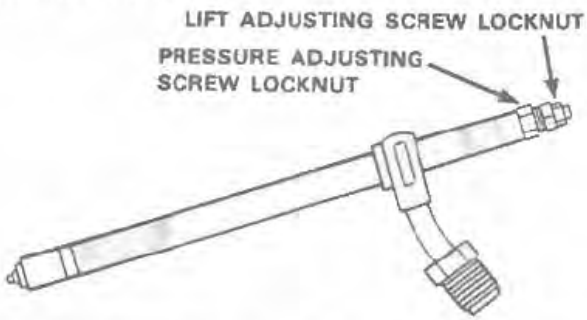


INJECTOR ADJUSTMENTS

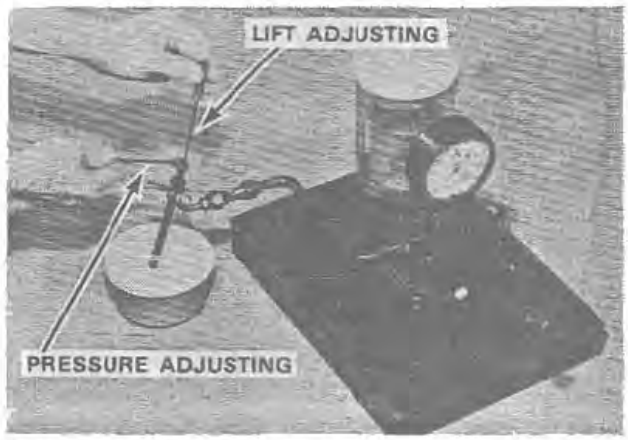
Adjusting Opening Pressure



1. Remove the injector from the test stand and secure in holding tool, Bacharach Part No. 66-0147, in a vise. Loosen the pressure adjusting screw locknut.



2. Loosen the valve lift adjusting screw locknut if equipped, while holding the valve lift adjusting screw. Then reconnect the injector, with the tip downward onto the test stand, Case Part No. M20322.



3. Back out the lift adjusting screw one full turn. While pumping fuel through the injector, note the opening pressure. Turn the pressure adjusting screw, while holding the lift adjusting screw,clockwise to increase opening pressure or counterclockwise to lower the opening pressure. Do not tighten the pressure adjusting locknut at this time.

Setting Valve Lift

1. While pumping fuel through injector, hold the pressure adjusting screw and slowly turn lift adjusting screw clockwise until valve ceases to open.

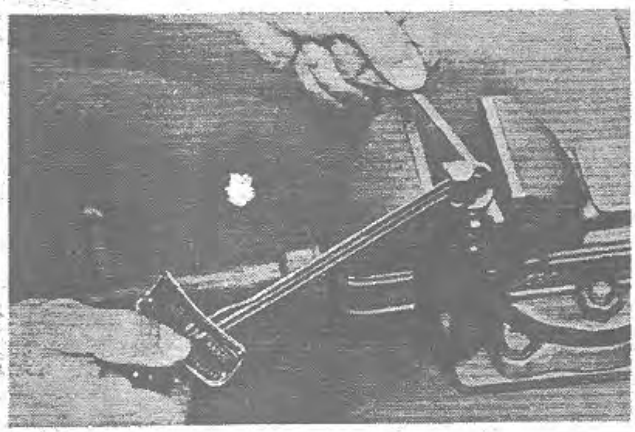
2. Check for bottoming of the valve by raising the pressure 200-500 PSI over injector opening pressure. Although some fuel may collect on the tip, a rapid dribble should not be apparent. Do not manually bottom the valve with excessive force as bending of the valve can result.

3. Turn the lift adjusting screw counter-clockwise 1/2 of a turn to obtain the specified lift. Hold the lift adjusting screw and tighten the lift adjusting screw locknut 40 to 45 in. lbs. Use Snap-On Tool 1/4" Crowsfoot Wrench No. AN9508-6 and a in. lb. torque wrench.

4. Recheck the opening pressure. Note that the lift is set before checking spray pattern and chatter as the amount of lift will affect these characteristics.

Tightening Locknut

TORQUE WRENCH
ADAPTER 66-0146



Remove the injector from the test stand and place in the holding tool in vise. Tighten the pressure adjusting screw locknut 70 to 75 in. lbs. torque, using torque wrench adapter, Bacharach No. 66-0146. *NOTE:* The pressure adjusting screw must be kept from turning while tightening the locknut. Recheck opening pressure on the test stand.

Section 3052

ENGINE CONTROLS, FUEL LINES AND FUEL TANK

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

THROTTLE ADJUSTMENTS

Engine Speeds

Low idle . . . . . 725 ± 25 rpm (r/min)

High idle . . . . . 2250 ± 20 rpm (r/min)

Hand Throttle Adjustment

1. Engage parking brake and place four speed transmission in Neutral.

2. Check low and high idle speeds using a suitable tachometer.

   a. Start engine and run at low idle. Disconnect throttle rod at throttle lever on injection pump.

   b. Hold throttle lever against low idle and high idle stops on injection pump and note engine speed.

   c. If necessary, adjust engine speeds as instructed in Section 3012.

3. Adjust length of throttle rod so throttle lever on injection pump moves an additional 1/16"-1/8" (1.6-3.2 mm) after contacting the low idle stop on the injection pump.

4. Check to see that the throttle lever on the injection pump moves an additional 1/16"-1/8" (1.6-3.2 mm) after contacting the high idle stop on the injection pump. Adjust the hand throttle stop bolt, Figure 1, as required.

Accelerator Pedal Height

1. Check to see that hand throttle linkage is properly adjusted.

2. Place hand throttle in full throttle position. Adjust length on pedal clevis rod as required to obtain 1/16"-1/8" (1.6-3.2 mm) clearance between the pedal and pedal stop.

FUEL TANK REMOVAL AND INSTALLATION

1. Remove engine as instructed in Section 2050.

2. Drain the right and left-hand hydraulic reservoirs.

3. Remove tube between hydraulic oil filter and reservoir manifold tube.

4. Remove tube connected to hydraulic filter inlet and filter assembly from the machine.

5. Remove manifold between reservoirs.

6. Drain fuel from tank.

7. Remove fuel filler cap, filler neck grommet and wire from fuel level sending unit.

8. Remove nuts and washers from bottom of fuel tank straps.

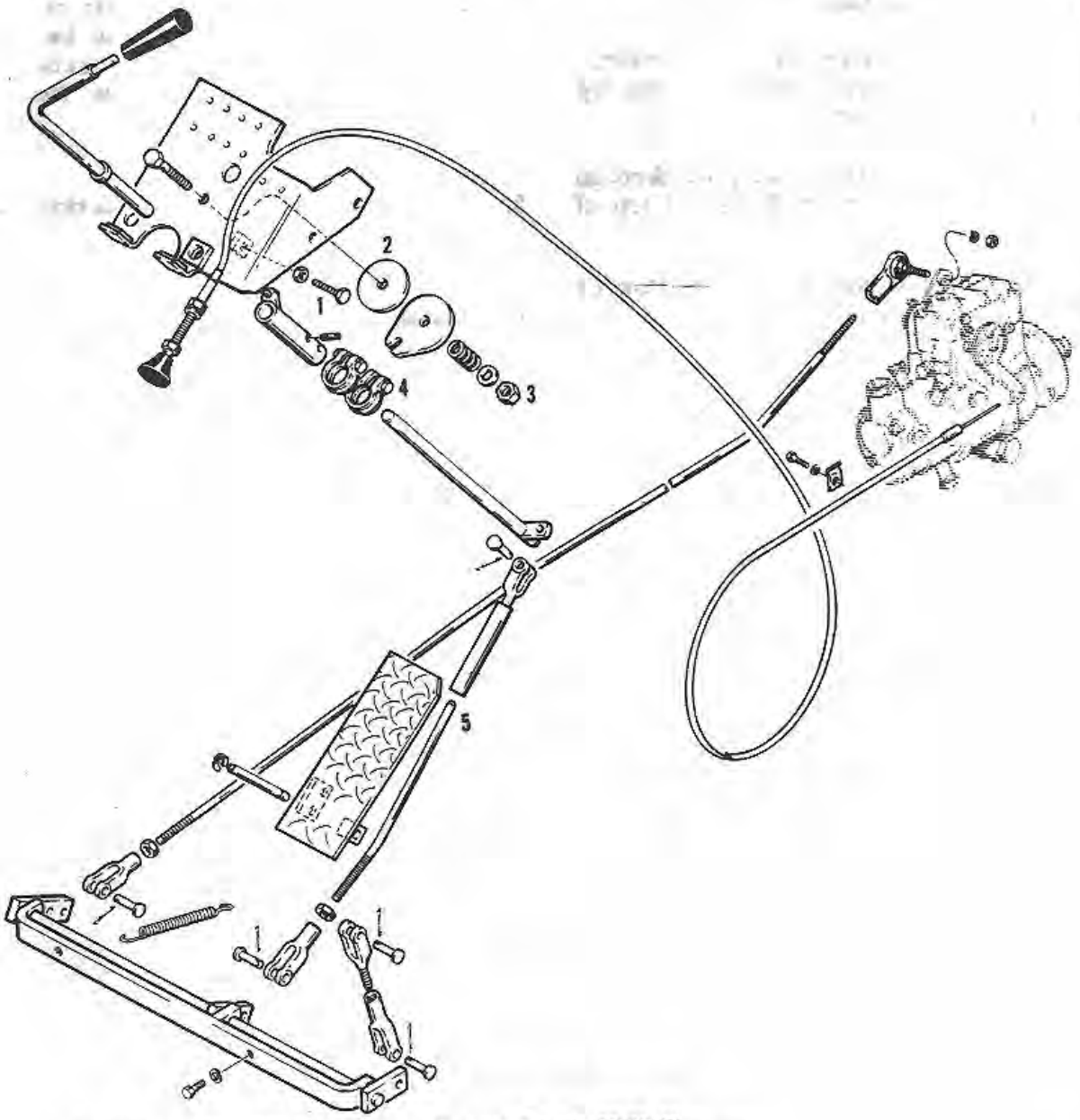
9. Lower fuel tank and swing bottom of tank toward the front at the same time to remove the tank.

10. Reverse steps 1 through 9 to install the fuel tank. It is recommended that fuel drained from tank be filtered before it is returned to the tank.

FUEL TANK MOUNTING STRAP REPLACEMENT

A mounting strap can be replaced without removing the fuel tank.

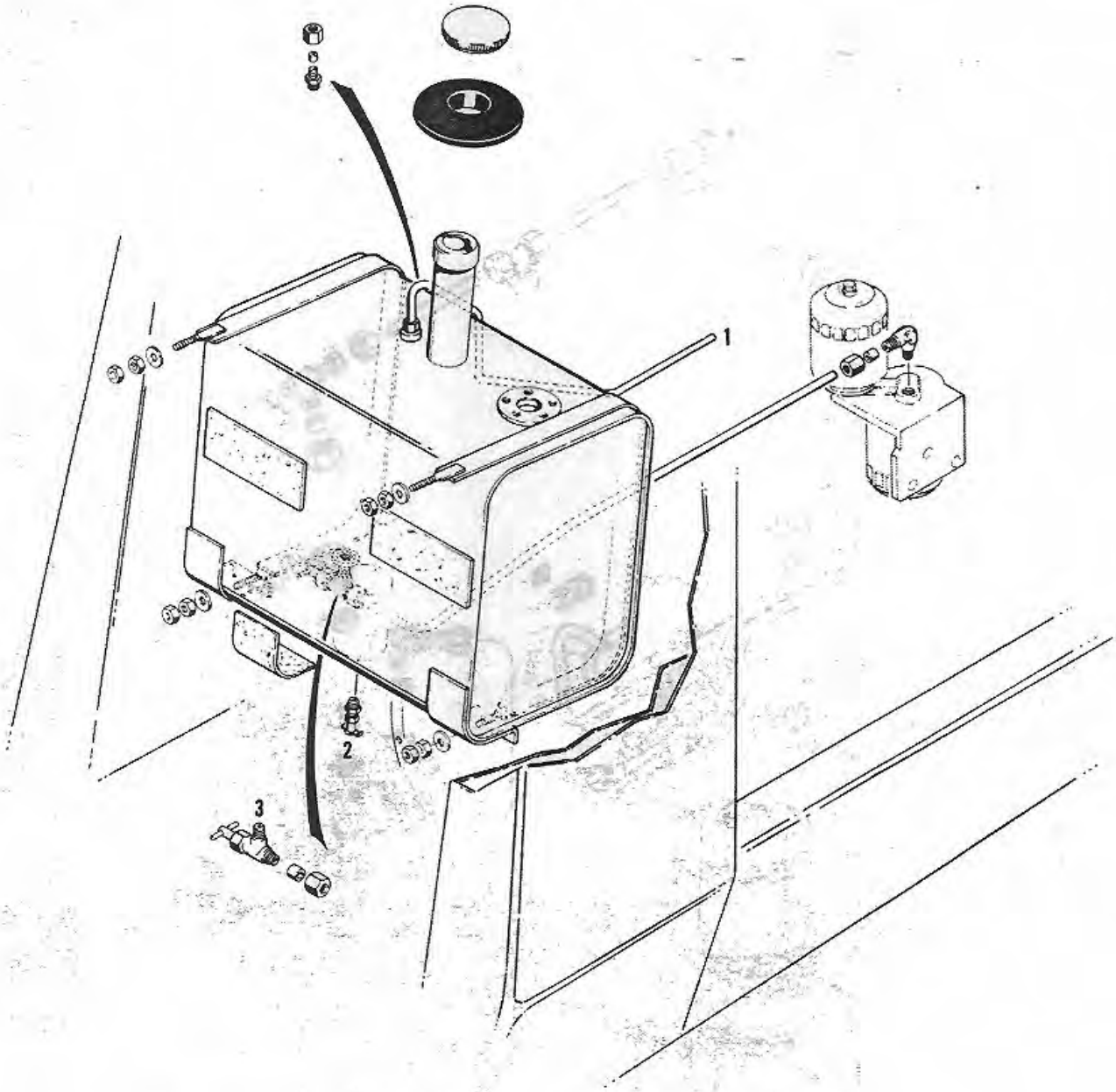
1. Remove access cover on top of instrument panel to gain access to the top strap nut and washer.
2. The mounting strap stud goes through the firewall just below flange at top of firewall.
3. Remove nut and washer from bottom of strap and remove strap.
4. Install top end of mounting strap first. Remove cover over hydraulic reservoir relief valve. The strap can be viewed through this hole to aid in installation. Install washer and nut on top strap stud.
5. Install washer and nut on bottom strap stud.
6. Install access covers.



1. HAND THROTTLE STOP BOLT
2. FRICTION DISC
3. TIGHTEN TO HOLD HAND THROTTLE IN PLACE YET MOVE SMOOTHLY
4. TORQUE CLAMP BOLTS TO 13-15 FOOT-POUNDS (18-20 N m)
5. IF ACCELERATOR PEDAL STICKS, LUBRICATE ROD AND TUBE

751617

Figure 1 - Throttle Linkage



1. FUEL RETURN LINE CONNECTED TO REAR FUEL INJECTOR
2. DRAIN VALVE
3. SHUTOFF VALVE

751618

Figure 2 - Fuel Tank and Fuel Lines

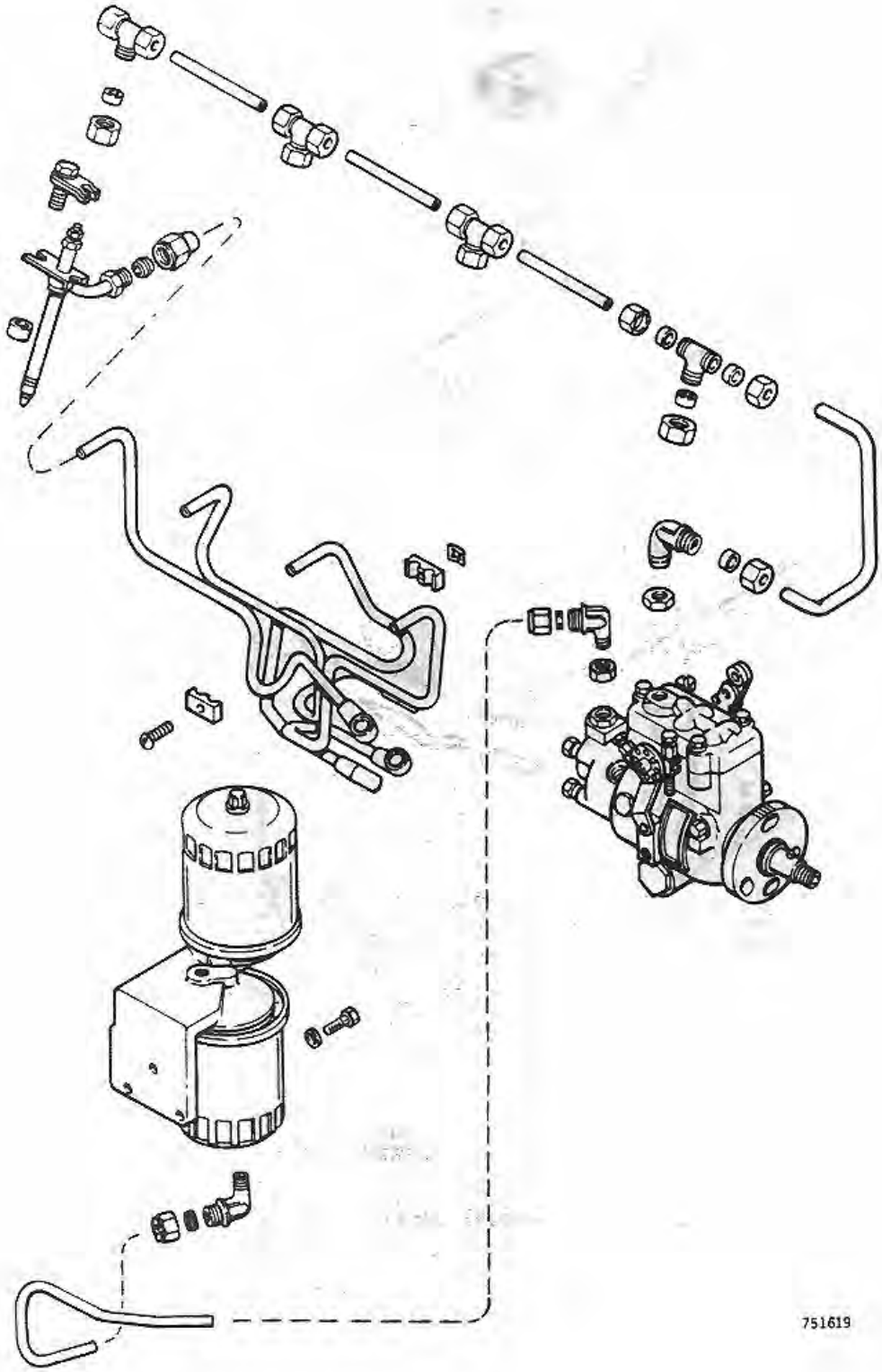


Figure 3 - Fuel Lines, Filter to Fuel Injectors

Section 4002

HYDRAULIC DIAGRAMS, MAINTENANCE, TROUBLE SHOOTING AND PRESSURE CHECKS

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Pump output		
Cessna or TRW pumps	24 U.S. gpm at 2000 rpm at 2000 psi (91 l/min at 2000 r/min at 13 789 kPa)	
Main relief valve setting		
Oil temperature for test purposes	120° F (49° C) or loader control valve inlet tube very warm to the touch.	
Loader control valve	2300 ± 50 psi at full throttle (15 857 ± 344 kPa at full throttle)	
Three point hitch control valve	1800 ± 50 psi at full throttle (12 410 ± 344 kPa at full throttle)	
Backhoe and stabilizer control valves	None. Circuit pressures controlled by relief valve in loader control valve.	
Pump protection valve (three point hitch only machine)	2600 ± 50 psi at 1100 engine rpm (17 9264 ± 344 kPa at 1100 engine r/min)	
Secondary relief valve		
Oil temperature for test purposes	Oil temperature for hand pump should be at room temperature, preferably 70°-80° F (21°-26.7° C).	

	Hand pump setting	Full flow setting
Loader bucket A and B port	2100-2300 psi (14 479-15 857 kPa)	
Backhoe bucket and dipper A and B port	2400+200 -50 psi (16 547+1387 -344 kPa)	
Swing A and B port	1800 ± 100 psi (12 410 ± 689 kPa)	
Boom A port	700 ± 75 psi (4826 ± 517 kPa)	1000 ± 75 psi at 10 U.S. gpm (684 ± 517 kPa at 37.8 l/mn)
Boom B port	2400+200 -50 psi (16 547+1378 -344 kPa)	
Three point hitch lift	1900 psi (13 100 kPa)	
Boom lockout relief valve	3400 ± 100 psi (23 442 ± 688 kPa)	

Hydraulic oil	Case TCH Fluid
Alternate oil	1. Type C2 transmission fluid such as Tenneco Hytrans Fluid.
	2. SD or CA engine oil. If lowest expected temperature is above 32° F (0° C) use SAE 10W. If temperature is below 32° F (0° C) use SAE 5W.
Hydraulic reservoir and system capacities	
Reservoir refill, all models	17 U.S. gallons (64 liters)
System capacity	
Loader only	20.5 U.S. gallons (77.5 liters)
Loader/backhoe	28.8 U.S. gallons (109 liters)
Loader/three point hitch	24 U.S. gallons (91 liters)
Three point hitch only	19 U.S. gallons (72 liters)
Oil change interval	After every 1000 hours of operation
Oil filter change interval	Every oil change and whenever filter condition light comes on. Refer to page 4002-7.

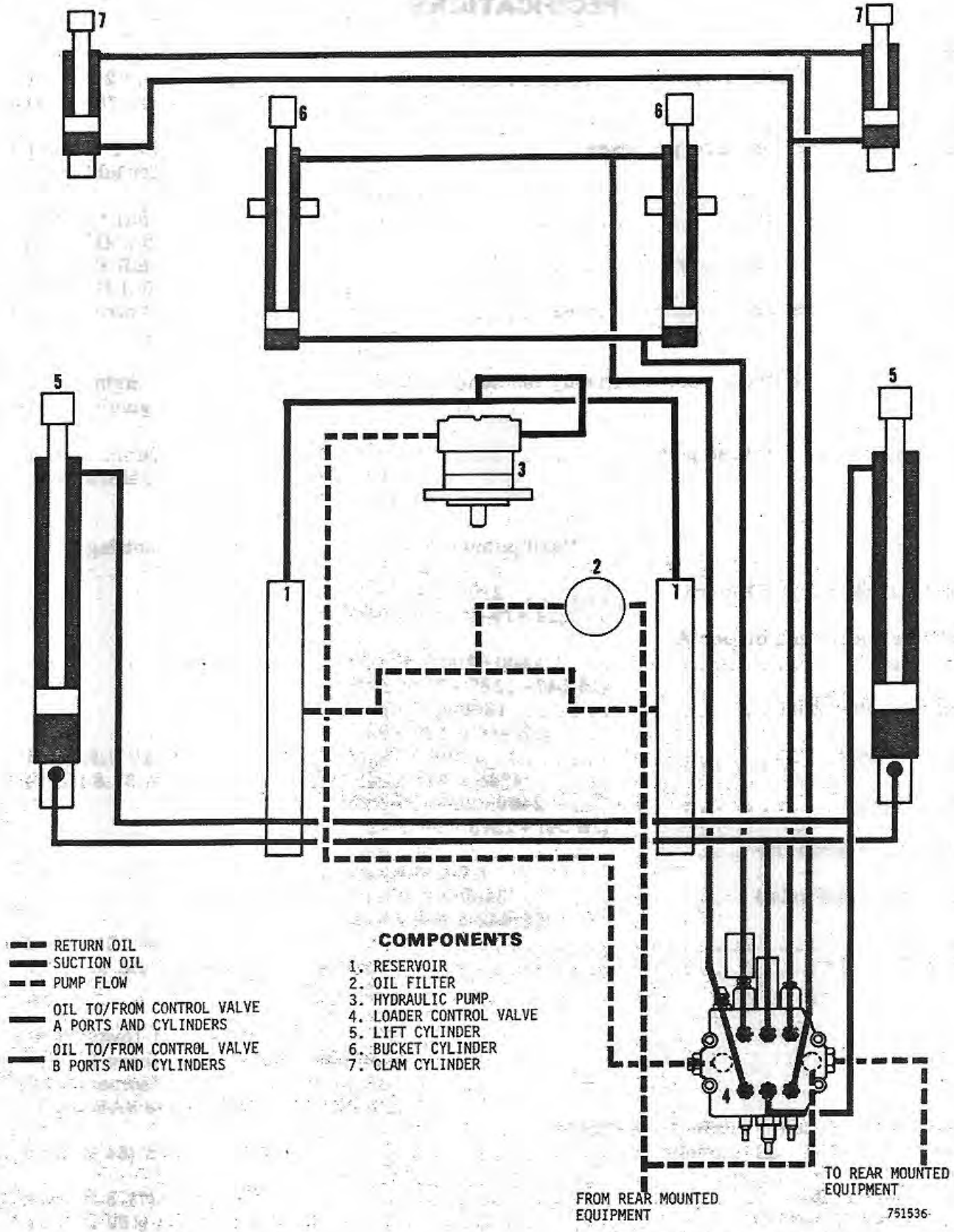
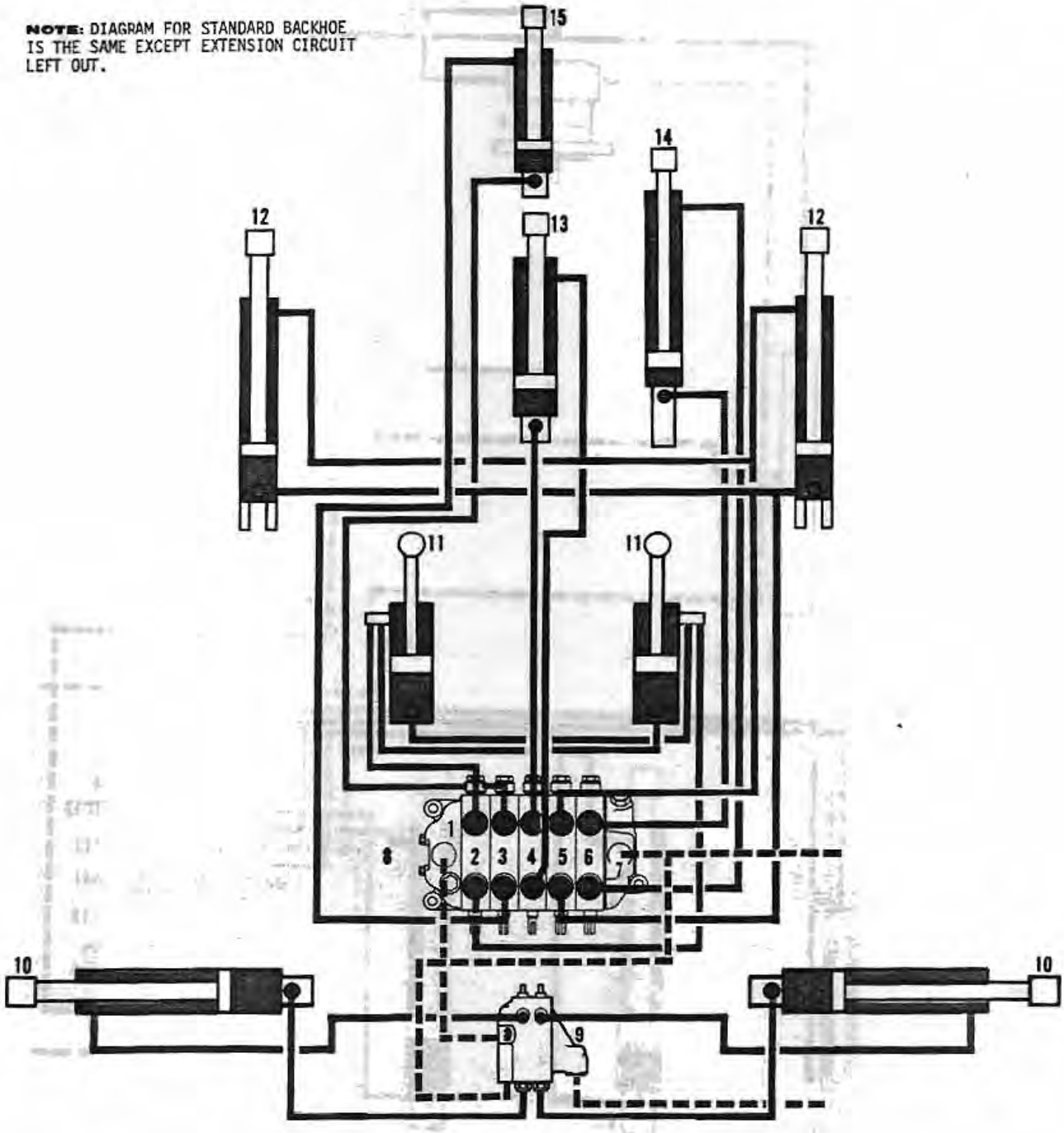


Figure 1 - Loader Hydraulic Diagram

NOTE: DIAGRAM FOR STANDARD BACKHOE IS THE SAME EXCEPT EXTENSION CIRCUIT LEFT OUT.



PUMP FLOW, VIA LOADER CONTROL VALVE
OIL TO/FROM CONTROL VALVE A PORTS AND CYLINDERS
OIL TO/FROM CONTROL VALVE B PORTS AND CYLINDERS
RETURN OIL-TO RESERVOIR

BACKHOE VALVE SECTIONS

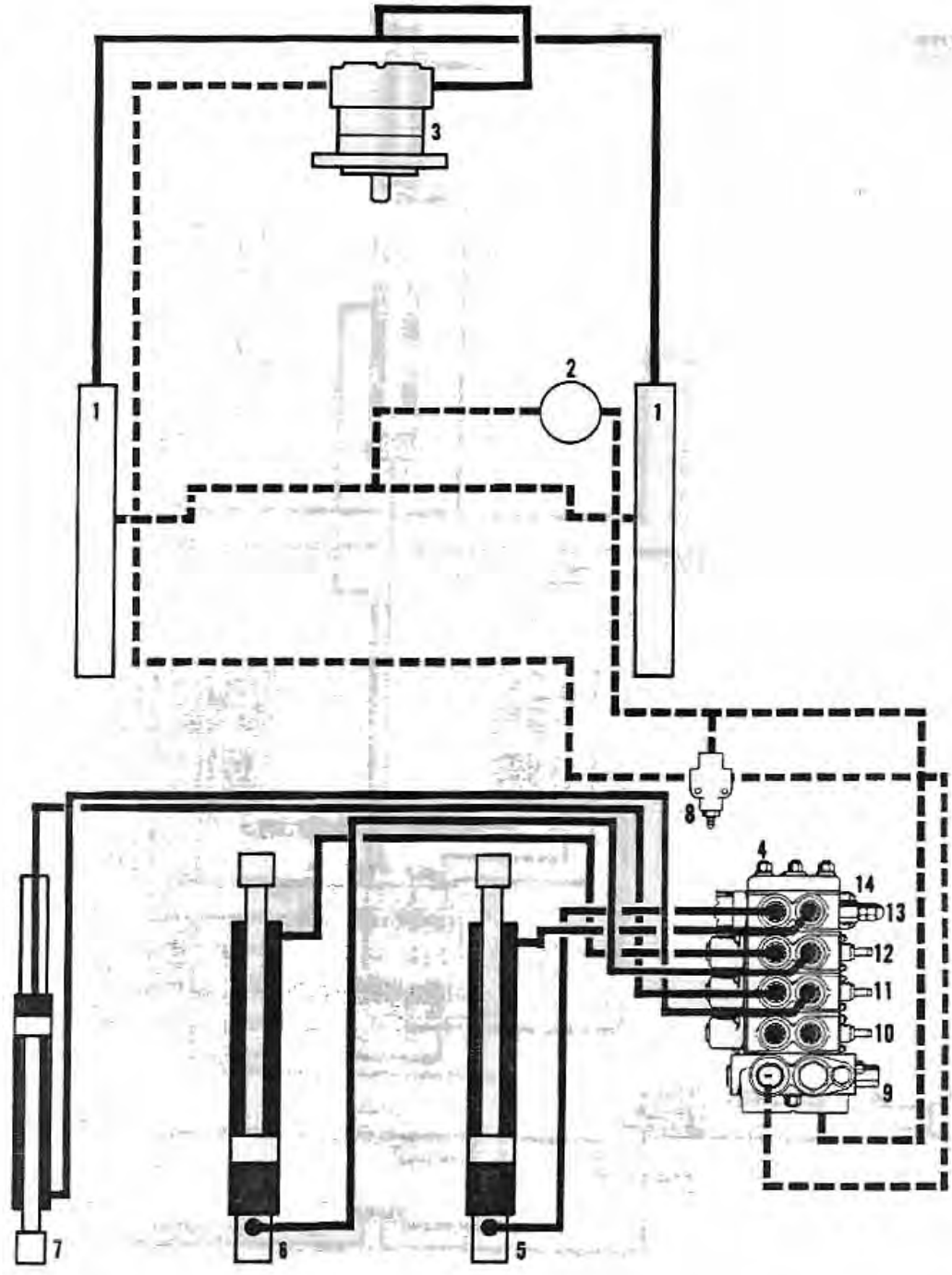
1. INLET
2. SWING
3. BUCKET
4. DIPPER
5. BOOM
6. EXTENSION
7. OUTLET

COMPONENTS

8. BACKHOE VALVE
9. STABILIZER VALVE
10. STABILIZER CYL.
11. SWING CYL.
12. BOOM CYL.
13. DIPPER CYL.
14. EXTENSION CYL.
15. BUCKET CYL.

751537

Figure 2 - Backhoe Hydraulic Diagram



SUCTION OIL
RETURN OIL
PUMP FLOW
OIL TO/FROM CONTROL VALVE A PORT AND CYLINDER
OIL TO/FROM CONTROL VALVE B PORT AND CYLINDER

COMPONENTS

1. RESERVOIR
2. FILTER
3. PUMP
4. HITCH CONTROL VALVE
5. LIFT CYLINDER
6. TILT CYLINDER
7. PITCH CYLINDER
8. RELIEF VALVE

VALVE SECTIONS

9. INLET/OUTLET
10. IMPLEMENT
11. PITCH
12. TILT
13. LIFT
14. END COVER

751538

Figure 3 - 3 Point Hitch Hydraulic Diagram

HYDRAULIC RESERVOIR AND FILTER SERVICE

Oil Level Check

The oil level must be checked when the oil is cold (prevailing temperature, indoors or outside).

1. Park machine on a level surface.
2. Place backhoe, if so equipped, in the transport position and the loader bucket rolled back at ground level.
3. A sight level gauge is located in the left-hand reservoir. If oil is not visible through the glass, remove plug and add oil as required. Refer to page 4002-3 for specified oil.

Oil Drain

The reservoir oil must be drained after every 1000 hours of operation.

1. If time allows, warm oil to operating temperature before draining.
2. Park machine on a level surface with backhoe, if so equipped, in the transport position and the loader bucket rolled all the way back at ground level.
3. Have on hand drain pan and containers that will hold 17 U.S. gallons (64 liters).
4. Remove fill and drain plugs from left-hand reservoir and drain oil. Then remove drain plug from right-hand reservoir and drain oil.
5. Install drain plugs and fill reservoir with 17 U.S. gallons (64 liters) of Case TCH Fluid. Add oil as required to fill reservoir to the proper level.

Reservoir Breather

A breather is located on the inner panel of the right-hand reservoir. The breather should be cleaned whenever the hydraulic oil is changed.

Access to the breather is through the hold on top of the frame. Remove the breather, clean in cleaning solvent and dry with moisture free compressed air before installing.

Oil Filter

The oil filter must be changed after the first 20 hours of operation, whenever the hydraulic oil is changed or when the filter warning light on the instrument panel stays on.

To check filter condition, warm oil to operating temperature and run engine at full throttle and observe filter warning light. If light comes on and stays on, the filter must be changed. The warning light may come on when the oil is cold; this is normal.

The filter is located under the hood in front of the fuel tank on the right-hand side of the machine.

To change the filter:

1. Loosen reservoir fill plug to relieve pressure in reservoir.
2. Unscrew filter housing from filter head. The filter may be torqued up to 90 foot-pounds (122 N m).
3. Remove filter and discard. Remove housing O-ring and inspect for damage that would result in leakage and replace as required.
4. Install filter on filter head. Gasket on I.D. must be on top.
5. Install O-ring in groove in filter housing. Lubricate O-ring with hydraulic oil and screw housing into head. Torque housing up to 90 foot-pounds (122 N m).

FLUSHING THE HYDRAULIC SYSTEM

The entire hydraulic system may require flushing if a system component failed due to contaminated oil. Whether to flush the system is dependent on an oil sample, page 4002-13, and your personal judgment. If the pump failed, also refer to Identifying Causes of Pump Failure in Section 4005.

Flushing Procedure

1. Retract all cylinder rods and swing backhoe all the way to the right.

WARNING: If retracting the cylinder rods causes the attachment to be raised, block the attachment in place before proceeding to the next step. 39-4

2. Drain the hydraulic reservoir and remove and discard the hydraulic filter(s).

3. Install new filter and fill reservoir with new Case TCH Fluid.

WARNING: Before completing step 5, make sure all attachments are blocked in place. 39-5

4. Disconnect all lines to cylinders at the cylinder.

   NOTE: Check reservoir oil level frequently while performing steps 6 and 7 to prevent pump damage.

5. Start the engine and flush each circuit by moving each control lever in both directions until the lines are flushed with new oil. This flushes the lines and valves from the pump to the cylinders.

6. Connect lines to the CLOSED end of all cylinders except the swing cylinders. Leave the rod end of the cylinders disconnected and with the engine running at 1/4 throttle, activate each circuit slowly until the cylinders bottom out. New oil will be put in the closed end of the cylinders and the contaminated oil forced out of the rod end.

WARNING: If attachment is raised, block in place before completing step 7. 39-6

7. Connect lines to rod end of all cylinders except swing cylinder and check reservoir oil level.

8. Connect hoses to the rod end of the left swing cylinder and closed end of the right swing cylinder. Slowly swing backhoe all the way to the left. Then connect remaining hoses to both swing cylinders.

9. Operate all cylinders alternately for 15 minutes with engine running at full throttle.

10. Change the hydraulic filter. Check reservoir oil level and add as required.

TROUBLE SHOOTING

Problem: Poor Operation of a Single Circuit Only

If only one circuit is performing poorly the problem is in that circuit. Possible causes are worn cylinder packing, secondary relief valve (if used) setting to low or leaking, leaking load check valve or worn spool or spool bore.

CHECK	DETAILED INSTRUCTIONS
1. Check cylinder packing.	
a. Loader lift cylinder.	a. Raise loader arm to full height and block in place. Disconnect tube at rod end of each cylinder and loosen clamp and slide tube away from fitting. Start engine and run at full throttle. Move control lever to the Raise position, hold in place and check for leakage at each cylinder. Any leakage indicates worn packing and repair of that cylinder. Checking leakage in the opposite direction cannot be done unless the pistons are prevented from bottoming in the cylinder. In almost all cases, leakage in one direction will result in leakage in the opposite direction.
b. Loader bucket cylinder.	b. Raise loader arm, completely rollback bucket and rest bucket on the floor and block in place. Disconnect hose at rod end of each cylinder. Start engine and run at full throttle. Move control lever to the Rollback position, hold in place and check for leakage. Any leakage indicates worn packing and repair of that cylinder. However, leakage in one direction usually results in the opposite direction.
c. Clam bucket cylinder.	c. Close clam. Disconnect hose to rod end of each cylinder. Start engine and run at full throttle. Hold control lever in Close position and check for leakage. Any leakage indicates worn packing and repair of that cylinder. Checking leakage in the opposite direction cannot be done unless the pistons are prevented from bottoming in the cylinders. Usually, leakage in one direction results in leakage in the opposite direction.
d. Backhoe boom cylinder.	d. Place backhoe boom in the transport position. Disconnect tubes at rod end of each cylinder. Loosen tube clamp and slide tube away from fitting. Start engine and run at full throttle. Hold control lever in the Lower position and check for leakage. Any leakage indicates worn packing and repair of that cylinder. Leakage in one direction usually results in leakage in the opposite direction.

CHECK	DETAILED INSTRUCTIONS
e. Backhoe dipper cylinder.	e. With the boom in the transport position, completely extend the dipper cylinder. Disconnect tube at rod end of dipper cylinder. Loosen tube clamp and slide tube away from fitting. Start engine and run at full throttle. Hold control lever in the In position and check for leakage. Any leakage indicates worn packing and cylinder repair. Checking leakage in the opposite direction cannot be done unless the piston is prevented from bottoming in the cylinder. However, leakage in one direction usually results in leakage in the opposite direction.
f. Backhoe bucket cylinder.	f. Completely extend the bucket cylinder. Disconnect tube at rod end of bucket cylinder. Loosen tube clamp and slide tube away from fitting. Start engine and run at full throttle. Hold control lever in the Load position and check for leakage. Any leakage indicates worn packing and cylinder repair. Leakage in the opposite direction can be checked by disconnecting hose to closed end of the cylinder and holding the control lever in the Dump position. However, leakage in one direction usually results in leakage in the opposite direction.
g. Backhoe swing cylinders.	g. Pin swing tower in center position. Disconnect hose to closed end of left swing cylinder. Start engine and run at full throttle. Actuate swing control to swing to the left and hold. Any leakage indicates worn cylinder packing and repair of that cylinder. To check leakage in the opposite direction actuate swing control to swing to the right. However, leakage in one direction usually results in leakage in the opposite direction.
h. Backhoe stabilizer cylinder.	h. Block up rear of machine so stabilizer can be completely lowered without touching the floor. Disconnect line to rod end of cylinder. Start engine and run at full throttle. Hold control lever in the Lower position and check for leakage. Any leakage indicates worn packing and repair of that cylinder.
i. Backhoe extension cylinder.	i. Completely extend dipper extension and rest backhoe bucket on the floor. The hose to rod end of the extension cylinder is connected to tube on the top left side of the dipper; disconnect hose at this connection. Start engine and run at full throttle. Hold control lever in the Out position and check for leakage. Any leakage indicates worn packing and cylinder repair.

CHECK	DETAILED INSTRUCTIONS
j. Three point hitch cylinders.	j. Completely extend all cylinders and block hitch and attachment in place. Disconnect hose to rod end of cylinders as required. Start engine and run at full throttle. Move control lever to extend the cylinder, hold and check for leakage. Any leakage indicates worn packing and repair of that cylinder.
2. If no leakage was found, or cylinder was repaired and circuit still operates poorly, check secondary relief valve if in the circuit.	2. The following circuits contain secondary relief valves: loader bucket, backhoe boom, dipper, bucket and swing, and three point hitch lift. Refer to Testing Secondary Relief Valves With a Hand Pump in this section and check pressure setting.
3. If the complaint was that the load drops in the opposite direction, the problem is a leaking load check valve.	3. Load check valves are used in all the valves on this machine. The load check valves most likely to cause problems are in the backhoe bucket B port, boom B port, dipper A port, loader bucket A port and three point hitch lift which is located in the lift spool. Remove control valve for inspection and repair.
4. If checks and repairs to this point have not corrected the problem, spool leakage is probably the cause.	4. Remove control valve for disassembly and inspection. If a worn spool or spool bore is the problem, the complete valve or valve section must be replaced.

Problem: Poor Operation of All Backhoe or Three point Hitch Circuits, Loader OK

POSSIBLE CAUSE	REMEDY
1. Defective O-ring on power beyond fitting in loader control valve.	1. Disconnect tube connected to power beyond fitting. The fitting is located on the outlet side of the loader control valve. Remove O-ring on inner end of fitting and check for damage.
2. Damaged or plugged quick disconnect couplings.	2. Remove all couplings, male and female, and check for foreign material and properly operating valves. Repair or replace parts as required.
3. Dirt or worn or damaged parts in regeneration circuit in backhoe control valve.	3. Refer to Section 4107 and remove, disassemble, inspect and assemble the inlet and outlet section as instructed.
4. Backhoe valve inlet or outlet section cracked internally.	4. Same as above.
5. Three point hitch valve inlet section cracked internally.	5. Refer to Section 4034 and remove, disassemble, inspect and assemble control valve as instructed.
6. Dirt or worn parts in three point hitch valve inlet section.	6. Same as above.
7. Orifice plate or pilot passage in three point hitch control valve plugged.	7. Same as above.

Problem: Poor Operation of All Circuits

When all circuits perform unsatisfactorily, a worn pump is the most common cause. However, before removing the pump, make the checks listed below.

CHECK	DETAILED INSTRUCTIONS
1. Oil level.	1. Check the hydraulic oil level and add oil as required. See page 4002-7.
2. Oil level.	2. Change the hydraulic oil filter. See page 4002-7.
3. Check pump intake line.	3. Check the intake line between the pump and the hydraulic reservoir for a loose connection, damaged or loose fittings and lines.
4. Check setting of main relief valve.	4. See page 4002-29 in this section for main relief checks and adjustments.
5. Check hydraulic stall speed.	5. Refer to Section 2050 for instructions.

CHECK	DETAILED INSTRUCTIONS
6. Check for contaminated oil.	6. Operate the engine for a short period of time to circulate the hydraulic oil. Take an oil sample and look for the following signs: a. Feel the oil with your fingers. See if the oil is gritty or contains any particles large enough to be felt. b. Milky color oil is a sign of water in the oil. c. Foam is a sign that air is entering the system. d. The system has overheated severely if the oil is dark, thick or smells scorched. If the oil is found to be contaminated, the oil must be replaced and the filter changed. See Flushing the Hydraulic System on page 4002-8. After replacing the oil, check pump output with a flowmeter to determine how much damage, if any, the pump has sustained from the bad oil.
7. Check pump output with flowmeter.	7. Test procedure is in this section on page 4002-18. If pump output is not at least 80% of the specification, repair or replace the pump.

Trouble Shooting Chart

Boom Down and Swing Problems

SYMPTON	POSSIBLE CAUSE	REMEDY
Boom drops (lower) too fast	Restrictor in B port of boom section missing or improperly installed.	Lower backhoe bucket to the floor. Disconnect hose at B port of boom section and remove fitting. Check to see that restrictor is installed properly; large end toward valve section.
Boom coasts with spool in Neutral	Secondary relief valve pressure setting too low or foreign material holding poppet off its seat.	Check pressure setting with hand pump as instructed in this section, or remove valve, disassemble and check for foreign material.
Backhoe swing stops with jarring impact	Restrictor in closed end of either swing cylinder missing or improperly installed. Restrictor hole diameter: with Extendahoe .125" (3.17 mm) without Extendahoe .156" (3.96 mm) Same as Boom coasts with spool in Neutral. See above.	Disconnect hose at closed end of cylinder and remove fitting. Check to see that restrictor is installed properly; small end toward cylinder.

Failure or Poor Operation of Components

HYDRAULIC PUMP

SYMPTOM	POSSIBLE CAUSE	REMEDY
Pump is noisy	Loose mounting bolts. Loose pump tie bolts. Worn or damaged bearings or gears. Air leak in suction line.	Torque to specifications. Torque to specifications. Remove pump and repair. Repair as required.
Flowmeter test indicates low pump output	Worn or damaged pump. Also see Identifying Causes of Pump Failure, Section 4005.	Remove pump from machine. Repair or replace pump as required. If oil is contaminated, flush the complete system as instructed on page 4002-8.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Flowmeter test indicates low pump output (Cont'd)	Restriction or air leak between reservoir and pump inlet.	Repair as required.
	Use of improper oil.	Use oil specified on page 4002-3.
External oil leakage	Worn seal or pump shaft.	Remove pump and replace seal. Check shaft at sealing surface for damage.
	Shaft seal "blown" out.	Unplug passage between seal and relief valve in front cover. Check parts for damage.
	Pump tie bolts loose.	Torque to specification.
	Defective pump section O-ring.	Disassemble pump and replace the O-ring.
Low oil supply	Low oil level.	Fill reservoir to proper level with oil specified on page 4002-3.

CONTROL VALVE

SYMPTOM	POSSIBLE CAUSE	REMEDY
Spool leaks oil	Defective spool seal.	Replace spool seal.
Spool does not return to neutral	Centering spring broken.	Replace spring.
	Bent spool.	Replace control valve.
	Damaged spool bore.	Replace control valve.
	Warped valve body.	Loosen valve mounting bolts and shim at low spot.
	Tie rods over tightened.	Torque to specification.
Sluggish operation	Incorrect main relief valve setting.	Check and adjust pressure setting as instructed in this section.
	Main relief valve leaking internally.	Replace relief valve.
	Excessive clearance between spool and spool bore.	Replace control valve or valve section.
	Spool not properly positioned.	Measure spool travel and adjust control linkage.

SYMPTOM	POSSIBLE CAUSE	REMEDY
Spool will not stay in detent position	Worn or missing detent parts.	Disassemble detent mechanism and repair as required.
Load drops as control lever is moved to power position	Leaking load check valve.	Remove control valve and inspect load check valve parts including poppet seat. Also refer to page 4002-11.

CYLINDERS

SYMPTOM	POSSIBLE CAUSE	REMEDY
Sluggish or no movement	Worn piston packing.	Check cylinder packing instructed under Poor Operation of a Single Circuit, page 4002-9.
	Loose piston bolt.	Remove cylinder and repair as required.
	Hoses not properly connected.	Refer to hydraulic diagrams and check connections against diagram. Reconnect hoses as required.
Excessive cylinder bushing wear	Failure to lubricate pivot points as specified.	Lubricate pivot points daily or more often if operating in severe conditions.
Excessive cylinder packing wear	Contaminated oil.	Flush the complete hydraulic system as instructed on page 4002-7.
	Incorrect main relief valve pressure setting.	Check and adjust pressure setting as instructed in this section.
Bent piston rod	Failure to lubricate pivot pins as specified.	Lubricate fittings daily or more often if operating in severe conditions.
	Incorrect main relief valve pressure setting.	Check and adjust pressure setting as instructed in this section.

HOSES AND FITTINGS

SYMPTOM	POSSIBLE CAUSE	REMEDY
Hose cover separated from wire braid	Hose twisted.	Install hose properly; connect hose at swivel fitting last and make sure hose does not twist when fitting is tightened.
Fitting pulled from hose or broken hose	Hose twisted.	Install hose properly; connect hose at swivel fitting last and make sure hose does not twist when fitting is tightened.
	Incorrect main relief valve pressure setting.	Check and adjust pressure setting as instructed in this section.
Damaged threads	Overtorqued.	Torque to specifications, Section 1051.

TESTING THE HYDRAULIC SYSTEM WITH A FLOWMETER

Hydraulic troubles in this and other Case machines can be quickly and positively diagnosed with the aid of a flowmeter. This prevents trial-and-error replacement of parts.

The flowmeter is portable and can be used in the shop or easily transported to the field for on-the-spot trouble shooting.

Two Flowmeters Available

Two flowmeters are offered through the Case Service Tool Program. Refer to the Case Service Tool Catalog, SPS 179- Revised.

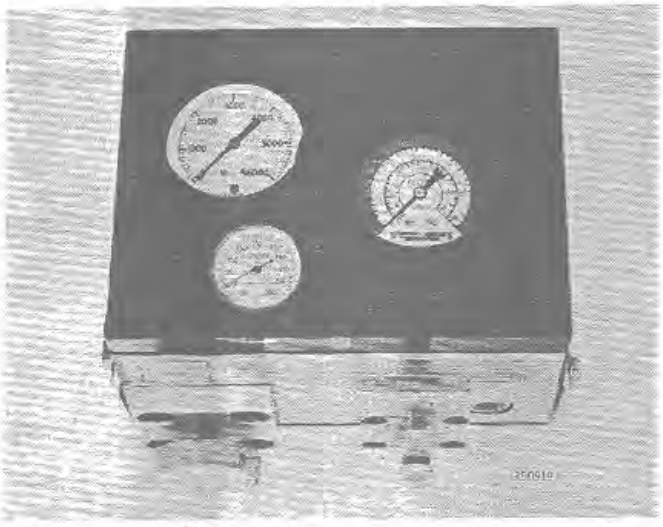


Figure 4 - 60 gpm Flowmeter

Description of Test

The flowmeter simulates the load conditions met during operation of the loader and backhoe and measures the temperature, volume, and pressure of the oil passing through the flowmeter.

By interpreting these measurements as described on the following pages, pump, valve, and cylinder faults can be identified.

NOTE: A check sheet will be found on page 4002-24 that can be copied on any office copier.

Figure 5 - 100 gpm Flowmeter

Test procedure consists of:

1. First, learning how much oil the pump delivers to the system at no load.

2. Then, by operating the pump at the same speed but against a pressure near the setting of the relief valve, finding out how much oil is unavailable for work because it is:

   a. Not delivered by the pump, due to an air leak or restriction in the suction line.

   b. Not delivered by the pump, due to internal damage or wear in the pump.

3. If the pump output is within specifications, it can be assumed that the problem is caused by leakage in the control valve or cylinders, or both.

Test No. 1 - Pump Output

1. Rest loader bucket on the floor and place backhoe in the transport position. If

equipped with three point hitch, lower hitch attachment to the floor.

2. Refer to Figure 6. Disconnect control valve inlet hose from tee fitting and install plug in hose. Then remove cap from end of tee and reinstall on top. Connect flowmeter inlet hose to this tee.

3. Remove cap from tee fitting in the control valve outlet and connect flowmeter outlet hose to this tee.

4. Set the flowmeter volume control to handle 30 U.S. gpm (113 l/min) and open the load valve.

   NOTE: In this hookup there is no relief valve. Therefore, the flowmeter load valve must be partially open at all times during this test.

5. Start engine and run at low idle. If oil temperature is less than 120° F (49° C), run engine at 1/2 to 3/4 throttle and close load valve until pressure gauge indicates about 1000 psi (6894 kPa). Hold until oil temperature is as specified.

6. Open the load valve completely. Run engine at 2000 rpm (r/min) and record flowmeter reading.

7. With engine running at 2000 rpm (r/min) gradually close flowmeter load valve and record flow reading at 600 psi (4136 kPa), 1000 psi (6894 kPa), 1800 psi (12 410 kPa) and 2000 psi (13 789 kPa). As pressure increases it will be necessary to adjust engine speed.

Interpreting Test Results

1. If output at 0 psi (0 kPa) is less than the rated pump output it is an indication of a restriction or air leak between the pump and reservoir. If output met or exceeded the rated output it does not mean the pump is good; it only indicates no problems between the reservoir and pump.

   NOTE: With the load valve completely open it is possible to exceed the output under specifications.

2. Loss of output at 2000 psi (13 789 kPa) indicates pump wear or damage. Divide the flow reading obtained at this pressure by the flow reading obtained at 0 psi (0 kPa) to determine pump efficiency. The point at which a pump should be repaired or replaced is a matter of judgement; however, if pump efficiency is 80% or less, servicing the pump is recommended.

3. The flow readings at 600 and 1800 psi (4136 and 12 410 kPa) have no bearing on pump condition. These flow readings will be used for comparison purposes in Test No. 3 and 4.

Test No. 2 - Main Relief Valve

1. Refer to Figure 7. Remove cap on top of tee in the inlet line and connect control valve inlet hose to tee. The flowmeter connections remain the same.

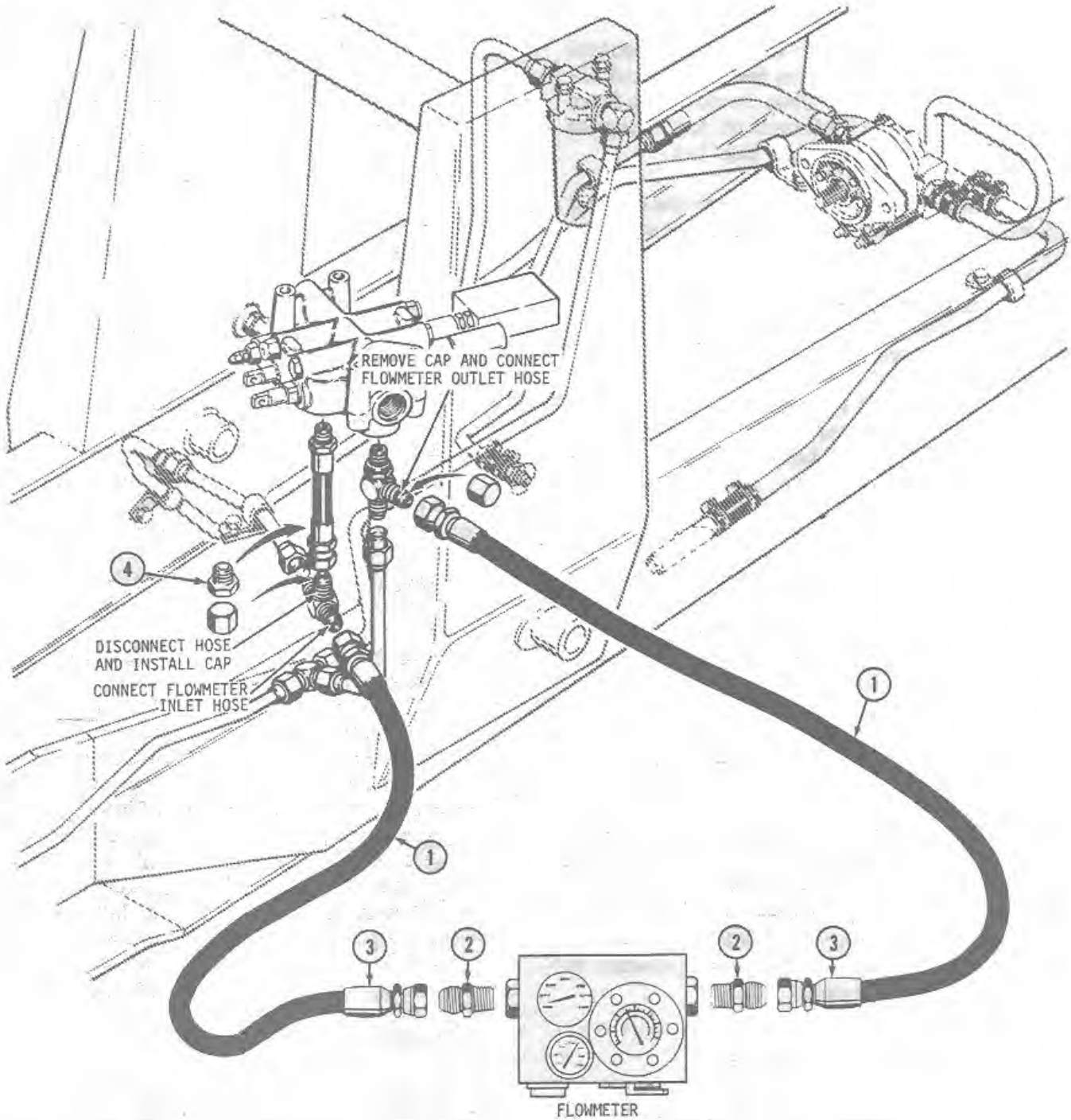
2. Open flowmeter load valve and start engine.

3. With the engine running at full throttle, move the bucket control lever to Rollback and hold lever in this position. Gradually close the flowmeter load valve; allow the bucket to roll back completely. Continue to hold the lever in Rollback and close the load valve. Watch the flow gauge; the volume will slowly drop as load increases due to engine rpm loss. However at the point of the main relief crack the flowmeter will take a more rapid dip; hold this point on load valve and flow gauge and read pressure gauge for crack pressure of main relief. This should be no more than 10% below the full open reading.

4. Continue to close the load valve. When the volume drops to zero or very near zero, read the pressure gauge and record the reading. This is the setting of the main relief valve. Open flowmeter load valve and stop the engine.

Interpreting Test Results

1. If the reading obtained in step 4 is not as specified, adjust the relief valve as instructed in this section.

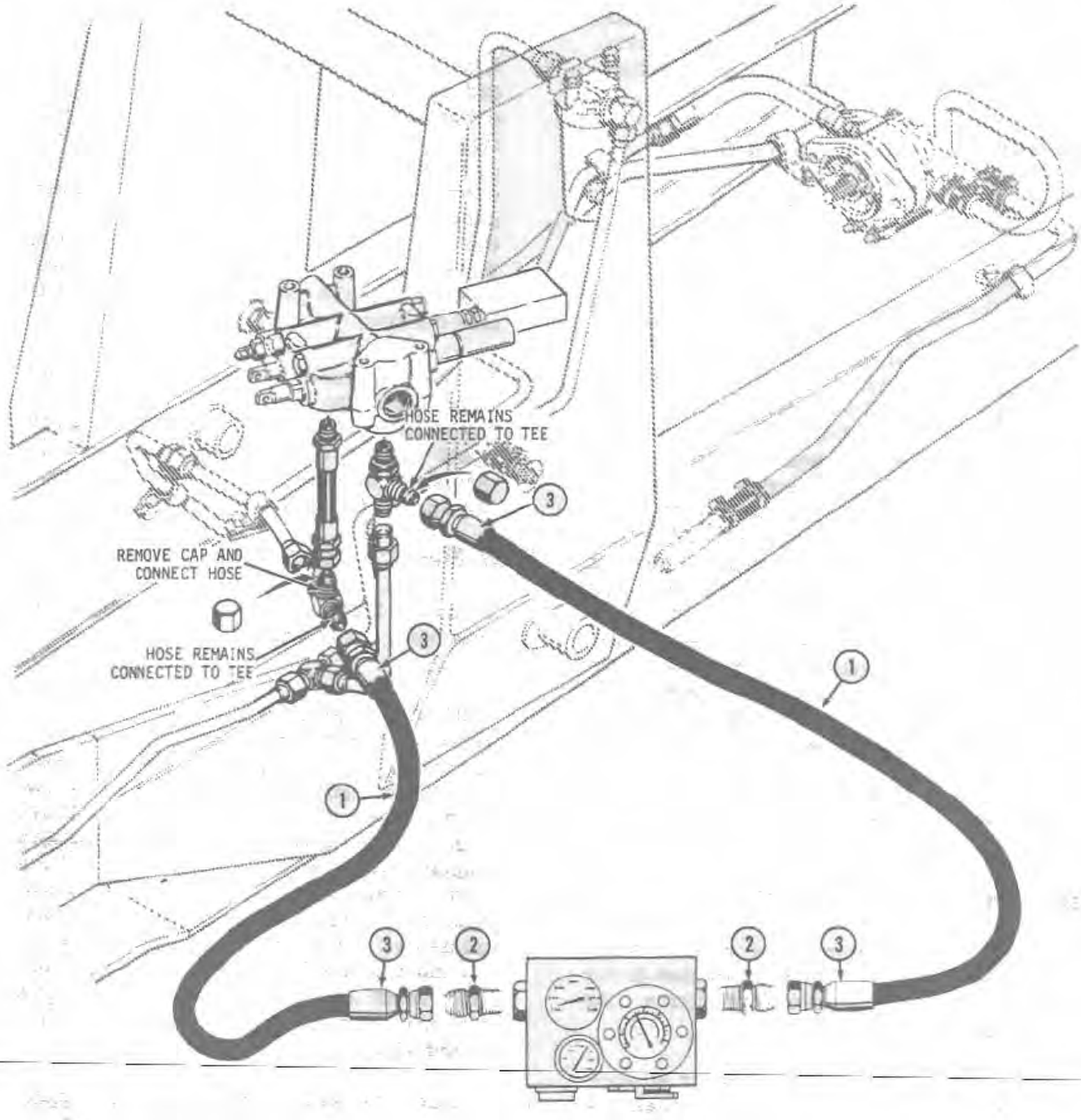


REF.	PART NO.	DESCRIPTION	NO. REQ'D
1.	A21574	3/4" I.D. BULK LONG ENOUGH TO USE FLOWMETER IN OPERATOR'S SEAT	
2.	218-466	3/4" NPT TO 1-1/16"-12 JIC ADAPTER	2
3.	220-206	1-1/16"-12 JIC SWIVEL FITTING	4
4.	218-777	PLUG	1

NOTE: CONNECTIONS AT FLOWMETER OPTIONAL DEPENDING ON HOSES ALREADY AVAILABLE.

751539

Figure 6 - Flowmeter Hookup for Pump Test



REF.	PART NO.	DESCRIPTION	NO. REQ'D
1.	A21574	3/4" I.D. BULK HOSE LONG ENOUGH TO USE FLOWMETER IN OPERATOR'S SEAT	
2.	218-466	3/4" NPT TO 1-1/16"-12 JIC ADAPTER	2
3.	220-206	1-1/16"-12 JIC SWIVEL FITTING	4

NOTE: CONNECTIONS AT FLOWMETER OPTIONAL DEPENDING ON HOSES ALREADY AVAILABLE.

751540

Figure 7 - Flowmeter Hookup for Circuit Test

2. If the pressure setting was as specified and the crack pressure was 2000 psi (13 789 kPa) or lower, disassemble the relief valve and check for worn parts. Replace parts as required and recheck crack pressure of the relief valve.

Test No. 3 - Loader Circuits

1. Connect flowmeter into circuit as illustrated in Figure 7 (same as Test No. 2).

2. With the engine running at 2000 rpm (r/min) move the control lever to the Rollback position. Loader arm must be all the way down so antirollback linkage will allow control spool to be fully stroked. Hold control lever in place and close flowmeter load valve until pressure gauge indicates 1800 psi (12 410 kPa). Adjust throttle setting as required to maintain the specified engine speed. When the piston rod stops moving observe the flow gauge and record the reading. Raise the loader arm high enough to completely dump the bucket (the flowmeter load valve must be partially closed or cylinders will not move) and repeat this step holding the control lever in the Dump position.

3. Test the loader raise circuit and the clam close circuit in the same manner.

Interpreting Test Results

1. If the flow reading for a given circuit was close to the reading obtained in the pump test at the same pressure, the circuit is good.

2. If the flow reading was low for all cylinders it indicates leakage before the oil reaches the cylinders. Leakage could be past the O-ring on the main relief valve cartridge or seat sleeve, or through the main relief valve itself because the circuit test was performed at a pressure higher than the crack pressure reading obtained in Test No. 2.

3. If the flow readings for the bucket circuits were both low, it indicates piston packing leakage in one or both cylinders or secondary relief problems. Refer to Poor Operation of a Single Circuit.

4. If the bucket circuits had one low reading and the other reading was close to pump output at the same pressure, the most likely cause is an improperly adjusted or leaking secondary relief valve for the circuit with the low reading or piston packing if loss was in Rollback. Remove the relief valve, disassemble and check for worn parts. Install relief valve and check pressure setting as instructed in this section.

5. If checks and/or repairs to this point have failed to correct the problem or reveal source of problem, a badly worn spool and/or spool bore is the probable cause. Remove control valve, disassemble and check for excessive wear.

Test No. 4 - Backhoe Circuits

1. Connect flowmeter into circuit as illustrated in Figure 7 (same as Test No. 2).

2. With the engine running at 2000 rpm (r/min) move the boom control lever to the Up position. Hold control lever in place and close flowmeter load valve. When the piston rod stops moving, close load valve until pressure gauge indicates 1800 psi (12 410 kPa) and adjust throttle as required to maintain the specified engine speed. Then observe flow gauge and record the reading. Repeat this test with the control lever in the Down positon with the flowmeter load valve adjusted to 600 psi (4136 kPa).

3. Check the bucket circuits with the control lever in the Load and Dump positions at 1800 psi (12 410 kPa) with the engine running at 2000 rpm (r/min). If test results in both positions were not the same or very close to the pump output at the same pressure, refer to step 3 under Interpreting Test Results. At least one bucket circuit must be in good condition to effectively check the stabilizer circuits.

4. Check both stabilizer cylinders in the Lower position at 1800 psi (12 410 kPa) with the engine running at 2000 rpm (r/min). When the stabilizer piston rod stops moving, move the bucket control lever to the Load or Dump Position, whichever circuit is good. Hold both levers in place for remainder of this test. The spools in the stabilizer control valve are a random fit in the spool bores which results in higher spool leakage than in valves with select fit spools. When a spool is actuated oil leaks past the spool to the open center passage. Therefore, the reason for actuating the bucket spool is to stop the flow of oil through the open center passage. This excess leakage could be interpreted as cylinder leakage if the bucket spool was not actuated. When the piston rod is completely retracted, packing leakage is difficult to detect because the piston is seated against the closed end of the cylinder.

5. Check the dipper and swing circuits in both directions at 1800 psi (12 410 kPa) with the engine running at 2000 rpm (r/min).

6. With the engine running at 800 rpm (r/min) hold the boom control lever in the Down positon and close the flowmeter load valve. When the flow reading drops to zero or very close to zero, observe the pressure gauge and record the reading. This is the setting of the secondary relief valve at the A port of the boom section.

Interpreting Test Results

1. If the flow reading for a given circuit was close to the reading obtained in the pump test at the same pressure, the circuit is good.

2. If the flow reading was low for all circuits it indicates leakage before the oil reaches the cylinders. Leakage could be past the O-ring on the main relief valve cartridge or seat sleeve (this should have been discovered in Test No. 3) or the O-ring on the power beyond fitting in the loader control valve. Leakage could also be through the main relief valve itself because the circuit test was performed at a pressure higher than the crack pressure reading obtained in Test No. 2.

3. If the bucket or swing circuits had one low reading and the other was close to pump output at the same pressure, the most likely cause is an improperly adjusted or leaking secondary relief valve for the circuit with the low reading or piston packing if the cylinder rod was extended. Remove the relief valve, disassemble and check for worn parts. Install relief valve and check pressure setting as instructed in this section.

4. If the flow reading for the boom Up and Down circuits were lower than pump output at the same pressure, the cause could be leaking piston packing or an improperly adjusted or leaking secondary relief valve. Check for leaking cylinder packing as instructed under Poor Operation of a Single Circuit. The boom down relief valve (A port) was checked in step 7. Check the relief valve at the B port as instructed in the section.

5. If the flow reading for the dipper In circuit was low the probable cause is leaking piston packing. Check cylinder packing as instructed under Poor Operation of a Single Circuit. If piston packing is good, check pressure setting of a secondary relief valve for this circuit as instructed in this section.

6. If the flow reading for the dipper Out circuit was low the probable cause is an improperly adjusted or leaking relief valve. Check setting of relief valve as instructed in this section. Piston packing leakage with the piston rod completely retracted is difficult to prove because the piston is seated against the closed end of the cylinder.

7. If checks and/or repairs to this point have failed to correct the problem or reveal source of problem, a badly worn spool and/or spool bore is the probable cause. Remove control valve, disassemble and check for excessive wear.

U.S. MEASURE FLOWMETER CHECK SHEET - 580C

Owner _____ Date _____

Model 580C Serial No. _____ Hours _____

Pump Efficiency Test: Temperature: Start Test _____ °F Finish Test _____ °F

*	_____	GPM at	0	psi at	2000	RPM
	_____	GPM at	600	psi at	2000	RPM
	_____	GPM at	1000	psi at	2000	RPM
	_____	GPM at	1800	psi at	2000	RPM
	_____	(% efficiency)				
(divide by *)	_____	GPM at	2000	psi at	2000	RPM

Circuit Leakage, "Tee" Test:

Main Relief, crack point _____ psi at Full RPM

setting _____ psi at Full RPM

LOADER CIRCUITS

Bucket, Rollback	_____	GPM at	1800	psi at	2000	RPM
Dump	_____	GPM at	1800	psi at	2000	RPM
Lift, Raise	_____	GPM at	1800	psi at	2000	RPM
Lower	_____	GPM at	1800	psi at	2000	RPM
Clam, Open	_____	GPM at	1800	psi at	2000	RPM
Close	_____	GPM at	1800	psi at	2000	RPM

BACKHOE CIRCUITS

Extendahoe In	_____	GPM at	1800	psi at	2000	RPM
Out	_____	GPM at	1800	psi at	2000	RPM
R. H. Stabilizer, Raise	_____	GPM at	1800	psi at	2000	RPM
Lower	_____	GPM at	1800	psi at	2000	RPM
L. H. Stabilizer, Raise	_____	GPM at	1900	psi at	2000	RPM
Lower	_____	GPM at	1800	psi at	2000	RPM
Swing, Right	_____	GPM at	1800	psi at	2000	RPM
Left	_____	GPM at	1800	psi at	2000	RPM
Bucket, Load	_____	GPM at	1800	psi at	2000	RPM
Dump	_____	GPM at	1800	psi at	2000	RPM
Crowd, In	_____	GPM at	1800	psi at	2000	RPM
Out	_____	GPM at	1800	psi at	2000	RPM
Boom, Up	_____	GPM at	1800	psi at	2000	RPM
Down	_____	GPM at	600	psi at	2000	RPM

Low Pressure Secondary Relief Valve (Flow) Settings:

Boom, Down _____ psi . . . . . at 800. . . RPM

METRIC MEASURE FLOWMETER CHECK SHEET - 580C

Owner _____ Date _____

Model 580C Serial No. _____ Hours _____

Pump Efficiency Test: Temperature: Start Test _____ °C Finish Test _____ °C

* _____	l/min at	0	kPa at	2000	r/min
_____	l/min at	4136	kPa at	2000	r/min
_____	l/min at	6894	kPa at	2000	r/min
_____	l/min at	12 410	kPa at	2000	r/min
(divide by *) _____ (% efficiency)	l/min at	13 789	kPa at	2000	r/min

Circuit Leakage, "Tee" Test:

Main Relief, crack point _____ kPa at Full r/min

setting _____ kPa at Full r/min

LOADER CIRCUITS

Bucket, Rollback _____	l/min at	12 410	kPa at	2000	r/min
Dump _____	l/min at	12 410	kPa at	2000	r/min
Lift, Raise _____	l/min at	12 410	kPa at	2000	r/min
Lower _____	l/min at	12 410	kPa at	2000	r/min
Clam, Open _____	l/min at	12 410	kPa at	2000	r/min
Close _____	l/min at	12 410	kPa at	2000	r/min

BACKHOE CIRCUITS

Extendahoe In _____	l/min at	12 410	kPa at	2000	r/min
Out _____	l/min at	12 410	kPa at	2000	r/min
R. H. Stabilizer, Raise _____	l/min at	12 410	kPa at	2000	r/min
Lower _____	l/min at	12 410	kPa at	2000	r/min
L. H. Stabilizer, Raise _____	l/min at	12 410	kPa at	2000	r/min
Lower _____	l/min at	12 410	kPa at	2000	r/min
Swing, Right _____	l/min at	12 410	kPa at	2000	r/min
Left _____	l/min at	12 410	kPa at	2000	r/min
Bucket, Load _____	l/min at	12 410	kPa at	2000	r/min
Dump _____	l/min at	12 410	kPa at	2000	r/min
Crowd, In _____	l/min at	12 410	kPa at	2000	r/min
Out _____	l/min at	12 410	kPa at	2000	r/min
Boom, Up _____	l/min at	12 410	kPa at	2000	r/min
Down _____	l/min at	4136	kPa at	2000	r/min

Low Pressure Secondary Relief Valve (Flow) Settings:

Boom, Down _____ kPa . . . . . at 800. . . r/min

TESTING SECONDARY RELIEF VALVES WITH A HAND PUMP

General

The following circuits are protected by secondary relief valves: loader bucket, boom, dipper, swing and backhoe bucket. The pressure setting of these relief valves can be checked on or off the machine with the hand pump set up as illustrated in Figure 8 and using the additional parts illustrated in Figures 9 and 10 as required.

The hoses and hose fittings in Figure 8 are listed in the Flexible Hose Lines and Reusable Fittings catalog SPS 124. The remaining parts can be ordered in the usual manner.

The fittings illustrated in Figures 9 and 10 are available in a complete hand pump fittings and gauge kit from the Nuday Co. Refer to Service Tool Catalog SPS 179-Revised for more information and mailing address.

The pressure setting for each relief valve is listed on page 4002-3. The original relief valves in the Case backhoe control valve have a nominal pressure setting stamped in the top of the valve cartridge. DO NOT use this figure when checking or setting a relief valve; use the pressure settings listed on page 4002-3.

Checking Pressure Setting, Control Valve Installed

1. The oil in the hand pump should be at room temperature, preferably 70°-80° F (21°-26.7° C). Also be sure the pump reservoir is filled with Case TCH Fluid.

2. Lower all buckets and/or attachments to the floor. Then move control lever for relief valve being tested to relieve circuit pressure.

3. Break the line between the cylinder and control valve for the relief valve being tested at any convenient connection.

   a. If checking a loader bucket or boom relief valve, break line at a connection that leads directly to the control valve.

   b. When checking swing relief valves, hand pump must be connected to tube to the swing section.

4. Refer to Figure 9 for the necessary parts and connect hand pump to line to control valve. Do not tighten connection at this time.

5. The hand pump must be operated against a solid column of oil. Operate hand pump to bleed air from line and tighten hose connection.

6. Actuate hand pump to build up pressure until the relief valve opens. Make several checks to obtain an accurate check.

7. Compare test reading with specified setting on page 4002-3 and adjust as required.

Checking Pressure Setting, Control Valve Removed

With the control valve removed the hand pump can be easily connected to the valve. Refer to Figure 10 to determine the adapter required and install in the port next to the relief valve being tested. Check setting as instructed in steps 5 and 6 above.

Relief Valve Adjustment

Loader Control Valve

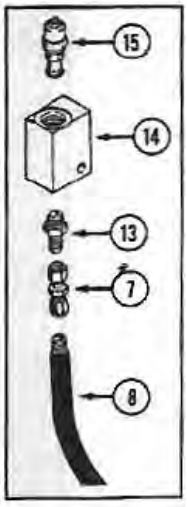
The relief valves are adjusted by removing or adding shims. The shims are installed between the plug and spring guide.

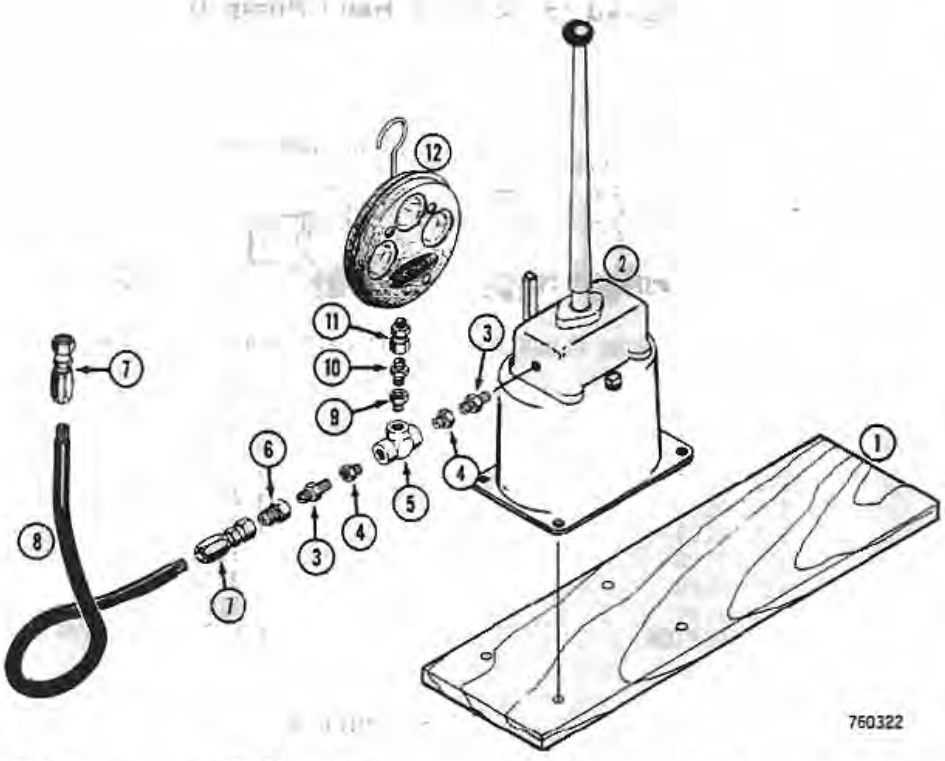
1. Remove plug from end of relief valve. If control valve is installed, use a magnet and remove spring guide/poppet assembly to be sure all shims are removed.

2. Add shims to increase pressure setting or remove shims to decrease the pressure setting.

3. Install spring guide/poppet assembly and shims.

(Continued on page 4011-29)

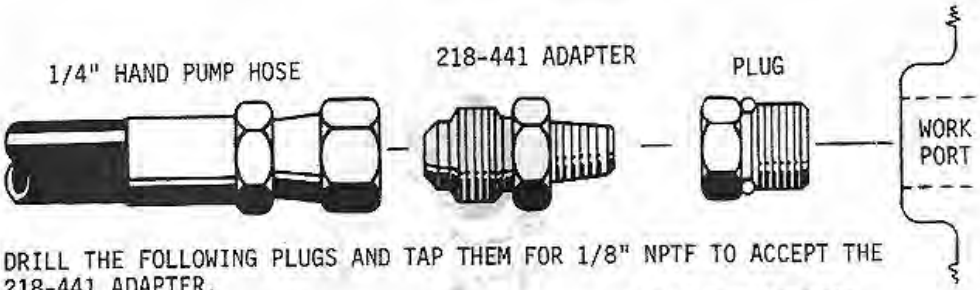




NO.	PART NO.	DESCRIPTION	REQ'D
1.		MOUNTING BOARD, MAKE LOCALLY	
2.	M20276	HAND PUMP	1
3.	217-1080	1/4" HEX NIPPLE	2
4.	221-88	1/2" NPT TO 1/4" NPT REDUCER	2
5.	D23911	1/2" NPT TEE	1
6.	218-1032	1/4" NPT TO 7/16"-20 JIC, 37 ADAPTER	1
7.	220-201	7/16"-20 JIC, 37 SWIVEL FITTING	2
8.	A21570	1/4" ID BULK HOSE (DOUBLE WIRE BRAID CUT TO 8 FOOT LENGTH)	
9.	221-87	1/2" NPT TO 1/8" NPT REDUCER	1
10.	221-1079	1/8" HEX NIPPLE	1
11.	218-900	1/8" NPT SWIVEL UNION	1
12.	M20671	SCHROEDER MULTI-GAUGE	1
13.	218-1022	7/16"-20 JIC-1/4" NPT ADAPTER	1
14.	G35216	TEST BLOCK FOR OFF-MACHINE TESTING OF CASE BACKHOE RELIEF VALVES	1
15.		CASE BACKHOE RELIEF VALVE	

Figure 8 - Hand Pump

Adapters Required to Connect Hand Pump to Control Valve Ports*

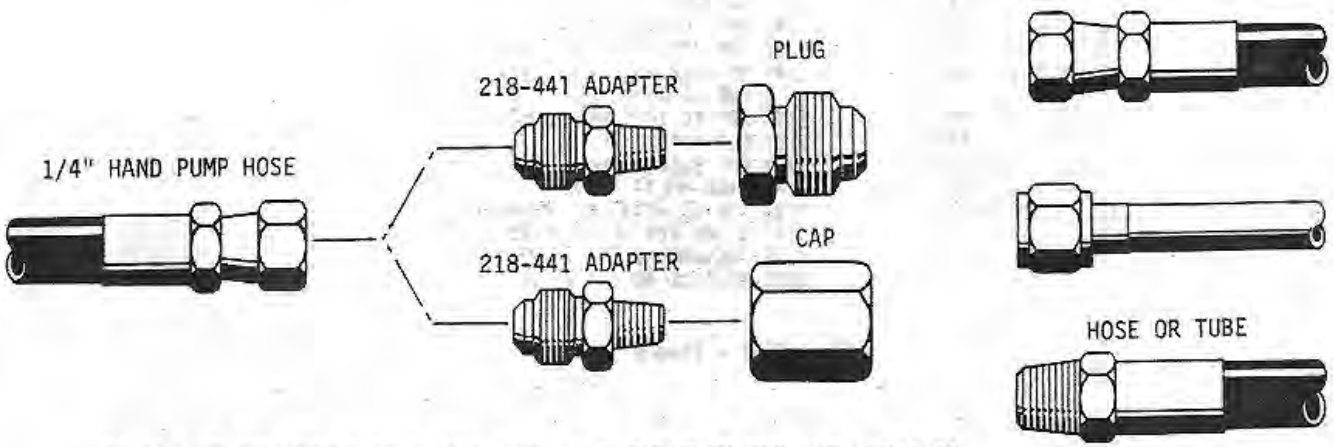


DRILL THE FOLLOWING PLUGS AND TAP THEM FOR 1/8" NPTF TO ACCEPT THE 218-441 ADAPTER.

CASE PART NO.	CONTROL VALVE PORT STRAIGHT THREAD WITH O-RING
218-5155 PLUG	9/16" - 18 (3/8" TUBE)
218-5156 PLUG	3/4" - 16 (1/2" TUBE)
218-5157 PLUG	7/8" - 14 (5/8" TUBE)
218-5158 PLUG	1-1/16" - 12 (3/4" TUBE)
218-5159 PLUG	1-3/16" - 12 (7/8" TUBE)
218-5160 PLUG	1-5/16" - 12 (1" TUBE)
218-441 ADAPTOR	USE IN EACH PLUG

Figure 9

Adapters Required to Connect Hand Pump to Hoses and Tubes*



DRILL THE FOLLOWING CAPS AND PLUGS AND TAP THEM FOR 1/8" NPTF TO ACCEPT THE 218-441 ADAPTER.

QTY.	CASE NO.		QTY.	CASE NO.	
1	218-774	3/8" TUBE PLUG	1	218-754	3/8" TUBE CAP
1	218-775	1/2" TUBE PLUG	1	218-755	1/2" TUBE CAP
1	218-776	5/8" TUBE PLUG	1	218-756	5/8" TUBE CAP
1	218-777	3/4" TUBE PLUG	1	218-335	3/4" TUBE CAP
1	218-778	7/8" TUBE PLUG	1	218-757	7/8" TUBE CAP
1	218-779	1" TUBE PLUG	1	218-758	1" TUBE CAP
			12	218-752	1/4" TUBE CAP

***NOTE:** ALL FITTINGS AND ADAPTERS LISTED ARE NOT REQUIRED FOR THIS MACHINE. PORTS AND HOSE OR TUBE THREADS WILL DETERMINE PARTS REQUIRED.

731195

Figure 10

4. Install plug and check pressure setting. Repeat adjustment procedure as required to obtain correct pressure setting.

Backhoe Control Valve

The relief valves are screw adjustable.

1. Loosen lock nut.
2. Turn adjusting screw clockwise to increase pressure setting or counterclockwise to decrease pressure setting.
3. Tighten lock nut while preventing adjusting screw from turning. Then torque nut to 50-80 inch-pounds (5.6-9 N m) and check pressure setting.
4. Repeat adjustment procedure as required to obtain correct pressure setting.

BOOM LOCK RELIEF VALVE PRESSURE CHECK

The pressure setting of the boom lock relief valve can be easily checked using the hand pump illustrated in Figure 8.

1. The oil in the hand pump should be at room temperature, preverable 70°-80° F (21°-26.7° C). Be sure pump reservoir is filled with Case TCH Fluid.
2. Lower the boom until the bucket is resting on the floor.
3. With the engine shut off, move the boom control lever back and forth to relieve circuit pressures.
4. Disconnect hose to tube to the rod end of the boom cylinders.
5. Refer to Figure 10 for the necessary parts and connect hand pump to hose. Do not tighten connections at this time.
6. The hand pump must be operated against a solid column of oil. Actuate the hand pump to bleed air from the line and tighten connection.
7. Place boom lock control valve lever in the Lock position. Actuate the hand pump to build up pressure until the relief valve opens. Make several checks to obtain an accurate check.
8. If the pressure setting is not as specified on page 4002-3 the relief valve must be replaced. It is nonadjustable and nonrepairable.
9. If leakage occurs past lock check seat out inlet port check for damaged lock check or seat.

LOADER MAIN RELIEF VALVE

Pressure Check

1. The hydraulic oil should be warm (120° F (49° C) or control valve inlet tube should be very warm to the touch) to obtain an accurate pressure reading. To warm the oil, hold the control lever in Rollback for 15 seconds, then return to Neutral for 30 seconds. Repeat this cycle until oil temperature is as specified.
2. Rest loader bucket flat on the floor.
3. Remove the plug in the right-hand side of the operators compartment to gain access to the test port in the control valve.
4. Remove the 1/4" pipe plug from the control valve and connect a 3000 psi (20 680 kPa) pressure gauge to the test port.
5. Start engine and run at full throttle. Hold the control lever in Rollback position and observe pressure gauge. The gauge should indicate 2300 ± 50 psi (15 857 ± 344 kPa).

Adjustment

1. Remove the acorn nut and loosen the lock nut.
2. Turn the adjusting screw in (clockwise) to increase the pressure setting or turn the screw out (counterclockwise) to decrease the pressure setting.
3. When the pressure setting is as specified, tighten lock nut without disturbing the adjusting screw. Then install acorn nut.

THREE POINT HITCH MAIN RELIEF VALVE

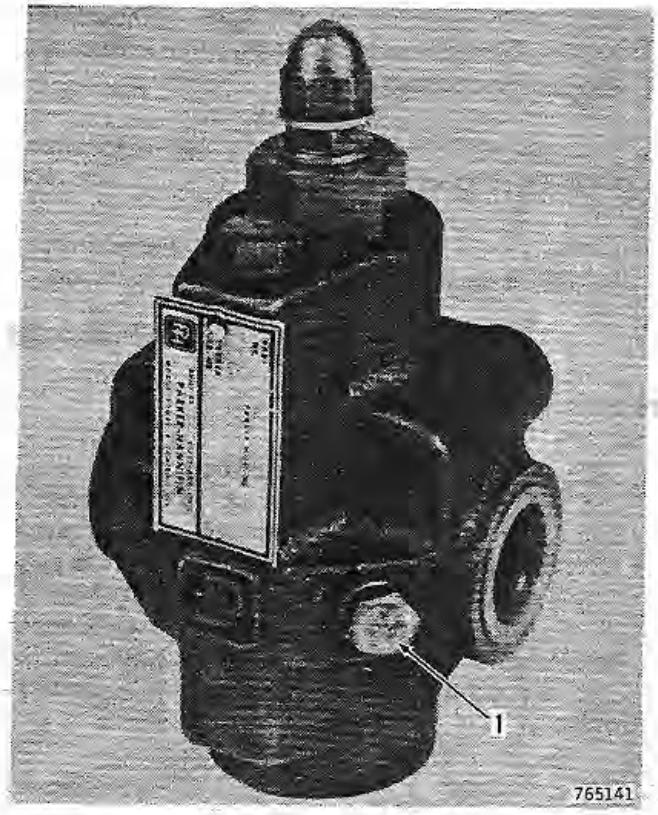
The main relief valve is located in the three point hitch control valve inlet/outlet section. To check the pressure setting of the relief valve, the test gauge is connected to the test port in the loader control valve or to test port in pump protection valve, Figure 11, if equipped with three point hitch only.

Pressure Check

1. The hydraulic oil should be warm (120° F (49° C) or control valve inlet hose should be very warm to the touch) to obtain an accurate pressure reading. To warm oil, hold the loader control lever in Roll-back for 15 seconds or one of the hitch control valve levers, then return to Neutral for 30 seconds. Repeat this cycle until oil temperature is as specified.
2. Rest loader bucket flat on the floor, if so equipped.
3. If equipped with a loader, remove the plug in the right-hand side of the operators compartment to gain access to the test port in the control valve.
4. Remove the 1/4" pipe plug from the control valve and connect a 3000 psi (20 680 kPa) pressure gauge to the test port.
5. If equipped with three point hitch only, remove the 1/8" pipe plug at pump protection valve inlet, Figure 11. The pump protection valve is located outside the R.H. reservoir.
6. Start engine and run at full throttle. Hold the three point hitch lift control lever in the Raise position and observe the pressure gauge. The gauge should indicate 1800 ± 50 psi (12 410 ± 344 kPa).

Adjustment

1. Remove the acorn nut and loosen the lock nut on control valve main relief valve.
2. Turn the adjusting screw in (clockwise) to increase the pressure setting or turn the screw out (counterclockwise) to decrease the pressure setting.
3. When the pressure setting is as specified, tighten lock nut without disturbing the adjusting screw. Then install acorn nut.



1. Pressure Test Port

Figure 11

PUMP PROTECTION VALVE

The pump protection valve is used on three point hitch only machines. The purpose of the valve is to prevent damage to the hydraulic pump if the hitch is removed and the hoses at the rear of the machine are not connected together.

The valve should rarely require repair or adjustment.

Pressure Check

WARNING: The hose must be disconnected from tube at rear of machine with the engine running. Safety goggles must be worn when disconnecting hose. It is also suggested that a rain suit be worn. 41-4

1. Remove 1/8" pipe plug at the valve inlet port, Figure 11. Connect a 0-5000 psi (0-34 4738 kPa) pressure gauge to test port.
2. Start engine and run at 1000 to 1200 rpm (r/min) and observe pressure gauge.
3. The gauge should indicate 2600 ± 50 psi (17 9264 ± 344 kPa).

Adjustment

1. Remove acorn nut and loosen lock nut.
2. Turn adjusting screw in (clockwise) to increase pressure or turn screw out (counterclockwise) to decrease pressure.
3. When the pressure setting is as specified, tighten lock nut without disturbing adjusting screw. Then install acorn nut.

Section 4005

HYDRAULIC PUMP

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

GENERAL INFORMATION

This machine uses pumps supplied by Cessna and TRW. Case part numbers will not be found on the pumps; however, there is enough difference between the pumps that you will be able to identify the pump you are working with.

PUMP REMOVAL AND INSTALLATION

Removal

1. Rest loader bucket flat on the floor or raise the loader arm and block in place with lift cylinder stops.
2. Have on hand clean containers and drain pan that will hold approximately 17 U.S. gallons (64 liters). Then drain the right and left-hand reservoirs.
3. Remove the grille and lower guard. If equipped with a counterweight, remove cover plate at rear of counterweight. The counterweight remains on the machine.
4. Disconnect outlet hose from pump. Then loosen outer hose clamps on each suction tube lower hose.
5. Remove the pump mounting cap screws. Pull pump from mounting bracket and pivot pump forward.
6. Loosen suction hose clamp at pump and remove pump from hose. Plug all hose openings.

Installation

1. Lubricate the pump drive shaft as instructed under Shaft Lubrication.
2. Attach pump to suction tube hose. Do not tighten clamp at this time.
3. Pivot pump into mounting bracket. Twist pump as required to engage the drive coupling. Install pump mounting cap screws and torque to 80-85 foot-pounds (108-115 N m).
4. Connect outlet hose to pump fitting and tighten all suction hose clamps.
5. If oil drained from reservoirs is to be used again, filter the oil before returning it to the reservoir. If new oil is to be used, use oil specified in Section 1050.
6. Break in pump as instructed on page 4005-4. Stop engine, check for leaks and check reservoir oil level and add oil as required.
7. Install the lower guard, cover plate at rear of counterweight if so equipped, and grille.

SHAFT LUBRICATION

1. The shaft splines must be lubricated with Molykote, Type G, (part no. D60210) whenever the pump is removed and installed or a new pump is installed. To obtain maximum service life, the shaft should be lubricated after 500 hours of operation or six months of operation.
2. Prior to lubricating shaft splines, remove all traces of oil, rust, dirt and any metal chips from the splines.
3. Do not fill splines with lubricant. Molykote has a peculiar affinity for metal and when properly applied will not wipe off or squeeze out from between metal surfaces. Molykote, Type G, is a concentrate and excessive usage should be avoided.
4. Apply Molykote to the entire length of the splines using a STIFF bristle brush. Brush the lubricant into the splines until they are well covered over their entire surface; THIS IS IMPORTANT. Brush parallel to the splines. Wiping a quantity of lubricant over the splines IS NOT acceptable.
5. Install pump in normal manner but do not allow dirt or other contaminants to come into contact with the lubricated surfaces.

BREAK IN OF REBUILT OR NEW PUMP

1. Start engine and run at half throttle for three minutes.
2. With the engine running at half throttle, hold bucket control lever in Rollback to open the main relief valve for five seconds. Then return control lever to Neutral for five seconds. Repeat this cycle for three minutes.
3. Increase engine speed to full throttle and repeat step 2.
4. Stop engine and check for leaks.

IDENTIFYING CAUSES OF PUMP FAILURE

Particular attention should be paid to the following information if the pump has a short service life. Any or all causes may be found in a pump that has had a long service life.

Wear Caused by Fine Particles

The particles that cause abrasive wear are usually not visible to the human eye. The filter used on this machine removes particles over 40 microns in size. A micron equals 1/1000 millimeter or .0000394 inches. Improper service procedures and failure to follow the prescribed maintenance schedule can be the cause of abrasive wear.

Wear Plate

A narrow band with a sandblasted appearance will be evident around the bores in the wear plate. The edges of the lubrication slots will be rounded and the ends enlarged.

Gears

A sandblasted appearance will be evident at the base of the teeth at each end. The bearing surface will have a dull finish as if sanded with fine sandpaper. A groove in seal lip area of the driveshaft may also be apparent.

Gear Housing

The gear track will have a sandblasted appearance on the inlet side.

Wear Caused by Metal Particles

Metal particles usually result from wear or insufficient flushing after a component failure. Wear may be gradual or sudden depending on the quantity and size of the particles.

Wear Plate

Circular scratches or grooving will be apparent near the outer edges. Depending on quantity and size of the particles, the entire surface may be heavily grooved.

Gears

The bearing surfaces will have many small grooves. The severity of the grooving will depend on the amount of contamination and operating pressure.

Gear Housing

The gear track will be grooved by particles large enough to be caught between the tips of the gear teeth and the housing.

Aeration or Cavitation

This type of failure is rare and careful investigation is required to pinpoint it. Aeration occurs when air is mixed with the oil. Air can enter the system through a small leak in the suction line.

Cavitation is usually the result of the pump suction being restricted.

Aeration and cavitation erode and pit the thrust plates and gear housings. Damage will be apparent on the suction side of the gear housing and on the high pressure (outlet) side of the thrust plates. As the air or vapor bubbles in the oil are compressed to pump discharge pressure they collapse. This collapse is called an implosion. The force of the implosion removes metal from the thrust plates and the gear housings.

A pump cavitating or operating on aerated fluid is usually noisy. It makes a sound like

pumping marbles. System operation is spongy and jerky.

Lack of Oil

Failure of this nature is usually due to a large air leak in the suction line. Heavy wear will be apparent on the end of the thrust plate and on both ends of the gears. Wear will be greater near the outside diameter of the gears.

Excessive Heat

Excessive heat is usually the result of a control valve spool not returning to neutral or a relief valve that is set too low. If the valve spool fails to return to neutral, the pump flow will be dumped continuously and will cause a rapid increase in oil temperature. If the relief valve is set too low, part of the oil will be dumped across the relief valve every cycle. In this case loader operation may be slow.

Excessive Pressure

There are two reasons for excessive pressure: (1) the relief valve fails to function. This produces one extreme surge of pressure and immediate failure. (2) The relief valve pressure setting is too high and failure is the result of repeated excessive pressure peaks.

Both reasons for excessive pressure can result in broken driveshafts or cracked housings.

CESSNA HYDRAULIC PUMP (D48950)

Specifications

Output	24 U.S. gpm at 2000 rpm at 2000 psi (91 l/min at 2000 r/min at 13 789 kPa)
Tie bolt torque	40 foot-pounds (54 N m)
Mounting bolt torque	80-85 foot-pounds (108-115 N m)
Rotation	Counterclockwise viewed from shaft end.
Wear allowances	See pages 4005-8 and 4005-9

General

The two gears revolve in a close fitting housing and trap oil between the gear teeth as the teeth move out of mesh. The oil is carried around the edge of the housing and discharged at the outlet side. Refer to Figure 1.

Operation

A bronze faced steel plate called a diaphragm reduces gear end clearance by applying hydraulic pressure from the outlet side of the pump. The area behind the diaphragm is divided into pressure compartments formed by grooves in the face of the front cover. A rubber diaphragm seal and two gaskets are installed in the groove in the front cover.

Pressurized oil from the outlet side of the pump is directed to the diaphragm seal through a drilled passage in the gear plate. The pressurized oil moves the diaphragm seal and two gaskets against the diaphragm. The diaphragm in turn presses against the gear faces reducing gear end clearance and oil leakage. Six small holes drilled in the diaphragm equalize pressure on both sides of the diaphragm.

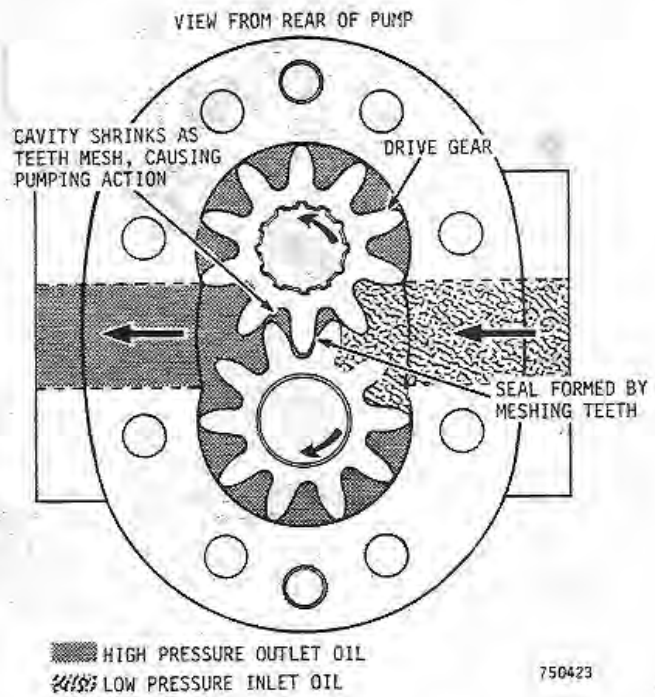
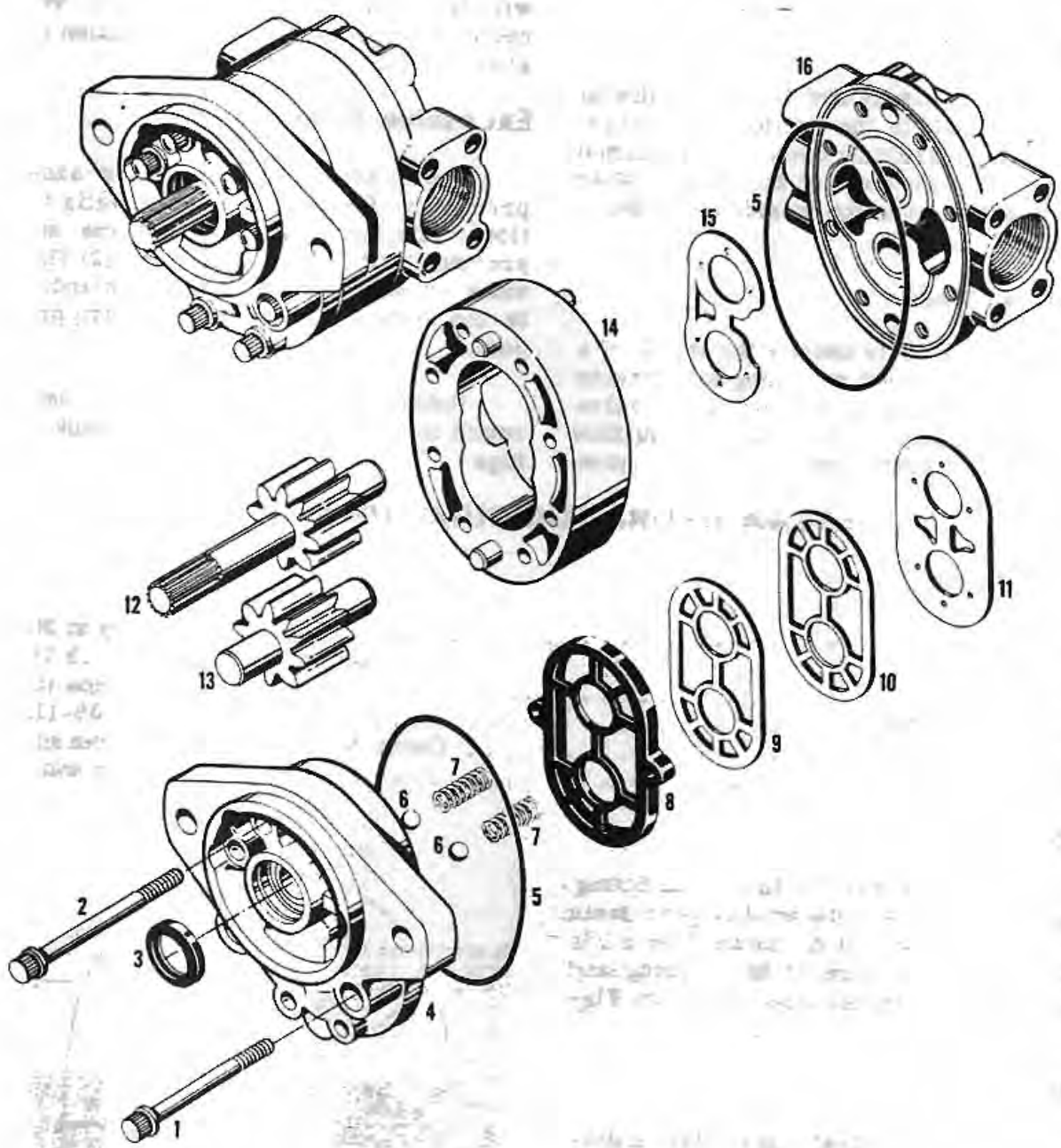


Figure 1 - Pump Operation



1. 3-1/4" (82.6 mm) LONG CAP SCREW (4)
2. 3-1/2" (88.9 mm) LONG CAP SCREW (4)
3. SEAL
4. DRIVE END COVER
5. O-RING
6. STEEL BALL
7. SPRING
8. DIAPHRAGM SEAL
9. PROTECTOR GASKET (THIN)
10. BACKUP GASKET (THICK)
11. DIAPHRAGM
12. DRIVE GEAR
13. IDLER GEAR
14. GEAR PLATE
15. THRUST PLATE
16. PORT END COVER

751544

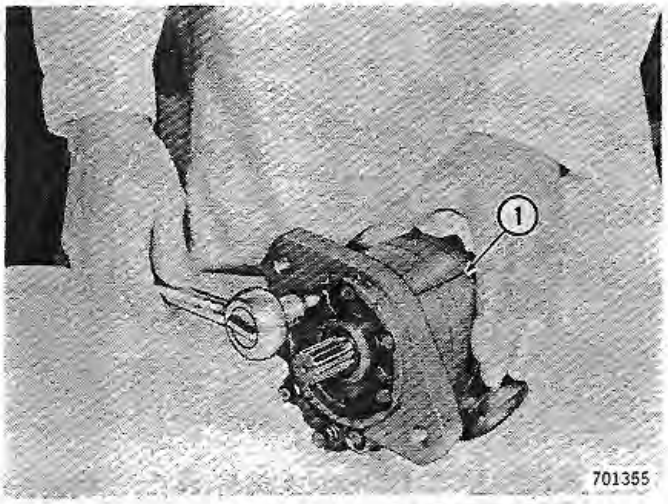
Figure 2 - Exploded View of Cessna Pump

A thrust plate is located at the opposite side of the gears to absorb wear from the gear faces. The six holes in the thrust plate maintain equal pressure on both sides of the thrust plate.

Two ball type relief valves located in the front cover prevent shaft seal blow out. One relieves into the suction side and the other into the outlet side. When the gear shaft lubrication pressure exceeds either the suction pressure or the outlet pressure, one of the steel balls will be forced from its seat and oil will flow past it.

Disassembly

1. Scribe a line across the three sections of the pump so that the drive end cover, port end cover, and gear plate can be reassembled in the same position.



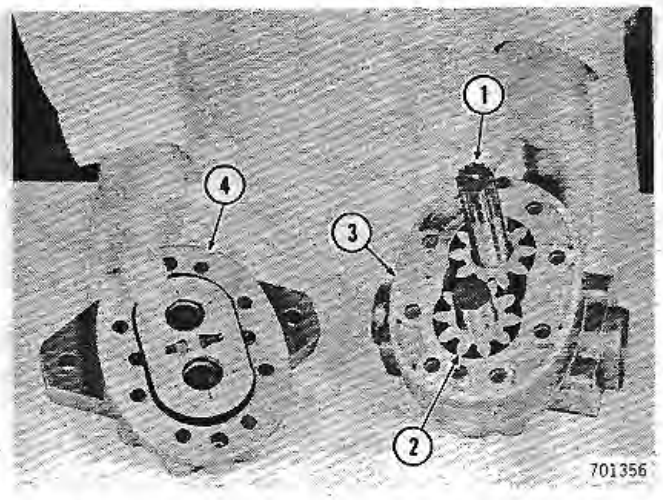
1. SCRIBED LINE

Figure 3 - Disassembling Pump

2. Use a standard 7/16", 12 point socket to remove the eight capscrews that hold the pump together.

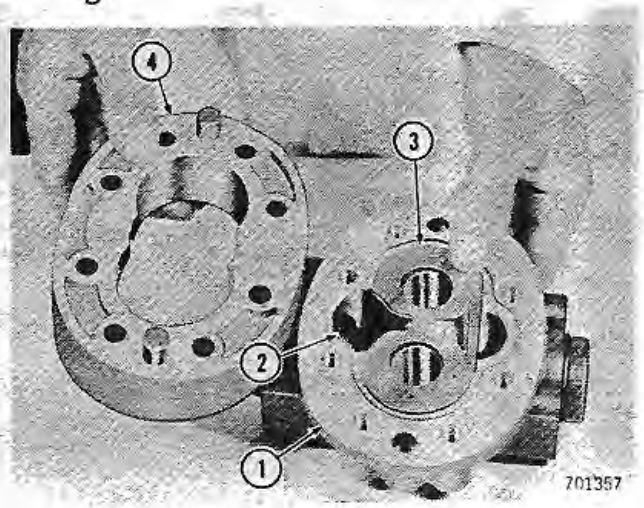
3. Use a soft metal hammer, tap the front cover from the gear plate. DO NOT try to pry sections apart, as the machined surfaces will be damaged, Figure 4.

4. To separate port cover from gear plate, tap end of driveshaft with soft hammer. Do not allow gear plate to cock on dowel pins, Figure 5.



1. DRIVE GEAR
2. DRIVEN GEAR
3. GEAR PLATE
4. DRIVE END COVER

Figure 4 - Drive End Cover Removed

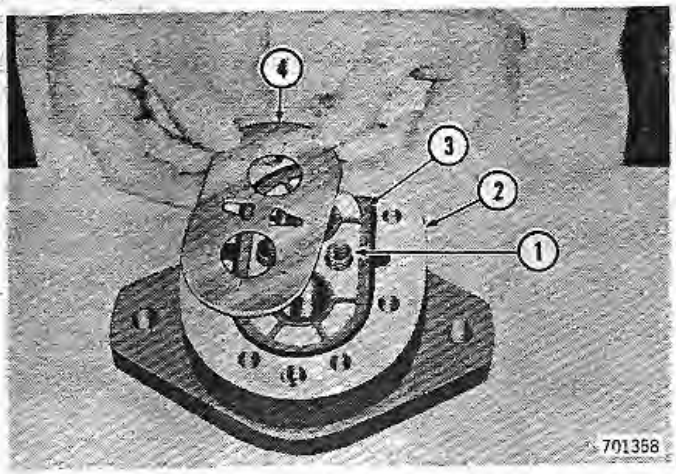


1. PORT END COVER
2. SUCTION SIDE
3. THRUST PLATE
4. GEAR PLATE

Figure 5 - Gear Plate and Port End Cover

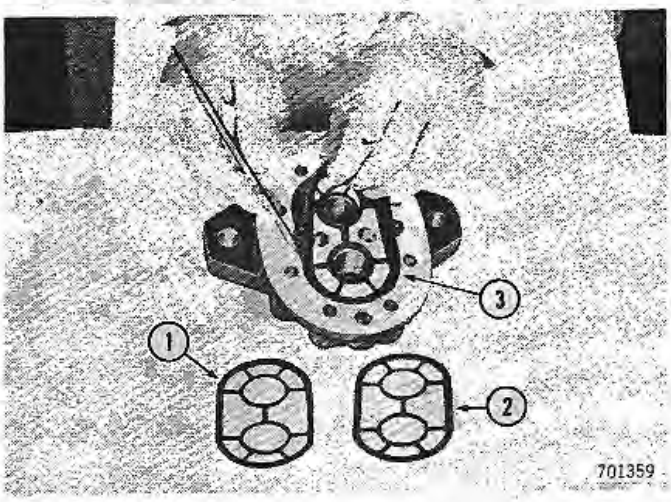
5. Slip a sharp instrument under the diaphragm on the drive end cover and gently pry the diaphragm loose, Figure 6. Remove the springs and balls, backup gasket, protector gasket, and diaphragm seal. Discard the gaskets and seals, Figure 7.

6. Remove and discard the shaft seal from the drive end cover, Figure 8.



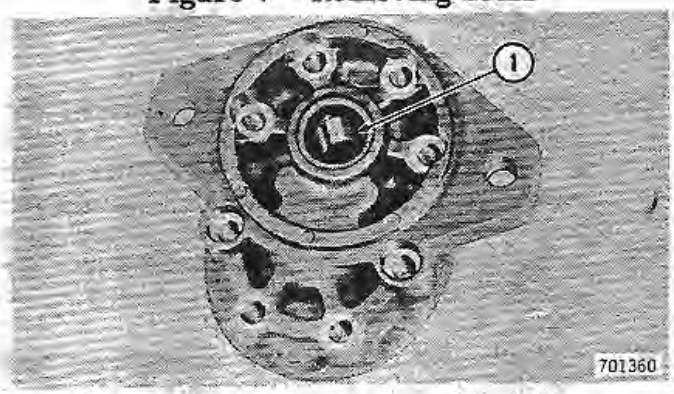
1. SPRING
2. DRIVE END COVER
3. GASKETS AND SEAL
4. DIAPHRAGM

Figure 6 - Removing Diaphragm (Wear Plate)



1. PROTECTOR GASKET
2. BACKUP GASKET
3. DIAPHRAGM SEAL

Figure 7 - Removing Seals



1. SHAFT SEAL

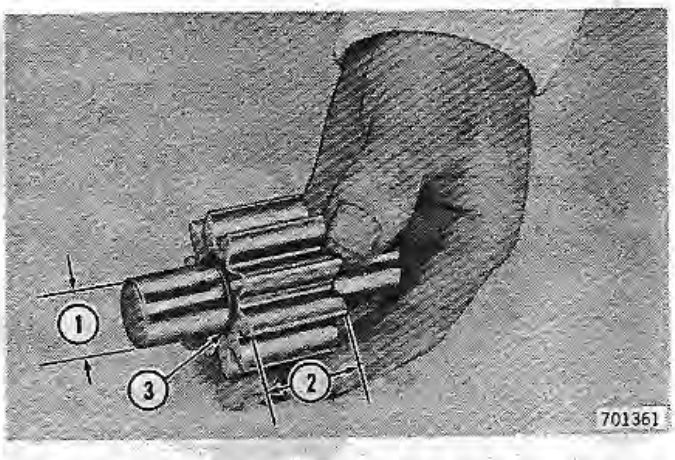
Figure 8 - Drive End Cover and Shaft Seal

Inspection

Clean all parts and inspect for nicks and burrs. Remove all imperfections on machined surfaces with fine emery cloth.

1. Inspect the driveshaft. Check the splines for small cracks, wear at shaft seal contact area, and rough spots.

2. Inspect the idler gear and shaft, Figure 9. If the bearing area of the shaft measures less than .873" (22.17 mm), the shaft and gear assemblies should be replaced. Check the gear ends for scoring, bluing due to heat, and excessive wear. Check gear width, if less than 1.517" (38.53 mm), replace gear. Make sure the snap rings are in place. If the gear teeth have sharp edges, break corner with emery cloth.



1. REPLACE GEAR ASSEMBLY IF SHAFT DIAMETER IS LESS THAN .873" (22.17 mm)
2. REPLACE GEAR ASSEMBLY IF GEAR WIDTH IS LESS THAN 1.517" (38.53 mm)
3. SNAP RING

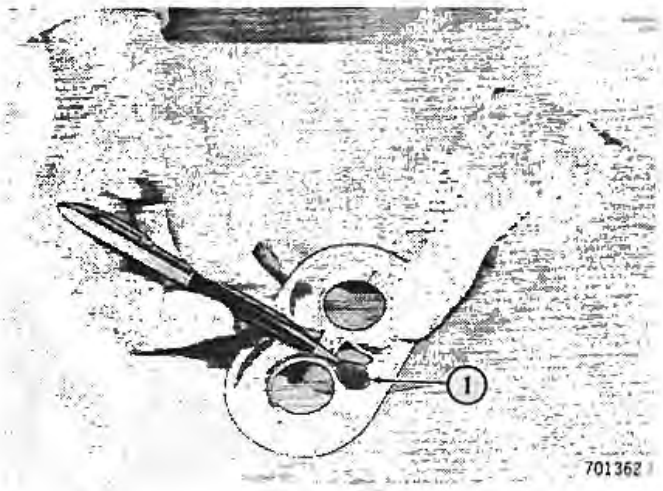
Figure 9 - Driven Gear Assembly

NOTE: Shafts and gears are serviced as an assembly only, and are not available separately.

3. Inspect the diaphragm and thrust plate. Check for score marks and erosion pits. If noticeably eroded in center, deeply scored or burned, replace.

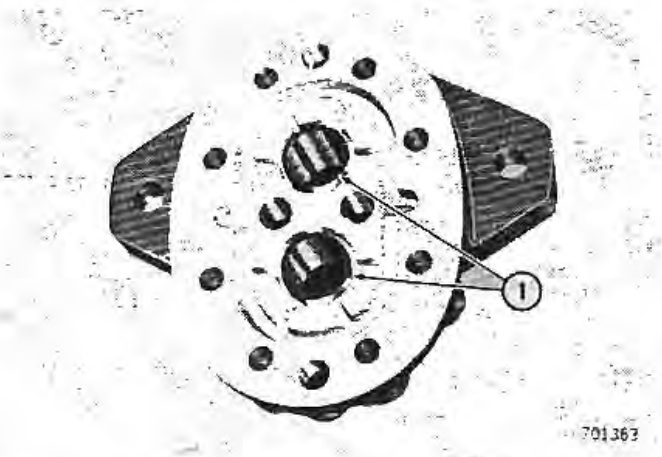
4. Inspect the bushings in both the drive end and port end covers, Figure 11. If the bearing inside diameter is more

than .879" (22.32 mm), both the drive end and port end covers must be replaced as an assembly with the bushings. Bushings are not supplied separately.



1. ERODED AREA

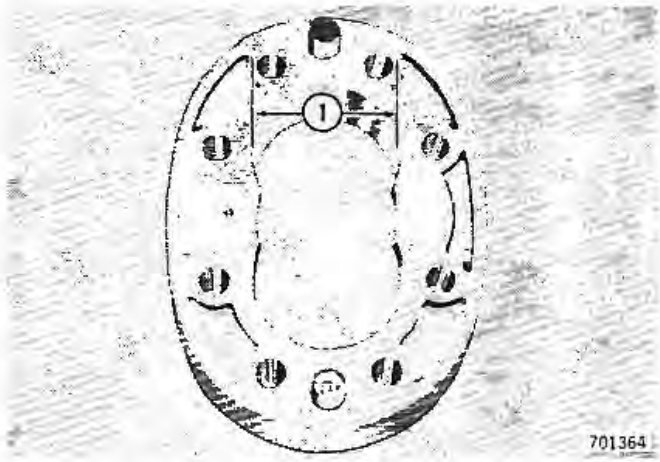
Figure 10 - Checking Diaphragm



1. REPLACE COVER IF EITHER BUSHING DIAMETER IS MORE THAN .879" (22.32 mm)

Figure 11 - Checking the Bushings

5. Inspect the gear plate, Figure 12. Check inside diameter of plate for excessive wear or score marks. If inside diameter of gear pockets measures over 2.107" (53.5 mm), replace.

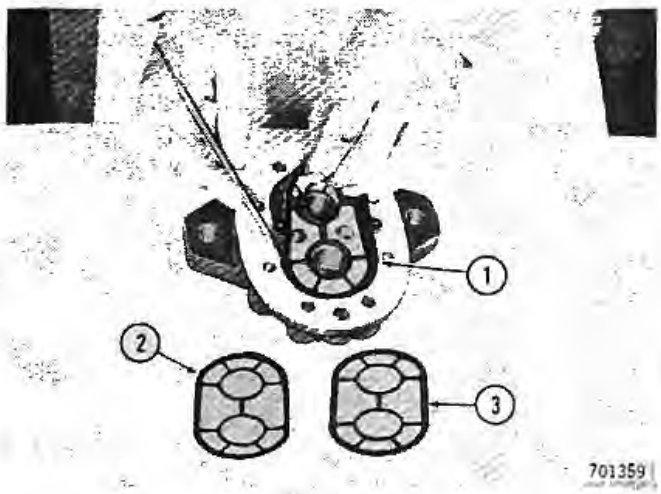


1. REPLACE GEAR PLATE IF EITHER GEAR POCKET DIAMETER IS MORE THAN 2.107" (53.5 mm).

Figure 12 - Checking the Gear Plate

Assembly

1. Place a new diaphragm seal on the drive end cover with the groove down. Use a dull instrument and work seal into grooves in cover. Install new protector gasket (thin) on the diaphragm seal. Install new backup gasket (thick).



1. DIAPHRAGM SEAL
2. PROTECTOR GASKET (THIN)
3. BACKUP GASKET (THICK)

Figure 13 - Installing Diaphragm Seal

2. Place one ball in each hole in the drive end cover. Place a spring on top of each ball.

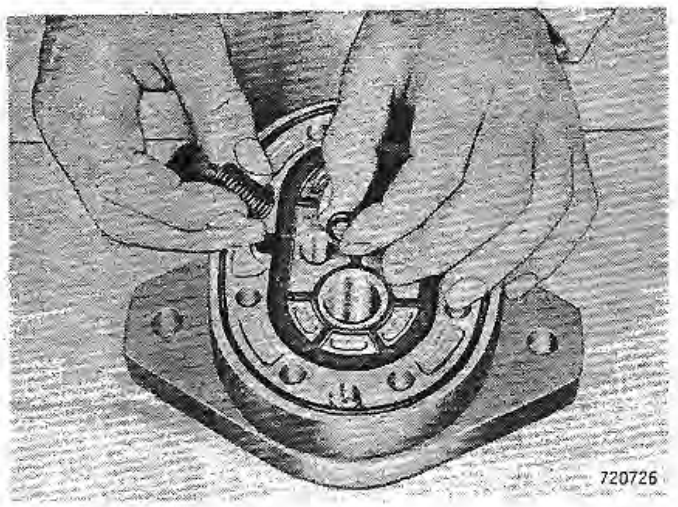
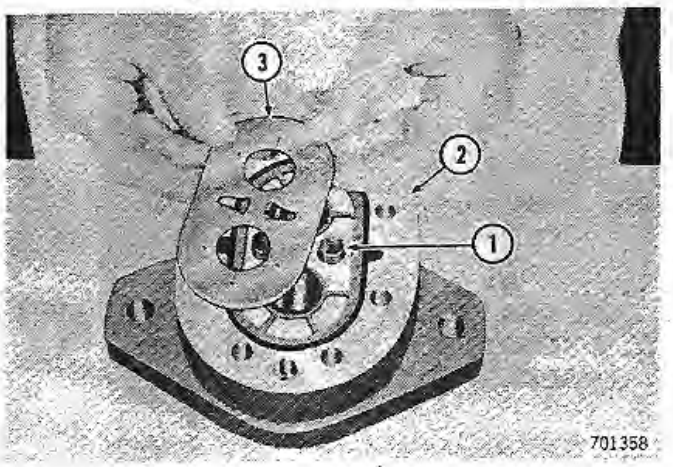


Figure 14 - Installing Balls and Springs

3. Install new diaphragm (wear plate) with the bronze side up. It must fit inside of the rim on the diaphragm seal. Make sure coils of the springs are not wedged between diaphragm and front cover, Figure 15.

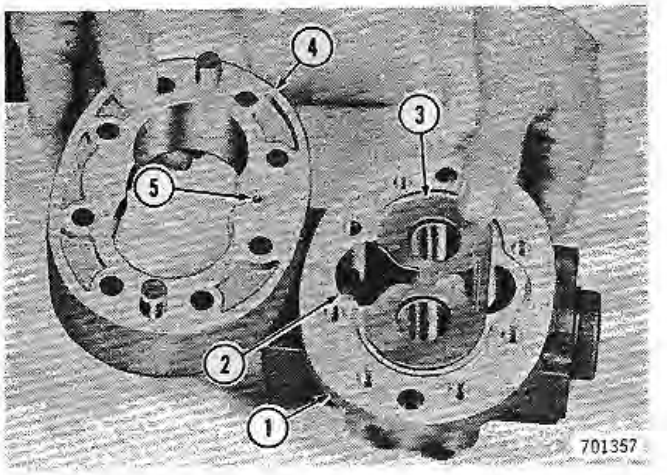
4. On the port end cover, install the thrust plate (wear plate) with bronze side toward the gears. Side with cutaway must be on the suction side of the pump, Figure 16. This plate fits inside the gear plate when gear plate is seated on rear cover.



1. SPRING
2. DRIVE END COVER
3. DIAPHRAGM

Figure 15 - Front Cover and Diaphragm

5. Notice that the gear plate has two half moon cavities on one side. Also the small hole drilled in one of the cavities. Install gear plate on port end cover with half moon cavities toward end cover and drilled hole on the outlet (pressure) side, Figure 16.



1. PORT END COVER
2. SUCTION SIDE
3. THRUST PLATE
4. GEAR PLATE
5. HOLE - MUST BE ON OUTLET SIDE

Figure 16 - Port End Cover and Gear Plate

6. Lubricate gears with clean hydraulic oil and install gears in port end cover.

7. Install drive end cover over gears. Install cap screws and torque evenly to specification on page 4005-5.

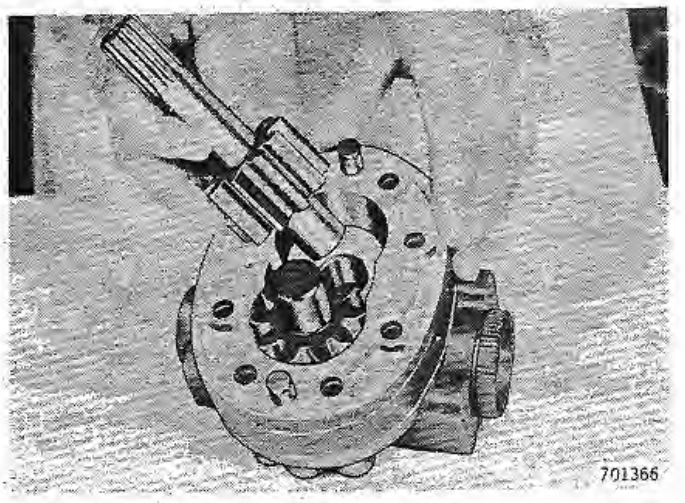


Figure 17 - Installing Gears

8. Install seal protector (sleeve, tape, etc.) on pump shaft. Carefully install seal

over the shaft. Use a 1-5/16" (33.3 mm) O.D. seal driver and hammer, tap the seal into drive end cover until seated against shoulder in seal bore.

9. Use a suitable tool and rotate the pump shaft 10 revolutions. Pump should be almost free enough to rotate shaft by hand. If not, disassemble pump to find the cause of the bind.

TRW HYDRAULIC PUMP (D49241)

Specifications

Rated output	24 U.S. gpm at 2000 rpm at 2000 psi (91 l/min at 2000 r/min at 13 789 kPa)
Tie bolt torque	25-35 foot-pounds (34-47 N m)
Mounting bolt torque	80-85 foot-pounds (108-115 N m)
Rotation	Counterclockwise viewed from shaft end.
Wear allowances	Refer to Inspection.

General

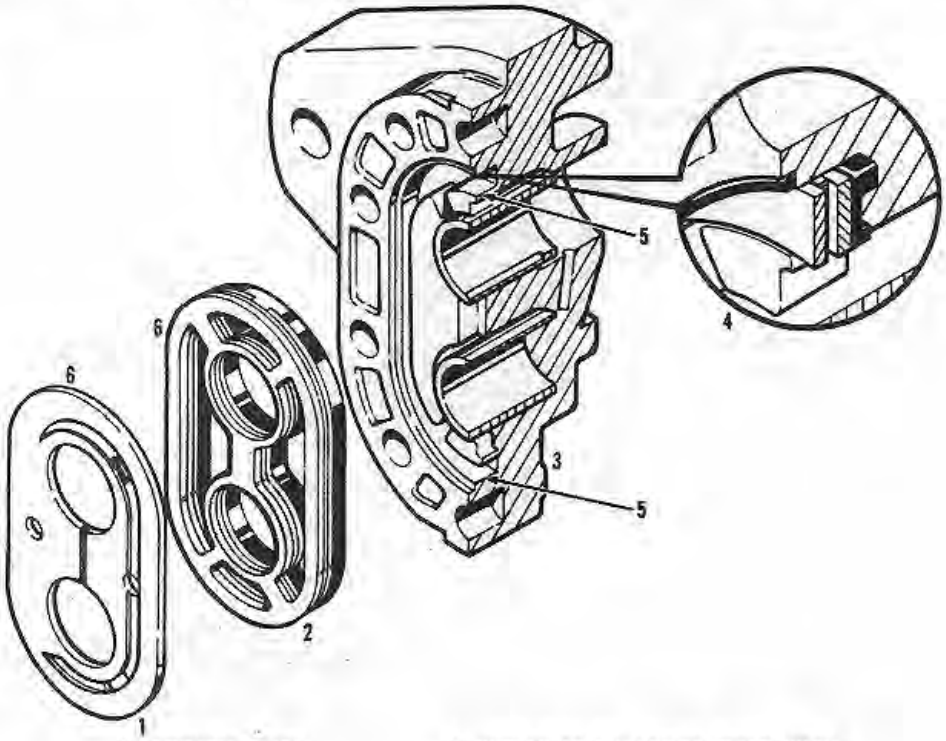
The two gears revolving in a close fitting housing trap oil between the gear teeth as the teeth move out of mesh. The oil is carried around the edge of the housing and discharged at the outlet side. Refer to Figure 1.

Operation

A bronze faced plate called a pressure plate reduces gear end clearance by applying hydraulic pressure from the discharge side of the pump. A seal package consisting of a rubber web seal, two paper backing webs and a phenolic backing web is pressed into the oil groove in the end cover. Oil from the discharge side of the pump is directed to the oil groove cast into the end cover by the two slots and groove in the pressure plate. As discharge pressure increases hydraulic pressure forces the seal package against the gears and prevents leakage from the pressure side to the suction side of pump.

Holes in the pressure plate permit pump oil to fill the pressure "compartments" formed by the seal pack. With pressure on both sides of the gear plate thus equalized, the pressure plate maintains contact with the gear sides through all pressure ranges.

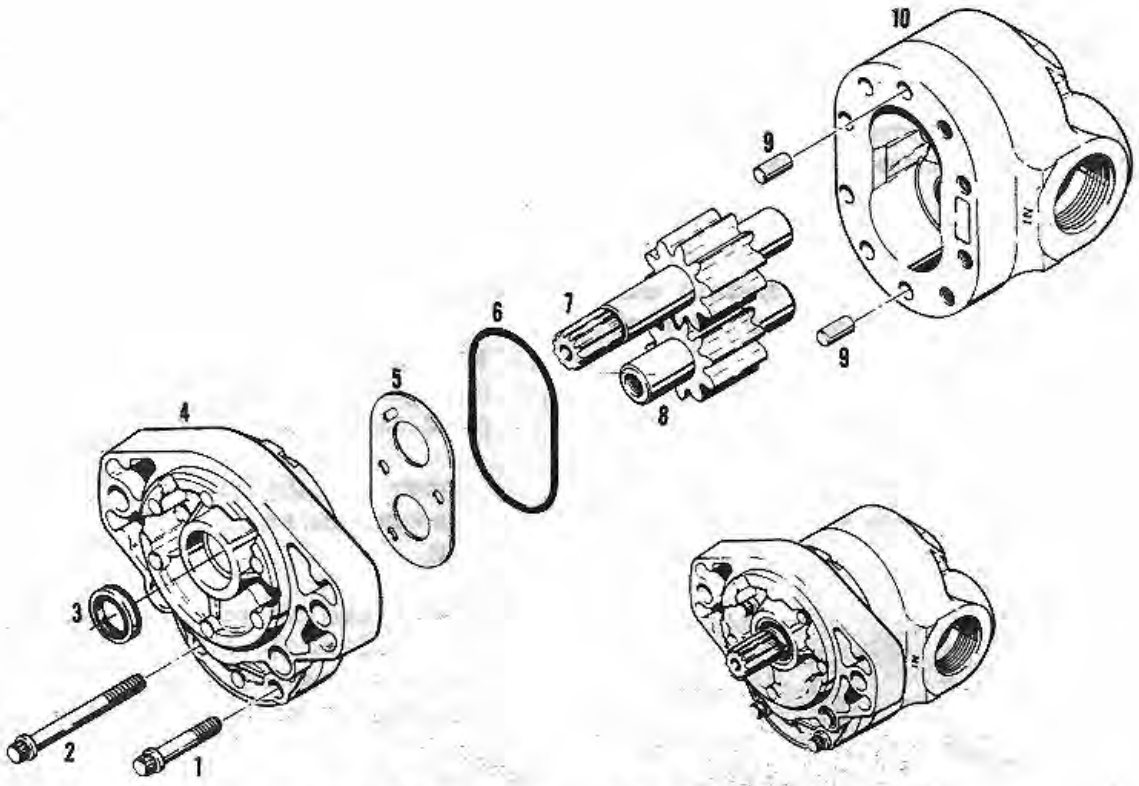
A positive pressure on the shaft seal is maintained by the oil passed through the end cover shaft bushings and a check valve in the driven gear shaft.



1. PRESSURE PLATE
2. SEAL PACKAGE
3. END COVER
4. SEAL PACKAGE IN GROOVE
5. HYDRAULIC OIL ENTERS GROOVE HERE
6. OIL UNDER SEAL PACKAGE FORCES PRESSURE PLATE AGAINST GEARS

751545

Figure 18 - Gear Loading



1. 3/4" (19.1 mm) LONG CAP SCREW (4)
2. 1-3/4" (44.5 mm) LONG CAP SCREW (4)
3. SEAL
4. END COVER
5. PRESSURE PLATE
6. O-RING
7. DRIVE GEAR
8. DRIVEN GEAR
9. DOWEL
10. BODY

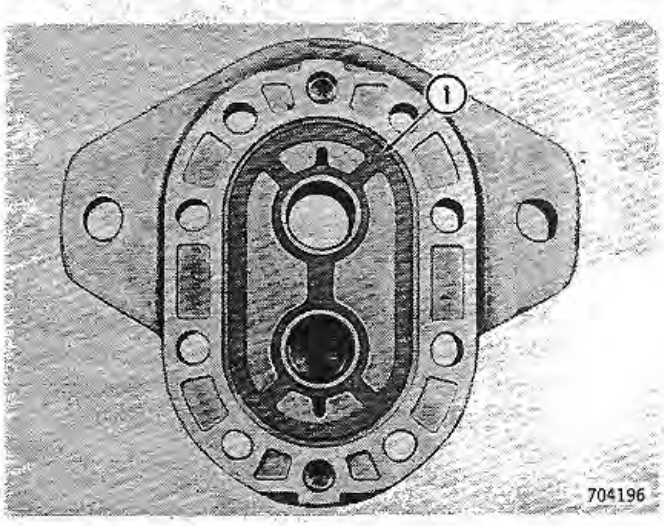
751546

Figure 19 - Exploded View TRW Pump

Disassembly

1. Scribe a mark on the end cover and body to assure proper reassembly.
2. Remove the eight end cover mounting bolts (four long and four short).
3. Using a soft hammer, strike the mounting ears alternately to separate the end cover from the body.
4. Remove the pressure plate and O-ring from the end cover.

   NOTE: DO NOT attempt to remove the seal package from the end cover. These parts are serviceable only as part of a new end cover assembly.
5. Remove the drive and driven gears from the pump body. Do not remove the spring or check valve from the driven gear.



1. SEAL PACKAGE INSTALLED

Figure 20 - Seal Package

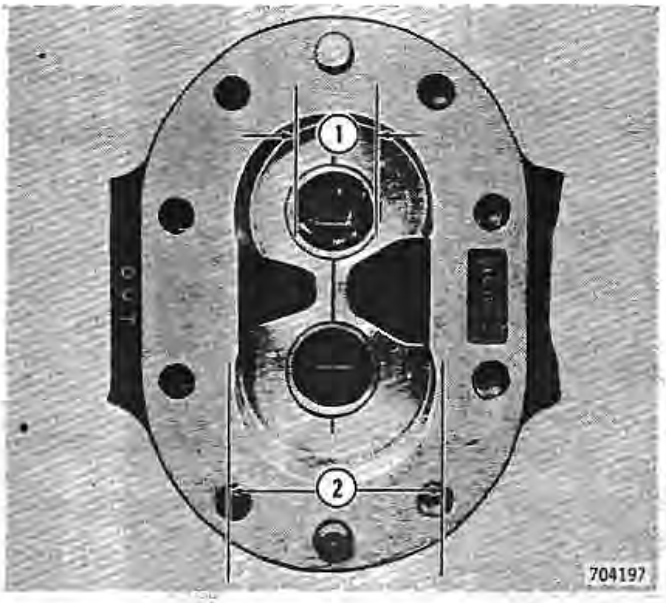
Inspection

Body

1. Check the sealing surface for nicks and burrs. If nicks or burrs are noted, remove with a piece of crocus cloth or flat India stone.

2. Clean the body in cleaning solvent and make sure all passages are free of foreign matter.

3. Using an inside micrometer, measure the gear bores. If either bore diameter exceeds 2.1253" (54 mm), the body must be replaced.



1. 0.8777" (22.3 mm) 2. 2.1253" (54 mm)

Figure 21

4. Using a depth micrometer, measure the depth of the gear bores. If either bore depth exceeds 1.5155" (38.5 mm) the body must be replaced.

5. Using an inside micrometer, measure the diameter of the gear bushings. If either bushing exceeds 0.8777" (22.3 mm) in diameter the body must be replaced.

Gears

1. Measure the diameter of both gears. If either gear has a diameter less than 2.1203" (53.8 mm) the gears must be replaced.

2. Measure the diameter of the gear journals. If the diameter of a journal is less than 0.8737" (22.2 mm) the gears must be replaced.

3. Measure the thickness of both gears. If one gear measures less than 1.5110" (38.3 mm) the gears must be replaced.

   NOTE: The thickness of the gears must measure the same within 0.0005" (0.013 mm).

4. Check gear faces and journals for scoring. Replace the gear set if heavy scoring is evident. The gear teeth should have sharp corners and not rounded.

End Cover

NOTE: DO NOT remove the seal package from the end cover. These parts are not serviceable items.

1. Use a lint free cloth moistened with cleaning solvent and clean end cover. Do not submerge in cleaning solvent or dry with compressed air.

2. Check the sealing surface for nicks and burrs. If nicks or burrs are noted, remove with a piece of crocus cloth or flat India stone.

3. Using an inside micrometer, measure the bushing diameter. If either bushing exceeds 0.8777" (22.3 mm) in diameter the end cover must be replaced.

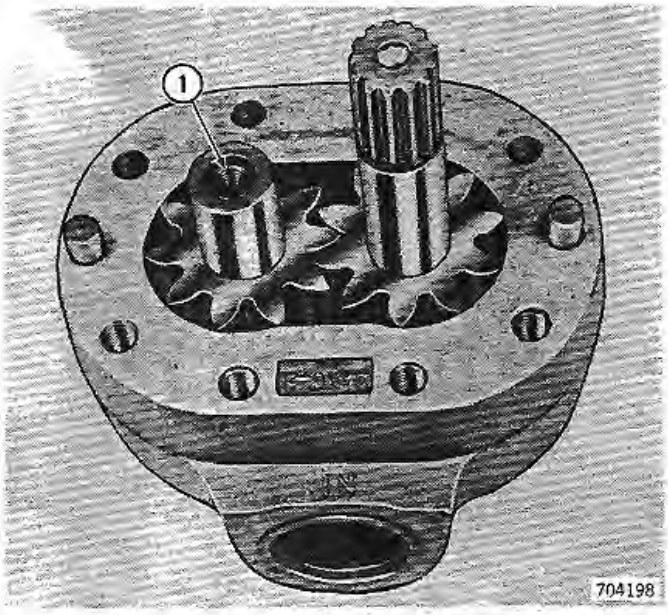
4. Inspect the shaft seal for cracks, deterioration and other defects.

5. If the pump has been disassembled because of low output and the pump body and gears are found to be serviceable, it can be assumed that the seal package is probably defective, requiring end cover replacement.

6. Inspect the pressure plate for scoring, pitting and excessive wear.

Assembly

1. Position gears in body as shown in Figure 22. The check valve spring in the driven gear must be up.



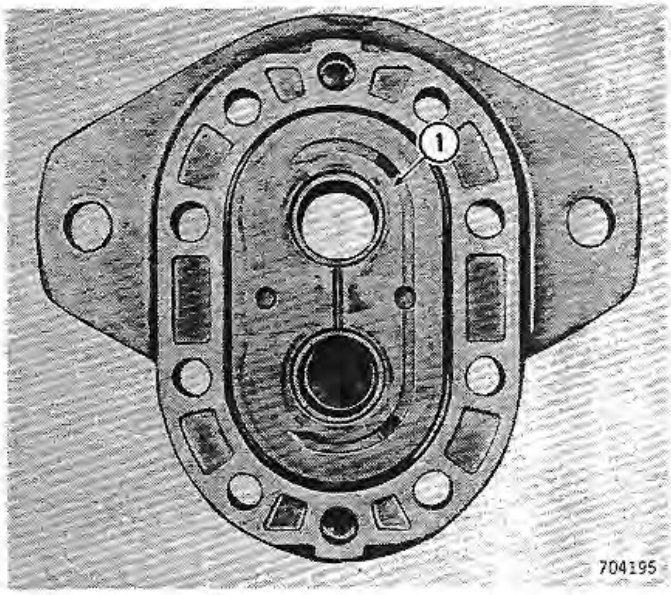
1. CHECK VALVE SPRING MUST BE UP

Figure 22 - Installing Gears

2. If the shaft seal was removed, press in a new seal. The seal must be square to the bushing within .002" (0.051 mm) and pressed in .010"-.020" (0.254-0.508 mm) below the edge of the seal bore.

3. Coat the smooth side of the pressure plate with a light, clean grease and position on end cover as shown in Figure 23. Then coat the O-ring with grease and position in groove formed by the pressure plate and end cover.

4. Set body on work bench with gears up and install end cover over gears being careful not to damage the shaft seal. When end cover starts on dowel pins invert the pump and set the pump on open jaws of vise. Strike the body with a soft hammer until the body is seated against the end cover.



1. PRESSURE PLATE MUST BE INSTALLED AS SHOWN

Figure 23 - Pressure Plate Installed

5. Secure the end cover to the body with the eight ferry head bolts (four long and four short). Torque the bolts evenly to specification on page 4005-12. Torque bolts in sequence as shown in Figure 24.

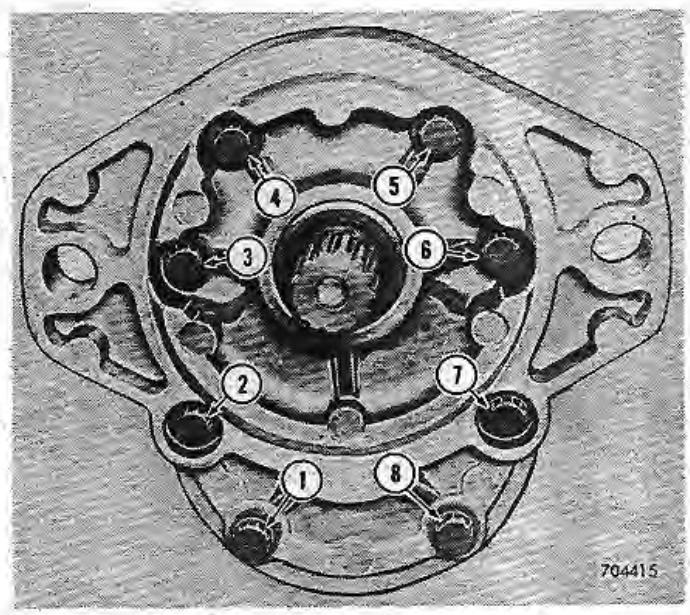


Figure 24 - Torque Sequence

Section 4007

LOADER CONTROL VALVE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Relief valve pressure settings
- Main relief valve ..... 2300 ± 50 psi at full throttle (15 857 ± 344 kPa at full throttle)
- Secondary relief valve, bucket spool A and B ports ..... Hand pump setting - 2100-2300 psi (14 479 - 15 857 kPa)
- Oil temperature for pressure check
  - Main relief valve ..... 120° F (49° C)
  - Secondary relief valve ..... Room temperature, preferably 70° - 80° F (21° - 26.7° C)

Spools and ports
- Spool travel, neutral to pressure ..... 3/8" (10 mm) in and out
  - Spool in ..... A port pressurized
  - Spool out ..... B port pressurized
- Spool travel, neutral to float ..... 11/16" (17 mm)
- Port threads
  - All work ports ..... 7/8" - 14 straight
  - Inlet port ..... 1-1/16" - 12 straight
  - Outlet port, power beyond ..... 1-1/16" - 12 straight
    - Power beyond fitting, internal ..... 1-1/16" - 12 straight
  - Outlet port, return oil ..... 1-1/16" - 12 straight

Weight (approx.) Compressed length
- 2 spool valve ..... 28 lbs. (12.7 kg)
- 3 spool valve ..... 36 lbs. (16.3 kg)

Springs
- Main relief plunger ..... 13/16" at 4 - 6 lbs. (20.64 mm at 1.8 - 2.7 kg)
- Main relief poppet ..... 11/16" at 25.5 - 28.5 lbs. (17.46 mm at 11.6 - 13 kg)
- Secondary relief ..... 27/32" at 145.5 - 178.5 lbs. (21.43 mm at 66 - 81 kg)
- Detent ..... 1-3/8" at 153 - 187 lbs. (34.9 mm at 69 - 85 kg)

U.S. and Metric Torque Specifications

Hydraulic Fittings (Steel)

Dash Size	Tube O.D. Hose I.D.	Thread Size	37° Flare Torque		Straight Thread O-ring Torque	
			Ft-lbs	N m	Ft-lbs	N m
4	1/4"	7/16"-20	6-12	8-16	12-19	16-25
5	5/16"	1/2"-20	8-16	11-21	16-25	22-33
6	3/8"	9/16"-18	10-25	14-33	25-40	34-54
8	1/2"	3/4"-16	15-42	20-56	42-67	57-90
10	5/8"	7/8"-14	25-58	34-78	58-92	79-124
12	3/4"	1-1/16"-12	40-80	54-108	80-128	108-174
14	7/8"	1-3/16"-12	60-100	81-135	100-160	136-216
16	1"	1-5/16"-12	75-117	102-158	117-187	159-253
20	1-1/4"	1-5/8"-12	125-165	169-223	165-264	224-357
24	1-1/2"	1-7/8"-12	210-250	285-338	250-400	339-542

SPECIAL TOOLS

The tools (kit part no. D45700) illustrated in Figure 1 are available from Service Parts Supply to aid in servicing the loader control valve.

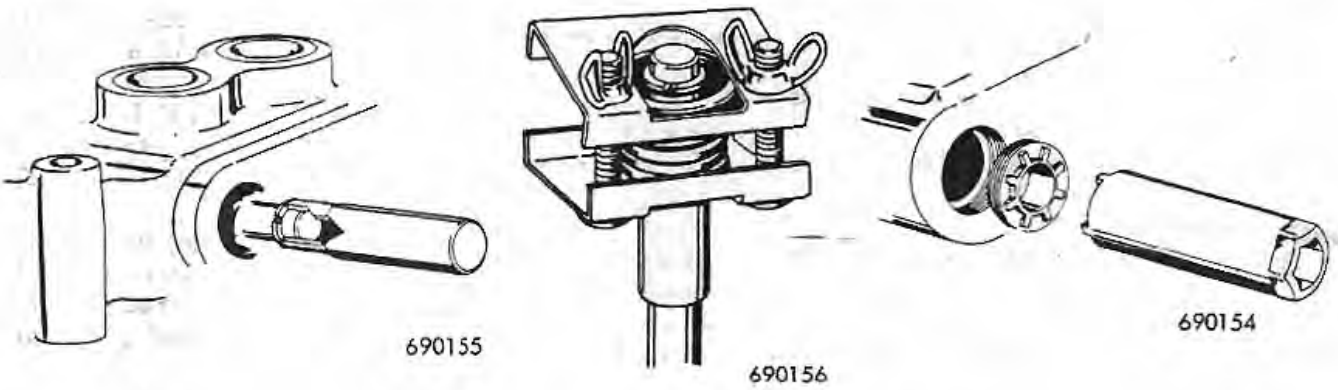


Figure 1 - Special Service Tools

CONTAMINATED OIL CAUSES PROBLEMS

1. Clean dipstick or level plug area before checking oil level.
2. Clean reservoir fill area before adding oil.
3. Use a clean funnel and container when adding oil.
4. Clean exterior of components, lines, and fittings before removal. Close openings with clean caplugs.
5. Make repairs on a clean work bench. Use clean tools.
6. Change oil and service filter(s) when making repairs.

   NOTE: If drained oil is reused, it should be filtered before reinstalling in reservoir.

7. If parts inspection indicates that metal chips, shredded packing, etc. have entered the hydraulic system, the system should be flushed, filter(s) serviced, and new oil installed.

701167

GENERAL

The loader control valve is a two spool (three spool with clam bucket and spool located on the outlet side of the lift spool) open center, series parallel valve. The parallel passages are the return passages at the top and bottom of the valve, Figure 2. In this valve all oil is directed to the cylinders being actuated. If more than one spool is actuated, the spool closest to the inlet port receives the oil. Example: When the bucket spool is actuated, no oil is available at the lift or clam spool until the bucket spool is returned to Neutral. The same would be true of the clam spool if the lift spool were actuated.

The valve contains two outlet ports, one connecting the work port return passages to the reservoir return line and the open center outlet which contains a power beyond fitting.

The power beyond fitting permits the installation of rear mounted hydraulics without additional valves to control oil flow. It also permits the use of the main relief valve to protect the backhoe hydraulic system from excessive pressure. However, only one system can be operated at one time--actuating a loader control valve spool blocks oil flow to the rear mounted hydraulic system.

An adjustable, pilot operated main relief valve at the control valve inlet prevents excessive pressure in the hydraulic system whenever a spool is actuated.

Load check valves between the work ports and the spools prevent reverse flow of oil between the cylinders and the control valve as a spool is moved into a power position.

Secondary relief valves are connected to the A and B ports of the bucket spool to protect the circuits when a cylinder is forced to move with the spool in Neutral.

Control valve operation is discussed and illustrated on pages 4007-6 through 4007-10.

With the loader control valve spools in neutral, oil flows straight through the open center passage and the power beyond fitting to the rear mounted hydraulics control valve(s) to the reservoir.

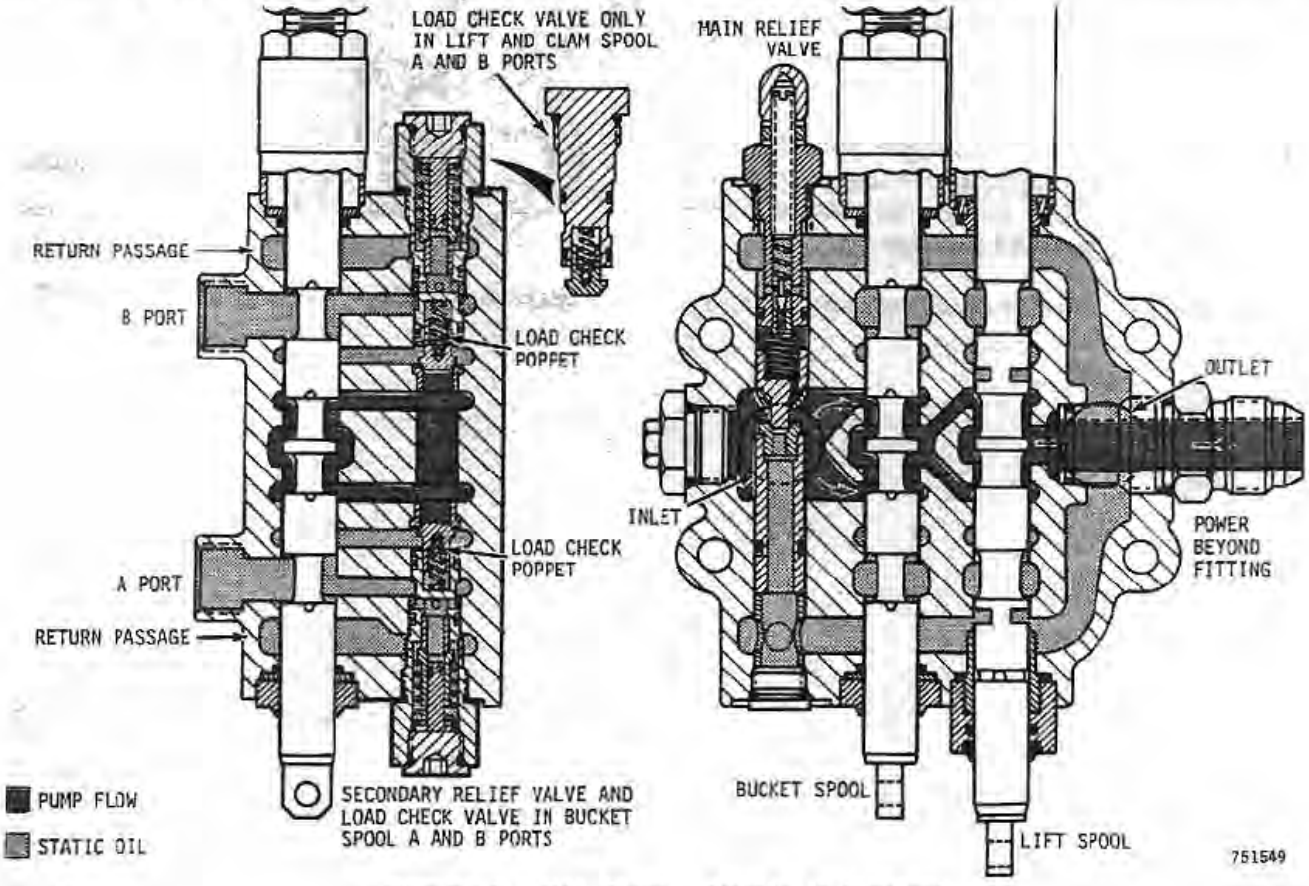


Figure 2 - Oil Flow - Spools in Neutral

OPERATION

Main Relief Valve

The main relief valve is located at the inlet of the control valve. The valve poppet protrudes into the open center passage as illustrated in Figure 2.

The main relief valve is pilot operated. This means a spear shaped pilot plunger controls the pressure at which the valve opens and permits a gradual opening of the relief valve. Note that a small hole is drilled through the poppet. This permits the same pressure to be maintained on both sides of the poppet during normal operation and helps control the gradual opening of the relief valve when pressure reaches the specified setting.

When a cylinder reaches the end of its travel or is held for any reason with the control valve spool in a power position, the main relief valve opens to protect the hydraulic system from damage. When the relief valve is open, oil is diverted to the reservoir.

1. When pressure in the open center passage reaches the pressure setting of the relief valve, the pilot plunger is forced off its seat.

2. Oil flows through the plunger seat faster than it can be supplied, creating a pressure differential (lower pressure) between the poppet and plunger.

3. The pressure in the open center passage then unseats the poppet and oil is diverted through the seat sleeve to the reservoir.

4. The relief valve will remain open until the cylinder moves or the control valve spool is returned to neutral.

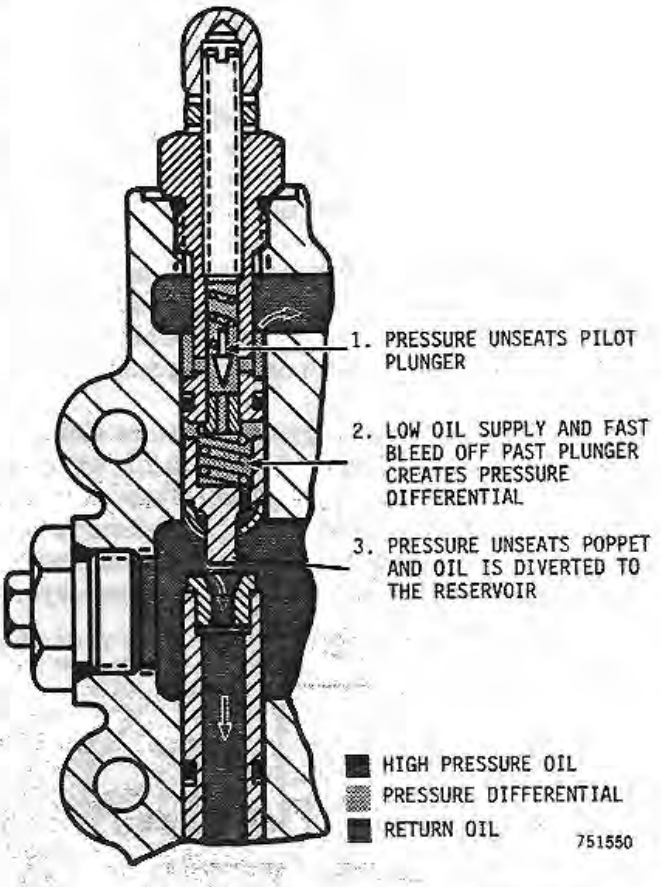


Figure 3 - Main Relief Valve Operation

Oil Flow - Bucket Spool Actuated

Figure 4 shows the bucket spool fully moved into the valve body, causing the bucket to be dumped. The effects of the spool movement and oil flow within the valve are as described under Oil Flow - Lift Spool Actuated.

In addition, all flow of oil from the pump to the lift spool is blocked by the bucket spool. For this reason, it is impossible to raise the lift arms when the bucket spool is fully actuated.

In machines equipped with a clam bucket and three-spool valve (not shown), oil flow to both the lift and clam spools is blocked when the bucket spool is fully actuated.

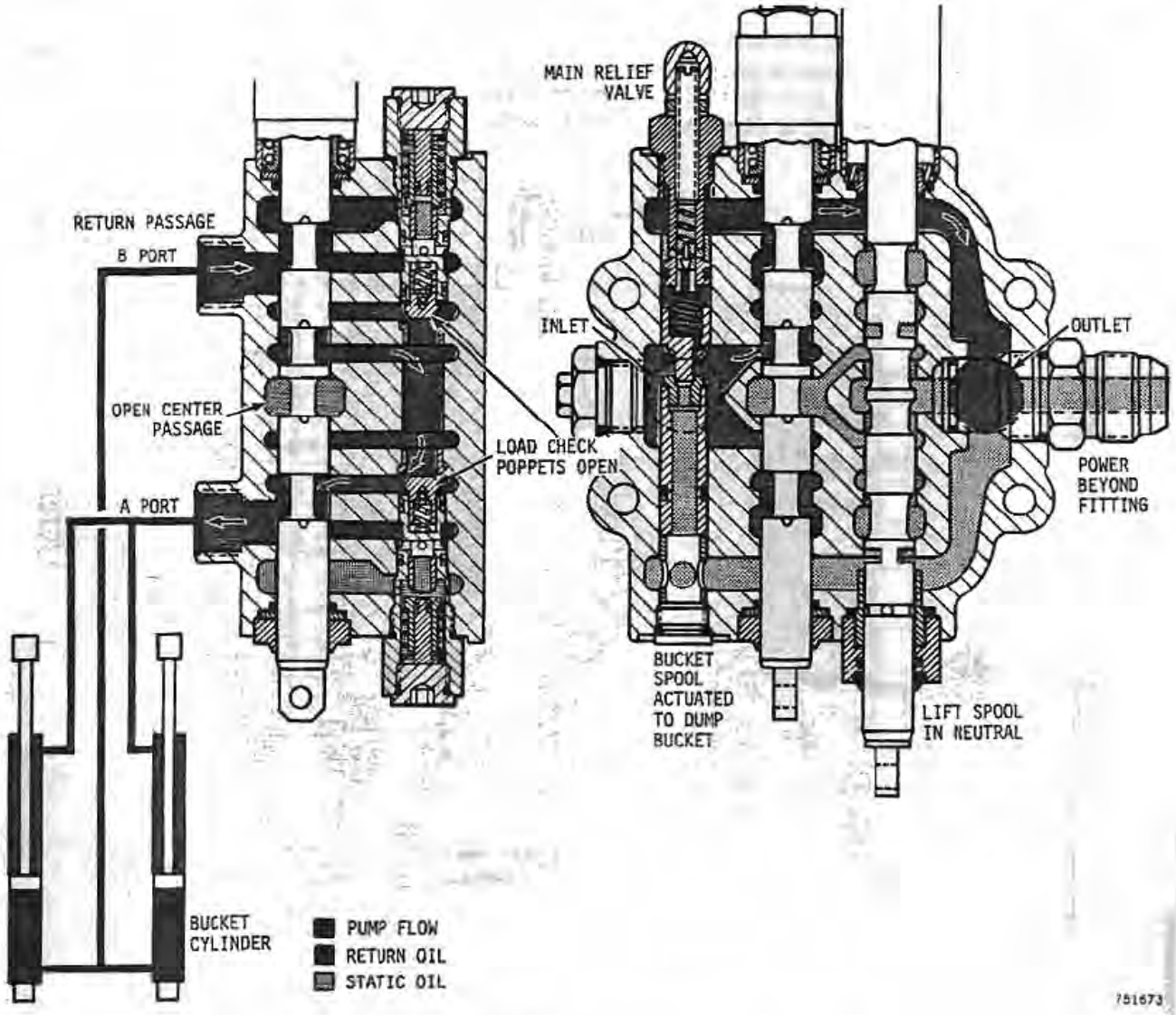


Figure 4 - Oil Flow - Bucket Spool Actuated

Oil Flow - Lift Spool Actuated

In Figure 5 the lift spool is moved into the valve body which:

a. Blocks the open center passage. With open center blocked, all oil from the pump flows to the spool being actuated.

b. As pressure in the open center pasage increases, the load check poppets open, permitting oil to flow to the A port. From the A port, oil is directed to the rod end of the lift cylinders causing the loader arm to lower.

c. Simultaneously, the B port is opened to the return passage, allowing oil displaced from the closed end of the lift cylinders to return to the reservoir.

When the spool is returned to neutral, oil is locked between the control valve and lift cylinders, preventing further movement of the loader frame.

To raise the loader frame, the spool is moved out of the valve body and oil flow is reversed.

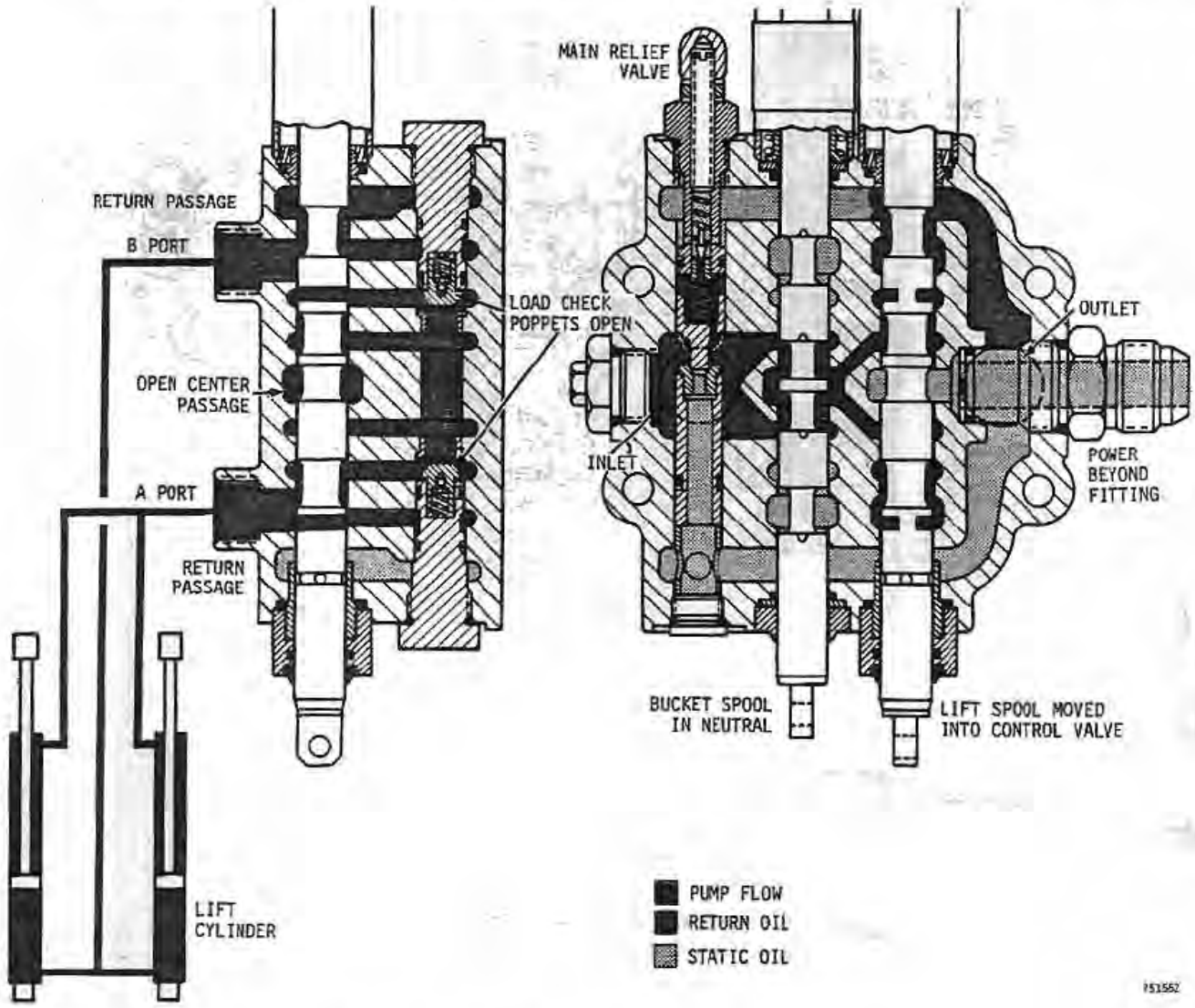


Figure 5 - Oil Flow - Lift Spool Actuated

Oil Flow - Lift Spool in Float

When the lift spool is in the float position, oil from the pump flows through the open center passage to the outlet. The two work ports are directly connected through the hollow center of the spool. Openings next to the narrow, outer lands permits oil to enter the hollow center of the spool. Oil in the lift cylinders is then free to flow through the spool in either direction. Another opening which is positioned in the return passage allows a small portion of oil to be diverted to the reservoir. The loader frame will lower because of its weight if raised, or follow the contour of the ground as in back filling.

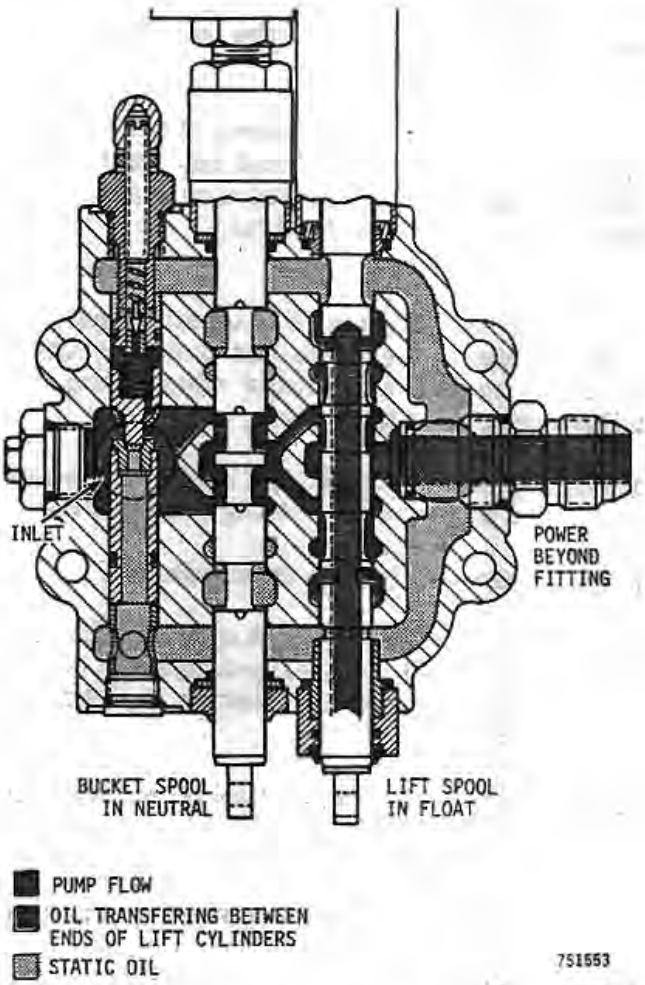
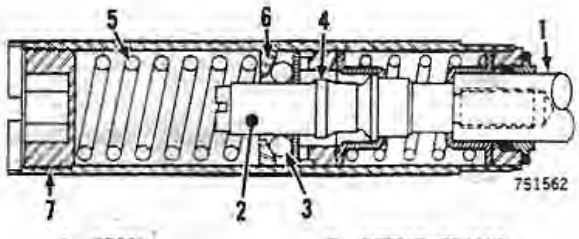


Figure 6 - Oil Flow - Lift Spool in Float

Float Detent

The float detent holds the lift spool in the float position mechanically. Refer to Figure 7. As the spool is pushed into the valve body, the detent stud forces the steel balls outward, allowing the spool to be positioned in float. When the ridge on the detent stud passes the balls, the detent spring and the tapered surface of the detent cam hold the balls in the groove on the stud, preventing the spool from returning to neutral when the control lever is released. A light tug on the control lever will allow the spool to return to neutral.

The amount of pressure required to engage or disengage the detent is determined by the position of the adjustment plug in the detent housing.



1. SPOOL
2. DETENT STUD
3. STEEL BALLS(8)
4. RIDGE
5. DETENT SPRING
6. DETENT CAM
7. ADJUSTMENT PLUG

Figure 7 - Float Detent (Spool in Neutral)

Secondary Relief Valve

Secondary relief valve are connected to the A and B ports of the bucket spool.

The relief valves protect the hydraulic circuits, and the bucket and related linkage from damage due to excessive pressure when the bucket spool is in Neutral.

Refer to Figure 8. Assume that the loader arm is being raised and the bucket is held by an immovable object and the following actions take place.

1. Pressure in rod end of bucket cylinders rises to pressure setting of relief valve.
2. Relief valve poppet is unseated.
3. Pistons move in bucket cylinders (allowing bucket to move) because oil can be displaced from the pistons through the relief valve.
4. Poppet closes when bucket moves past the obstruction.

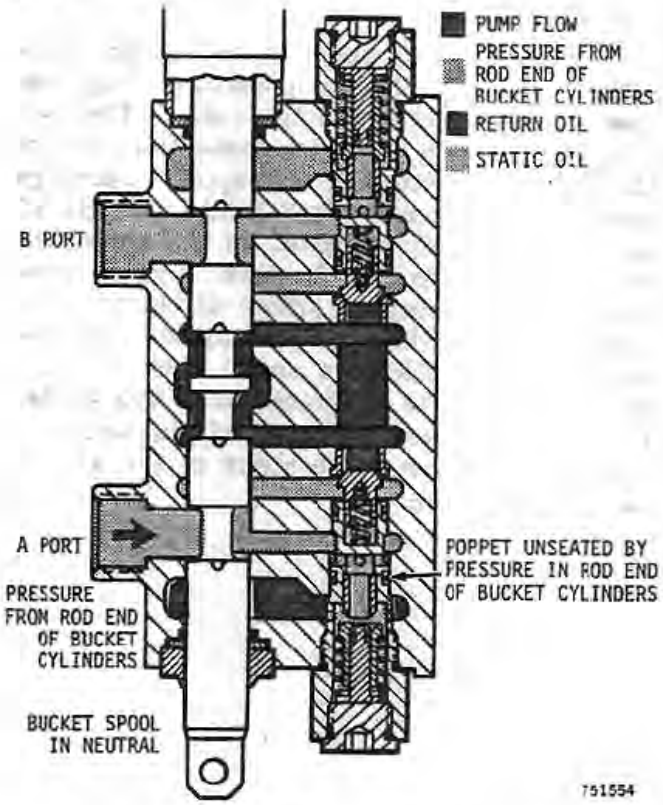


Figure 8 - Secondary Relief Valve Operation

SERVICING THE LOADER CONTROL VALVE

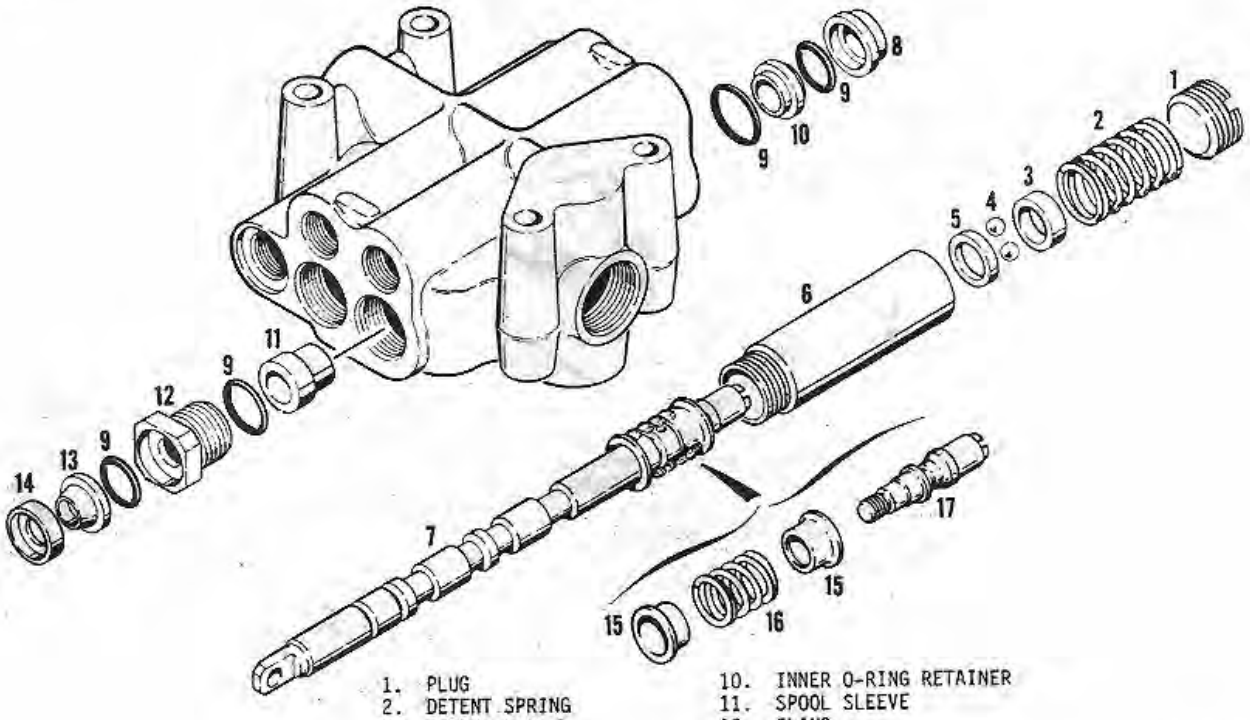
Removal

1. Remove accumulated dirt from the control valve and surrounding area.
2. Rest the loader bucket flat on the floor.
3. With the engine stopped, move the control lever(s) in all directions to equalize circuit pressures.
4. Swing battery out of way for easy access to the control valve.
5. Disconnect control linkage at the spools. Disconnect magnetic detent wiring from harness.
6. Remove the two outlet tubes.
7. Loosen lift cylinder tube clamp on frame. Disconnect cylinder tubes and hoses at control valve.
8. Disconnect inlet hose at tee fitting.
9. Remove nuts and washers from valve mounting bolts and hold valve in place. Then remove spacers and washers from top of valve.
10. Disengage valve from lift cylinder tubes and remove valve.

Disassembly

Lift Spool

1. Remove the detent adjusting plug and spring from the detent housing. Figure 9.
2. Remove the detent spring, cam, steel balls (8), and detent washer from the detent housing.



1. PLUG
2. DETENT SPRING
3. DETENT CAM
4. STEEL BALLS (8)
5. DETENT WASHER
6. DETENT HOUSING
7. SPOOL
8. OUTER O-RING RETAINER
9. O-RING
10. INNER O-RING RETAINER
11. SPOOL SLEEVE
12. GLAND
13. WIPER
14. WIPER RETAINER
15. SPRING SEAT
16. CENTERING SPRING
17. DETENT STUD

Figure 9 - Lift Spool

3. Unscrew detent housing from control valve.

4. Grasp spool centering spring and pull spool from valve body. Then remove the two O-ring retainers and O-rings from the spool.

5. Do not remove the centering spring unless 271 (red) Loctite is available for use during assembly. To remove the spring, secure the spool in a soft jawed vise and install the spring compressor shown in Figure 1. Compress spring and unscrew the detent stud. Remove spring compressor from spring.

6. Remove spool gland and sleeve from control valve. Then remove the wiper retainer, wiper and O-rings from the gland.

7. Do not remove the spool eye. The eye and an O-ring are not serviced.

Bucket Spool

NOTE: The bucket spool can be removed without removing the lift spool detent housing. Loosen the detent housing lock nut; then unscrew spring cap and pull spool from valve body and proceed to step 3.

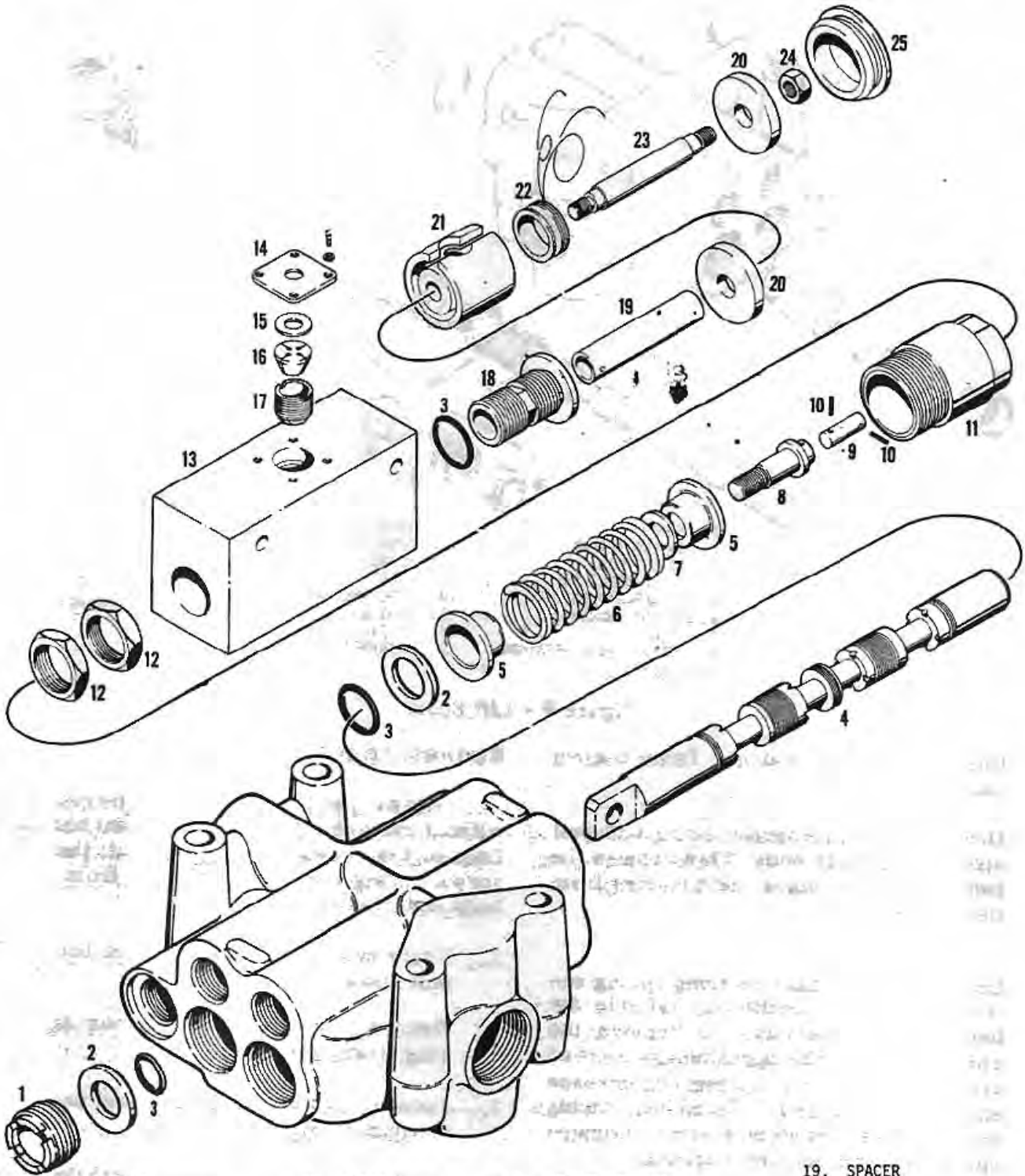
1. Unscrew spring cap from valve body and pull spool from body.

2. Remove gland, O-ring retainer and O-ring from valve body.

3. Loosen spring cap lock nut and unscrew connector from spring cap.

4. Secure spring cap in a vise with the spool horizontal. Be careful not to distort the spring cap.

5. Pull the connector/detent assembly away from the spring cap. Push the spool into the spring cap to expose the link to spacer roll pin and drive the pin out of these parts. Have someone hold the detent housing to prevent it from falling to the floor.



1. GLAND
2. O-RING RETAINER
3. O-RING
4. SPOOL
5. SPRING SEAT
6. CENTERING SPRING
7. SPACER
8. SPRING SCREW
9. LINK
10. ROLL PIN
11. SPRING CAP
12. LOCK NUT
13. DETENT HOUSING
14. COVER
15. WASHER
16. SEAL
17. COIL HOUSING LOCK SCREW
18. CONNECTOR
19. SPACER
20. WASHER
21. COIL HOUSING
22. COIL
23. DETENT STUD
24. NUT
25. PLUG

751556

Figure 10 - Bucket Spool

6. Remove the spring cap.

7. To remove the centering spring, secure the spool in a soft jawed vise and install the spring compressor illustrated in Figure 1. Use a pair of pliers or vise grips and remove the spring screw. Use care not to distort end of screw. Remove spring compressor from spring.

NOTE: Do not disassemble the detent assembly unless necessary.

8. Remove plug from detent housing. Push the detent stud in until the washer touches the coil housing. Grasp spacer with vise grips and remove nut from detent stud.

9. Remove the cover, washer and seal from the detent housing.

10. Loosen coil housing lock screw enough to allow the coil housing to be removed. Remove the washer and coil housing assembly. Be sure coil leads remain in slot in coil housing or the leads may be cut off during removal.

11. Remove detent stud and spacer assembly.

12. Remove lock nuts from connector and remove connector. Check condition of O-ring on connector and replace if necessary.

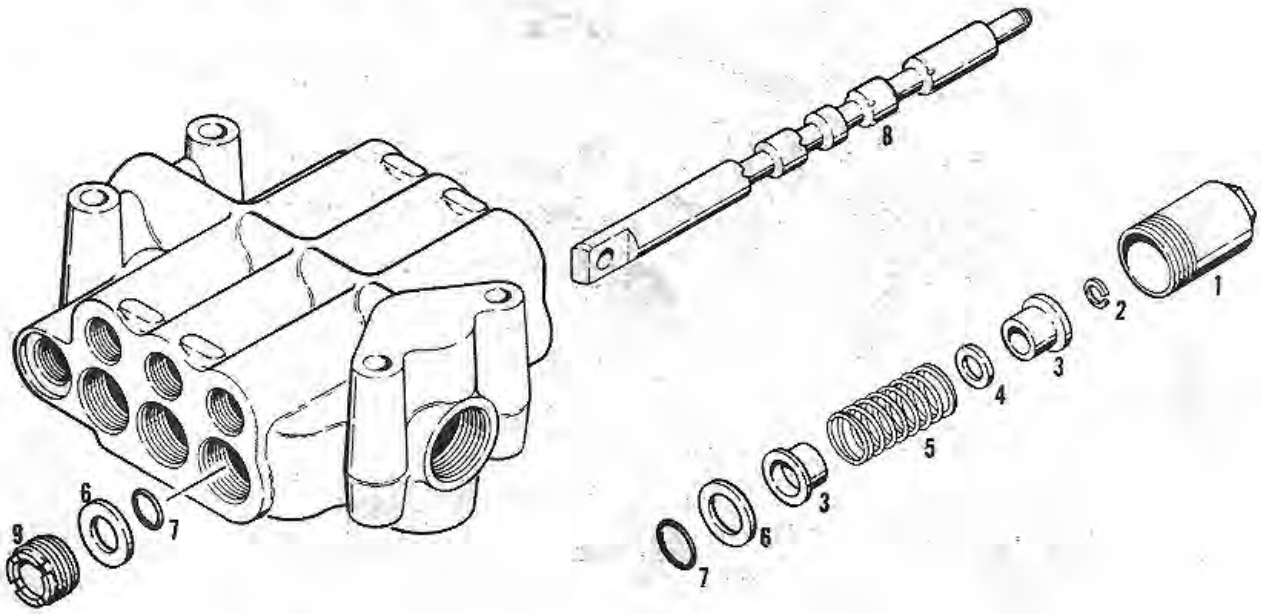
Clam Spool

1. Unscrew spring cap from valve body.

2. Grasp the spool centering spring and pull spool from valve body. Then remove O-ring and O-ring retainer from spool.

3. To remove the centering spring, secure spool in a soft jawed vise and install the spring compressor illustrated in Figure 1. Compress the spring and remove snap ring. Remove spring compressor from spring.

4. Remove spool gland, O-ring retainer and O-ring from valve body.



1. SPOOL CAP
2. SNAP RING
3. SPRING SEAT
4. SPACER
5. CENTERING SPRING
6. O-RING RETAINER
7. O-RING
8. SPOOL
9. GLAND

751557

Figure 11 - Clam Spool

Main Relief Valve

1. Unscrew the main relief valve cartridge from the valve body. Then pull cartridge from valve body, Figure 12.

2. Remove poppet spring and poppet from valve body.

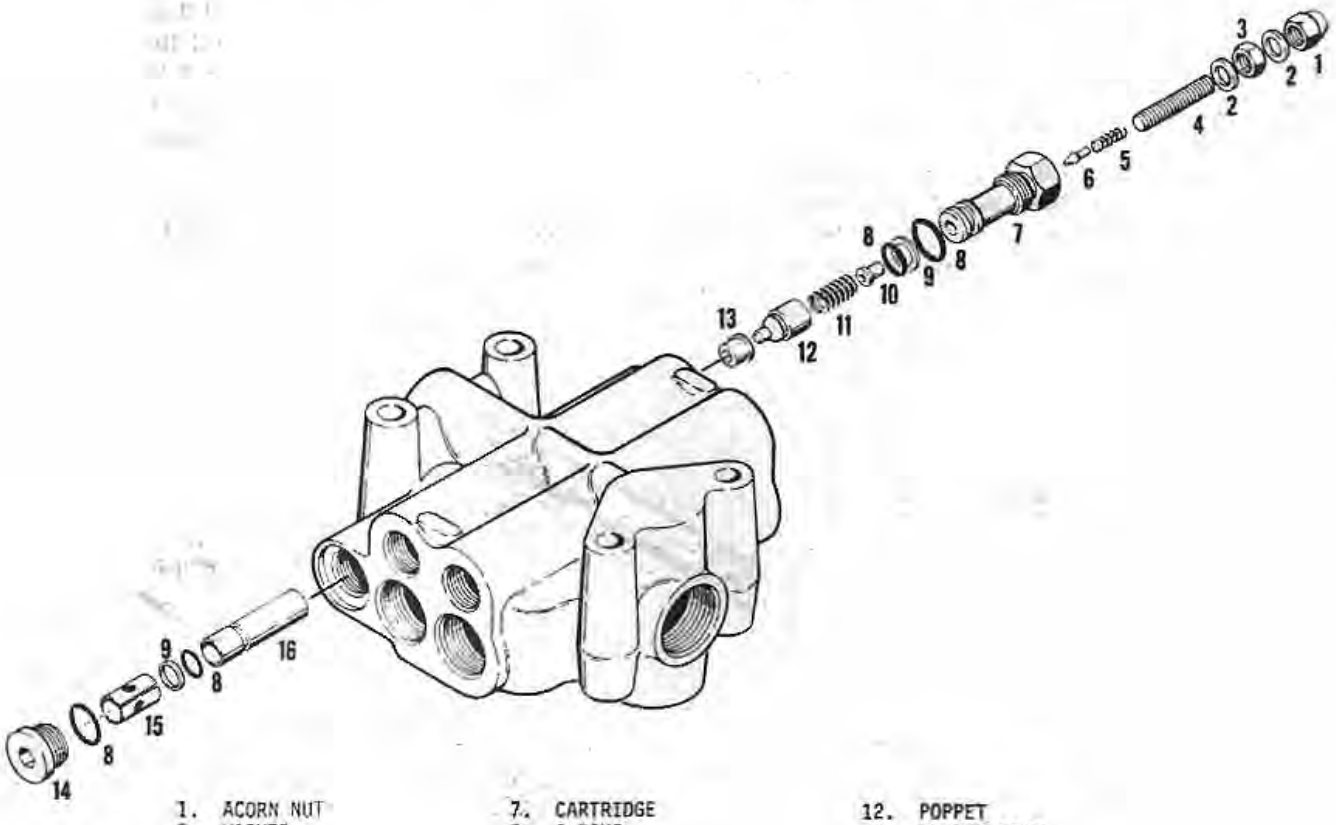
3. Remove plug from opposite end of valve body and remove the drain sleeve and seat sleeve from the relief valve bore. Then remove the O-ring from the plug and O-ring and backup ring from the seat sleeve. Do not remove the poppet seat from the seat sleeve unless it is to be replaced.

4. Disassemble the relief valve cartridge.

   a. Remove the acorn nut and loosen the lock nut. Then remove the adjusting screw.

   b. Remove the seal washers from the adjusting screw.

   c. Remove the spring and pilot plunger from the relief valve cartridge. Do not remove the plunger seat unless it is to be replaced.



1. ACORN NUT
2. WASHER
3. LOCK NUT
4. ADJUSTING SCREW
5. PLUNGER SPRING
6. PILOT PLUNGER
7. CARTRIDGE
8. O-RING
9. BACKUP RING
10. PILOT PLUNGER SEAT
11. POPPET SPRING
12. POPPET
13. POPPET SEAT
14. PLUG
15. DRAIN SLEEVE
16. SEAT SLEEVE

751603

Figure 12 - Main Relief Valve

Secondary Relief Valve

A secondary relief valve is located at the A and B ports of the bucket spool.

1. Remove the relief valve assembly from the valve body.

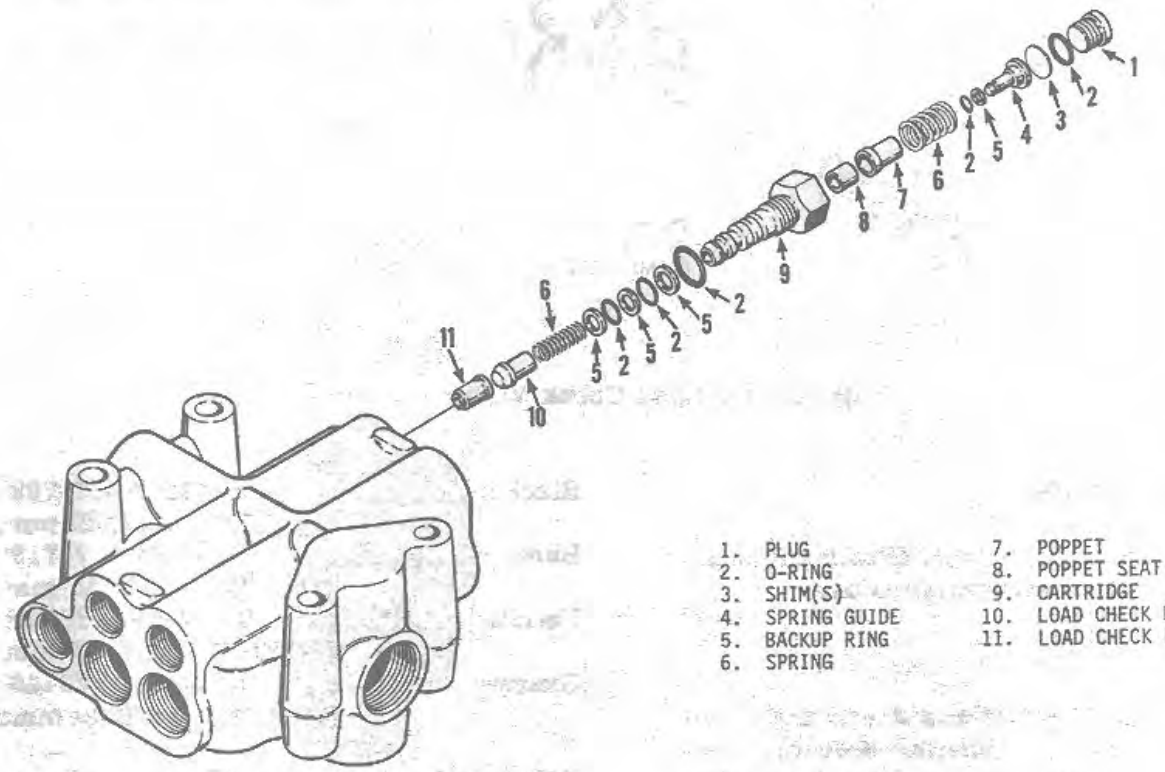
2. Remove the spring and load check poppet from the valve bore. If both check poppets are removed, keep them separate so they will be installed in the proper bore. Do not remove the poppet seat unless it is to be replaced.

3. Disassemble the relief valve.

   a. Remove plug and shim(s) from the cartridge.

   b. Remove the spring guide, spring and poppet from the cartridge.

   c. Do not remove the poppet seat unless it is to be replaced.



1. PLUG
2. O-RING
3. SHIM(S)
4. SPRING GUIDE
5. BACKUP RING
6. SPRING
7. POPPET
8. POPPET SEAT
9. CARTRIDGE
10. LOAD CHECK POPPET
11. LOAD CHECK POPPET SEAT

Figure 13 - Secondary Relief Valve

Load Check Valves

Load check valves are located at the A and B ports of the lift and clam spools. To remove a check valve, unscrew cap and remove spring and poppet from the valve bore. Do not remove the poppet seat unless it is to be replaced. Identify poppets so they will be returned to their respective bores.

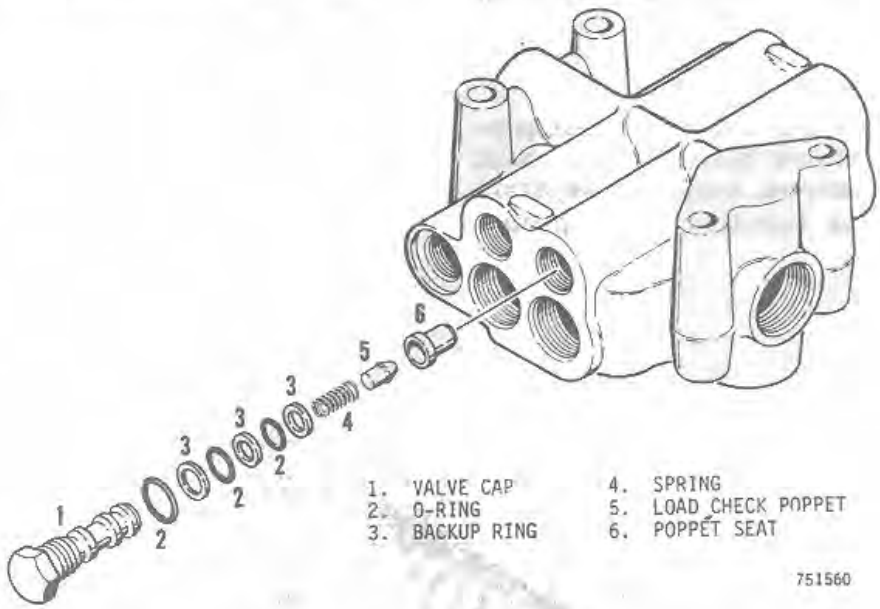


Figure 14 - Load Check Valve

Plugs and Fittings

Remove the power beyond fitting and any remaining plugs from the valve body.

Inspection

1. Discard all O-rings and clean the remaining parts in cleaning solvent. Inspect spool glands and wipers for wear and replace as required.

2. Inspect the valve spool bores for grooves, deep scratches and excessive wear. Check to see that the spools fit their respective bores. Light hand pressure should be required to install the spool and there should be no noticeable side clearance after the spool is installed.

3. Inspect the spool lands for deep scratches or excessive wear. Valve spools may be replaced if there is no damage to the spool bores. The lift and clam spools are coded to identify size and type of spool as follows:

Black	0.73700" - 0.73709" (18.7198 - 18.7220 mm)
Blue	0.73710" - 0.73719" (18.7223 - 18.7246 mm)
Yellow	0.73720" - 0.73729" (18.7249 - 18.7272 mm)
Green	0.73730" - 0.73740" (18.7274 - 18.7299 mm)

The letter code stamped on the eye of the spool identifies type, D double acting and F float. When ordering replacement spools be sure to include the color and type codes. Spools are shipped with the centering spring installed.

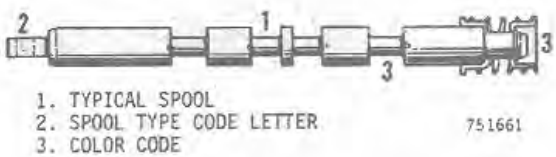


Figure 15 - Spool Code

4. Inspect the load check valve and secondary relief valve poppets and the poppet

seats for grooves, nicks and wear. Small nicks and grooves can be removed from the poppet and seat with a fine grinding compound. Lap sufficiently to remove the defect. Thoroughly wash the valve body and poppet in cleaning solvent to remove all traces of grinding compound.

5. Inspect the main relief valve plunger and poppet, and their respective seats for ridges, nicks, etc. Replace parts as required if worn or damaged.

6. Inspect all springs for signs of cracking and distortion. If spring testing equipment is available, check springs to see if they meet the specifications listed on page 4007-3. If in doubt about spring condition, replace the spring.

Assembly

Make sure all tools and work bench are clean before starting to assemble the control valve.

Lubricate spools, spool bores and O-rings with clean oil to aid in assembly.

Load Check Valve

1. Press new poppet seat into valve body if seat was removed.

2. Place check poppet and spring in the proper bore.

3. Install backup rings and new O-rings on the cap and screw cap into valve body until tight.

Secondary Relief Valve

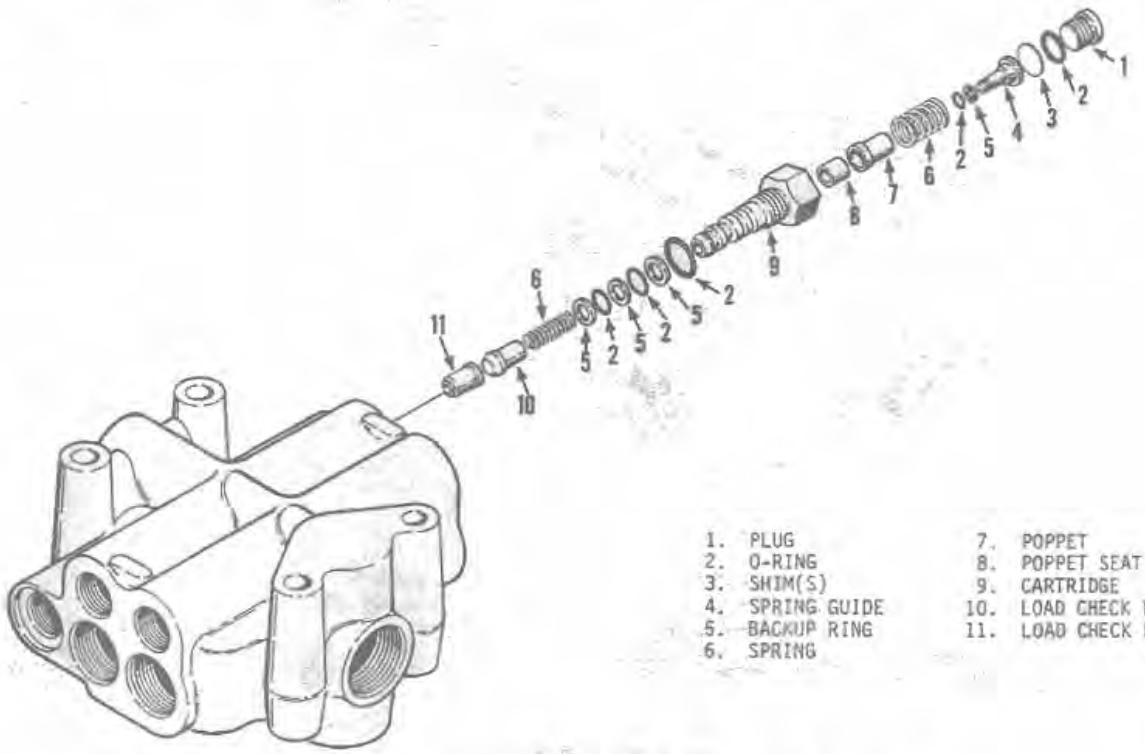
1. Press new poppet seat into valve body if seat was removed. Then place load check poppet and spring in valve bore.

2. Assemble the relief valve.

   a. Press in new poppet seat if seat was removed.

   b. Install poppet, spring and spring guide in valve.

   c. Place shims on spring guide and install plug. Use as many shims as were removed.



1. PLUG
2. O-RING
3. SHIM(S)
4. SPRING GUIDE
5. BACKUP RING
6. SPRING
7. POPPET
8. POPPET SEAT
9. CARTRIDGE
10. LOAD CHECK POPPET
11. LOAD CHECK POPPET SEAT

Figure 16 - Secondary Relief Valve

3. Install backup rings and new O-rings on relief valve and install in valve body. After the control valve is assembled, check the pressure setting as instructed in Section 4002.

Main Relief Valve

1. Press new poppet seat into seat sleeve if seat was removed.

2. Install backup ring and new O-ring on the seat sleeve. Then install the seat sleeve and drain sleeve in the valve body. Push the drain sleeve into valve body until two or three threads are visible, then screw plug with new O-ring into valve body. The seat sleeve is now properly positioned.

3. Place poppet and spring in relief valve bore.

4. Assemble the relief valve cartridge.

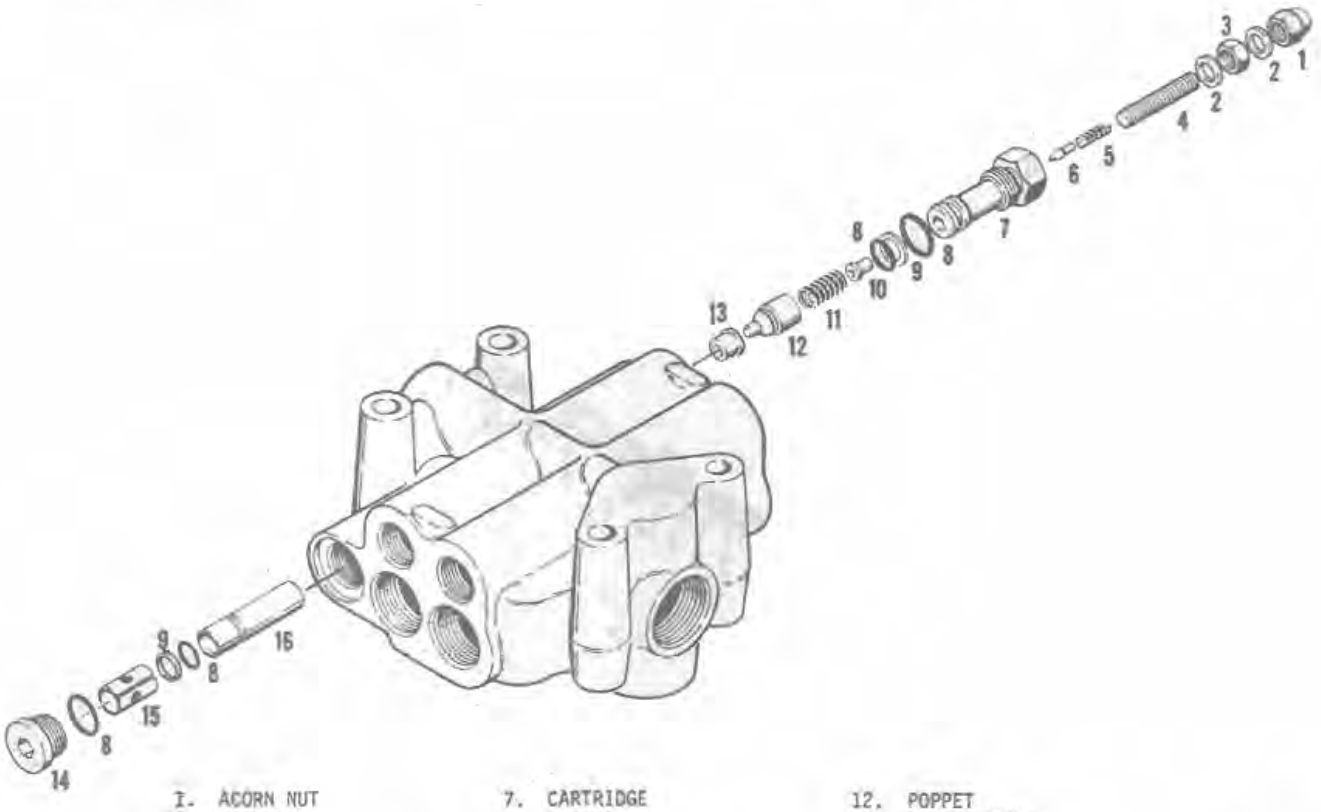
   a. Press new pilot plunger seat into cartridge if the seat was removed.

   b. Place the pilot plunger and spring in cartridge.

   c. Screw adjusting screw into cartridge. Then install seal washer, lock nut, seal washer and acorn nut. Do not tighten parts on adjusting screw at this time.

5. Install backup rings and new O-rings on the cartridge and screw cartridge into valve body until tight.

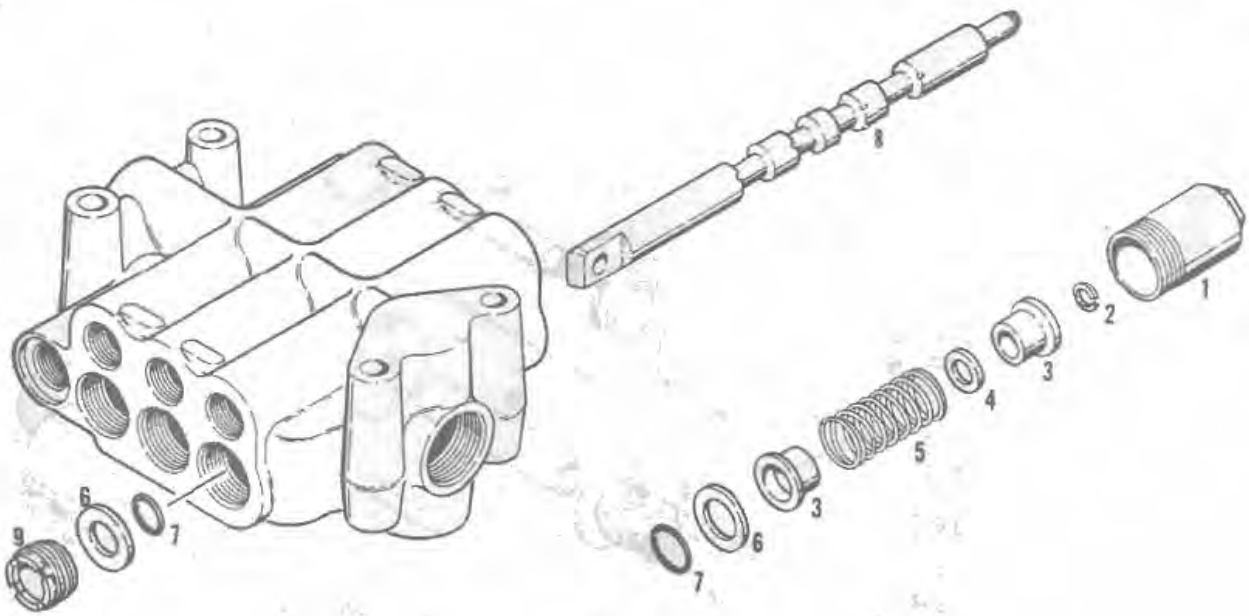
6. Check and adjust relief valve setting as instructed in Section 4002 after the control valve is installed.



1. ACORN NUT
2. WASHER
3. JAM NUT
4. ADJUSTING SCREW
5. PLUNGER SPRING
6. PILOT PLUNGER
7. CARTRIDGE
8. O-RING
9. BACKUP RING
10. PILOT PLUNGER SEAT
11. POPPET SPRING
12. POPPET
13. POPPET SEAT
14. PLUG
15. DRAIN SLEEVE
16. SEAT SLEEVE

751603

Figure 17 - Main Relief Valve



1. SPRING CAP
2. SNAP RING
3. SPRING SEAT
4. SPACER
5. CENTERING SPRING
6. O-RING RETAINER
7. O-RING
8. SPOOL
9. GLAND

751567

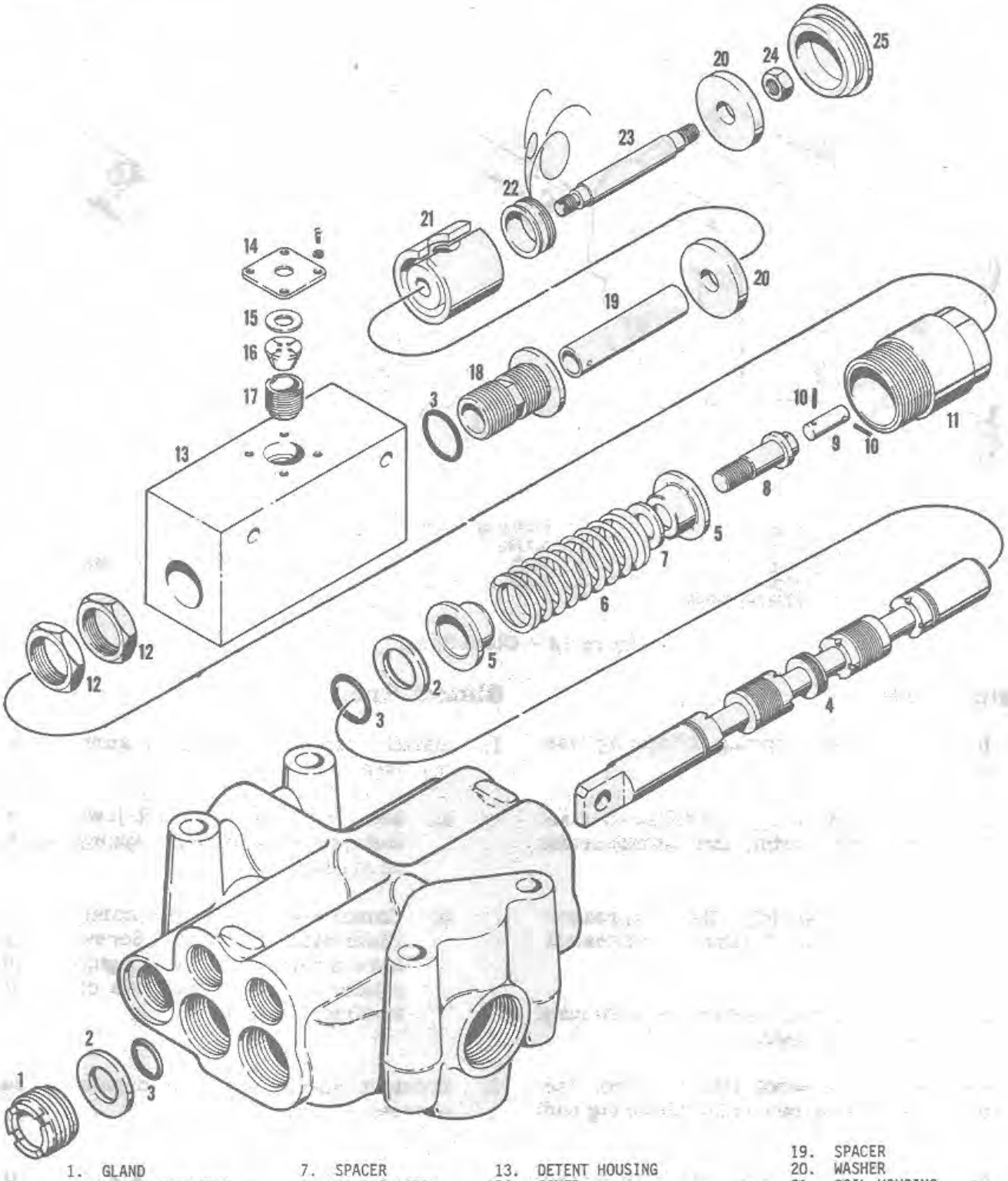
Figure 18 - Clam Spool

Clam Spool

1. Install centering spring if spring was removed.
   a. Secure spool in a soft jawed vise and place spring and spring seats on spool.
   b. Compress spring with compressor illustrated in Figure 1 and install snap ring.
2. Install O-ring retainer and new O-ring on spring end of spool.
3. Carefully slide spool into its bore. Use care not to damage O-ring at spring end of spool.
4. Screw spring cap into valve body and torque to 23-25 foot-pounds (31-34 N m).
5. Install new O-ring at eye end of spool. Work O-ring into groove formed by the spool and valve body. Then install O-ring retainer and gland. Tighten gland with wrench illustrated in Figure 1.

Bucket Spool

1. Install centering spring if spring was removed.
   a. Secure spool in a soft jawed vise and place spring and spring seats on spool.
   b. Compress spring with compressor illustrated in Figure 1. Screw spring screw into spool and tighten with pliers or vise grips. Use care not to distort end of screw.
2. If detent assembly was not disassembled proceed to step 8.
3. Install O-ring on connector and install connector in detent housing. Secure connector in place with lock nut and install the remaining lock nut.
4. Install the spacer/washer/detent stud assembly in detent housing.



1. GLAND
2. O-RING RETAINER
3. O-RING
4. SPOOL
5. SPRING SEAT
6. CENTERING SPRING
7. SPACER
8. SPRING SCREW
9. LINK
10. ROLL PIN
11. SPRING CAP
12. LOCK NUT
13. DETENT HOUSING
14. COVER
15. WASHER
16. SEAL
17. COIL HOUSING LOCK SCREW
18. CONNECTOR
19. SPACER
20. WASHER
21. COIL HOUSING
22. COIL
23. DETENT STUD
24. NUT
25. PLUG

751556

Figure 19 - Bucket Spool

5. Install coil housing assembly in detent housing with coil toward the plug end. Start coil leads through the housing. Push coil housing into detent housing making sure coil leads remain in slot in housing.

6. Align coil housing with lock screw and tighten screw. Then install seal, washer and cover.

7. Install washer on detent stud and secure in place with nut. Push detent stud into housing, grasp spacer with vise grips and tighten nut.

8. Place spring cap over spring and secure cap in vise with the spool horizontal. Be carefull not to distort the spring cap.

9. Have someone available to help install the detent assembly. Push spool into spring cap and detent stud into housing to expose the roll pin hole in the link and spacer. Align roll pin holes and install roll pin.

10. Screw connector into spring cap several turns and tighten lock nut.

11. Install O-ring retainer and new O-ring on spring end of spool.

12. Carefully slide spool into its bore. Use care not to damage O-ring at spring end of spool.

    NOTE: If lift spool has not been removed proceed to step 14.

13. Screw spring cap into valve body and torque to 23-25 foot-pounds (31-34 N m). Measure the space between the valve body and detent housing; it should be 2-11/16" (68.3 mm). Loosen spring cap lock nut and turn connector into cap to obtain this dimension. Then loosen detent housing lock nut several turns and position housing coil leads toward the main relief valve.

14. Loosen the spring cap lock nut and loosen the detent housing lock nut several turns. Hold detent housing so coil leads are toward the main relief valve and screw spring cap into valve body. Torque cap to 23-25 foot-pounds (31-34 N m). Tighten the detent housing lock nut and measure the space between the valve body and detent housing; it should measure 2-11/16" (68.3 mm). Turn the connector into the spring cap to obtain this dimension and check for proper position as previously instructed.

15. Install new O-ring at eye end of spool. Work O-ring into groove formed by spool and valve body. Then install O-ring retainer and gland. Tighten gland with wrench illustrated in Figure 1.

Lift Spool

1. Install centering spring on spool if spring was removed.

   a. Secure spool in a soft jawed vise and place inner spring seat, spring and outer spring seat on the spool.

   b. Compress spring with spring compressor illustrated in Figure 1.

   c. Coat detent stud threads with 271 (red) Loctite and screw stud into spool. Torque stud to 9-10 foot-pounds (12-14 N m).

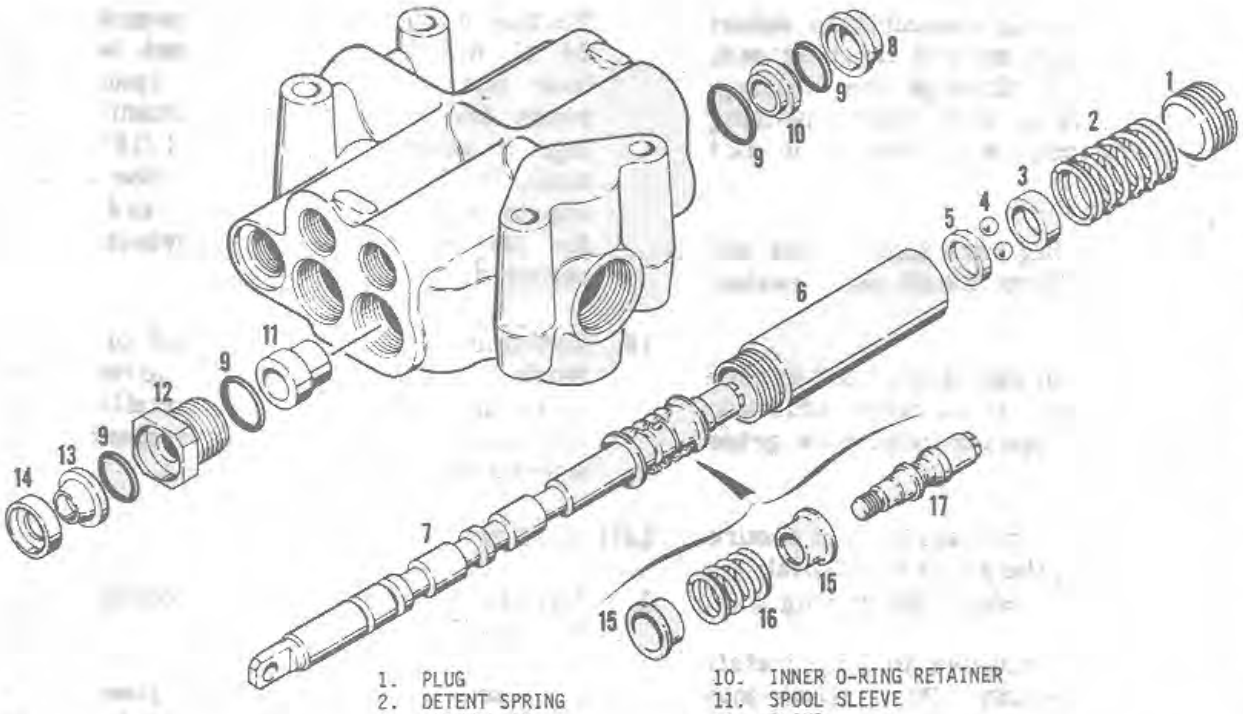
2. Install outer O-ring retainer, small O.D. first, on spring end of spool. Install O-ring retainer and install O-rings around the large O.D.

3. Grasp the centering spring and carefully slide the spool into its bore. Use care not to damage O-ring at spring end of spool.

4. Screw detent housing into valve body and torque to 23-25 foot-pounds (31-34 N m).

5. Install detent washer in the detent housing. Make sure washer is seated against shoulder in housing.

6. Drop the steel balls (8) into the housing around the detent stud. Apply a liberal amount of grease to the detent cam and install cam in housing.



1. PLUG
2. DETENT SPRING
3. DETENT CAM
4. STEEL BALLS (8)
5. DETENT WASHER
6. DETENT HOUSING
7. SPOOL
8. OUTER O-RING RETAINER
9. O-RING
10. INNER O-RING RETAINER
11. SPOOL SLEEVE
12. GLAND
13. WIPER
14. WIPER RETAINER
15. SPRING SEAT
16. CENTERING SPRING
17. DETENT STUD

Figure 20 - Lift Spool

7. Install detent spring and screw the adjustment plug into detent housing until flush with housing. Adjust detent feel as required after the control valve has been installed.

8. Install new wiper in spool gland and press wiper retainer into gland. Then install O-ring in gland bore.

9. Install sleeve, small diameter first, over the spool. Install O-ring in groove formed by the sleeve and valve body and screw gland into valve body until it bottoms.

Plugs and Fittings

Install new O-rings on the power beyond fitting and plugs and install in valve body.

Installation

1. Check to see that the metal sleeves remained in the rubber bushings.

2. Engage control valve with tubes and temporarily install a mounting bolt and nut.

3. Start a mounting bolt with flat washer through a bushing and place a flat washer and spacer on the bolt. Push bolt through valve mounting hole and install a flat washer, lock washer and nut. Do not tighten nut at this time. Install the remaining flat washers and spacers in the same manner, then tighten all nuts.

4. Connect cylinder hoses and tubes to control valve fittings. Then tighten lift cylinder tube clamp on frame.

5. Install the two outlet tubes and connect inlet hose to tee fitting.

6. Connect control linkage to the valve spools and connect detent wires to wiring harness.

7. Start engine and run at low idle. Operate all cylinders through several complete cycles to bleed air from the circuits.

8. Stop engine and check for leaks. Check reservoir oil level and add oil as required.

Section 4034

THREE-POINT HITCH CONTROL VALVE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Description	Four-spool directional control valve consisting of six sections shown in Figure 1. Three parallel passages in working sections carry oil to and from cylinders. Orifice plate at inlet restricts oil flow to maximum cylinder requirements. Compensating spool in inlet section regulates oil flow as follows: first priority to cylinders, excess to reservoir through outlet port. Also see pages 4034-4 to 4034-5.
Relief valves	
Main relief valve	
Type	Cartridge type, direct acting, adjustable
Setting	1800 ± 50 psi at full throttle (12 410 ± 344 kPa at full throttle)
Secondary relief valve, lift section	
Type	Cartridge type, direct acting, adjustable
Setting	Hand pump setting, 1900 psi (13 100 kPa)
Ports and Spools	
Spool travel	
Neutral to pressure	5/16" (8 mm)
Neutral to float	19/32" (15 mm)
Spool movement into valve body	Pressurizes port A
Spool movement out of valve body	Pressurizes port B
Service specifications	
Tie rod nut torque	28 foot-pounds, lubricated with oil (38 N m)
Springs	
Centering, all but lift spool	1-1/4" at 15 pounds (31.8 mm at 6.8 kg)
Centering, lift spool	1-17/32" at 15 pounds (38.8 mm at 6.8 kg)
Lift spool detent	21/32" at 5 pounds (16.66 mm at 2.3 kg)
Plunger	1-1/4" at 14 pounds (31.8 mm at 6.3 kg)
Spool	1-1/8" at 6 pounds (28.6 mm at 2.7 kg)

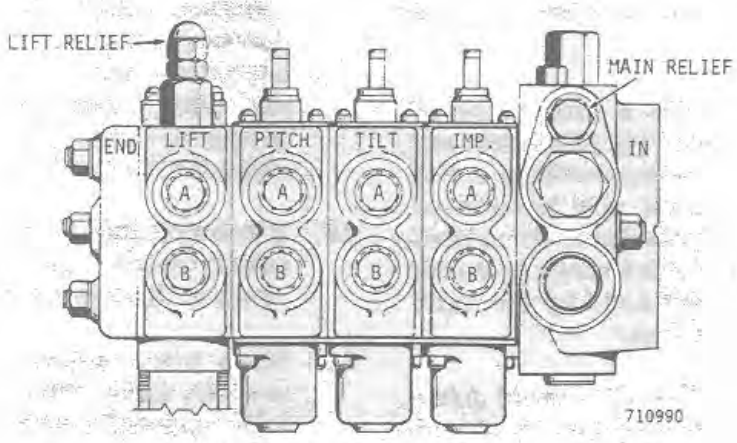


Figure 1 - Control Valve

GENERAL

The valve is a pressure compensated directional control valve consisting of six sections as follows: an inlet section containing the outlet, inlet, flow regulator, restrictor, and main relief valve; three sections for the tilt, pitch, and implement cylinders with a three-position spool in each; one section for the lift cylinder with a four-position spool; and an end section.

The three positions available at all spools are power at A port, neutral, and power at B port. In addition, the lift spool has a fourth position, Float Down. In Float Down, the spool is mechanically held (detented) until manually released. The spools are returned to neutral from the power positions by centering springs.

OPERATION

Flow Regulation

Flow from the inlet section to the cylinders passes through a fixed orifice which prevents oversupplying the cylinders. The compensating spool regulates flow on a priority basis--the cylinder being operated receives oil first with the excess (if any) returned to the reservoir.

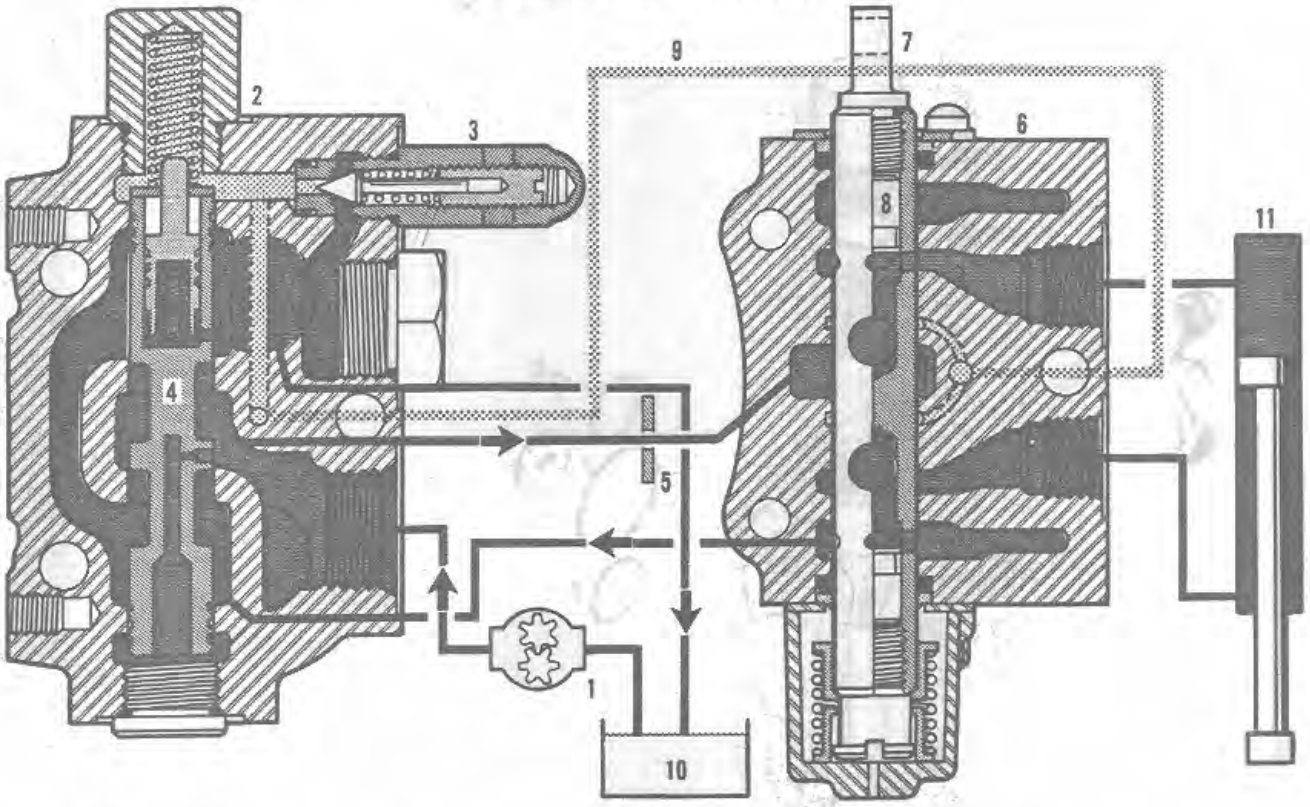
To explain the remaining valve components and their function, we will describe a typical operating sequence.

Operating Sequence

Refer to Figure 2.

1. The pump (1) is operating at normal speed.
2. The operator pulls a control lever moving the spool (7) into the valve body.
3. Pump supply flows through the inlet port of the inlet section.
4. Pump oil flows through a small hole in the compensating spool (4) filling chamber. This causes the compensating spool to shift upward against the tension of spring on top of spool. As the spool shifts, the floating plunger slides down to compensate for the oil displaced by the shift of the compensating spool.

   NOTE: A check ball (not shown) prevents movement of oil in the light red colored passage toward the spool (7).
5. At the same time, the spool (7) opens passages which allow the pump supply to flow through the orifice plate (5), and load check poppet (8) into the closed end of the cylinder (11) causing the cylinder to extend.
6. Note that the shift of the compensating spool (4) opens the pump supply to the outlet passage. Excess pump supply flows through the outlet port to the reservoir (10).
7. The pressure created by the cylinder (11) movement is transmitted via grooves in the valve face to the pilot passage to the top of the compensating spool (4).
8. This pilot pressure acts against the rim of the compensating spool and the floating plunger causing the plunger to bottom out in the bore of the compensating spool.
9. These forces, added to tension of the spring, shift the compensating spool downward against pump pressure at the opposite end of the spool. As conditions of supply, resistance, and demand change in the system, the spool is reshifted as required.
10. If the cylinder (11) cannot move, the main relief valve (3) opens at 1800 psi and vents oil to the reservoir (10).
11. When the operator returns the spool to neutral, the compensating spool (4) shifts fully upward and the entire pump supply flows to the outlet port.



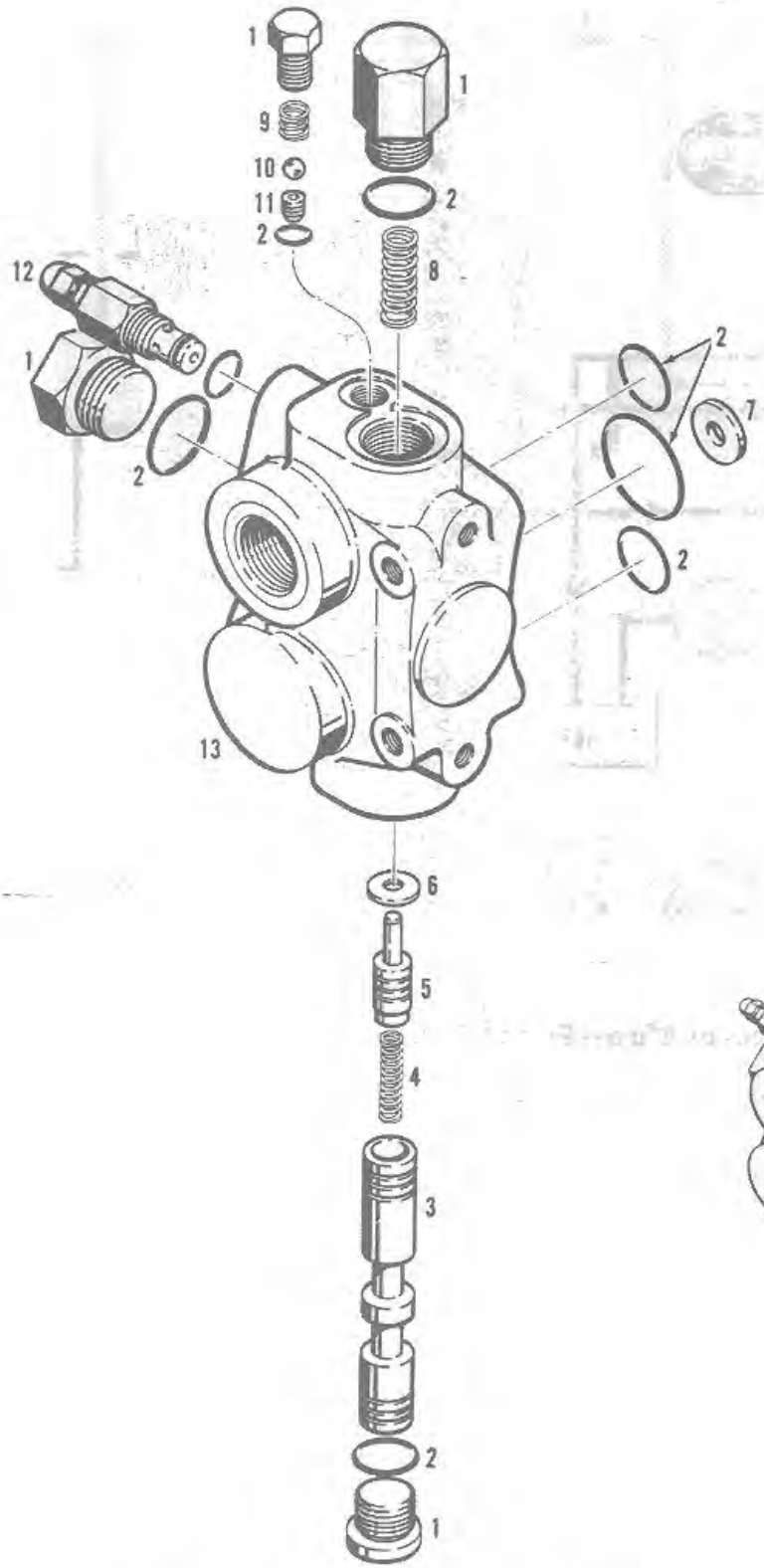
SUCTION OIL
PUMP FLOW
PILOT PRESSURE
RETURN OIL

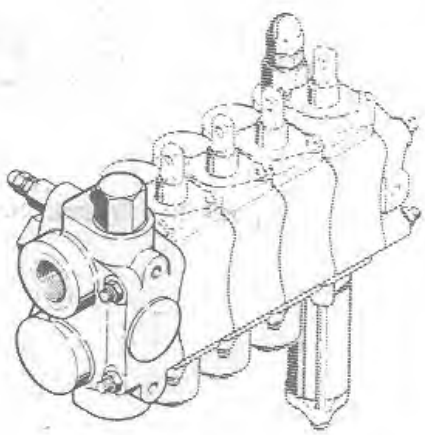
1. PUMP
2. INLET SECTION
3. MAIN RELIEF VALVE
4. COMPENSATING SPOOL
5. ORIFICE PLATE
6. WORKING SECTION
7. SPOOL
8. LOAD CHECK POPPET
9. PILOT PASSAGE
10. RESERVOIR
11. TYPICAL CYLINDER

751563

Figure 2 - Operation of Three-Point Hitch Control Valve

EXPLODED VIEWS

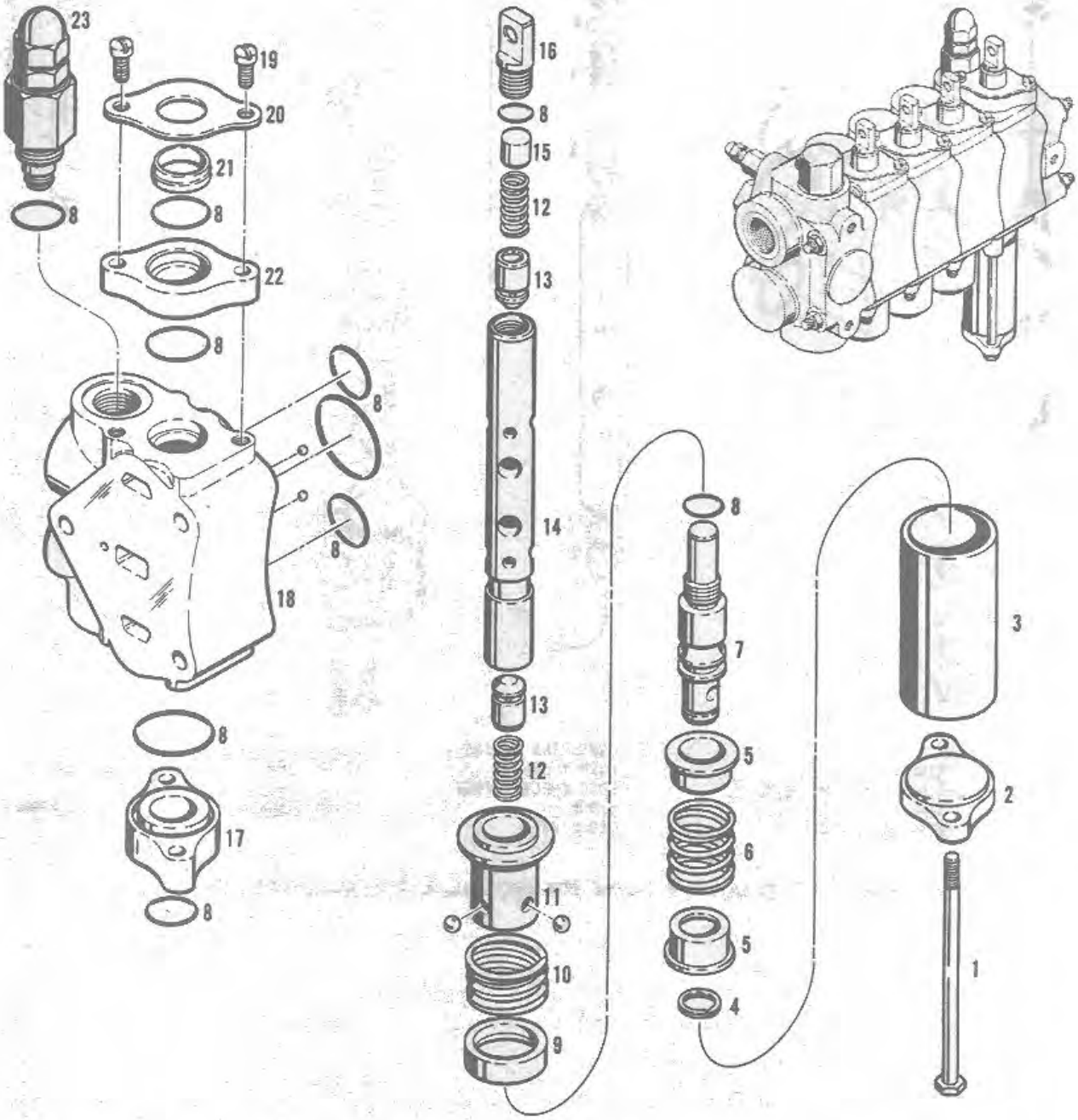




1. PLUG
2. O-RING
3. COMPENSATING SPOOL
4. PLUNGER SPRING
5. PLUNGER
6. WASHER
7. ORIFICE PLATE
8. SPOOL SPRING
9. CHECK VALVE SPRING
10. CHECK BALL
11. ORIFICE SCREW
12. MAIN RELIEF CARTRIDGE
13. HOUSING

751564

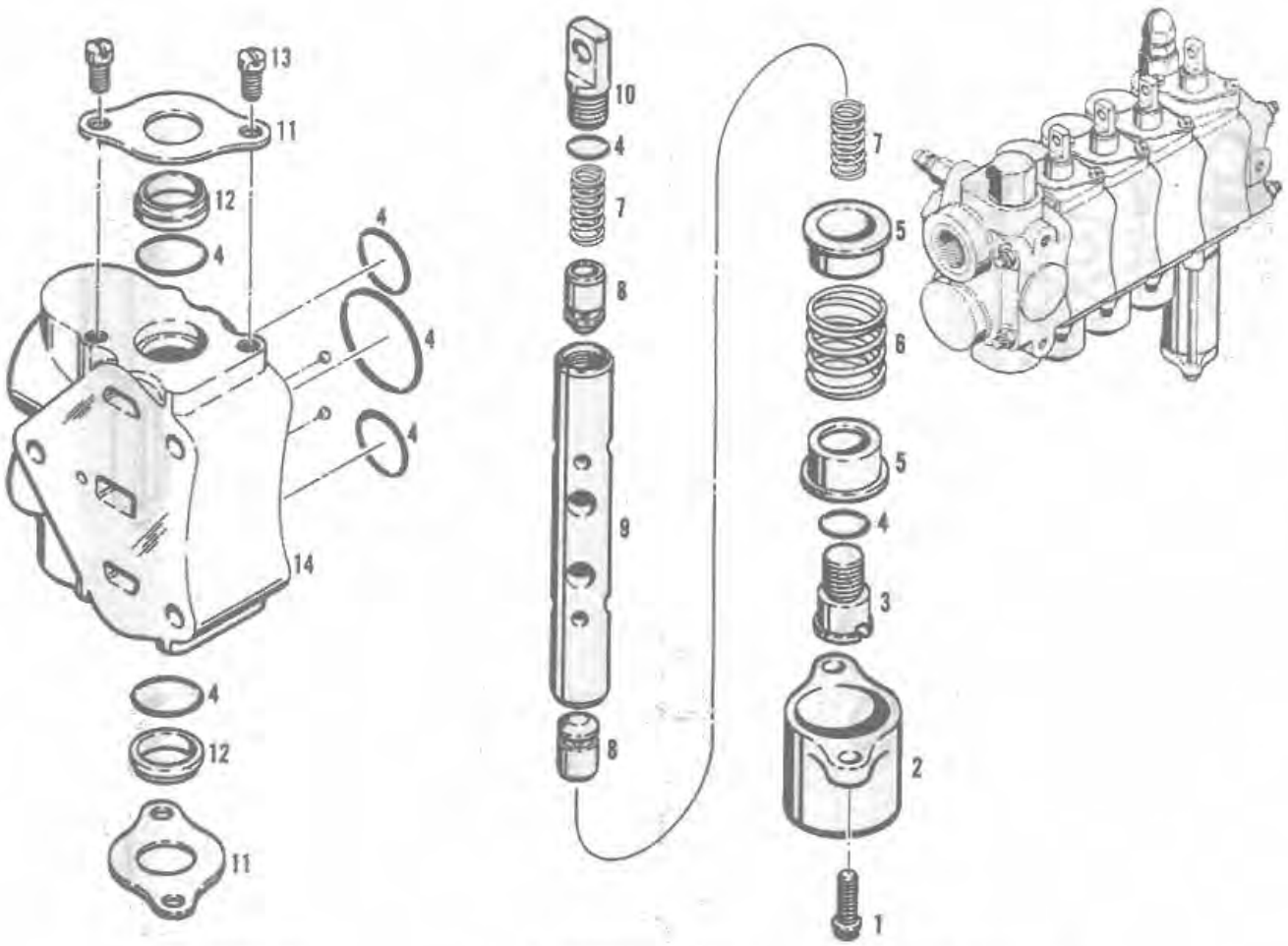
Figure 3 - Exploded View of Inlet Section



1. CAP SCREW (2)
2. DETENT CAP
3. DETENT HOUSING
4. SNAP RING
5. SPRING SEAT
6. CENTERING SPRING
7. DETENT STUD
8. O-RING
9. DETENT CAM
10. DETENT SPRING
11. BALL RETAINER
12. POPPET SPRING
13. LOAD CHECK POPPET
14. SPOOL
15. SPACER
16. SPOOL EYE
17. BOTTOM O-RING RETAINER
18. HOUSING
19. SCREW
20. WIPER RETAINER
21. WIPER
22. TOP O-RING RETAINER
23. SECONDARY RELIEF VALVE

751565

Figure 4 - Exploded View of Lift Section

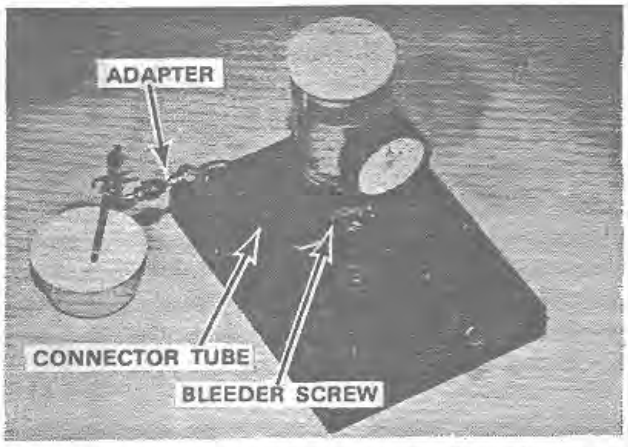


1. CAP SCREW (2)
2. SPRING CAP
3. SPRING RETAINING SCREW
4. O-RING
5. SPRING SEAT
6. CENTERING SPRING
7. POPPET SPRING
8. LOAD CHECK POPPET
9. SPOOL
10. SPOOL EYE
11. WIPER RETAINER
12. WIPER
13. SCREW
14. HOUSING

751566

Figure 5 - Exploded View of Implement, Pitch and Tilt Sections

INJECTOR TEST STAND



An "Approved" Injector Test Stand, Case Part No. M20322 (Bacharach No. 65-934D), is required for testing and adjusting the injectors and can be purchased through the Service Parts Supply, J. I. Case Co., Racine, Wisc. Except for descriptions referring especially to adjustments on the test stand itself, all of the following instructions will apply to all makes. Operating instructions are also furnished with the test stand.

An injector tool kit, Case Part No. M20520 (Bacharach No. 60-0010), is required to service the injectors. A compression gauge adapter, Bacharach No. 70-314 (D-558) is also included in the tool kit. This kit is used in conjunction with the Case Diesel Tool Kits, Case Part No. M20247 (CD-800) and Case Part No. M20246 (CD-350).

The test stand is used to perform the following checks:

1. Check and adjust the injector opening pressure. This is a duplicate of the factory procedure.

2. Check the injector assembly for fuel leakage.

3. Check and adjust the injector leak-off.

4. Accurately check the injector spray pattern.

Fuel injectors must be checked on the test stand when performing the following service operations:

1. Whenever an injector has been removed from the engine for cleaning, the injector must be checked on the test stand prior to installing it on the engine.

2. When a new injector assembly is to be installed, it must be checked on the test stand prior to installing it on the engine.

3. When a complete engine overhaul is performed, the injectors should be removed and checked on the test stand.

4. When an injec or is suspected to be the cause of unsatisfactory engine performance, it should be removed from the cylinder head and checked on the test stand prior to disassembling it.

IMPORTANT: ALWAYS CHECK THE PERFORMANCE OF AN INJECTOR ON THE TEST STAND BEFORE DISASSEMBLING IT. IF IT CHECKS OUT SATISFACTORILY, THERE IS NO NEED TO DISASSEMBLE OR ADJUST IT.

Preparing Test Stand

1. After filling the test stand fuel reservoir, loosen the bleeder screw.

2. When the fuel flowing from the bleeder screw opening is free of air bubbles, tighten the screw.

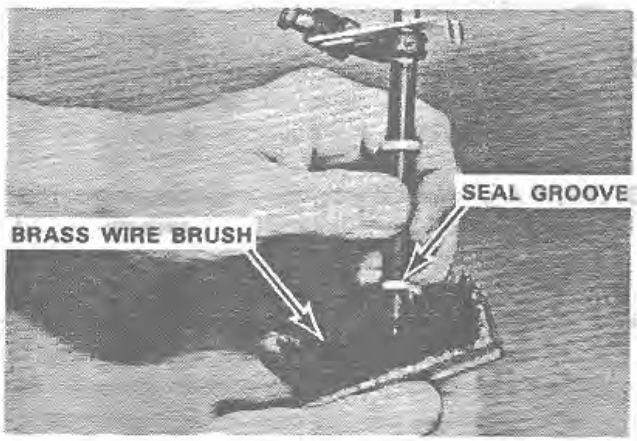
3. Wash the connector tube and adapter in clean diesel fuel. Blow clean with filtered compressed air and connect securely to the test stand.

4. Operate the hand lever slowly until clean fuel flows from the adapter.

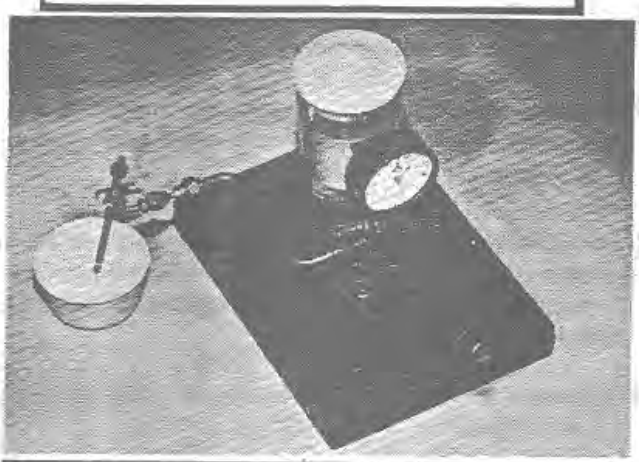
5. The test stand is now ready for use. NOTE: Complete operation and maintenance instructions are furnished with the test stand. Follow the instructions carefully.

TESTING INJECTORS

Prior to testing an injector, remove the loose carbon from the tip with an injector cleaning brush. Clean the carbon seal groove and body below the groove in the same manner. *IMPORTANT:* Do not scrape or brush the Teflon coating above the carbon seal groove.



Using the test pump adapter Bacharach Part No. 65-878, connect the injector with the tip facing downward.



CAUTION: *The injector tip should always be directed away from the operator. Fuel from the spray orifices can penetrate clothing and skin causing serious infection. The tip should always be enclosed in a receptacle, preferably transparent, to contain the spray.*

Do not attempt to connect the injector inlet fitting directly to a standard Ermeto or 60° swaged type line as damage to the tubing can result.

Checking Opening Pressure

Close the pressure gauge valve and flush the injector by operating the test pump rapidly. Open the gauge and raise the pressure slowly until the injector valve opens. (The gauge reading will drop sharply at this point). Check opening pressure against the specifications.

NOTE: When testing more than one injector out of the engine, there must not be more than 100 PSI difference between any of the injectors in that engine.

If the injectors do not meet the specified opening pressure:

1. New injectors can be adjusted to the specified opening pressure. See Page 22.
2. Injectors that do not check out on the test stand should be disassembled and cleaned. See Pages 16 thru 21.
3. Valve lift screw may be out of adjustment. See Page 22.
4. Check for broken or weak opening pressure control spring, see specifications.

Checking Seat Leakage

Point the injector tip down and operate the test pump rapidly to firmly seat the valve. Dry the injector tip thoroughly. Raise the pressure at the injector 200-300 PSI under the specified opening pressure. A drop should not form on the tip within 10 seconds. Slight dampness, however, is permissable with a used injector.

If drops form on the injector tip, the following should be done.

1. Disassemble and clean injector, pages 16 thru 21.
2. Valve is not free in guide. Lap valve to guide. See pages 18 & 19.
3. Inspect for pitted or cracked valve tip, eroded valve seat or pitted and distorted body. These conditions require replacement of the complete injector assembly.

SERVICING THE CONTROL VALVE

Removal

1. Remove accumulated dirt and grease from the valve and surrounding area to prevent entry of dirt into the hydraulic system.

2. Lower the hitch fully or rest implement (if attached) on the ground. With the engine shut off, move each control lever back and forth to relieve circuit pressures.

3. Before removing the valve, tag and number the hoses that connect to the valve, starting at the inlet section. Number the top port of the inlet section No. 1; the bottom port No. 2; the top port of the implement section No. 3, etc.

4. Disconnect hoses and close openings with clean caplugs.

5. On the tractor, connect the pump supply hose to the return line.

   NOTE: Do not start the engine without completing step 5.

6. Remove the control lever pins from the valve spools.

7. Remove three mounting bolts and lockwashers. Carry the control valve to a clean work bench for disassembly.

   NOTE: Cleanliness is very important. Service this control valve in the cleanest surroundings possible.

Disassembling the Valve

1. Starting at the inlet end, number all the sections to assure reassembly in the original position.

2. Remove three tie rod nuts at the inlet section. Slide sections off the tie rods as required.

3. Remove the three O-rings from the face of each section and inspect for damage. Take care not to lose the two steel balls from the face of each section (lift, tilt pitch, implement).

Inlet Section

Disassembly

Refer to Figure 3.

1. Remove plugs from top and bottom of valve. Remove parts shown in Figure 3.

2. Use an Allen wrench to remove the orifice screw.

3. Remove the relief valve cartridge and O-ring.

Inspection

1. Inspect the compensating spool and plunger for scoring, burrs, and excessive wear. Make sure spool orifice is open. If spool or plunger require replacement, the complete section must be replaced.

2. Inspect the housing for cracks. Shine a light in the spool bore and check for scoring and wear. If the housing must be replaced, replace the complete section.

3. Check the spool spring compression with a suitable spring testing device. Replace spring if it does not meet specification on page 4034-3.

4. The relief valve may be disassembled for inspection and cleaning. Check the plunger and seat. If the relief valve is damaged in any way, replace the entire relief valve.

5. Replace O-rings.

6. Replace the steel ball and orifice screw if damaged. Make sure the orifice in the orifice screw is open.

7. Clean all parts in solvent and dry before reassembly.

Assembly

1. Lubricate O-rings with hydraulic oil.

2. Assemble parts shown in Figure 3. Lubricate spool and plunger with hydraulic oil before installation.

Pitch, Tilt, and Implement Sections

Disassembly

Refer to Figure 5.

1. Remove two spring cap cap screws. Remove the spring cap and wiper retainer.
2. Pull the spool assembly out of the valve.
3. Clamp the spool in a SOFT jawed vise or between wood or brass strips.
4. Unscrew the centering spring retaining screw. This will permit removal of all parts from the cap end of the spool.

   NOTE: Poppets must be returned to their original position, if reused.

5. Unscrew the spool eye. Remove the poppet and spring from the spool.
6. Remove remaining wiper retainer. Remove wiper and O-ring from each end of the spool bore.

Inspection

NOTE: Do not intermix spools and sections. Always return a spool to its original section. If either the spool or housing must be replaced, the complete section must be replaced.

1. Clean the metal parts in solvent and dry with moisture free compressed air.
2. Replace check poppets if worn or damaged. Replace wipers and O-rings.
3. Inspect the valve body and spool for grooves, deep scratches, and excessive wear. See that the spool slides in and out with a slight hand pressure and without noticeable side clearance.
4. Inspect the machined faces of the sections for nicks and burrs. Use a fine oil stone, working with light rotary motion, to remove any nicks and burrs. Thoroughly wash the valve section in cleaning solvent to remove all traces of grit.

Assembly

1. Lubricate seals and internal parts with hydraulic oil before assembly. Coat the centering spring and spring guides with grease or hydraulic oil.
2. Clamp the spool in the vise used during disassembly. Assemble the centering spring, poppets, and spool eye as shown in Figure 5.
3. Install wiper retainer, wiper, small diameter toward retainer, and new O-ring on spring end of spool.
4. Lubricate spool and spool bore with hydraulic oil and install spool in valve section using care not to damage O-ring. Secure spool in place with spring cap.
5. Install new O-ring in groove formed by the spool and valve section at eye end of spool. Install wiper, large diameter first, over O-ring. Then install wiper retainer.

Lift Section

Disassembly

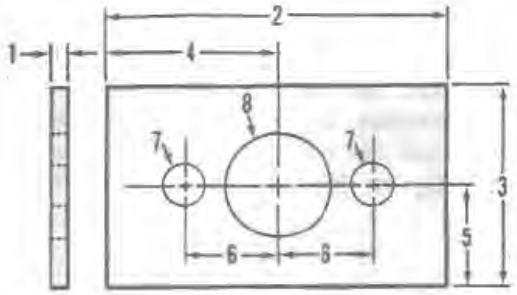
Refer to Figure 4.

1. Remove two long capscrews which retain the detent assembly.
2. Remove the detent housing cap and detent housing.
3. Pull the spool assembly out of the valve.
4. Slide the O-ring retainer and detent assembly off the spool. Use care not to lose the four detent balls.
5. Remove the centering spring:

   a. The centering spring must be compressed to remove the snap ring. Fabricate a pair of compressor plates, Figure 6, or use the compressor supplied with Case Kit No. D45700. Compress the springs as shown.

6. Clamp the spool in a SOFT jawed vise or between wood or brass strips.

7. Unscrew the detent stud and spool eye.

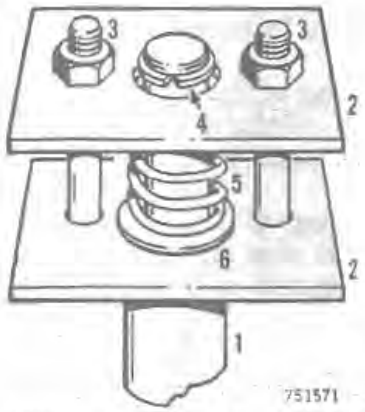


MAKE FROM COLD ROLLED STEEL
MAKE TWO PIECES

1. 1/8" (3.2 mm)
2. 2-1/2" (63.5 mm)
3. 1-1/2" (38.1 mm)
4. 1-1/4" (31.8 mm)
5. 3/4" (19.1 mm)
6. 11/16" (17.5 mm)
7. 5/16" DIA. (7.9 mm)
8. 13/16" (20.6 mm) TOP PLATE
8. 11/16" (17.5 mm) BOTTOM PLATE

751567

Figure 6 - Compressor Plates



751571

1. SPOOL
2. COMPRESSOR PLATE
3. BOLT AND NUT
4. SNAP RING
5. SPRING
6. WASHER

Figure 7 - Compressor Spring

8. Remove poppet and spring from both ends of the spool.

NOTE: Poppets must be returned to their original position, if reused.

9. Remove the remaining retainer from the valve body.

10. Remove the relief valve cartridge.

Inspection

1. Clean the metal parts in solvent and dry with moisture free compressed air. Discard the wipers and O-rings.

2. Replace poppets if worn or damaged.

3. Inspect the valve body and spool for grooves, deep scratches, and excessive wear. See that the spool slides in and out with slight hand pressure and without noticeable side clearance. If either the spool or housing must be replaced, replace the entire section.

4. Inspect the parts in the detent assembly and replace worn or damaged parts. Test the spring with a suitable spring tester--it should compress at the rate specified on page 4034-3.

5. Inspect the machined faces of the section for nicks and burrs. Remove any nicks and burrs with a fine oil stone, working with a light rotary motion. Wash the section in cleaning solvent to remove all traces of grit.

6. The relief valve may be disassembled for inspection and cleaning. Check the plunger and seat. If the relief valve is damaged in any way, replace the entire relief valve. If relief valve was disassembled and is to be used again, check pressure setting as instructed in Section 4002.

Assembly

1. Lubricate seals and internal parts with hydraulic oil before assembly. Coat the centering spring and detent assemblies with grease or hydraulic oil.

2. Clamp the spool in the vise used during disassembly. Install the check poppets and springs, spool eye, and detent stud, Figure 4.

3. Assemble the centering spring and spring seats over the detent stud. Compress the

centering spring, Figure 7, and install the snap ring.

4. Install the seal retainer with O-rings and wiper at the spool eye end of the valve housing.

5. Assemble the detent mechanism parts and seal retainer on the spool. Use grease if required to retain the steel balls.

6. Lubricate the spool with hydraulic oil. Slide the spool into the valve housing. Take care not to damage wiper and seals.

7. Install the detent housing cap and two long capscrews.

8. Install the relief valve cartridge and O-ring.

Assembling the Valve

Refer to Figure 1.

1. Lubricate new O-rings with hydraulic oil and install in the grooves on the faces of the valve sections.

2. Clamp the inlet section (tagged no. 1) in a vise with the machined face pointing up.

3. Install greased O-rings, and orifice plate on the face of the inlet section.

4. Stack the implement section on the inlet section and install the O-rings and steel balls.

5. Assemble the remaining sections in the numbered order until all six sections are stacked up.

6. Install the tie rods and nuts. Lubricate the threads on the end of the tie rods and the bosses on the end section which bear against the nuts. Torque the tie rod nuts evenly to 28 foot-pounds (38 N m).

Installation

1. Mount the valve on the bracket with three bolts and lockwashers.

2. Connect control lever linkage.

3. If fittings were removed, be sure the restrictor fittings are installed in the upper (A ports) of the tilt, pitch and lift sections. Connect hose to valve. A hydraulic diagram showing proper connecting points is in Section 4002.

4. If the setting of the main relief valve was disturbed, perform the pressure check and adjustment, Section 4002.

5. If the setting of the relief valve in the lift section was disturbed, perform the pressure check and adjustment, Section 4002.

NOTE: Replacement relief valves are preset.

Section 4090

CYLINDERS

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Piston Bolt Torque and Cylinder Weight

Loader Cylinders	Bolt Torque	Weight (approx.)
Lift	475-525 ft-lbs (644-711 N m)	50 lbs. (23 kg)
Tilt	200-220 ft-lbs (271-298 N m)	36 lbs. (16 kg)
Clam	475-525 ft-lbs (644-711 N m)	31 lbs. (14 kg)
Grapple	200-220 ft-lbs (271-298 N m)	23 lbs. (10 kg)
Backhoe Cylinders		
Boom	475-525 ft-lbs (644-711 N m)	83 lbs. (38 kg)
Dipper	1000-1200 ft-lbs (1356-1627 N m)	101 lbs. (46 kg)
Bucket	475-525 ft-lbs (644-711 N m)	81 lbs. (37 kg)
Swing	700-750 ft-lbs (949-1017 N m)	58 lbs. (26 kg)
Stabilizer	1000-1200 ft-lbs (1356-1627 N m)	70 lbs. (32 kg)
Extension	200-220 ft-lbs (271-298 N m)	96 lbs. (43 kg)
3 Point Hitch Cylinders		
Tilt	200-220 ft-lbs (271-298 N m)	23 lbs. (10.4 kg)
Lift	200-220 ft-lbs (271-298 N m)	29 lbs. (13 kg)
Pitch	200-220 ft-lbs (271-298 N m)	24 lbs. (10.9 kg)

Hydraulic Fittings (Steel)

Dash Size	Tube O.D. Hose I.D.	Thread Size	37° Flare Torque		Straight Thread O-ring Torque	
			Ft-lbs	N m	Ft-lbs	N m
4	1/4"	7/16"-20	6-12	8-16	12-19	16-25
5	5/16"	1/2"-20	8-16	11-21	16-25	22-33
6	3/8"	9/16"-18	10-25	14-33	25-40	34-54
8	1/2"	3/4"-16	15-42	20-56	42-67	57-90
10	5/8"	7/8"-14	25-58	34-78	58-92	79-124
12	3/4"	1-1/16"-12	40-80	54-108	80-128	108-174
14	7/8"	1-3/16"-12	60-100	81-135	100-160	136-216
16	1"	1-5/16"-12	75-117	102-158	117-187	159-253
20	1-1/4"	1-5/8"-12	125-165	169-223	165-264	224-357
24	1-1/2"	1-7/8"-12	210-250	258-338	250-400	339-542

740314

SPANNER WRENCH SET

Spaner wrench set, part no. D44110 contains the necessary wrenches to remove and install glands on Case manufactured cylinders. The wrench set is available through Service Parts Supply.

ALL LOADER CYLINDERS, 3 POINT HITCH CYLINDERS AND BACKHOE DIPPER, BUCKET, EXTENSION AND STABILIZER CYLINDERS

Removal

1. Rest the loader bucket on the floor. Position the backhoe as required to allow easy access to the cylinder being removed. Provide support for the backhoe to prevent it from collapsing when hoses are disconnected or the cylinder is removed.

2. Remove accumulated dirt from cylinder and hose or tube fittings before disconnecting lines. As lines are disconnected, close all openings with clean caplugs.

3. With the engine stopped, move the cylinders control lever in both directions to equalize circuit pressures.

4. Note the weight of the cylinder being removed on page 4090-3 and have lifting equipment or additional help available as required to prevent personal injury or unnecessary damage.

5. Remove the cylinder.

   a. Dipper cylinder. Disconnect hose at tube to rod end of cylinder. Remove hose clamp inside the boom and remove cylinder pivot pins. Disconnect hose at closed end of cylinder.

   b. Backhoe bucket cylinder. If equipped with standard dipper, disconnect hoses at tubes on boom. Remove cylinder pivot pins and remove cylinder. If equipped with an extendable dipper, disconnect hoses at the cylinder.

   c. Extension cylinder. Refer to Section 9100 and remove dipper extension, then the cylinder.

   d. Stabilizer cylinders. Lower stabilizer to the floor. Disconnect hoses at tubes on cylinder. Remove pivot pins and remove cylinder.

   e. Raise loader arm slightly above hood level and block in place using a suitable support under the bucket or loader arm crossmember.

      Remove the lift cylinder rod eye pivot pins. Have someone available to prevent the cylinder from falling when the pin is removed.

      If chain hoist can be used, attach hoist to bucket and lower bucket to the floor.

      If chain hoist cannot be used, reinstall the rod eye pin and lower the bucket to the floor. Then remove the pins.

      Disconnect hoses at manifold tubes on inside of loader frame. Remove cylinder from pivot pin.

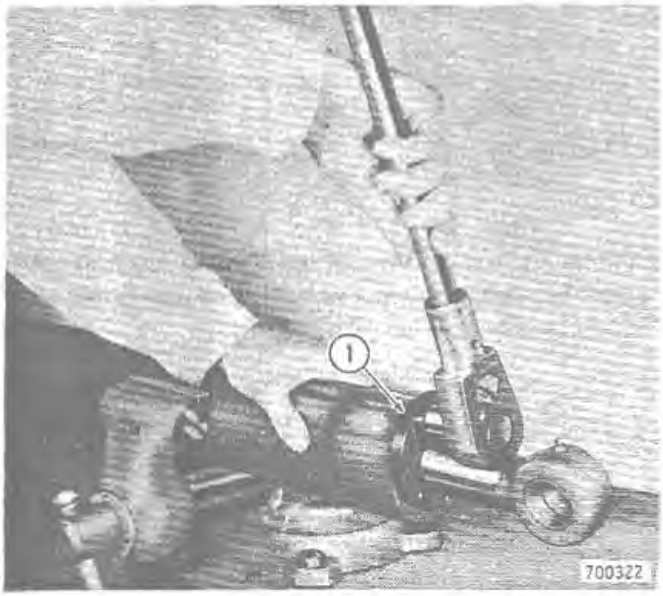
   f. Loader bucket cylinder. Disconnect cross hoses at swivel connections. Remove rod eye pivot pin. Remove inner cylinder mounting link and remove cylinder.

   g. Clam cylinder. Disconnect hoses at cylinder. Remove pivot pin retaining bolts and remove pivot pins and cylinder.

   h. Three point hitch cylinders. Provide support for hitch as required. Disconnect hoses at cylinder. Remove pivot pins and remove cylinder.

Disassembly

1. Secure cylinder in a vise using care not to distort the tube. Remove the self-tapping screw from the gland. Use a spanner wrench and unscrew gland, Figure 1.



1. SPANNER WRENCH

Figure 1 - Removing Gland

2. Carefully pull the piston rod from the cylinder. Pull the rod straight out to prevent damage to the cylinder wall.

3. Secure piston rod eye in a vise as shown in Figure 2 and remove piston bolt. Bolt torque ranges from 200 to 1200 foot-pounds (271-1627 N m).

4. Remove piston assembly from piston rod. Pull piston halves apart and remove the center ring, vee rings and end rings from the piston halves.

   NOTE: If disassembling three point hitch pitch cylinder with one piece piston, remove wear ring, Teflon piston ring and O-ring.

5. Remove gland from piston rod. If necessary, the gland may be driven off the rod with a soft hammer. Refer to Figure 3 and disassemble gland.

1. PROTECT ROD WITH CLOTH
2. CLAMP ACROSS ROD EYE

Figure 2 - Removing Highly Torqued Piston Bolt

Inspection

1. Wash parts in cleaning solvent and dry with moisture free compressed air.

2. Discard piston packing (vee rings), O-rings, backup rings, seal, wiper and other parts found to be excessively worn.

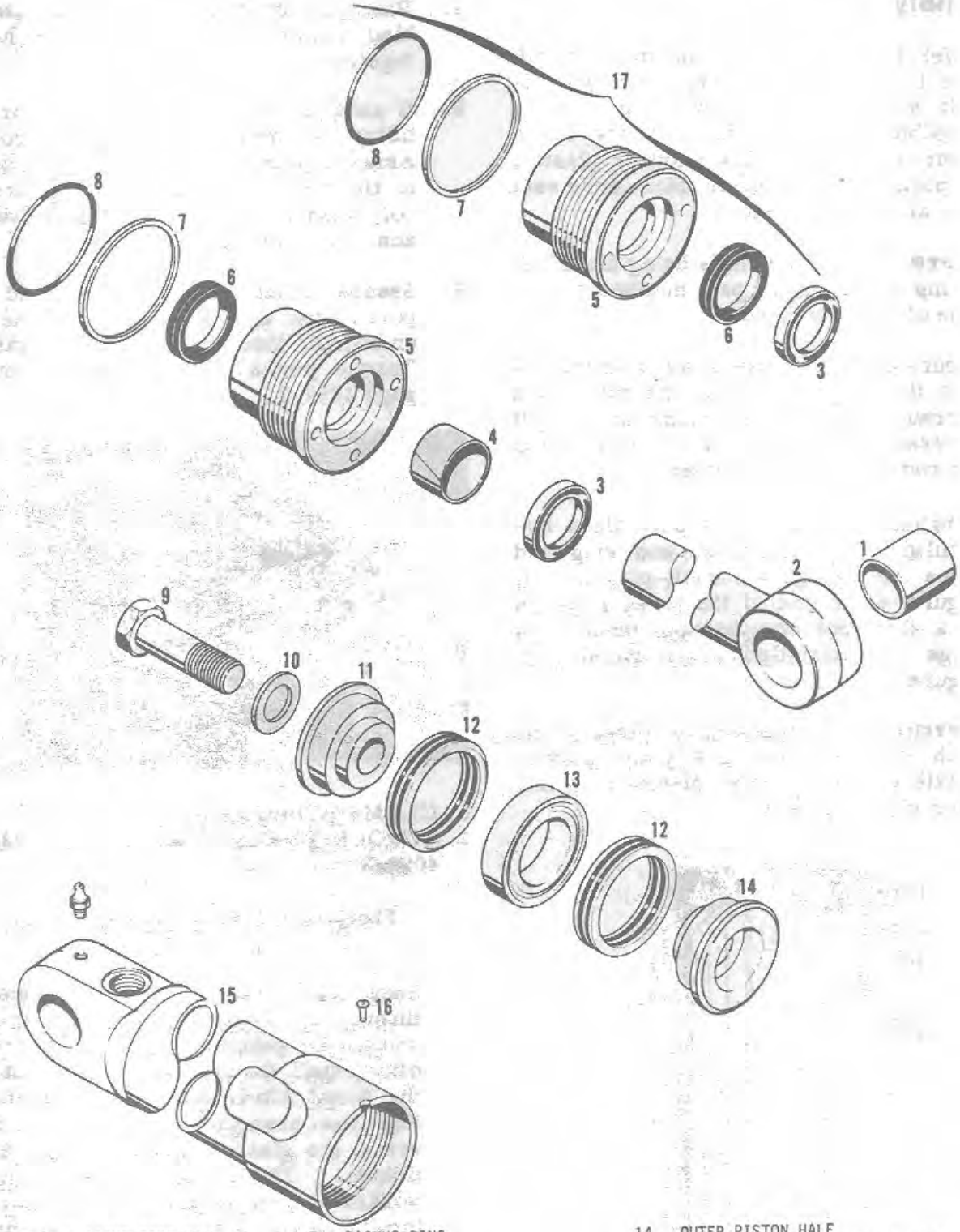
3. Shine a light into the cylinder tube. If it has deep grooves or score marks, or has been severely damaged in any way, it should be replaced.

4. Inspect piston rod for alignment. Replace if bent; do not attempt to straighten.

5. Inspect bushings or bearings and replace as required.

6. Before assembling the cylinder, remove any minor nicks, scratches, etc. on the rod or in the cylinder tube with a medium grit emery cloth. Polish with a rotary motion rather than lengthwise.

7. Scoring, pitting, etc. are signs of possible oil contamination. Check hydraulic oil for contamination.



1. BUSHING (SOME RODS HAVE SNAP RING RETAINED SELF-CENTERING BEARING)
2. PISTON ROD
3. WIPER
4. BEARING
5. GLAND
6. U-CUP SEAL
7. BACKUP RING
8. O-RING
9. PISTON BOLT
10. WASHER
11. INNER PISTON HALF
12. VEE RINGS AND END RING
13. CENTER RING
14. OUTER PISTON HALF
15. CYLINDER (LOADER LIFT CYLINDER SHOWN. OTHER CYLINDERS MAY USE BUSHING OR SNAP RING RETAINED SELF-CENTERING BUSHING)
16. SELF-TAPPING-SCREW
17. GLAND ASSEMBLY USED ON LOADER BUCKET CYLINDER ONLY

751578

Figure 3

Assembly

1. Refer to Figure 3 and assemble gland. The U-cup rod seal may be very difficult to install. Use as much care as possible not to cut the seal lips. Use a blunt tool, preferably wood or plastic, to push seal into place. Make sure seal lips are to the inside.

   NOTE: If a new gland is being installed, stamp the cylinder part number on the face of the new gland.

2. Secure piston rod eye in a vise and lubricate the gland bore and rod with clean hydraulic oil. Install gland on rod. If necessary, the gland may be driven onto the rod with a soft hammer.

3. Lubricate the vee rings with clean hydraulic oil. Position an end ring and three vee rings on each piston half, Figure 4. If one of the three rings is of a different composition, make sure rings are installed as illustrated in Figure 4.

   NOTE: If assembling a three point hitch cylinder with one piece piston, install O-ring, Teflon piston ring and wear ring on piston.

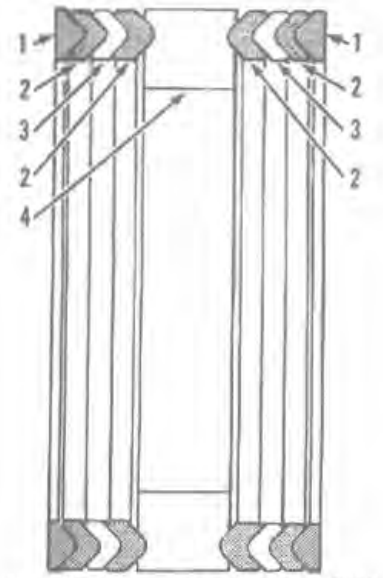
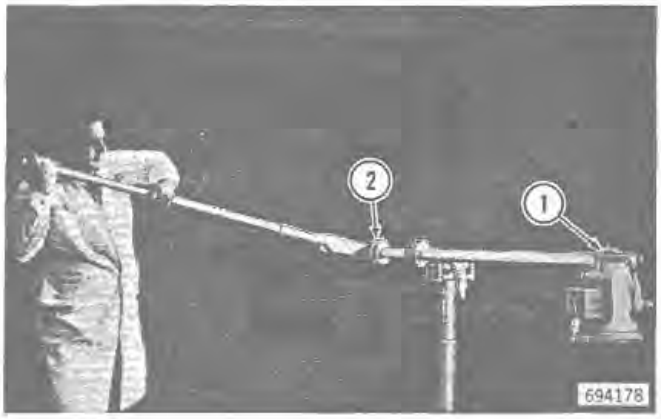


Figure 4 - Vee Ring Installation

4. Place center ring on one of the assembled piston halves and fit the halves together.

5. If assembling a dipper cylinder or stabilizer cylinder, apply a light coat of Amojell petroleum jelly (or equivalent) to the following surfaces: bolt threads, bolt washer surface, both sides of washer and end of piston rod.

6. Secure piston rod eye in a vise and support piston end. Place piston assembly on rod and install piston bolt with washer. Torque piston bolt to specifications on page 4090-3.



1. CLAMP ACROSS ROD EYE
2. TORQUE TO SPECIFICATION ON PAGE 4090-3

Figure 5 - Torquing Piston Bolt (High Torque)

7. Secure the cylinder tube in a vise and throughly lubricate the cylinder wall and piston packing with clean hydraulic oil. Install the piston rod straight into the tube. After the piston has started into the smooth portion of the tube, screw the gland into the tube but do not tighten. The piston rod can now be worked farther into the tube with a rod through the rod eye or a soft hammer.

8. Torque the gland until the self-tapping screw holes in the gland and cylinder line up. Then install self-tapping screw. Gland torque should be between 100 and 200 foot-pounds (135-271 N m).

   NOTE: If a new gland or tube is being

used, drill a new hole for the self-tapping screw after the gland has been torqued to 100-200 foot-pounds (135-271 N m). Using a No. 26 (3.7338 mm) drill, drill the hole half in the gland and half in the cylinder approximately 5/16" (7.9 mm) deep. Do not drill in line with the spanner wrench holes.

Installation

1. All cylinders can be installed by reversing the removal procedure on page 4090-5.

2. It is suggested that one end of the cylinder be anchored and then connect hoses and/or tubes. If hose or tube connecting points were not identified, refer to the appropriate section in the 90 Series to assure proper connections.

3. Start engine and run at low idle. Slowly move the cylinder's control lever to extend or retract the piston rod as required to align loose end of cylinder with its mounting point.

WARNING: Use extreme caution when performing step 3. DO NOT use your fingers to check pivot pin hole alignment while the control lever is actuated. 39-7

4. Torque hose and tube connections to specifications in Section 1051.

5. Lubricate cylinder pivot points with grease specified in Section 1050.

6. Start engine and run at low idle. Operate the cylinder(s) through several cycles to bleed air from the circuits. Do not "bottom out" the cylinder(s) until the cylinder(s) move smoothly and without hesitation. After the cylinder is filled with oil, engine speed may be increased and the cylinder(s) may be operated normally.

7. Stop engine and check for leaks. Check reservoir oil level and add oil as required.

SWING CYLINDER

Removal

1. Rest backhoe bucket on the floor.

2. Remove accumulated dirt from cylinders, hoses and fittings.

3. Disconnect hoses to right hand cylinder at tube at top of mainframe and closed end of left hand cylinder.

4. Disconnect hoses to left hand cylinder at closed end of right hand cylinder and the remaining hose at a convenient swivel connecting point.

5. Remove rod eye pin retaining plate on bottom of swing tower and drive pin out.

6. Remove the trunnion plate. Remove the four mounting bolts with nuts and hardened washers. The bolts are torqued to 520-640 foot-pounds (705-867 N m). Then remove cylinder from mainframe.

Disassembly

1. Secure cylinder in a vise using care not to distort the cylinder. Use a spanner wrench and unscrew gland. Figure 6.

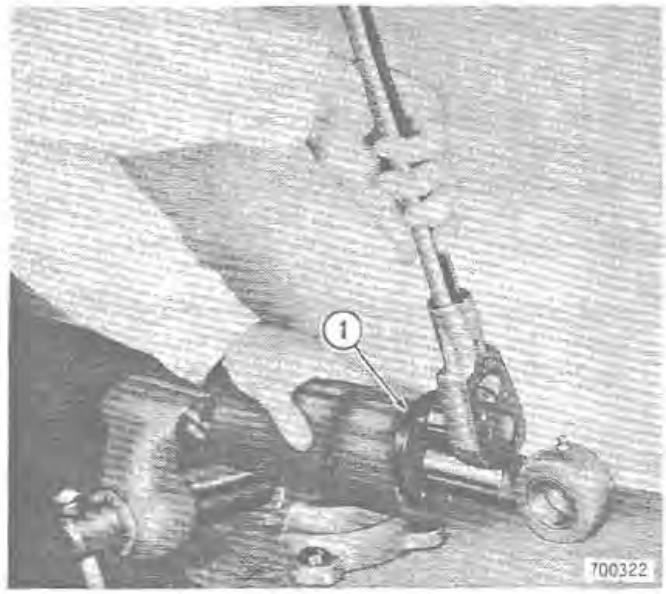
2. Carefully pull the piston rod from the cylinder. Pull rod straight out to prevent damage to the cylinder wall.

3. Secure piston rod eye in a vise and support piston end as shown in Figure 7 and remove piston bolt. The bolt is torqued to 700-750 foot-pounds (949-1017 N m) and will require considerable force to loosen.

4. Remove restrictor pin from bolt or piston rod. Then remove spring and spacer from piston rod.

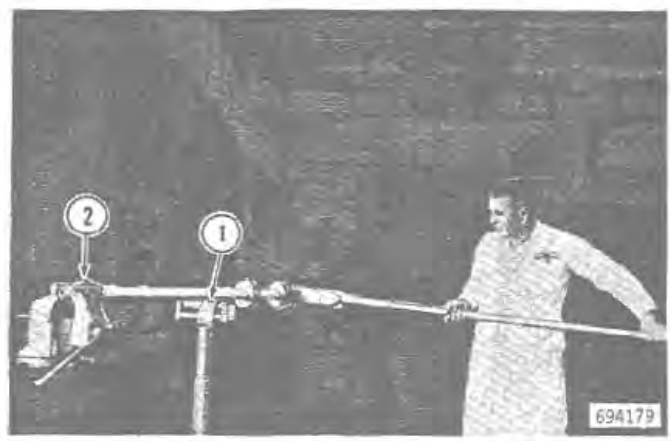
5. Remove piston from piston rod. Then pull piston halves apart and remove the center ring, vee rings and end rings from piston halves.

6. Remove gland from piston rod. If necessary, the gland may be driven off the rod with a soft hammer. Refer to Figure 8 and disassemble gland.



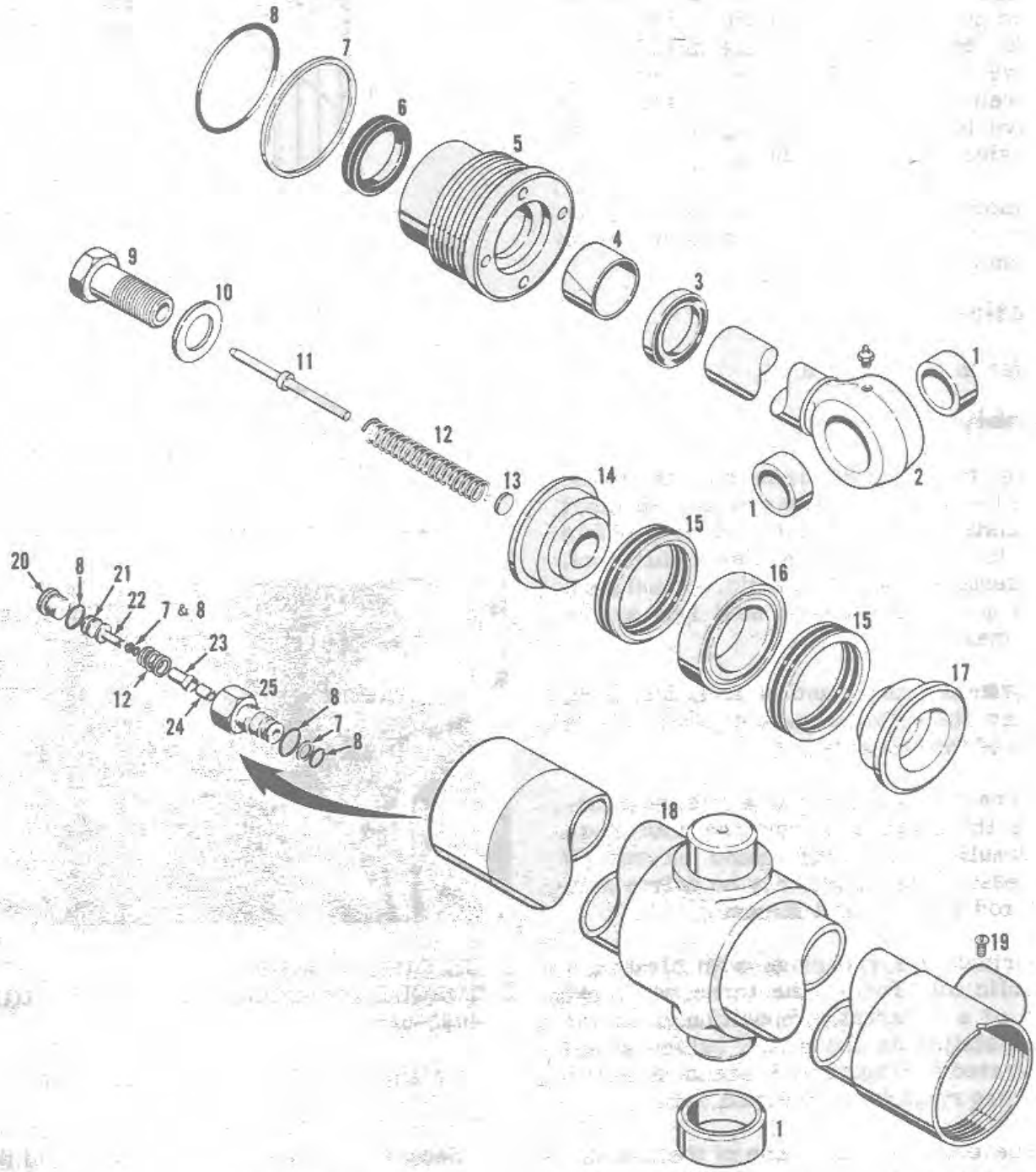
1. SPANNER WRENCH

Figure 6 - Removing Gland



1. PROTECT ROD WITH CLOTH
2. CLAMP ACROSS ROD EYE

Figure 7 - Removing Piston Bolt



1. BUSHING
2. PISTON ROD
3. WIPER
4. BEARING
5. GLAND
6. U-CUP SEAL
7. BACKUP RING
8. O-RING
9. PISTON BOLT
10. WASHER
11. RESTRICTOR
12. SPRING
13. SPACER
14. INNER PISTON HALF
15. VEE RINGS AND END RING
16. CENTER RING
17. OUTER PISTON HALF
18. CYLINDER
19. SELF-TAPPING SCREW
20. PLUG
21. SHIMS
22. SPRING GUIDE
23. POPPET
24. POPPET SEAT
25. BODY

Figure 8 - Swing Cylinder

7. Remove relief valve from closed end of cylinder. If the relief valve has an Allen head plug, the internal parts are serviceable. However, do not disassemble the valve unless it is suspect (jarring or extremely spongy stops). If the relief valve has a hex head plug, the valve is serviced as an assembly only.

8. Remove elbow from closed end of cylinder and remove flow restrictor from cylinder.

Inspection

Refer to page 4090-6.

Assembly

1. Refer to Figure 8 and assemble the gland. The U-cup rod seal may be very difficult to install. Use as much care as possible not to cut the seal lips. Use a blunt tool, preferably wood or plastic, to push seal into place. Make sure seal lips are to the inside.

   NOTE: If a new gland is being installed, stamp the cylinder part number on the face of the new gland.

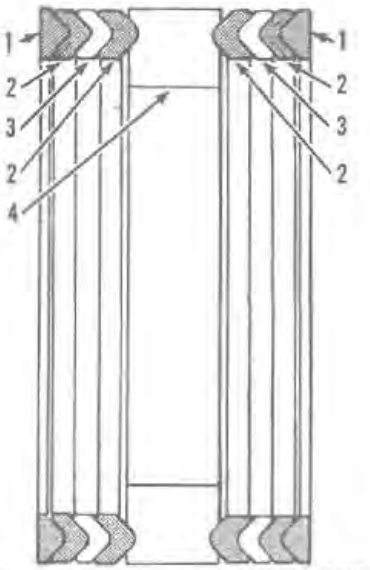
2. Secure piston rod eye in a vise and lubricate the gland bore and rod with clean hydraulic oil. Install gland on rod. If necessary, the gland may be driven onto the rod with a soft hammer.

3. Lubricate the vee rings with clean hydraulic oil. Two of the three vee rings are of a different composition and must be installed on the piston halves as illustrated in Figure 9. Place an end ring and vee rings on each piston half.

4. Place center ring on one of the assembled piston halves and fit the halves together.

5. Place the spacer in bolt hole in piston rod and place piston assembly on rod.

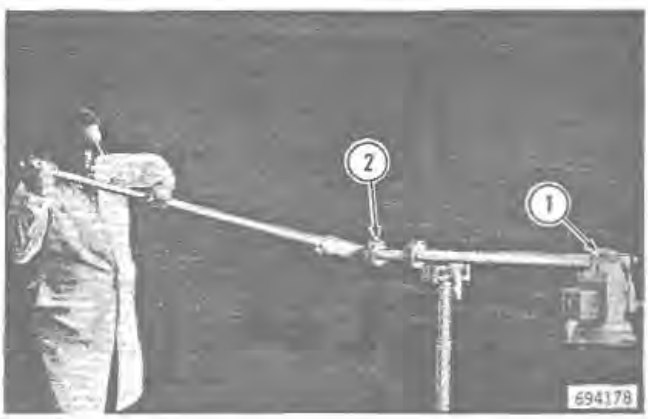
6. Place washer on piston bolt. Install restrictor pin in piston bolt, tapered end first, and place spring on pin. Screw bolt as assembled into piston rod and torque to 700-750 foot-pounds (949-1017 N m).



1. END RING 3. NEOPRENE RING
2. NYLON RING 4. CENTER RING

751579

Figure 9 - Vee Ring Installation



1. CLAMP ACROSS ROD EYE
2. TORQUE TO SPECIFICATION ON PAGE 4090-3

Figure 10 - Torquing Piston Bolt

7. Secure cylinder tube in a vise and thoroughly lubricate the cylinder wall and piston packing with clean hydraulic oil. Install the piston straight into the tube. After the piston has started into the smooth portion of the tube, screw gland into tube but do not tighten. The piston rod can now be worked farther into the tube with a rod through the rod eye or a soft hammer.

8. Torque the gland until the self-tapping screw holes in the gland and cylinder

line up. Gland torque should be between 100 and 200 foot-pounds (135-271 N m).

NOTE: If a new gland or tube is being used, drill a new hole for the self-tapping screw after the gland has been torqued to 100-200 foot-pounds (135-271 N m). Using a No. 26 (3.7338 mm) drill, drill the hole half in the gland and half in the cylinder approximately 5/16" (7.9 mm) deep. Do not drill in line with the spanner wrench holes.

9. If the relief valve was disassembled, refer to Figure 8 and assemble valve. If parts were satisfactory and jarring stops were noted during operation, remove one or two shims. If stop was extremely spongy, add one or two shims.

10. Install relief valve in closed end of cylinder. Be sure new O-rings and back-up ring have been installed on the valve body.

11. Install flow restrictor in port in closed end of cylinder. Restrictor must be installed small end first. Then install the 90° elbow.

NOTE: Two different restrictors are used and can be identified by restrictor hole diameter as follows:

With Extendahoe . . . .125" (3.17 mm)
Without Extendahoe . .126" (3.96 mm)

Installation

1. Position cylinder in mainframe and secure in place with trunnion plate. Make sure hardened washers are used between bolt and trunnion plate, and nut and mainframe. Torque trunnion plate mounting bolts to 520-640 foot-pounds (705-867 N m).

2. Position rod eye in swing tower and install pivot pin. Make sure retaining plate groove is to the center of the swing tower and drive pin in from bottom of swing tower. Secure pivot pins in place with retaining plate.

3. Connect hoses to cylinder and tubes and/or control valve. Torque connections to specifications in Section 1051.

4. Lubricate the cylinder pivots with No. 2 moly disulfide grease.

5. Start engine and run at low idle. Operate the cylinders through several complete cycles to bleed air from the circuit. After the cylinder has been filled, engine speed may be increased.

6. Stop engine and check for leaks. Check reservoir oil level and add oil as required.

BOOM CYLINDER

Removal

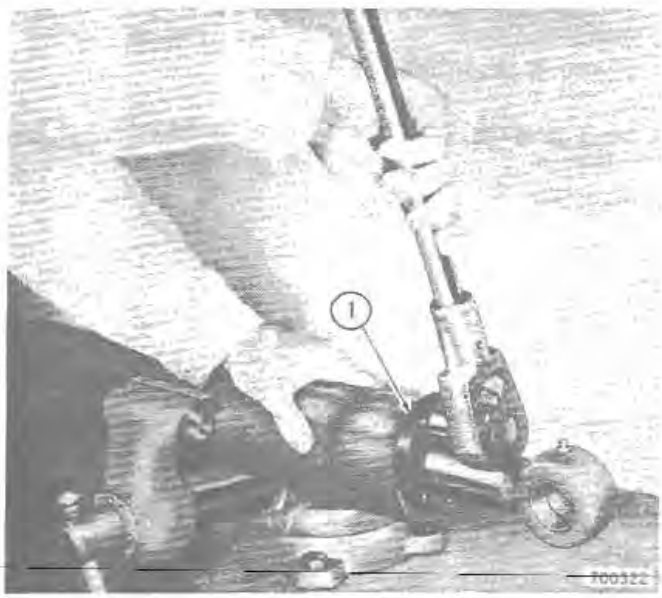
1. Completely retract the dipper and bucket and lower boom so bucket rests on the floor. Move boom control lever in both directions to equalize circuit pressures.

2. Remove the cylinder pivot pin retaining bolts and nuts. Disconnect hoses at cylinder and close openings with clean caplugs.

3. Have lifting equipment or another person available to aid in removing the cylinder. Remove the pivot pin at closed end of cylinder. Then work cylinder off the rod eye pin. If necessary, remove pin retaining hardward on eye end of opposite cylinder and drive pin out of rod eye.

Disassembly

1. Secure cylinder in a vise using care not to distort the cylinder. Use a spanner wrench and unscrew gland, Figure 11.

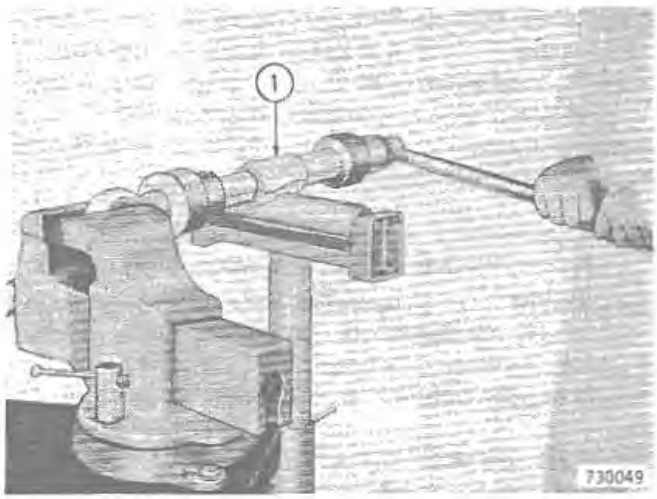


1. SPANNER WRENCH

Figure 11 - Removing Gland

2. Carefully pull the piston rod from the cylinder. Pull rod straight out to prevent damage to the cylinder wall.

3. Secure piston rod eye in a vise and support piston end as shown in Figure 12 and remove piston bolt.



1. PROTECT ROD WITH CLOTH

Figure 12 - Removing Piston Bolt

4. Remove piston from piston rod. Then separate piston halves. Remove the vee rings and adapter rings from the outer piston half. Remove wear ring from inner piston half.

5. Remove gland from piston rod. If necessary, the gland may be driven off the rod with a soft hammer. Refer to Figure 14 and disassemble gland.

Inspection

Refer to page 4090-6.

Assembly

1. Refer to Figure 14 and assemble the gland. The U-cup seal may be very difficult to install. Use as much care as possible not to cut the seal lips. Use a blunt tool, preferably wood or plastic, and push seal into place. Make sure seal lips are to the inside.

NOTE: If a new gland is being installed, stamp the cylinder part number on the face of the new gland.

2. Secure piston rod eye in a vise and lubricate rod and gland bore with clean hydraulic oil. Install gland on rod. If necessary, the gland may be driven onto the rod with a soft hammer.

3. Lubricate the vee rings with clean hydraulic oil. Two of the three vee rings are of a different composition and must be installed as illustrated in Figure 13. Install the vee rings and adapter rings on the outer piston half as illustrated in Figure 13.

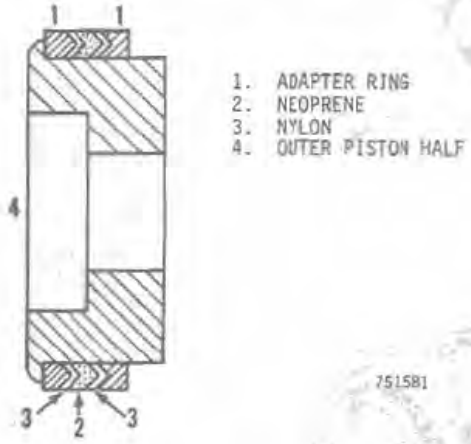


Figure 13 - Vee and Adapter Ring Installation

4. Place outer piston half on piston rod. Then install washer and inner piston half on piston bolt and screw bolt into piston rod. Torque bolt to specification on page 4090-3.

5. Install new wear ring on inner piston half.

6. Secure cylinder tube in a vise and thoroughly lubricate the cylinder wall and piston packing with clean hydraulic oil. Install the piston straight into the tube. After the piston has started into the smooth portion of the tube, screw the gland into the tube but do not tighten. The piston rod can now be worked farther into the tube with a rod through the rod eye or a soft hammer.

7. Torque the gland until the self-tapping screw holes in the gland and cylinder line up. Gland torque should be between 100 and 200 foot-pounds (135–271 N m).

NOTE: If a new gland or tube is being used, drill a new hole for the self-tapping screw after the gland has been torqued to 100 - 200 foot-pounds (135–271 N m). Using a No. 26 (3.7338 mm) drill, drill half in the gland and half in the cylinder approximately 5/16" (7.9 mm) deep. Do not drill in line with the spanner wrench holes.

Installation

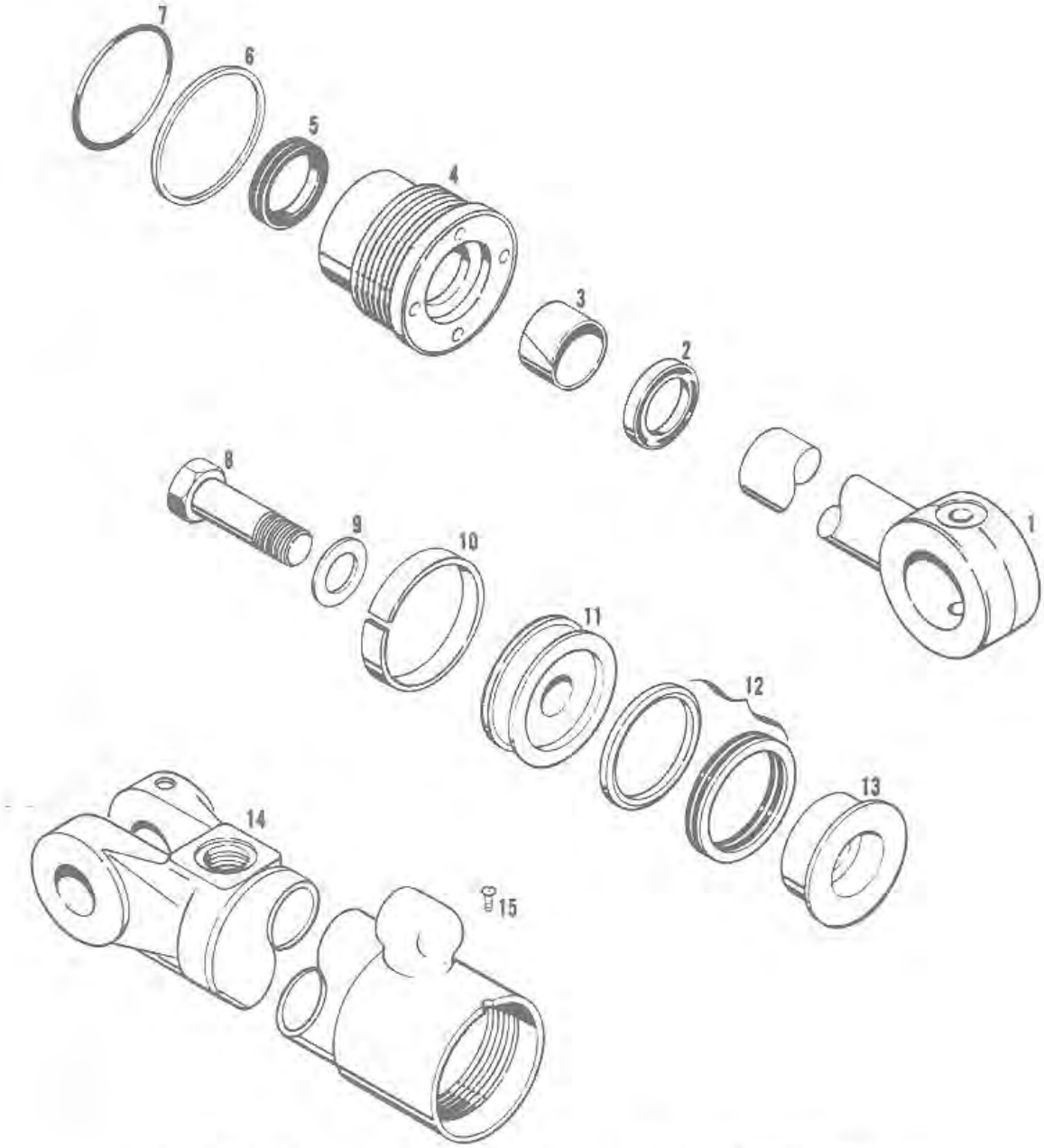
1. Attach piston rod eye to its pivot pin. Make sure flat washer is installed between the boom and rod eye.

2. Align closed end of cylinder with mounting ear on swing tower and install pivot pin. Make sure hole in pin and cylinder yoke are lined up before installing pin. Secure both pins in place with nut and bolt.

3. Connect hoses to cylinder.

4. Start engine and run at low idle. Operate the boom through several complete cycles to bleed air from the circuits. After the cylinder has filled, engine speed may be increased.

5. Stop engine and check for leaks. Check reservoir oil level and add oil as required.



1. PISTON ROD
2. WIPER
3. BEARING
4. GLAND
5. U-CUP SEAL
6. BACKUP RING
7. O-RING
8. PISTON BOLT
9. WASHER
10. WEAR RING
11. INNER PISTON HALF
12. VEE AND ADAPTER RINGS
13. OUTER PISTON HALF
14. CYLINDER
15. SELF-TAPPING SCREW

Figure 14 - Boom Cylinder

Section 4107

BACKHOE CONTROL VALVE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

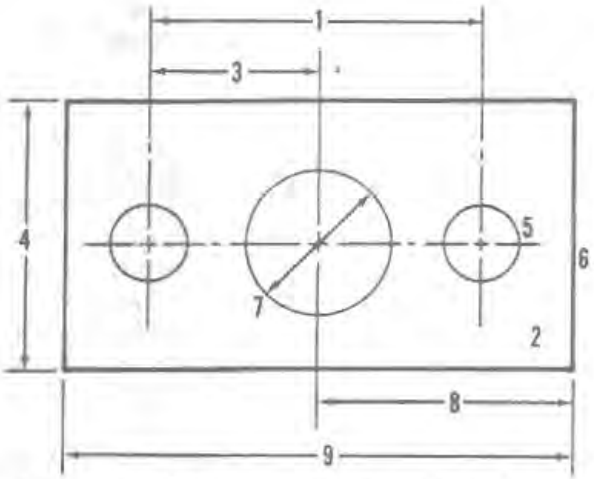
NOTE: The following specifications and service information apply to control valve part numbers G34897 and G35360. The difference between the valve is the added section in the G35360 valve for the dipper extension.

Secondary relief valve pressure settings	Relief valves will have pressure setting stamped on body. This figure indicates the nominal setting at full flow and should be disregarded when checking pressure setting. Refer to Section 4002 for specifications and test procedures.
Main relief valve pressure setting	Refer to loader control valve main relief valve setting in Section 4002.
Ports and spools	
Spool travel, neutral to pressure	.45" (11.4 mm) in and out
Spool in	A port pressurized
Spool out	B port pressurized
Port threads, all	1-5/16"-12, O-ring
Special torques	
Tie bolt nuts	20-30 foot-pounds (27-41 N m)
Centering spring cap	20-30 foot-pounds (27-41 N m)
Secondary relief valve cartridges	65-85 foot-pounds (85-115 N m)
Secondary relief valve adjusting screw lock nut	50-80 inch-pounds (5.6-9 N m)
Check valve plug	65-85 foot-pounds (85-115 N m)

Springs	Free length	Compressed length
Regeneration spool	2.097" (53.26 mm)	1.61" at 62 ± 4 lbs. (41 mm at 28 ± 1.8 kg)
Inlet section check valve	2.04" (51.8 mm)	1.56" at .95 ± .1 lbs. (39.6 mm at .43 ± .05 kg)
Swing section anticavitation	1.085" (27.6 mm)	.75" at .57 ± .04 lbs. (19 mm at .026 ± .018 kg)
Load check valves	.709" (18 mm)	.31" at .43 ± .04 lbs. (7.9 mm at .2 ± .02 kg)
Secondary relief valve	1.785" (45.3 mm)	1.51" at 137 ± 16 lbs. (38.4 mm at 62 ± 7.25 kg)
Spool centering	2.27" (57.6 mm)	.87" at 35 ± 2.1 lbs. (22 mm at 15.9 ± 1 kg)

Weight (approx.)	95 pounds (43 kg)

SPECIAL TOOLS

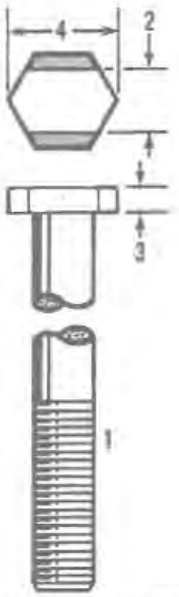


1. 1-5/8" (41.3 mm)
2. 2 REQUIRED
3. 3/4" (19.1 mm)
4. 1-1/2" (38.1 mm)
5. 5/16" DIA. (7.9 mm)
6. 1/8" THICK (3.2 mm)
7. 7/8" DIA. (22.2 mm)
8. 1-1/16" (27 mm)
9. 2-1/8" (54 mm)

MAKE TWO PIECES FROM COLD ROLLED STEEL 751604

Figure 1
Spring Compressor Plates

NOTE: Retainer plates, part number D26830, also can be used. See Figure 9.



1. 3/8" - 16 x 3" (76 mm) OR LONGER HEX BOLT
2. GRIND TWO SIDES EVENLY TO 15/32" (11.9 mm)
3. GRIND TO 1/8" (3.2 mm)
4. 5/8" (10.9 mm)

751605

Figure 2
Check Valve Plug Removal Tool

GENERAL

Refer to Figure 3 and 4. The backhoe is an open center parallel passage control valve. The parallel passage starts at the inlet section and dead ends at the regeneration sensing piston in the outlet section. Oil displaced from the cylinders flows to the outlet section through the return passages at the top and bottom of the valve sections. The return oil flows to the outlet port past the regeneration spool. The function of the regeneration spool and check valve located in the inlet and outlet section is discussed under Operation.

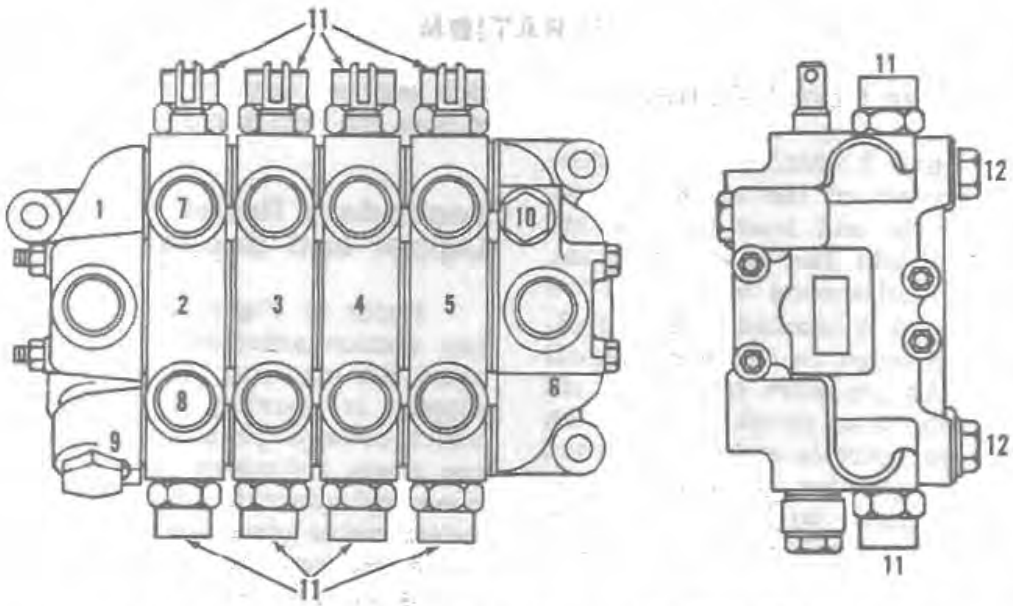
The design of the total loader/backhoe hydraulic system allows the main relief valve in the loader control valve to protect all hydraulic ciruits. Therefore, the backhoe control valve has no main relief valve.

Load check valves between the parallel passage and the work ports prevent reverse flow of oil between the cylinders and the control valve as a spool is moved into a power position.

Secondary relief valves are connected to the A and B ports of all working sections except the extension section to protect the individual circuits when a cylinder is forced to move with the valve spool in Neutral.

Anticavitation valves are connected between the return passages and work ports in the swing section to prevent voids in the swing circuits.

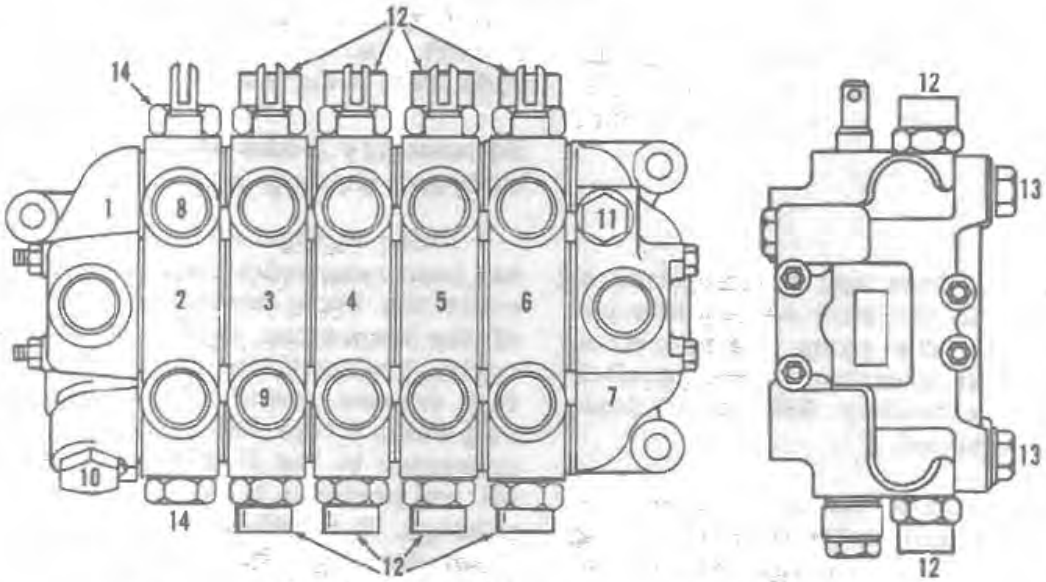
Control valve operation is discussed on page 4107-6. With all control valve spools in Neutral, oil from the pump flows straight through the open center passage to the outlet section and back to the reservoir.



1. OUTLET SECTION
2. BOOM SECTION
3. DIPPER SECTION
4. BUCKET SECTION
5. SWING SECTION
6. INLET SECTION
7. A PORT
8. B PORT
9. REGENERATION SPOOL
10. REGENERATION CHECK VALVE
11. SECONDARY RELIEF VALVE
12. ANTICAVITATION VALVE

751594

G34897



1. OUTLET SECTION
2. EXTENSION SECTION
3. BOOM SECTION
4. DIPPER SECTION
5. BUCKET SECTION
6. SWING SECTION
7. INLET SECTION
8. A PORT
9. B PORT
10. REGENERATION SPOOL
11. REGENERATION CHECK VALVE
12. SECONDARY RELIEF VALVE
13. ANTICAVITATION VALVE
14. PLUG

751595

G35360

Figure 3 - Backhoe Control Valve

OPERATION

Oil Flow, Dipper Spool Actuated

Refer to Figure 8 which shows the dipper spool moved out of the valve body to move the dipper in and load the bucket. Moving the spool into the power position causes several simultaneous events: (1) the open center passage is blocked by the spool, (2) the parallel passage is charged with oil from the pump. As pressure builds, the oil then flows past the load check valve to the B port of the dipper section and to the closed end of the dipper cylinder, pushing the dipper toward the machine to load the bucket, (3) the A port is connected to the upper return passage so oil displaced from the rod end of the dipper cylinder can be returned to the reservoir.

Because the parallel passage is connected to all working sections more than one spool can be actuated at the same time. However, the cylinders(s) meeting the least resistance will move first.

When the spool is returned to Neutral, oil is locked between the cylinder(s) and spool preventing further movement of the cylinder(s).

Regeneration

Oil displaced from any of the cylinders can be diverted to the inlet section to supplement oil from the pump. Regeneration occurs only when pressure in the parallel passage is approximately 350 psi or less and a spool is actuated.

Refer to Figure 6. As an example, regeneration could occur as the bucket is being lowered into a trench. The weight of the boom, dipper and bucket would have a tendency to pull the piston rods out of the boom cylinders. When this happens, pressure in the parallel passage drops to 350 psi or less and the spring under the regeneration spool in the outlet section moves the spool to block the return passage. The pressure created in the return passage opens the check valve in the inlet section and the oil displaced from the rod end of the boom cylinders then supplements the pump flow. When pressure in the parallel passage rises to 350 psi or more, the sensing piston in the outlet section pushes against the regeneration spool to open the return passage.

Secondary Relief Valves, Boom, Dipper and Bucket Sections

Refer to Figure 8 which shows the dipper section actuated to push the dipper toward the machine to load the bucket. As the dipper is moving it pushes the boom up which creates pressure in the closed end of the boom cylinders. When pressure in the boom cylinders is equal to the setting of the relief valve connected to the A port of the boom section, the relief valve opens and relieves oil and pressure to the return passage. The boom section was used as an example only; the relief valves in the dipper and bucket sections will function in the same manner if the cylinders are forced to move the valve spool in Neutral.

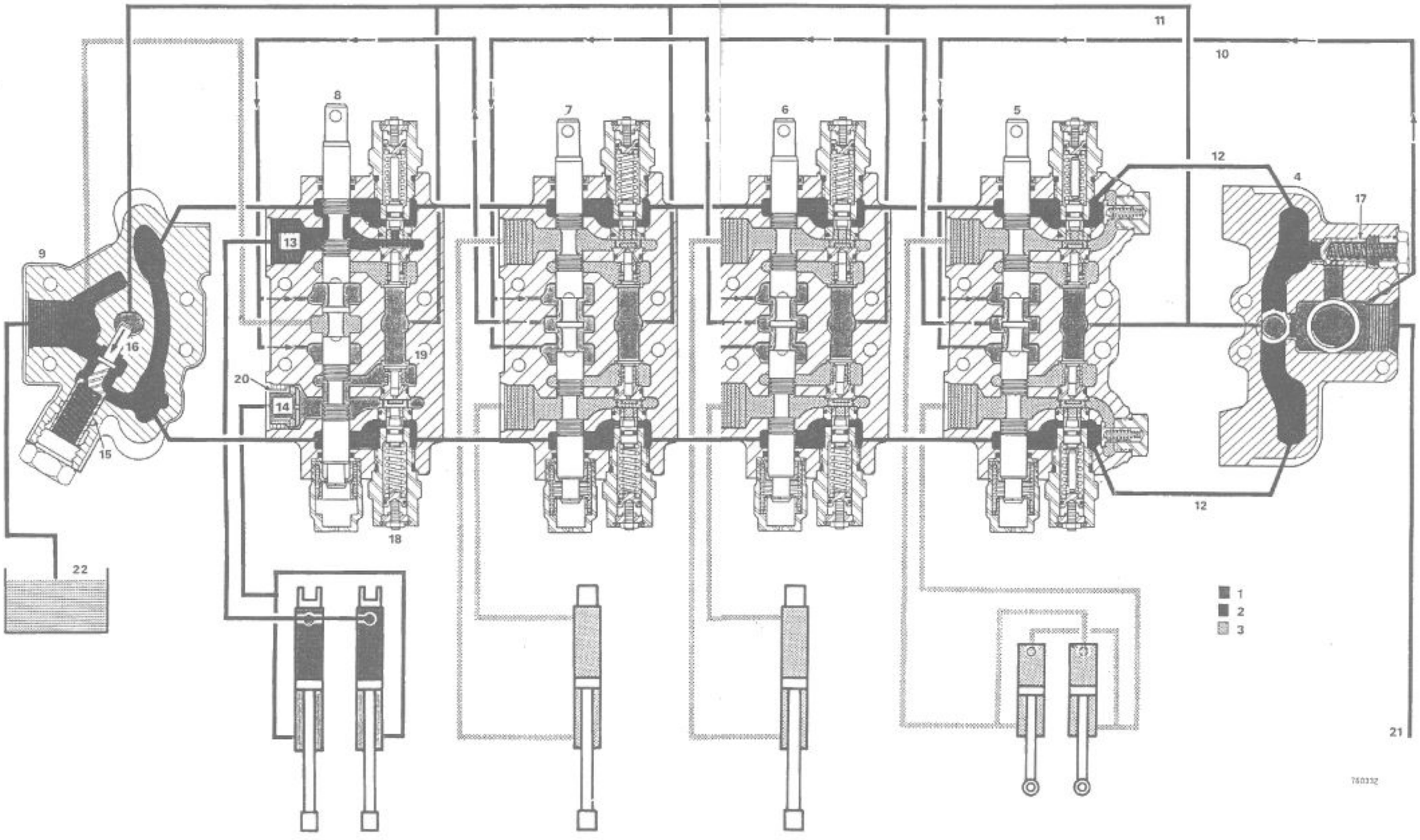
NOTE: The low pressure setting of the relief valve connected to the boom section A port also protects boom cylinder piston rods from being bent when extended.

Secondary Relief and Anticavitation Valves, Swing Section

Refer to Figure 7. After the swing spool has been returned to Neutral to stop the swing cycle the boom continues to move because of the momentum created during the swing cycle. The continued movement of the boom then creates pressure within the return circuit which forces the poppet in the relief valve connected to the B port off its seat allowing oil and pressure to be relieved to the return passage. In addition to protecting the circuit from damage, the relief valve prevents a jarring stop of the boom.

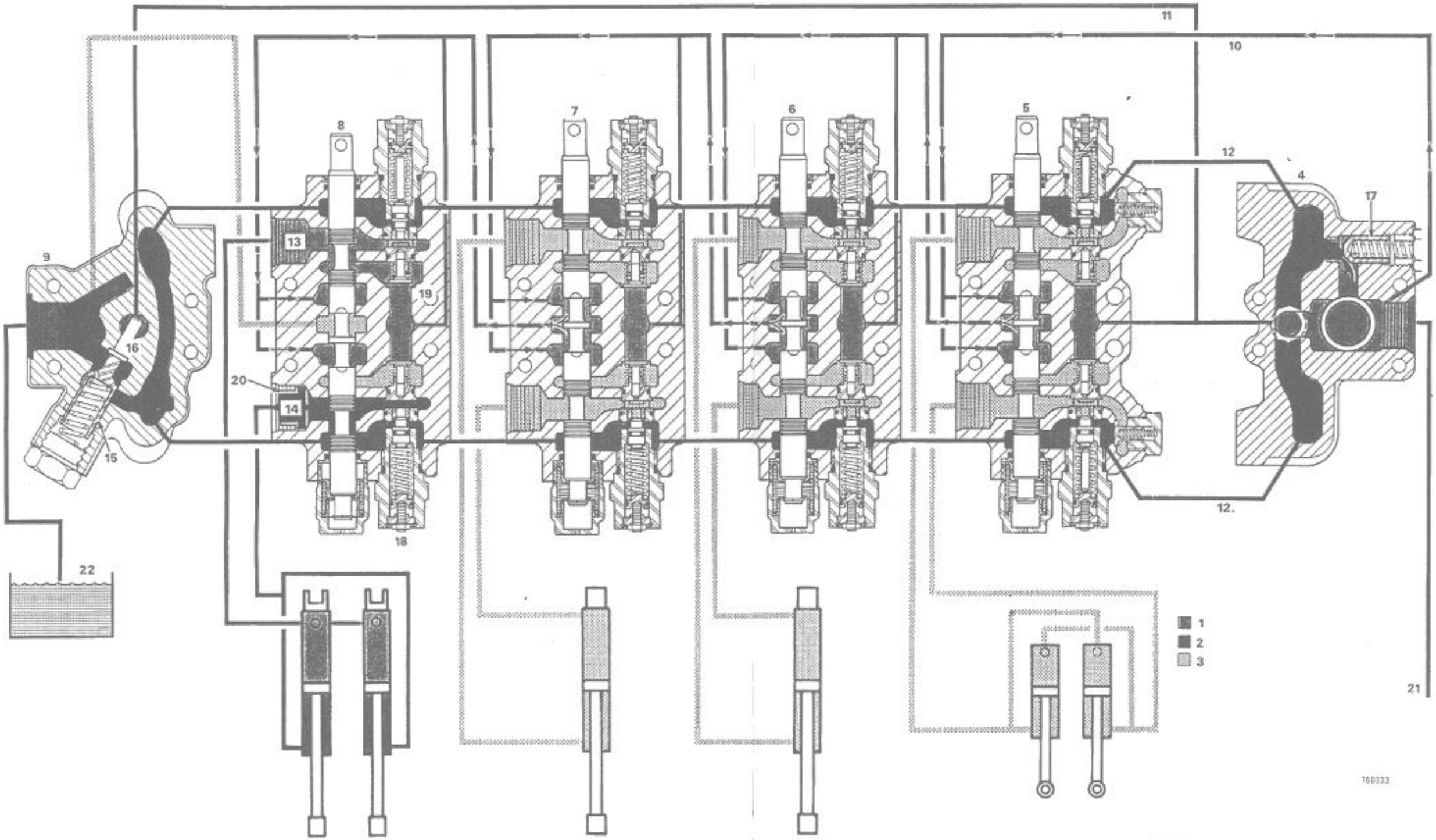
At the same time, pressure in the return passage unseats the anticavitation valve connected to the A port to prevent voids in the swing circuit. Cavitation (voids or air pockets) occurs because of unequal movement of the piston rods in the swing cylinders.

The anticavitation valves will also open during a powered swing if the pressure in the parallel passage is approximately 350 psi or less. Refer to Regeneration on this page.



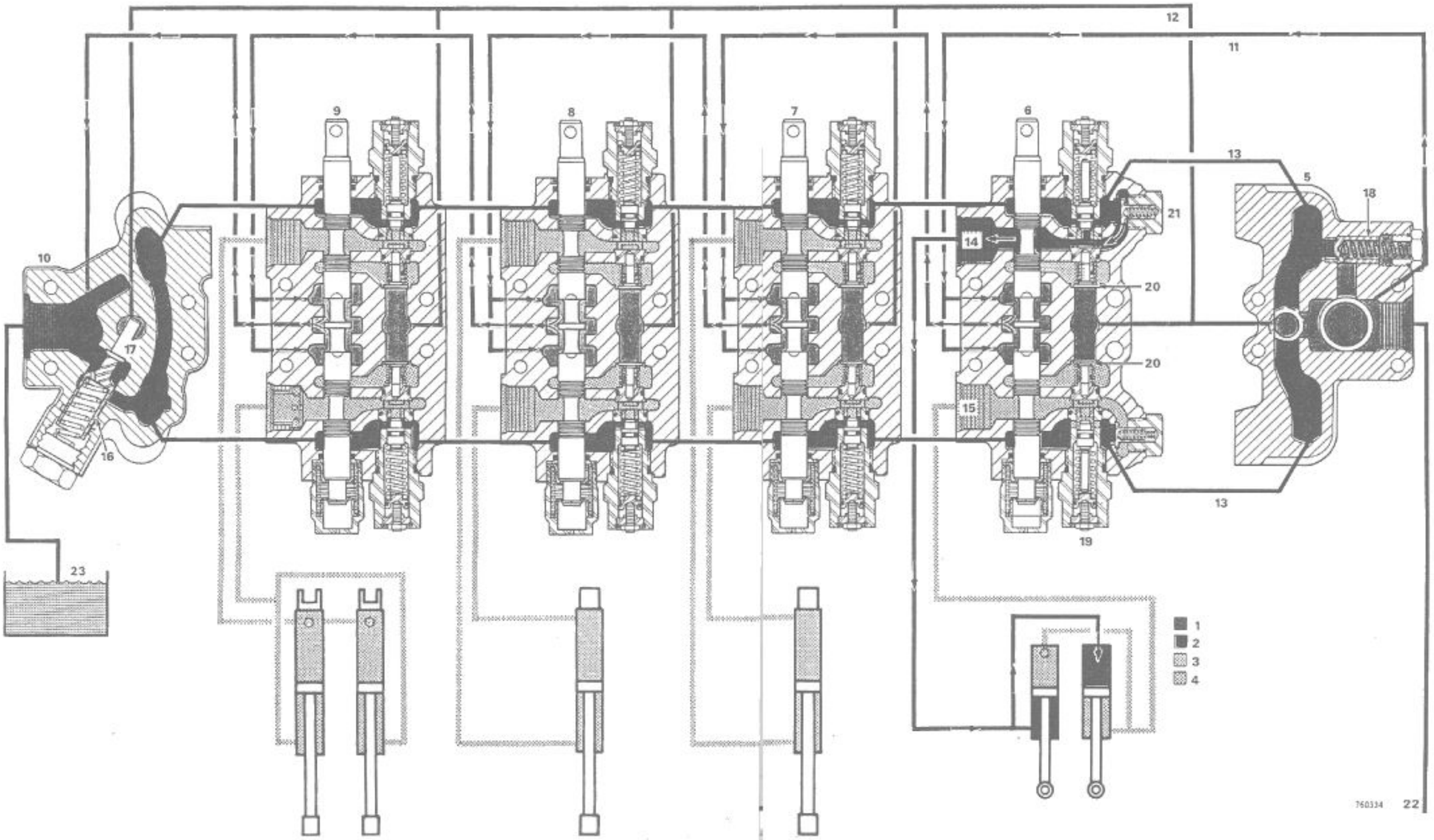
1. PUMP FLOW
2. RETURN OIL
3. STATIC OIL
4. INLET
5. SWING
6. BUCKET
7. DIPPER
8. BOOM
9. OUTLET
10. OPEN CENTER PASSAGE (INTERNAL)
11. PARALLEL PASSAGE (INTERNAL)
12. RETURN PASSAGE
13. A PORT
14. B PORT
15. REGENERATION SPOOL
16. RENERATION SENSING PISTON
17. RENERATION CHECK VALVE
18. SENDARY RELIEF VALVE
19. LO/ CHECK VALVE OPEN
20. BOOM DOWN RESTRICTOR
21. FROM PUMP VIA LOADER CONTROL VALVE AND STABILIZER CONTROL VALVE
22. RESERVOIR

Figure 5 - Oil Flow to Raise Boom



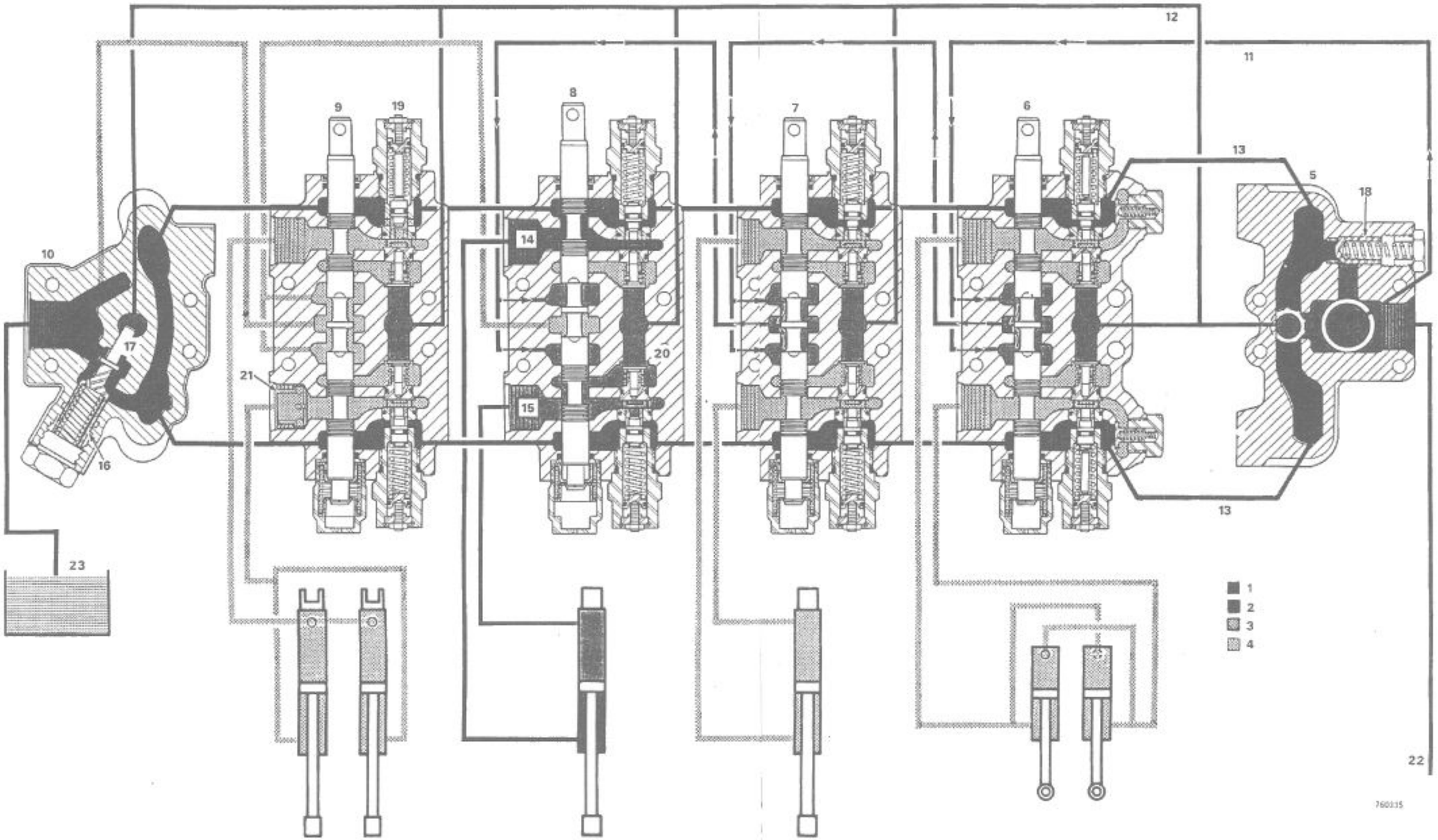
1. PUMP FLOW
2. RETURN OIL
3. STATIC OIL
4. INLET
5. SWING
6. BUCKET
7. DIPPER
8. BOOM
9. OUTLET
10. OPEN CENTER PASSAGE (INTERNAL)
11. PARALLEL PASSAGE (INTERNAL)
12. RETURN PASSAGE
13. A PORT
14. B PORT
15. REGENERATION SPOOL
16. REGEIRATION SENSING PISTON
17. REGEIRATION CHECK VALVE OPEN
18. SECOIARY RELIEF VALVE
19. LOADHECK VALVE OPEN
20. BOOM DOWN RESTRICTOR
21. FROM PUMP VIA LOADER CONTROL VALVE AND STABILIZER CONTROL VALVE
22. RESERVOIR

Figure 6 - Oil Flow, Lowering Boom and Regeneration



1. PUMP FLOW
2. RETURN OIL
3. STATIC OIL
4. OIL DISPLACED FROM SWING CYLINDERS
5. INLET
6. SWING
7. BUCKET
8. DIPPER
9. BOOM
10. OUTLET
11. OPEN CENTER PASSAGE (INTERNAL)
12. PARALLEL PASSAGE (INTERNAL)
13. RETURN PASSAGE
14. A PORT
15. B PORT
16. REGENERATION SPOOL
17. REGENERATION SENSING PISTON
18. REGENERATION CHECK VALVE
19. SECONDARY RELIEF VALVE OPEN
20. LOAD CHECK VALVE
21. ANTICAVITATION VALVE
22. FROM PUMP VIA LOADER CONTROL VALVE AND STABILIZER CONTROL VALVE
23. RESERVOIR

Figure 7 - Oil Flow, Boom Swinging to Right and Stopping



1. PUMP FLOW
2. RETURN OIL
3. STATIC OIL
4. OIL DISPLACED FROM BOOM CYLINDERS
5. INLET
6. SWING
7. BUCKET
8. DIPPER
9. BOOM
10. OUTLET
11. OPEN CENTER PASSAGE (INTERNAL)
12. PARALLEL PASSAGE (INTERNAL)
13. RETURN PASAGE
14. A PORT
15. B PORT
16. REGENERATION SPOOL
17. REGENERATION SENSING PISTON
18. REGENERATION CHECK VALVE
19. SECONDARY RELIEF VALVE OPEN
20. LOAD CHECK VALVE OPEN
21. BOOM DOWN RESTRICTOR
22. FROM PUMP VIA LOADER CONTROL VALVE AND STABILIZER CONTROL VALVE
23. RESERVOIR

Figure 8 - Oil Flow, Dipper Cylinder Extending, Boom Section Relief Valve Open

SERVICING THE CONTROL VALVE

Removal

NOTE: The control valve weights approximately 95 pounds (43 kg). Use care in handling valve to prevent personal injury or damage to the valve.

1. Swing backhoe to the right or left. Place backhoe in transport position and install the cranning lock pin or completely retract the bucket and dipper and lower boom until bucket rest on the floor.
2. Move all control levers in both directions to equalize circuit pressures. Then disconnect control linkage at the valve spools.
3. Remove tube between the stabilizer valve outlet and the backhoe control valve inlet.
4. Remove grease fittings from top swing cylinder trunnions. Place a piece of 1/2" plywood or a metal plate on top of the trunnion bracket and under the control valve. Secure front end of plywood or plate to swing cylinder rods.
5. Disconnect hoses and tubes at control valve. Loosen tube clamps as required and place tubes out of way so control valve can be removed through opening in the main frame. Cap or plug hoses and tubes.
6. Remove control valve mounting nuts, washers and bolts and remove control valve from main frame.

Disassembly of Control Valve

1. Cap control valve fittings and remove accumulated dirt from valve if this has not been done.
2. Place control valve on a clean work surface. Starting at the inlet section, number the working sections to assure proper assembly.
3. Remove nuts from tie bolts and remove valve sections. Remove and discard all O-rings and keep shims for use during assembly.

Disassembly and Assembly of Outlet Section

1. Refer to Figure 12 and remove regeneration spool plug.
2. Remove spring, regeneration spool and piston. The spool is held by the fit of an O-ring.
3. Remove O-ring from groove in spool bore and plug, and discard.
4. If spring testing equipment is available, check spring against specification on page 4107-3. Also check spring for distortion and signs of cracking. Replace spring if either condition is evident or it does not meet the specification.
5. Check spool and piston for nicks and burrs that may cause them to stick in their bores. Use crocus cloth to remove defects.
6. Install new O-ring on plug and in groove in spool bore.
7. Install piston and regeneration spool in outlet section. Place spring in spool and secure parts in place with plug.

Disassembly and Assembly of Inlet Section

1. Refer to Figure 12 and remove check valve plug. Then remove spring and poppet.
2. Inspect poppet seat in the inlet section. The seat is pressed into the inlet section; do not attempt to remove unless it is to be replaced. Minor defects can be removed using lapping compound. Clean inlet section thoroughly to be sure all traces of grit has been removed.
3. To replace the valve seat:
   a. Place the valve section on a drill press. The section must be secured in a suitable fixture.

b. Use a 21/32" (16.7 mm) drill and drill the length 11/32" (8.7 mm) of the seat.

NOTE: Use care when drilling. If the bore in which the seat is installed is damaged in any way, the valve section must be replaced.

c. After drilling, a thin shell will remain. Remove this shell and wash the valve section in cleaning solvent. Be absolutely certain that all traces of metal are removed.

d. Press the new seat, chamfered end first, into the bore until it bottoms.

4. Check spring for distortion and signs of cracking. If spring testing equipment is available, check spring against specification on page 4107-3.

5. Install new O-ring on plug and place poppet and spring in valve section. Secure parts in place with plug.

Disassembly of Working Sections

NOTE: If more than one section is to be disassembled, identify the parts as they are removed to assure they will install in the proper section during assembly.

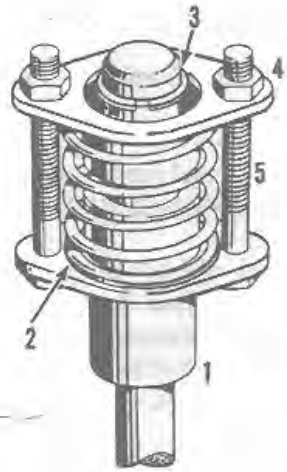
1. Refer to Figure 13 or 14 and unscrew spring cap. The cap is torqued to 20-30 foot-pounds (27-41 N m).

2. Grasp centering spring and pull spool from valve section.

3. Remove the wiper and O-ring from top of spool bore, and O-ring from bottom of bore if it was not removed with the spool.

4. Remove the centering as shown in Figure 9. Compress spring with shop-made plates or Case supplied retainer plates, Figure 9. Remove snap ring, release spring tension and remove parts from spool.

5. Remove the secondary relief valve cartridges. The cartridges are torqued to 65-85 foot-pounds (85-115 N m). If disassembling the boom section, mark relief valve in top of boom section to assure proper assembly.



1. SPOOL
2. SPRING
3. SNAP RING
4. D26830 RETAINER PLATE OR SHOP MADE PLATES
5. BOLT AND NUT

Figure 9 - Removing Centering Spring

6. Using the tool illustrated in Figure 2, remove the load check valve plug. Place tool in slot and twist to engage notches in plug. Pull straight up to remove. The plug is held by the fit of the O-ring.

1. SHOP MADE TOOL
2. CHECK VALVE PLUG
3. O-RING

Figure 10 - Check Valve Plug Removal

7. Remove the load check valves and springs. The parts will fall out of the valve.

8. Swing section only: Refer to Figure 14 and remove the two plugs on the rear. Remove the anticavitation valves and springs.

Inspection of Working Sections

1. Discard all O-rings and replace with new parts.

2. Clean parts in cleaning solvent and dry with moisture free compressed air.

3. Inspect the spool and spool bore for scoring or other defects that would result in excessive spool leakage. If the spool or its bore is defective, the entire section must be replaced.

4. Inspect the machined surfaces of the valve sections for burrs and nicks. Use a flat India stone and remove any nicks or burrs, Figure 11. Move the stone in a circular motion and keep it flat at all times. Do not stone a section that has not been completely disassembled. Thoroughly wash the valve section in cleaning solvent to remove all traces of grit.

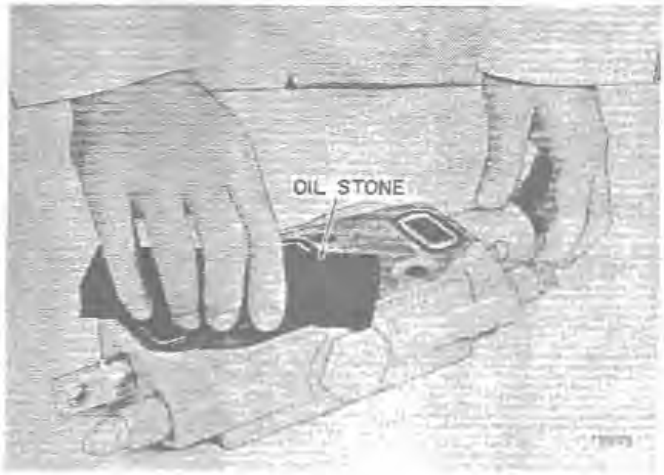


Figure 11 - Stoning a Valve Section

5. Check springs for distortion and signs of cracking. Replace if either condition is evident. If spring testing equipment is available, check all springs against specifications on page 4107-2.

Assembly of Working Sections

1. Refer to Figure 13 or 14. Install new O-rings on load check valve plugs and lubricate with clean hydraulic oil. Hold the valve section upright and install a load check valve and spring. Place check valve plug on special tool and install plug. Push plug down until it bottoms. Then position plug so slot points toward the spool. Install the remaining valve, spring and plug in the same manner.

2. Install the secondary relief valve cartridges using new O-rings and torque to 65-85 foot-pounds (85-115 N m). If assembling the boom section, make sure the relief valve stamped 1000 or marked during disassembly is installed in the top of the valve section.

3. Install new O-ring in groove at top of spool bore. Then press or drive in wiper, lip to the outside, in recess at top of spool bore until it bottoms.

4. Place new O-ring and the O-ring retainer on spring end of spool. Secure spool in a soft jawed vise and place centering spring and spring guides on spool. Compress spring as instructed under disassembly and secure parts in place with snap ring.

5. Lubricate spool and spool bore with clean hydraulic oil and install spool from bottom of valve section.

6. Install spring cap and torque to 20-30 foot-pounds (27-41 N m).

7. Swing section only: Refer to Figure 14 and place anticavitation valves and springs in bores on rear of valve. Install new O-rings on plugs and install plugs.

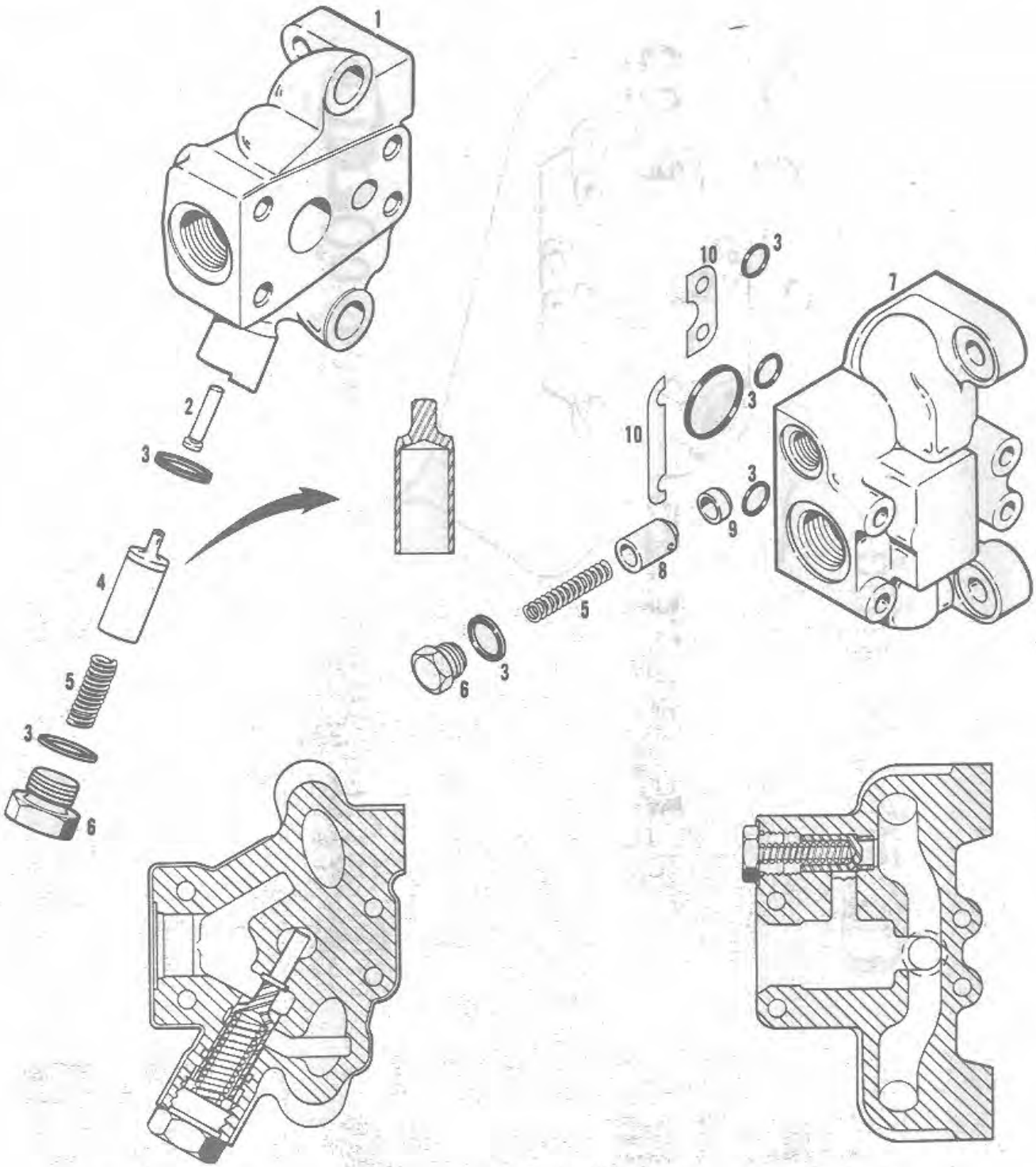
Assembling Control Valve

1. Place a small amount of clean grease in the O-ring recesses (4) in each valve section. Then place new O-rings in each recess.

2. Install the four tie bolts in the inlet section. Then place inlet section on bench with tie bolts up.

3. Install the working sections in the sequence established during disassembly. Make sure shims used between the valve sections are in place before the next section is installed.

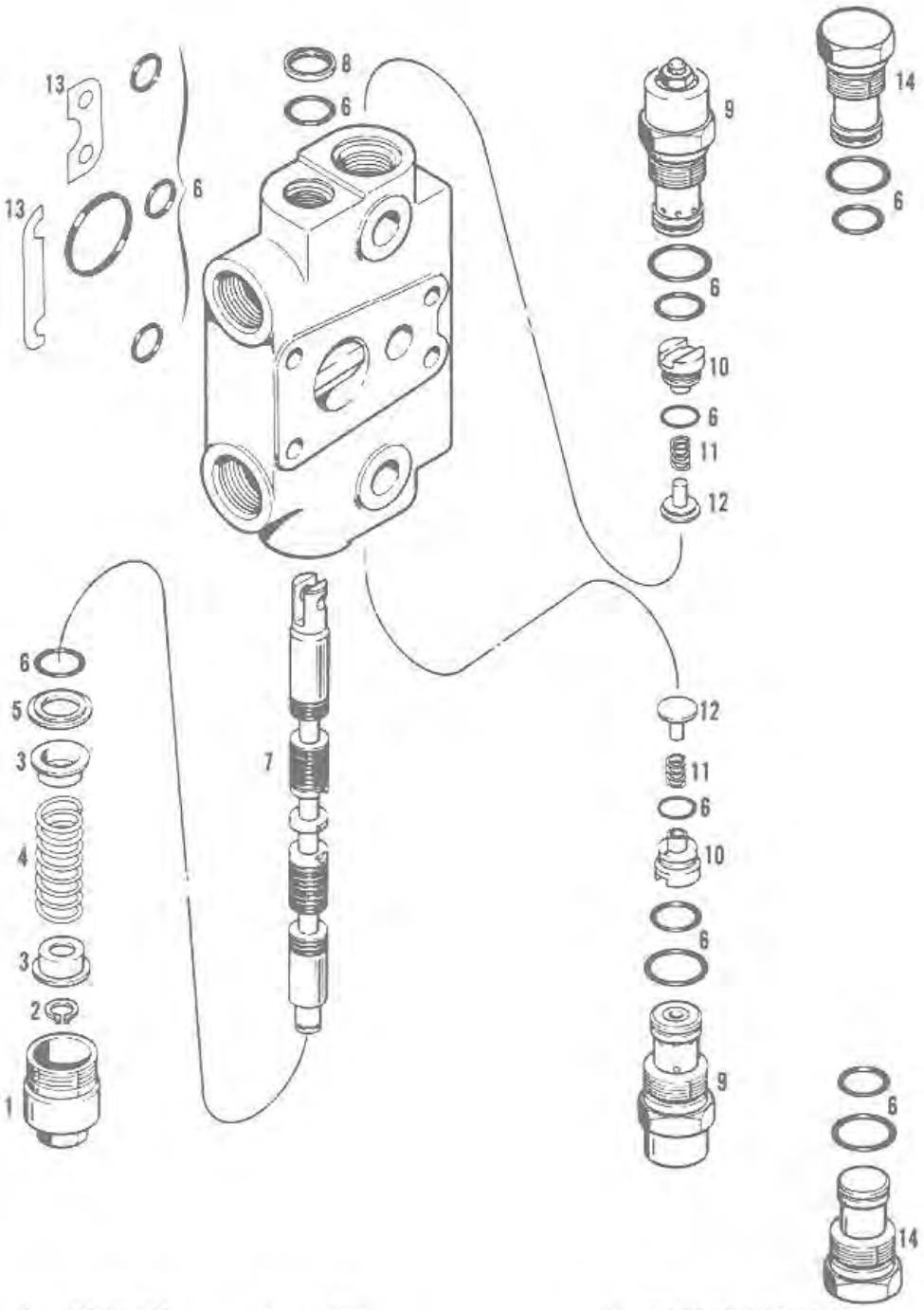
Continued on page 4107-22



1. OUTLET SECTION
2. SENSING PISTON
3. O-RING
4. REGENERATION SPOOL
5. SPRING
6. PLUG
7. INLET SECTION
8. POPPET
9. POPPET SEAT (REFER TO DISASSEMBLY AND ASSEMBLY OF INLET SECTION)
10. SHIM

751596

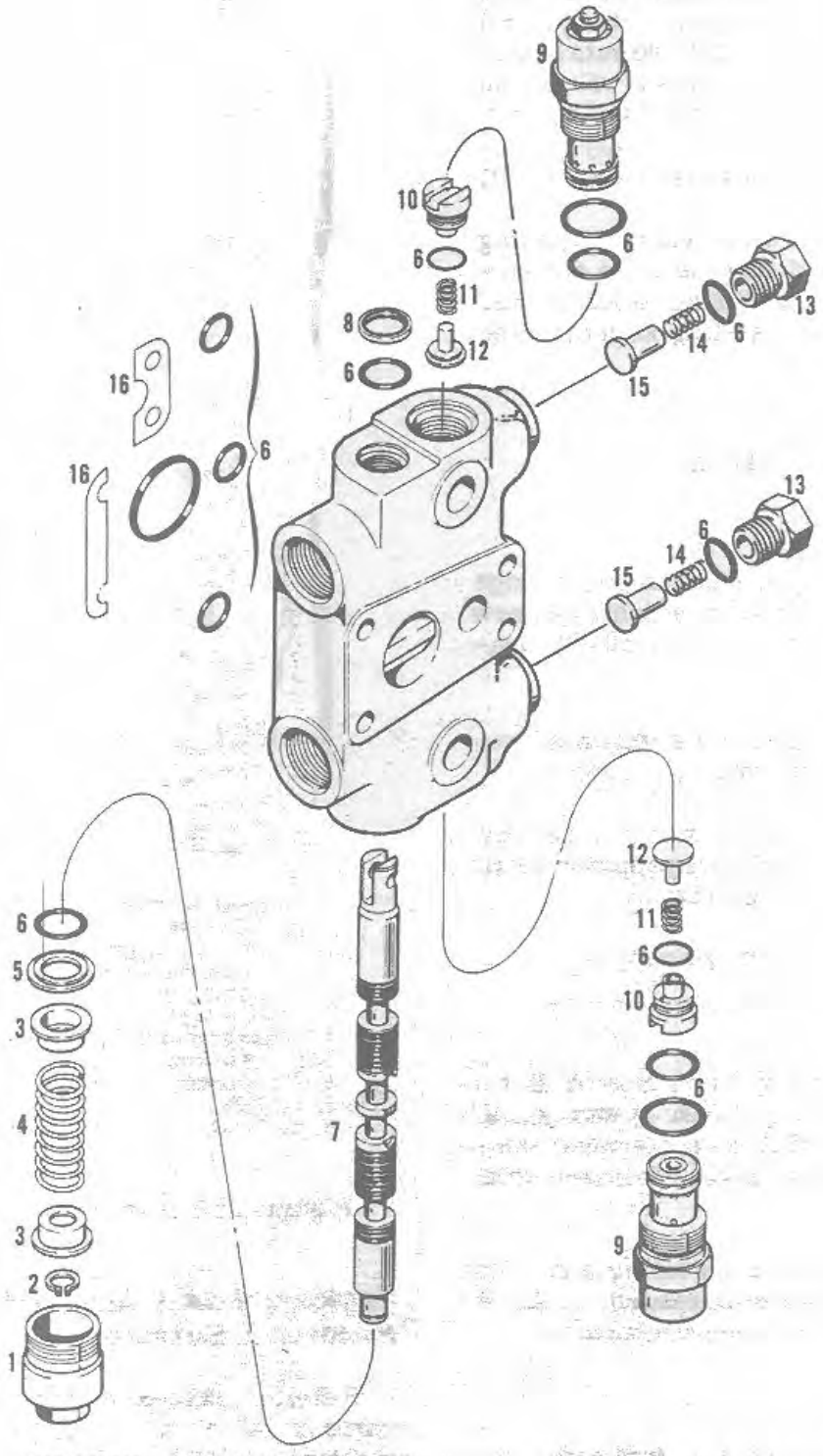
Figure 12 - Inlet and Outlet Sections



1. SPRING CAP
2. SNAP RING
3. SPRING GUIDE
4. SPRING
5. RETAINER
6. O-RING
7. SPOOL
8. WIPER
9. SECONDARY RELIEF VALVE
10. CHECK VALVE PLUG
11. CHECK VALVE SPRING
12. CHECK VALVE
13. SHIM
14. PLUG (USED ON EXTENSION SECTION ONLY)

751597

Figure 13 - Boom, Dipper, Bucket and Extension Valve Sections



1. SPRING CAP
2. SNAP RING
3. SPRING GUIDE
4. SPRING
5. RETAINER
6. O-RING
7. SPOOL
8. WIPER
9. SECONDARY RELIEF VALVE
10. CHECK VALVE PLUG
11. CHECK VALVE SPRING
12. CHECK VALVE
13. PLUG
14. ANTICAVITATION VALVE SPRING
15. ANTICAVITATION VALVE POPPET
16. SHIM

751598

Figure 14 - Swing Section

4. Install the outlet section and screw nuts on tie bolts finger tight. Lay control valve on bench and torque the nuts evenly to 20-30 foot-pounds (27-41 N m) in increments of 10 foot-pounds (13 N m). If the nuts are tightened unevenly or over tightened, binding spools may result.

5. If a secondary relief valve adjusting screw has been disturbed or a new relief valve has been installed, check and adjust the pressure setting as instructed in Section 4002.

Secondary Relief Valve

Disassembly

1. Refer to Figure 15. Place the cartridge in a vise and remove the adjusting screw lock nut. Nut is torqued to 50-80 inch-pounds (6-9 N m).

2. Remove snap ring. Note number of exposed threads on adjusting screw.

3. The remaining parts now can be easily removed. The piston and poppet may be held by the fit of the O-ring.

4. Remove and discard O-rings.

Inspection

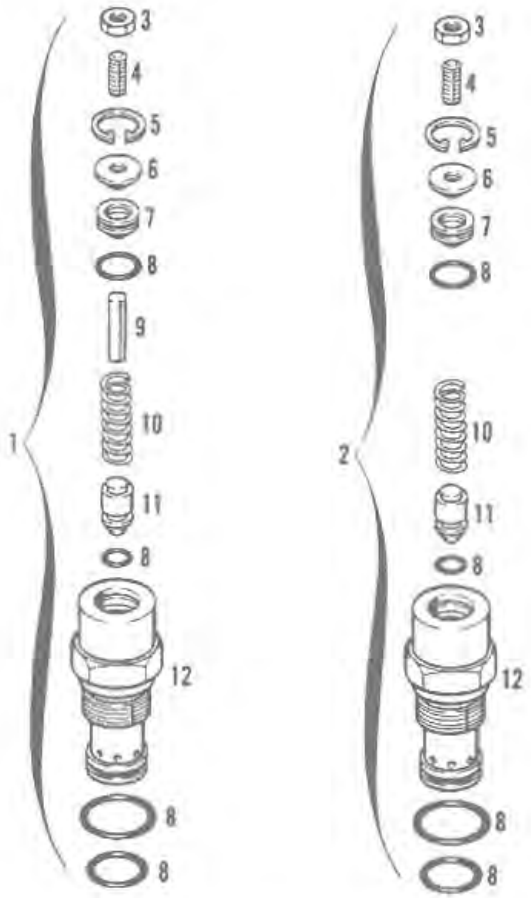
1. Inspect the spring for signs of distortion and cracking. Check spring on a spring tester--if it does not meet specifications on page 4107-3, replace with a new spring.

2. Inspect poppet and its seating surface. If seating surface is damaged, the entire relief valve must be replaced.

Assembly

1. Assemble parts in the order shown in Figure 15. Assemble adjusting screw in approximate position noted during removal.

2. Install cartridge in valve section and torque to 65-85 foot-pounds (88-115 N m).



1. USED IN SWING SECTION A AND B PORTS, AND BOOM SECTION A PORT.
2. USED IN BUCKET AND DIPPER SECTION A AND B PORTS, AND BOOM SECTION B PORT
3. LOCK NUT. TORQUE TO 50-80 INCH-POUNDS (5.6-9 N m).
4. ADJUSTING SCREW
5. SNAP RING
6. RETAINER
7. PISTON
8. O-RING
9. STOP PIN
10. SPRING
11. POPPET
12. CARTRIDGE

751601

Figure 15 - Secondary Relief Valves

Checking and Adjusting Pressure Setting

Relief valves can be checked with the control valve on or off the machine. Refer to Section 4002.

NOTE: A nominal setting is stamped on the cartridge. This setting is not to be used for those relief valves tested with a hand pump. Specifications and instructions are given in Section 4002.

Installation

NOTE: The control valve weighs approximately 95 pounds (43 kg). Use care when handling the valve to prevent personal injury or damage to the valve.

1. Position valve against mounting plate and secure in place with bolts, washers and nuts. Be sure flat washers are installed between the valve and mounting plate.
2. Connect control linkage to valve spools.
3. Connect hoses and tubes to control valve.

If fitting was removed from bottom port in the boom section or a new section was installed, make sure restrictor is installed in the bottom port, large diameter first. Torque fittings to specifications in Section 1050.

4. Start engine and run at low idle. Operate all cylinders through several complete cycles to bleed air from the control valve and hydraulic circuits. Do not bottom the cylinders in either direction during the first two cycles. Stop engine and check for oil leaks. Check reservoir oil level and add oil as required.

Section 4109

STABILIZER CONTROL VALVE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

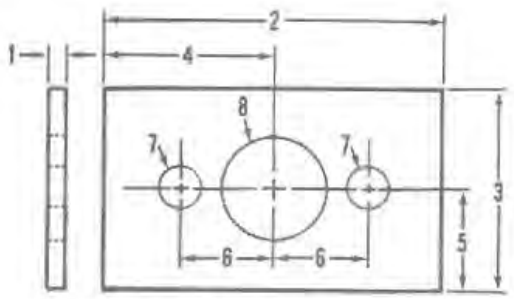
PRINTED IN U.S.A.

SPECIFICATIONS

Ports and spools		
Spool travel, neutral to pressure		5/16" (7.9 mm) in and out
Spool moved in		Upper work port pressurized
Spool moved out		Lower work port pressurized
Port thread		
Inlet and power beyond ports		1-1/16" - 12
Work ports and outlet port		7/8" - 14
Springs	Free Length	Compressed Length
Spool centering	15/16" (23.8 mm)	.687" at 26.1 to 31.9 lbs. (17.4 mm at 11.8 to 14.4 kg)
Check valve	1.083" (27.5 mm)	.750" at .4 to .6 lbs. (19 mm at 0.18 to 0.27 kg)
Spool cap torque		35-40 foot-pounds (47-54 N m)
Plug		35-40 foot-pounds (47-54 N m)

Special Tool

Make two plates to dimensions in Figure 1 to compress the spool centering springs whenever a spring is removed or installed.



MAKE FROM COLD ROLLED STEEL
MAKE TWO PIECES

1. 1/8" (3.2 mm)
2. 2-1/2" (63.5 mm)
3. 1-1/2" (38.1 mm)
4. 1-1/4" (31.8 mm)
5. 3/4" (19.1 mm)
6. 11/16" (17.5 mm)
7. 5/16" DIA. (7.9 mm)
8. 13/16" (20.6 mm) TOP PLATE
8. 11/16" (17.5 mm) BOTTOM PLATE

751567

Figure 1 - Spring Compressor Plate

Operation

This open center control valve contains two spools and two check valves with plunger. Each spool and check valve controls a stabilizer cylinder.

Oil flow through the valve with spools in neutral and with one spool actuated is shown in Figures 2 and 3.

Note that when a spool is actuated, Figure 3, flow of oil through the valve to the backhoe is blocked by the spool. However, because the spools in the stabilizer valve are a random fit, some oil will flow past one or both spools in some valves. Because of valve design, both stabilizers can be moved at the same time.

The check valves are located at the bottom work ports. When the stabilizers are lowered and the spools are in Neutral (usual operating condition) the poppets are held on their seats, locking oil in the closed end of the cylinders. This prevents the backhoe from settling.

To allow the flow of return oil through the check valve when the cylinder is being retracted (stabilizer raised), the poppet is held off the seat by the plunger which is moved by pressurized oil at the upper work port. See Figure 3.

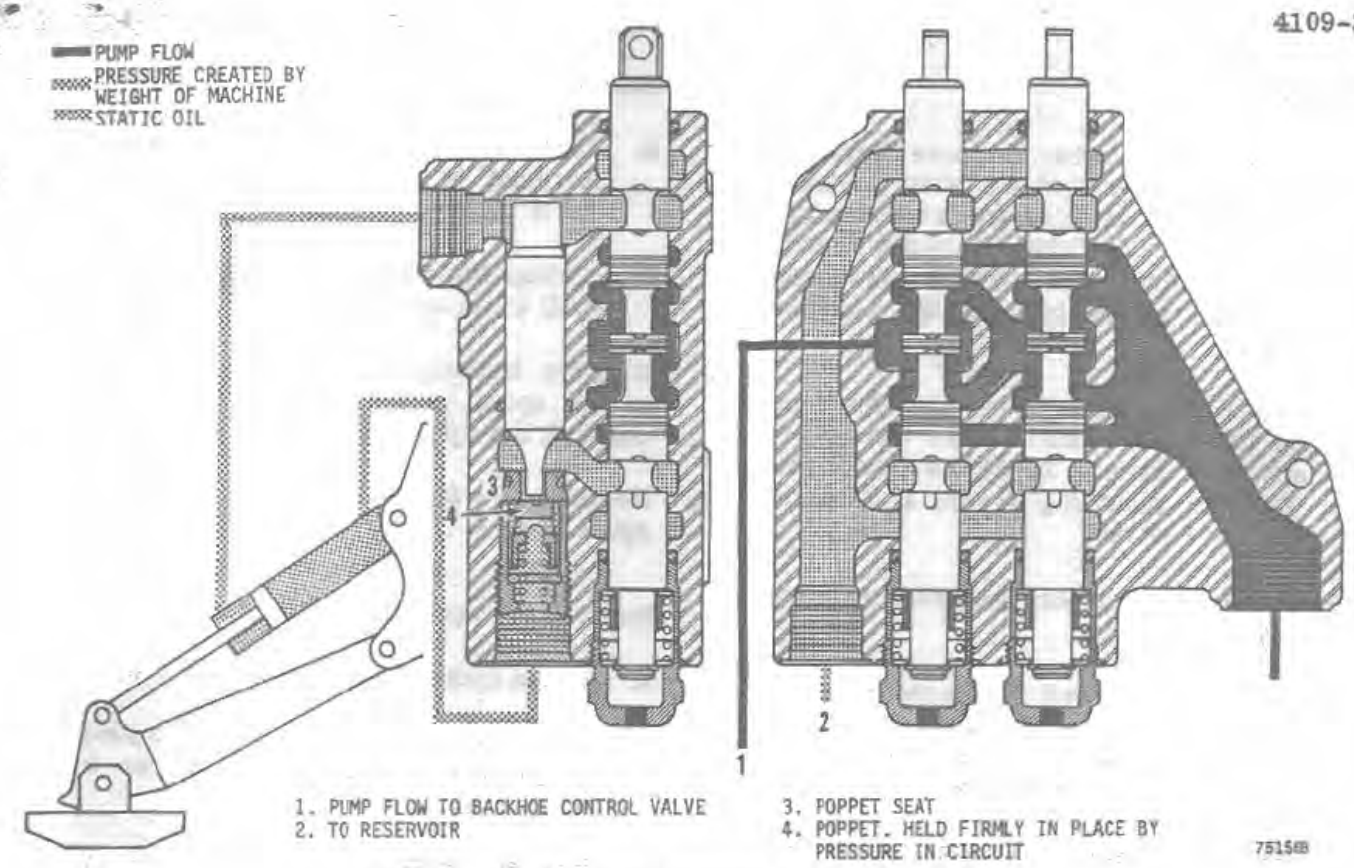


Figure 2 - Spool in Neutral, Stabilizers Down

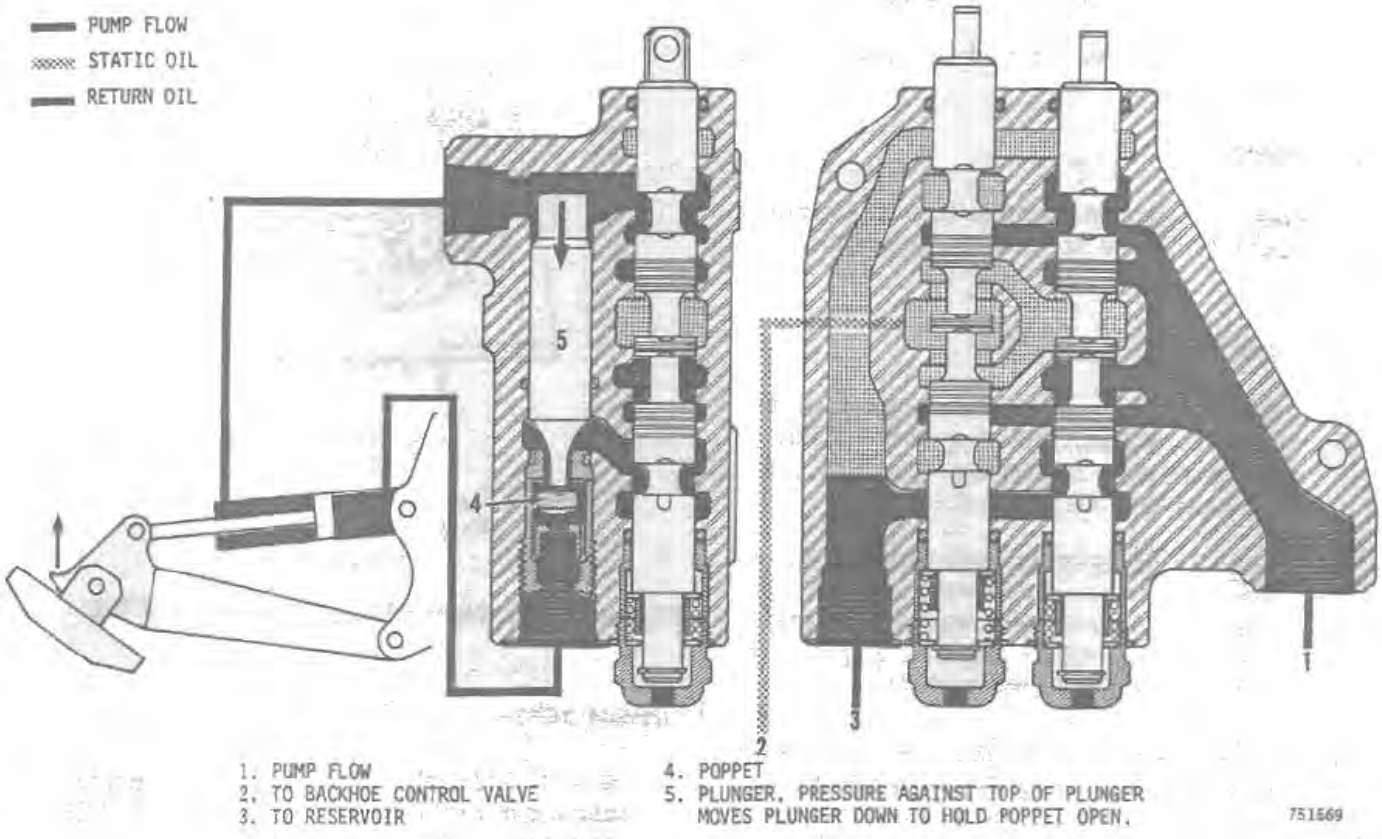


Figure 3 - Spool Actuated to Raise Stabilizer

Removal

1. Cab equipped models: Remove the backhoe from the tractor. All other models: Removal of the backhoe from the tractor will provide additional working space, but the control valve can be removed (with some difficulty) with the backhoe attached.

2. Lower the stabilizers to the floor or raise the stabilizers and tie the stabilizers together with heavy wire or chain, or blockup mounting frame if backhoe has been removed.

3. If the backhoe is not removed, remove the operator's seat.

4. With the engine shut off, move the stabilizer control levers in both directions to equalize circuit pressure. Then disconnect linkage from the spools.

5. Disconnect hoses and tubes from the control valve and close openings with clean caplugs. Then remove the nuts and washers from the mounting bolts.

6. Remove control valve and spacer from mounting plate.

Disassembly

NOTE: Tag or otherwise identify parts as they are removed to assure proper assembly.

1. Remove the check valves:

   a. Remove the check valve plug. The plug is staked and may be difficult to remove. Squirting oil on the threads will be helpful.

   b. With the plug removed, the remaining parts in the check valve assembly should be easily removed. Reach into the plunger bore with a piece of wire and remove the seat.

   c. To remove O-ring from plunger bores, use a long sharp pointed instrument. Refer to Figure 5 for O-ring location.

2. Remove the spools:

   a. Unscrew the spool cap. Cap is torqued to 35-40 foot-pounds (47-54 N m).

   b. Grasp the spool at the cap end and pull from bore.

3. Remove bushing and O-ring from cap end of spool bore (if they did not come out with the spool).

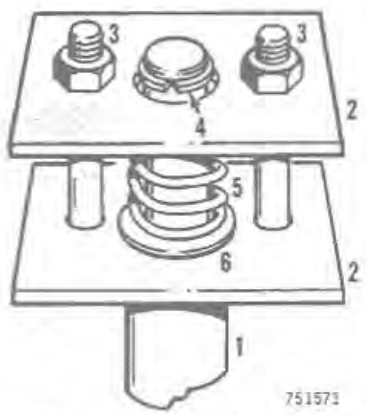
4. Remove O-ring from opposite end of spool bore.

5. Remove the spool centering spring:

   a. Place spool in a SOFT JAWED vise.

   b. Compress the spring using two shop made retainer plates as shown in Figure 4.

   c. Remove snap ring. Release spring, then remove washers, spacer, and centering spring.

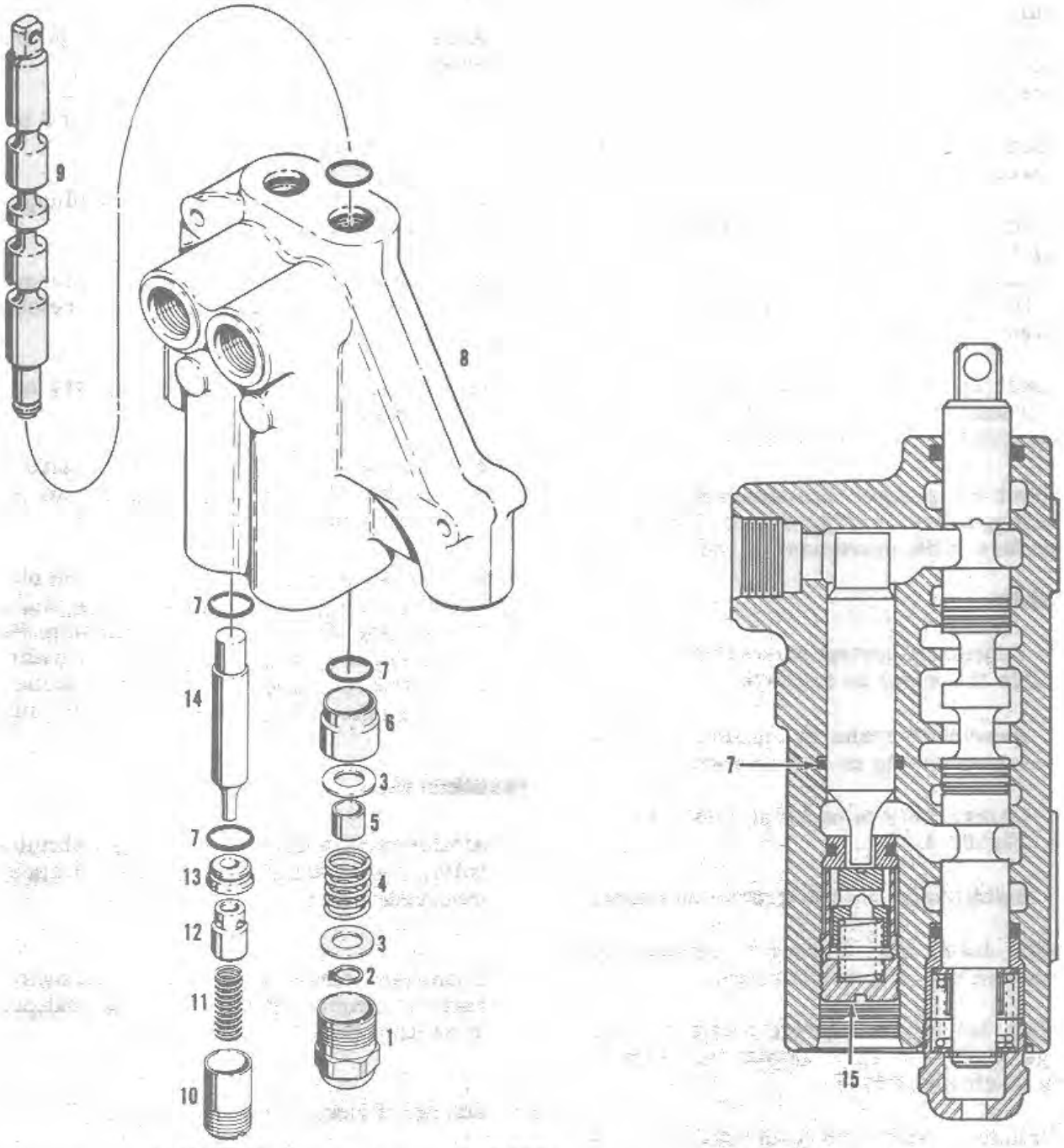


1. SPOOL
2. COMPRESSOR PLATE
3. BOLT AND NUT
4. SNAP RING
5. SPRING
6. WASHER

Figure 4 - Compressing Centering Spring

Inspection

1. Discard O-rings. Clean all other parts in cleaning solvent. Dry with moisture free compressed air.



1. SPOOL CAP
2. SNAP RING
3. WASHER
4. CENTERING SPRING
5. SPACER
6. BUSHING
7. O-RING
8. BODY
9. SPOOL
10. PLUG
11. POPPET SPRING
12. POPPET
13. SEAT
14. PLUNGER
15. STAKE PLUG IN FOUR PLACES

751570

Figure 5 - Control Valve

2. Inspect the spools and spool bores for scoring and other defects that would result in excessive spool leakage. If inspection indicates replacement of a spool or the valve body, the complete valve must be replaced.

3. Inspect the check valve poppets and seats for wear and replace if necessary.

4. Inspect the check valve plug threads and plug threads in the valve body. Clean up threads if damage is present. Be sure all traces of metal particles are removed from the valve body.

5. Inspect springs for distortion and signs of cracking. Check spring tension; see page 4109-2 for specifications.

6. Inspect the plunger and plunger bore for scoring, burrs or other defects that could interfere with movement of the plunger.

Assembly

1. If a centering spring was removed, assemble the spool as follows:

   a. Assemble washers, spacer, and centering spring on end of spool.

   b. Compress the spring as shown in Figure 4.

   c. Install snap ring in groove on spool.

2. Install lubricated O-ring in groove at spool eye end of spool bores.

3. Install bushing on spring end of spool, large O.D. toward spring. Then install new O-ring on spool.

4. Lubricate spool with hydraulic oil and slide the spool into its bore. Install spool in its original bore--do not intermix.

5. Lubricate parts attached to spool with Lubriplate.

6. Install spool cap and torque to 35-40 foot-pounds (47-54 N m).

7. Assemble and install the parts in the check valve assembly as follows:

   a. Lubricate the plunger bore and install a new O-ring.

   b. Lubricate and install the plunger carefully into the bore.

   c. Install a new O-ring on the plunger seat and install the seat carefully into the bore.

   d. Lubricate the remaining parts and install.

   e. Screw the plug into the bore until it seats. Torque the plug 35 to 40 foot-pounds (47-54 N m).

   f. Using a sharp punch, stake the plug in four places to lock into place. Check the plug by reversing the torque. If the plug turns out before 30 foot-pounds (41 N m) is reached, restake the bottom of the plug.

Installation

1. Attach valve to mounting plates with nuts, bolts, and washers. Use spacer at upper mounting bolt.

2. Connect hoses and tubes to the control valve. Torque fittings to specifications in Section 1051.

3. Connect linkage to valve spools.

4. Install backhoe on tractor, if removed.

5. Start the engine and move the stabilizers through several cycles to remove any trapped air and to check for leaks.

Section 4121

BOOM LOCK SYSTEM

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

OPERATION

General

The optional boom lock system improves the craning or load handling capacity of the backhoe. The system consists of the control valve with relief valve and the necessary hoses and tubes to connect it into the boom circuit.

When the control valve handle is in the Closed position, the 2750 psi (18 960 kPa) relief valve at the bottom port of the boom section is locked out of the boom cylinder circuit.

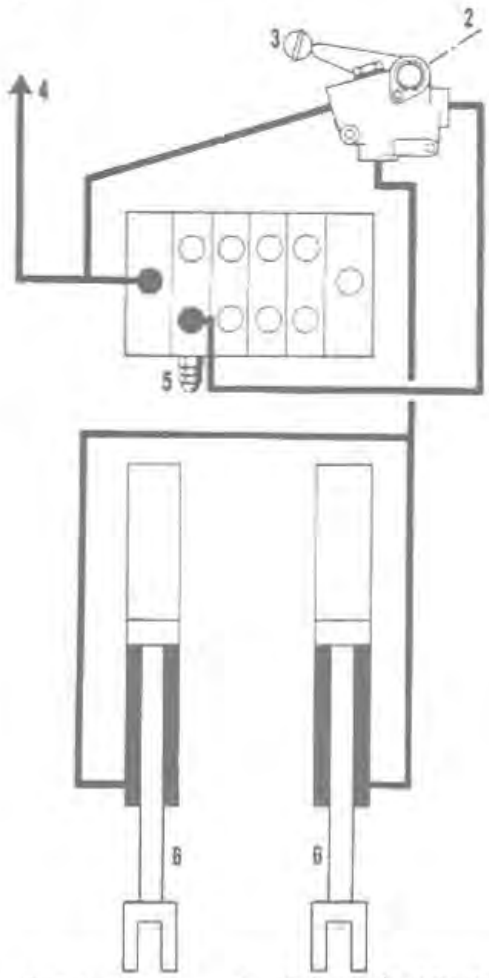


Figure 1 - Boom Lockout Hydraulic Diagram

The relief valve in the boom lock control valve is set to relieve at 3400 psi (23 442 kPa). This higher pressure setting allows movement of heavier loads. In addition, the boom cannot settle due to leakage past the boom spool (all spools leak slightly due to valve clearances).

The boom cannot be lowered hydraulically with the control valve in the Lock position.

The boom can be raised hydraulically with the control valve in the Lock position if pressure in the boom circuit is below setting of main relief valve.

Refer to Figure 2. The center of the control valve shaft is eccentric. When the lever is moved to the Closed position, this eccentricity allows the poppet spring to seat the poppet against its seat in the valve body. When the load pulls down on the boom, oil between the boom cylinders and the control valve is blocked by the seated poppet. The heavier the load, the more firmly the poppet is seated.

If pressure in the locked circuit reaches 3400 psi (23 442 kPa), the relief valve will open and vent oil to the reservoir.

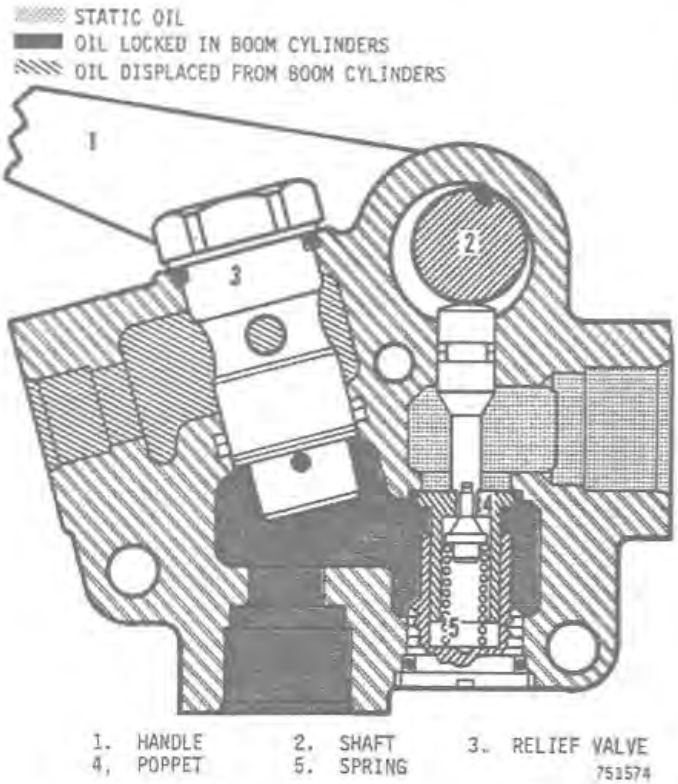


Figure 2

CONTROL VALVE

Removal

1. Completely retract the dipper and lower boom until bucket is resting on the floor.
2. With the engine shut off, move the boom control lever in both directions to equalize circuit pressure.
3. Remove lower front panel from the control tower.
4. Remove the control valve mounting bolts and remove top panel from control tower.
5. Disconnect tubes and hose from valve fittings and remove valve. Close all openings with cap or plug as required.

Disassembly

1. Remove plug from bottom of valve. The spring, spring seat and poppet should be removed with the plug. If not, the parts are loose and will fall out.
2. Through the plug opening, grasp end of plunger with needle nose pliers and pull plunger from valve. The plunger is held in the valve by the fit of the O-ring.

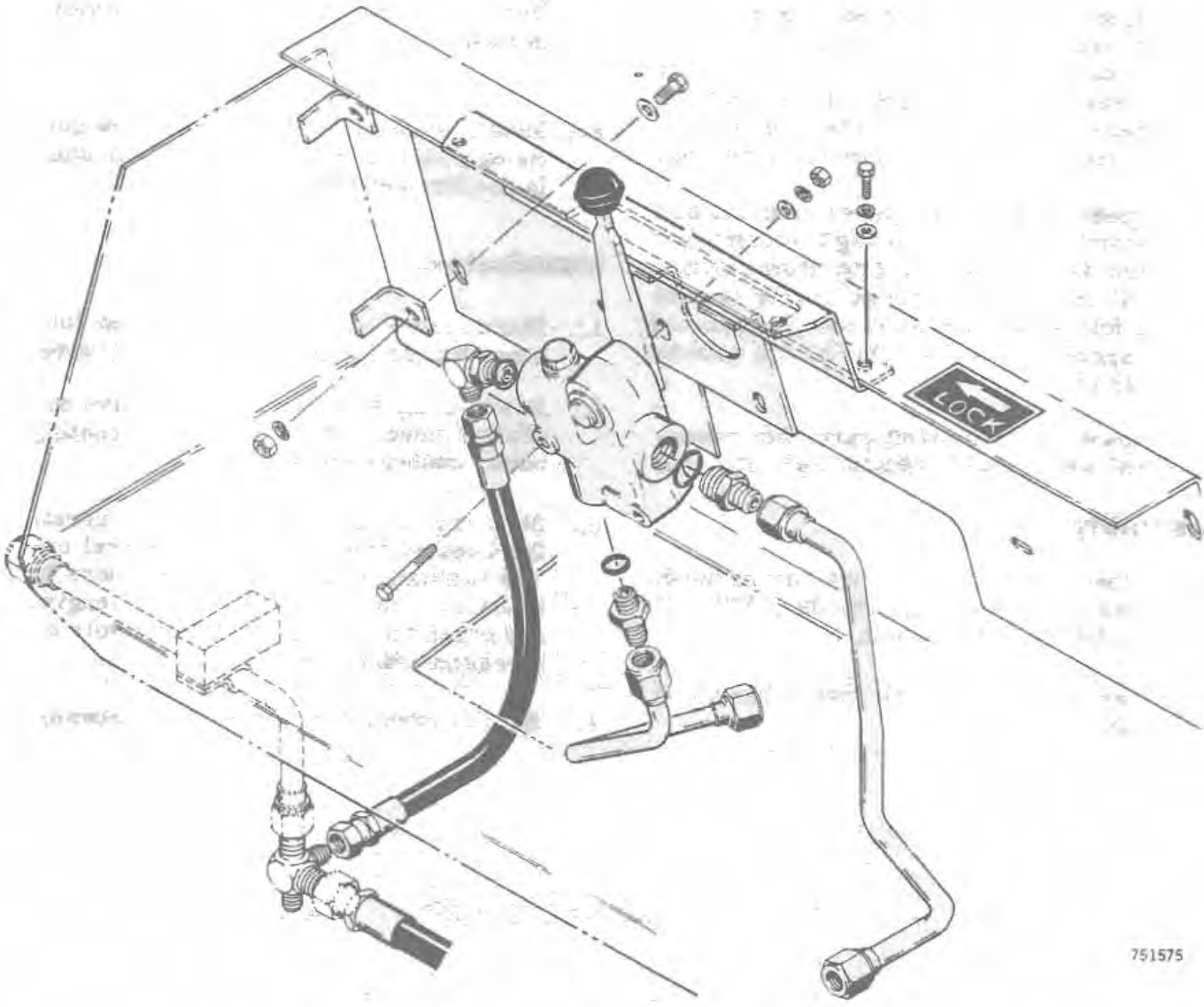


Figure 3 - Lockout Control Valve Installation

3. Remove relief valve. The relief valve is nonadjustable and nonrepairable; DO NOT attempt to disassemble the relief valve.

4. Remove screw from spring clip, and snap ring from end of shaft. Then pull shaft from body.

5. Remove all O-rings and backup rings and discard.

Inspection

1. Clean all parts in cleaning solvent and dry with moisture free compressed air or allow to air dry.

2. Inspect the seating surface on the poppet and its mating surface in the body for damage or wear that would result in leakage. The poppet can be replaced separately. If seat in body is defective, the complete valve must be replaced.

3. Inspect spring for signs of cracking and distortion. Replace spring if either condition is present. If spring testing equipment is available, check spring against the following specification: spring should compress to 1" (25 mm) at 2.2 pounds (0.99 kg).

4. Inspect the remaining parts for excessive wear and replace as required.

Assembly

1. If the shaft or pin must be replaced, press pin in until it extends .187" (4.7 mm) beyond end of shaft.

2. Refer to Figure 4 and install handle on shaft.

3. Lubricate shaft and shaft bore with Lubriplate or other suitable lubricant. Secure shaft in place with snap ring.

4. Install new O-ring and backup ring on plunger. Grasp end of plunger with needle nose pliers and start plunger into bore in the body. Then push plunger into contact with the shaft.

5. Install new O-ring on plug.

6. Place spring seat and spring in poppet. Then slide plug over poppet. Install this assembly in body.

7. Install new O-ring and backup ring in groove in relief valve bore. Install new O-ring on relief valve and install valve in body.

8. Install spring clip. Tighten screw just enough so spring clip will hold shaft in position selected.

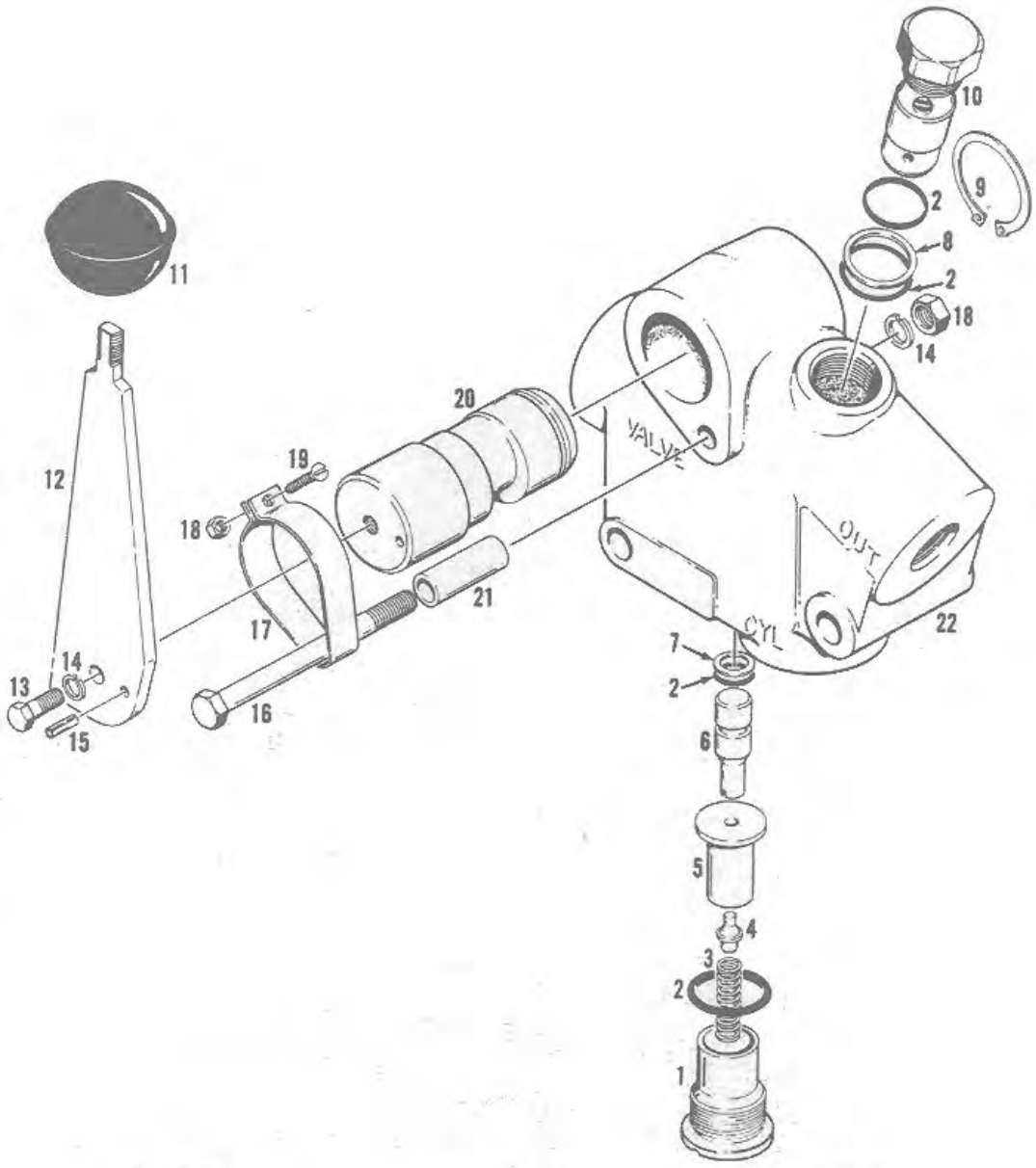
Installation

1. Place valve in tubes and tighten tube connections. Then connect hose to valve.

2. Position top panel on control valve and control tower and install valve mounting bolts, washers and nuts.

3. Start engine and run at low idle. Operate the boom cylinders through several cycles without bottoming the cylinders to bleed air from the circuit. Stop engine and check for leaks. Check reservoir oil level and add as required.

4. Install lower front panel on control tower.



1. PLUG
2. O-RING
3. SPRING
4. SPRING SEAT
5. POPPET
6. PLUNGER
7. BACKUP RING
8. RUBBER BACKUP RING
9. SNAP RING
10. RELIEF VALVE
11. KNOB
12. HANDLE
13. CAP SCREW
14. LOCK WASHER
15. PIN
16. BOLT
17. SPRING CLIP
18. NUT
19. SCREW
20. SHAFT
21. SPACER
22. BODY

751576

Figure 4 - Lockout Valve

Section 5002

HYDRAULIC DIAGRAM, TROUBLE SHOOTING AND PRESSURE CHECK

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

SPECIFICATIONS

Rated pump output	6.7 U.S. gpm at 1800 psi at full throttle (25 l/min at 12 410 kPa at full throttle)
Reservoir capacity	1 U.S. quart (0.9 liter)
System capacity	3 U.S. quarts (2.8 liters)
Type of oil	Case TCH Fluid
Relief valve pressure setting	2000 ± 100 psi at full throttle (13 789 ± 689 kPa at full throttle)

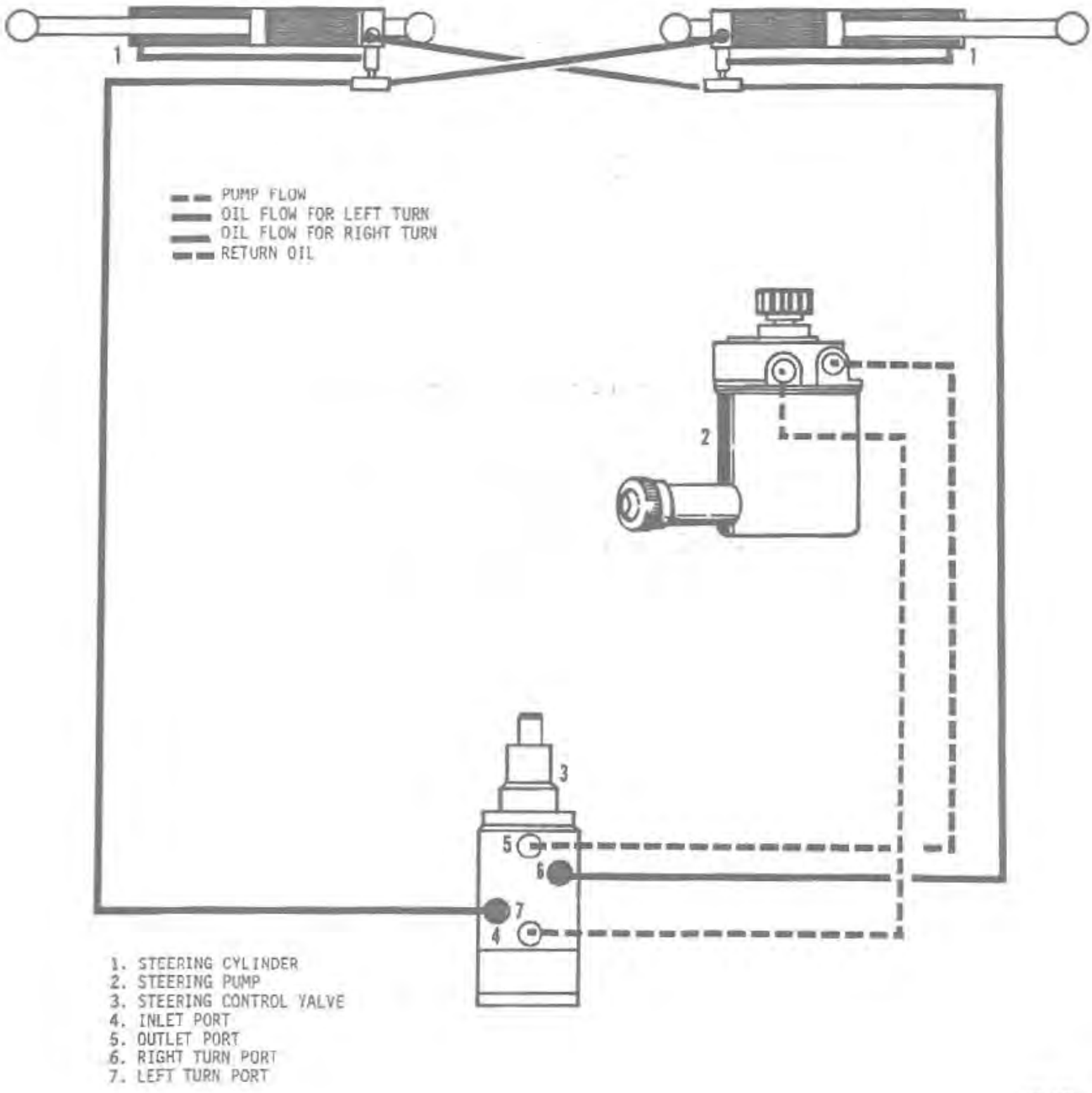


Figure 1 - Steering Hydraulic Diagram

TROUBLE SHOOTING CHART

PROBLEM	POSSIBLE CAUSE	REMEDY
Steering wheel turns freely, no response	Low reservoir oil level.	Fill to proper level with Case TCH Fluid.
	Recirculation valve in steering control valve not seating.	Remove plug and steel ball and check for damage and foreign material that would prevent ball from seating.
	Worn or damaged parts in steering control valve.	Remove valve, disassemble and inspect all parts. Refer to Section 5007.
	Leaking piston O-ring in a steering cylinder.	Check each cylinder for leakage. Turn wheels all the way to the right and disconnect hose at rod end of left cylinder. Start engine, hold steering wheel for full right turn and have someone observe leakage from left cylinder. Turn wheels all the way to the left and disconnect hose at rod end of right cylinder. Start engine, hold steering wheel for full left turn and have someone observe leakage from right cylinder. Remove cylinder(s) and repair as required.
Steering wheel turns hard, no response	Low reservoir oil level.	Fill to proper level with Case TCH Fluid.
	Steering pump failure.	Check relief valve pressure setting as instructed in this section. Low pressure indicates a bad relief valve or worn pump. Disassemble pump and repair as required.
	Improper connections in cylinder circuits.	Check connections against diagram.
	Worn or damaged parts in steering control valve.	Remove valve, disassemble and inspect all parts. Refer to Section 5007.
Slow or hard steering	Low reservoir oil level.	Fill reservoir to proper level with Case TCH Fluid.
	Worn or damaged parts in steering control valve.	Remove valve, disassemble and inspect all parts. Refer to Section 5007.

PROBLEM	POSSIBLE CAUSE	REMEDY
Slow or hard steering (cont'd)	Low system pressure.	Check pressure setting of relief valve. If setting is not as specified, remove steering pump and replace relief valve. Refer to Section 5005.
	King pins binding.	Lubricate king pins according to maintenance schedule.
	Low tire pressure.	Inflate to specified pressure.
Touchy or erratic steering response	Air in steering circuit.	Bleed air from circuit.
	Dirt prevents proper action of spool in steering valve.	Remove valve, disassemble and clean and repair as required. Refer to Section 5007.

RELIEF VALVE PRESSURE CHECK

The following items are needed to perform the pressure check: (1) a 0-3000 psi (0-20 684 kPa) pressure gauge, (2) one swivel tee, part number 218-845 and (3) one tube cap, part number 218-755 drilled and tapped with 1/8 NPT threads.

1. Disconnect outlet (top) hose from the steering pump.
2. Install cap on tee and install tee between hose and pump fitting.
3. Connect pressure gauge to cap on tee.
4. Start engine and run at full throttle. Turn wheels all the way to the right or left and observe pressure gauge.
5. If pressure was not as specified on page 5002-2 the relief valve must be replaced. The valve is nonadjustable and nonrepairable. The relief valve is inside the steering pump; refer to Section 5005.

Section 5005

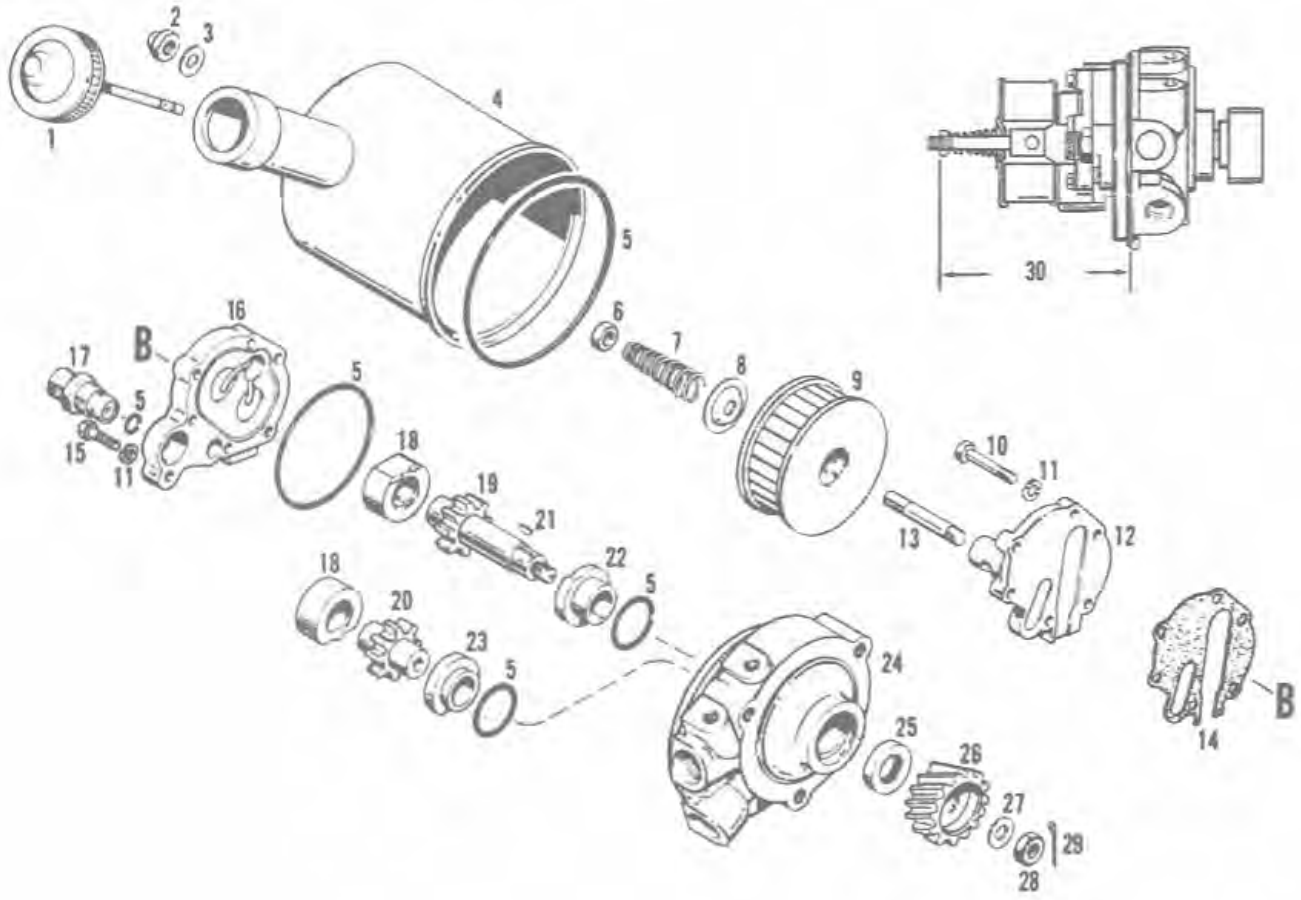
STEERING PUMP

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.



1. FILL CAP
2. ACORN NUT
3. COPPER WASHER
4. RESERVOIR
5. O-RING
6. NUT
7. SPRING
8. WASHER
9. FILTER
10. LONG CAP SCREW
11. LOCK WASHER
12. REAR COVER
13. STUD
14. GASKET
15. SHORT CAP SCREW
16. INTERMEDIATE COVER
17. RELIEF VALVE
18. REAR BEARING
19. DRIVE SHAFT
20. DRIVEN GEAR
21. WOODRUFF KEY
22. DRIVE SHAFT FRONT BEARING
23. DRIVEN GEAR FRONT BEARING
24. BODY
25. SEAL
26. GEAR
27. FLAT WASHER
28. HUG NUT
29. COTTER PIN
30. 4-15/16" (125.4 mm)

751572

Figure 1 – Steering Pump

STEERING PUMP

Removal

1. Disconnect hoses at pump and close all openings with clean caplugs.
2. The pump mounting cap screws are installed from the front through the timing gear cover. Unscrew the three cap screws and remove pump from engine.

Disassembly

1. Remove fill cap and drain reservoir. Then remove all accumulated dirt from pump and reservoir.
2. Make an alignment mark on the pump and reservoir. This must be done to assure the proper oil level after the pump is assembled.
3. Remove cotter pin from drive shaft. Then remove nut, washer, gear and Woodruff key from shaft.
4. Remove reservoir retaining nut, copper washer and reservoir.
5. Remove filter retaining nut, spring, washer and filter.
6. Remove the six rear cover retaining cap screws and the cap screw next to the relief valve.
7. Remove the rear cover and intermediate cover. Remove gasket and O-ring from covers.
8. Loosen relief valve lock nut and remove relief valve from intermediate cover.
9. Tap gear end of drive shaft with a soft hammer to remove the shaft and rear bearing from the body.
10. Remove driven gear rear bearing and gear from body.
11. Remove driven gear and drive shaft front bearings from the body.
12. Remove shaft seal from body only if it is to be replaced.

Assembly

1. If shaft seal was removed, clean seal bore in body and apply a light coat of No. 3 Permatex or equivalent to seal bore. Then press new seal into bore.
2. Install new O-rings on the driven gear and drive shaft front bearings.
3. The front bearings are a close fit in the body, but when properly lined up they will slide into place. Install the bearings at the same time with the flats together and the tapered surfaces up (toward gears). Do not force the bearings into place. Lubricating the bearings and bearing bore will aid in installation. Be sure bearing with the long sleeve is installed in the drive shaft bore.
4. Lubricate both gears and install them in the body. Use care not to damage the shaft seal.
5. Install the rear bearings in the same manner as the front bearings with the tapered bearing surfaces towards the gears.
6. Place new O-ring in groove in the intermediate cover. Use grease to hold O-ring in place if necessary.
7. Place new O-ring in groove in end of relief valve. Then install relief valve in intermediate cover so it extends through cover 7/16" (11 mm).
8. Secure the body in a vise and place intermediate cover on body. Then place a new gasket and the rear cover on the intermediate cover.
9. Install the six long cap screws in holes in rear cover and the short cap screw in the intermediate cover. Torque cap screws evenly to 9-11 foot-pounds (12-15 N m).
10. Torque relief valve to 10-12 foot-pounds (13-16 N m). Then torque lock nut to 18-20 foot-pounds (24-27 N m).
11. Install new filter and secure in place with washer, spring and nut. Screw nut onto

stud to obtain the dimension shown in Figure 1. The nut must be properly installed to prevent damage to the reservoir.

12. Install reservoir and align mark made during disassembly. Secure reservoir in place with copper washer and nut. Torque nut to 20-25 foot-pounds (27-34 N m).

13. Place Woodruff key in slot in drive shaft. Install gear and secure in place with washer and nut. After tightening nut, install new cotter pin.

Installation

1. Install new gasket on pump body and install pump on engine. Install cap screws and tighten.

2. Connect hoses to pump fittings.

3. Start engine and turn the steering wheel through several complete turns to bleed air from the steering circuits.

Section 5007

STEERING CONTROL VALVE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Wear Specifications

Commutator and commutator ring thickness difference	.0015" (0.038 mm) max.
Rotor and stator thickness difference	.002" (0.051 mm) max.
Rotor and stator clearance	.006" (0.152 mm) max.

Special Torques

Cover cap screws	18-22 foot-pounds (24-30 N m)
End plate cap screws	15-19 foot-pounds (20-26 N m)
Steering wheel nut	32-37 foot-pounds (43-50 N m)

OPERATION

General

Refer to Figure 5. The steering control valve consists of three major assemblies; the control section, control valve section and the metering section.

Control Valve Section

The control valve section contains a mechanically actuated linear, open center type spool. The spool is centered in the housing by the torsion bar.

The functions of the control valve section are:

1. Direct oil from the steering pump to the metering section (steering wheel turning) or to the outlet port (steering wheel at rest).
2. Receive oil from the metering section and direct it to the steering cylinders.
3. Direct return oil from the cylinders to the outlet.

Metering Section

The metering section consists of the gerotor (rotor and stator), commutator, commutator ring and manifold.

Due to design, it is impractical to present an illustration that would clearly show the flow of oil through the metering section.

The function of the commutator, commutator ring and manifold is to direct the flow of oil between the gerotor and control valve section. The commutator turns in unison with the steering wheel and rotor.

Controlling oil flow to the cylinders is the primary function of the gerotor. The gerotor consists of the stator (gear ring) and rotor (gear). The rotor has six lobes and the stator seven lobes. The rotor has one less lobe to form the pockets required to permit oil flow through the complete valve assembly. When the steering wheel is being turned, the rotor and commutator also turn, admitting oil to three expanding pockets, and discharging oil from three contracting (shrinking) pockets. The seventh pocket is inactive as it changes from discharging oil to admitting oil.

If the engine stops, and the steering wheel is turned, the gerotor then functions as a pump to permit continued steering of the machine. However, with a dead engine, steering effort is greatly increased. In case of a power failure the machine should be brought to a stop as quickly as possible.

Oil Flow, Right and Left Turn, Engine Running

1. As the steering wheel starts turning, several actions occur almost simultaneously:

   a. The spool starts to move into the valve (right turn) or out of the valve (left turn) allowing oil from the steering pump to charge the metering section.

   b. The rotor and commutator, which are connected to the input shaft through the drive link and torsion bar, resist turning because of cylinder pressure required to overcome the steering forces.

   c. Continued rotation of the steering wheel (even slight movement) moves the spool farther into or out of the valve, opening ports to the steering cylinders, and passages between the metering section and control valve section. At the same time, the rotor and commutator turn, directing oil to the control valve section and steering cylinders.

2. When the steering cylinders reach the end of their travel, a hydraulic stop is created because the metering section can no longer discharge oil and the steering wheel can no longer be turned. If the steering wheel is held against this hydraulic stop, the relief valve in the steering pump opens and diverts oil to the reservoir.

3. When the operator stops turning the steering wheel, the spring action of the torsion bar returns the spool to neutral, blocking the passages to the cylinders and the front wheels hold their last position, straight ahead or turned right or left.

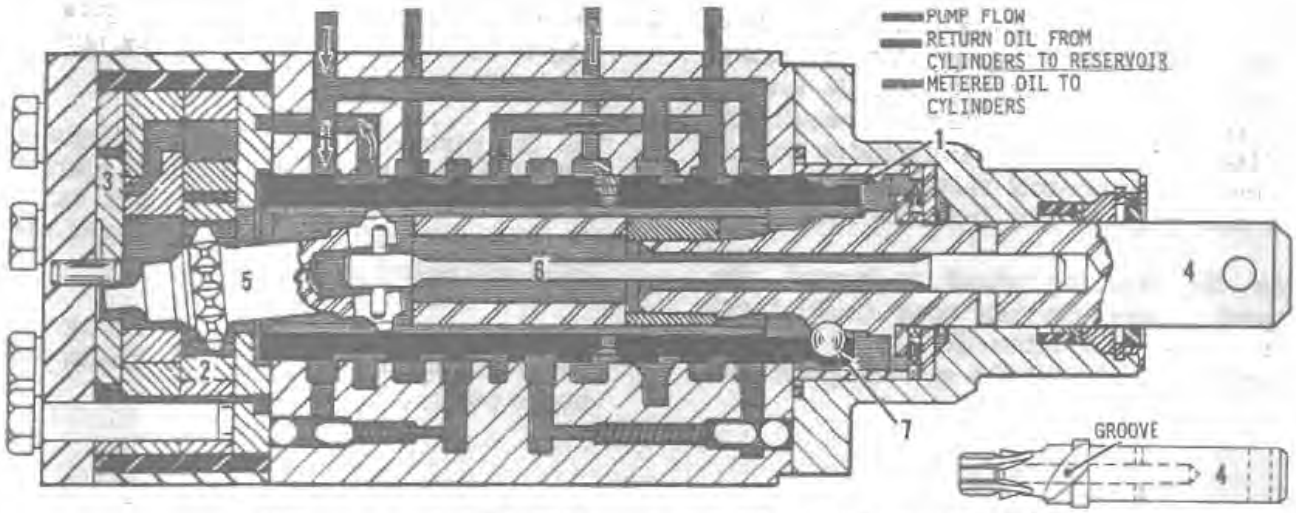


Figure 1 - Oil Flow, Right Turn, Engine Running

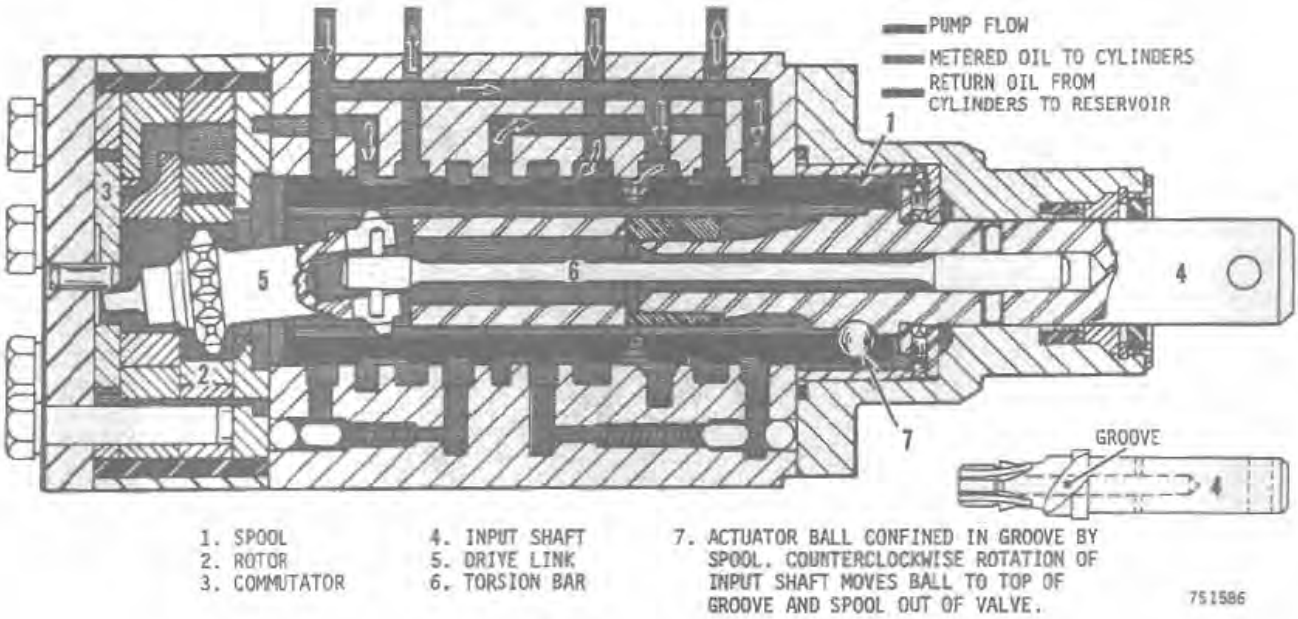


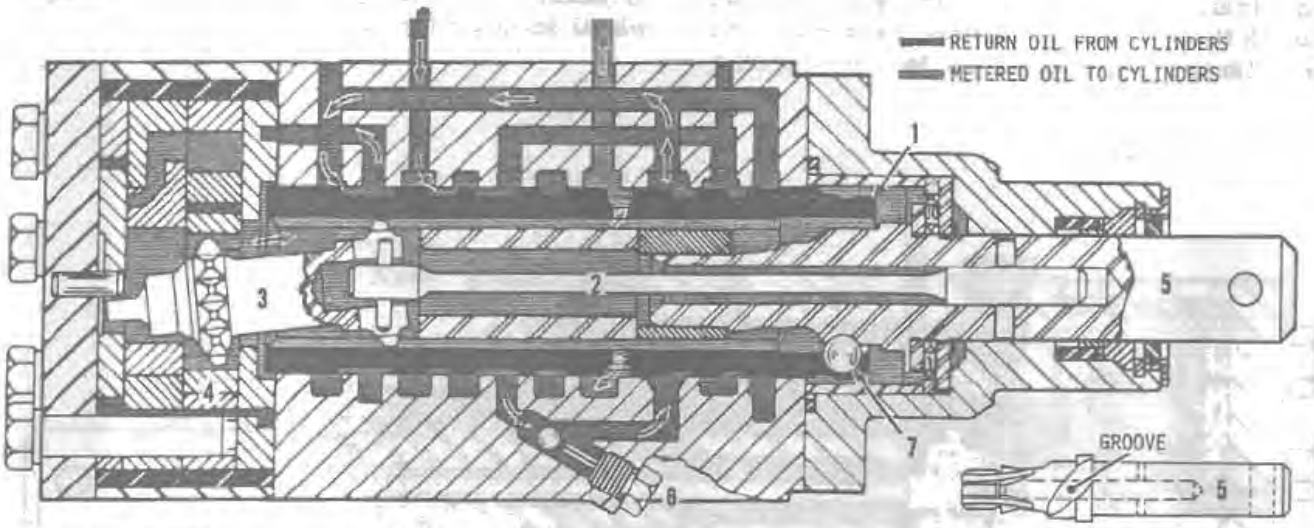
Figure 2 - Oil Flow, Left Turn, Engine Running

Oil Flow, Right and Left Turn, Engine Not Running

Steering the machine with a dead engine is possible because the gerotor functions as a pump when the steering wheel is turned (much greater manual effort is required). Essentially, the gerotor recirculates the oil contained in the control valve, steering cylinders and lines to and from the cylinders.

1. As the steering wheel is turned, the spool moves into the valve (right turn) or out of the valve (left turn) opening passages between the metering section and cylinders.
2. When the spring action of the torsion bar is overcome, the gerotor then pumps oil to the cylinders.
3. As the pistons in the cylinders displace oil, this oil is directed to the control valve inlet via the recirculation valve and the connecting passage between the inlet and outlet ports.

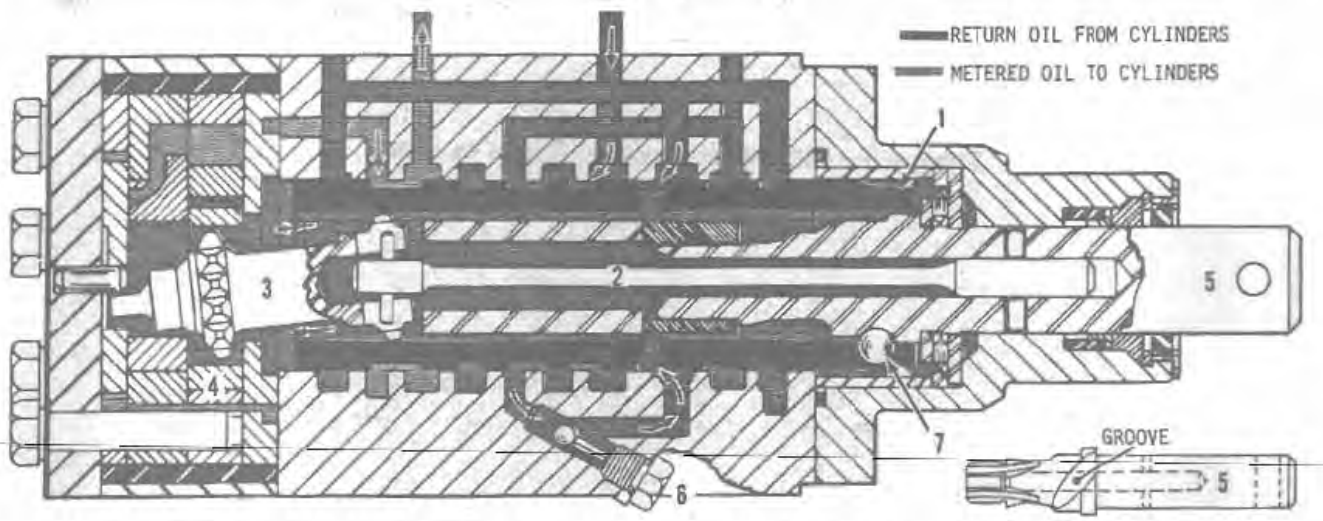
NOTE: When the engine is running the recirculation valve blocks oil flow to the outlet port.



1. SPOOL
2. TORSION BAR
3. DRIVE LINK
4. GEROTOR
5. INPUT SHAFT
6. RECRICULATING VALVE
7. ACTUATOR BALL CONFINED IN GROOVE BY SPOOL. CLOCKWISE ROTATION OF INPUT SHAFT MOVES BALL TO BOTTOM OF GROOVE AND SPOOL INTO VALVE.

751587

Figure 3 - Oil Flow, Right Turn, Engine Not Running



1. SPOOL
2. TORSION BAR
3. DRIVE LINK
4. GEROTOR
5. INPUT SHAFT
6. RECIRCULATING VALVE
7. ACTUATOR BALL CONFINED IN GROOVE BY SPOOL. COUNTERCLOCKWISE ROTATION OF INPUT SHAFT MOVES BALL TO TOP OF GROOVE AND SPOOL OUT OF VALVE.

751588

Figure 4 - Oil Flow, Left Turn, Engine Not Running

Oil Flow, Control Valve in Neutral

Refer to Figure 5. With the steering valve in neutral, oil from the steering pump flows through the valve to the pump reservoir. The spool lands block oil flow to the steering cylinders, permitting the machine to hold its direction. To change direction, the steering wheel must be turned.

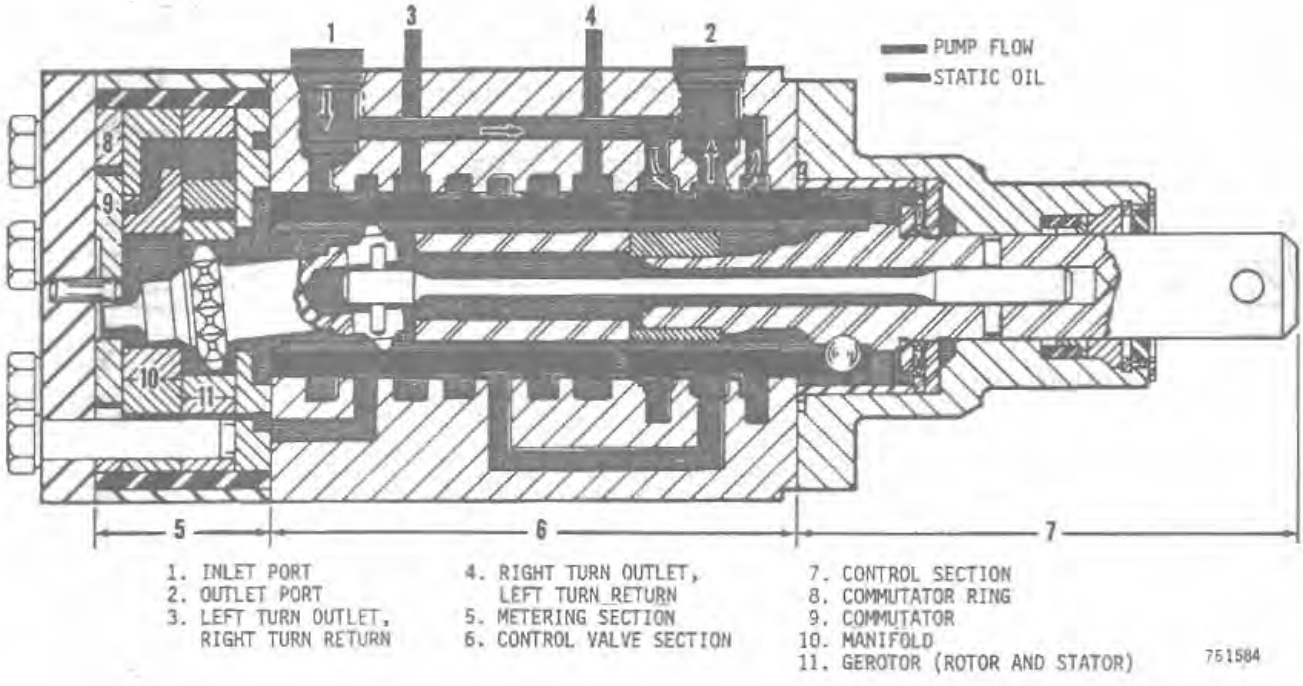


Figure 5 - Oil Flow, Control Valve in Neutral

SERVICING THE CONTROL VALVE

Removal

1. Remove floor plate. Then remove accumulated dirt from control valve, fittings and surrounding area.

2. Remove steering wheel.

3. Disconnect tubes at control valve and plug tube openings.

4. Loosen steering column clamp at the control valve and on front of instrument panel. Raise column to expose the shaft coupling and remove the lower retaining ring and pin. Remove the column and shaft.

5. Remove the four ferry head mounting cap screws and remove valve from machine. Do not allow valve to fall when removing the cap screws.

General Information

1. Before disassembling the control valve, cap the fittings and throughly clean the exterior of the valve.

2. Disassemble and assemble valve on a clean work bench and use clean tools.

3. Parts should be cleaned only in a clear, clean petroleum base solvent and dried with moisture free compressed air or be allowed to air dry. Do not wipe parts with a cloth or steam clean.

4. Some parts of this control valve are replaceable only as part of a set or in a complete control valve. Refer to parts catalog.

Disassembly

1. To prevent possible damage to the control valve if placed directly in a vise, the following procedure should be used. Remove all fittings from the control valve except the fitting in the outlet port. Install a tube cap (part no. 218-754) on the fitting. Reposition fitting as required so valve can be secured in a vise as illustrated in Figure 6.

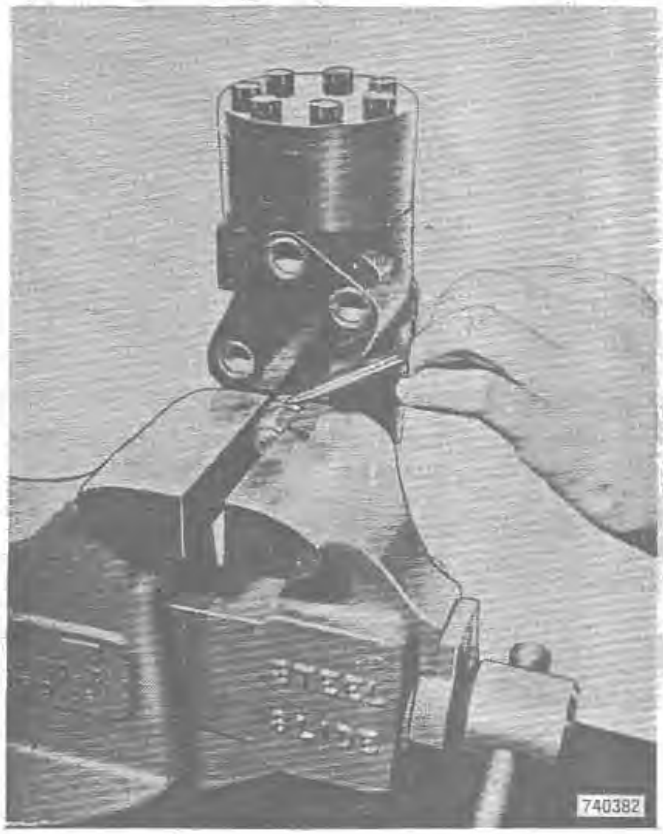


Figure 6

2. Remove the seven end plate cap screws.

NOTE: Use care in completing steps 3 through 8 to prevent damage to the ground and lapped surfaces of the components.

3. Grasp end plate and retainer and lift these parts from the body. Then separate end plate and retainer.

NOTE: Separate parts that are stuck together with a sliding and lifting motion.

4. The commutator ring may come with the end plate. Remove commutator ring from end plate or manifold.

5. Separate manifold from the stator and rotor.

6. Remove the stator and rotor, and spacer and drive link as an assembly, Figure 7.

Figure 7

7. Refer to Figure 8. Remove drive link by sliding the stator and rotor on the spacer allowing the drive link to drop through the spacer.

Figure 8

8. Hold the spacer and stator and rotor straight up and down and remove spacer using a sliding motion. The spacer should be removed in this manner to prevent the rotor from falling out of the stator. Place stator and rotor assembly on the bench and lift stator from rotor. Then remove vanes and springs from the rotor.

9. Reposition control valve in the vise with the input shaft up. Mark the cover and body with a center punch as shown in Figure 9 to assure proper assembly.

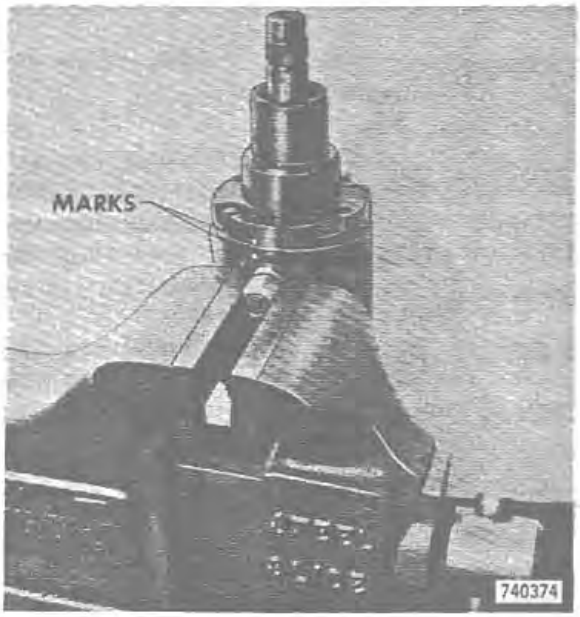


Figure 9

10. Remove the four cover retaining cap screws using a 5/16" 12 point socket or box end wrench.

NOTE: The spool is a close fit in the body but is easily removed if pulled straight out. Never force the spool out of the body.

11. Grasp the input shaft and with a smooth upward motion remove the cover, shaft and spool as an assembly. Then remove O-ring from face of cover.

12. Wrap spool with paper, hold spool with one hand and pull cover from shaft. The spacer in the cover will be removed with the spool.

13. Remove shims from cover bore or input shaft and tie shims together for use during assembly.

14. Use a screwdriver and pry dirt seal

from cover. Then remove snap ring and spacer, seal and seal ring.

15. Remove snap ring, thrust washers and thrust bearing, and spring from input shaft.

16. Place input shaft on a block of soft wood as illustrated in Figure 10. Use drift punch with a maximum diameter of .120" (3 mm) and drive torsion rod retaining pin out of input shaft.

Figure 10

17. Remove torsion bar and spacer by holding open end of spool down and allowing the parts to fall out as shown in Figure 11.

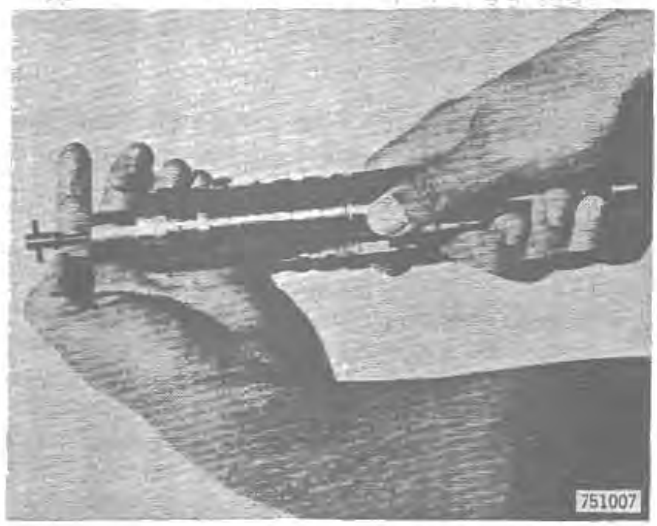


Figure 11

18. To remove the drive ring, place open end of spool on bench and rotate input shaft to extremes of travel until drive ring falls free, Figure 12.

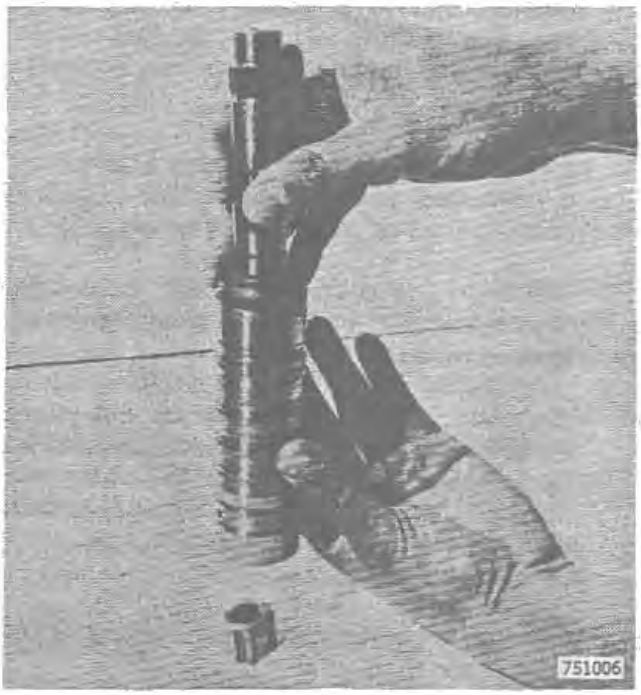


Figure 12

19. With open end of spool down, turn input shaft clockwise to disengage actuator ball and remove shaft from spool. The ball will probably drop from the spool; use care not to lose ball.

20. Do not remove ball retainer from spool unless the retainer is to be replaced. To remove the retainer, grasp the ball end with needle nose pliers and work it over the end of the spool. A screwdriver may be used to aid in removal. Use care to prevent damage to spool lands and remove any burrs made while removing the retainer.

21. Remove body from vise and remove plug and steel ball from body. These parts make up the recirculation check valve.

Inspection

1. Clean all parts in clean petroleum base solvent and dry with moisture free com-

pressed air or allow the parts to air dry. Use care not to damage the lapped and machined surfaces.

2. Inspect the valve body ends and spool bore for wear and damage that would result in leaks or improper operation.

3. Inspect spool lands for wear, scoring, etc. Some burnishing of spool lands may be observed and is acceptable. Also inspect splines in spool for wear.

   NOTE: If either the spool or valve body must be replaced, the complete valve must be replaced.

4. Inspect input shaft seal area for rust, pitting and excessive wear. Light polishing in the seal areas may be observed and is acceptable. Also inspect spiral ball groove for pitting, chipping and surface breakdown.

5. Inspect thrust bearing and washers for pitting, scoring, etc.

6. Inspect drive link teeth for excessive wear. Also check width of slot in drive link. Use a pair of inside calipers and micrometer. If the width of the slot varies more than .001" (0.0254 mm) the drive link must be replaced.

7. Measure diameter of pin in the torsion bar. If the diameter varies more than .001" (0.0254 mm) the torsion bar must be replaced.

8. The spacer, manifold, rotor, commutator and end plate must be free of nicks, burrs and scoring on the machined surfaces.

9. Measure the thickness of the rotor and stator. If the difference between the two parts exceeds .002" (0.051 mm) they must be replaced as an assembly.

10. Install the rotor in the stator and measure rotor to stator clearance as shown in Figure 13. If the clearance exceeds .006" (0.1524 mm) the rotor and stator must be replaced as an assembly.

Figure 13

11. Measure the thickness of the commutator and commutator ring. If the difference exceeds .0015" (0.0381 mm) the parts must be replaced as an assembly.

Assembly

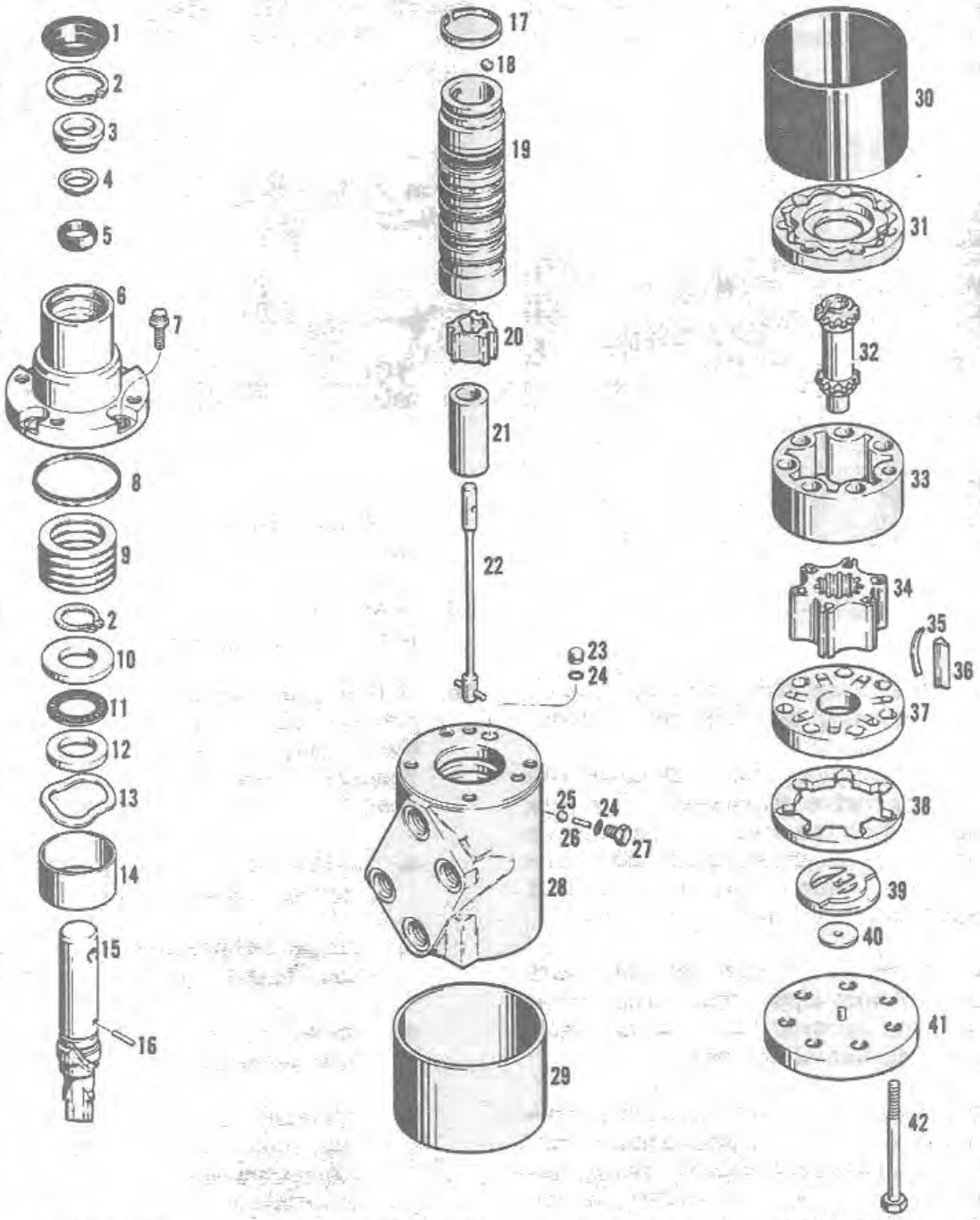
1. Install new O-ring on recirculating check valve plug. Place check ball in valve body and install plug. Torque plug to 10-14 foot-pounds (14-19 N m).

2. Install small O.D. thrust washer, thrust bearing and large O.D. thrust washer on input shaft in this order and secure in place with snap ring.

3. If ball retainer was removed from the spool, install new retainer using care not to damage the spool.

4. Place actuator ball in seat in spool.

5. Install wave spring over thrust bearing. The spring should rest against the large O.D. thrust washer. Install input shaft in spool turning shaft counterclockwise to engage actuator ball with spiral groove in shaft. Perform this operation holding the spool and shaft in a horizontal position.



1. DIRT SEAL
2. SNAP RING
3. SEAL SPACER
4. SEAL RING
5. SEAL
6. COVER
7. CAP SCREW
8. O-RING
9. SHIMS
10. LARGE O.D. THRUST WASHER
11. THRUST BEARING
12. SMALL O.D. THRUST WASHER
13. WAVE SPRING
14. SPACER
15. INPUT SHAFT
16. PIN
17. BALL RETAINER
18. ACTUATOR BALL
19. SPOOL
20. DRIVE RING
21. SPACER
22. TORSION BAR
23. PLUG
24. O-RING
25. CHECK BALL
26. PIN
27. PLUG
28. BODY
29. RETAINER
30. SEAL
31. SPACER
32. DRIVE LINK
33. STATOR
34. ROTOR
35. SPRING(6)
36. VANE (6)
37. MANIFOLD
38. COMMUTATOR RING
39. COMMUTATOR
40. WASHER
41. END PLATE
42. CAP SCREW (7)

751589

Figure 14

6. Using the middle of the torsion bar as a gauge, place torsion bar between small O.D. thrust washer and spool as shown in Figure 15.

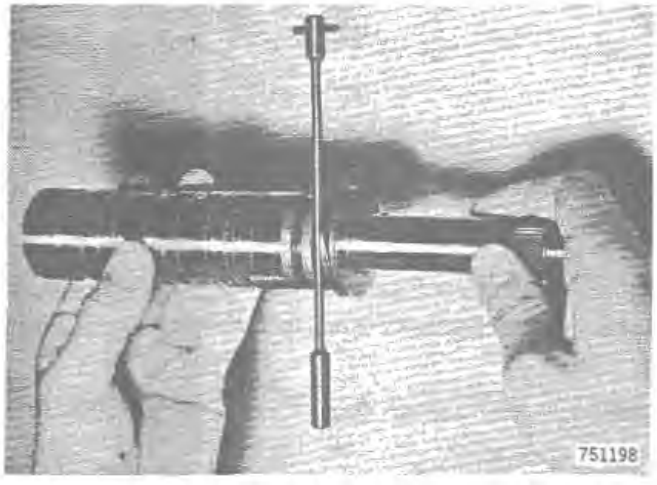


Figure 15

7. Stand spool assembly on input shaft. Make sure torsion bar remains in place.

8. Drop drive ring into spool and align with spool. If the drive ring does not engage the shaft, rotate the shaft as required so drive ring will drop onto shaft. Make sure drive ring is seated against input shaft and remove torsion bar.

9. Place spacer on torsion bar and start torsion bar into input shaft. Align holes in shaft and torsion bar and use drift punch to maintain alignment.

10. Install retaining pin and tap lightly several times to start pin into torsion bar. Place spool assembly in press and press pin into place. Use a relatively larger diameter 1/2" drive socket for shaft support, Figure 16. Then use drift punch and drive pin in until about 1/32" (0.793 mm) below the shaft O.D.

11. Secure valve body in vise as illustrated in Figure 17. Make sure top of body is up (locate alignment mark made during disassembly).

12. Slide spacer all the way onto the spool and install spool assembly in valve body. The spool is easily installed if it is

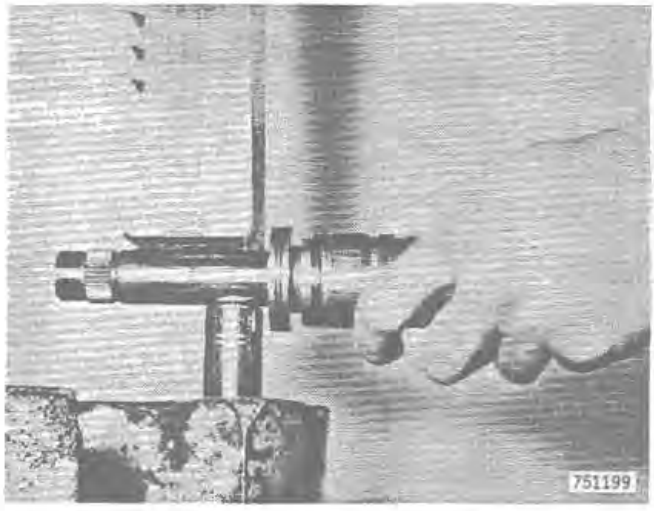


Figure 16

lowered straight into the valve body. Do not force the spool into place.

13. Coat cover O-ring with clean grease and place O-ring in groove in cover.

14. If the input shaft or cover were not replaced, the cover can be installed using the original shims. If a shim is damaged replace it with a new shim of equal thickness.

    a. Place shims on top of large O.D. thrust washer and install cover.

    b. Align mark on cover and valve body and install cap screws finger tight.

    c. Install a worm drive hose clamp around body pilot and cover.

    d. Tighten clamp to center cover on body and torque cap screws to 18-22 foot-pounds (24-30 N m). Then proceed to step 16.

15. If the input shaft or cover was replaced, the following procedure must be used to properly position the spool in the valve body.

    a. Place original shim pack on top of large O.D. thrust washer. If a shim is damaged replace it with one of equal thickness. Then install cover. If original cover is being used, align marks made during disassembly. Then install cap screws finger tight.

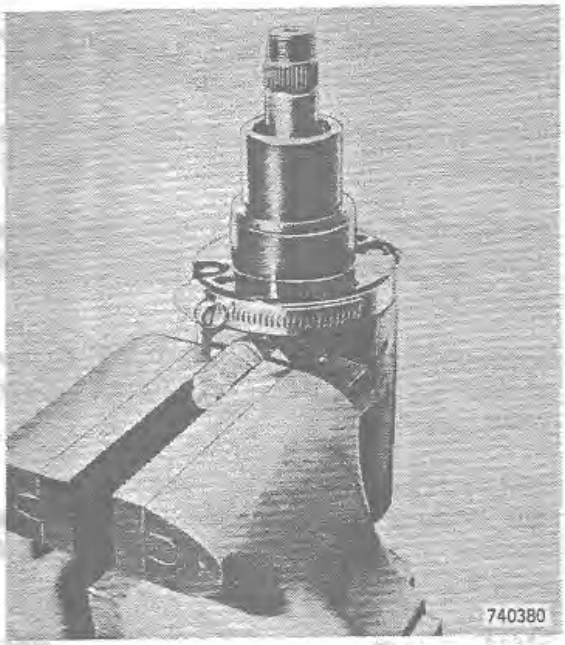


Figure 17

b. Install worn drive hose clamp around valve body pilot and cover, Figure 17. Tighten clamp to center cover and torque cap screws to 18-22 foot-pounds (24-30 N m).

c. Reposition valve body in vise with input shaft down.

d. Install drive link in spool but do not engage torsion bar. Grasp input shaft and pull down. Prevent shaft from turning and rotate drive link to move the spool up (toward open end of body) as far as possible. Remove drive link, align slot in link with torsion bar pin and reinstall drive link.

e. The end of the spool should be flush with to .0025" (0.0635 mm) below end of valve body while pulling the input shaft down. Check spool position using a straight edge and feeler gauge as illustrated in Figure 18 or use a depth micrometer. If spool position is not as specified, remove or add shims as required. A shim kit containing .002" (0.051 mm), .005" (0.127 mm), .010" (0.254 mm) and .030" (0.762 mm) shims is available.

Figure 18

f. If reshiming is required, repeat steps 15b through 15e. Then proceed to step 17.

16. Install drive link in spool making sure it has engaged the torsion bar pin.

17. Install springs and vanes in the rotor. The springs should be installed so ends of springs contact the rotor.

18. Place spacer on work bench with smooth surface up. Then install rotor in stator and place this assembly on the spacer.

19. Install spacer and rotor/stator assembly on valve body. Rotate input shaft as required to align holes in stator with holes in body.

20. Note that the manifold has slots near the inside diameter on one side. Install manifold with the slotted side up (toward end plate).

21. Note that the commutator ring has a groove on one side. Install commutator ring with groove up (toward end plate) and align cap screw holes.

22. Place new seal in retainer and place retainer on valve body.

23. Install commutator, engaging slot with drive link and washer countersink side up.

24. Coat washer with clean grease and place over pin in end plate.

25. Apply a few drops of oil specified on page 5002-3 to the commutator and manifold.

26. Install end plate making sure pin engages hole in center of commutator. Rotate plate as required to align cap screw holes and install cap screws.

27. Alternately and progressively tighten the cap screws to a final torque of 15-19 foot-pounds (20-26 N m) while rotating the input shaft.

28. Reposition control valve in vise with input shaft up.

29. Lubricate seal with clean oil and install seal over input shaft. Install seal ring, and seal spacer, small diameter first on the input shaft. Then push these parts into cover bore. Secure parts in place with snap ring with rounded edge toward the seal spacer. It may be necessary to use a 7/8" deep socket or a piece of tubing with a 1-3/16" (30 mm) O.D. and 15/16" (24 mm) I.D. to push parts into place. Then install dirt seal.

30. Install fittings removed during disassembly and close all openings before installing the control valve.

Installation

1. Engage valve fittings with tubes and secure valve to mounting plate. If a mounting cap screw is lost, it must be replaced by the cap screw specified in the parts catalog. Using a longer cap screw may result in valve body damage.

2. Tighten all tube connections at control valve.

3. Attach shaft coupling to valve input shaft with pin. Secure pin in place with retaining ring.

4. Slide column onto cover and tighten clamp at control valve and on front of instrument panel.

5. Install steering wheel with a spoke at the bottom and straight up and down. Secure in place with nut but do not install cap at this time.

6. Start engine and run at low idle. Slowly turn the steering wheel through several complete turns to bleed air from the steering circuit.

7. Attach an inch-pound torque wrench to steering wheel nut and check the torque required to turn the wheels in both directions with the engine running at half throttle. The torque readings should be equal within 2 inch-pounds (0.22 N m).

8. If the torque readings were not as specified, shims must be added or removed to equalize the torque readings. Remove the control valve and add shims to increase left turn torque or remove shims to increase right turn torque.

9. Torque steering wheel nut to specification on page 5007-3 and install cap.

10. Install floor plate.

STEERING COLUMN

Removal and Disassembly

1. Remove steering wheel.
2. Loosen clamp at bottom of column and on front of instrument panel.
3. Remove lower pin retaining ring and pin and remove column.
4. Pull shaft out of bottom of tube.
5. Remove the bearing/seal assembly only if it is to be replaced.

Assembly and Installation

1. Press new bearing/seal assembly into top of tube.
2. Attach coupling to shaft with pin and secure pin in place with retaining ring.
3. Lubricate bearing bore with grease or oil and install shaft from bottom of tube.
4. Start column through instrument panel clamp and install bottom clamp on column.
5. Lower column assembly onto the control valve input shaft. Align holes in shaft and coupling and install pin. Secure pin in place with retaining ring. Tighten both column clamps.
6. If front wheels are not in the straight ahead position, start engine and position wheels straight ahead.
7. Install steering wheel with a spoke at the bottom and straight up and down.
8. Install steering wheel nut and torque to 32-37 foot-pounds (43-50 N m).

1. STEERING WHEEL NUT
2. SHAFT
3. BEARING/SEAL ASSEMBLY
4. TUBE
5. CLAMP
6. RETAINING RING
7. PIN
8. COUPLING

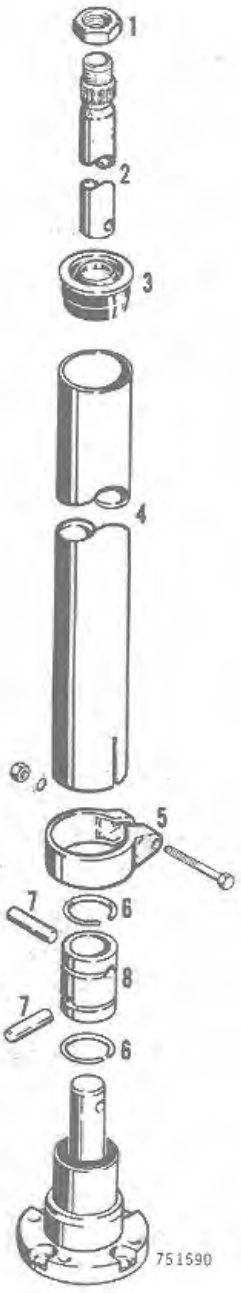


Figure 19

Section 5010

STEERING CYLINDERS

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

STEERING CYLINDER

Removal

1. Disconnect hoses from cylinder and close all openings with clean caplugs.

2. Remove cotter pin and nut from each ball joint. Use a tie rod removal tool to remove the cylinder or reinstall nuts with notches down and flush with stud, and strike nut with hammer to loosen ball joint. If tie rod removal tool is used the rubber boots must be replaced.

Disassembly

1. Do not remove the ball joints unless the cylinder tube, piston rod or ball joint is to be replaced.

2. Secure cylinder in a vise using care not to distort the tube. Remove the outer lock ring and push gland into the cylinder about 3/4" (19 mm).

3. Remove the lock ring spacer and the inner lock ring.

4. Carefully pull the piston from the cylinder. Pull the rod straight out to prevent damage to the cylinder wall.

5. Loosen ball joint clamp on piston rod and slide clamp onto rod. Secure clamping section of rod in a vise. Then remove piston nut.

6. Remove piston from rod. Then remove O-ring and backup rings from piston and O-ring from piston rod.

7. Remove gland from rod and remove O-rings and wipers from gland.

Inspection

1. Discard all O-rings, backup rings and wipers.

2. Clean all parts in cleaning solvent and dry with moisture free compressed air.

3. Shine a light into the cylinder tube. If it has deep grooves or score marks, or has been damaged in any way, it should be replaced.

4. Inspect the piston rod for straightness. Replace if bent; do not attempt to straighten.

5. Before reassembling, remove any minor nicks, scratches, etc. on the rod or in the cylinder with a medium grit emery cloth. Polish with a rotary motion.

Assembly

1. If cylinder tube or cylinder ball joint was replaced, place clamp on cylinder end and screw ball joint in to obtain the dimension shown in Figure 1.

2. Install O-ring in groove around gland. Install O-ring and seal in inner groove in gland bore. Install seal with lips to the inside. Then install wiper in outer groove with lip to the outside.

   NOTE: The seal and wiper are identical parts and must be installed as instructed in step 2.

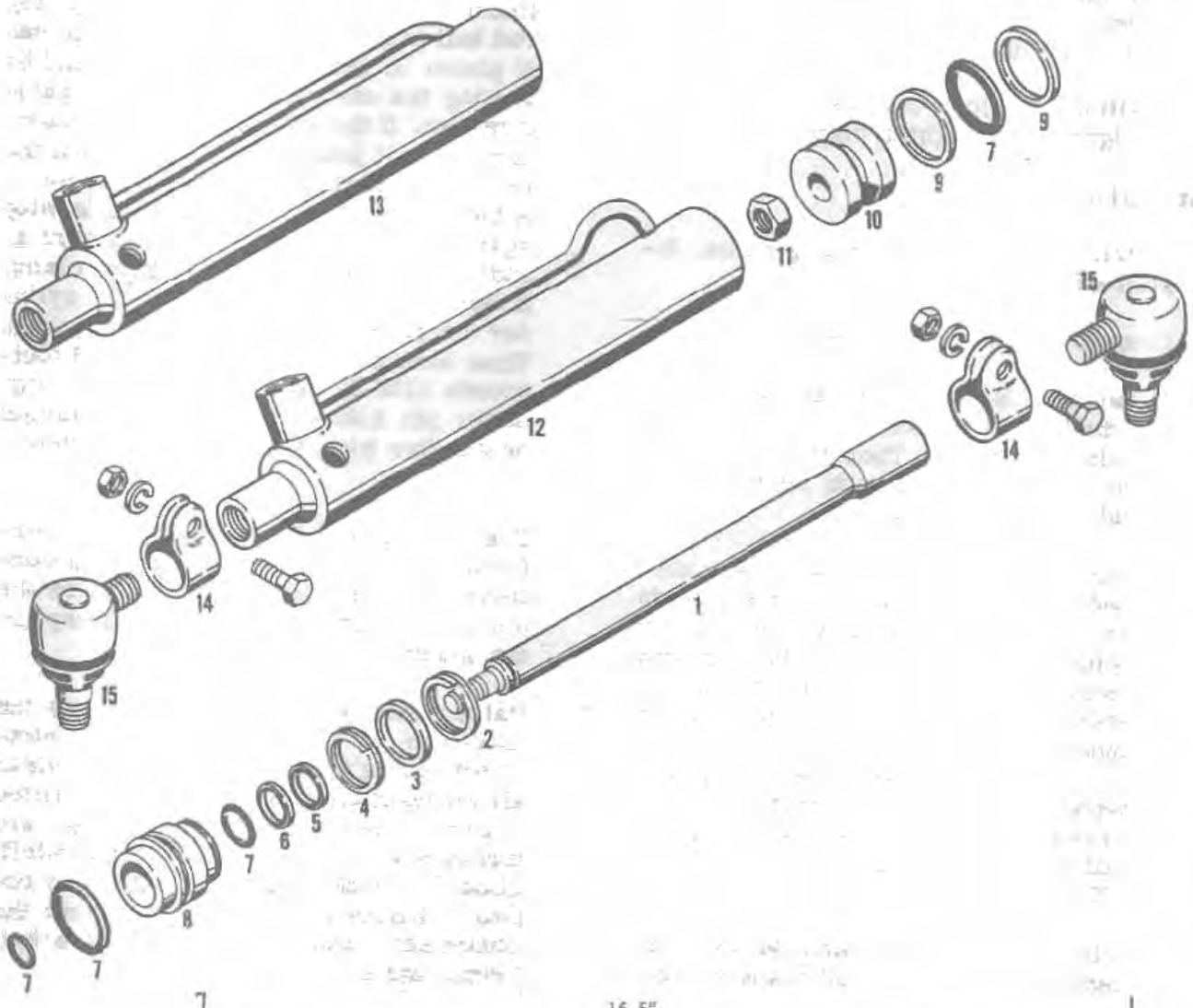
3. Lubricate piston rod and gland bore with hydraulic oil. Be sure ball joint clamp is on piston rod and install gland on piston rod.

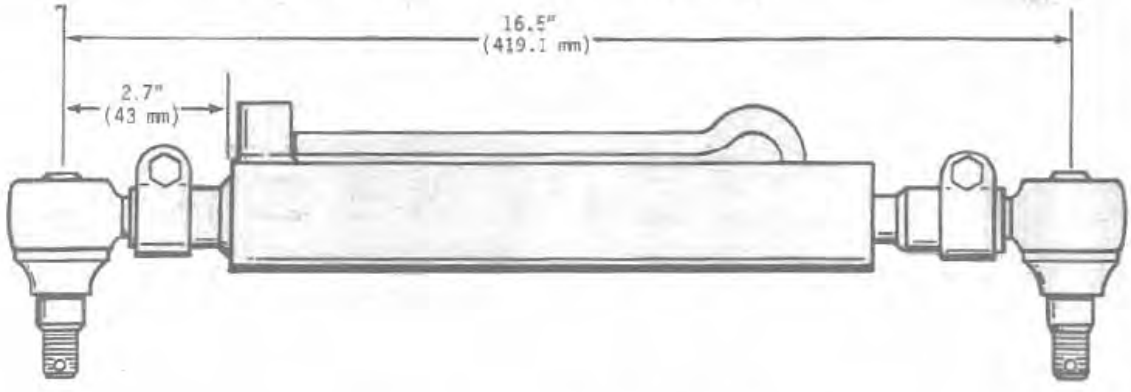
4. Secure clamping section of piston rod in vise. Install new O-ring on piston rod and install piston. Install piston nut and torque to 110-130 foot-pounds (149-176 N m). Then install new backup rings and O-ring in groove in piston. The O-ring must be between the backup rings.

5. Thoroughly lubricate cylinder wall and piston with hydraulic oil. Secure cylinder tube in vise and install piston straight into cylinder. Push the piston into the cylinder about 2" (55 mm).

6. Slide gland into the cylinder about 3/4" (19 mm) beyond the lock ring groove. Then install the inner lock ring. Be sure ring is seated in groove.

7. Pull piston rod out of cylinder to seat gland against the inner lock ring. Then install lock ring spacer and outer lock ring. Be sure ring is seated in groove.





1. PISTON ROD
2. OUTER LOCK RING
3. SPACER
4. INNER LOCK RING
5. WIPER
6. SEAL
7. O-RING
8. GLAND
9. BACKUP RING
10. PISTON
11. PISTON NUT
12. PRODUCTION CYLINDER TUBE
13. REPLACEMENT CYLINDER TUBE
14. BALL JOINT CLAMP
15. BALL JOINT

751613

Figure 1

8. If piston rod or rod ball joint was replaced, push piston rod all the way into cylinder and turn ball joint as required to obtain the dimension shown in Figure 1.

9. Position ball joint clamps as illustrated in Figure 1 and tighten clamps.

Installation

1. Install cylinder in mounting holes. Install nuts finger tight.

2. Connect hoses to cylinder(s).

3. If the cylinder and rod ball joints were not disturbed, tighten nuts to 100 foot-pounds (135 N m). Then tighten nuts to align cotter pin hole with next slot and install new cotter pin.

4. If only the cylinder ball joint was disturbed, turn the wheels all the way to right or left depending on which cylinder is being installed. If the spindle stop does not contact the axle, remove cylinder ball joint from spindle and turn ball joint into cylinder until spindle stop contacts the axle. Then torque ball joint nuts to 100 foot-pounds (135 N m). Tighten nuts to align cotter pin hole with next slot and install new cotter pin. Then proceed to step 7.

5. If only the piston rod ball joint was disturbed, turn the wheels all the way to the left if the right-hand cylinder is being installed or to the right if the left-hand cylinder is being installed. Remove piston rod ball joint from spindle. Check to see if piston is seated against the gland by turning the steering wheel in the same direction. If the piston rod does not move, turn the ball joint out of the rod until the ball joint stud is aligned with hole in spindle with the opposite spindle stop against the axle; then turn ball joint an additional two full turns and tighten clamp. If the piston rod moved out of the cylinder no further adjustment is required. Then torque ball joint nuts to 100 foot-pounds (135 N m). Tighten nuts to align cotter pin hole with next slot and install new cotter pin. Then proceed to step 7.

6. If a new cylinder is being installed, perform step 4 to be sure spindle stop contacts the axle and step 5 to be sure the piston does not bottom against the cylinder gland.

7. Raise front wheels high enough so the axle can be tilted against each stop. Check to see that hoses and fittings clear all obstructions when the axle is tilted against the stops and the wheels are turned all the way to the right and left. Loosen cylinder ball joint clamp and rotate cylinder as required to obtain the necessary clearance. Then tighten ball joint clamp.

Section 5021

FRONT AXLE

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Service

Toe in	0-1/8" (0-3 mm)
Clean and repack wheel bearings	After every 500 hours of operation
Wheel bearing grease	No. 2 wheel bearing grease

Special Torques

Wheel bearing nut	75-85 foot-pounds (101-115 N m) then back off 1/6 turn maximum
Tie rod end nuts	100-120 foot-pounds (135-162 N m)
Steering cylinder ball joint nuts	100 foot-pounds (135 N m)
Front wheel bolts	115-130 foot-pounds (156-176 N m)

FRONT WHEEL BEARING

Removal, Inspection and Installation

1. Raise front wheels off the floor and block machine in place.
2. Remove dust cap. Then remove cotter pin, nut and washer.
3. Remove wheel from spindle.
4. Remove outer bearing from hub.
5. Remove hub seal and inner bearing from hub. Do not remove bearing cups unless inspection indicates replacement.
6. Remove spindle seal from spindle and discard seal.
7. Clean the bearings in cleaning solvent to remove all traces of grease.
8. Remove grease from bearing cups and spindle with a clean cloth. Also remove grease from hub bore.
9. Inspect the bearing cups for scoring, galling, etc. Also check bearing race and cage for signs of cracking.
10. Thoroughly pack each bearing with No. 2 wheel bearing grease.
11. Place a liberal amount of grease in hub bore and on each bearing cup.
12. Place inner bearing in bearing cup. Install a new hub seal with seal lip away from bearing. Use a driver that contacts the O.D. of the seal and press or drive seal into hub until seated against shoulder in bore. Fill cavity made by seal body and seal lip with grease.
13. Install a new spindle seal on spindle with seal lip toward flange on spindle. Use a driver that contacts the I.D. of the seal only and seat seal against flange. Fill cavity made by seal body with grease.
14. Install wheel on spindle using care not to damage the hub seal. Then install outer bearing, washer and nut.
15. Adjust bearings as instructed under Wheel Bearing Adjustment.
16. Install dust cap.

Wheel Bearing Adjustment

1. Rotate the wheel while torquing the nut to 75-85 foot-pounds (101-115 N m).
2. When nut torque is as specified, back the nut off 1/6 turn maximum and install new cotter pin.

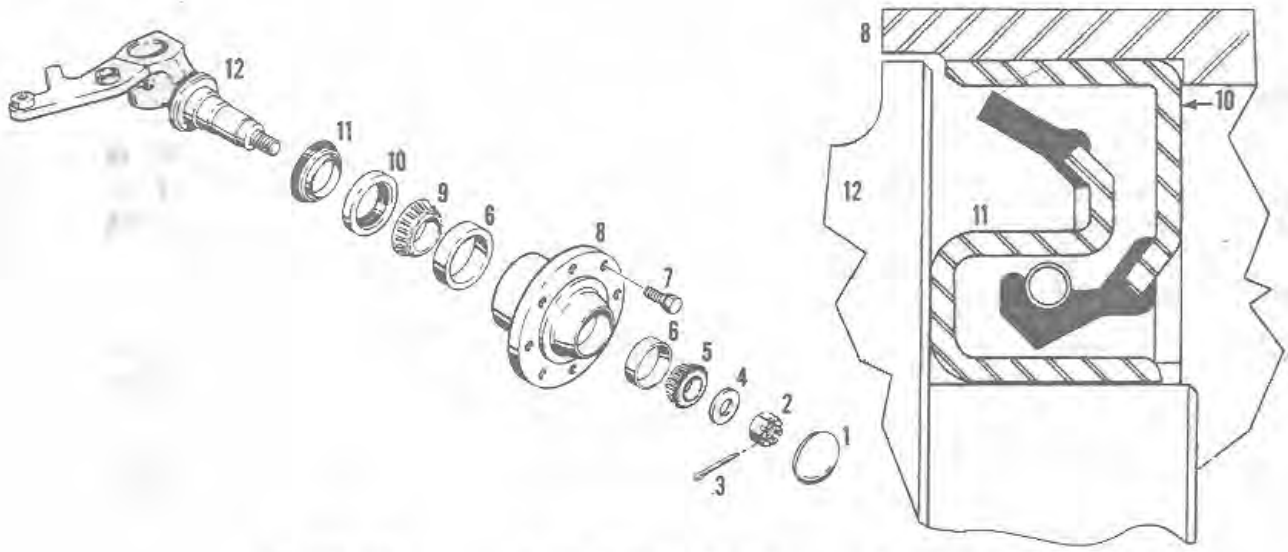


Figure 1 - Front Hub Assembly

SPINDLE AND KING PIN

Removal

1. Raise front wheel off the floor and block machine in place.

2. Remove hub dust cap, wheel bearing nut and washer. Then remove wheel using care not to damage the hub seal.

3. Remove tie rod end nut. Reinstall nut, smooth side up and flush with stud. Strike nut with hammer to loosen tie rod. Then remove nut, and tie rod from the spindle.

4. Remove steering cylinder rod end in the same manner as the tie rod end.

5. Remove nut and lock washer from king pin lock pin. Reinstall nut flush with end of lock pin and strike nut with hammer to loosen lock pin. Remove nut and drive pin out of spindle.

6. Remove snap ring, spacer and O-ring on top and bottom of king pin. Check condition of O-rings and replace with new parts if necessary.

7. Use brass driver and drive king pin out of spindle. Drive the spindle upward to prevent damage to the seal.

8. Remove spindle, thrust bearing and thrust washer from axle.

Installation

1. Place spindle in axle. Then install thrust washer between the axle and bottom of spindle and the thrust bearing on top of spindle, with bearing shield on top.

2. Install king pin so notch in pin will be aligned with lock pin hole in spindle. Install king pin from the bottom to prevent damage to the seal.

3. Install lock pin from rear of spindle with tapered surface toward the king pin. Secure pin in place with lock washer and nut.

4. Install O-ring on top of upper bearing. Then install spacer and secure in place with snap ring. It may be necessary to use a drift punch and hammer and tap snap ring into groove.

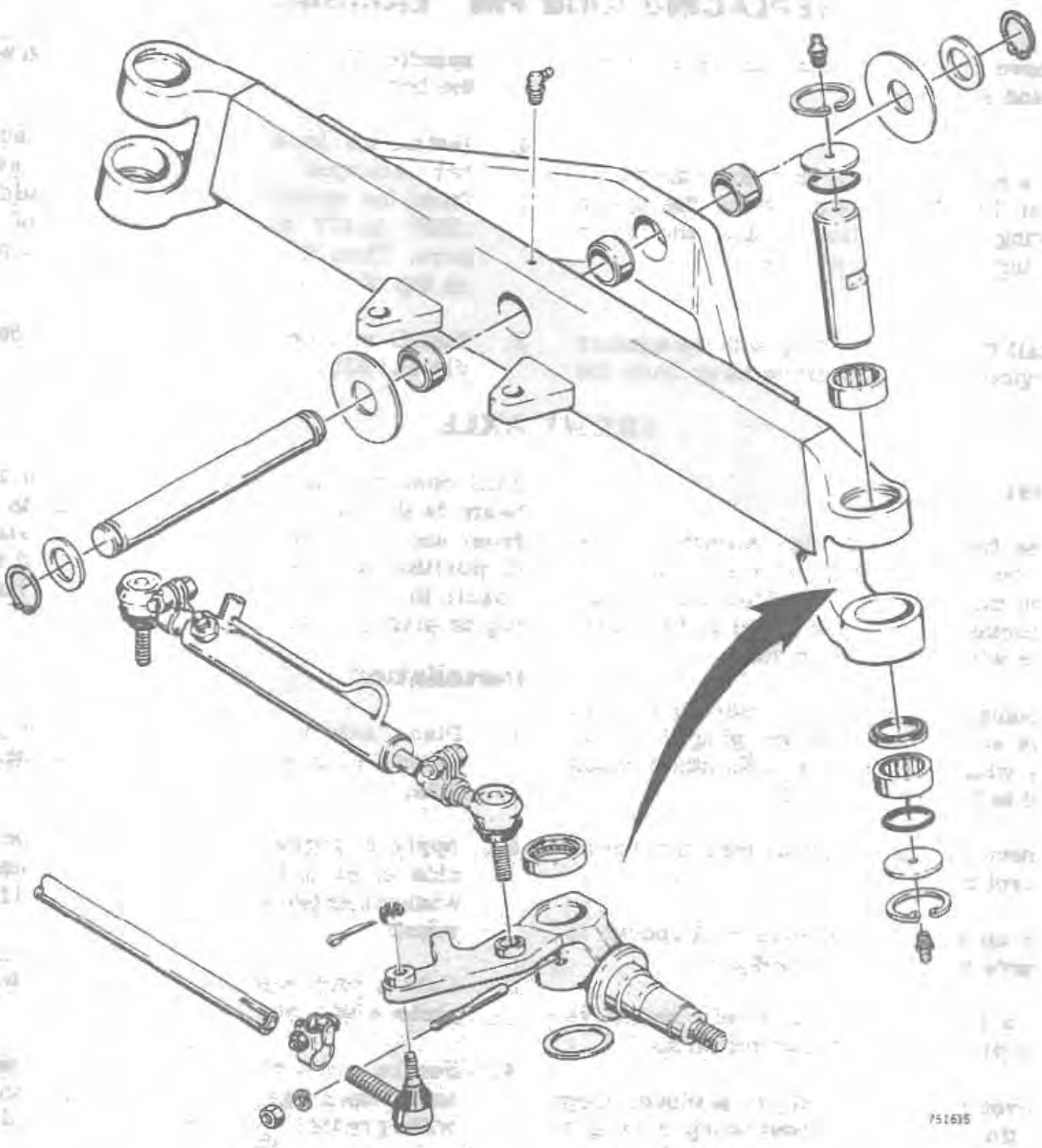


Figure 2 - Spindle Installation

5. Attach steering cylinder rod to the spindle. Torque the nut to 100 foot-pounds (135 N m). Then tighten nut to align cotter pin hole with next slot and install cotter pin.

6. Attach tie rod end to spindle. Torque nut to 100-120 foot-pounds (135-162 N m) and install new cotter pin.

7. If a new spindle has been installed, install a new spindle seal with seal lip toward flange on spindle. Use a driver that contacts the I.D. of the seal only and seat seal against flange Also remove hub seal and replace with a new seal. Fill cavities made by seal bodies with grease.

8. Install wheel, outer bearing, washer and nut. Adjust wheel bearings as instructed under Wheel Bearing Adjustment.

9. Lubricate king pin bearings with grease specified in Section 1050.

REPLACING KING PIN BEARINGS

1. Remove spindle as instructed under Spindle and King Pin.

2. Use a suitable driver and drive the bearing(s) from the axle. Drive the upper bearing toward bottom of axle and lower bearing toward top of axle.

3. Install the upper bearing with the number stamped in end of bearing away from the spindle. The bearing should be flush with the bottom of the bore.

4. Install the lower bearing with the number stamped in end of bearing away from the spindle. The bearing should be .255" (6.477 mm) below the top of the bore. Then install new seal with lip up on top of the bearing.

5. Install spindle as instructed under Spindle and King Pin.

FRONT AXLE

Removal

1. Raise front wheels high enough so axle can be lowered out of the frame and block machine in place. Then raise loader bucket above head level and block in place with lift cylinder stops.

2. Disconnect hose from steering control valve at each cylinder and plug all openings with clean caplugs. No other hoses need to be disconnected.

3. Remove snap ring and washer from rear of pivot pin.

4. Jack up one side of axle just enough to remove weight from pivot pin.

5. Use a brass rod as a driver and drive pivot pin toward front of machine.

6. If pivot pin is difficult to remove, drop one tie rod end, remove snap ring and washer from front of pin and drive pin toward rear of machine.

7. Prevent axle from binding in frame and lower wheel to floor. Roll axle away from machine.

Pivot Bushing Installation

Three bushings are used in the front axle; one in the front yoke and two in the axle beam. Press or drive front yoke bushing into yoke until centered in yoke. Press or drive axle beam bushings into place until flush with the front and rear surfaces of the axle. Failure to position axle bushings as instructed will result in lack of lubrication and early bushing or pivot pin failure.

Installation

1. Place axle under frame and raise into frame. Align pivot pin holes in fame and axle.

2. Apply a liberal amount of grease on one side of each large washer and position washers between frame and axle and front yoke.

3. Coat pivot pin with oil and drive pin into place with a brass hammer.

4. Secure pivot pin in place with washers and snap rings. Lubricate axle bushings with grease specified in Section 1050.

5. Connect hoses to steering cylinders.

6. If tie rod was dropped, attach tie rod to spindle arm. Torque nut to 100-120 foot-pounds (135-162 N m) and install new cotter pin.

7. Start engine and run at low idle. Turn steering wheel slowly through several complete turns to bleed air from the steering circuit.

TOE IN ADJUSTMENT

The toe in at the front of the wheels should be 0-1/8" (0-3 mm). Measurements are taken at the front and rear of the tires to determine the amount of toe in. Adjustment is made by turning the tie rod at the rear of the axle.

Measuring Toe In

1. Raise front wheels until they clear the floor.
2. Using a sharp pointed instrument held securely in one position, turn a wheel and scribe a fine line around the center line of the tire. Repeat for the other wheel.
3. Lower machine to the floor and position the wheels straight ahead.
4. Measure the distance between the scribe marks at the front and rear of the tires. The measurement at the front of the tires should be equal to, or up to 1/8" (3 mm) less than the measurement at the rear of the tires.

Adjustment

1. Loosen tie rod end clamps.
2. Turn the tie rod as required to increase or decrease toe in. Then tighten each clamp.

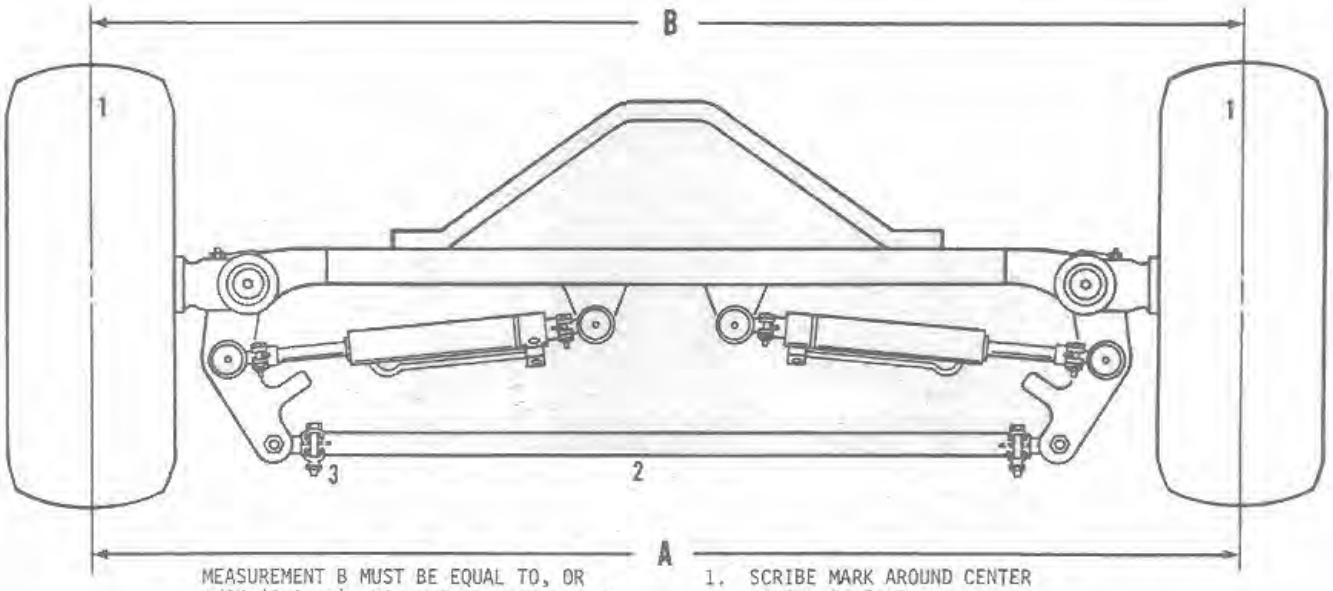


Figure 3 - Toe In Adjustment

Section 6202

POWER SHUTTLE AND TORQUE CONVERTER

MAINTENANCE, OPERATION

AND

TROUBLE SHOOTING

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Oil temperature for test purposes	Temperature gauge needle in middle green zone on gauge.
Pump (main line) pressure	
Engine at low idle and oil at specified temperature	65 psi (448 kPa) minimum in Neutral
Engine at 2000 rpm (r/min) and oil at specified temperature	130 psi (896 kPa) minimum in Neutral
Torque converter out (cooling circuit) pressure	30 psi (206 kPa) or less, engine at 2000 rpm (r/min)
Specified oil	Case TCH Fluid
Alternate oil	Dexron or automatic transmission oil type A, suffix A.
Shuttle oil capacity	2-1/4 U.S. quarts (2.1 liters)
Torque converter capacity	5-1/2 U.S. quarts (5.2 liters)
Total system capacity (approx.)	8-1/2 U.S. quarts (8 liters)
Service specifications	Refer to Section 6210.

MAINTENANCE

Oil Level Check

The oil should be checked after every 50 hours of operation or once a week, whichever occurs first.

The oil level must be checked with the oil at operating temperature.

Park machine on a level surface, apply parking brake, place transmission in 4th gear and shuttle in Neutral. The dipstick has an expandable rubber plug. Turn handle counterclockwise several turns and remove the dipstick. With the engine running at low idle and the dipstick pushed all the way in, the oil should be between the L and F marks on the dipstick. Add oil whenever the oil level is at the L mark or lower.

Oil Drain

The oil must be drained and the filter screen cleaned after every 1000 hours of operation or once a year, whichever occurs first. If time permits, warm oil to operating temperature before draining.

Park machine on a level surface and apply the parking brake. Remove plug from bottom of flywheel/converter housing. If the converter drain plug is not visible, turn engine over as required to position plug over opening. Then remove converter and shuttle drain plugs and drain the oil.

Remove shuttle oil pan and remove the filter screen. The screen is held in place by the fit of an O-ring. Clean these parts in cleaning solvent and dry with compressed air. Check the condition of the O-ring and pan gasket and replace parts as required.

Install O-ring on filter screen tube and install screen. Place gasket on oil pan and install pan, and install drain plugs in pan and converter. Install plug in bottom of flywheel/converter housing.

Filling Power Shuttle and Torque Converter

NOTE: Do not deviate from this procedure or costly and unnecessary damage may result.

1. Have on hand 8 U.S. quarts (7.5 liters) of Case TCH Fluid.
2. Add three U.S. quarts (2.8 liters) to the shuttle. Have the remaining oil ready to add to the shuttle.
3. Start engine and run at low idle and immediately add the remaining oil.
4. Shift the shuttle to Forward and Reverse to fill the clutch cylinders and all internal passages.
5. When the oil is at operating temperature, check oil level and add oil as required.

POWER SHUTTLE OPERATION

General

The power shuttle is a torque converter driven forward/reverse transmission that allows the operator to change directions without bringing the machine to a complete stop. Shifts to change direction must be made at engine speeds below 1500 rpm (r/min) to prevent unnecessary damage to the power shuttle.

The power shuttle consists of a planetary gear set, multiple disc forward and reverse clutches, control valve, pump and the necessary internal passages and external fluid lines.

Refer to Figure 1. The cresent type pump pumps oil to the control valve and regulator valve built into the control valve. The regulator valve maintains system pressure. The oil not required for lubrication or clutch application flows from the control valve to the torque converter relief valve which maintains converter inlet pressure and diverts any excess oil to the shuttle oil pan. The front bearing is also lubricated by oil at converter pressure. Oil from the converter is directed to the oil cooler and back to the oil pan.

A solenoid controlled clutch cutout function is built into the control valve and is discussed on page 6202-8.

With the control valve in Neutral, Figure 1, oil flow from the pump is blocked at the control valve. Oil continues to flow to the torque converter and through lubrication passages in the shuttle case and input and output shafts.

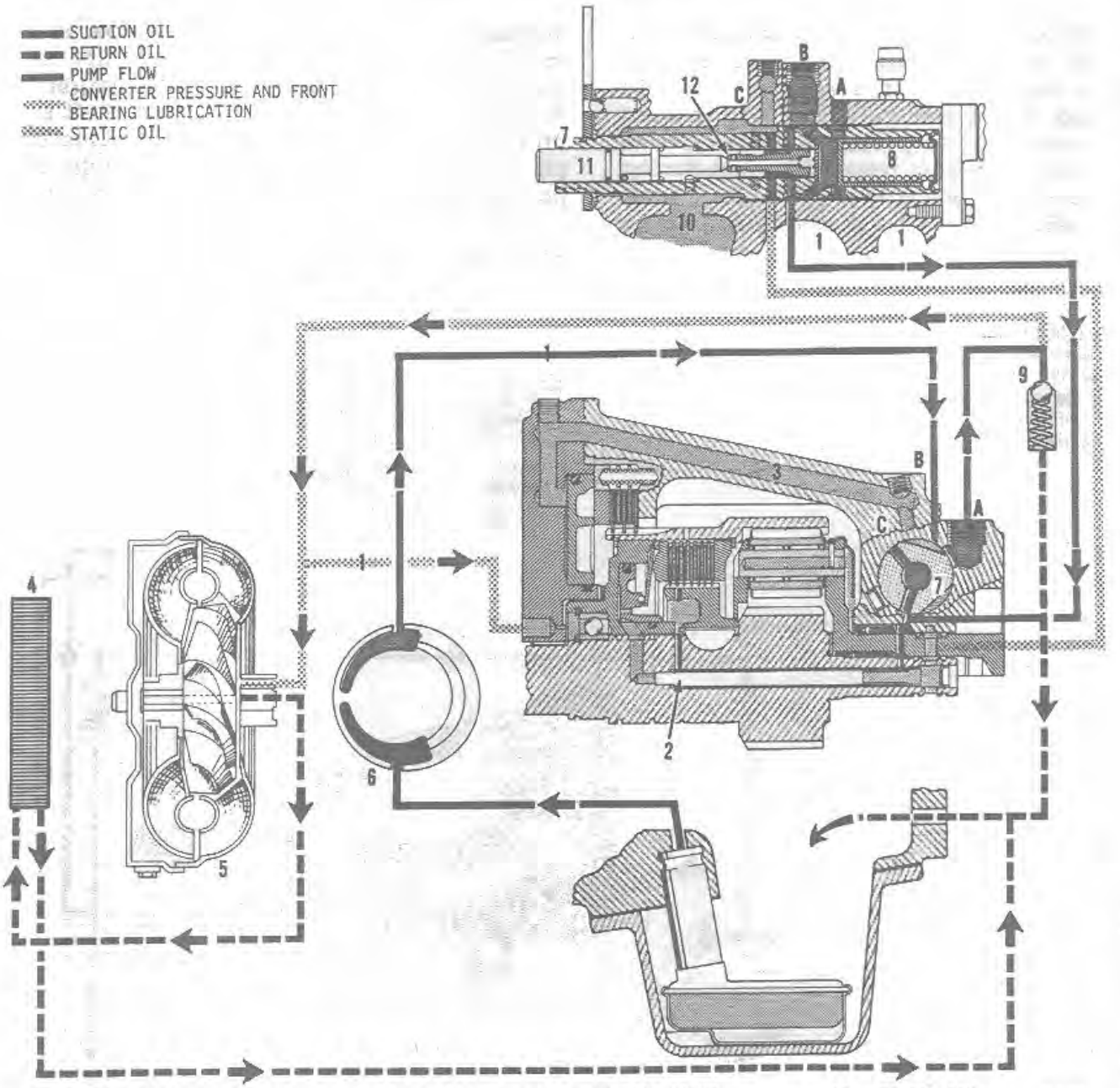

SUCTION OIL
RETURN OIL
PUMP FLOW
CONVERTER PRESSURE AND FRONT BEARING LUBRICATION
STATIC OIL
1. INTERNAL PASSAGE
2. FORWARD CLUTCH FEED
3. REVERSE CLUTCH FEED
4. OIL COOLER
5. TORQUE CONVERTER
6. PUMP
7. CONTROL VALVE
8. REGULATOR VALVE
9. CONVERTER RELIEF VALVE
10. TO OIL PAN
11. PLUNGER
12. SPOOL
751608

Figure 1

Power Shuttle in Forward

With the control valve in the forward position, oil at system pressure flows from the control valve through passages in the shuttle case and output and input shafts to forward clutch cylinder. As pressure in the cylinder increases, the piston moves the clutch spring. The movement of the spring creates a lever action which forces the forward clutch discs together. The friction discs are secured to the clutch hub and the steel discs are secured to the ring gear. The application of the forward clutch locks the input shaft and ring gear together. This in turn prevents the pinion gears from rotating and locks the input shaft, ring gear and output shaft together causing them to rotate as a one piece shaft.

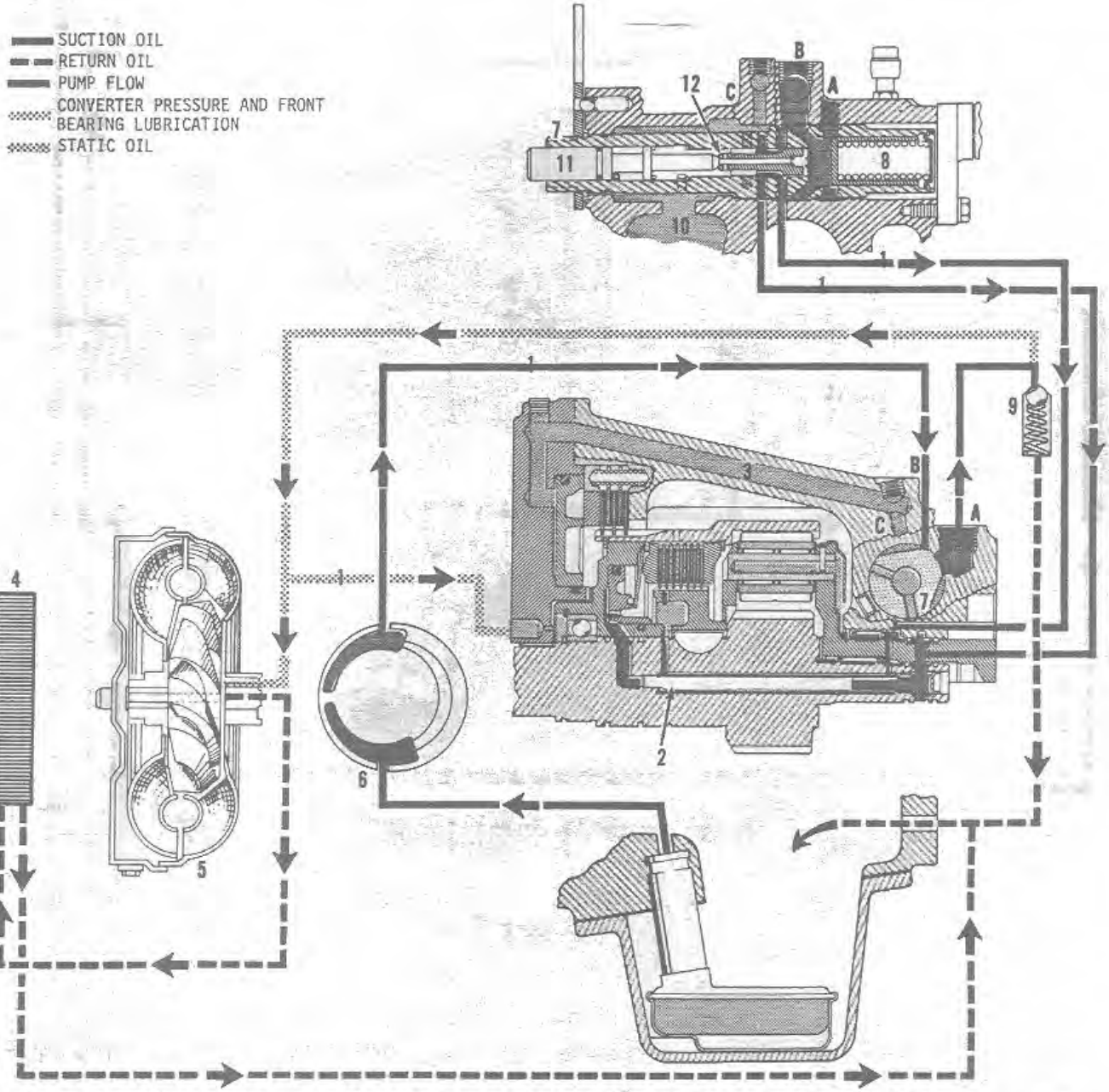


Figure 2

Power Shuttle in Reverse

With the control valve in the reverse position, oil at system pressure flows from the control valve through a passage in the shuttle case to the adapter and into the reverse clutch cavity. As pressure in the cavity increases, the piston pushes against the pressure plate which in turn pushes against the clutch discs and locks them together. The steel discs are secured to the shuttle case and the friction discs are secured to the ring gear. With the clutch discs locked together the ring gear cannot rotate. However, the rotation of the input shaft causes the pinion gears to rotate on their shafts which in turn causes the pinion cage/output shaft to rotate within the ring gear reversing the direction of the machine.

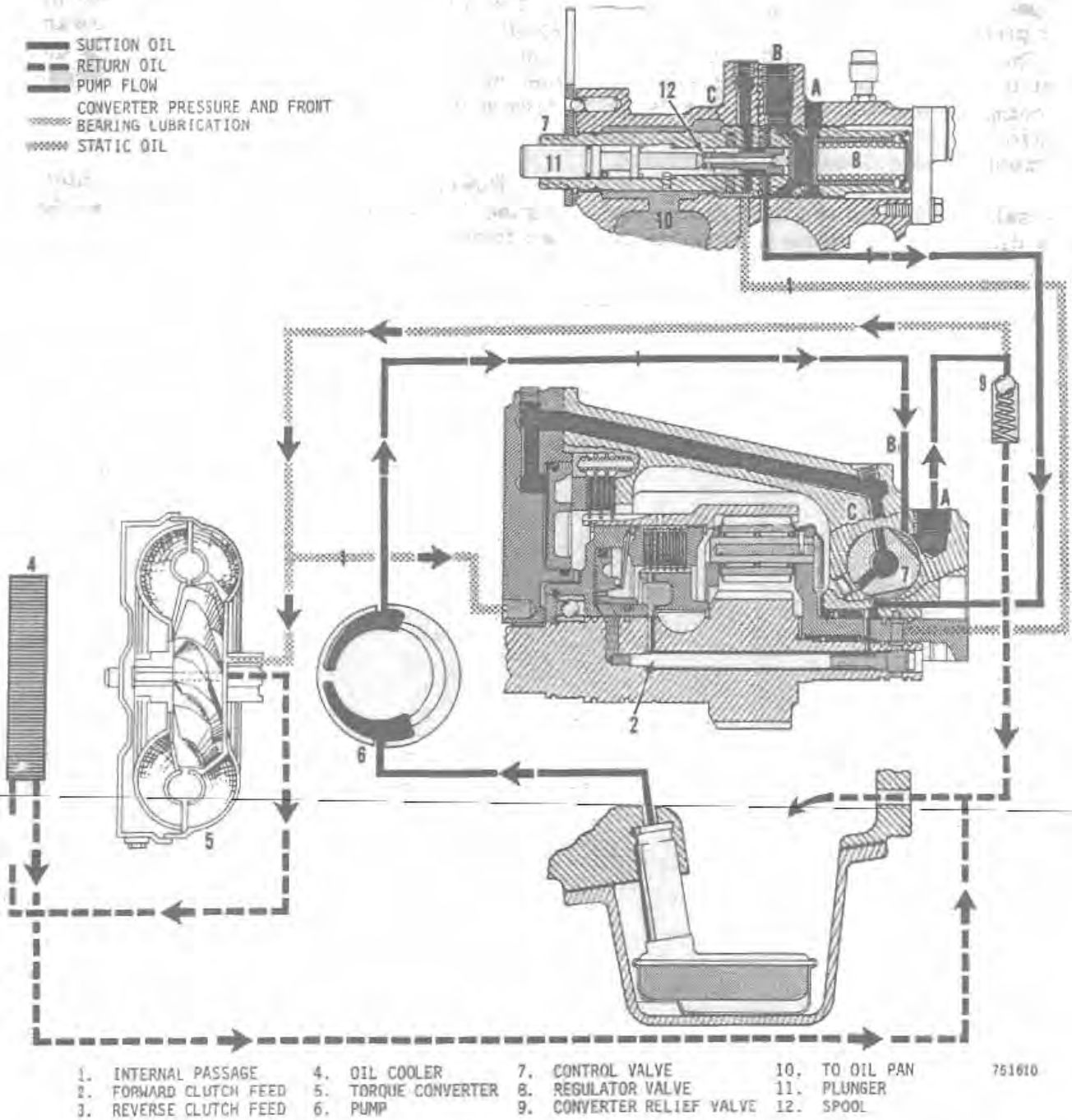


Figure 3

Power Shuttle in Forward, Clutch Cutout Solenoid Actuated

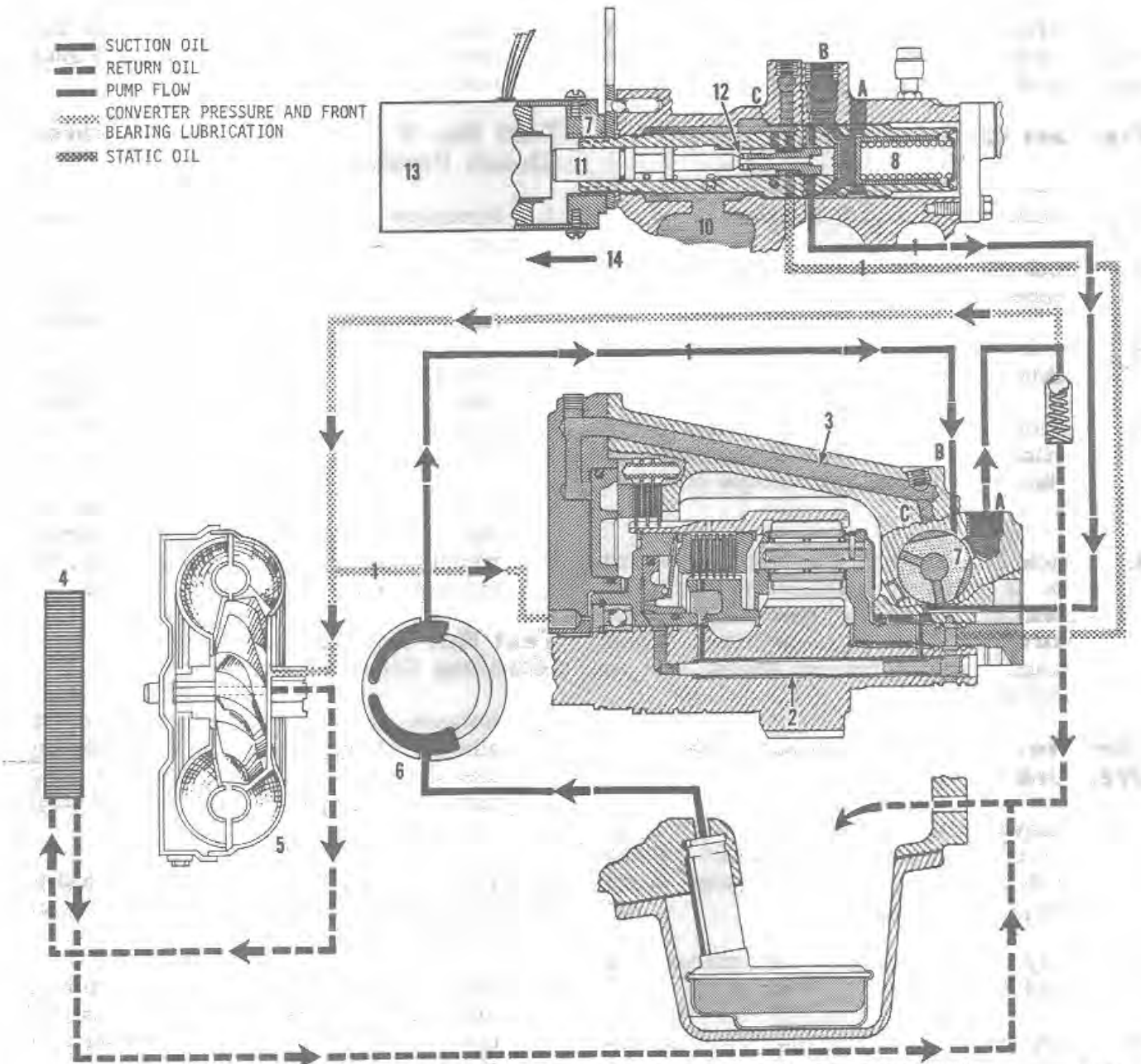
The clutch cutout feature allows power to be interrupted without manually placing the control valve in Neutral. In some loading operations it is desirable to disengage the power shuttle to make maximum engine power available to the hydraulic pump.

The clutch cutout solenoid can be actuated by depressing the combined brake pedal (far right) or the right wheel brake pedal (center pedal) or by depressing the switch in the floor plate just below the individual brake pedals. The clutch cutout control in the instrument panel must be in the Neutral position to complete the electrical circuit. When the control is in the Drive position, the clutch cutout solenoid cannot be actuated.

The solenoid is screwed onto the control valve as illustrated in Figure 4. The solenoid limits the travel of the plunger and spool, is spring loaded to hold the plunger and spool in place for normal shuttle operation and is electrically actuated for the clutch cutout function.

When the solenoid is actuated the springs behind the plunger and spool position the spool in the control valve to block oil flow to the forward clutch. At the same time the spool connects the passage to the forward clutch cylinder to an exhaust passage in the control valve to immediately relieve pressure at the forward clutch.

Power to the reverse clutch is interrupted in the same manner as described for the forward clutch.



1. INTERNAL PASSAGE
2. FORWARD CLUTCH FEED
3. REVERSE CLUTCH FEED
4. OIL COOLER
5. TORQUE CONVERTER
6. PUMP
7. CONTROL VALVE
8. REGULATOR VALVE
9. CONVERTER RELIEF VALVE
10. TO OIL PAN
11. PLUNGER
12. SPOOL
13. CLUTCH CUTOUT SOLENOID ACTUATED.
14. PLUNGER (11) AND SPOOL (12) SHIFTED THIS DIRECTION.

Figure 4

TROUBLE SHOOTING WITH A PRESSURE GAUGE

NOTE: A check will be found at the end of this section that can be copied on any type of copying machine.

Pre-Test Checks

These checks must be made before making the following pressure checks.

1. Check to see if shuttle oil should be changed (normal maintenance).
2. Check shuttle oil level as instructed in this section.
3. Perform stall checks as instructed in Section 2050 to be sure the problem is in the power shuttle (or torque converter).
4. Check to see that the shuttle control arm is properly positioned. The steel detent ball should be seated against the control arm in each position. Adjust linkage and/or free up detent ball as required.

Test No. 1 - Pump (Main Line) Pressure

1. Remove the 3/8" pipe plug on the top rear of the shuttle and connect a 0-600 psi (0-2136 kPa) pressure gauge to the open port, Figure 5.
2. Apply parking brake and place four speed transmission in Neutral.
3. Start engine, run at low idle and observe pressure gauge and record the reading. Increase engine speed to 2000 rpm (r/min) and record pressure gauge reading.

Test No. 2 - Forward and Reverse Clutch Pressure

1. Pressure gauge installation is the same as Test No. 1.
2. Be sure parking brake is applied and four speed transmission is in Neutral.
3. Place power shuttle in Forward and check clutch pressure with the engine running at low idle and at 2000 rpm (r/min). Record pressure readings.
4. Place power shuttle in Reverse and check clutch pressure with the engine running at low idle and at 2000 rpm (r/min). Record pressure readings.

Test No. 3 - Converter Out (Cooling Circuit) Pressure

1. Remove the 1/8" pipe plug from the adapter at the front of the shuttle, Figure 5, and connect a pressure gauge that will acurately indicate low pressures.
2. Be sure parking brake is applied and the shuttle and four speed transmission are in Neutral.
3. Start engine and run at 2000 rpm (r/min). Check and record pressure with the shuttle in Neutral, Forward and Reverse.

REF.	PART NO.	DESCRIPTION	REQ'D
1.	M20671	MULTI-GAUGE	1 (OR OTHER SUITABLE GAUGE)
2.	A22790	SNUBBER	1
3.	PURCHASE LOCALLY	1/4" NPT COUPLING	1
4.	220-221	1/4" NPT MALE HOSE FITTING	1
5.	A21570	1/4" I.D. BULK HOSE (LONG ENOUGH TO REACH OPERATORS COMPARTMENT)	
6.	220-201	7/16"-20 JIC SWIVEL HOSE FITTING	1
7.	218-441	7/16"-20 JIC TO 1/8" NPT ADAPTER	1
8.	221-52	3/8" NPT TO 1/8" NPT REDUCER	1 (TESTS 1 AND 2 ONLY)

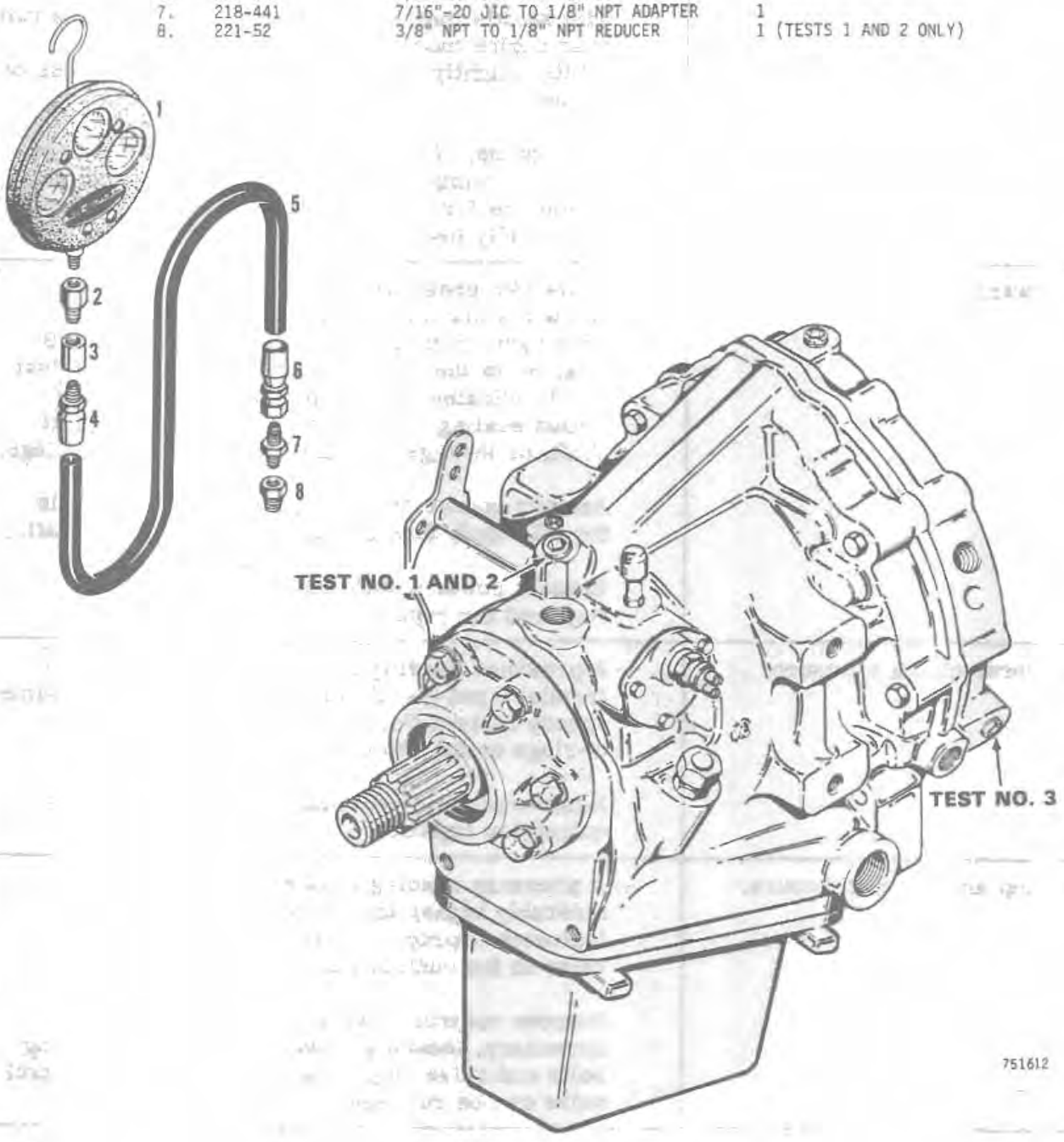


Figure 5

Interpreting Test Results

Pressure Indication	Possible Cause and Repair
Low pump (main line) pressure.	Sticking regulator valve or broken regulator valve spring. Remove control valve from shuttle case and remove regulator valve. Check for broken or weak spring or foreign material that may cause valve to stick. Remove control valve with shuttle installed. If necessary, loosen the two rear engine mounting bolts and raise rear of shuttle slightly so control valve will clear boss on frame. Worn pump. The shuttle must be removed to replace the pump. Do not declare the pump at fault unless the forward and reverse clutch pressures are equally low.
Low forward clutch pressure.	A low idle pressure reading 25 psi (172 kPa) below the low idle reading in Test No. 1 or a 2000 rpm (r/min) pressure reading 10 psi (69 kPa) below the 2000 rpm (r/min) reading in Test No. 1 indicates leakage past the metal and/or Teflon sealing rings on the input and/or output shaft, or leakage past the clutch cylinder O-rings. Another source of leakage but very unlikely, is the oil supply tube or cup plug in the input shaft. Remove power shuttle and disassemble as required for repair.
Low reverse clutch pressure.	A pressure reading at low idle or at 2000 rpm (r/min) 5 psi (34 kPa) below readings at the same speeds in Test No. 1 indicate leakage past the O-rings on the reverse clutch piston. Remove power shuttle and disassemble as required for repair.
High pump and clutch pressure.	A pressure reading at 2000 rpm (r/min) considerably higher than obtained in Test no. 1 indicates improper operation of the regulator valve in the control valve. Remove control valve and check for cause. If necessary, loosen the two rear engine mounting bolts and raise rear of shuttle slightly so control valve can be removed.
Pump pressure as specified, no forward or reverse clutch pressure.	Clutch cutout solenoid not operating properly or cutout spool in control valve is stuck. Check solenoid first. If solenoid is not the problem, remove the control valve, disassemble and check for cause. See preceding paragraph concerning control valve removal.

Pressure Indication	Possible Cause and Repair
Pump pressure as specified, no forward or reverse clutch pressure (Cont'd)	Another possible cause could be a faulty clutch cutout switch; brake pedal or foot operated.
High converter out (cooling circuit) pressure.	A pressure reading considerably higher than specified is an indication of a restriction in the oil cooling circuit. Remove oil cooler, connecting hoses and tubes and check for restriction.
Low converter out (cooling circuit) pressure in Neutral.	A slightly low pressure reading is of little concern. However, the pressure will drop as pump volume falls because of wear. If the reading is extremely low and pump (main line) pressure is as specified, it indicates a damaged converter and replacement of the converter.
Low converter out (cooling circuit) pressure with Forward or Reverse clutch applied.	A considerably lower pressure reading with a clutch applied in comparison to converter out pressure in Neutral indicates a clutch circuit problem. At the same time, Test No. 2 should also show low pressure and clutch circuit problem.

TROUBLE SHOOTING CHART

NOTE: The following problems and possible causes are not listed in order of importance or occurence.

PROBLEM	POSSIBLE CAUSE	REMEDY
External oil leak	Adapter to shuttle case cap screws loose.	Remove shuttle. Check for damaged gasket and tighten cap screws.
	Oil line connections loose.	Tighten as required.
	Damaged or worn control valve O-ring.	Remove control valve and replace O-ring.
	Loose control valve cover or damaged gasket.	Replace cover gasket if necessary and tighten cover cap screws.
	Worn or damaged rear seal.	Replace seal.
	Loose bearing retainer cap screws or damaged gasket.	Replace gasket as required and tighten cap screws.
Low or no oil pressure	Damaged torque converter.	Replace converter.
	Regulator valve in control valve sticking.	Remove control valve, disassemble and check for cause.
	Broken or weak regulator valve spring.	Remove control valve, disassemble and repair as required.
	Low oil level.	Fill to proper level.
	Worn pump.	Remove shuttle and replace pump.
High oil pressure	Regulator valve in control valve sticking.	Remove control valve, disassemble and check for cause.
High oil temperature	Internally or externally plugged oil cooler.	Unplug oil cooler as required.
	Low oil level.	Fill to the proper level.
	Operating at converter stall.	Use clutch cutout. Refer to Operator's Manual.
Control lever does not remain in position position.	Control arm detent spring broken.	Replace spring.
	Control arm detent ball corroded and sticking.	Clean and lubricate ball, spring and bore in shuttle case.
High stall speed with tinny sound	Converter blades damaged.	Replace converter.

580C POWER SHUTTLE CHECK SHEET

OWNER_____ DATE_____

TRACTOR S/N_____ HOURS_____

Pre-Test Checks

Low idle _____rpm (r/min)

Full throttle _____rpm (r/min)

Converter stall_____rpm (r/min)

Hydraulic stall_____rpm (r/min)

Combined stall _____rpm (r/min)

Oil Temperature

Oil temperature gauge needle should be in middle of green zone on gauge.

Test No. 1 - Pump (Main Line) Pressure

	At low idle	At 2000 rpm (r/min)
Neutral only	_____	_____

Test No. 2 - Forward and Reverse Clutch

Forward clutch	_____	_____
Reverse clutch	_____	_____

Test No. 3 - Converter Out Pressure

Neutral	no test	_____
Forward	no test	_____
Reverse	no test	_____

Section 6210

POWER SHUTTLE

J I Case
A Tenneco Company

TENNECO

C.E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Power shuttle dry weight (approx.)		113 pounds (51.3 kg)
Torque converter dry weight (approx.)		32 pounds (14.5 kg)
Springs	Free length (approx.)	Compressed length (approx.)
Regulator valve	2.668" (67.767 mm)	2.073" at 74-82 pounds (52.654 mm at 33.6-37.2 kg)
Plunger	1.45" (36.83 mm)	.86" at 2.7 pounds (21.844 mm at 1.22 kg)
Clutch cutout	.686" (17.424 mm)	.453" at 1.9-2.2 pounds (11.506 mm at 0.86-0.99 kg)
Pressure plate	1.25" (31.75 mm)	1" at 13.5-16.5 pounds (25.4 at 6.12-7.48 kg)

Special torques

Rear bearing retainer cap screws	40-50 foot-pounds (54-67 N m)
Output flange nut	75-85 foot-pounds (102-115 N m)
Adapter cap screws	27-37 foot-pounds (36-50 N m)
Coverter support flat head screw	25-35 inch-pounds (3-4 N m)
Pump mounting cap screws	17-22 foot-pounds (23-29 N m)
Shuttle mounting cap screws	45-55 foot-pounds (61-74 N m)
Flex plate to converter cap screws	28-32 foot-pounds (37-43 N m)
Flex plate to flywheel cap screws	13-15 foot-pounds (18-20 N m)
Universal joint cap screws	20-24 foot-pounds (27-32 N m)

SPECIAL TOOL

The special tool illustrated in Figure 1 must be used whenever the flex plate is being attached to the torque converter. The tool centers the flex plate on the converter. Order part number D51651 from SPS in the usual manner.

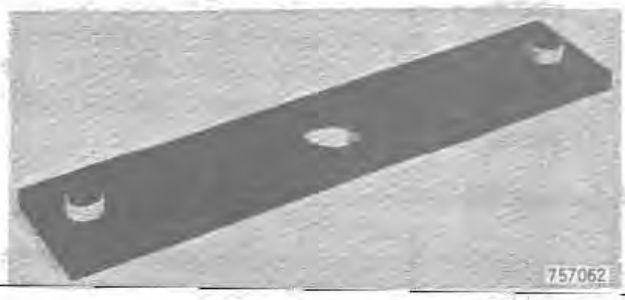


Figure 1

SERVICING THE POWER SHUTTLE

Removal

1. Remove plug from bottom of the flywheel housing. Turn engine over until drain plug in torque converter can be see in hole. Remove the shuttle and converter drain plugs and drain oil. Approximately 8 U.S. quarts (7.5 liters) will be drained.

2. Disconnect drive shaft from power shuttle output flange and remove the drive shaft.

3. Disconnect oil cooler lines at the power shuttle. Remove shuttle dipstick and disconnect fill tube from shuttle.

4. Unplug solenoid wiring harness. Disconnect wiring from temperature sender and neutral switch. Remove ground wire from shuttle valve cover cap screw.

5. Disconnect linkage at shuttle control arm.

6. Place transmission jack under shuttle and remove the six shuttle mounting cap screws, three on each side.

7. Move shuttle straight back using care not to damage the torque converter. Lower shuttle to the floor.

NOTE: Whenever the clutch cutout solenoid is removed, handle the shuttle carefully. If the control valve plunger is pushed in too far, internal damage will result.

Disassembly

1. Before disassembling the shuttle, remove all traces of accumulated dirt.

2. Remove the oil pan and filter screen. The filter screen tube is held by the fit of an O-ring.

3. Remove the four pump mounting cap screws, Figure 2. Then remove pump and gasket from adapter.

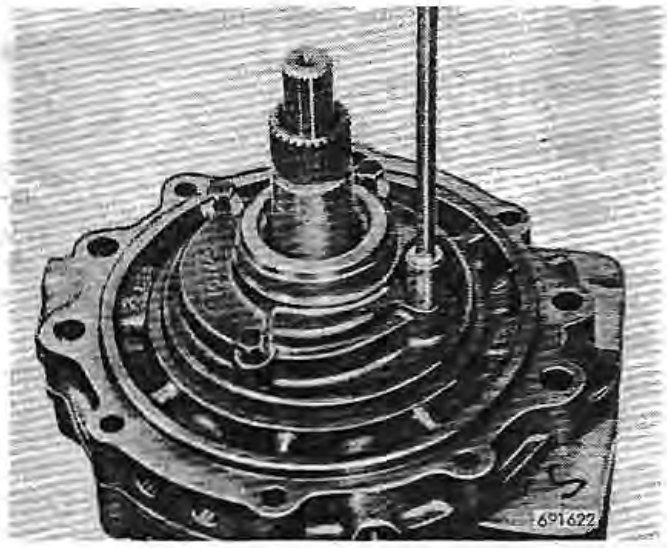


Figure 2

4. Place pump on bench with converter support down and remove flathead screw from rear of pump, Figure 3.

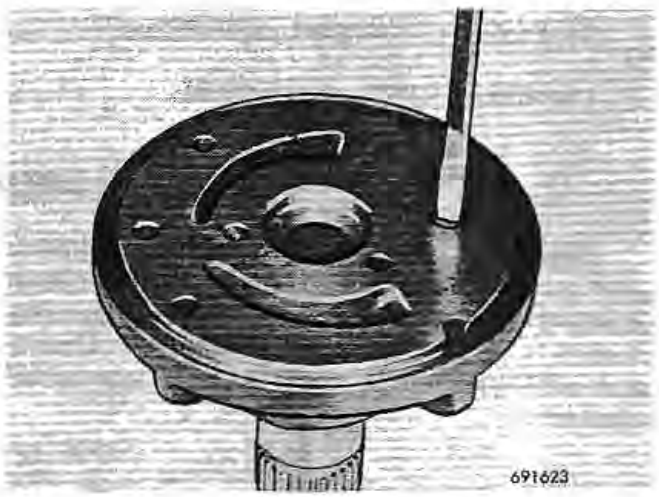
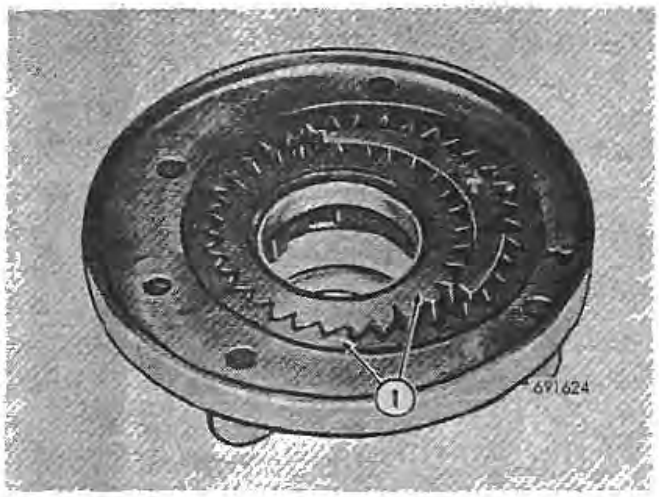


Figure 3

a. Lower pump housing and gears straight down.

b. Before removing the gears mark each gear face to assure that the gears will be properly installed.



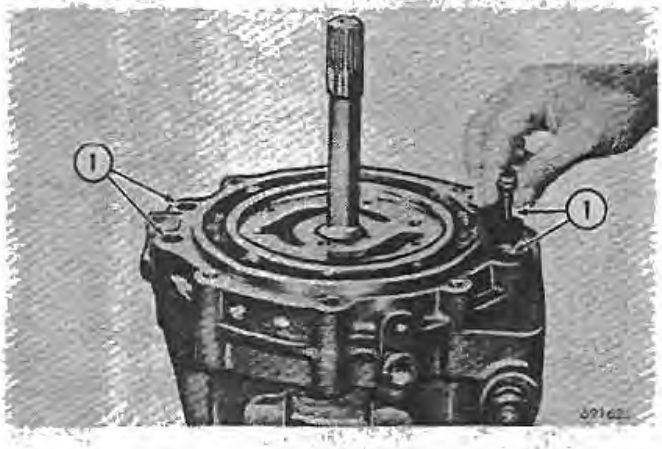
1. MARK GEAR FACES BEFORE REMOVING

Figure 4

5. Remove seal from pump housing and discard seal.

6. Before removing the adapter check input shaft end play with a dial indicator. End play should be between .010" and .086" (0.25-2.18 mm). If end play is greater than specified, check for worn thrust washers and mating parts.

7. Remove the four cap screws which secure the adapter to the shuttle case, Figure 5. Then remove the adapter and reverse piston assembly, Figure 6. Use care when removing the adapter as the reverse clutch pressure plate may stick to the reverse piston. Prevent the pressure plate from falling and causing needless damage.



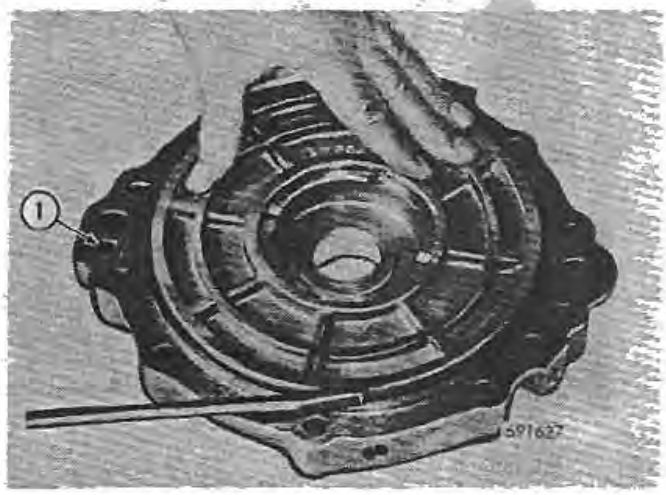
1. CAP SCREWS

Figure 5

Figure 6

8. Remove reverse clutch pressure plate from adapter or shuttle case.

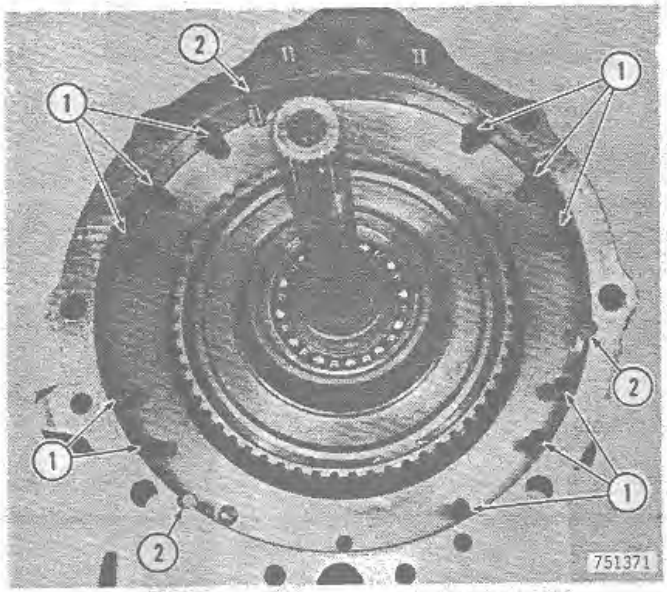
9. Apply compressed air to the reverse clutch supply hole in the adapter to aid in removing piston from adapter, Figure 7. Then remove O-ring from adapter hub and quad ring from piston.



1. REVERSE CLUTCH SUPPLY HOLE

Figure 7

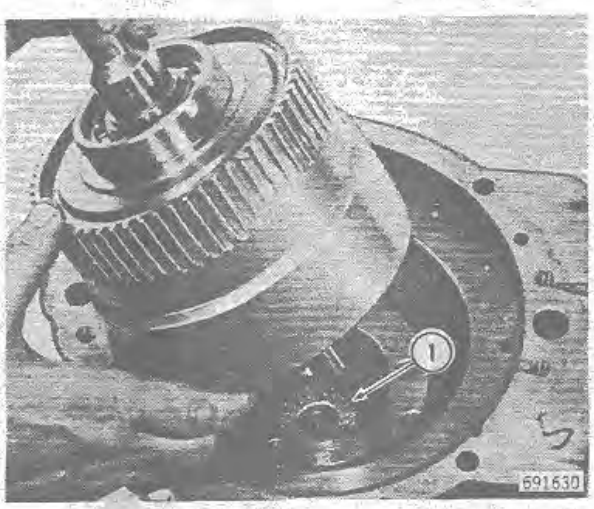
10. Remove the reverse clutch springs, dowel pins and clutch discs, Figure 8.



1. SPRING (11) 2. DOWEL PIN

Figure 8

11. Lift the forward clutch assembly from the shuttle case. Then remove thrust washer from either the rear of the clutch assembly or the pinion cage as oil may cause it to stick to either piece, Figure 9.



1. THRUST WASHER

Figure 9

12. Remove thrust washer from face of forward clutch cylinder and remove bearing retaining ring from input shaft, Figure 10.

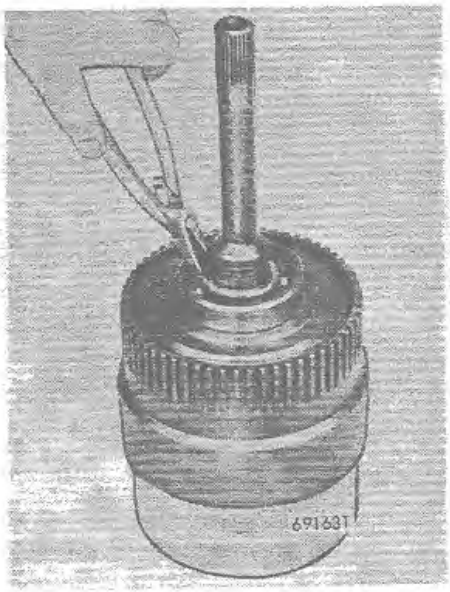


Figure 10

13. Place forward clutch assembly in a press with the input shaft up. Press shaft from clutch. Do not allow shaft to fall to the floor. A soft hammer may also be used to drive shaft from clutch.

14. Place forward clutch assembly on bench with clutch cylinder up. Remove cylinder retaining ring and remove cylinder/piston assembly from ring gear.

NOTE: The cylinder is a light press fit in the ring gear. Press or carefully drive cylinder from ring gear.

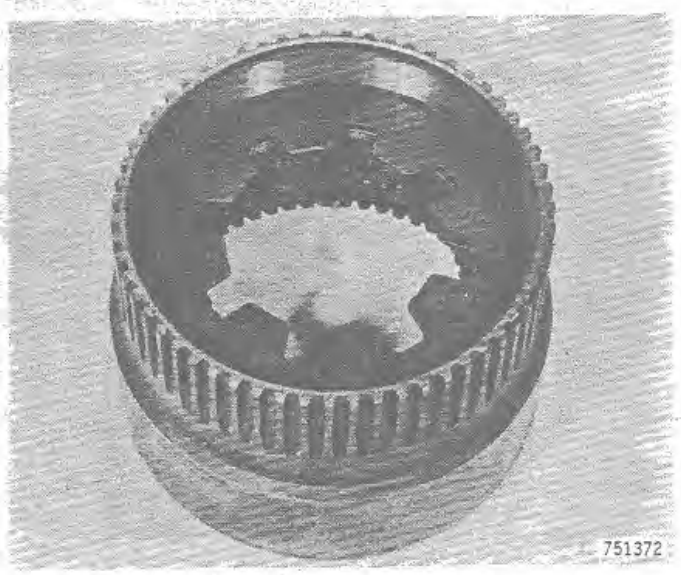


Figure 11

15. Remove the clutch spring, Figure 11, and front pressure plate retaining ring, Figure 12, from ring gear. Remove front pressure plate, clutch discs and rear pressure plate. Then remove rear pressure plate retaining ring.

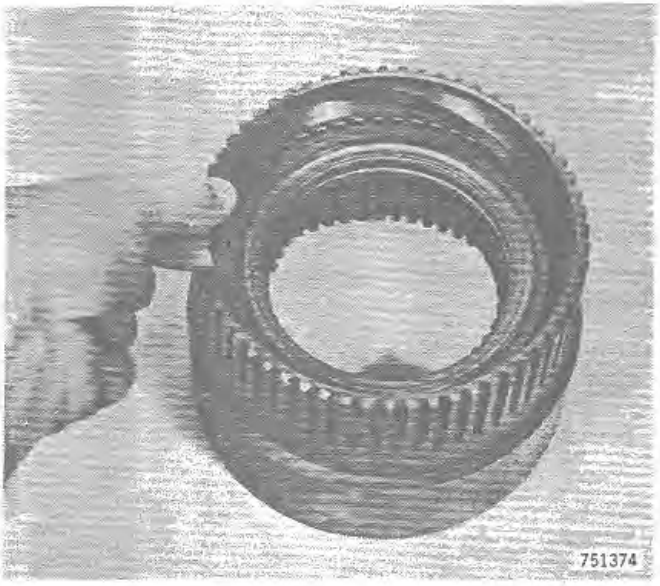


Figure 12

16. Unlock the two large diameter sealing rings on the input shaft. Use a suitable pair of pliers and remove the sealing rings, Figure 13. Then remove the Teflon sealing rings from opposite end of shaft.

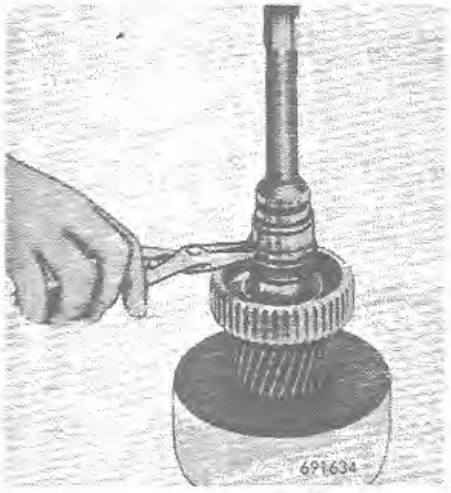


Figure 13

17. Remove the forward clutch hub retaining ring, Figure 14. Place shaft assembly in press with long end of shaft up and press shaft out of hub. Then remove Woodruff key from shaft.

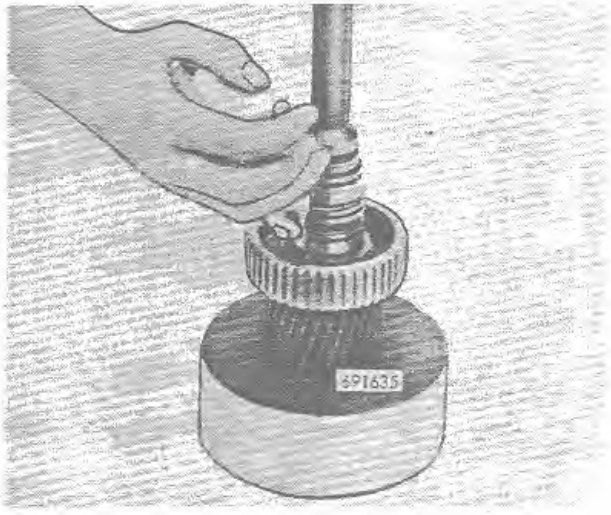


Figure 14

18. Attach a suitable tool to the output flange and remove flange retaining nut. Then remove flange from output shaft.

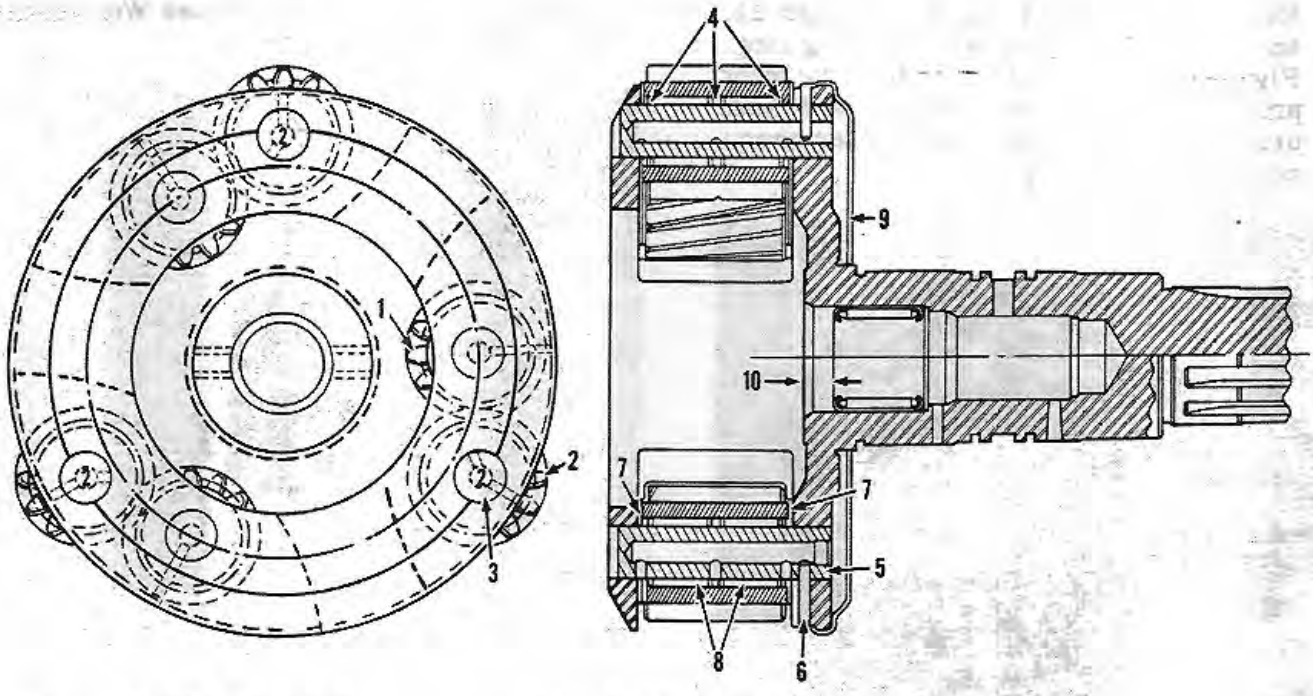
19. Pull pinion cage/output shaft assembly from shuttle case. If necessary, use a soft hammer and tap end of shaft to aid in removal.

20. DO NOT disassemble the pinion cage unless inspection reveals badly worn or damaged parts and a lathe and qualified machinist are available for oil collector ring installation. The oil collector ring must be spin formed to the pinion cage and be leak proof. If disassembly is necessary:

    a. Remove oil collector ring from rear of pinion cage. Damage to the ring from removal will prevent using the ring again.

    b. Remove the pinion shaft retaining pins. Then press the pinion shafts out of pinion cage. There are forty-eight needle bearings and three spacers for each pinion.

    c. Remove pinion gears and thrust washers from pinion cage. Keep mating gears and thrust washers together if they are to be used again.



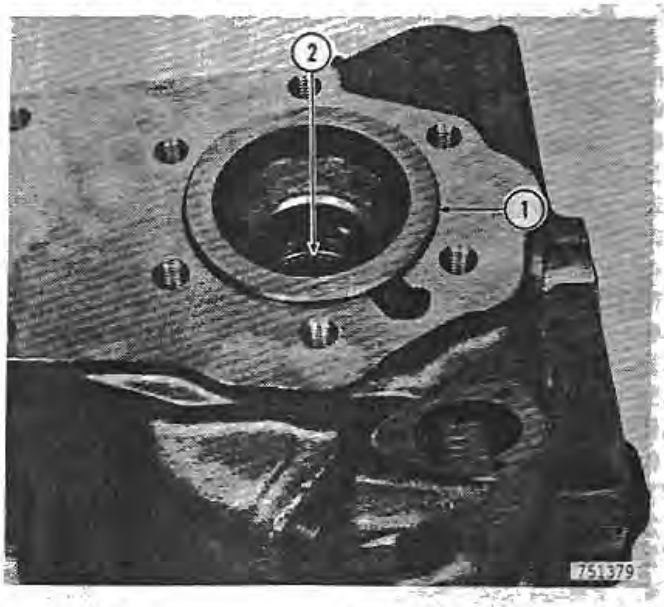
1. INNER PINION GEAR (PLAIN TEETH)
2. OUTER PINION GEAR (NOTCHED TEETH)
3. PINION SHAFTS STAMPED WITH NUMBER 2 MUST BE INSTALLED IN OUTER PINION GEARS
4. NEEDLE BEARING SPACER (3 PER PINION GEAR)
5. PINION SHAFT
6. PINION SHAFT RETAINING PIN
7. THRUST WASHER (2 PER PAIR OF PINION GEARS
8. NEEDLE BEARINGS (48 PER PINION GEAR)
9. OIL COLLECTOR RING
10. 5/16" (7.9 mm)

Figure 15

21. Remove needle bearing from bore in pinion cage/output shaft only when inspection indicates replacement. Use a puller that will not damage the bearing bore.

22. Remove rear bearing retainer cap screws and retainer. Remove gasket from shuttle case or bearing retainer. The bearing is a slip fit in the retainer; remove bearing from retainer.

23. DO NOT remove the sleeve or needle bearing from shuttle case, Figure 16, unless inspection indicates parts replacement.



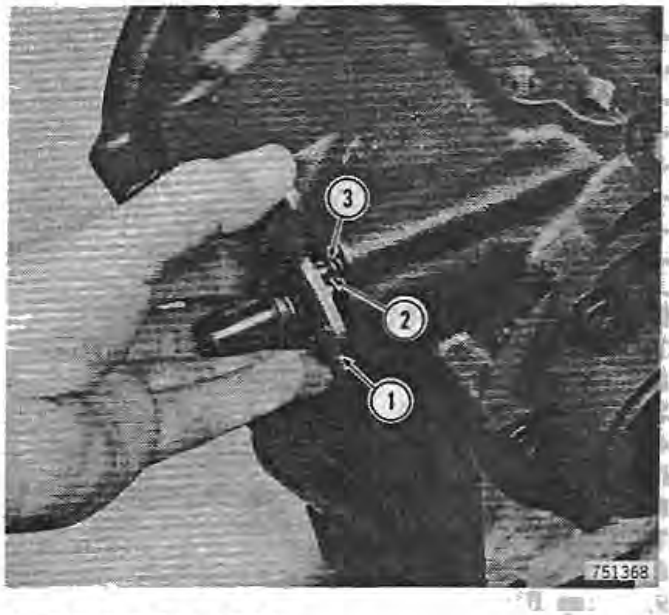
1. SLEEVE 2. NEEDLE BEARING

Figure 16

24. Unscrew clutch cutout solenoid from control valve. Remove control arm, Figure 17, using care not to loose steel ball and spring, Then remove spring, and snap ring from control valve, Figure 18.

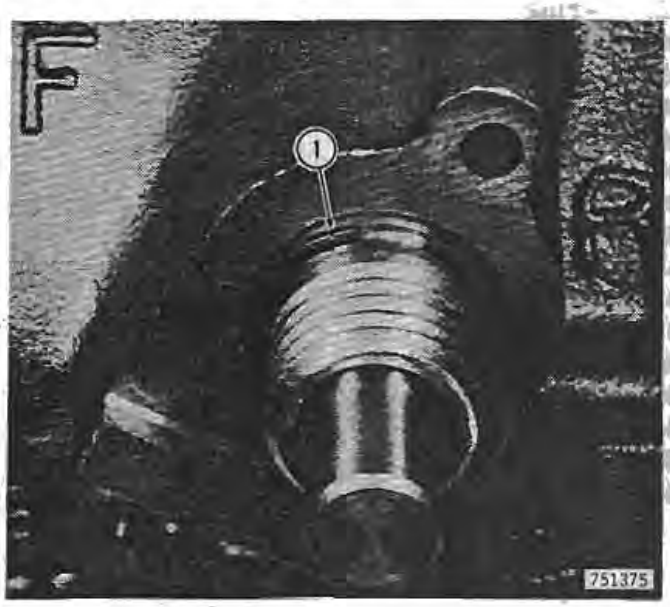
25. Remove valve cover retaining cap screws, cover, gasket, neutral start cam, and fill tube fitting. Push control valve part way out of shuttle case then pull valve from case.

26. Refer to Figure 20. Place control valve on a piece of wood and drive the two roll pins out of the control valve. Remove plunger, plunger spring, spool and spool spring from the control valve. Remove O-ring from plunger and valve body.



1. CONTROL ARM
2. DETENT BALL
3. SPRING

Figure 17



1. SNAP RING

Figure 18

27. Place control valve between two blocks of wood in a machinists vise with the regulator valve up. Then compress regulator valve spring in a press and remove the snap ring. Refer to Figure 20. Remove valve from press and remove the spring seat, spring and regulator valve the valve body. Do not remove expansion plug from bore in control valve.

1. Seal
2. Pump Housing
3. Bushing
4. Drive Gear
5. Driven Gear
6. Converter Support
7. Gasket
8. Adapter
9. Gasket
10. Reverse Clutch
11. Piston
12. Quad Ring
13. Pressure Plate
14. Dowel Pin (3)
15. Spring (11)
16. Friction Disc (3)
17. Lugged Disc (2)
18. Forward Clutch
19. Snap Ring
20. Ball Bearing
21. Thrust Washer
22. Cylinder
23. Piston
24. Clutch Spring Bearing Ring
25. O-ring
26. Clutch Spring
27. Front Pressure Plate
28. Friction Disc (7)
29. Steel Disc (6)
30. Rear Pressure Plate
31. Clutch Hub
32. Ring Gear
33. Select Fit Snap Ring
34. Metal Sealing Ring
35. Input Shaft
36. Woodruff Key
37. Teflon Sealing Ring
38. Forward Clutch Supply Tube
39. Cup Plug
40. Bronze Thrust Washer
41. Pinion Cage/Output Shaft Assembly
42. Pinion Cage/Output Shaft
43. Needle Bearing
44. Oil Collector Ring
45. Long Retaining Pin
46. Short Retaining Pin
47. Inner Pinion Shaft (3)
48. Outer Pinion Shaft (3)
49. Outer Pinion Gear (3)
50. Inner Pinion Gear (3)
51. Needle Bearing (48 per gear)
52. Bearing Spacer (3 per gear)
53. Thrust Washer (2 per gear set)
54. Oil Baffle
55. Shuttle Case
56. Breather
57. Clutch Cutout Solenoid
58. Control Arm
59. Steel Ball (detent)
60. Detent Spring
61. Plunger
62. Plunger Spring
63. Clutch Cutout Spool
64. Cutout Spool Spring
65. Roll Pin
66. Control Valve
67. Expansion Plug
68. Regulator Valve
69. Regulator Valve Spring
70. Spring Seat
71. Neutral Start Cam
72. Valve Cover
73. Neutral Start Switch
74. Filter Screen
75. Oil Pan
76. Sleeve
77. Bearing Retainer
78. Yoke
79. Washer
80. Self-locking Nut

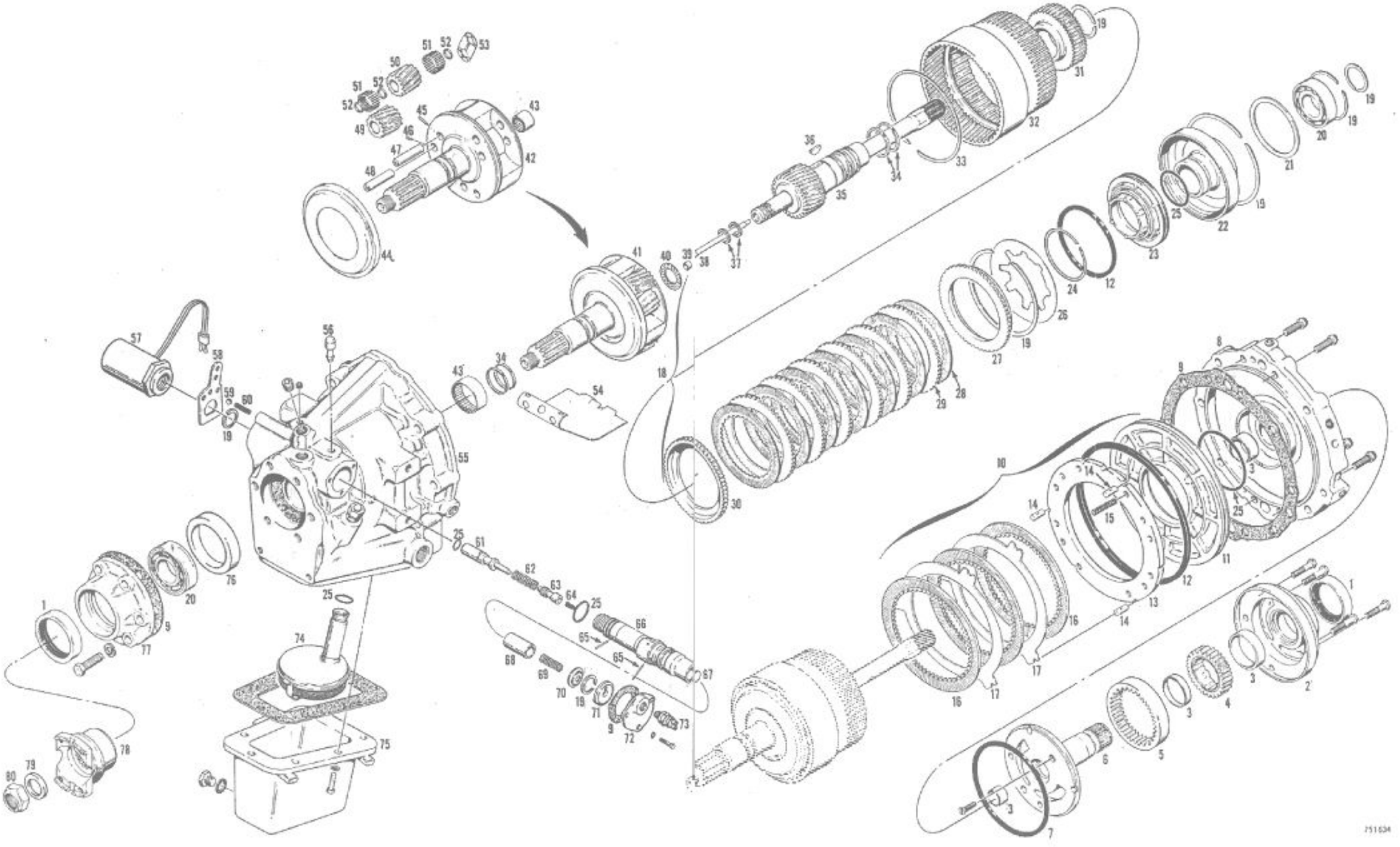
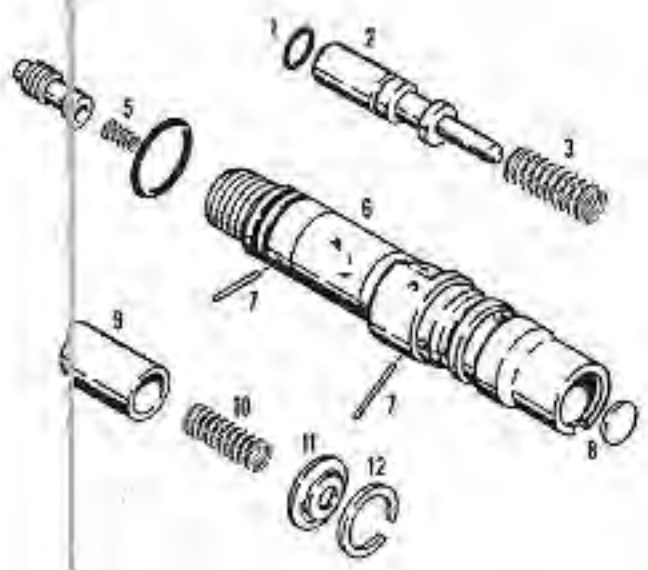


Figure 19



1.	O-RING	7.	ROLL PIN
2.	PLUNGER	8.	EXPANSION PLUG
3.	PLUNGER SPRING	9.	REGULATOR VALVE
4.	SPOOL	10.	REGULATOR VALVE SPRING
5.	SPOOL SPRING	11.	SPRING SEAT
6.	VALVE BODY	12.	SNAP RING

Figure 20

28. emove baffle from shuttle case. The affle is a snap fit on bosses in the case. ush baffle off bosses and remove from ase.

Inspection

Pump

1. nly the front seal is a serviceable part. other parts of the pump should re- uire replacement, the complete pump ust be replaced.

   OTE: Clearance in excess of .0025" 0.063 mm) between the gear faces and ump housing and converter support will ffect pump output at high oil temper- tures. Therefore, a pump that is worn o the point of repair may look good. If ll pressure was low in Neutral and Re- erse and all valves are working prop- rly, the pump should be replaced.

2. heck gears for excessive wear, nicks n gear teeth and scored faces. Also check ushing in drive gear for wear, pitting nd scoring.

3. Check housing for cracks, excessive wear, pitting and scoring.

4. Check converter support for signs of cracks and wear from gears. Also check bushing for wear, pitting and scoring.

Adapter

1. Check adapter for cracks and wear in the piston area. Make sure all passages in adapter are open and free of foreign matter. Also check bushing for wear, pitting and scoring.

Reverse Clutch

1. Check reverse clutch piston for wear, scoring and nicks and burrs on the inside and outside diameters.

2. Check pressure plate for wear and scoring on the rear (clutch disc) face.

3. Check the pressure plate springs for distortion and signs of cracking. The free height of the springs should be very close to being equal.

4. Check dowel pins for wear.

5. Check the reverse clutch discs for wear on faces and teeth. All the discs should be flat.

Forward Clutch

1. Check forward clutch cylinder for wear and scoring in the piston and input shaft bores.

2. Check the clutch piston for wear and scoring on the inside and outside diameters. Also check to see that bleed hole in piston is open, Figure 21.

3. Check the front and rear pressure plate faces for wear and scoring. Also check teeth for wear.

4. Check the friction discs for wear, metal build up and discoloration due to excessive heat. If the discs are smooth or nearly smooth they should be replaced. All friction discs should be replaced at replaced at the same time.

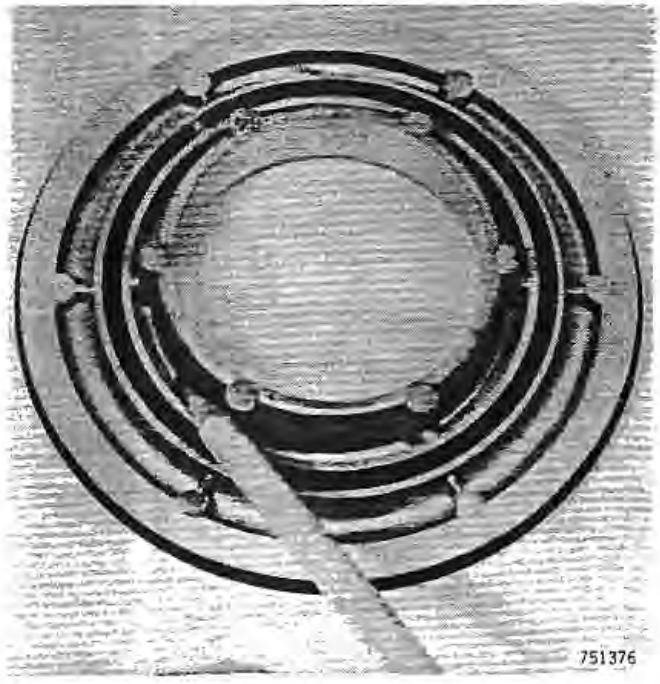


Figure 21

5. Check the steel discs for wear, scoring, metal build up and discoloration due to excessive heat. The disc should be slightly coned but not warped. All steel discs should be replaced at the same time.

6. Check the clutch spring for signs of cracking and loss of cone.

7. Check clutch hub for wear. Also check keyway for wear.

8. Check ring gear for wear and damage that could result in failure.

9. Check input shaft for wear and scoring in the bearing contact area. Check drive gear teeth for wear, nicks and other damage. Make sure oil passages are open and free of foreign matter.

Pinion Cage/Output Shaft Assembly

NOTE: Disassemble pinion cage only if inspection reveals defective parts and a lathe and qualified machinist are available.

1. Check pinion gears for free rotation. Also check gear teeth for nicks and scoring.

2. Check for excessive pinion gear end play between thrust washers.

3. Check needle bearing in output shaft for flat spots, gallings, etc. If no defects are found and the needles are free of excessive play and remain in the cage there is no need to replace the bearing.

4. Check splines on output shaft for cracks and burrs.

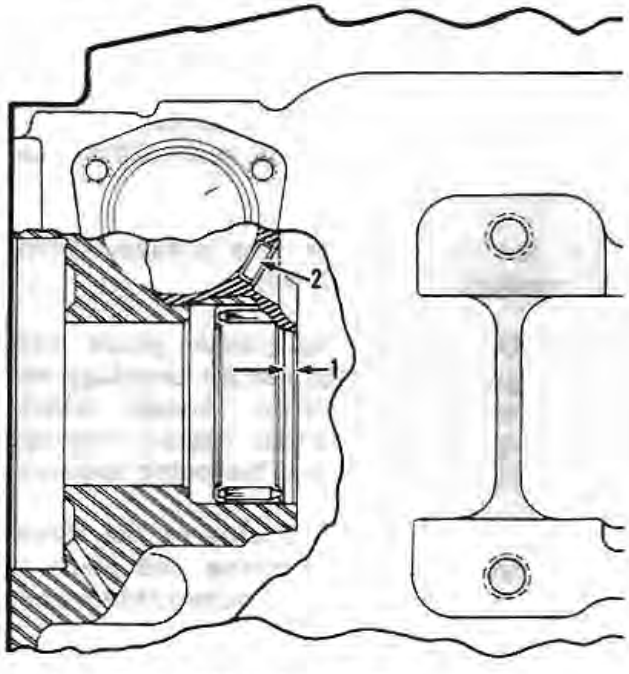
Other Components

1. Discard all seals, O-rings, metal sealing rings and Teflon sealing rings.

2. Check thrust washers for wear and scoring.

3. Check shuttle case for cracks and other damage. Make sure all passages are open and free of foreign matter. Check needle bearing in case for flat spots, galling, etc. If no defects are found and the needles are free of excessive play and remain in the cage there is no need to replace the bearing.

Assembly



1. 1/8" ± 1/32" (3.2 ± 0.8 mm)
2. CUP PLUG (SHOULD RARELY NEED REPLACING) 751636

Figure 22

1. If the sleeve was removed from the rear of the shuttle case, press in a new sleeve at this time. When the sleeve is seated in the bore it will extend beyond the case about 1/8" (3.2 mm).

2. Press new needle bearing into shuttle case to the dimension shown in Figure 22. If bearing has part number or other markings on one end, press against this end of bearing.

3. Position oil baffle under the two bosses on rear of case as shown in Figure 23.

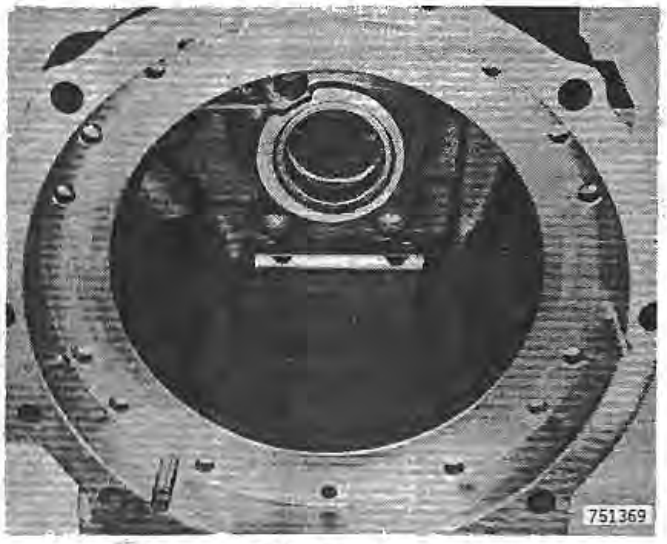


Figure 23

4. Place front edge of baffle on ledge at front of case and lift rear of baffle and snap over bosses at the rear of the case, Figure 24.

5. If the pinion cage was disassembled, reassemble as follows:

   a. Coat inside of pinion gears with grease to hold needle bearings and spacers in place. Install middle spacer and install needle bearings (48 per gear) and the outer spacers.

   b. Coat the smooth side of the thrust washers with grease and place in pinion cage with grooved side toward the gears.

   c. Install the gears with notches in teeth between thrust washers and align with the outer pinion shaft holes.

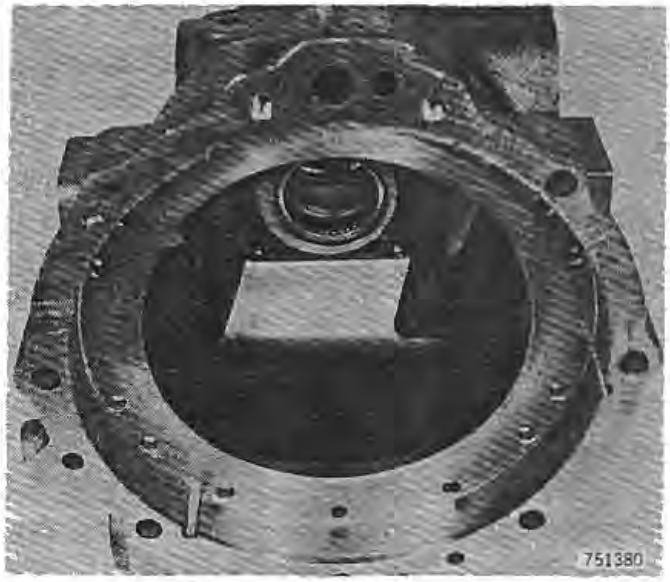


Figure 24

   d. Press pinion shafts with the number 2 stamped on end of shaft into the outer shaft holes. Be sure retaining pin hole in shaft and pinion cage are aligned. Secure shafts in place with retaining pin.

   e. Place remaining pinion gears between thrust washers and press pinion shafts into place. Be sure retaining pin hole in shafts and pinion cage are aligned. Secure shafts in place with retaining pin.

   NOTE: The next step must be completed on a lathe by a qualified machinist.

   g. Place oil collector on rear of pinion cage. Place pinion cage assembly in lathe and form the oil collector ring against the pinion cage to form an oil tight seal. Remove any burrs made during forming.

6. Press new needle bearing into output shaft to the dimension shown in Figure 15. If bearing has part number or other markings on one end, press against this end of bearing.

7. Place pinion cage/output shaft assembly on a block 5" (127 mm) in diameter and 2-7/8" (73 mm) high with the shaft up. Then place these parts in a press.

8. Lower the shuttle case over the output shaft. The case should be resting against the press bed.

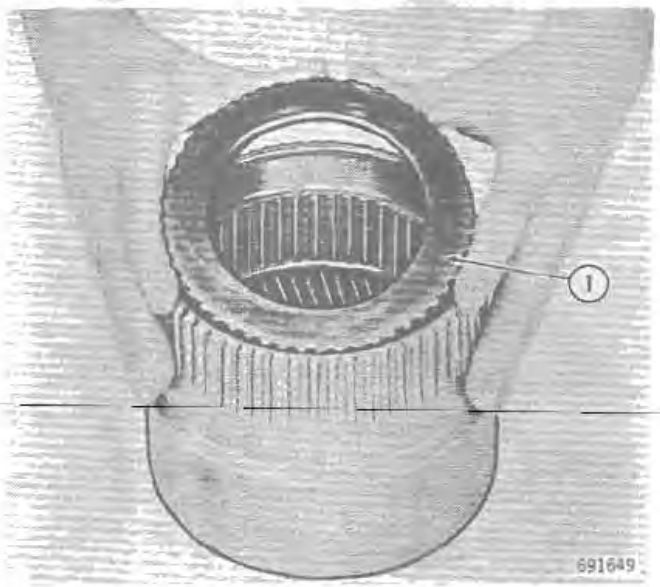
9. Start the rear bearing onto the output shaft. Then use a driver that contacts both the inner and outer bearing races and press bearing onto shaft until seated against the sleeve.

10. Press a new seal into bearing retainer until seated against shoulder in seal bore.

11. Place new bearing retainer gasket on shuttle case. Install bearing retainer over bearing. Press retainer into place if necessary. Torque bearing retainer cap screws to specification on page 6210-3.

12. Install output flange on shaft and secure in place with washer and nut. Attach a suitable tool to the flange and torque nut to specification on page 6210-3.

13. Place ring gear on clean bench with the outside teeth up, Figure 25. Then install rear pressure plate with smooth surface up. The rear pressure plate is recessed on one side.



1. SMOOTH FACE OF PRESSURE PLATE UP

Figure 25

14. Lubricate the clutch discs with clean Case TCH Fluid. Place a friction disc and then a steel disc in the ring gear. Continue alternating discs until all discs have been installed, Figure 26.

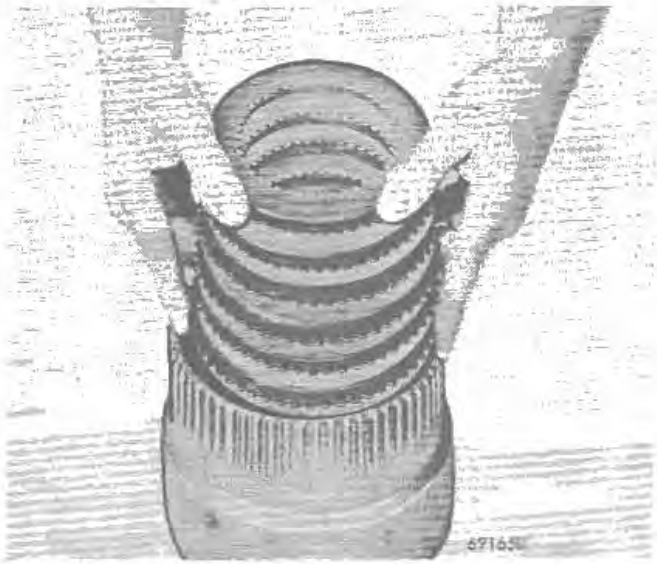
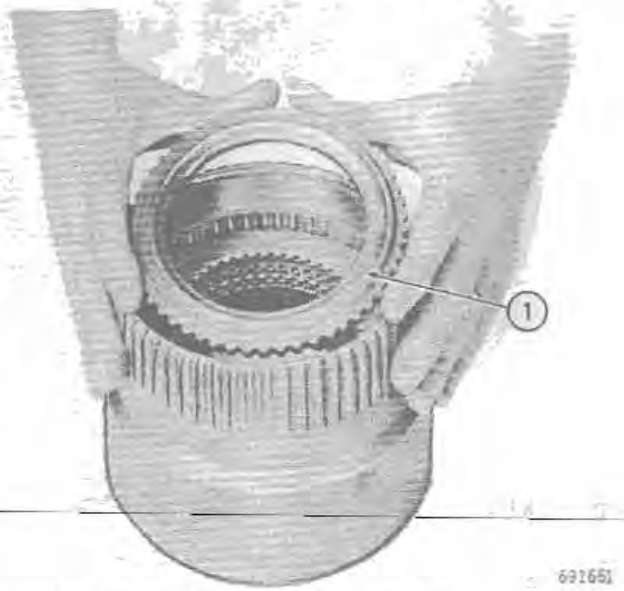


Figure 26

15. Install front pressure plate in ring gear with smooth face down, Figure 27.



1. SMOOTH FACE OF PRESSURE PLATE DOWN

Figure 27

16. Install the front pressure plate retaining ring, Figure 28. Make sure the proper ring is installed. This ring measures .090"-.093" (2.29-2.36 mm) thick and has a free diameter of 5-19/32" (142.1 mm).

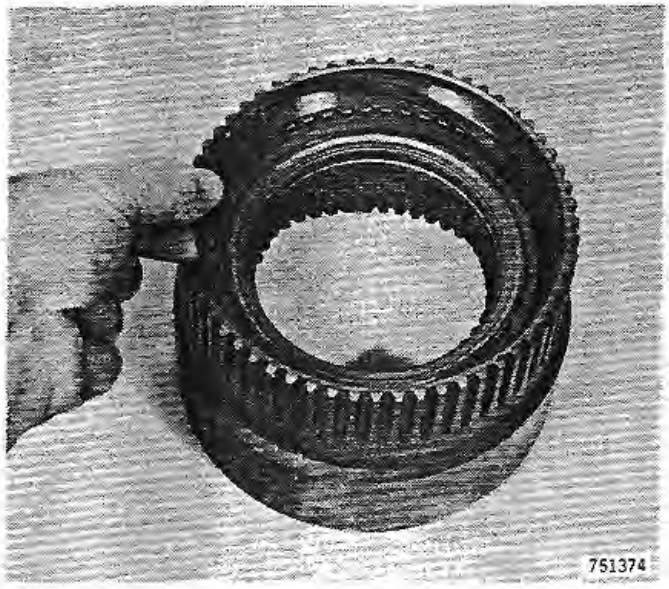
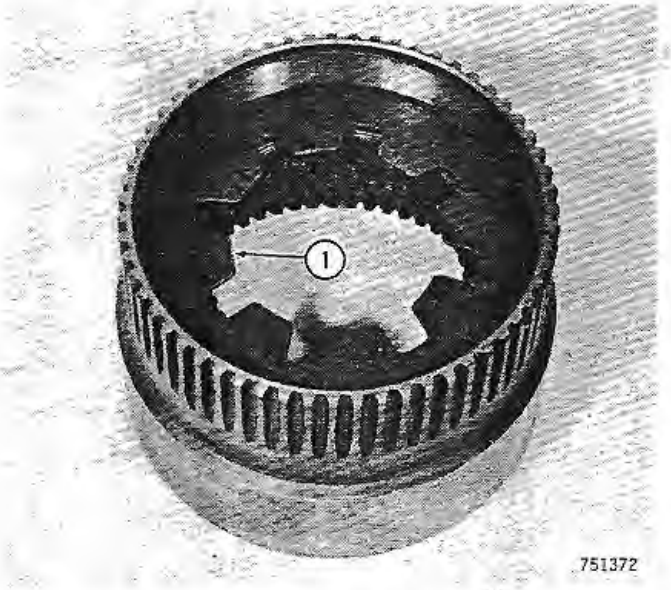


Figure 28

17. Place forward clutch spring in ring gear with fingers up, Figure 29.



1. INSTALL SPRING WITH FINGERS UP

Figure 29

18. Lubricate new forward clutch piston quad ring and install quad ring in groove in piston, Figure 30. Then install clutch spring bearing ring in groove in piston. Be sure ring is seated in groove.

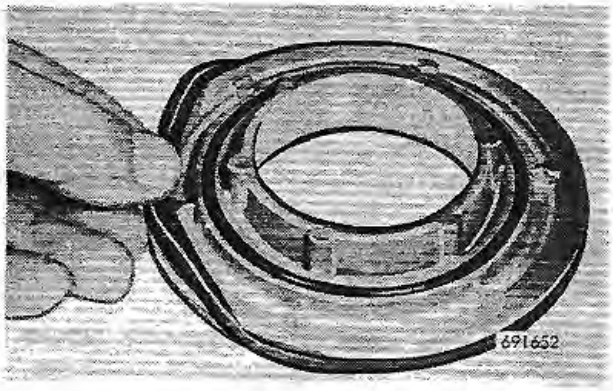


Figure 30

19. Install O-ring in groove in forward clutch cylinder hub, Figure 31.

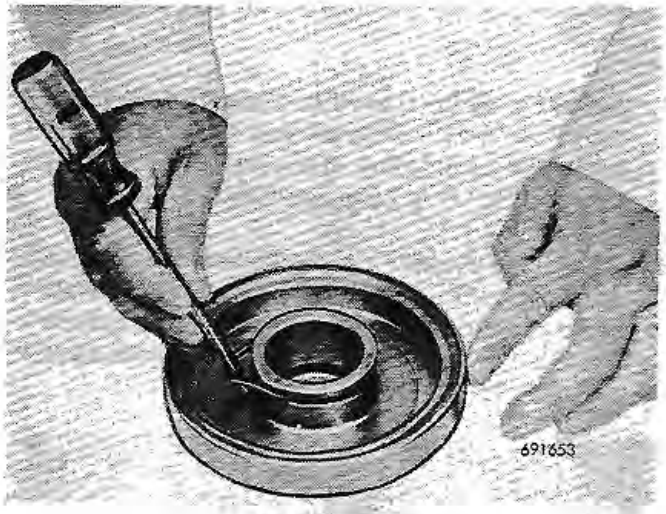


Figure 31

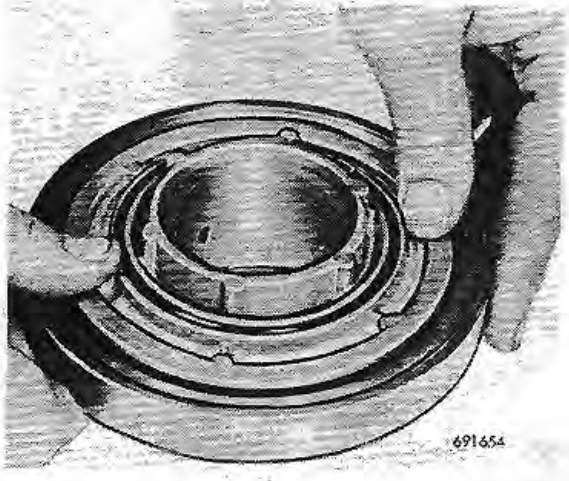
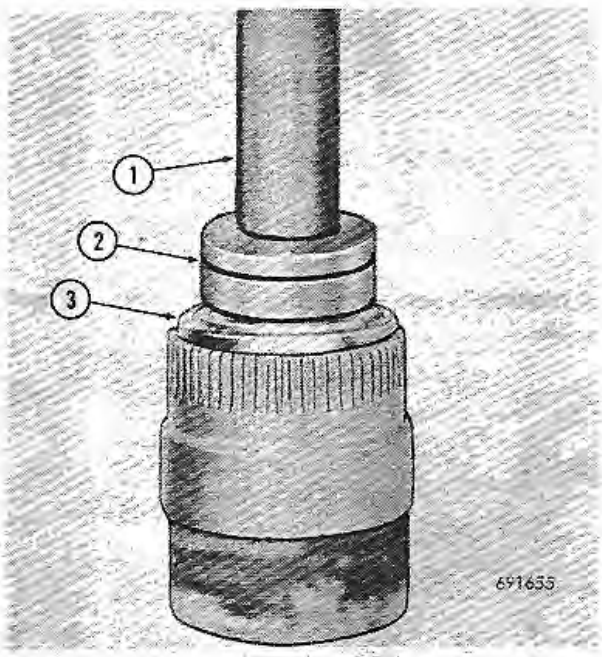


Figure 32

20. Lubricate the cylinder wall and hub with clean oil. Start piston squarely into cylinder and push into cylinder until it bottoms, Figure 32. The piston can be pressed into the cylinder if desired.

21. Install clutch cylinder in ring gear with piston toward clutch spring. Then place ring gear assembly in a press and press cylinder into ring gear until snap ring groove is visible, Figure 33.



1. PRESS
2. DRIVER
3. FORWARD CLUTCH ASSEMBLY

Figure 33

22. With the ring gear assembly in the press install the clutch cylinder retaining ring. Make sure the proper snap ring is installed. This ring measures .074"-.078" (1.88-1.98 mm thick and has a free diameter of 5-7/8" (149.2 mm).

23. Place the ring gear on a fixture that will support the ring gear without contacting the cylinder hub. Place ring gear and support in press and lightly compress the clutch discs against the front pressure plate, Figure 35.

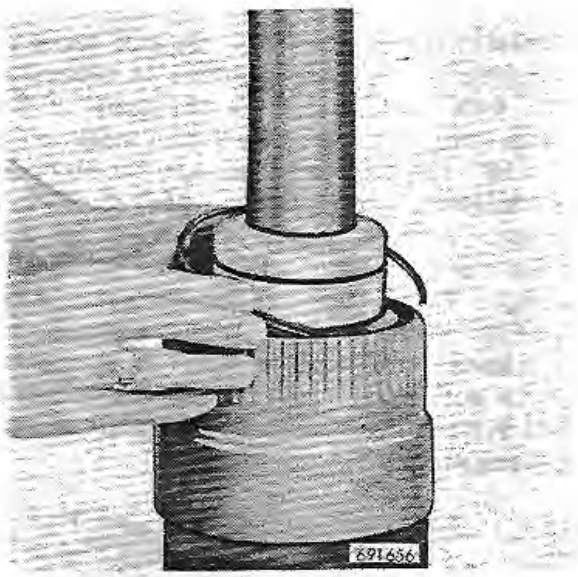


Figure 34

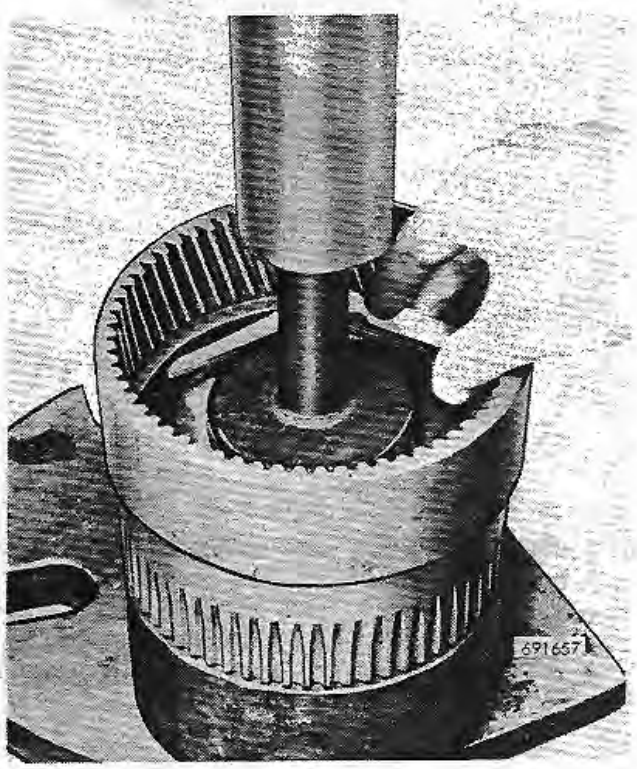


Figure 35

24. With the clutch discs compressed, use a feeler gauge and measure the space between the pressure plate and top surface of the snap ring groove, Figure 35. Record this measurement.

25. Install the necessary select fit snap ring(s), Figure 36, to obtain a clearance of .040"-.065" (1.02-1.65 mm). These snap rings have a free diameter of 5-11/16" (144.5 mm) and are color coded as follows; green, .050"-.054" (1.27-1.37 mm), orange, .074"-.078" (1.88-1.98 mm), and white, .096"-.100" (2.44-2.54 mm). The color code is not always easily visible, therefore, check ring thickness with micrometer as required. It is sometimes necessary to use two of the thinner snap rings to obtain the proper clearance.

Figure 36

26. Install Woodruff key in input shaft and lubricate bore of forward clutch hub with clean oil. Install hub on shaft with the open side away from gear on shaft. Press hub onto shaft until seated against gear.

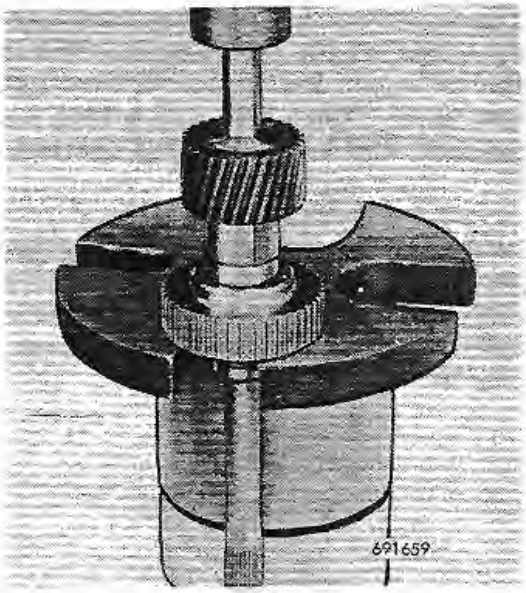


Figure 37

27. Install hub retaining snap ring, Figure 38.

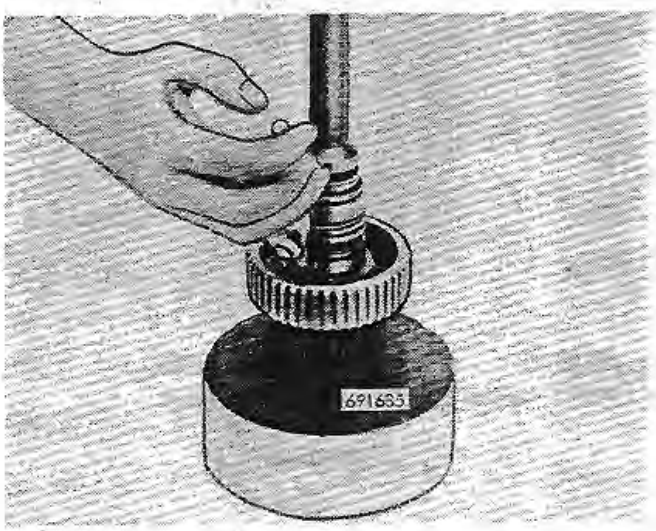


Figure 38

28. Install two new metal sealing rings in grooves in input shaft, Figure 39 and lock ends of rings together. Then in-

stall new Teflon sealing rings in grooves at opposite end of shaft.

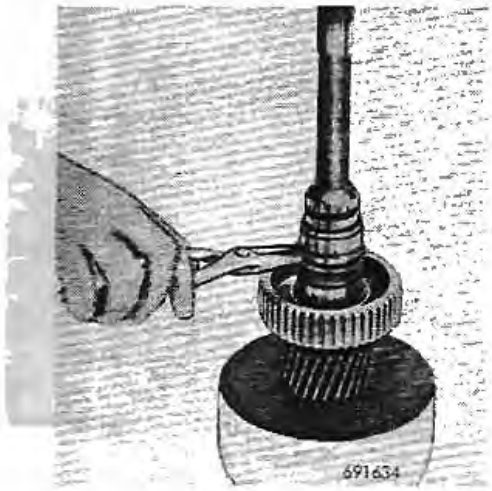


Figure 39

29. Place the input shaft in a suitable fixture and lower the ring gear assembly over the input shaft, Figure 40. DO NOT force the ring gear down as damage to the friction discs may result. When the ring gear is in the proper position the ring gear will be flush with the drive gear. Do not remove this assembly from fixture.

Figure 40

30. Place input shaft and ring gear assembly and fixture in a press. Start front bearing onto shaft and use a suitable tool and press bearing onto shaft, Figure 41, until snap ring groove in the clutch cylinder bore is exposed.

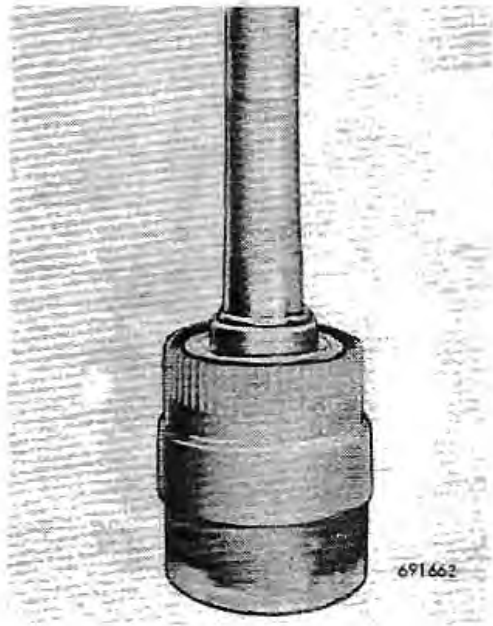


Figure 41

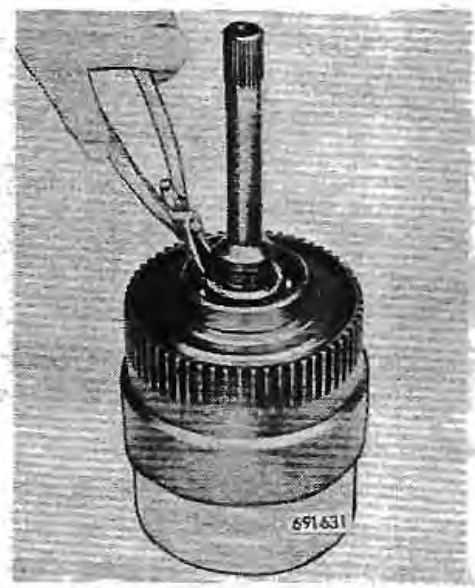


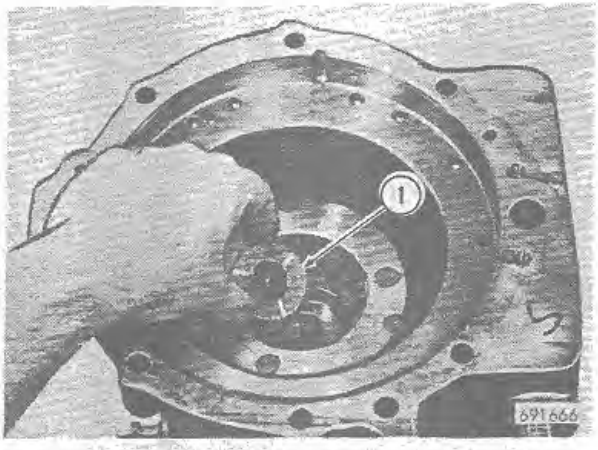
Figure 42

31. Install front bearing retaining ring on input shaft, Figure 42.

32. Install front bearing retaining ring in groove in clutch cylinder hub, Figure 43.

Figure 43

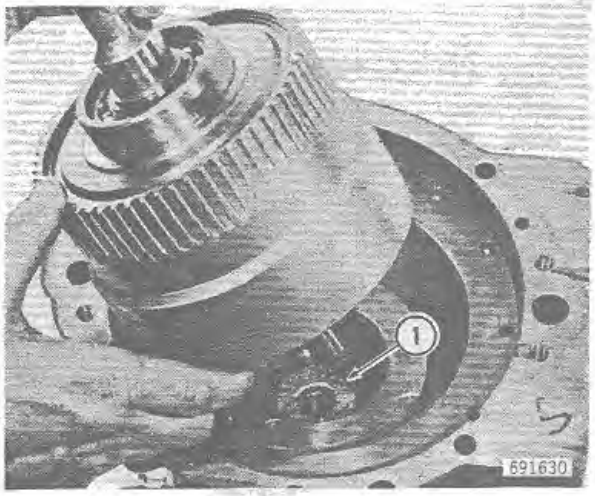
33. Coat the bronze thrust washer with clean grease and place on front face of the output shaft, Figure 44.



1. BRONZE THRUST WASHER

Figure 44

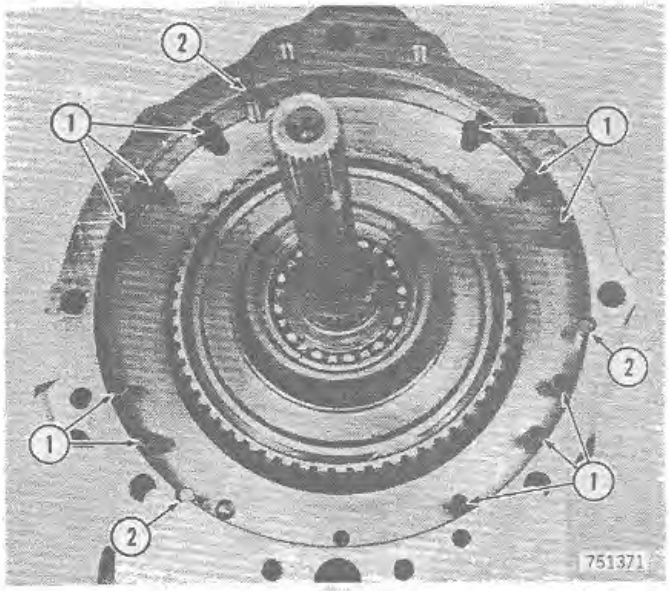
34. Pour clean oil over the pinion cage and install the forward clutch/input shaft assembly using care not to move thrust washer out of place or damage the Teflon sealing rings, Figure 45. Rotate the ring gear as required to engage the pinion gears.



1. THRUST WASHER

Figure 45

35. Refer to Figure 46 and install the eleven reverse clutch springs and the three dowel pins in the shuttle case.

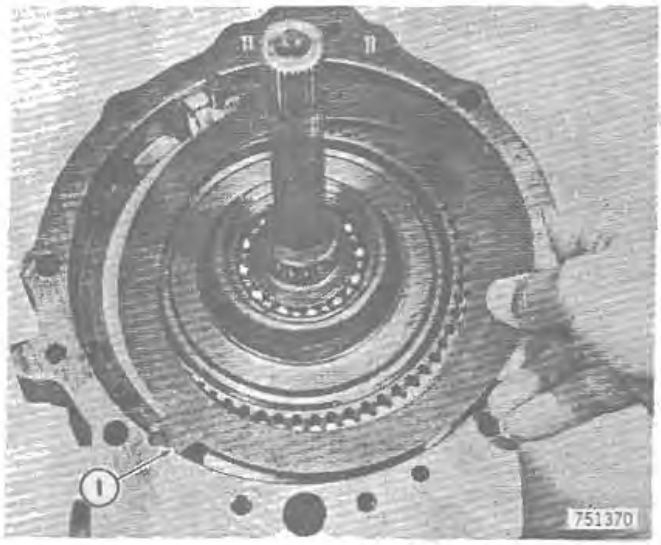


1. SPRING 2. DOWEL PIN

Figure 46

36. Lubricate the reverse clutch discs with clean oil. Place friction disc then a lugged disc in the reverse clutch cavity, Figure 47. The odd lug must be positioned as

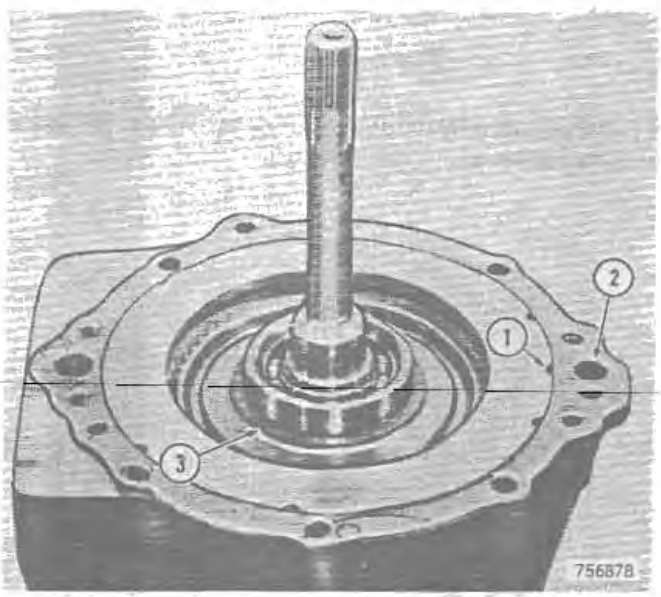
shown in Figure 47. Continue alternating clutch discs until all have been installed.



1. ODD LUG. MUST BE INSTALLED ON DOWEL PIN WITH WIDE SIDE OF LUG TOWARD THE BOTTOM.

Figure 47

37. Place the reverse clutch pressure plate on the springs with the smooth face up and the V-groove in the pressure plate aligned with large hole at top of shuttle case, Figure 48. When properly installed, the pressure plate will be just about flush with the case.



1. VEE GROOVE 2. LARGE HOLE
3. THRUST WASHER

Figure 48

38. Install thrust washer on clutch cylinder hub and place new adapter gasket on the shuttle case, Figure 48.

39. Install a new quad ring in groove in reverse clutch piston, Figure 49.

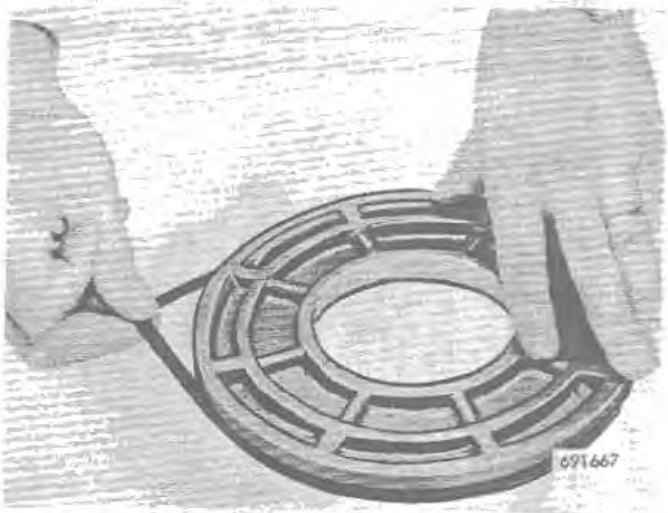


Figure 49

40. Install a new O-ring in groove in adapter hub, Figure 50.

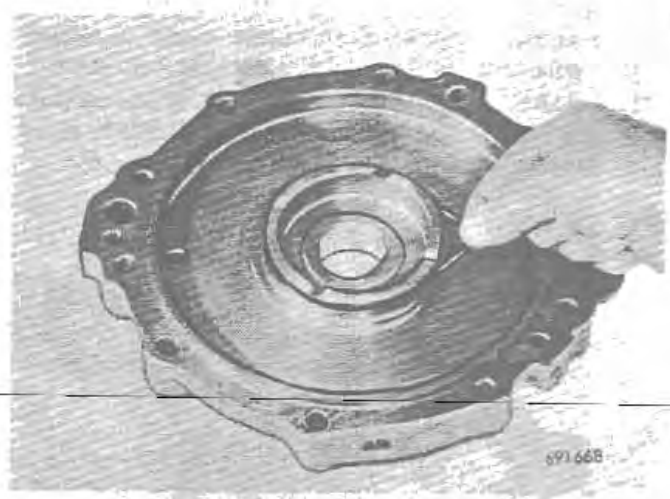


Figure 50

41. If bushing was removed from adapter, press in a new bushing at this time. The split in the bushing must be to the right on the horizontal centerline of the adapter in its installed position viewed from the rear. Press bushing in from

the rear of the adapter. The bushing should be flush with, to .020" (5.08 mm) below end of bushing bore. The hole in the bushing serves no useful purpose and should be ignored.

42. Lubricate the reverse clutch piston bore and quad ring with clean oil. Install piston in adapter with smooth face toward adapter, Figure 51. Use the flat surface of a clean screwdriver blade to help start quad ring into adapter if necessary.

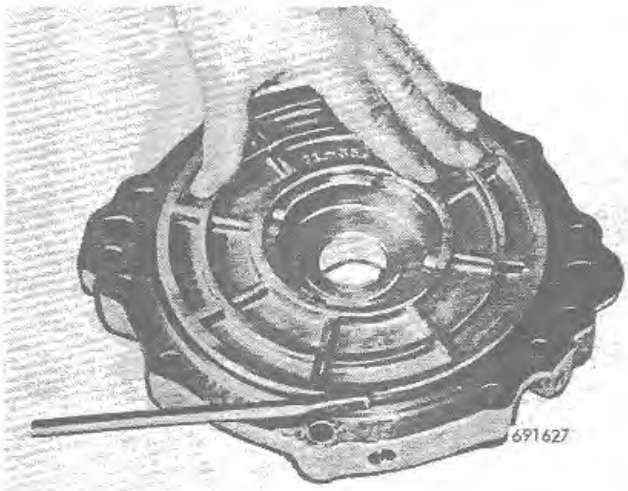
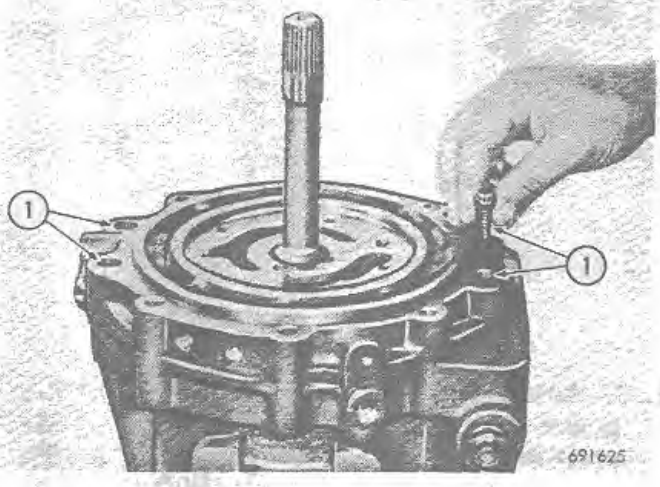


Figure 51

43. Lower the adapter over the input shaft and squarely onto the shuttle case. When the pilot diameter of the adapter enters the case, align the cap screw holes and check gap between adapter and case to assure squareness.

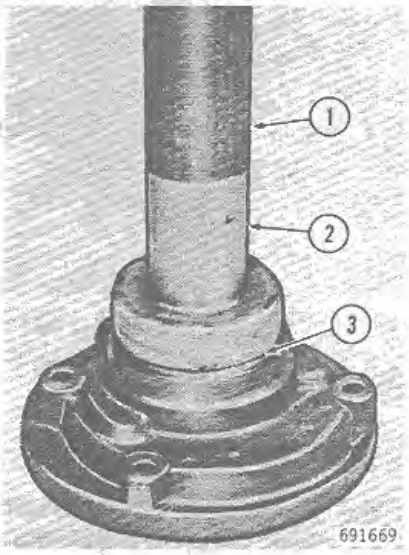


1. CAP SCREW

Figure 52

44. Install the four adapter retaining cap screws, Figure 52, and tighten alternately and evenly. Torque the cap screws evenly to specification on page 6210-3.

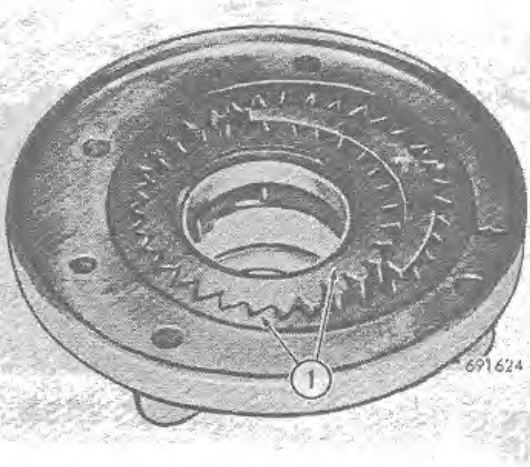
45. Start new seal into pump housing and press into place until lightly seated against shoulder in housing, Figure 53.



1. PRESS
2. DRIVER
3. SEAL

Figure 53

46. Install gears in pump housing with marked surfaces up, Figure 54.



1. MARKED SURFACES MUST BE UP

Figure 54

47. Pour clean oil over the gears and install the converter support. Secure support in place with flat head screw, Figure 54. Torque screw to specification on page 6210-3. Check to see that the gears turn freely. If gears bind, disassemble pump and check for cause.

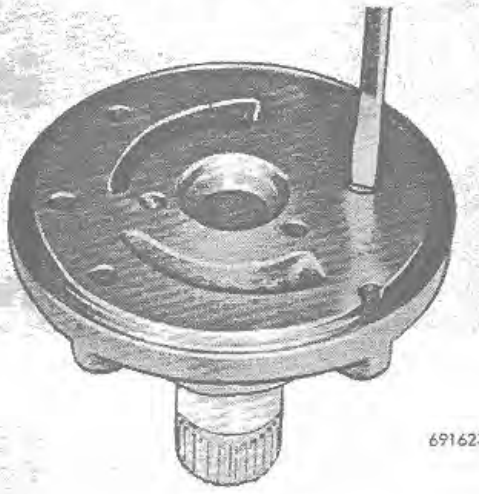


Figure 55

48. Coat one side of new pump gasket with clean grease and place gasket on pump. Please pump on adapter and secure in place with cap screws. The long cap screws should be installed in holes with high bosses. Torque cap screws to specification on page 6210-3.

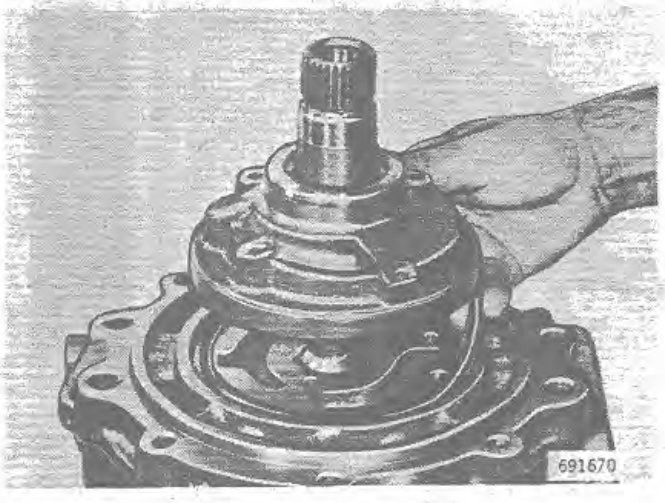
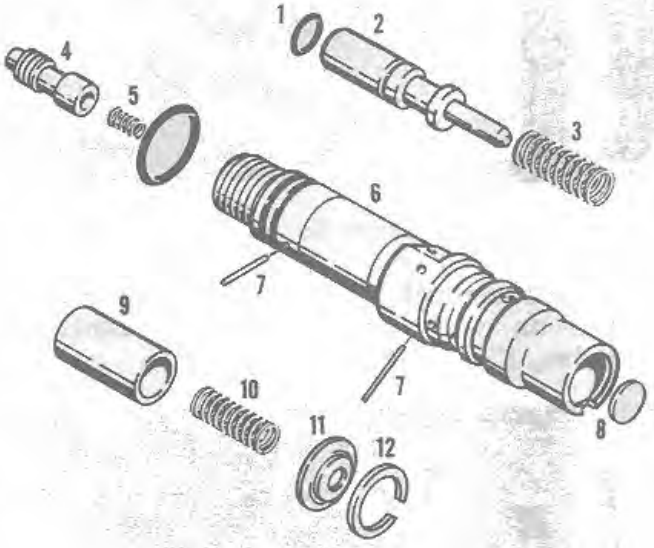


Figure 56

49. Install regulator valve and spring in the control valve. Compress spring as instructed during disassembly. Place spring seat on spring and compress spring until snap ring groove is exposed. Then install snap ring and remove control valve from vise.

50. Place spring in end of spool and install spool, spring first, in control valve. Partially compress the spring and drive a new roll pin into the control valve to properly position the spool.



1. O-RING
2. PLUNGER
3. PLUNGER SPRING
4. SPOOL
5. SPOOL SPRING
6. VALVE BODY
7. ROLL PIN
8. EXPANSION PLUG
9. REGULATOR VALVE
10. REGULATOR VALVE SPRING
11. SPRING SEAT
12. SNAP RING

Figure 57

51. Install new O-ring on plunger. Install plunger spring and plunger in control valve. Push plunger into control valve until it extends from control valve about 5/8" (15.9 mm); hold plunger in this position and drive new roll pin into control valve to retain and properly position the plunger.

52. Install new O-ring on control valve. Coat control valve with clean oil and install valve in shuttle case. Before pushing valve all the way in, position valve so notch in valve is at the bottom, Figure 58.

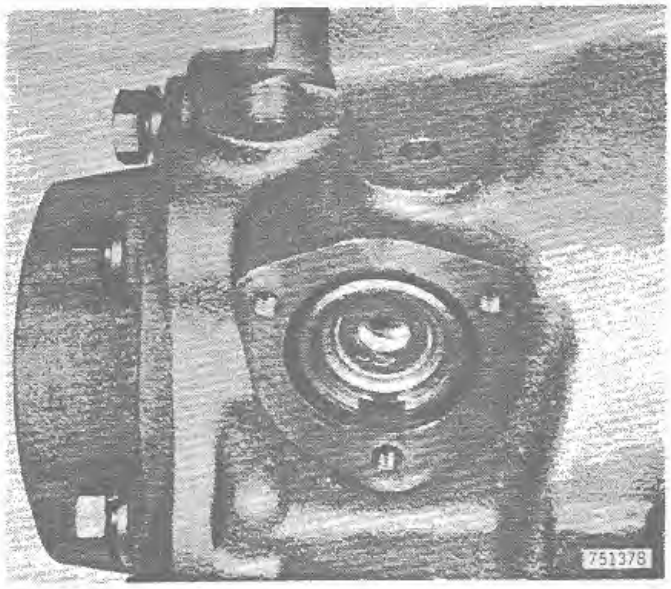


Figure 58

53. Install neutral start cam making sure tab on cam engages notch in control valve, Figure 59.

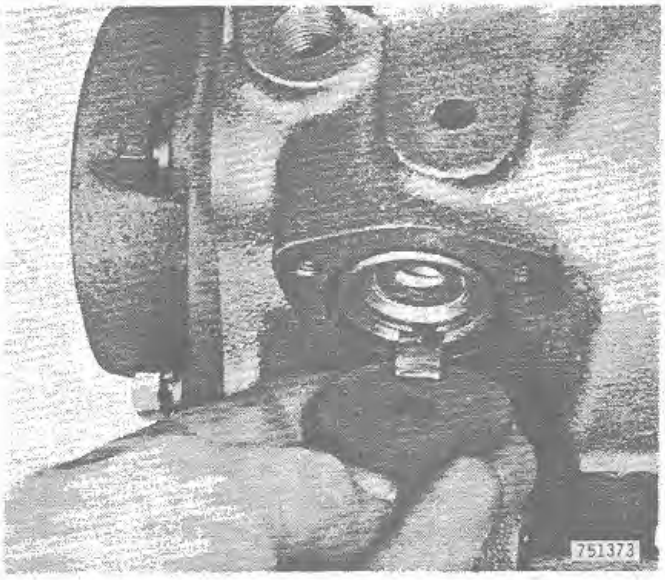


Figure 59

54. Install valve cover with a new gasket and secure in place with cap screws and lock washers. Torque cap screws to specification on page 6210-3.

55. Install snap ring in groove at control end of valve, Figure 60. Then place detent spring in shuttle case.

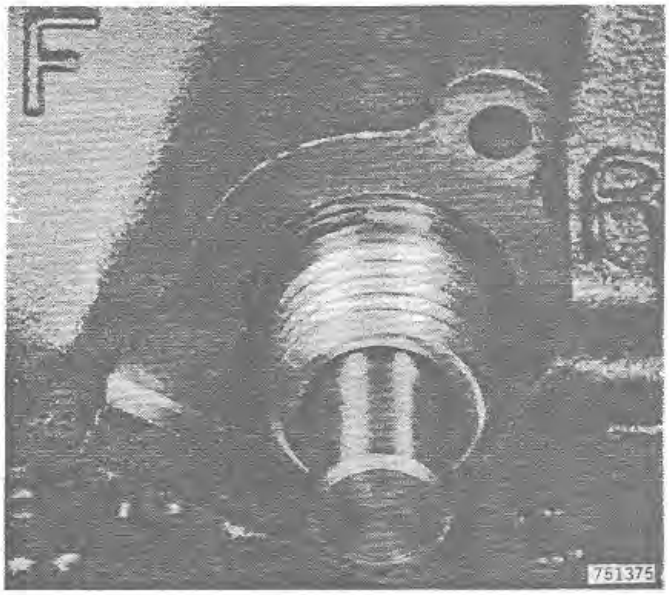
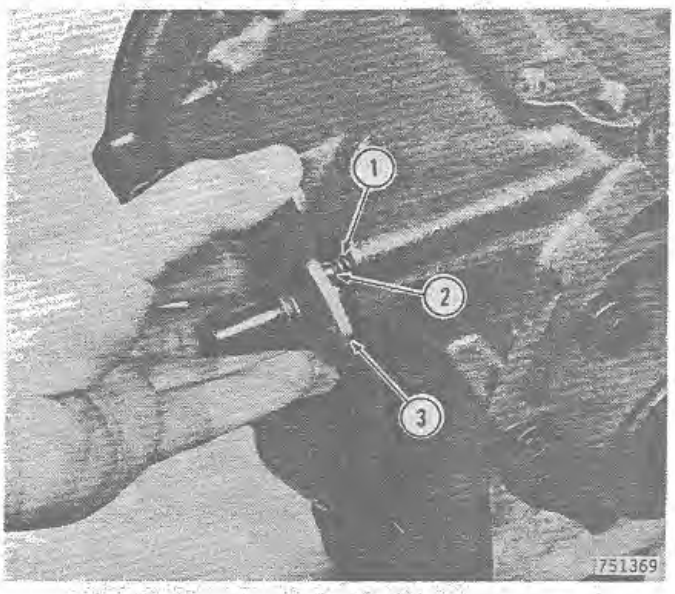


Figure 60

56. Install control arm as illustrated in Figure 61. Screw solenoid part way onto control valve and place steel ball between the detent spring and control arm. Then tighten solenoid on control valve.



1. DETENT SPRING
2. STEEL BALL
3. CONTROL ARM

Figure 61

57. Install new O-ring on filter screen tube and install filter in shuttle housing,

Figure 62. Place new oil pan gasket on housing, install pan and secure in place with cap screws and lock washers.

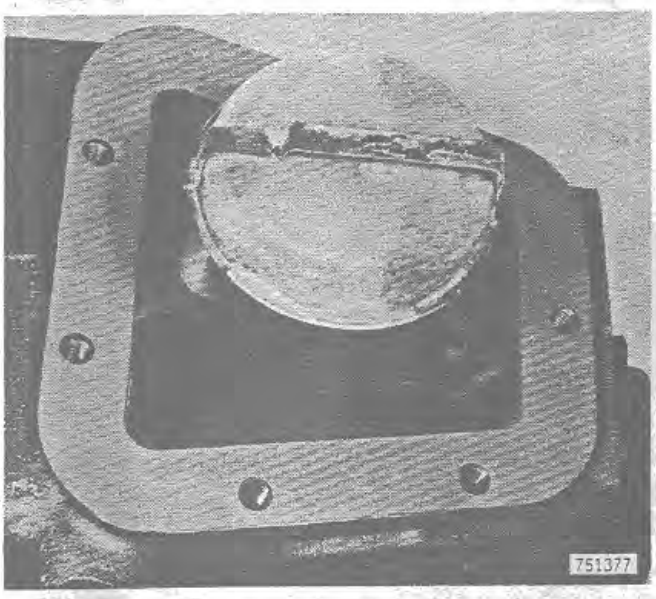


Figure 62

58. Install fill tube fitting in shuttle case.

Installation

1. Before installing the power shuttle, make two guide studs by cutting the heads off two 7/16"-NC x 6" bolts and cut a screwdriver slot in each side of the converter housing.

2. Set shuttle on transmission jack and raise into alignment with the guide bolts. Start shuttle onto guide bolts and check to see that the shuttle and converter housing mating surfaces are parallel. Adjust shuttle position as required.

3. Move the shuttle forward to engage the input shaft, converter support and pump drive gear with tangs on converter. Turn the flywheel as required with a screwdriver to align splines and drive tangs. If the shuttle cannot be pushed against the converter housing, parts are not properly aligned. Turn flywheel as required. DO NOT force the shuttle into place; it must slide into place by hand or damage will result.

4. Install the two top shuttle mounting cap screws but do not tighten at this time. Then remove the guide bolts and install the four remaining cap screws. Torque the cap screws evenly to specification on page 6210-3.

5. Connect oil lines to power shuttle.

6. Install drive shaft and connect to shuttle output flange. Torque cap screw to specification on page 6210-3.

7. Connect control linkage to control valve control arm.

8. Install shuttle fill tube. Be sure tube bottoms in fitting. If tube is not properly installed, overfilling and unnecessary damage will result.

9. Fill shuttle with new Case TCH Fluid as instructed under Maintenance in Section 6202.

TORQUE CONVERTER

Should it be necessary to service the torque converter, the complete converter must be replaced. Replacement is necessary because the welded construction of the converter prevents replacement of internal parts.

Removal

1. Remove the power shuttle as instructed in this section.
2. Remove front cover from flywheel/converter housing.
3. Support the engine with a jack under the rear of the oil pan.
4. Remove the rear engine mounting bolts.

   NOTE: The flywheel/converter housing weighs approximately 65 pounds (29.5 kg); have someone available to help remove the housing.
5. Remove the nut, hardened washers and bolt on each side of the housing. Then remove the two nuts, lock washers and hardened washers at the top and remove the housing.
6. Remove the six flex plate to flywheel caps screws and washers and remove converter.

Installation

1. If the converter or flex plate is being replaced, place converter on bench with converter hub down. Then place flex plate and reinforcing ring on converter and install two opposing cap screws but do not tighten.
2. Install alignment tool, Figure 1, over pilot boss on converter with pins in reinforcing ring and flex plate as illustrated in Figure 63. Install the remaining cap screws and torque cap screws to specifications on page 6210-3.
3. Attach the converter to the flywheel with cap screws and hardened flat washers. If a washer is to be replaced, refer to parts catalog for the proper part. Do not torque cap screws at this time.

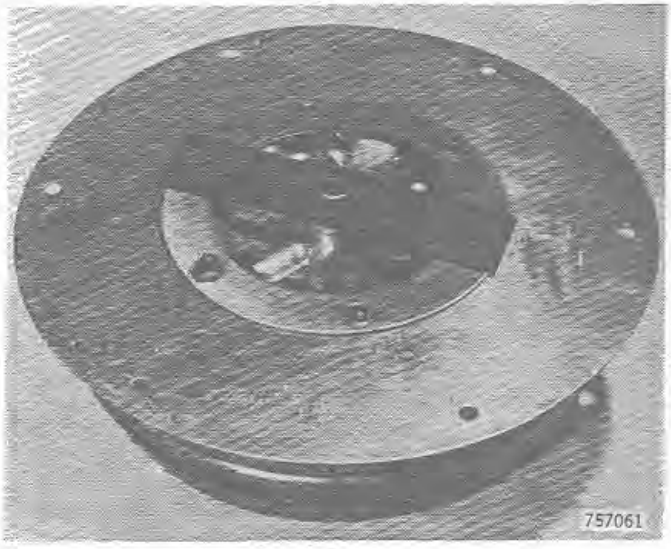


Figure 63

4. The torque converter MUST be centered on the flywheel within .004" (0.102 mm). Check converter position using a dial indicator positioned against the converter hub. Reposition converter as required and torque cap screws to specification on page 6210-3.
5. Install flywheel/converter housing. Install hardened washers, lock washers and nuts on studs at top of housing. Do not tighten nuts at this time.
6. Install the bolts with hardened washers on each side of housing. If a bolt is to be replaced, use the bolt specified in the parts catalog. These bolts position the housing relative to the converter. The use of any other bolt could result damage to the converter, pump or pump seal.
7. Install hardened washer and nut on each bolt and tighten all four nuts.
8. Install shuttle as instructed in this section.

Section 6211

SHUTTLE CONTROLS

(POWER AND MECHANICAL)

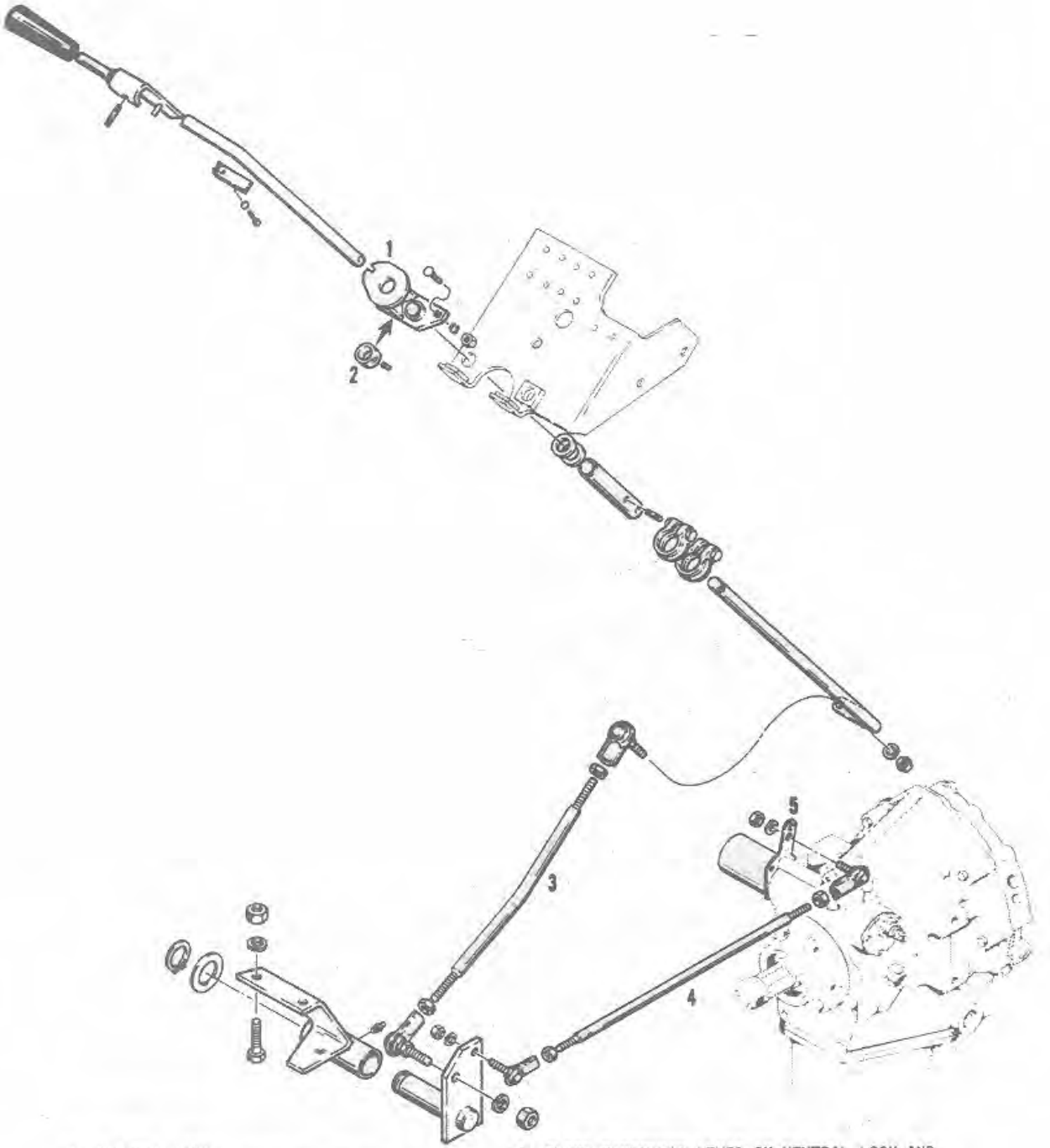
J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

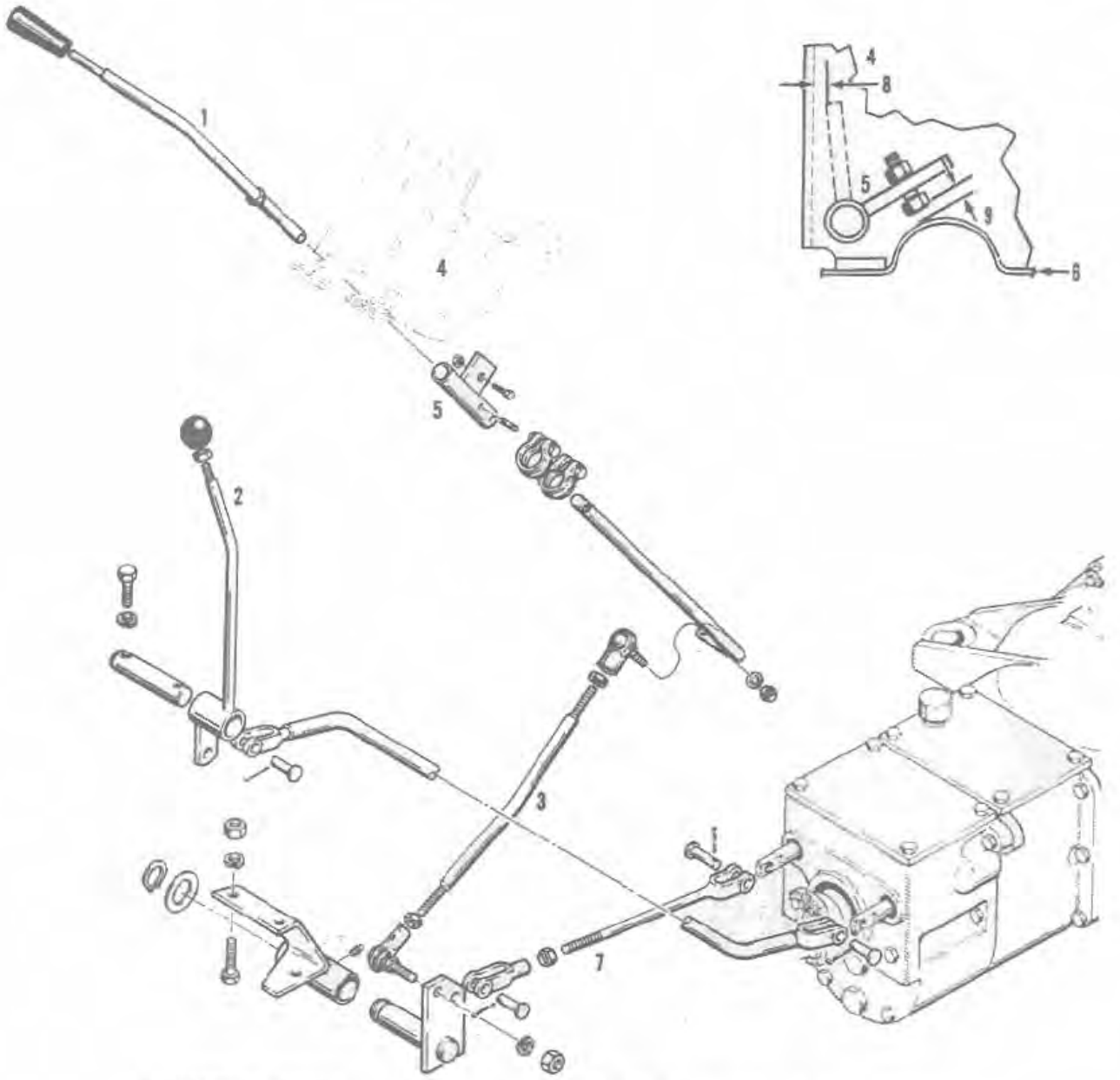
PRINTED IN U.S.A.



1. NEUTRAL LOCK
2. WHEN UPPER AND LOWER SHAFTS ARE ASSEMBLED, POSITION COLLAR TO OBTAIN 1/32"-3/32" (0.8 mm-2 mm) SHAFT FREE PLAY.
3. INSTALL BALL JOINTS ON ROD FINGER TIGHT. THEN POSITION BALL JOINTS AS SHOWN AND TIGHTEN LOCK NUTS.
4. PLACE DIRECTION LEVER IN NEUTRAL LOCK AND SHUTTLE CONTROL ARM IN NEUTRAL, AND ADJUST LENGTH OF ROD AS REQUIRED.
5. SHUTTLE CONTROL ARM.

751631

Figure 1 - Power Shuttle Control Installation



1. DIRECTION CONTROL
2. RANGE CONTROL
3. INSTALL BALL JOINTS ON ROD FINGER TIGHT. THEN POSITION BALL JOINTS AS SHOWN AND TIGHTEN LOCK NUTS.
4. STEERING COLUMN BRACKET
5. CONNECTOR
6. INSTRUMENT PANEL
7. CLEVIS ROD
8. 1/4" - 5/16" (6.3 mm - 7.9 mm). ADJUST LENGTH OF CLEVIS ROD AS REQUIRED WITH SHUTTLE IN REVERSE TO OBTAIN THIS DIMENSION.
9. 3/16" - 1/4" (4.7 mm - 6.3 mm). WITH SHUTTLE IN FORWARD, POSITION BOLT TO OBTAIN THIS DIMENSION.

Figure 2 - Mechanical Shuttle Control Installation

Section 6212

TRANSAXLE REMOVAL

AND

INSTALLATION

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TRANSAXLE REMOVAL

1. Raise rear wheels off the floor and block machine in place with jack stands or other suitable support. Then remove rear wheels.

2. Disconnect drive shaft from shuttle output flange and remove from transaxle.

3. Disconnect brake fluid line at hose to transaxle brake cylinders.

4. Disconnect differential lock linkage at the transaxle.

5. Disconnect parking brake cable from cross shaft on top of transaxle. Remove cable housing clamp and place cable out of way.

6. Place transmission in Neutral. Remove rubber boot from gear shift lever. Then remove shift lever snap ring and remove lever and lever seat.

7. Remove hydraulic tube clamp on the top rear of the transaxle.

8. If equipped with dual rear floodlights, remove wiring harness clamp cap screws on the top right and left of the transaxle.

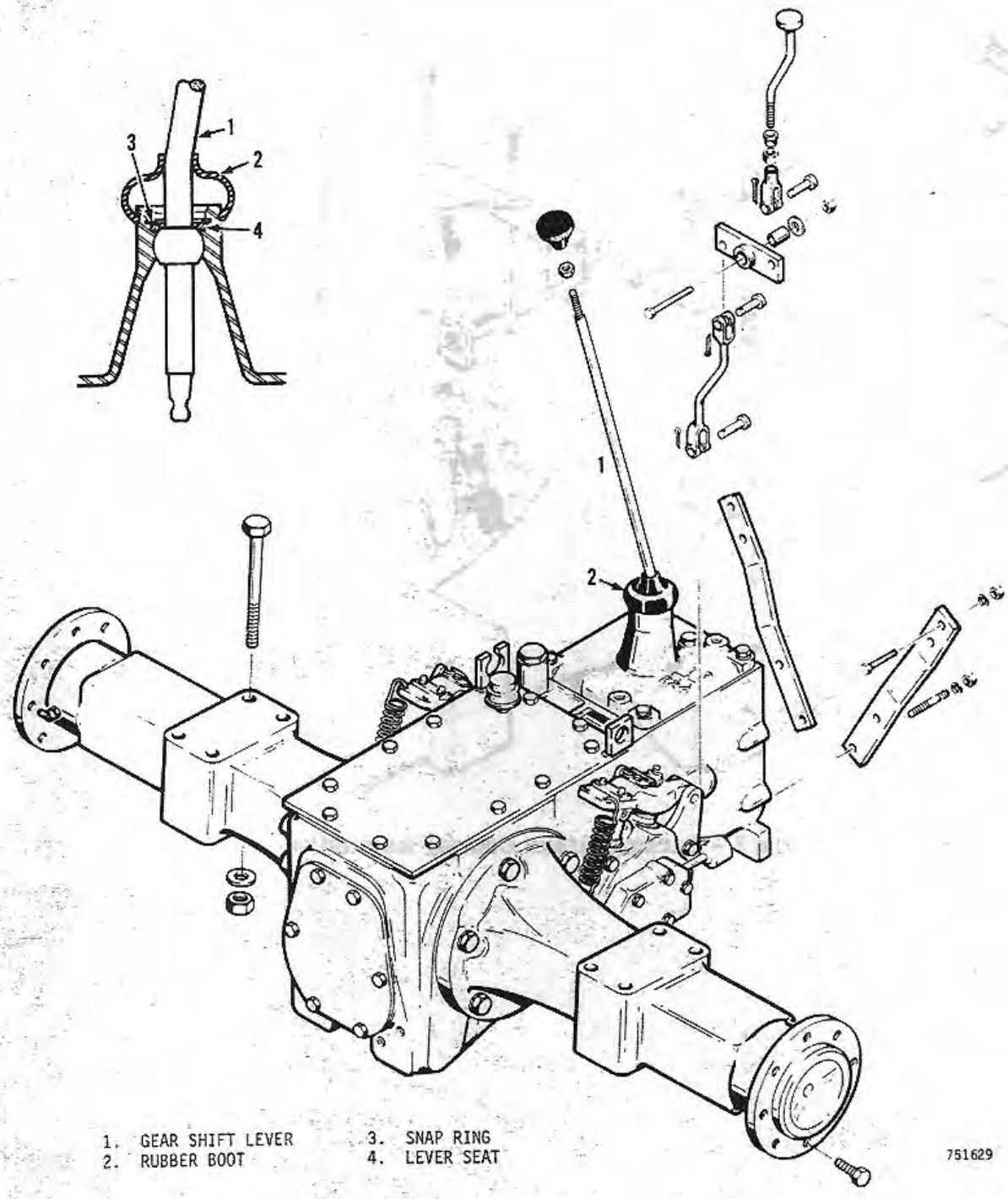
9. Remove tube clamp from right side of frame above the axle mounting pad. Clamp must be removed so tube can be moved to allow transaxle mounting bolt removal.

10. Place a floor (service) jack under the front and rear of the transaxle. Be sure jack pads are in contact with transaxle.

11. Remove the support straps at front of transaxle.

12. Remove nuts and washers from the four mounting bolts on each side and remove the bolts.

13. Lower rear of transaxle 1/4" to 1/2" (6 mm to 12 mm) and move transaxle to the rear until studs in front of transaxle clear the center crossmember. Then lower transaxle and pull from under machine.



1. GEAR SHIFT LEVER
2. RUBBER BOOT
3. SNAP RING
4. LEVER SEAT

Figure 1 - Transaxle Installation

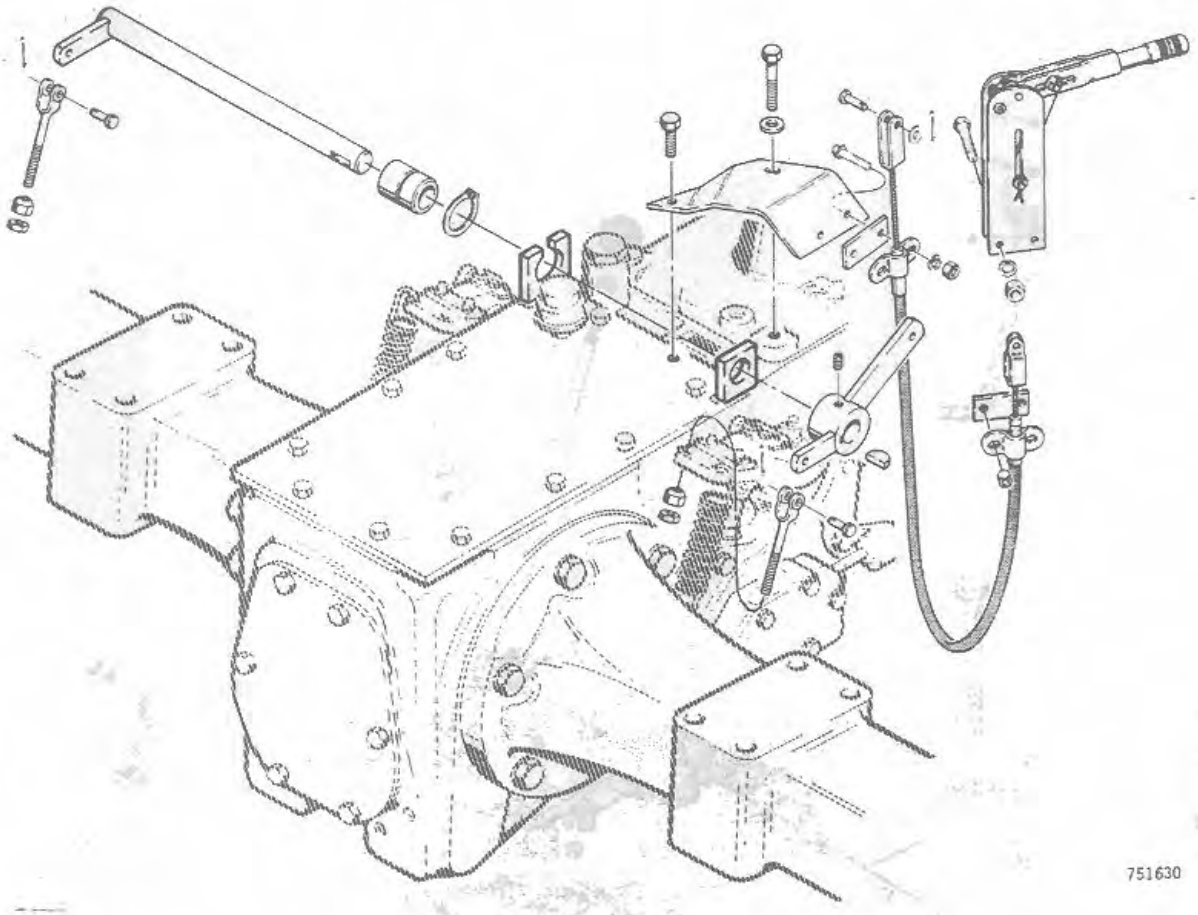


Figure 2 - Parking Brake Control Installation

TRANSAXLE INSTALLATION

1. Place transaxle on jacks and roll under machine.

2. Raise transaxle into place keeping the front slightly higher than the rear. Guide studs on front of transaxle into holes in center crossmember.

3. Install the four mounting bolts on each side and install hardened washers and nuts. Do not tighten nuts at this time. If a washer must be replaced, use washer specified in the parts catalog.

4. Install the front support straps and tighten all nuts and cap screws. Then torque nuts on rear mounting bolts to 250-300 foot-pounds (338-406 N m). The rear mounting bolt nuts must be re-torqued after 50 hours of operation.

5. Install tube clamp on right side of frame and tube clamp on top rear of transaxle.

6. If equipped with dual rear flood lights, attach wiring harness clamps to top right and left of transaxle.

7. Attach parking brake cable to cross shaft on transaxle and secure cable housing to bracket.

8. Connect differential lock linkage to transaxle.

9. Connect brake fluid lines to brake hose. Bleed brakes as instructed in Section 7025.

10. Install drive shaft on transaxle input shaft and attach to shuttle output shaft. Torque cap screws to 20-24 foot-pounds (27-32 N m).

11. Place shift lever seat on shift lever and install lever in transmission. Secure in place with snap ring and install rubber boot.

12. Install rear wheels and torque wheel bolts to 115-130 foot-pounds (155-176 N m).

Section 6214

TRANSAXLE

AND

DIFFERENTIAL LOCK

J I Case
A Tenneco Company

TENNECO

Rac 9-79236

PRINTED IN U.S.A.

GENERAL INFORMATION

CLEANING - Steam clean the complete exterior of the transmission case before any service work is performed. All metallic parts, except bearings, should be cleaned in mineral spirits or by steam cleaning. Do not use caustic soda solution for steam cleaning. All parts should be dried and lightly oiled after cleaning. Oil passages can be cleaned with compressed air. Bearings should be cleaned in mineral spirits and lightly oiled.

INSPECTION - Inspection of all parts should be made when disassembly is required. Any part that shows excessive wear or damage must be replaced. Small nicks or grooves can be removed in most cases with a hone or crocus cloth. Thorough visual inspection for indications of wear, stress, pitting and the replacement of such parts as necessary will eliminate costly and avoidable unit failure.

GEARS - Inspect all gears for wear and damage. Gears which are worn, ridged or scored must be replaced. *NOTE:* If it is necessary to replace either the bevel gear (differential ring gear) or pinion shaft, the bevel gear and pinion shaft must be replaced as a matched set.

SHAFTS - Inspect all shafts for worn, pitted or broken splines. Also, check for damaged bearing and oil seal surfaces on shafts.

OIL SEALS, "O" RINGS AND GASKETS - When installing any parts, always install new gaskets, oil seals and "O" rings. Lubricate rubbing surface of all lip type seals with a lubricant before installation.

BEARINGS - Check bearings for free smooth action. If bearings have a loose fit or rough action, replace the bearing. Always replace cup and cone as a set, never just one part of a bearing. Wash bearings with a good solvent and let air dry. DO NOT SPIN DRY.

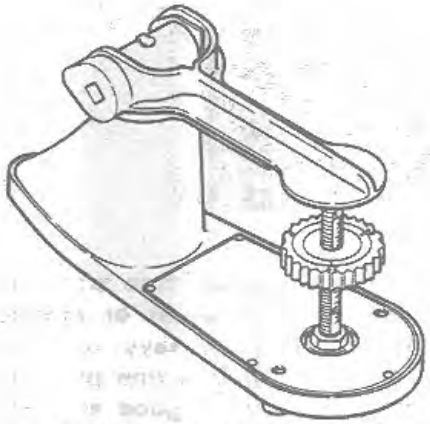
To facilitate assembly in many areas, bearings may be heated. This will expand the bearing inner race, eliminating the need of a hydraulic press when installing bearings over shafts.

NEEDLE BEARINGS - Always remove any burrs in bore or edge of bore before pressing in needle bearings. Lubricate inside and outside diameter of bearings with a lubricant before pressing into place.

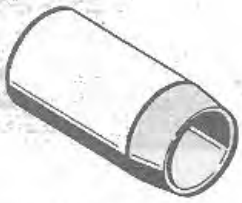
When pressing needle bearings into place, always use a bearing arbor. Place bearing on arbor with stamped end (end with numbers) against stepped shoulder of pressing arbor.

TABLE OF CONTENTS

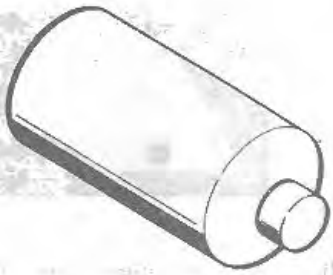
SPECIAL TOOLS



SPRING COMPRESSION TESTER



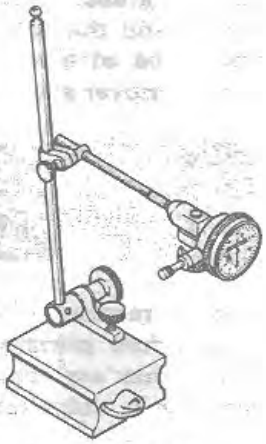
G13503 PROTECTIVE SLEEVE



G13504 OIL SEAL DRIVER

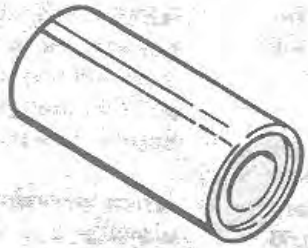
G15016 SEAL DRIVER

A44602 OIL SEAL DRIVER

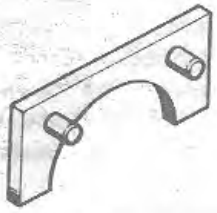


DIAL INDICATOR

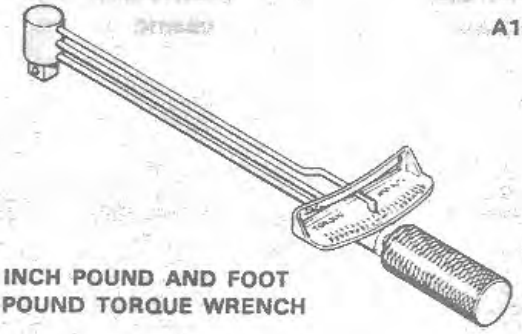
G15043 PROTECTIVE SLEEVE



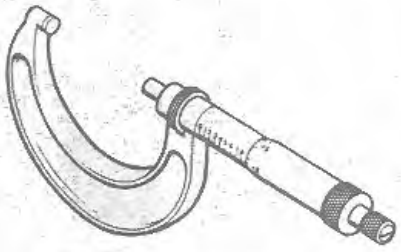
A146285 BEARING DRIVER



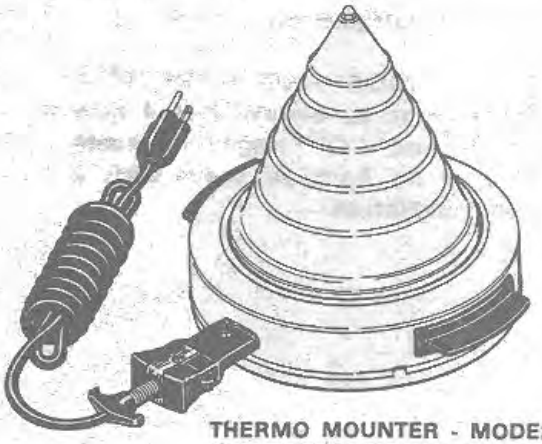
G13505 OIL SEAL DRIVE (2)



INCH POUND AND FOOT
POUND TORQUE WRENCH

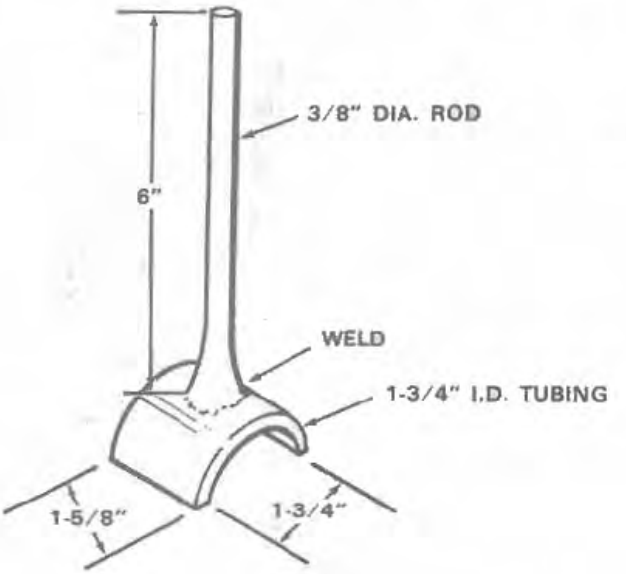


0" TO 1" MICROMETER

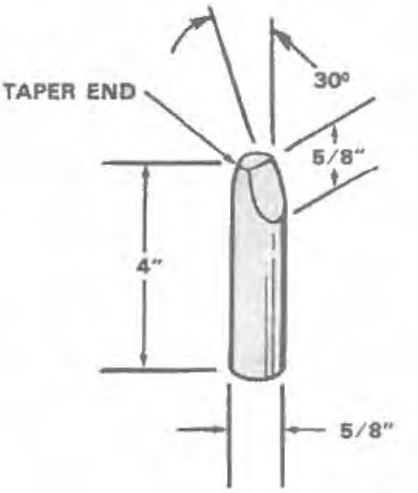


THERMO MOUNTER - MODEL "C"
ELECTRONIC DESIGNS, INC.
5164 N. 62ND STREET
MILWAUKEE, WIS. 53218

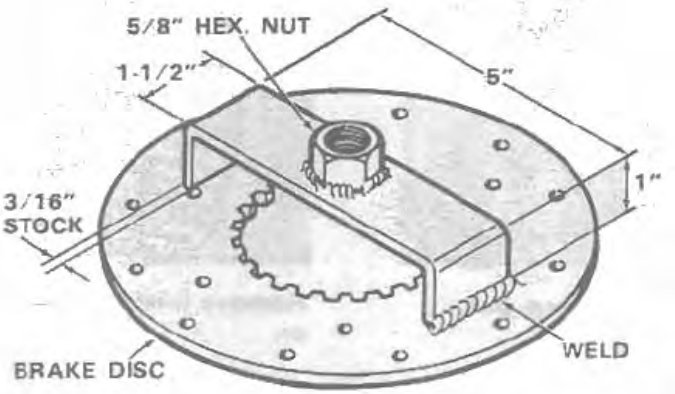
SPECIFICATIONS FOR TOOLS WHICH MUST BE MADE



MAINSHAFT SPACER TOOL



SHIFT RAIL PILOT SLEEVE

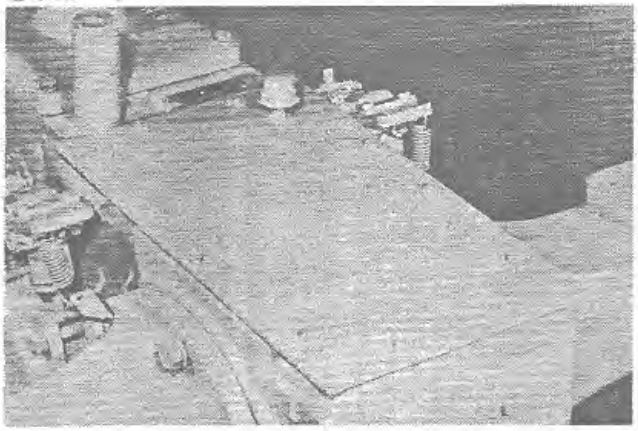


MODIFIED BRAKE DISC

SERVICING THE TRANSAXLE ASSEMBLY

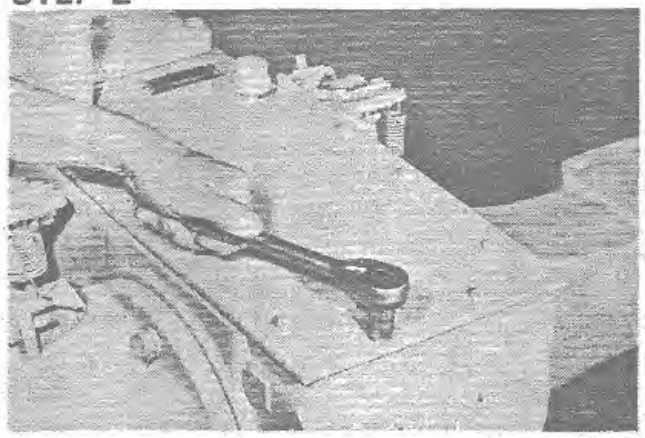
Final Drive Gear and Axle Housing Removal

STEP 1



Clean the complete exterior of the transaxle assembly before performing any service work.

STEP 2

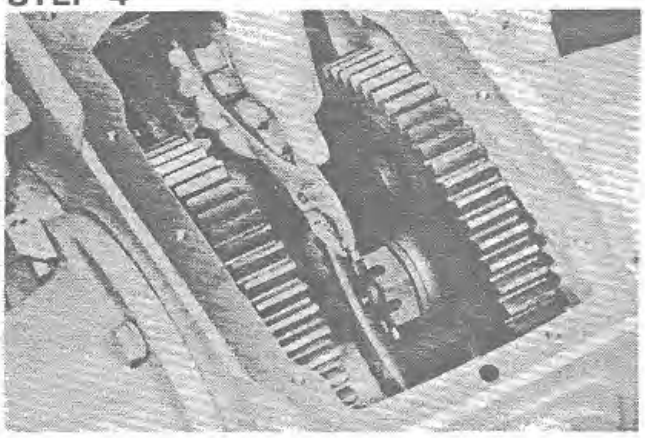


Remove the rear top cover retaining bolts.

STEP 3

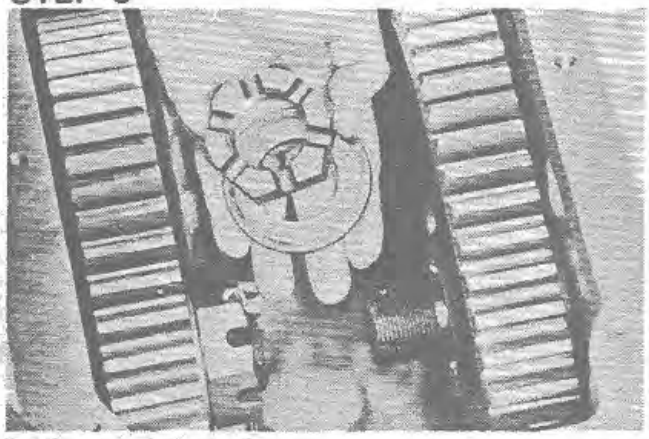
Remove the rear top cover.

STEP 4



Remove the cotter pin retaining final drive gear nut.

STEP 5



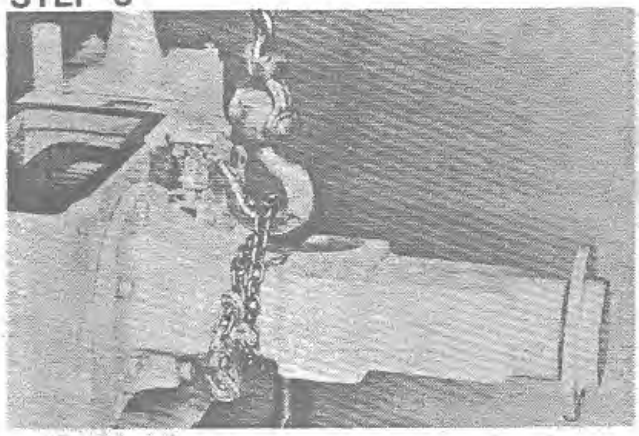
Remove final drive gear retaining nut and washer.

IMPORTANT: **Final Drive Gear Removal - There are two methods by which the final drive gears can be removed from the transaxle case.**

1. **Complete removal of axle housings - follow Steps 6 thru 14.**
2. **Removal of axle shaft from axle housing - follow Steps 15 thru 19.**

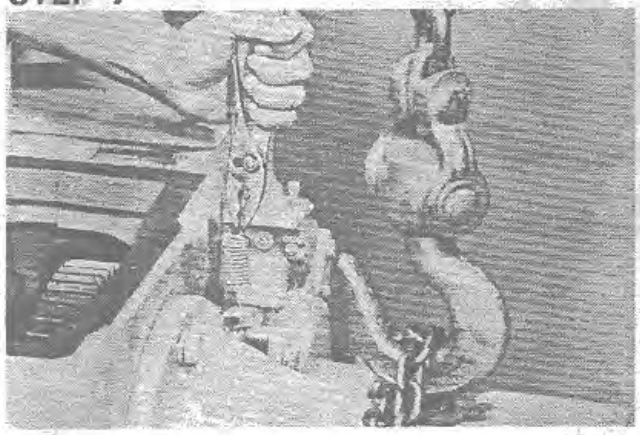
Axle Housing Removal

STEP 6



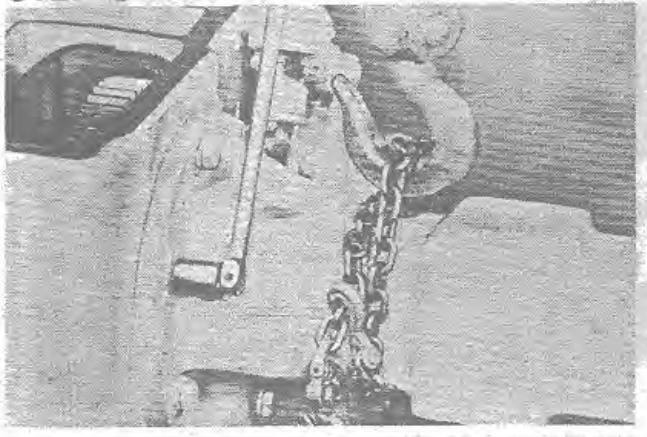
Before the final drive gear can be removed from the transaxle case, the axle housing must be partially removed. Support the axle housing with a hoist.

STEP 7



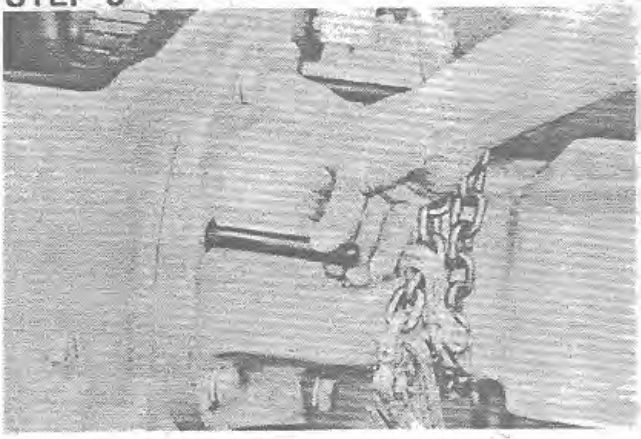
Remove the self adjusting brake return spring.

STEP 8



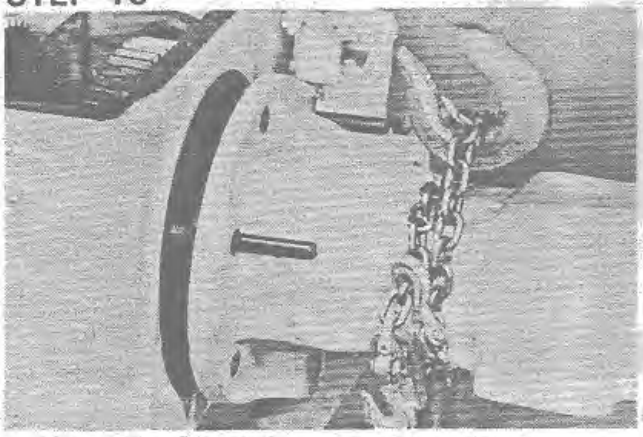
Remove two axle housing bolts.

STEP 9



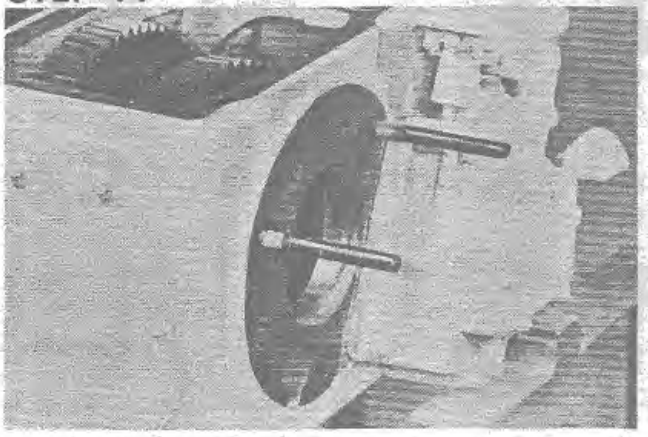
Install two guide pins in transaxle case.

STEP 10



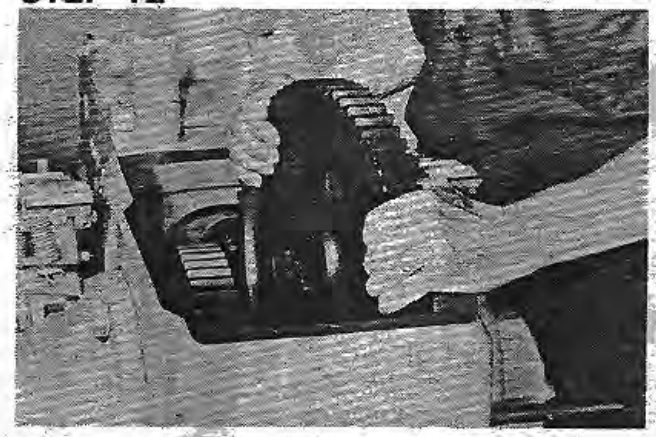
Remove the rest of the axle housing bolts and pull housing from case.

STEP 11



Axle housing removed from transaxle case.

STEP 12



Remove the final drive gear.

STEP 13

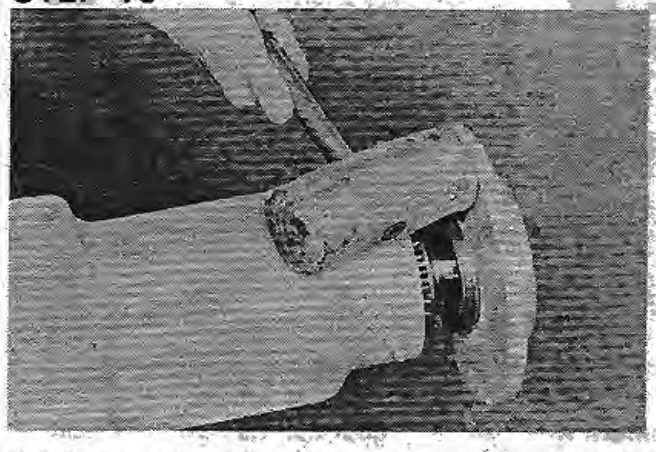
Support the other axle housing and remove axle housing and final drive gear following Steps 4 thru 12.

STEP 14

Both axle housings and final drive gears removed from transaxle case.

Axle Shaft Removal

STEP 15

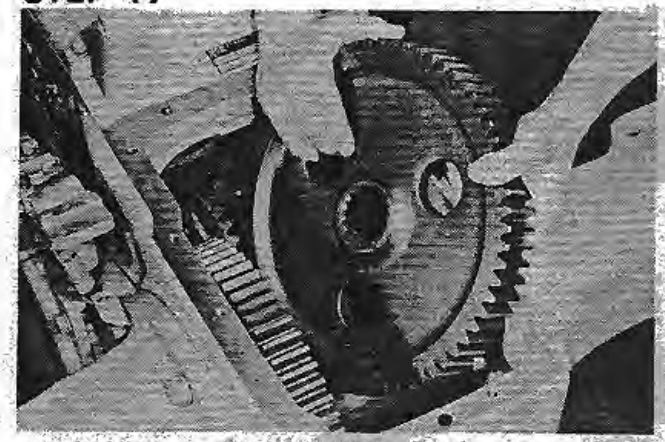


Drive the axle shaft from the housing.

STEP 16

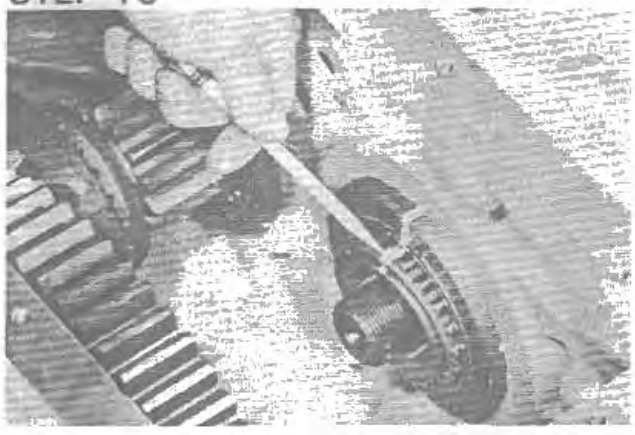
Drive axle from housing until the inner bearing cone is loose.

STEP 17



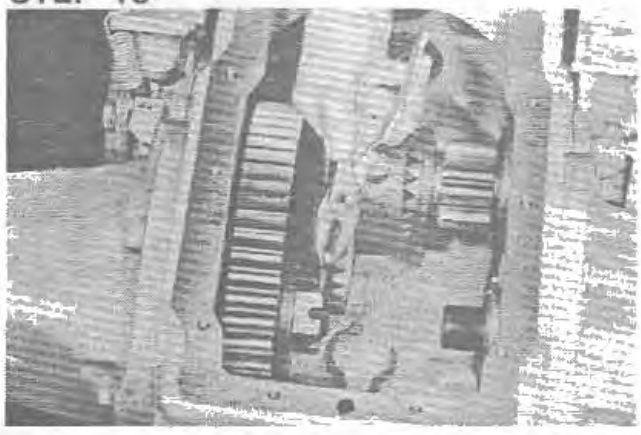
Remove the final drive gear.

STEP 18



Mark the axle housing, bearing cup and cone before removal for correct side placement of parts during assembly. *NOTE:* If either bearing cup or cone are replaced, always replace both halves of the bearing.

STEP 19



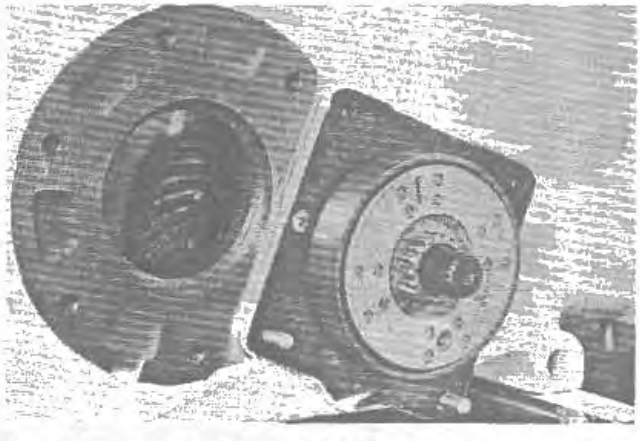
Remove the cotter pin securing the other final drive gear nut and repeat Steps 15 thru 18 for final drive gear removal.

Differential Side Gears and Center Wheel Removal

STEP 20

Remove brake return spring and bolts securing brake housing.

STEP 22

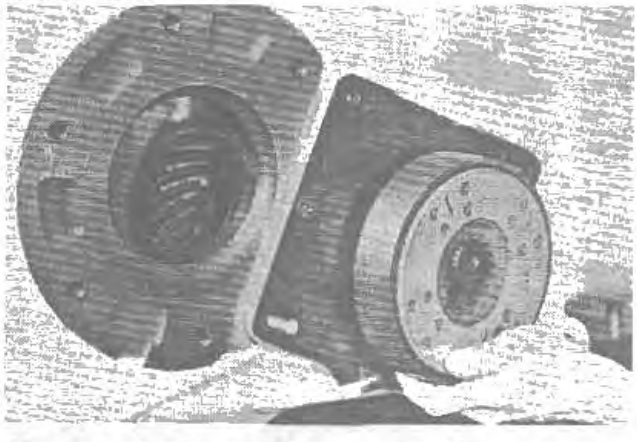


Brake housing removed from transaxle case.

STEP 21

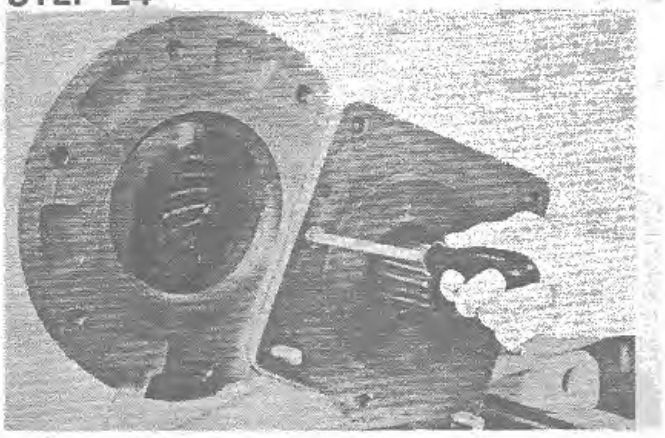
Remove the brake housing.

STEP 23



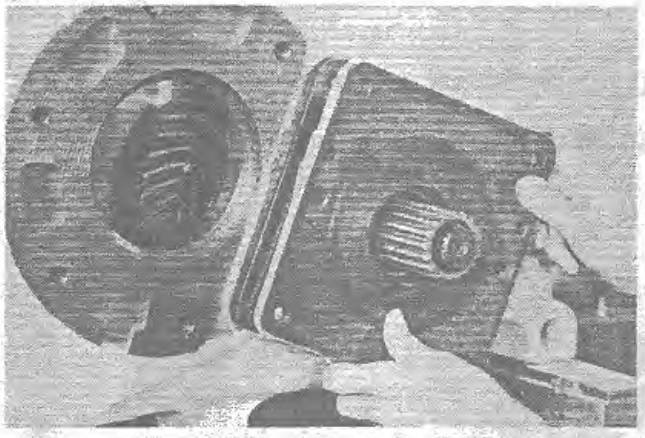
Remove the brake drum assembly.

STEP 24



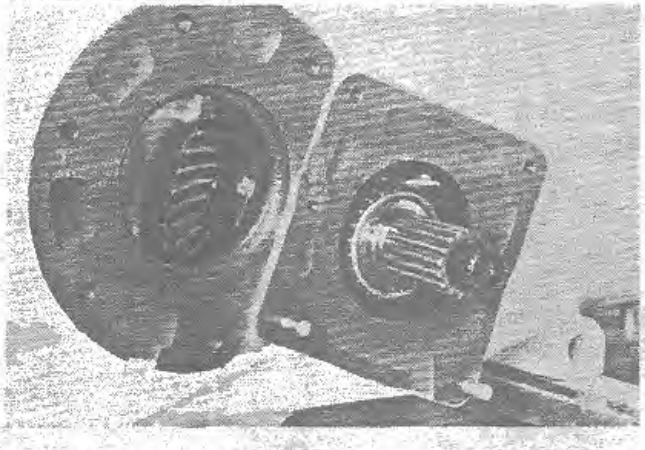
Remove the screws securing the differential bearing carrier.

STEP 25



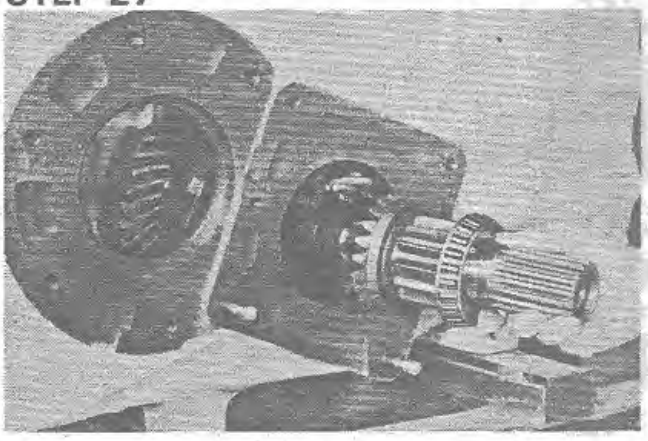
Remove the differential bearing carrier and shims.

STEP 26



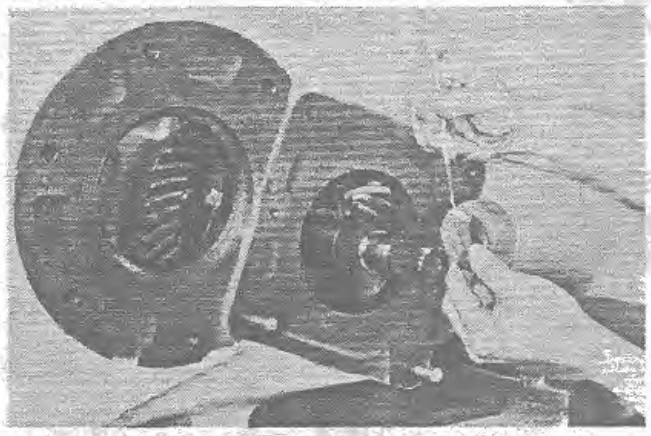
Differential bearing carrier removed.

STEP 27



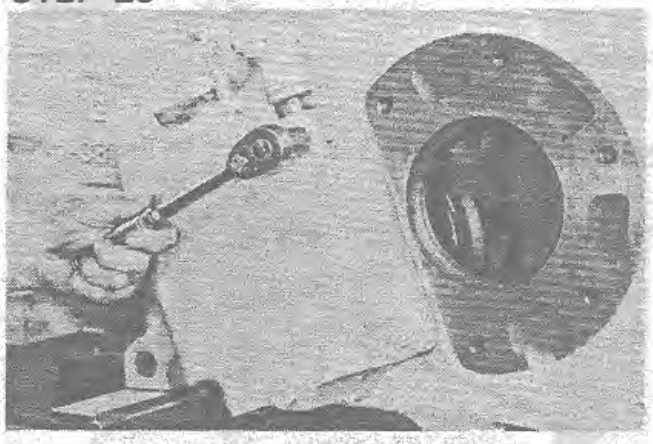
Remove the differential side gear assembly.

STEP 28



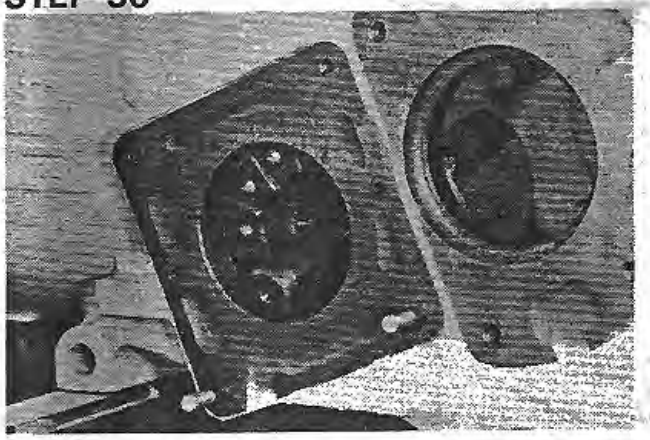
Remove the side gear shims, mark or tag shims for relocation during assembly.

STEP 29



Remove the L.H. brake housing and side gear following Steps 20 thru 28.

STEP 30

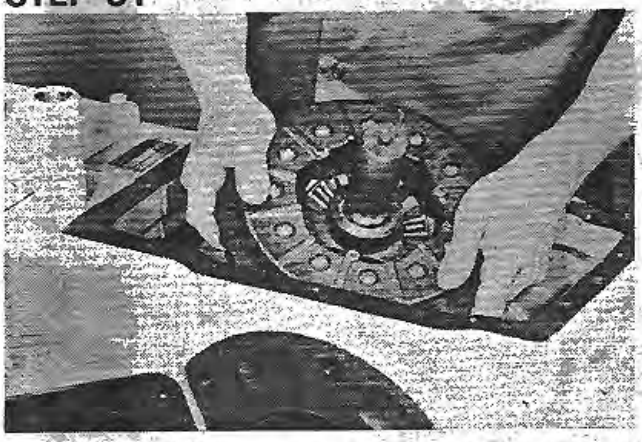


L.H. brake housing and differential side gear removed from transaxle case.

STEP 32

Differential removed from transaxle case.

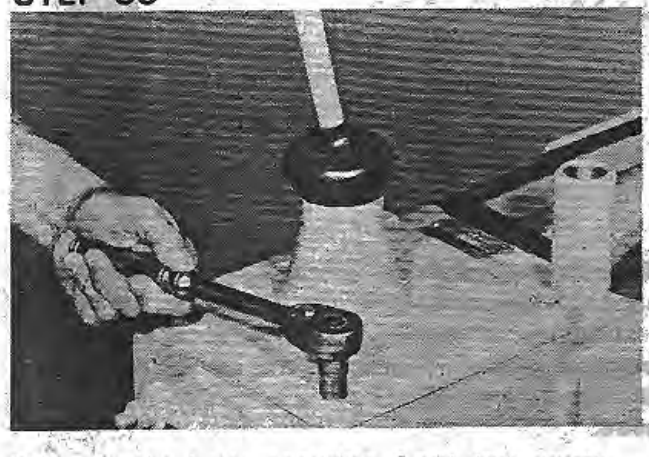
STEP 31



Remove the differential center wheel and ring gear assembly.

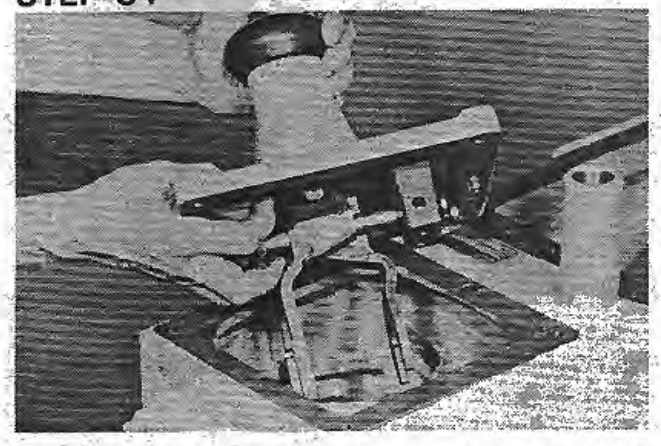
Mainshaft Removal

STEP 33



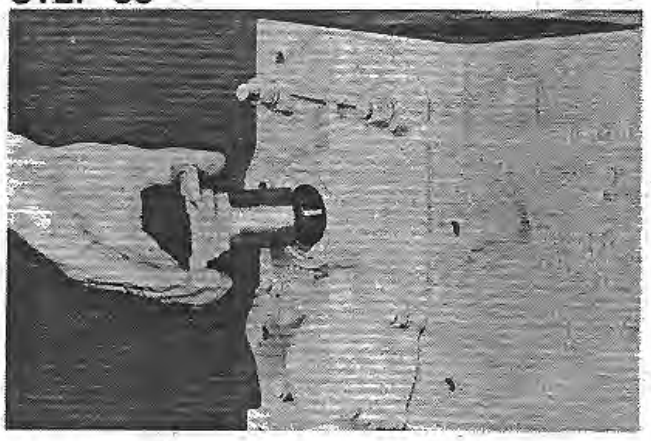
Remove the bolts securing front top cover.

STEP 34



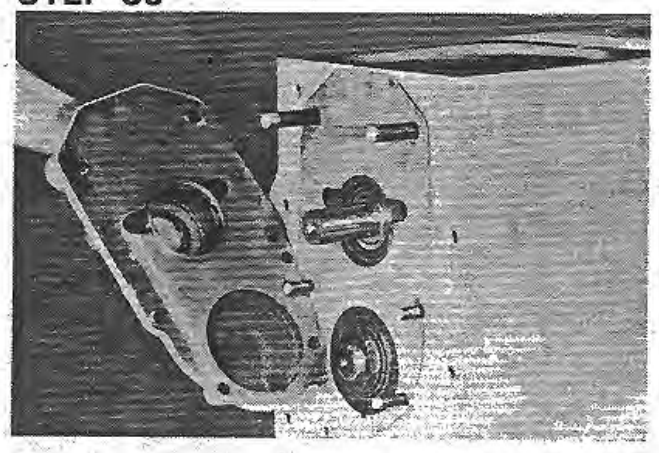
Remove front top cover and shifter assembly.

STEP 35



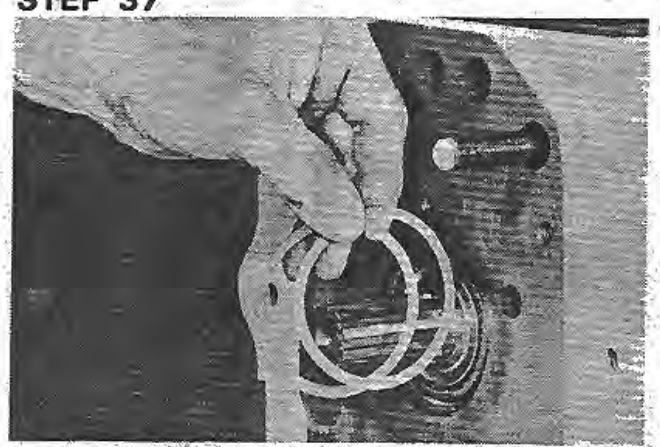
Remove the mainshaft yoke.

STEP 36



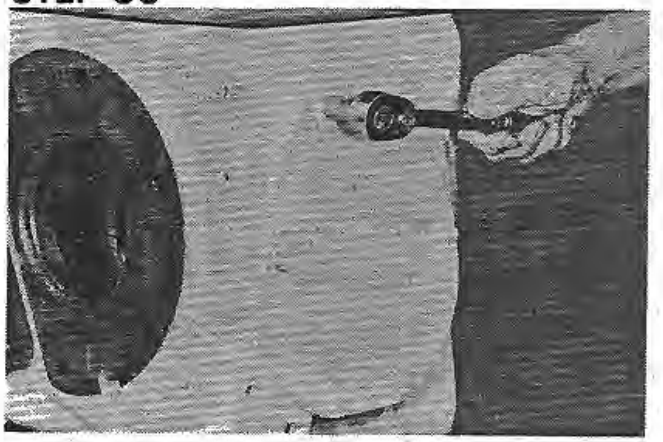
Remove the transaxle front cover.

STEP 37



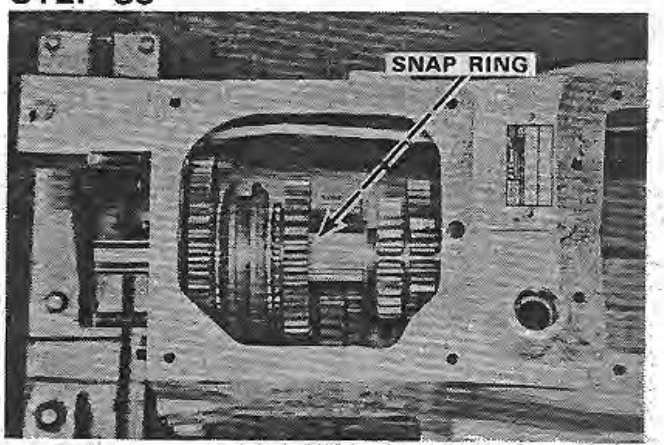
Remove the mainshaft front bearing shim pack. *IMPORTANT:* Retain the shim pack for later installation procedure.

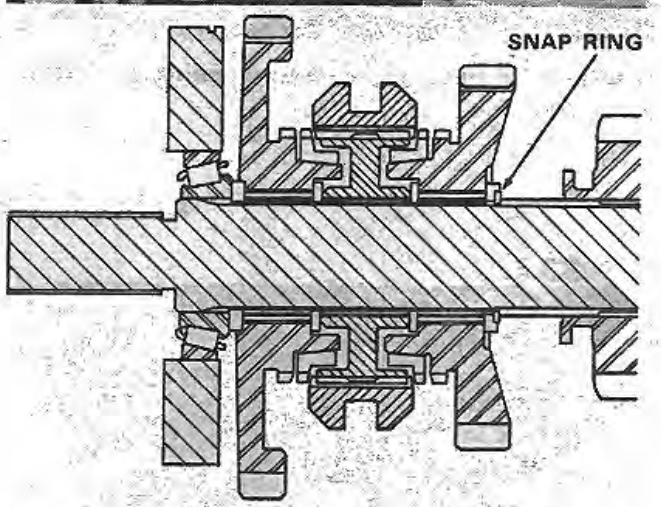
STEP 38



Remove the transaxle rear cover.

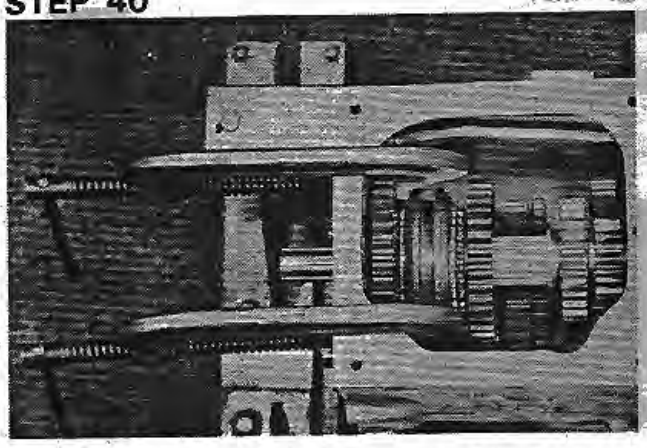
STEP 39





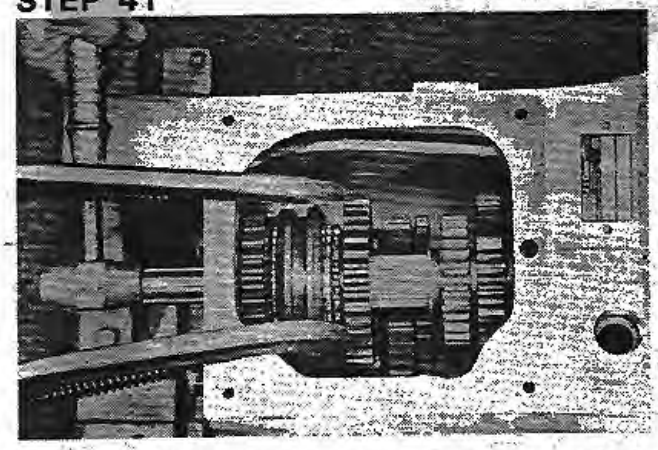
Before the mainshaft and gears can be removed, the front bearing cup and cone must be unseated. Unseating of bearing will allow access to the captive snap ring. This snap ring must be partially removed before the mainshaft can be removed.

STEP 40



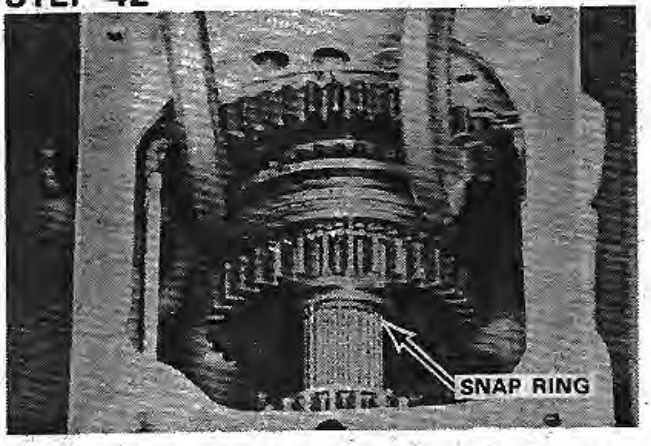
Place two large "C" clamps on 4th gear and draw gear evenly until it makes contact with transmission case. *NOTE:* As gear is drawn towards case the mainshaft will also move.

STEP 41



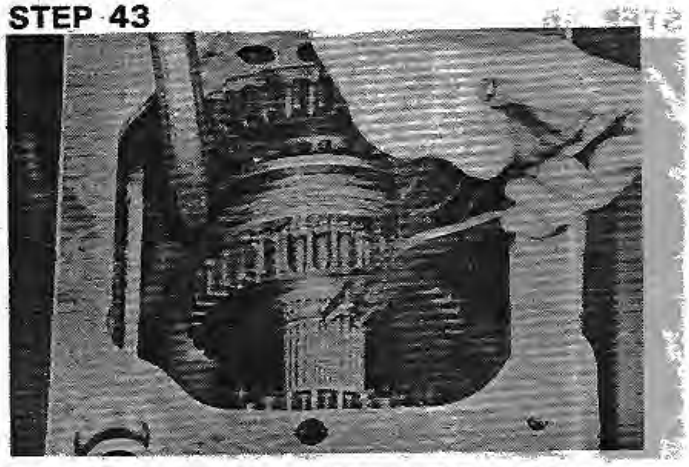
With a soft headed hammer, drive mainshaft into case.

STEP 42



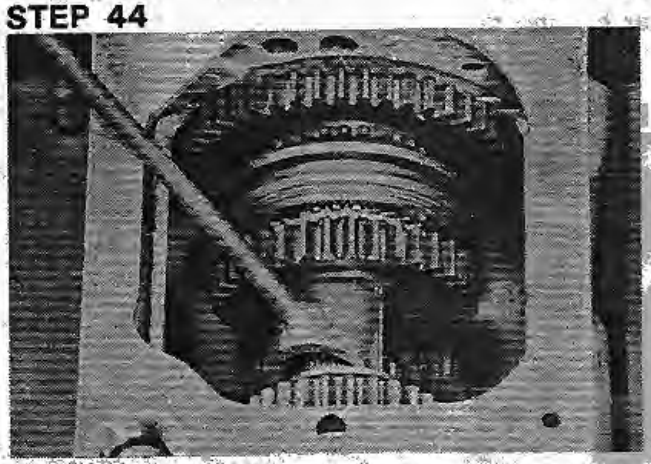
Move the captivating washer towards 3rd gear uncovering snap ring.

STEP 43



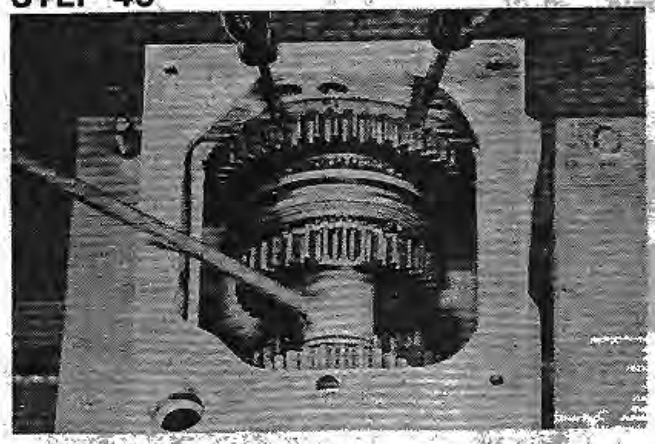
Move snap ring down shaft until it makes contact with 1st and 2nd sliding gear.

STEP 44



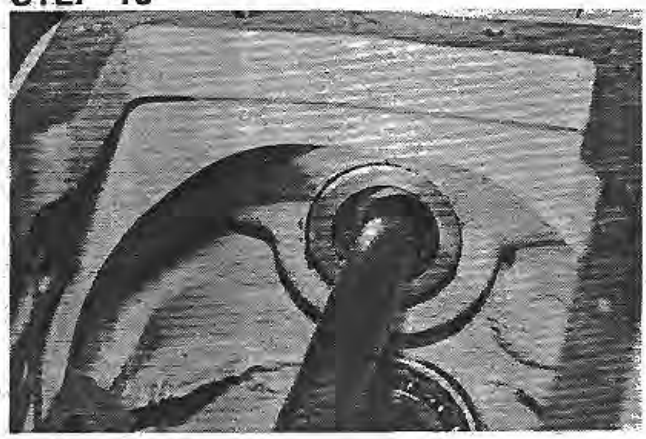
Remove "C" clamps and place spacer tool between snap ring and captivating washer.

STEP 45



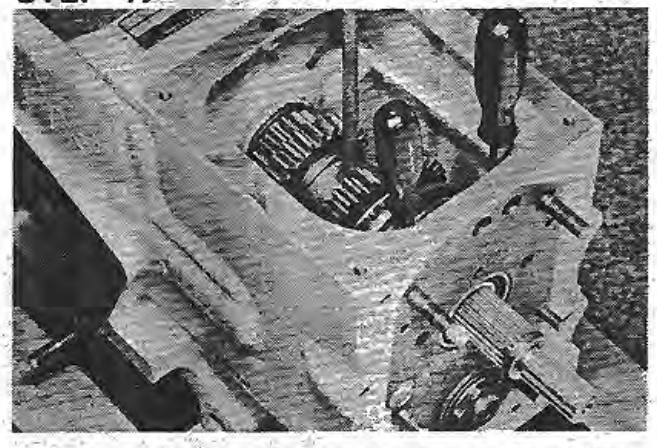
Place two large screwdrivers or pry bars between 4th gear and case, taking up all slack in gear cluster.

STEP 46



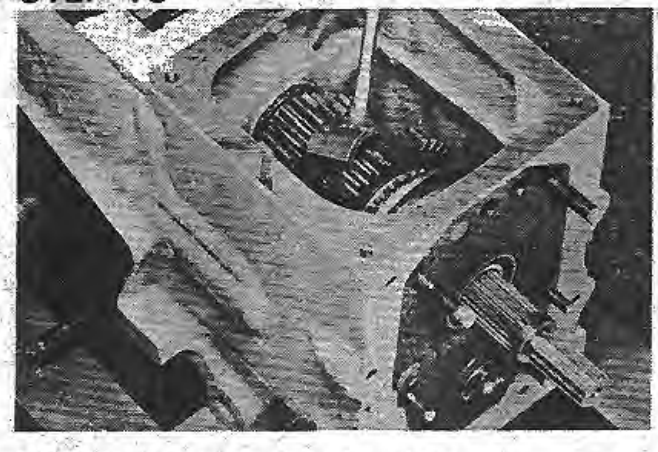
Place a large rod through the rear opening in the case. Drive the mainshaft forward out of the rear bearing cone. *NOTE:* Use extreme care when driving shaft to prevent damaging rear bearing cone.

STEP 47



Drive mainshaft until it has exited from case about two or three inches.

STEP 48



Remove spacer tool and prybars.

STEP 49

Pull mainshaft from case, removing shaft gears.

STEP 50

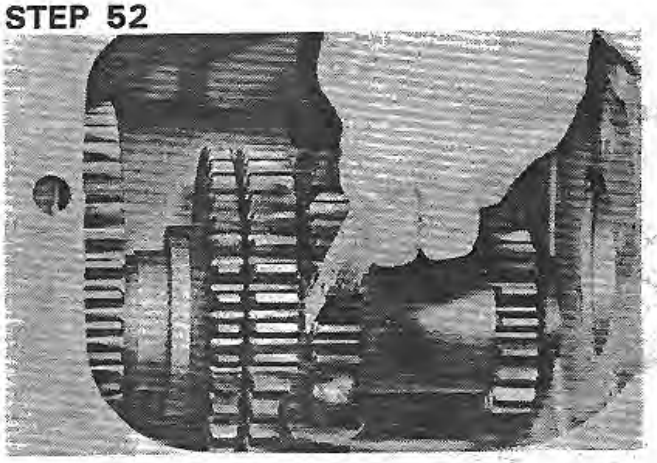
Mainshaft removed from transaxle case.

Countershaft Removal

STEP 51

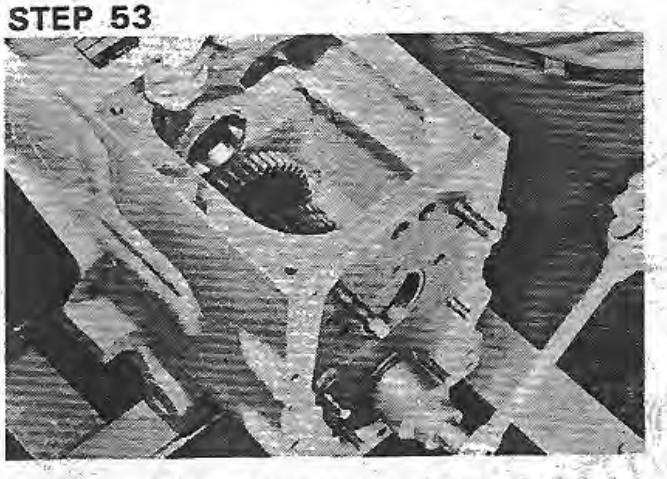
Before disassembling the countershaft assembly, the clearance between 2nd and 3rd gear hubs must be measured and recorded for use when the countershaft is reassembled. *NOTE:* Any new part/s that are installed must have their hub thickness measured and compared against the hub thickness of replaced part/s. This will determine spacer thickness required to maintain necessary clearance between gears during assembly.

STEP 52



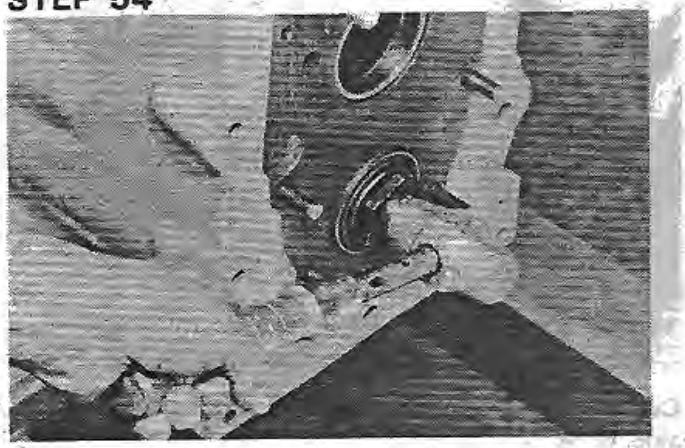
To measure clearance, do not merely tilt the gears on the shaft splines, use two screwdrivers to spread gears apart and check clearance with a feeler gauge.

STEP 53



Lock up countershaft gears with a prybar to prevent rotation and loosen the shaft adjusting nut.

STEP 54



With a soft headed hammer, drive pinion shaft into case.

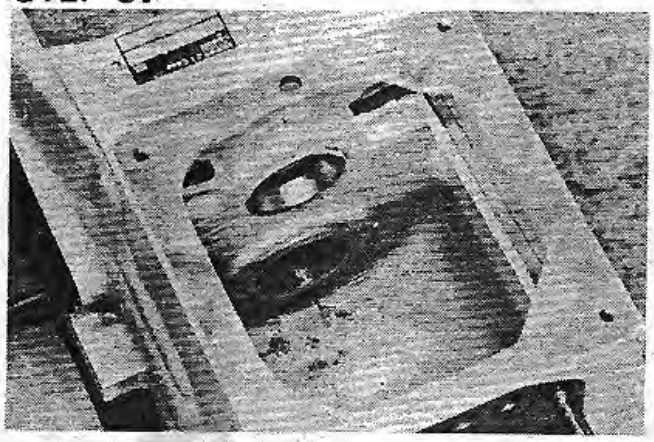
STEP 55

Remove adjusting nut and front bearing cone.

STEP 56

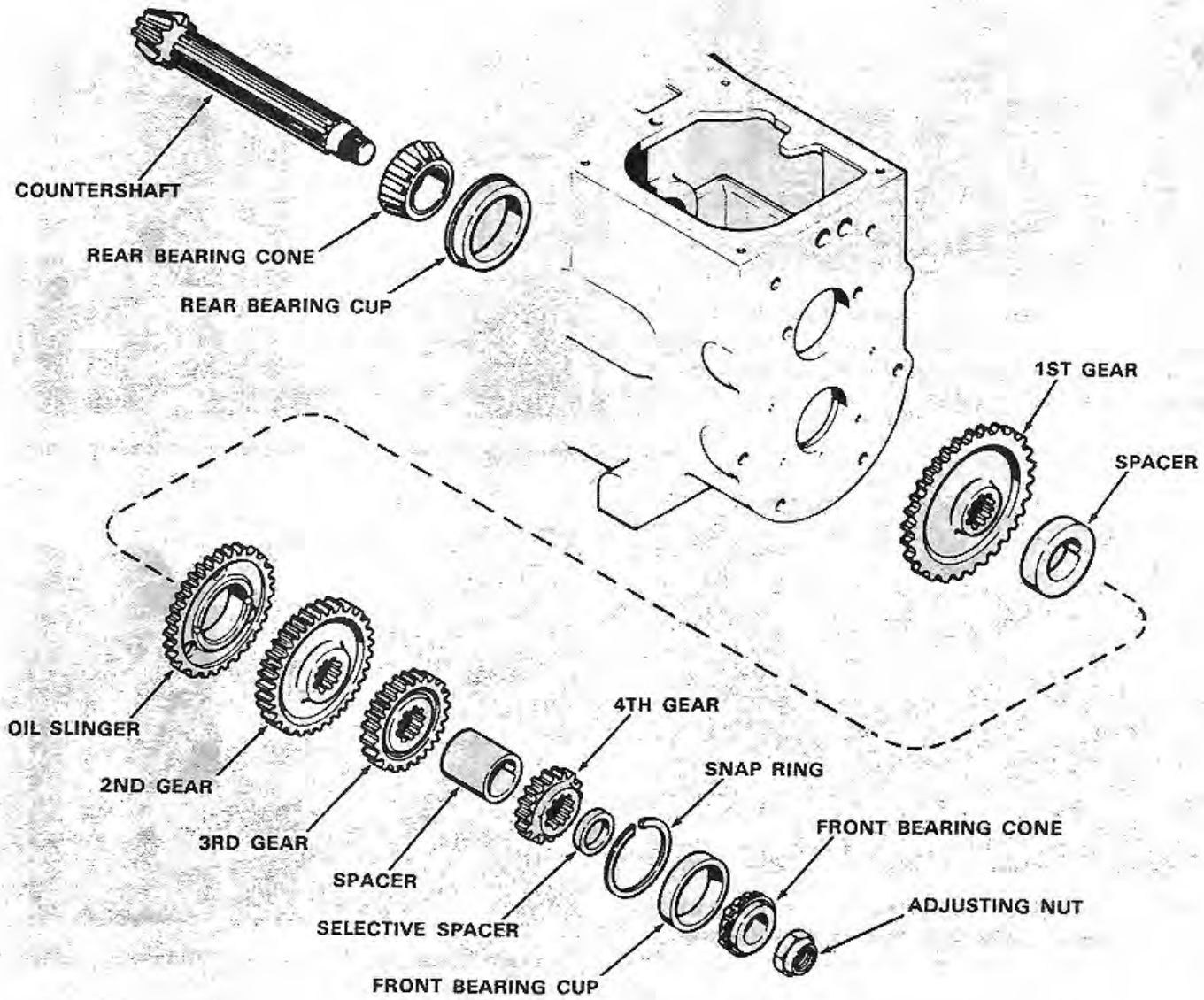
Pull shaft rearward into case, removing gears.

STEP 57

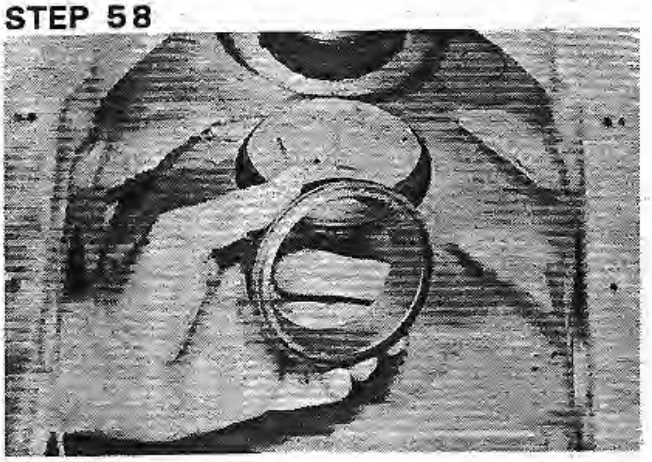


Countershaft assembly removed from transaxle case.

Countershaft Installation

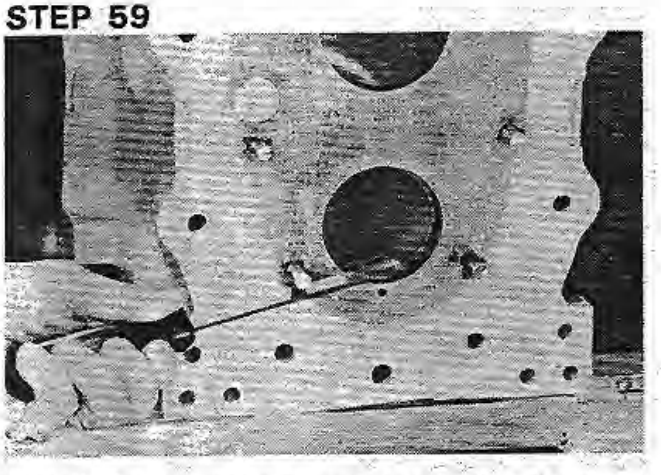


STEP 58



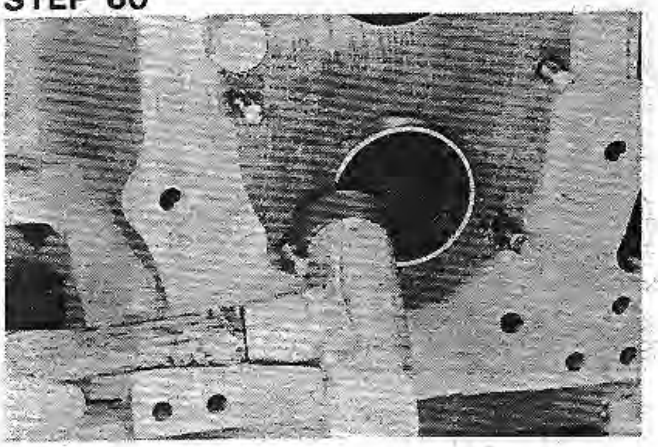
Install pinion shaft rear bearing cup and snap ring into case until the snap ring is firmly seated against bore shoulder.

STEP 59



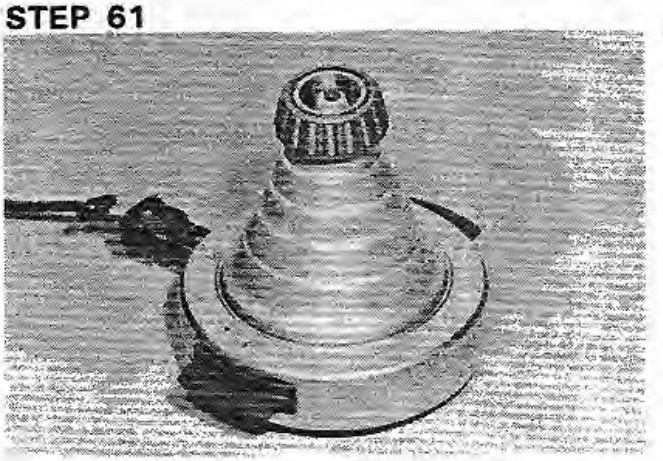
Install front bearing cup snap ring in case groove.

STEP 60



Install front bearing cup (small I.D. inward) until cup seats against the snap ring.

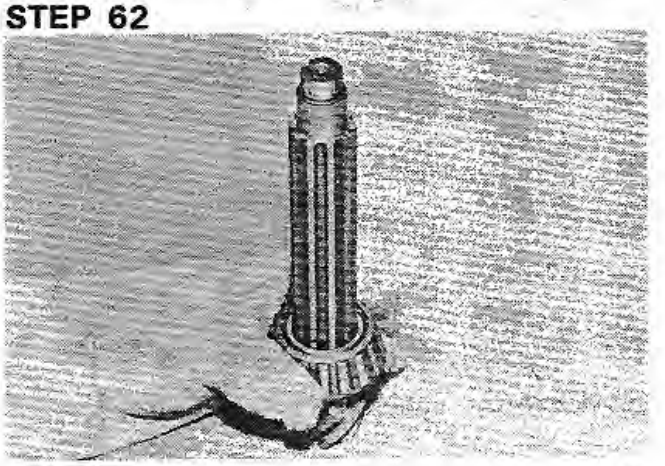
STEP 61



Heat pinion shaft rear bearing cone on a bearing heater.

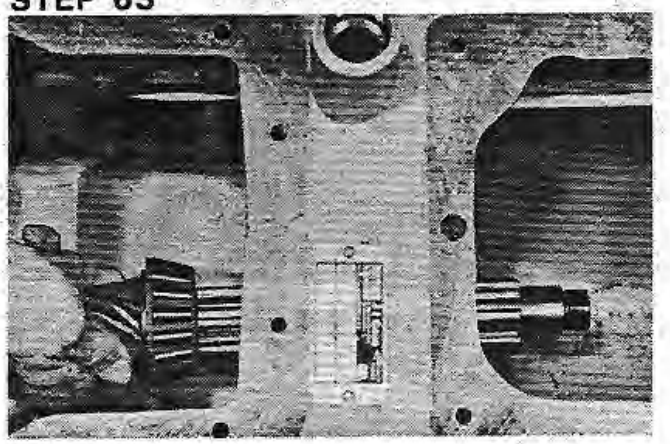
CAUTION *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*

STEP 62



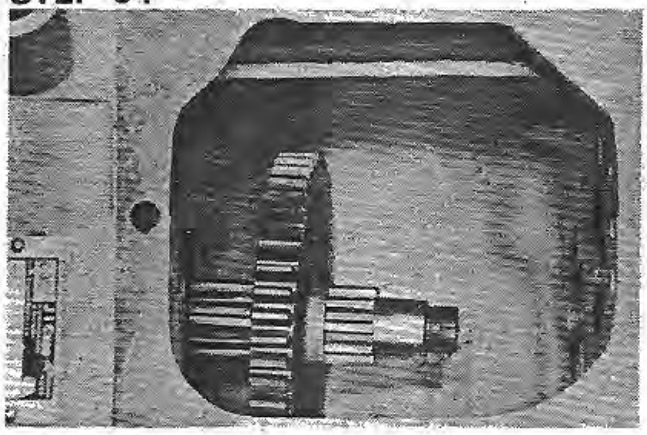
Place heated bearing cone on pinion shaft. *NOTE:* Bearing must make contact with pinion gear end of shaft.

STEP 63



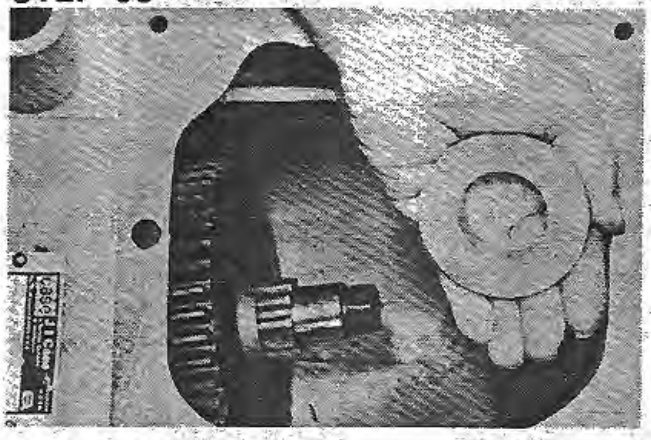
Install pinion shaft in case through rear opening.

STEP 64



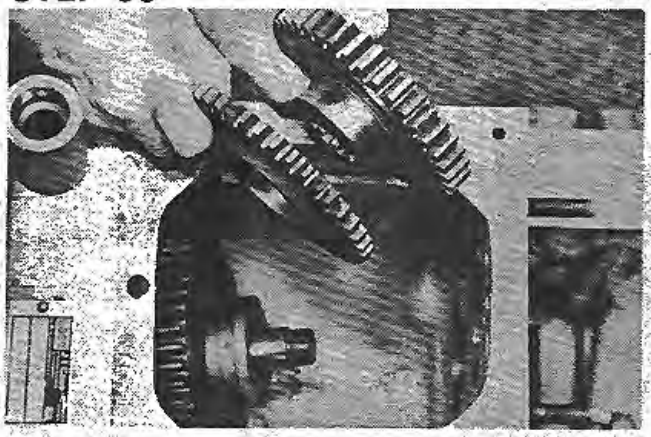
Install 1st speed gear on pinion shaft with gear hub forward.

STEP 65



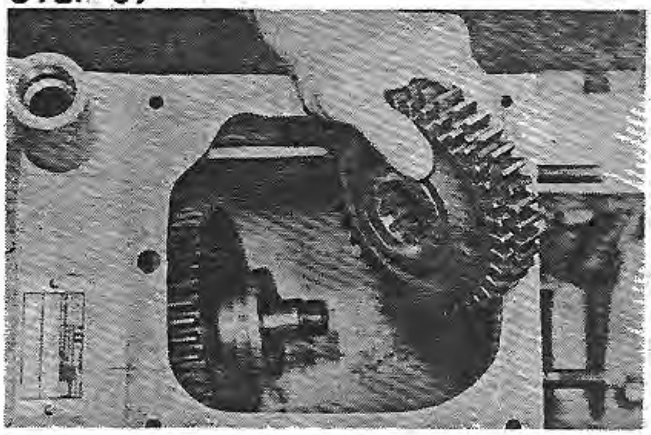
Install narrow gear spacer.

STEP 66



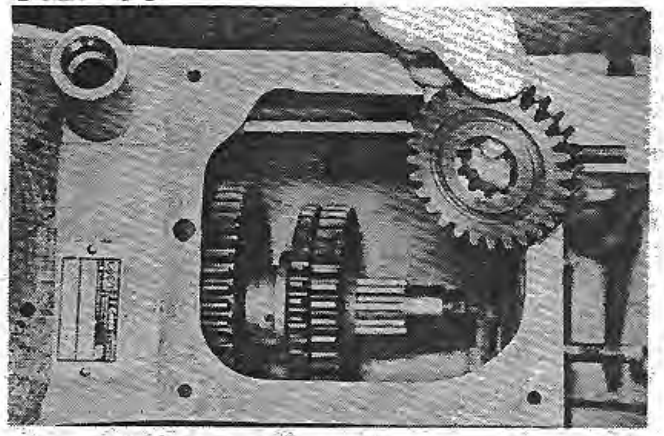
Install oil slinger gear on 2nd speed gear hub.

STEP 67



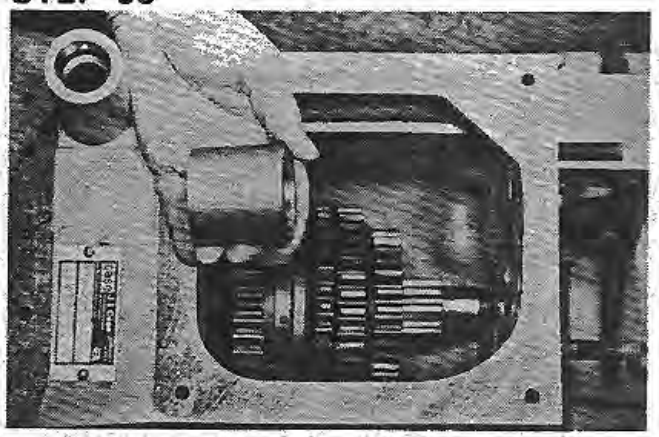
Install 2nd speed gear on pinion shaft with oil slinger gear towards spacer.

STEP 68



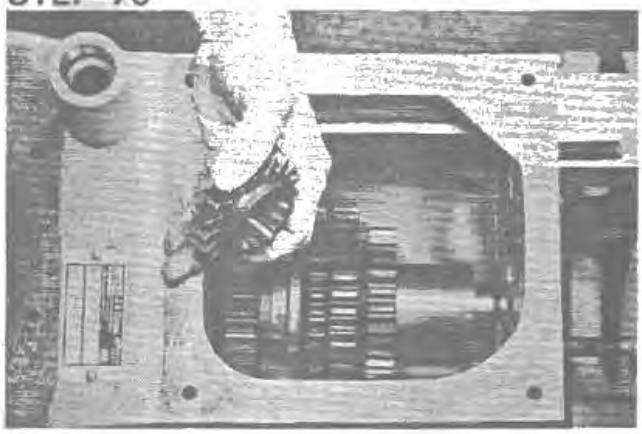
Install 3rd speed gear on pinion shaft.

STEP 69



Install wide gear spacer on pinion shaft.

STEP 70



Install 4th speed gear on pinion shaft with gear hub forward.

STEP 71

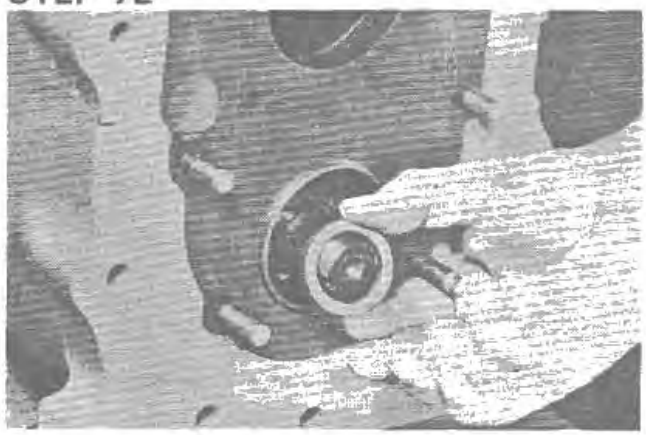
Measure gear selective spacer thickness and select correct spacer which will provide .001" to .006" clearance between gears, see Steps 51 and 52. *NOTE:* Selective spacers are furnished in increments of .005", ranging in size from .164" to .244". Do not use shim stock.

Remember:

A. When the total thickness of new parts is <u>less</u> than the thickness of replaced parts, <u>add</u> the difference in thickness to clearance figure obtained in Step 52. If the sum of these two figures exceeds .006", a thicker spacer must be used.

B. When the total thickness of new parts is <u>greater</u> than the thickness of replaced parts, <u>subtract</u> the difference in thickness from clearance figure obtained in Step 52. If the result is less than .001", a thinner spacer must be used.

STEP 72



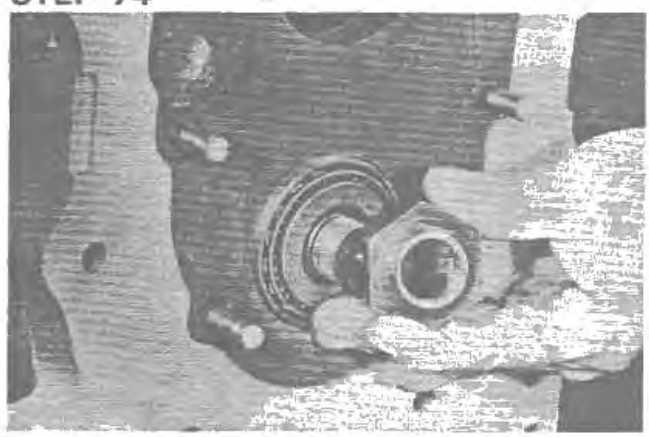
After the correct size spacer has been determined, install spacer on pinion shaft.

STEP 73

Heat the front bearing cone on a bearing heater and install heated bearing on pinion shaft.

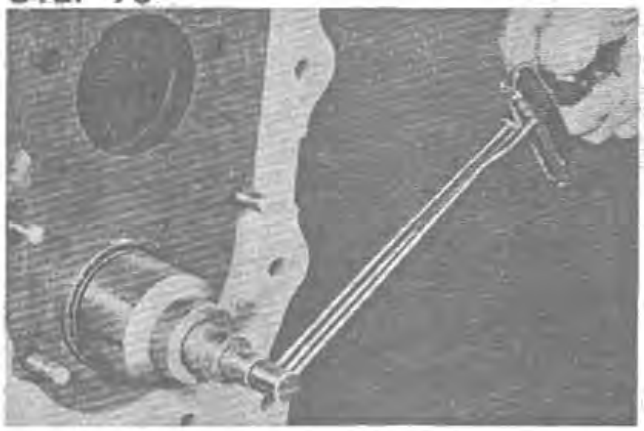
CAUTION *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*

STEP 74



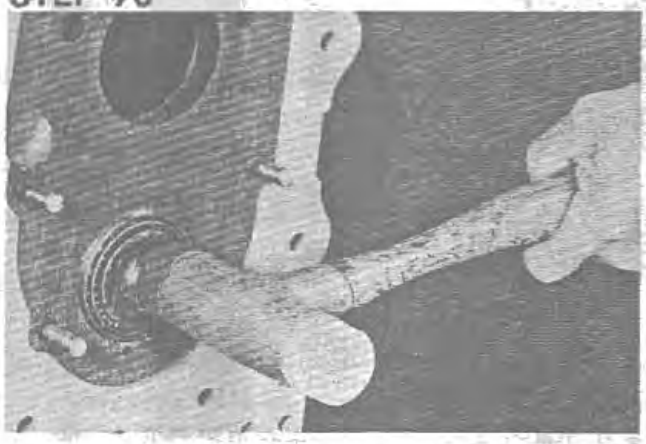
Install pinion shaft adjusting nut and tighten nut until bearing endplay is removed.

STEP 75



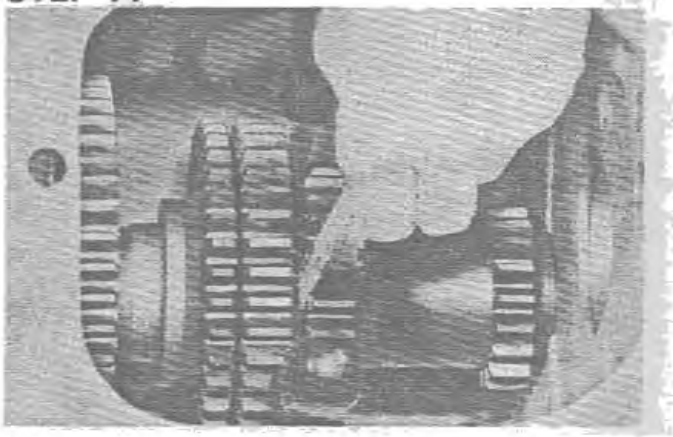
Preload countershaft bearings, such that a torque of 4 to 12 inch pounds above no load rolling torque is required to turn countershaft assembly.

STEP 76



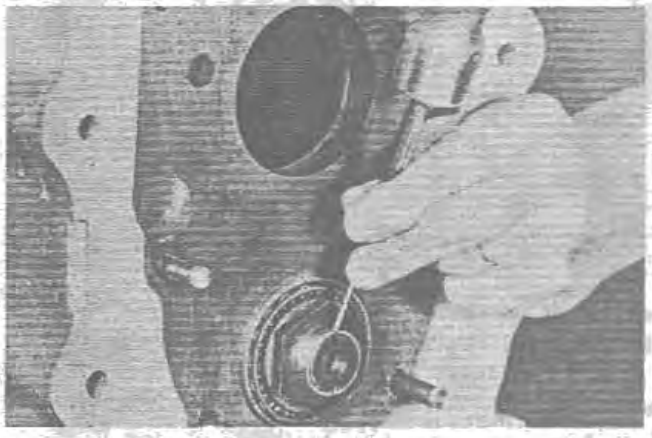
Tap both ends of the pinion shaft to help seat bearing, then recheck the bearing rolling torque, Step 75.

STEP 77

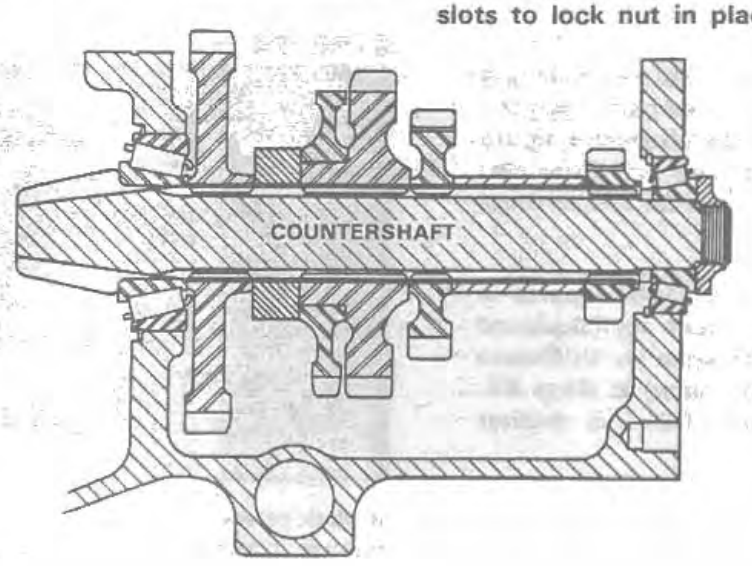


Check the clearance between 2nd and 3rd gear hubs with a feeler gauge and gears spread apart. Clearance must be .001" to .006". If clearance is incorrect, a different size spacer must be used. Remove rear bearing cone and spacer, repeat Steps 73 thru 76 until proper clearance is obtained.

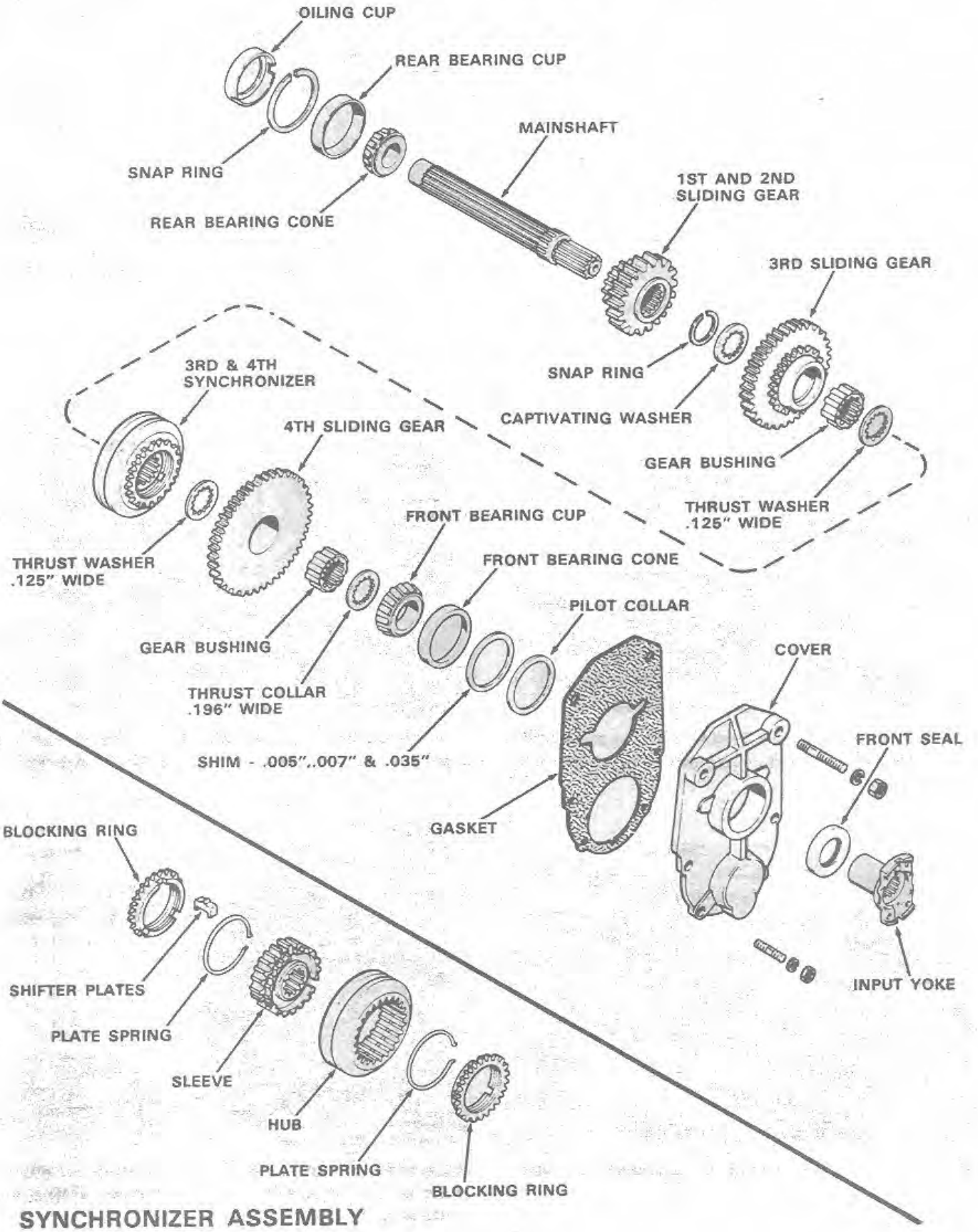
STEP 78



Peen the thin section of adjusting nut into shaft slots to lock nut in place.

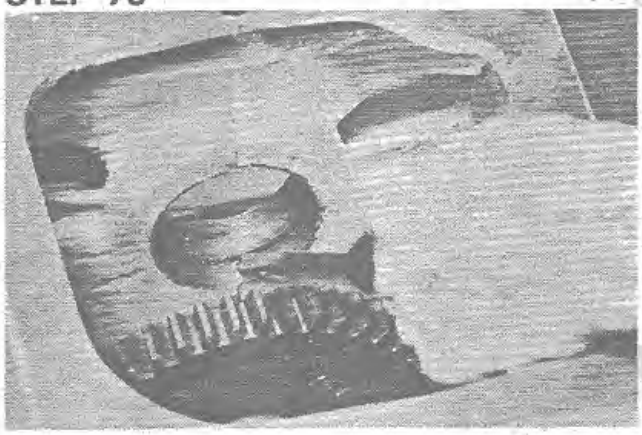


Mainshaft Installation



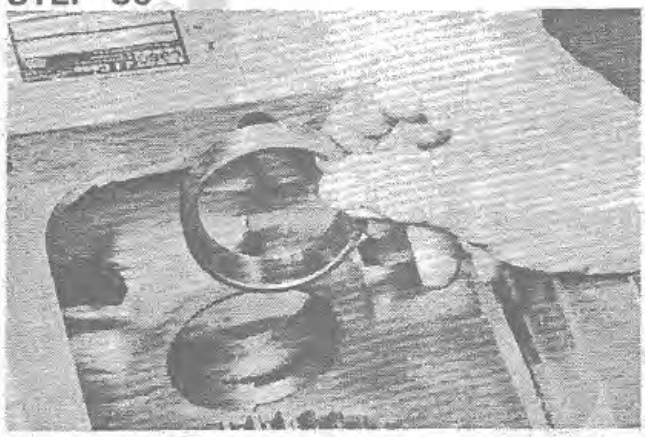
SYNCHRONIZER ASSEMBLY

STEP 79



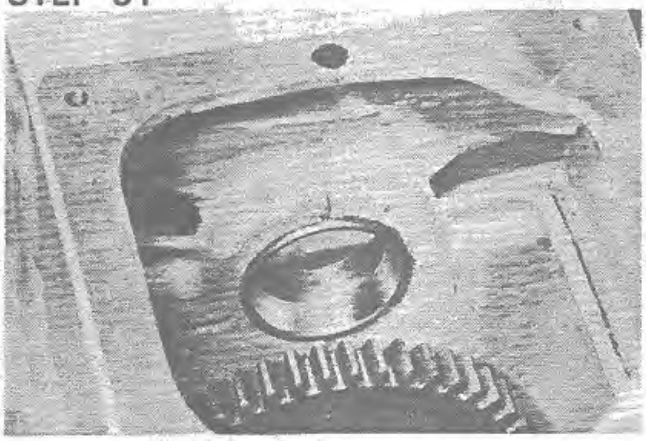
Install rear mainshaft bearing cup snap ring in case groove.

STEP 80



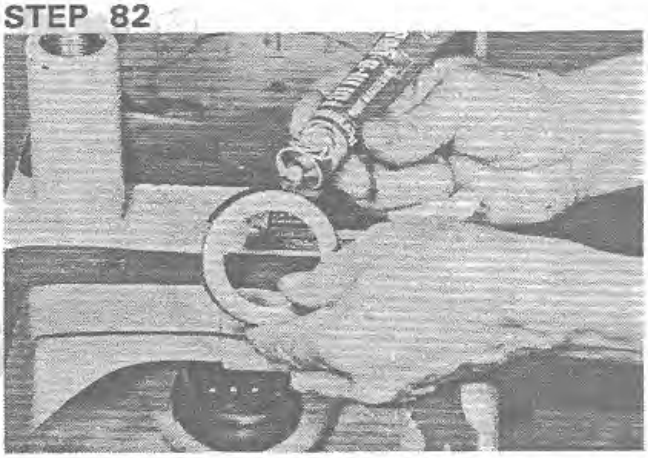
Install rear bearing cup (small I.D. rearward) into case until cup seats against the snap ring.

STEP 81



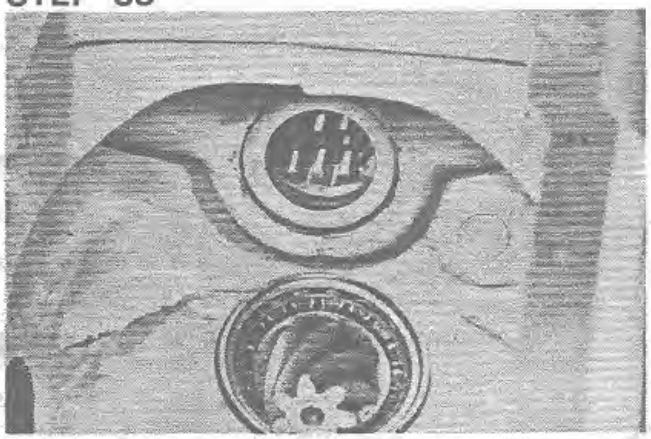
Rear bearing cup installed in transaxle case.

STEP 82



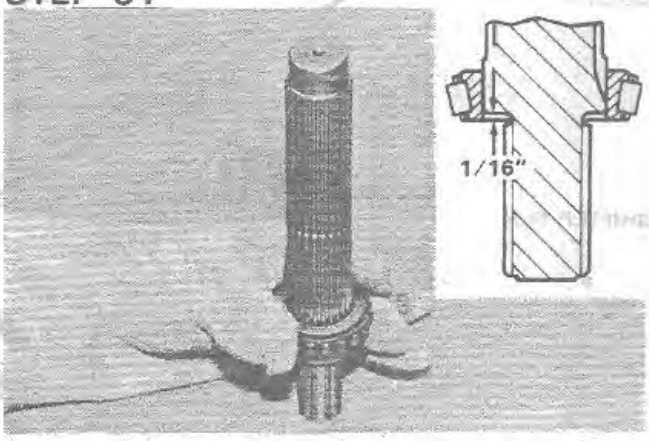
Apply #2 Permatex to the outside surface of the rear bearing oil cup.

STEP 83



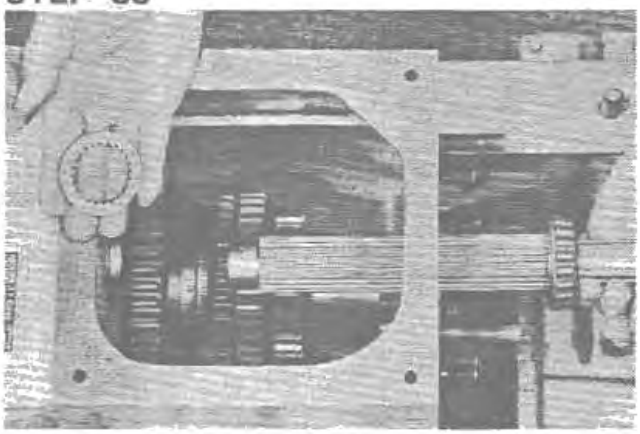
Align oiling cup notches with case openings and press cup into case until it is flush with case.

STEP 84



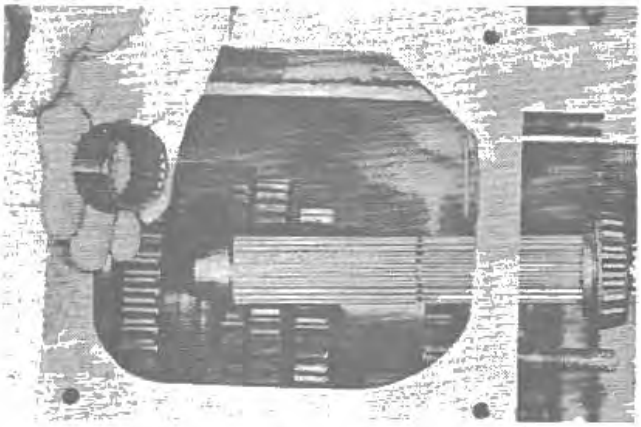
Heat front bearing cone and install on mainshaft so that it extends 1/16" passed step on shaft end.

STEP 85



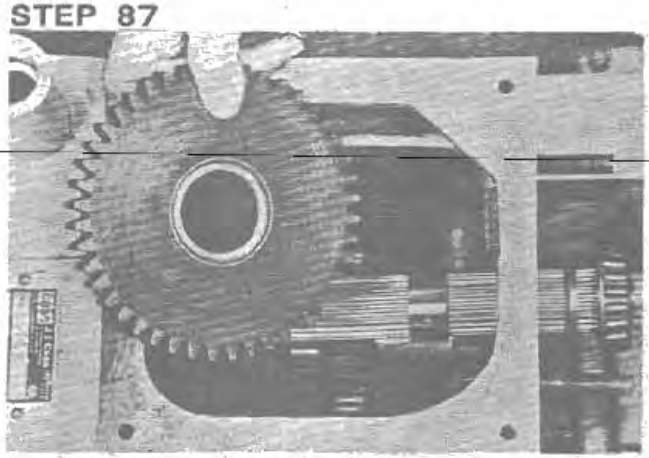
Start mainshaft through front opening in case and install thrust collar (.196" wide) on mainshaft.

STEP 86



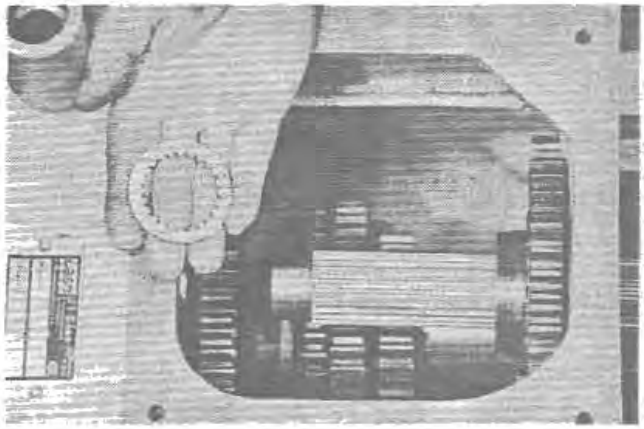
Install gear bushing on mainshaft.

STEP 87



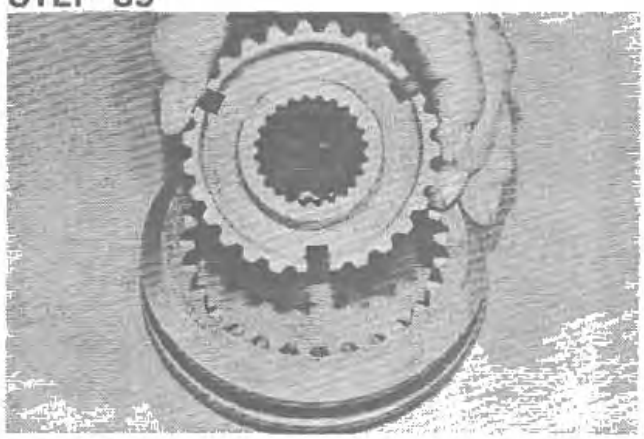
Install 4th gear (flat side towards case front) on mainshaft over bushing.

STEP 88



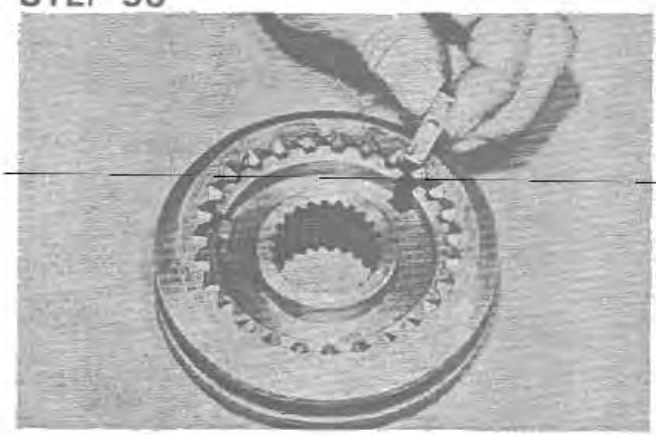
Install thrust washer (.125" wide) on mainshaft.

STEP 89



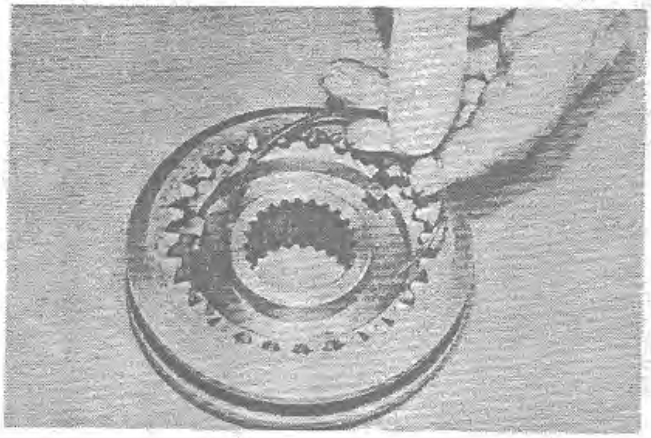
Place synchronizer sleeve inside of hub.

STEP 90



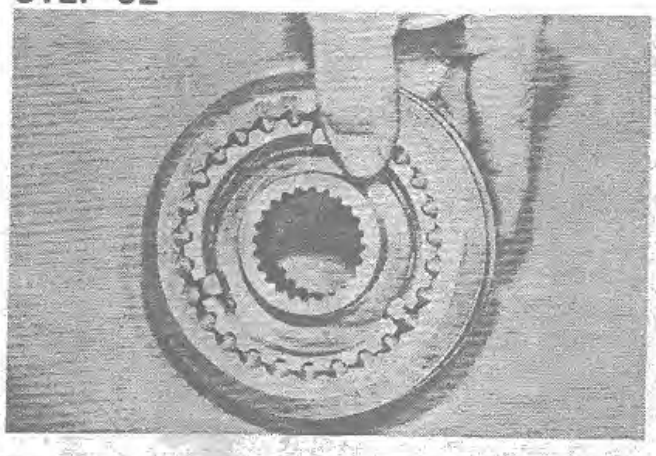
Install the three shifter plates in synchronizer sleeve grooves.

STEP 91



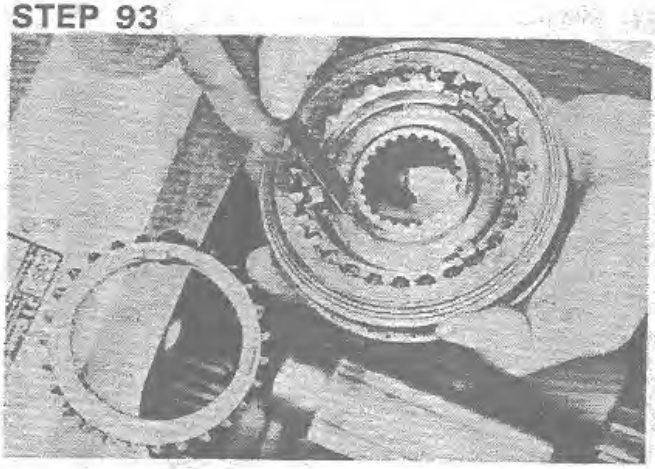
Retain the shifter plates in place with spring.

STEP 92



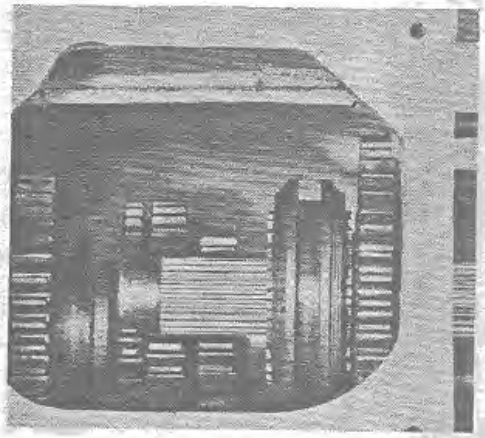
Turn the synchronizer hub and sleeve over and install the other shifter plate spring.

STEP 93



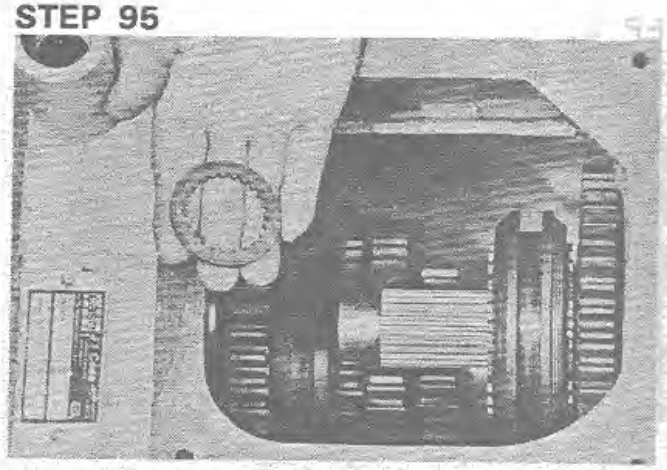
Measure synchronizer sleeve hub length, noting which side has short hub length and place blocking rings on synchronizer hub.

STEP 94



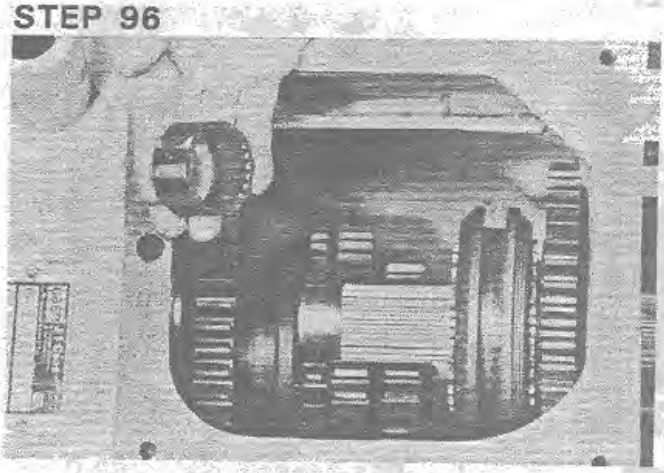
Install synchronizer assembly on mainshaft. *IMPORTANT:* Short sleeve hub side of synchronizer must face forward, see Step 94.

STEP 95



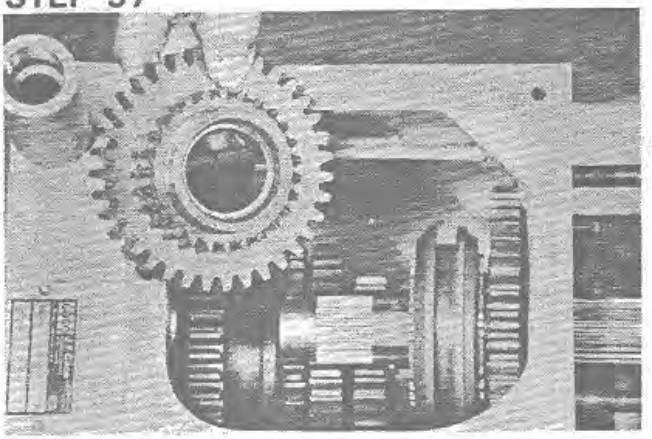
Install thrust washer (.125" wide) on mainshaft.

STEP 96



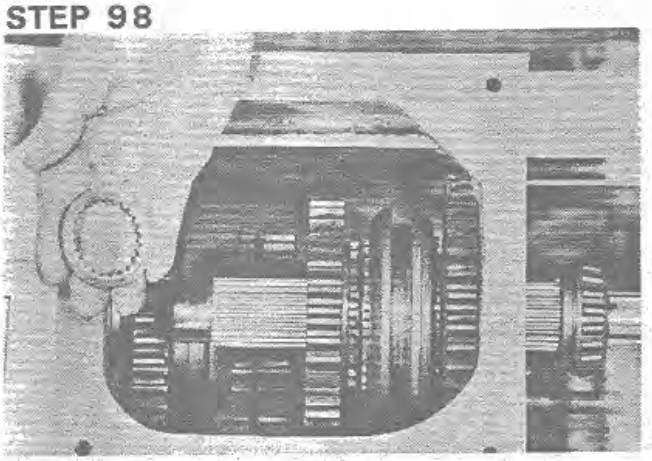
Install gear bushing on mainshaft.

STEP 97



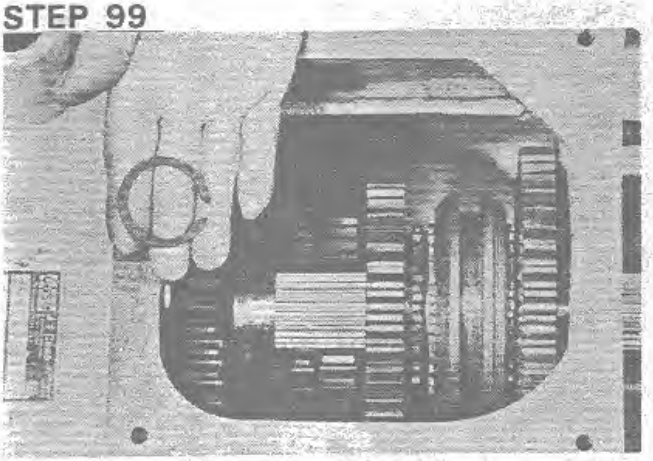
Install 3rd gear (tapered hub towards synchronizer) on mainshaft over the gear bushing.

STEP 98



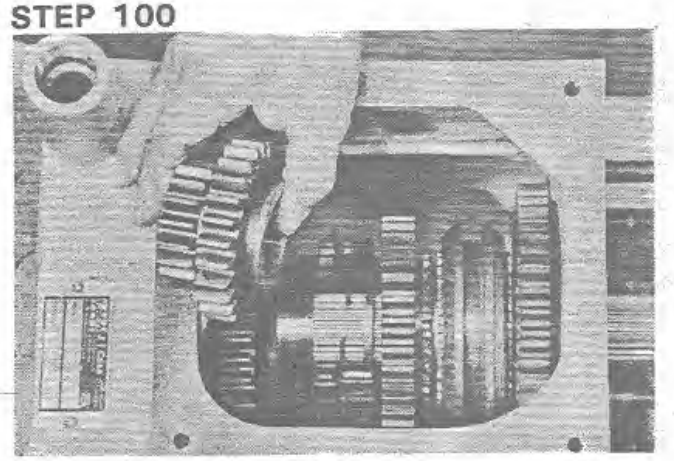
Install captivating washer (flat side towards 3rd gear) on mainshaft.

STEP 99



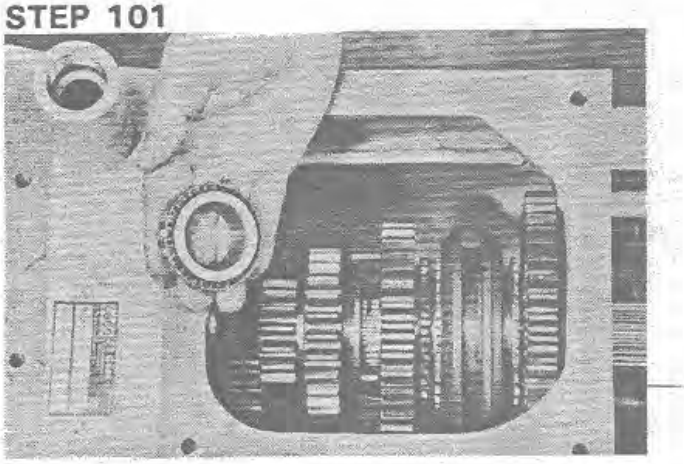
Install gear retaining snap ring on mainshaft, but do not place snap ring in shaft groove at this time.

STEP 100



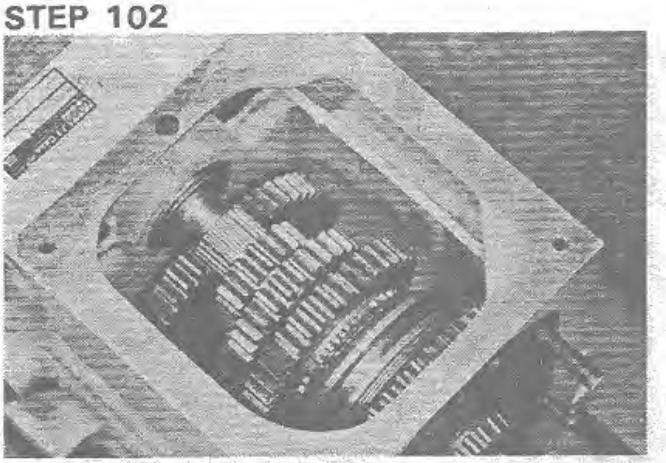
Install 1st and 2nd sliding gear (small gear rearward) on mainshaft.

STEP 101



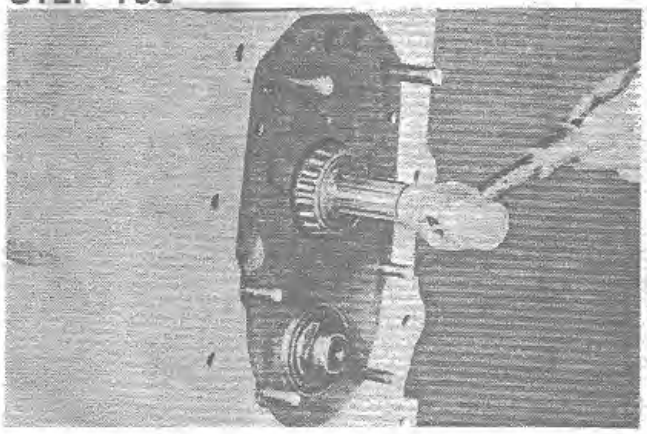
Place rear bearing cone in bearing cup.

STEP 102



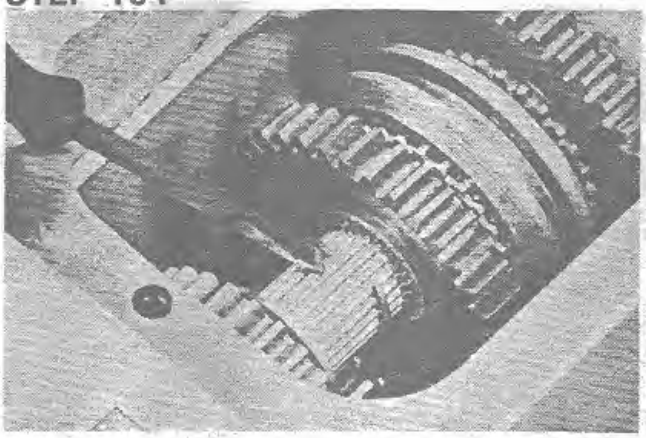
Position mainshaft so that it is aligned with and just started into rear bearing cone.

STEP 103



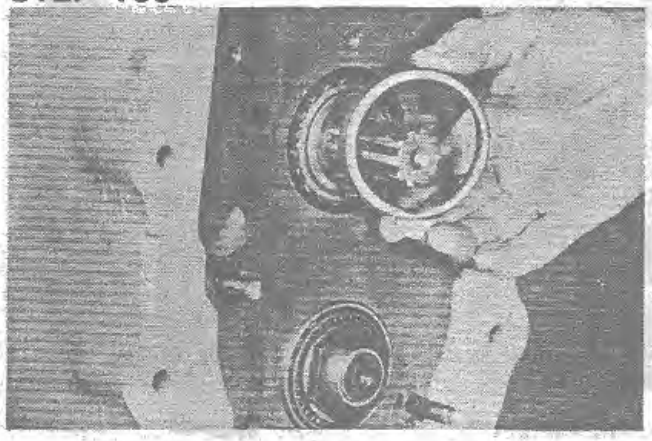
With a soft headed hammer drive mainshaft into rear bearing cone.

STEP 104



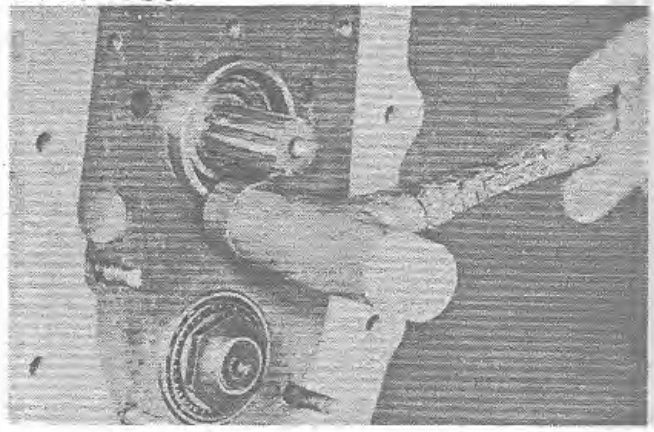
Pull gear cluster as far forward as possible and install snap ring in shaft groove.

STEP 105



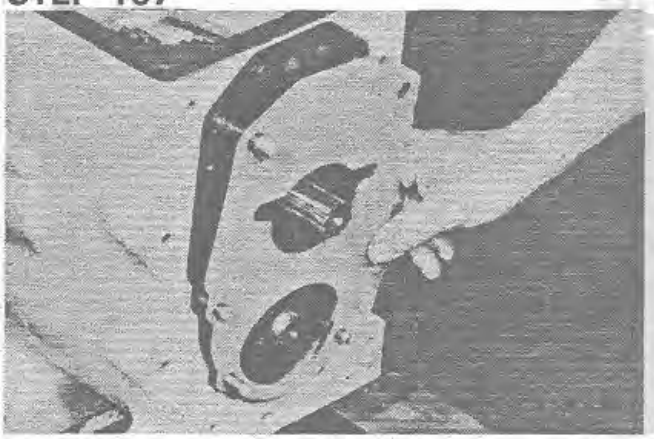
Place front bearing cup in housing bore.

STEP 106



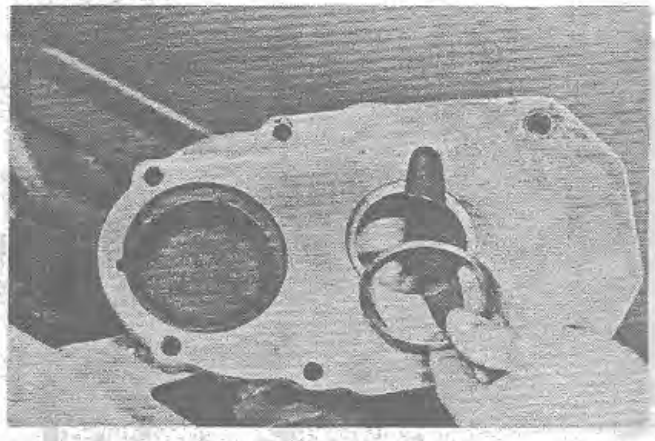
Carefully drive bearing cup into housing bore until it is flush with housing.

STEP 107



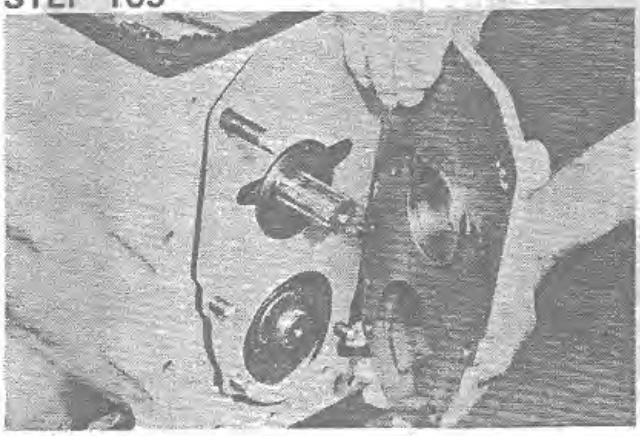
Place a new front cover gasket on housing.

STEP 108



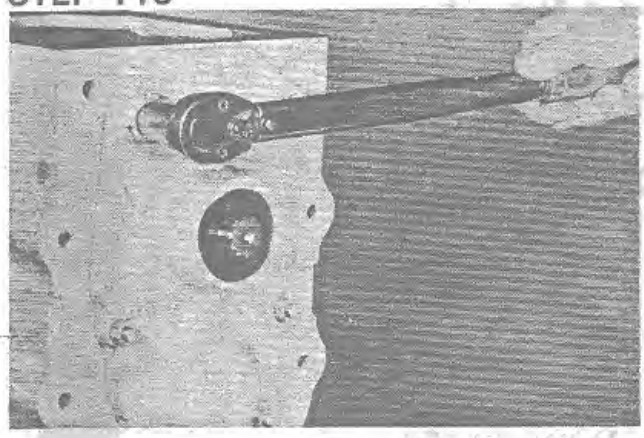
Press pilot collar in front cover until it bottoms.

STEP 109



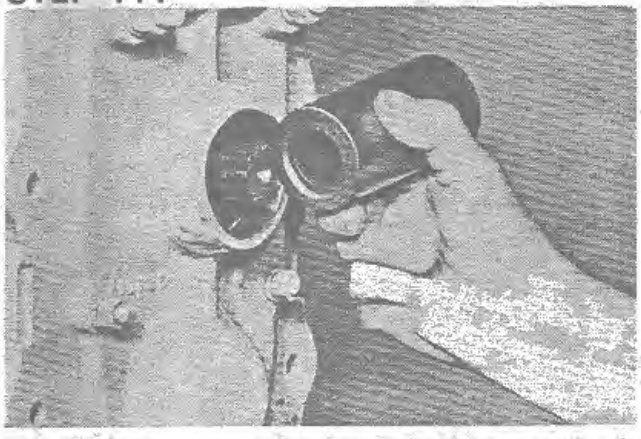
Install front cover on housing.

STEP 110



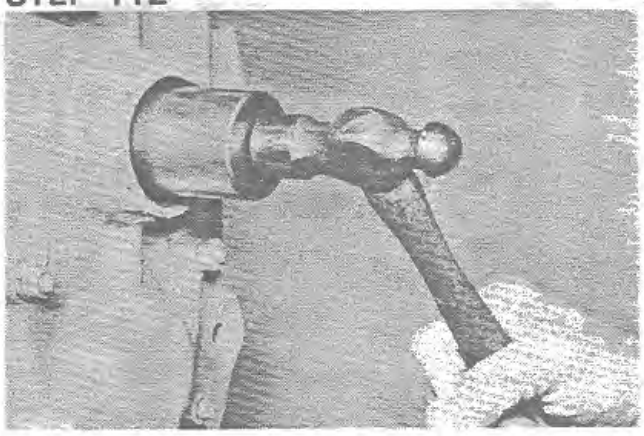
Torque front cover 1/2" mounting nuts 80 to 96 ft. lbs. and 3/8" mounting nuts 35 to 42 ft. lbs.

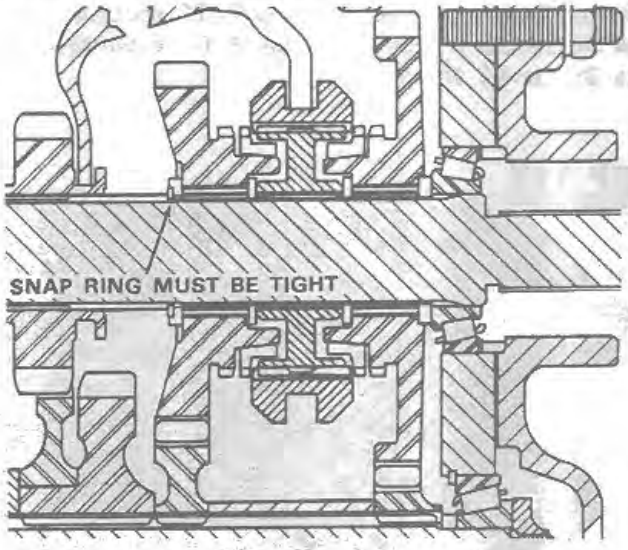
STEP 111



Place main front bearing driver A146285 on mainshaft.

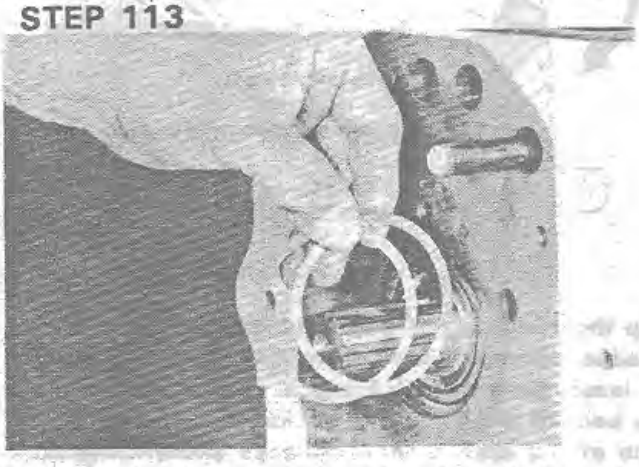
STEP 112





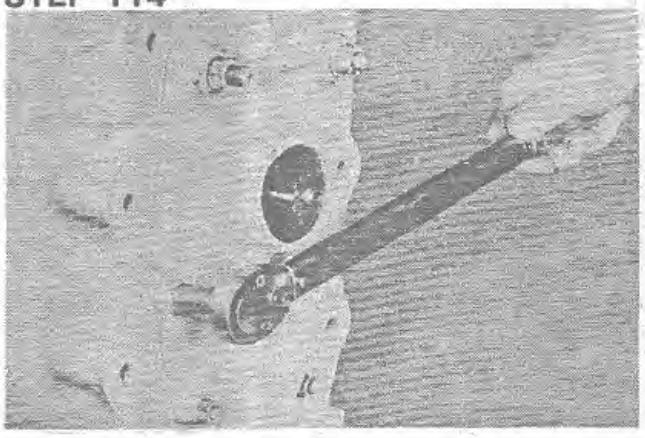
Place a wedge between 4th gear and housing. Seat front bearing cone, removing all end play between gears. *NOTE:* End play will be removed when captive snap ring is tight.

STEP 113



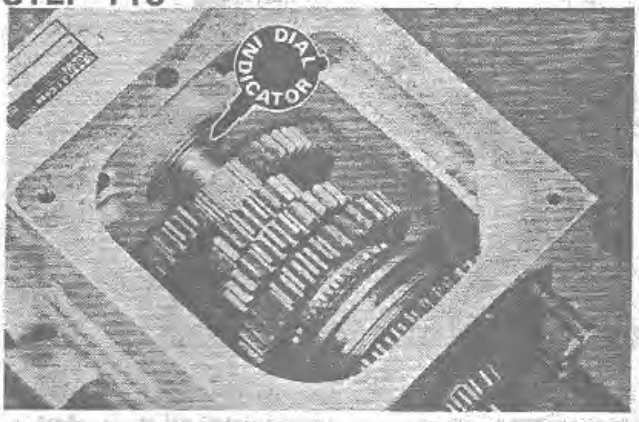
Remove the front cover and re-install the old shim pack, retained from Step 37 during disassembly, minus some shims to assure an end play reading.

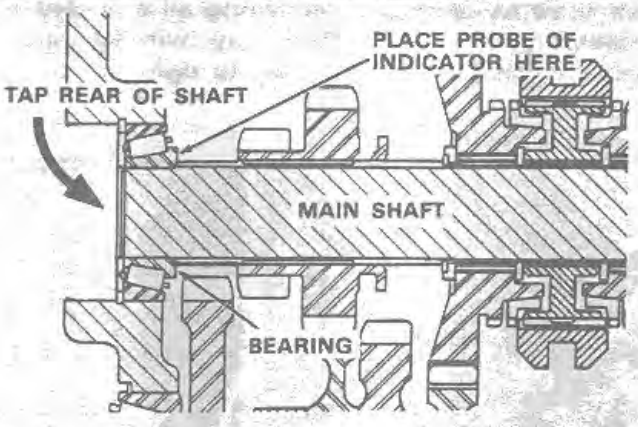
STEP 114



Reinstall front cover and torque 1/2" mounting nuts 80 to 96 ft. lbs. and the 3/8" mounting nuts 35 to 42 ft. lbs.

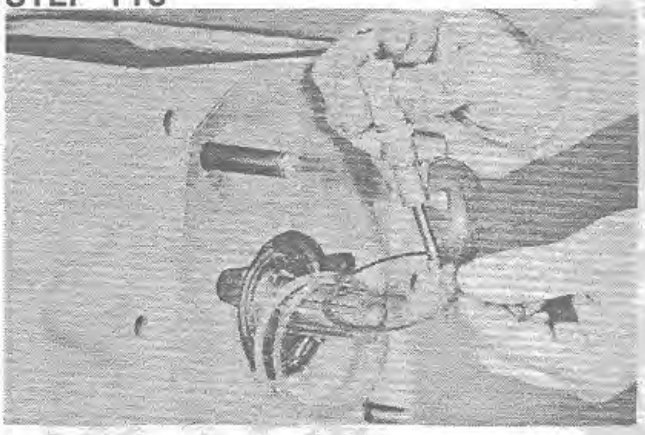
STEP 115





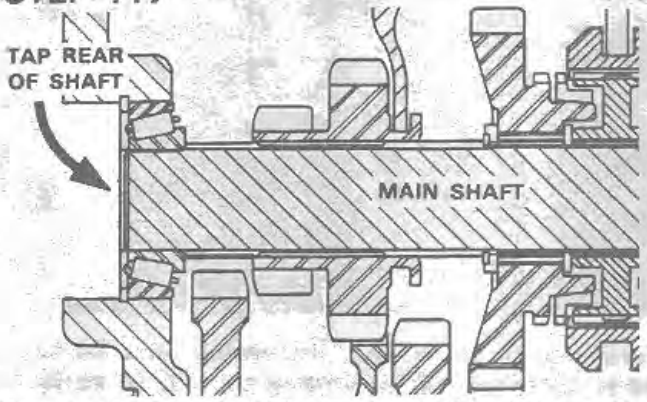
Tap the back end of the main shaft with a soft headed hammer and turn shaft at the same time at least three turns. Place a dial indicator at the back of the shaft with indicator probe on the face of the rear bearing cone as shown. Move shaft back and forth, while reading indicator, which will determine the amount of shim stock that must be added to provide correct .001" shaft end play or close as possible to .001" play.

STEP 116

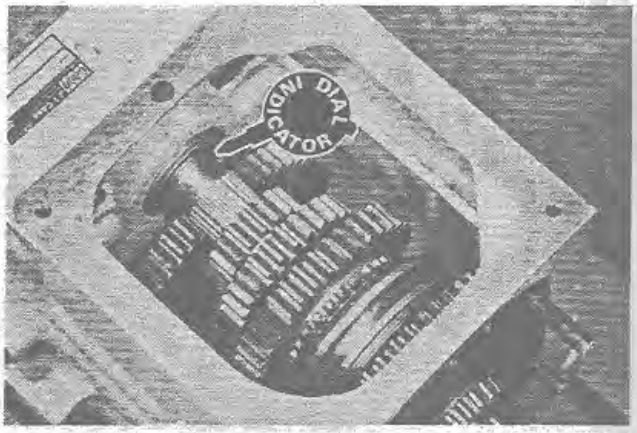


Remove front cover and add shims to achieve .000" to .001" end play to .001 preload. Shims are available in .005", .007" and .035" sizes. Re-install front cover and torque nuts as specified in Step 114.

STEP 117

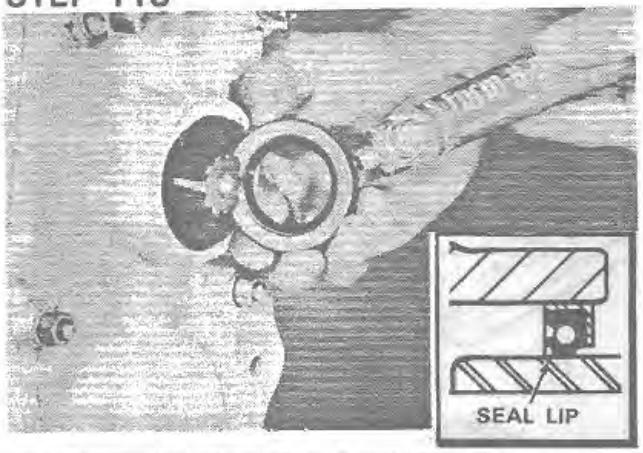


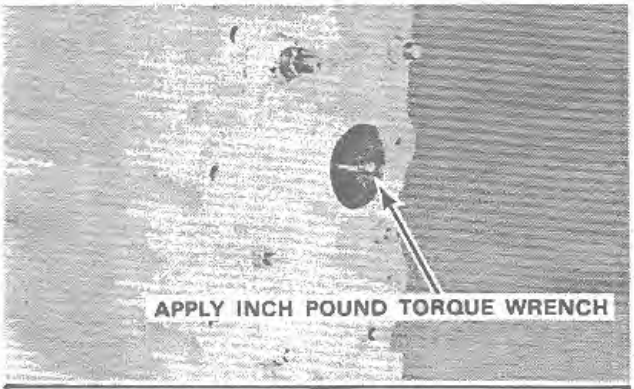
Tap the back end of the main shaft with a soft headed hammer and rotate the shaft several turns while tapping shaft.

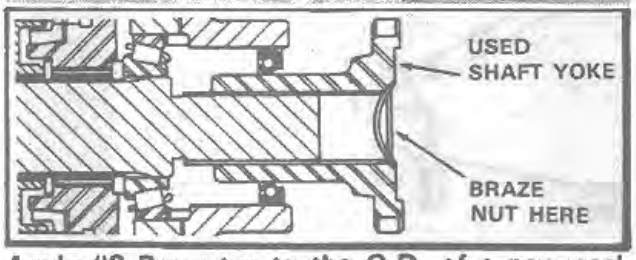


Recheck for shaft end play with a dial indicator as shown in Step 115. End play must be .000" to .001" to .001" preload. If not, add or subtract shims, see Step 116, to obtain correct end play and preload.

STEP 118

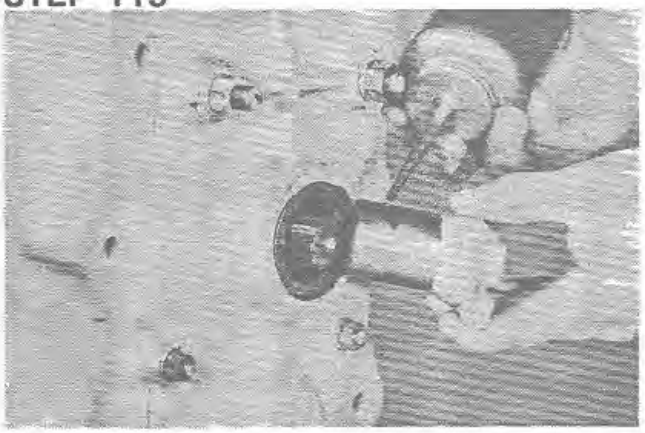






Apply #2 Permatex to the O.D. of a new seal and install seal (lip inward) see Inset, in housing cover. Apply an inch pound torque wrench and an adapter to front end of shaft and check the rolling torque. The rolling torque must not exceed 5 inch pounds for correct bearing preload, including seal drag. If more than 5 inch pounds a shim or shims may have to be removed. *NOTE:* A make-up adapter may be made from a used yoke, see inset, by brazing a nut to the used yoke.

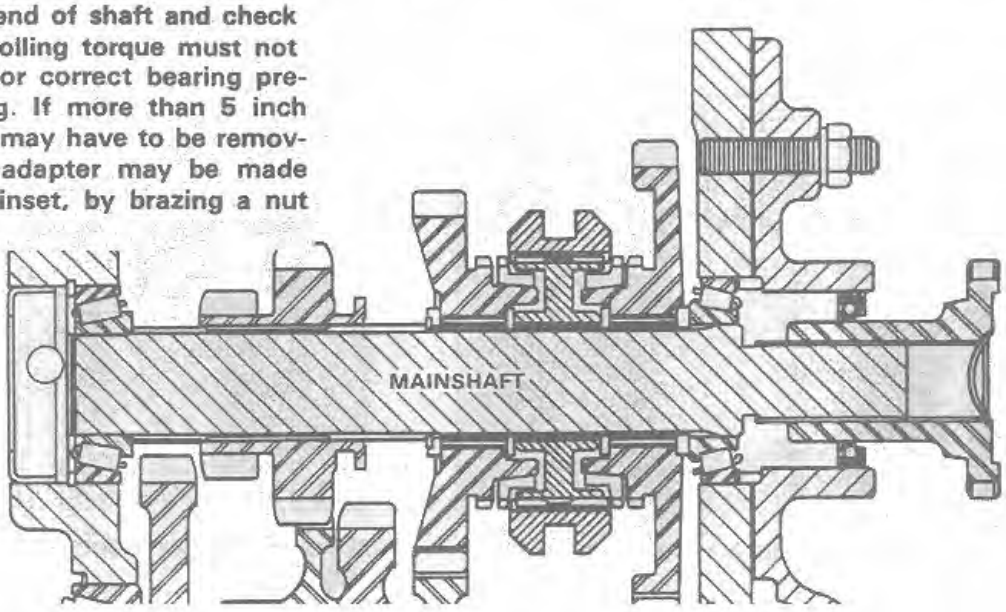
STEP 119



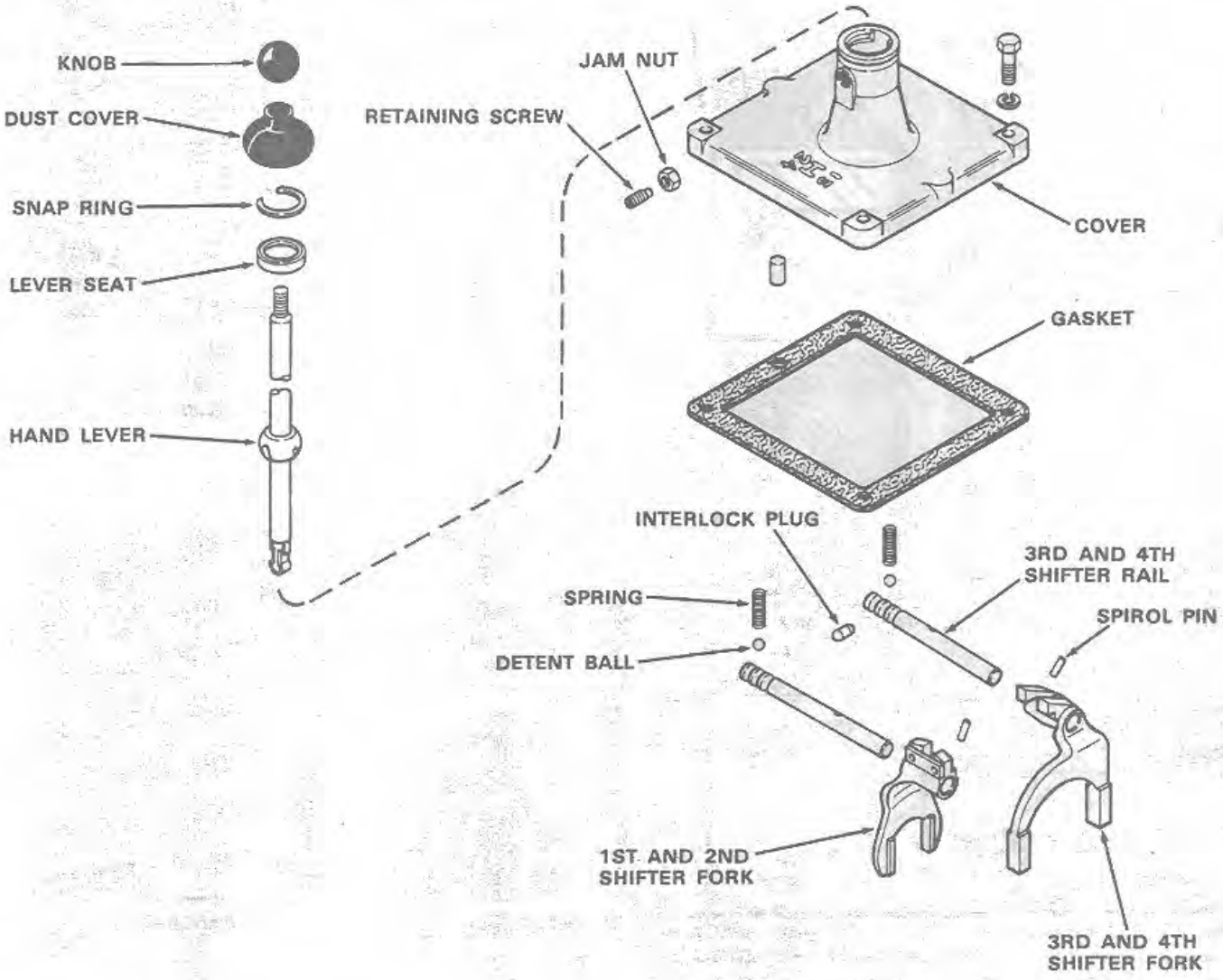
Oil shaft yoke and carefully install over shaft and into seal. *NOTE:* Yoke must be hand installed, DO NOT drive onto shaft with hammer.

STEP 120

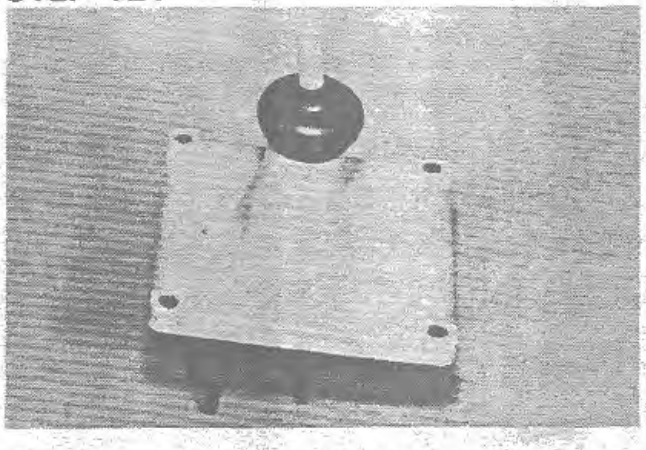
Mainshaft assembly installed in transaxle housing.



Rebuilding Shifter Assembly

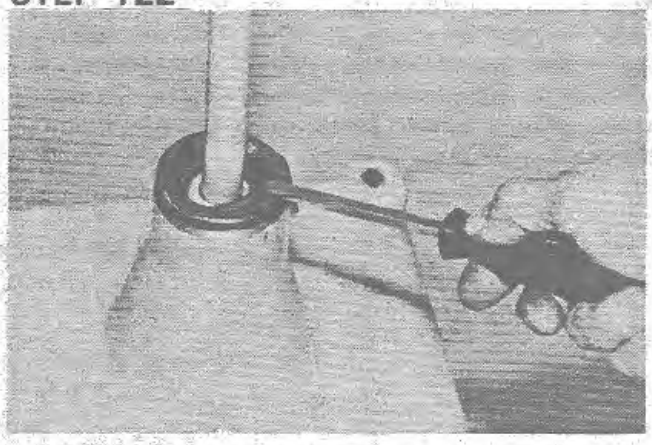


STEP 121



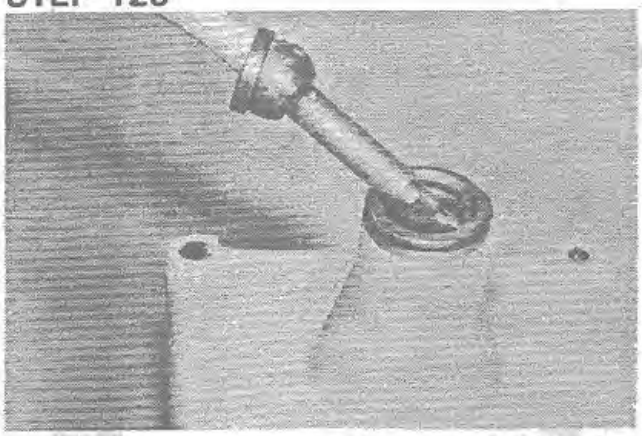
Place the shifter assembly on a suitable work surface.

STEP 122



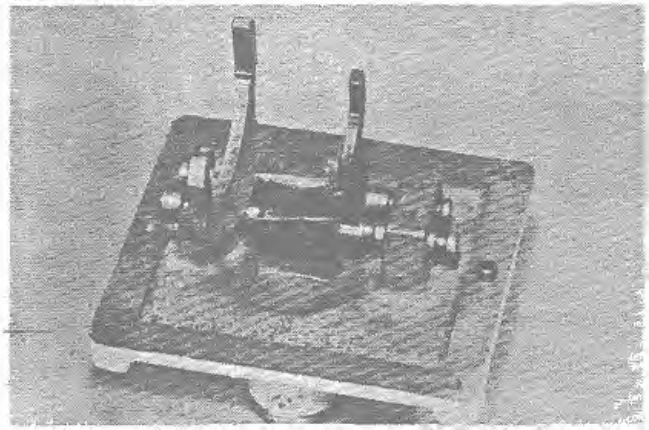
Remove rubber boot and seat retaining snap ring.

STEP 123



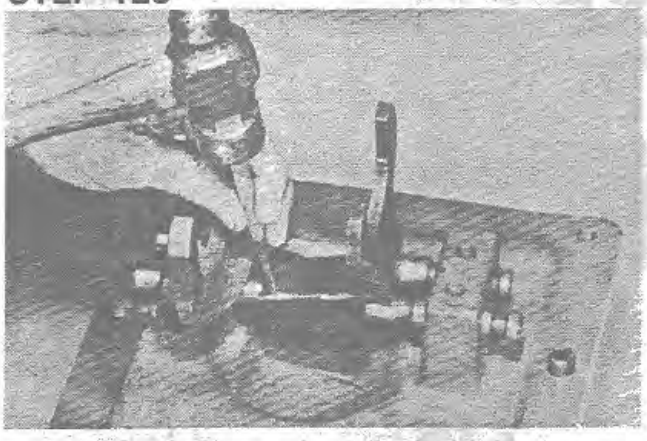
Remove gear shift hand lever.

STEP 124



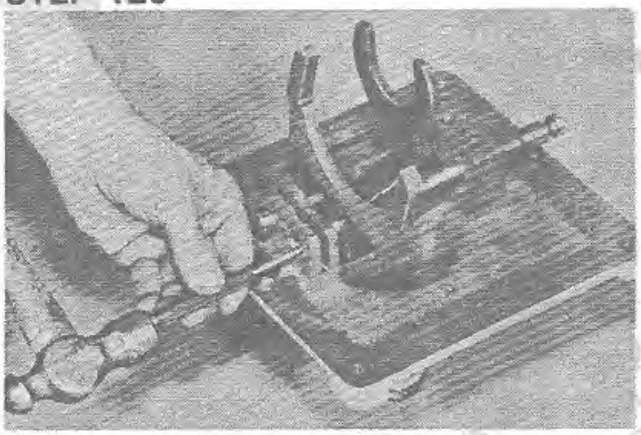
Turn shifter cover over on its top.

STEP 125



Remove the roll pins retaining forks to shifter rails.

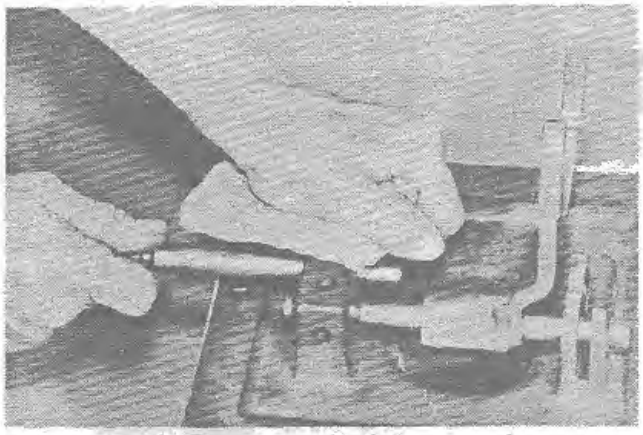
STEP 126



Drive rail through 1st and 2nd fork and remove fork.

STEP 127

CAUTION *The 3/8" steel detent balls are held in the cover under spring tension and will fly out with great force when removing the shift rails from the cover.*



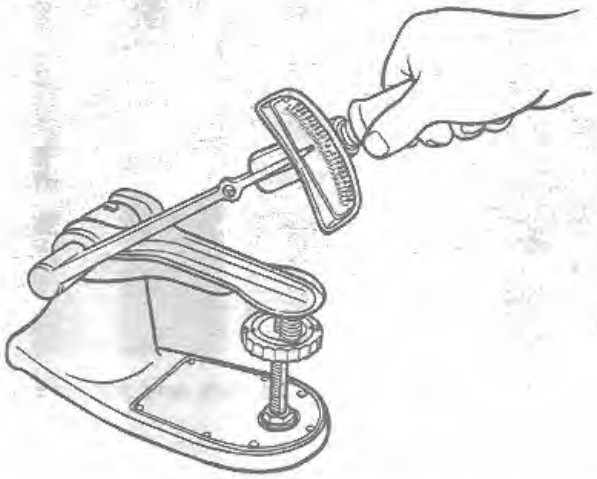
Cover the openings in shift cover when removing rails to prevent injury from the flying detent balls.

STEP 128

Repeat the same procedure removing 3rd and 4th shifter fork and rail.

Assembly

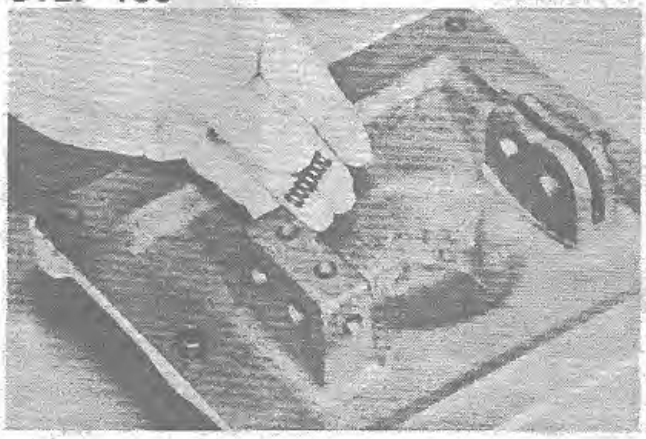
STEP 129



Inspect the detent springs. springs must meet the following specifications:

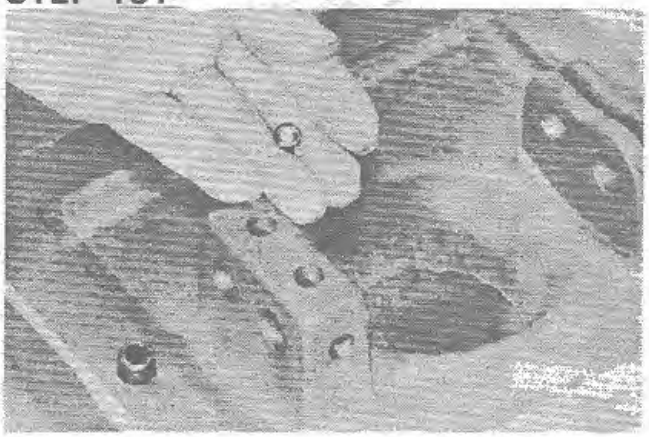
Free length	Optional
O.D.	Work in .390" bore
Compress to .812"	28 to 45 lbs.
Wire dia.	.072"

STEP 130



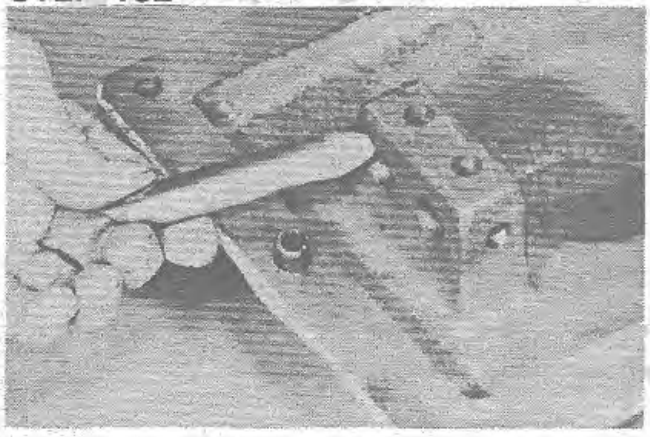
Install detent spring in 1st and 2nd housing bore.

STEP 131



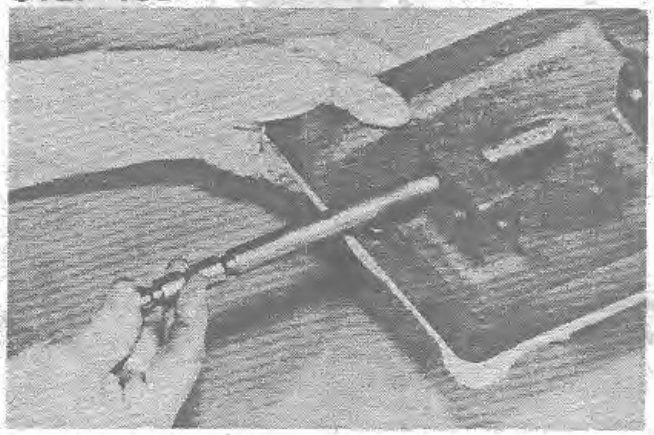
Install steel detent ball in cover on top of spring.

STEP 132



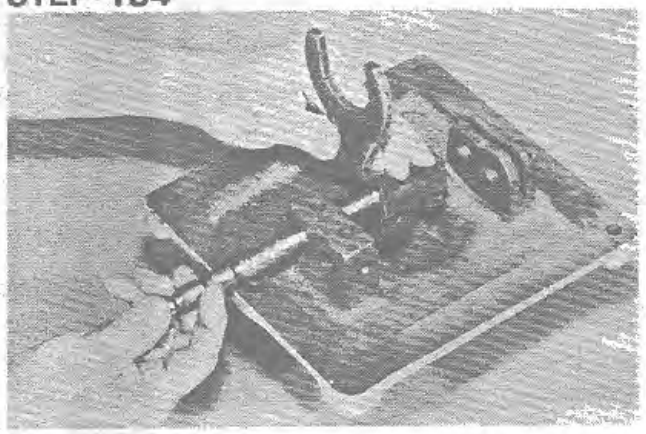
Install pilot sleeve to compress detent spring and ball. Refer to Page 5 for sleeve specifications.

STEP 133



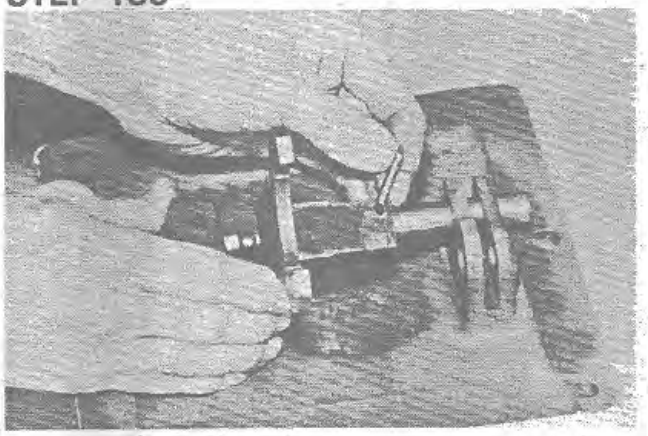
Install 1st and 2nd shift rail (rail with 5/8" lands between detent slots) part way into cover.

STEP 134



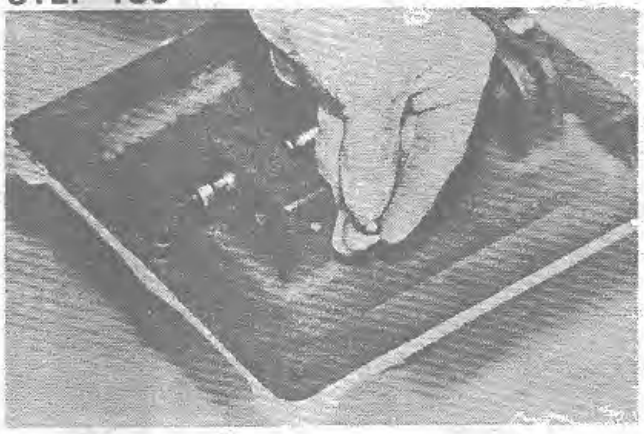
Install 1st and 2nd shift fork (small fork) on shift rail.

STEP 135



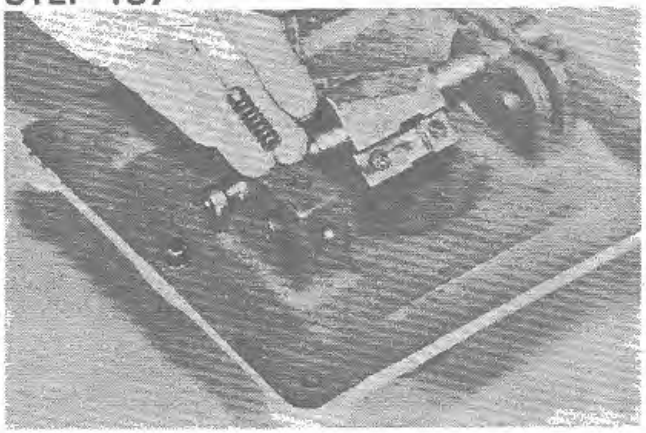
Install fork retaining spirol roll pin.

STEP 136



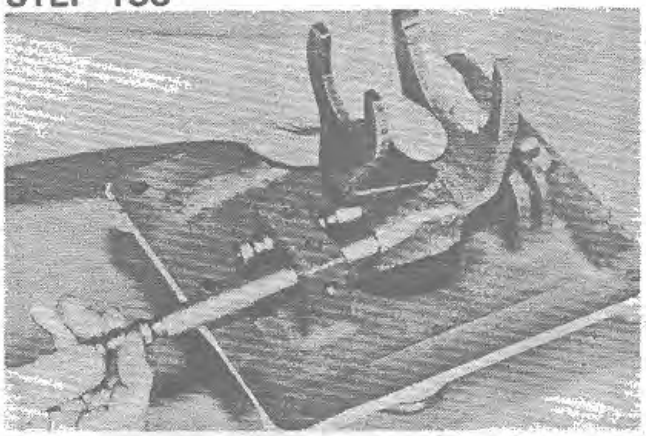
Install shift rail interlock lock plug.

STEP 137

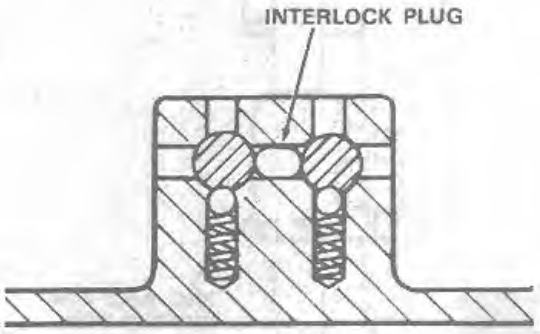


Install spring and ball for 3rd and 4th shift rail.

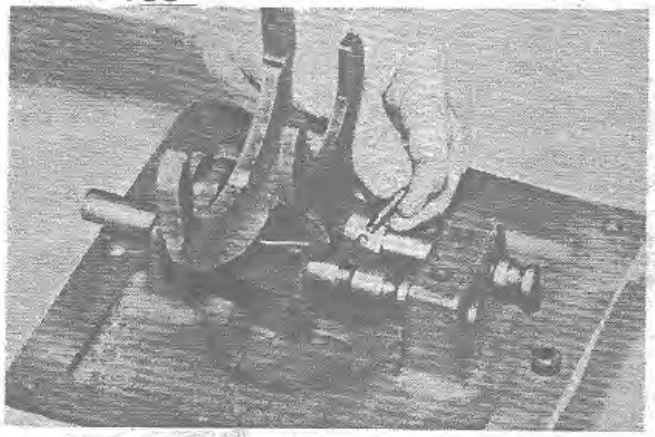
STEP 138



Using pilot sleeve, Step 132, install 3rd and 4th shift rail and fork.

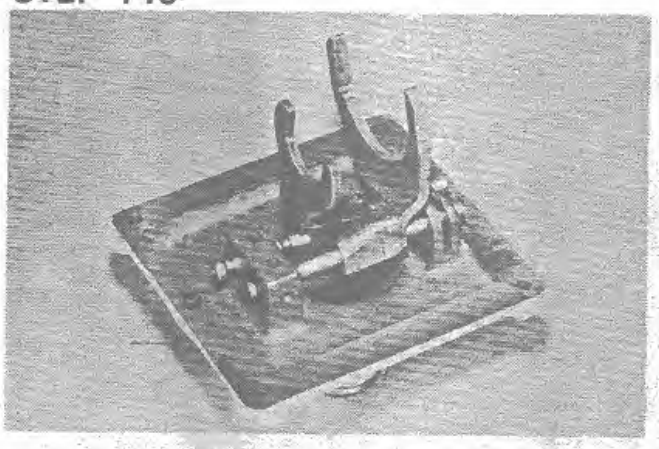


STEP 139

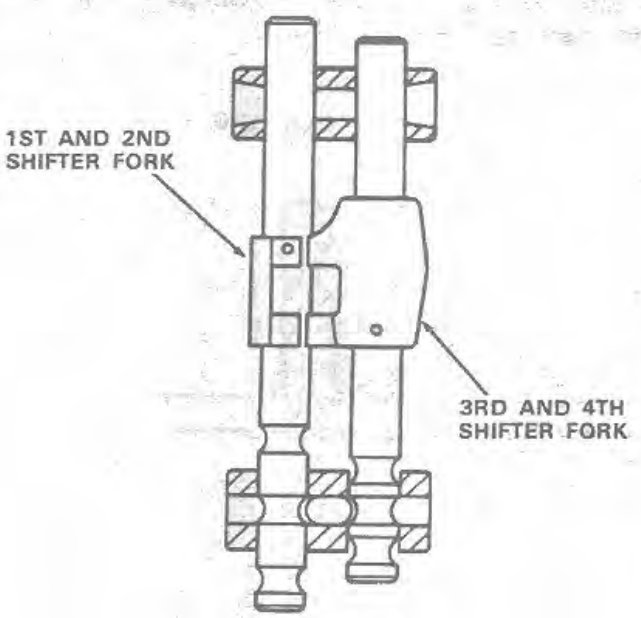


Install fork retaining spirol roll pin.

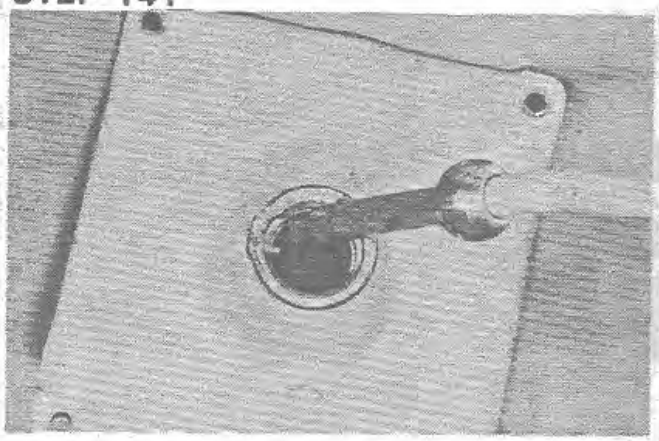
STEP 140



Shift rails and forks installed in shift cover.

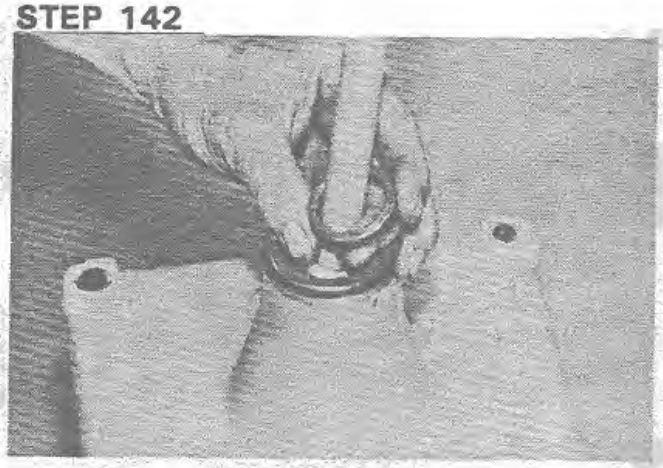


STEP 141



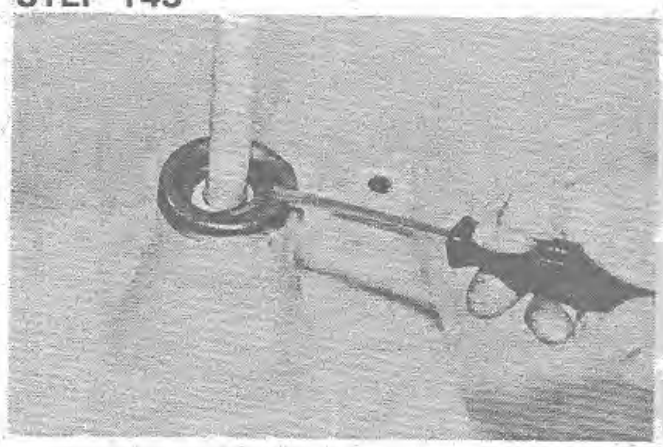
Install shift lever in cover top opening. Make sure lever engages shift forks.

STEP 142



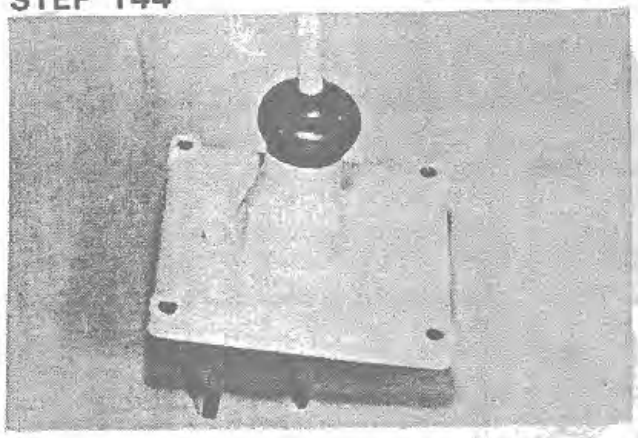
Install gear shift lever seat.

STEP 143



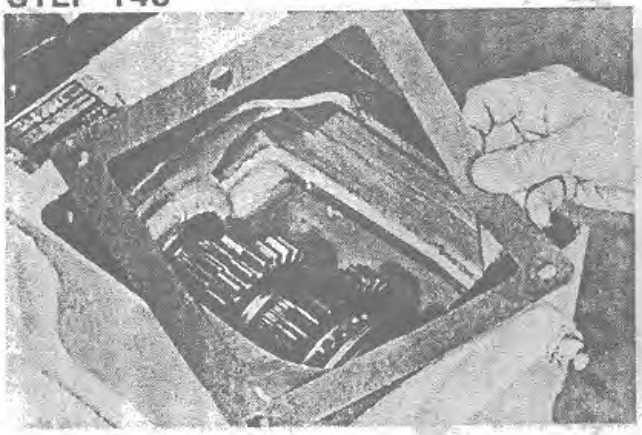
Install lever seat retaining snap ring.

STEP 144



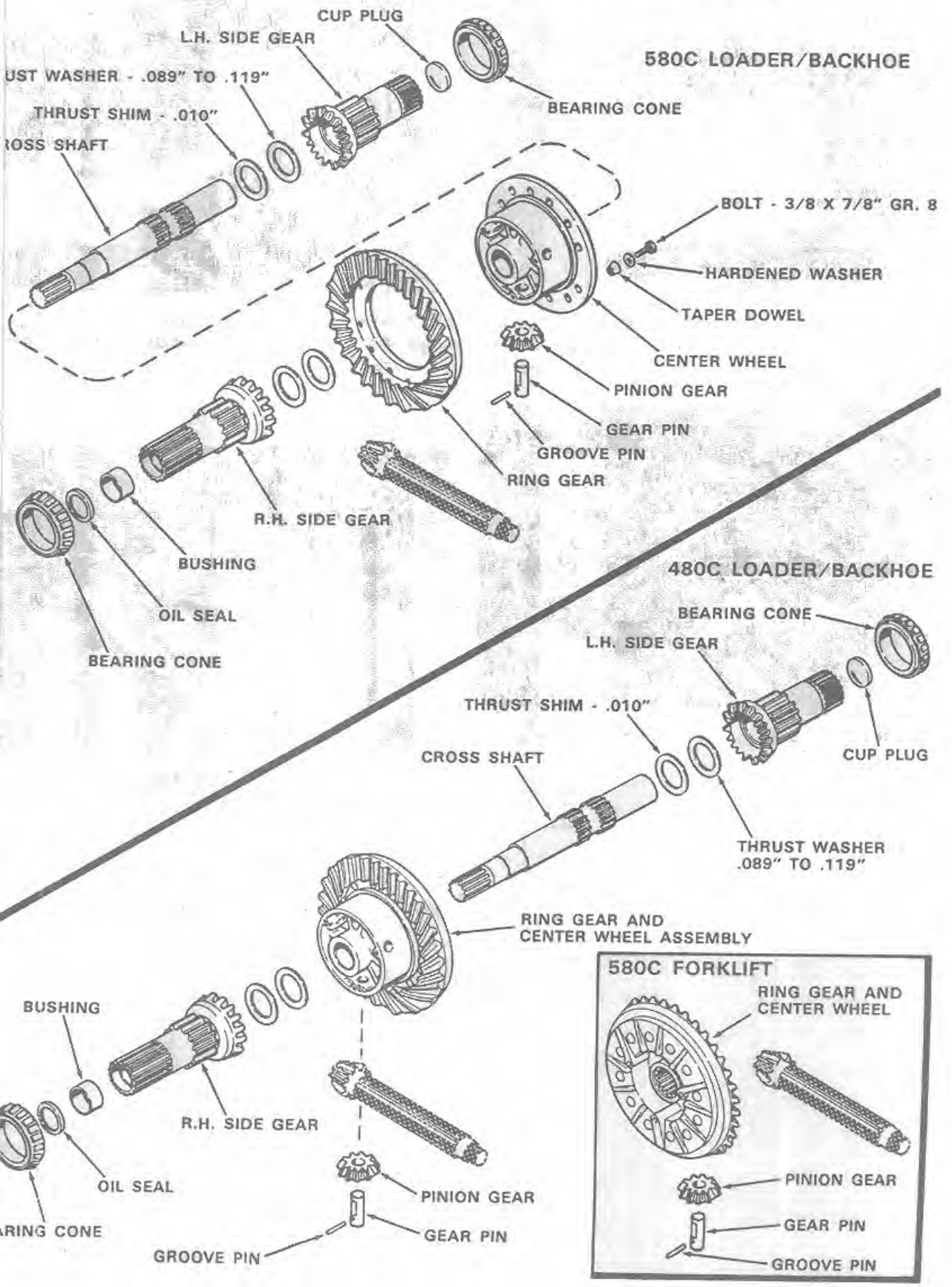
Install shift lever rubber dust cover.

STEP 145



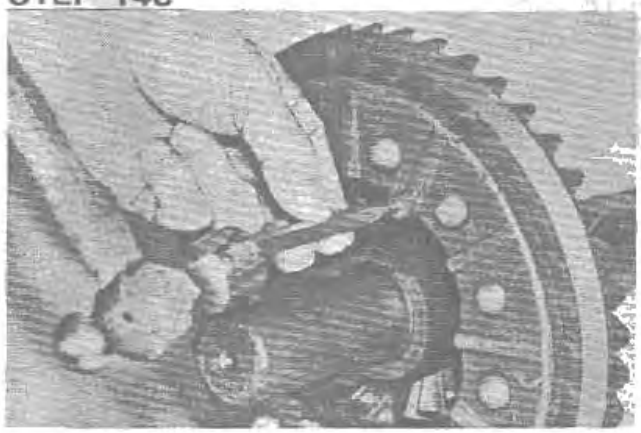
Install a new shift cover gasket.

Rebuilding Differential Center Wheel and Side Gears



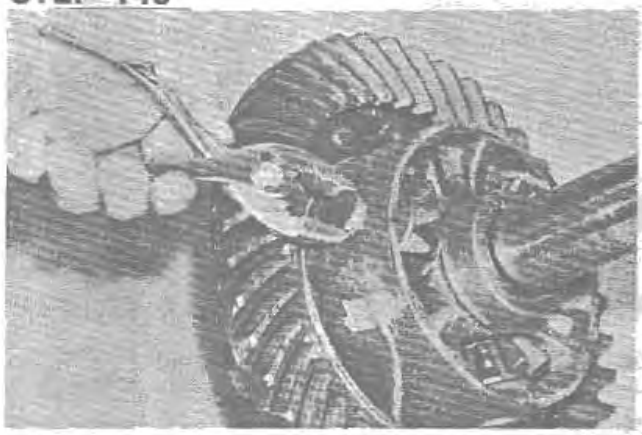
Disassembly

STEP 148



Remove the pinion gear retainer groove pins.

STEP 149

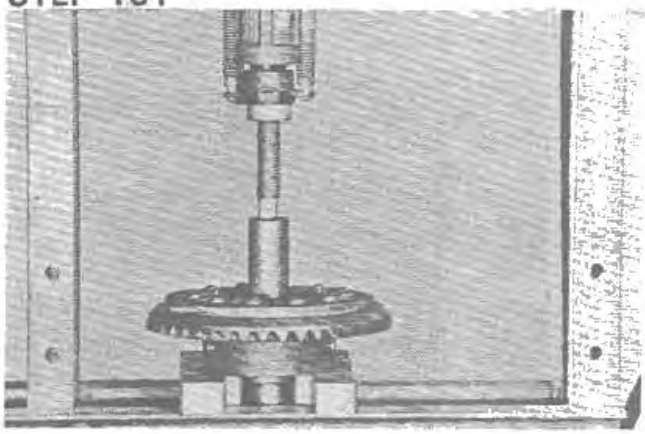


Loosen the pinion pins.

STEP 150

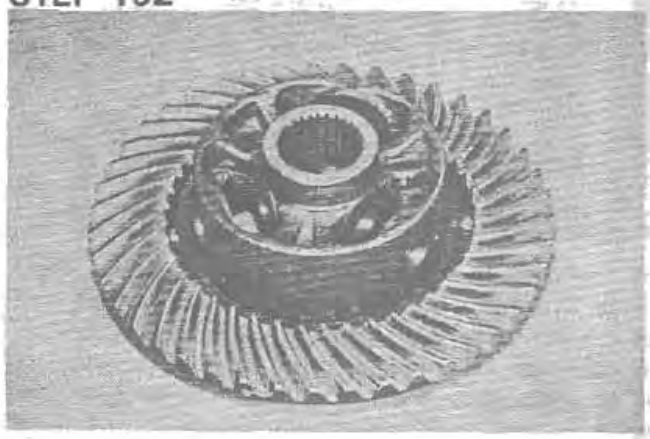
Remove pinion pins and gears. Inspect gear bores for out-of-round and rough spots. Replace gears if worn, damaged or pitted.

STEP 151



Place the center wheel in a hydraulic press and press cross shaft out of center wheel. *IMPORTANT:* Press on shaft end w/o splines, since shaft splines a tapered in one direction only.

STEP 152



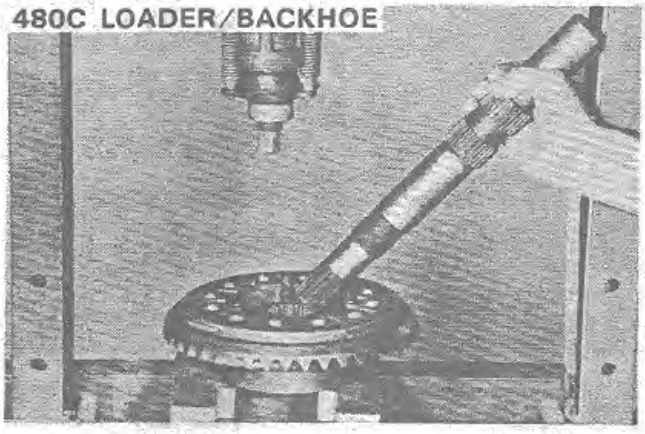
Cross shaft removed from center wheel.

NOTE: On 580C Loader/Backhoe models, the ring gear can be removed from the center wheel for replacement of either part. If the ring gear and center wheel are disassembled, always replace the retaining bolts. On 480C Loader/Backhoe or 580C Forklift models the ring gear and center wheel must be replaced as an assembly, since these parts are riveted together.

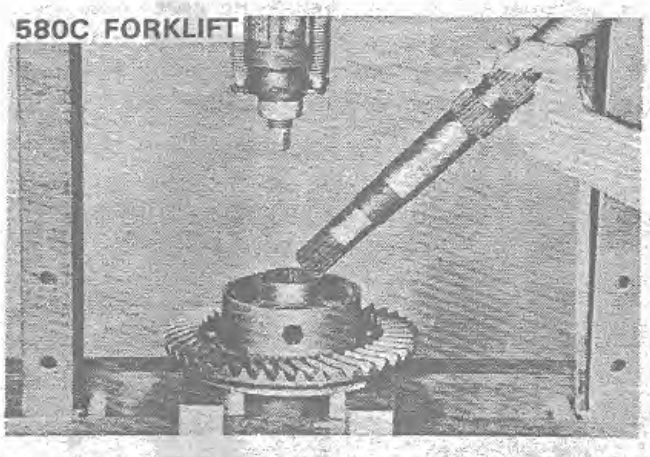
480C LOADER/BACKHOE & 580C FORKLIFT CENTER WHEEL BUILD-UP

STEP 153

480C LOADER/BACKHOE

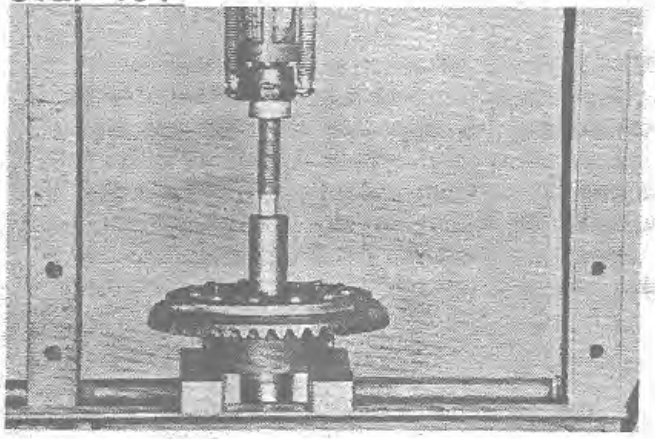


580C FORKLIFT



Place the ring gear and center wheel assembly in a hydraulic press, as shown. Start the cross shaft into the center wheel. *NOTE:* Shaft splines are tapered in one direction only, so start splined end of shaft into center wheel.

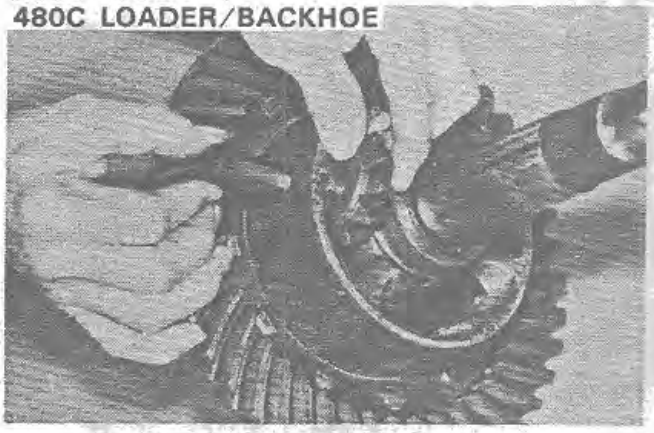
STEP 154



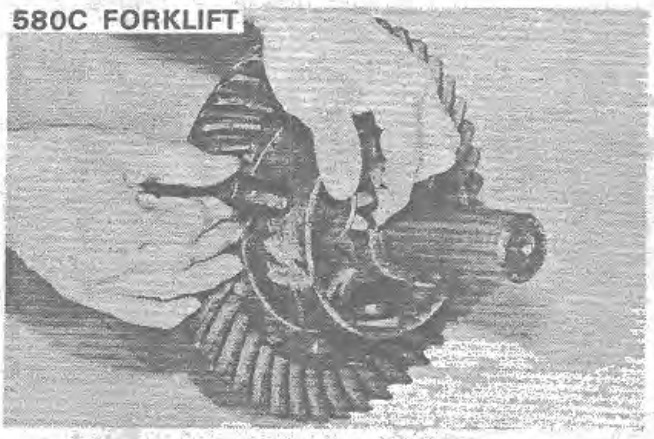
Press cross shaft into centerwheel until smooth area between splines is visible in pinion gear mounting holes.

STEP 155

480C LOADER/BACKHOE

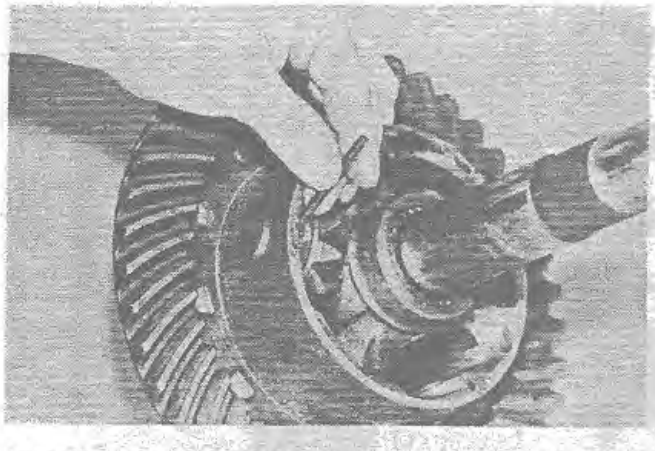


580C FORKLIFT



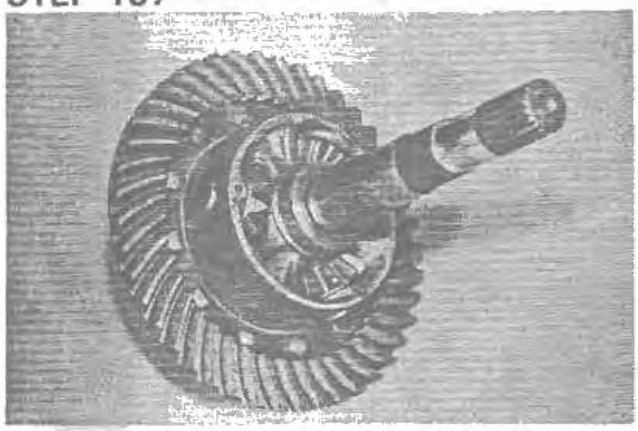
Install pinion gears and pins. *NOTE:* Make sure pin retaining hole aligns with center wheel hole.

STEP 156

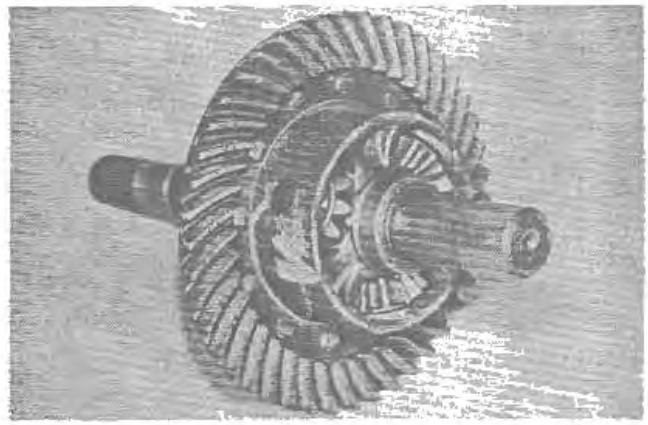


Install pinion retaining groove pins until they are flush with center wheel.

STEP 157



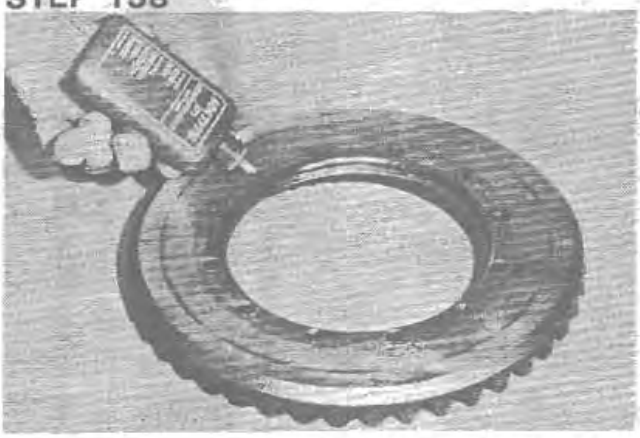
480C Loader/Backhoe center wheel, ring gear, cross shaft and pinions assembled.



580C Forklift center wheel, ring gear, cross shaft and pinions assembled.

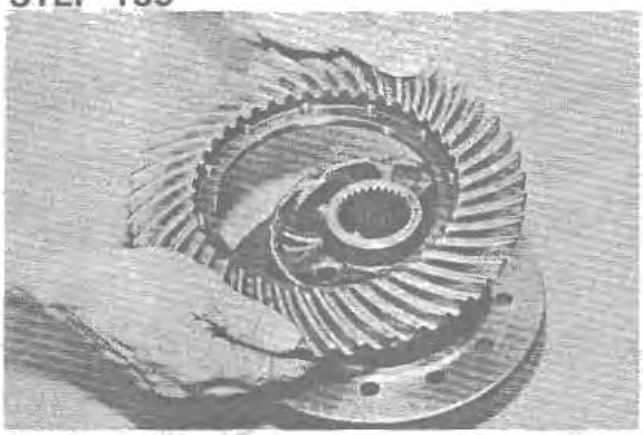
580C LOADER/BACKHOE CENTER WHEEL BUILD-UP

STEP 158



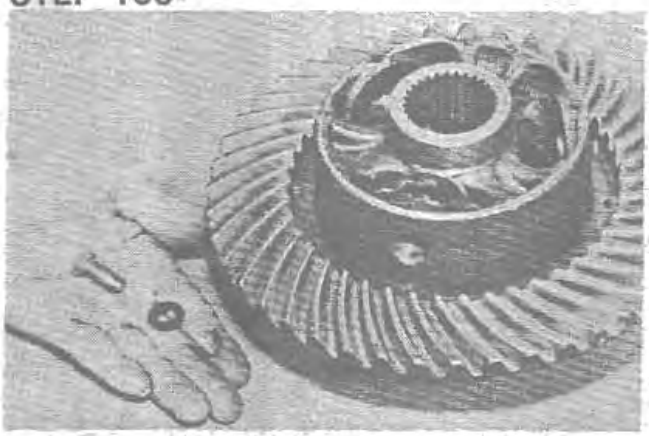
Apply Loctite #271 (Case No. B17423) to the ring gear tapped threads.

STEP 159



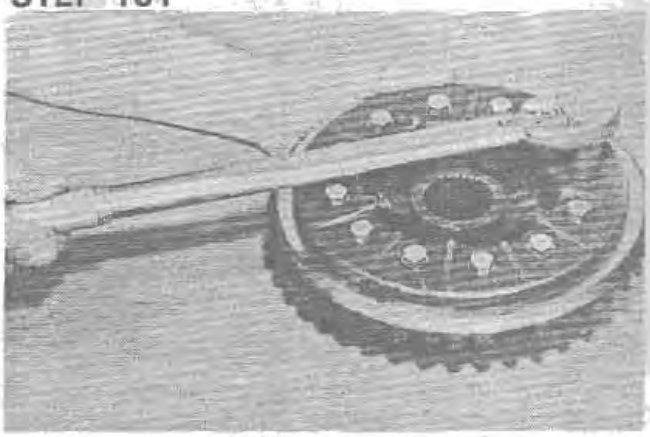
Place the ring gear on the center wheel. *NOTE:* If the ring gear is being replaced, the pinion shaft must also be replaced since these parts are a matched set.

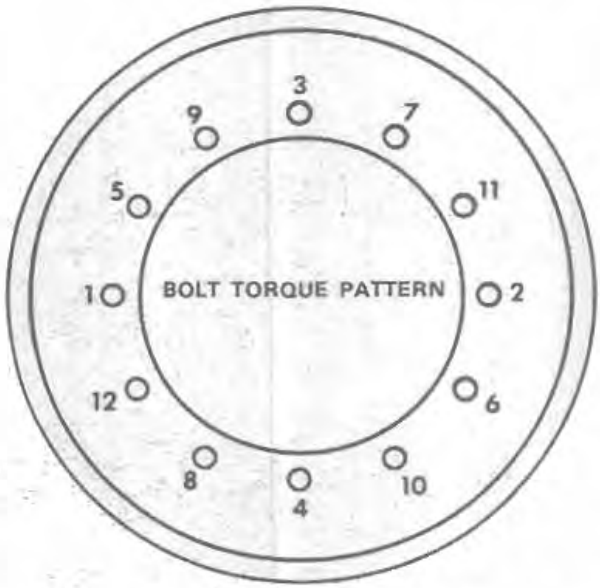
STEP 160



Install tapered sleeves, hardened washers and new retaining bolts.

STEP 161





IMPORTANT: To insure adequate Loctite retention and even mating of ring gear to centerwheel the following torque sequence must be followed.

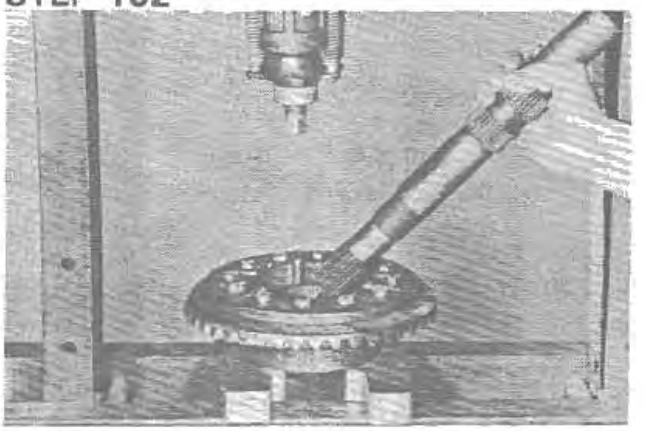
1. Tighten bolts 1 and 2 simultaneously by hand until finger tight - then tighten bolts 1 and 2 alternately 1/2 turn at a time until 30 ft. lbs. is reached.

2. Tighten the remaining bolts (3 thru 12) to 30 ft. lbs. in the numerical sequence shown.

3. Tighten bolts 1 thru 12 to 40 ft. lbs. in the numerical sequence shown.

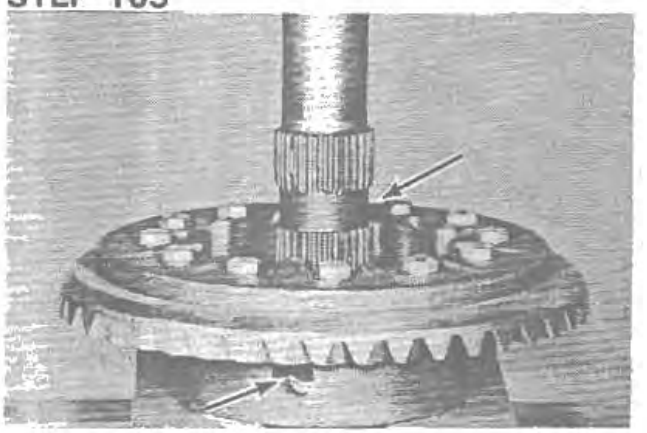
4. Then back-off each bolt (one at a time) until loose in numerical sequence shown and retorque bolt 50 to 55 ft. lbs. *NOTE:* Each bolt must be backed off and retorqued before proceeding to the next one.

STEP 162



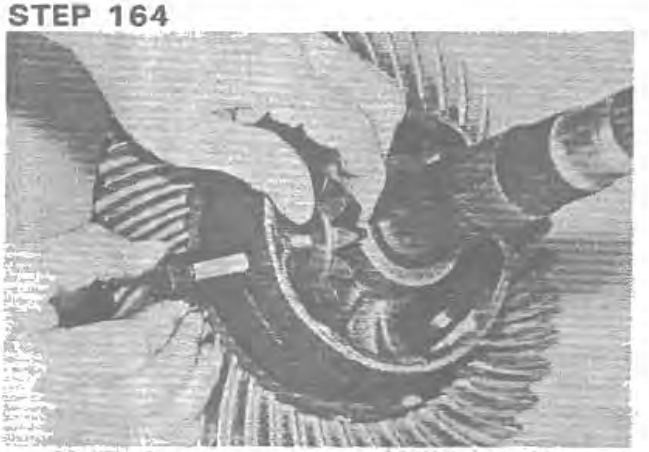
Place ring gear and center wheel assembly in a hydraulic press, as shown. Start the cross shaft into the center wheel. *NOTE:* Shaft splines are tapered in one direction only, so start splined end of shaft into center wheel.

STEP 163



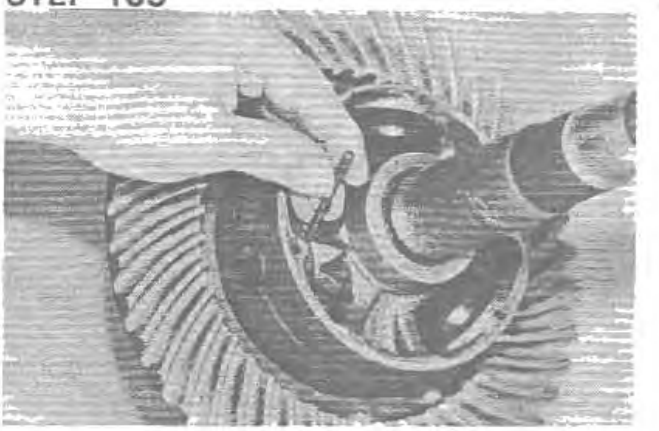
Press cross shaft into center wheel until smooth area between splines is visible in pinion gear mounting holes.

STEP 164



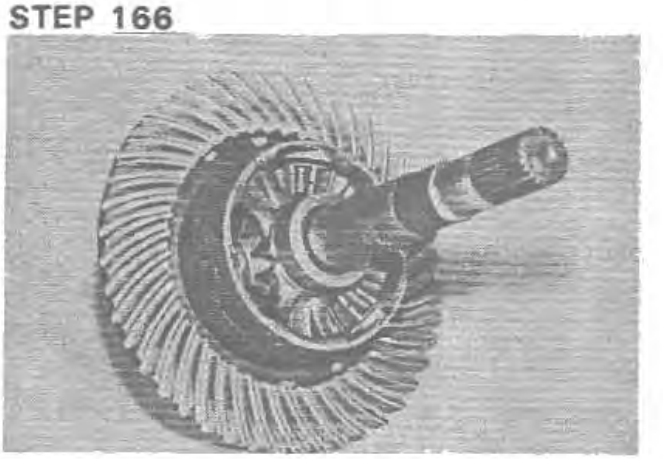
Install pinion gears and pins. *NOTE:* Make sure pin retaining hole aligns with center wheel hole.

STEP 165



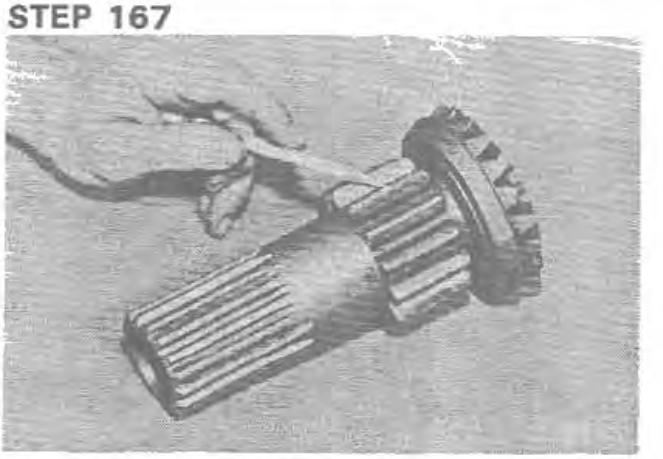
Install pinion retaining groove pins until they are flush with center wheel.

STEP 166



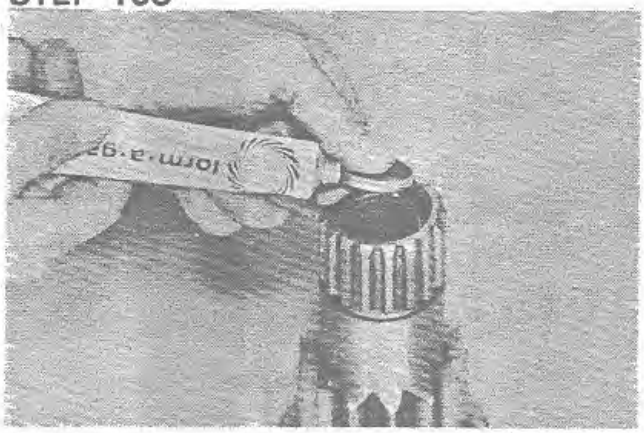
Center wheel, ring gear, cross shaft and pinions assemblied.

STEP 167



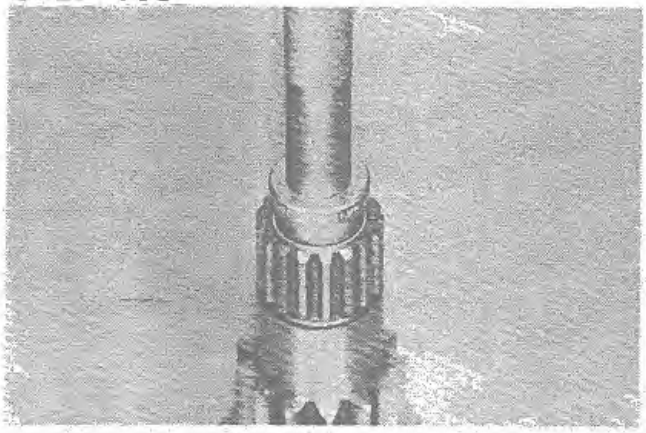
NOTE: The 580C Loader/Backhoe side gears have an identification groove cut in the center of the spur gear. Do not use these side gears on 480C or 580C Forklifts, since they will not properly mate with the final drive gears.

STEP 168



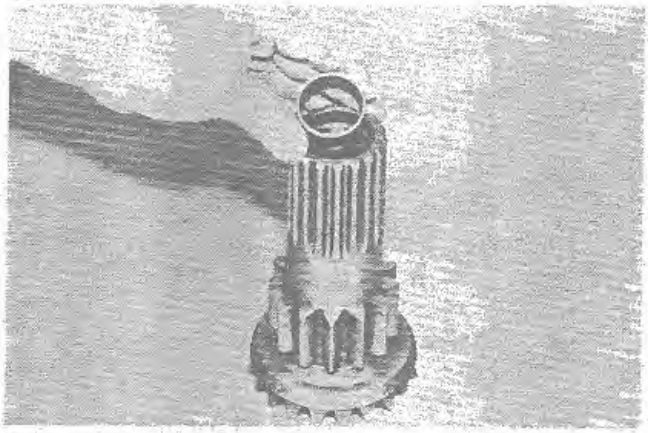
Apply #1 Permatex to the O.D. of a new cup plug.

STEP 169



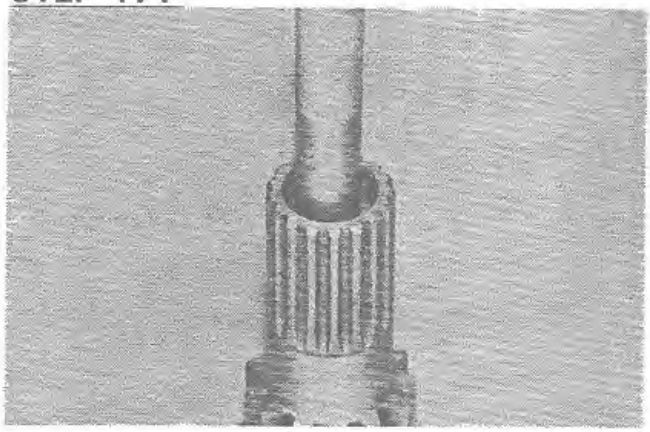
Drive cup plug into L.H. side gear until it bottoms in gear bore.

STEP 170



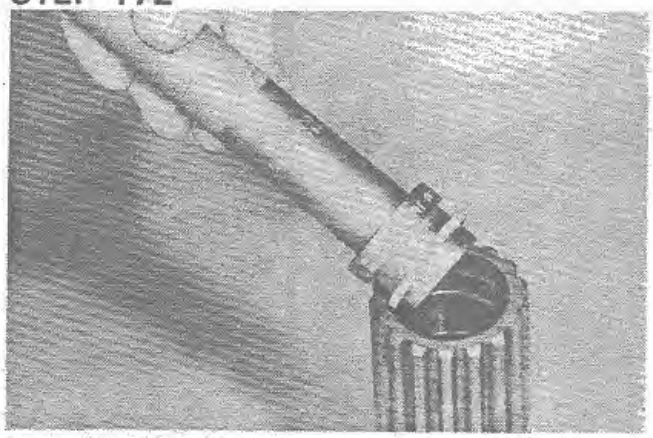
Place new bushing in R.H. side gear.

STEP 171



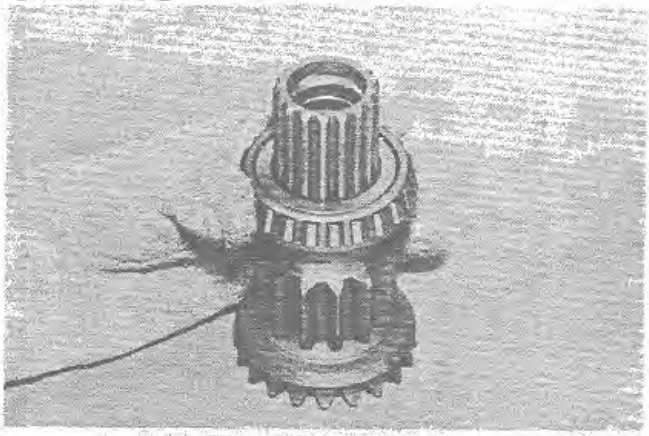
Press bushing in until the outer edge is even with the shoulder or step in the side gear.

STEP 172



Using A44602 oil seal driver, press new seal (lip inward) until it bottoms on gear shoulder.

STEP 173

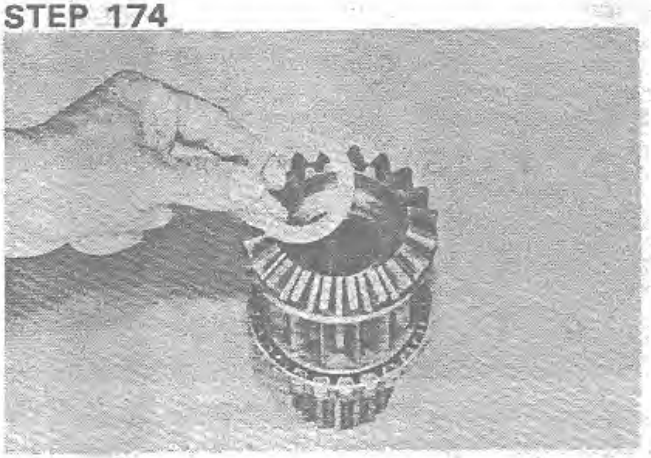


Heat bearings and install on R.H. and L.H. side gears until they bottom on the spur gear.

CAUTION *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*

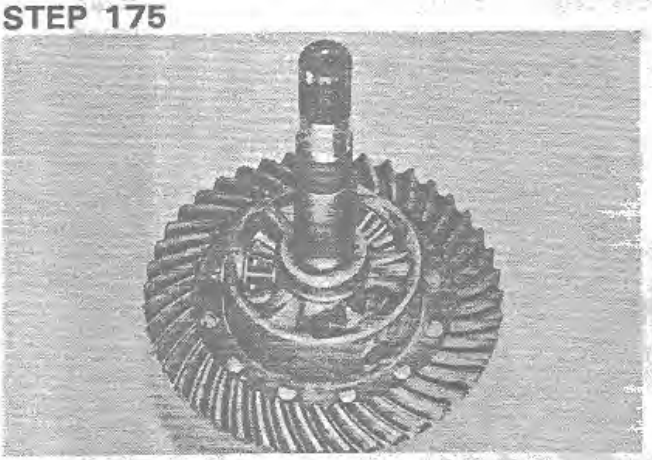
Setting Differential Pinion to Side Gear Backlash

STEP 174



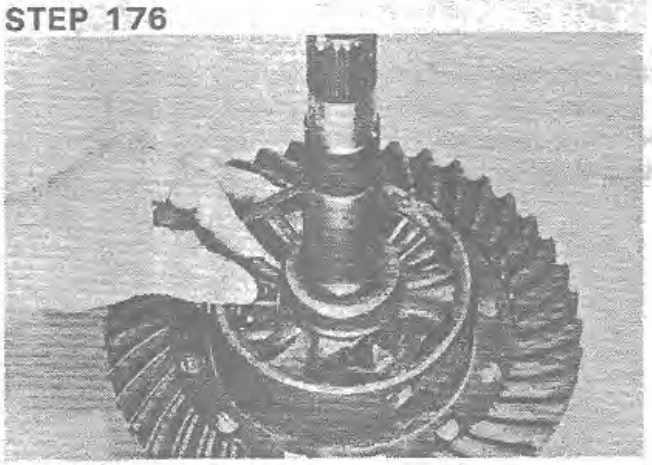
Turn L.H. side gear over and place a nominal thickness thrust washer in side gear.

STEP 175



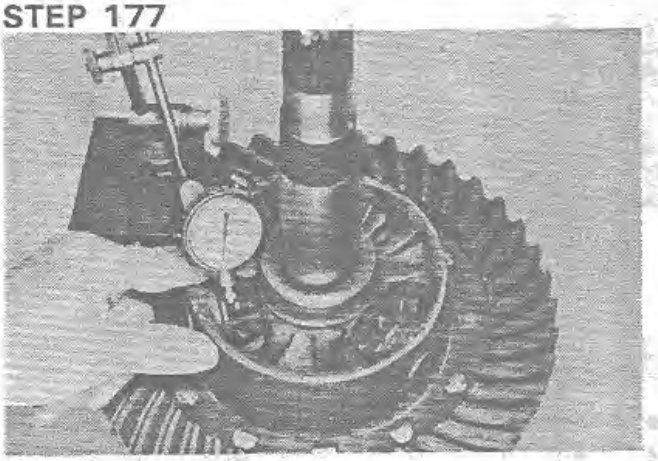
Place center wheel assembly in side gear.

STEP 176



Check pinion gears to insure there is some backlash present. *NOTE:* Install a thicker thrust washer if no backlash is present. Thrust washer thicknesses .089" to .119".

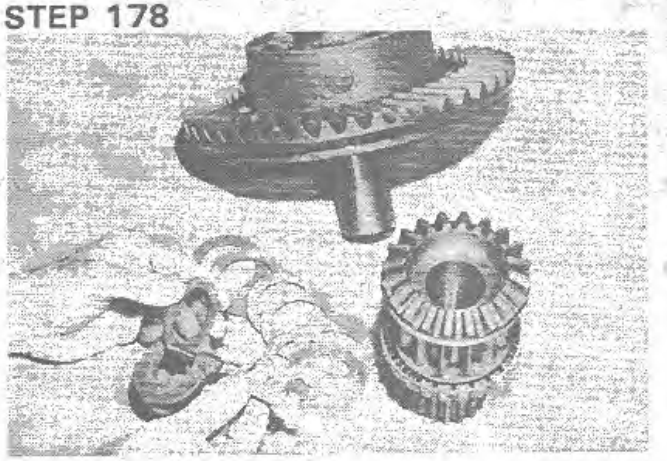
STEP 177



Place a dial indicator on pinion gear tooth. Hold side gear in place and rotate pinion gear back and forth, checking backlash. Rotate center wheel and check backlash at various sections of side gears.

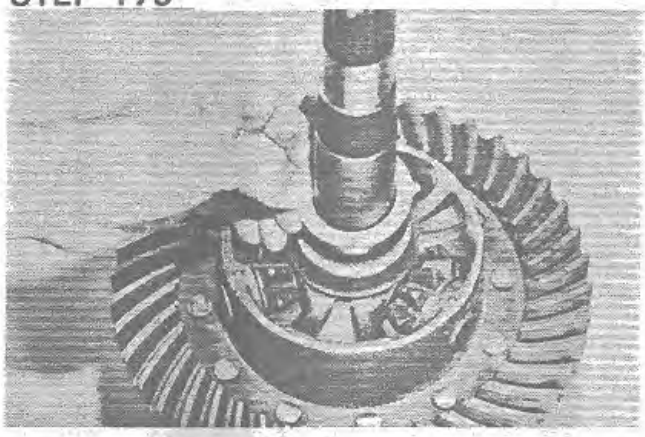
IMPORTANT: Backlash must be .005" minimum at the tightest pinion gear and must not exceed .015" at the loosest pinion gear.

STEP 178



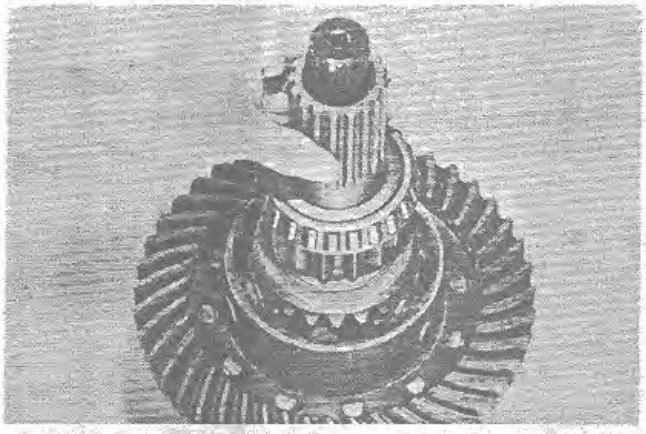
A .005" change in thrust washer thickness will change backlash approximately .0035". *NOTE:* Thrust washers are available in sizes from .089" to .119" and steel shims are available in .010" size.

STEP 179



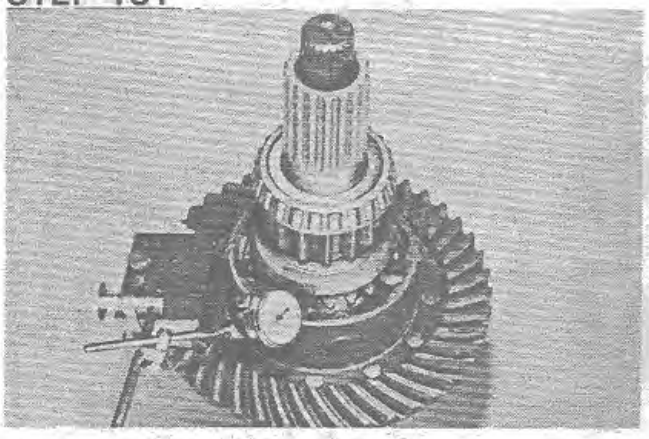
Place a nominal thickness thrust washer on cross shaft. *NOTE:* L.H. side gear, thrust washer and shims must be removed.

STEP 180



Install R. H. side gear and check pinions to insure there is backlash present.

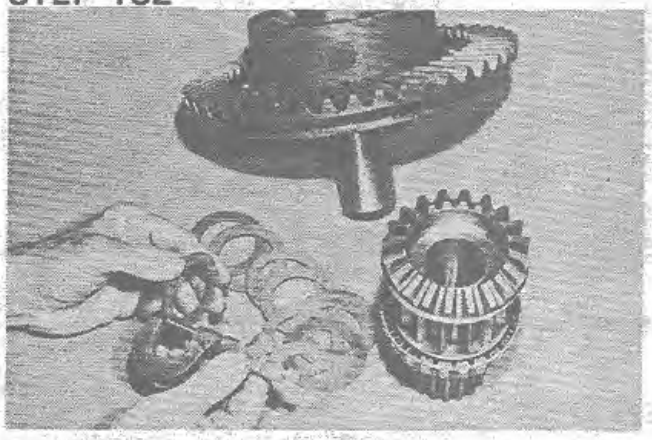
STEP 181



Place a dial indicator on pinion gear tooth. Hold side gear in place and rotate pinion gear back and forth, checking backlash. Rotate side gear and check backlash at various sections of side gear.

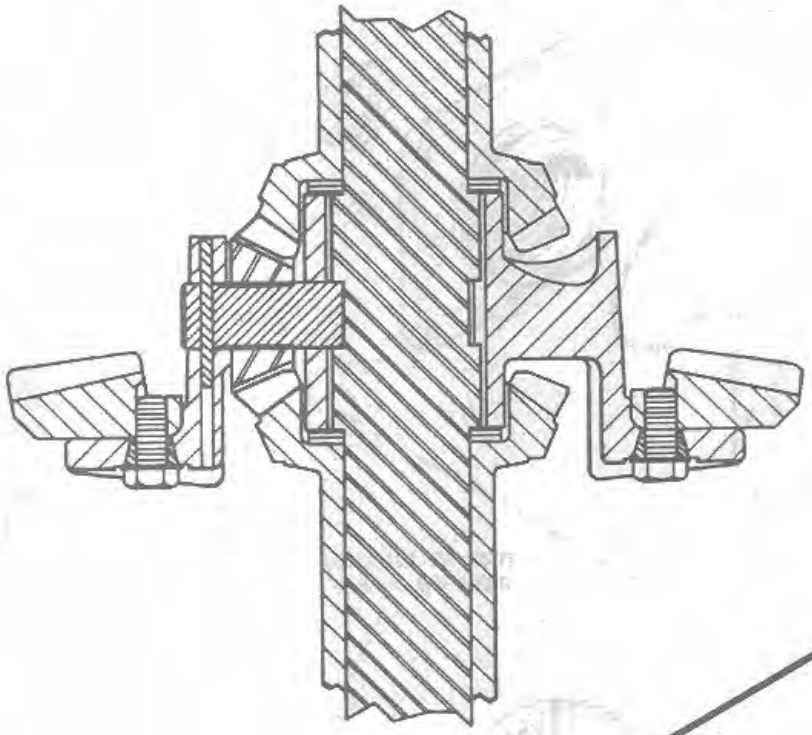
IMPORTANT: Backlash must be .005" minimum at the tightest pinion gear and must not exceed .015" at the loosest pinion gear.

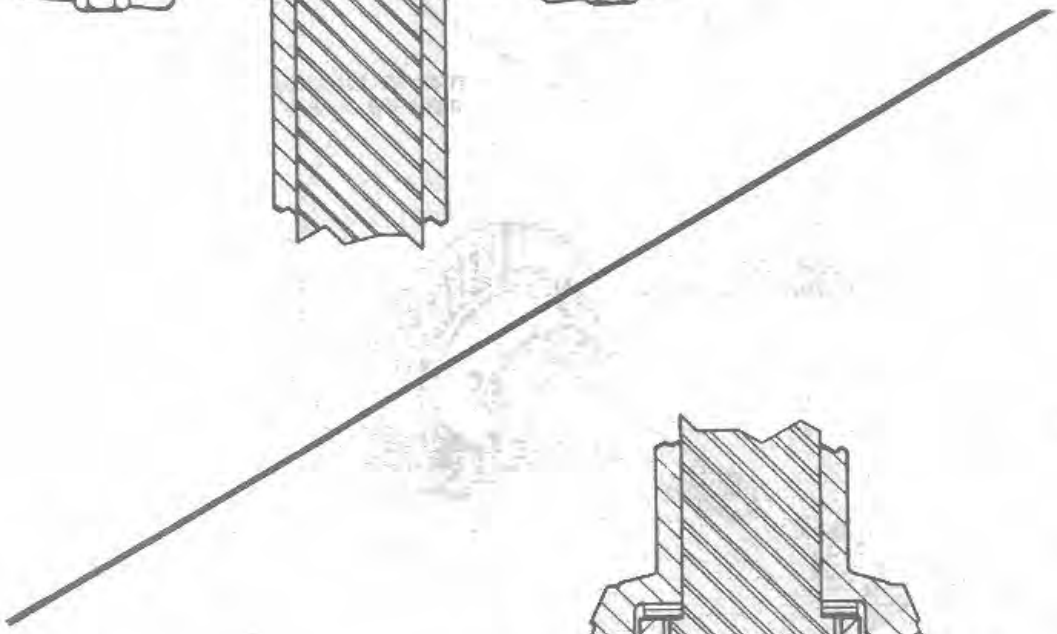
STEP 182



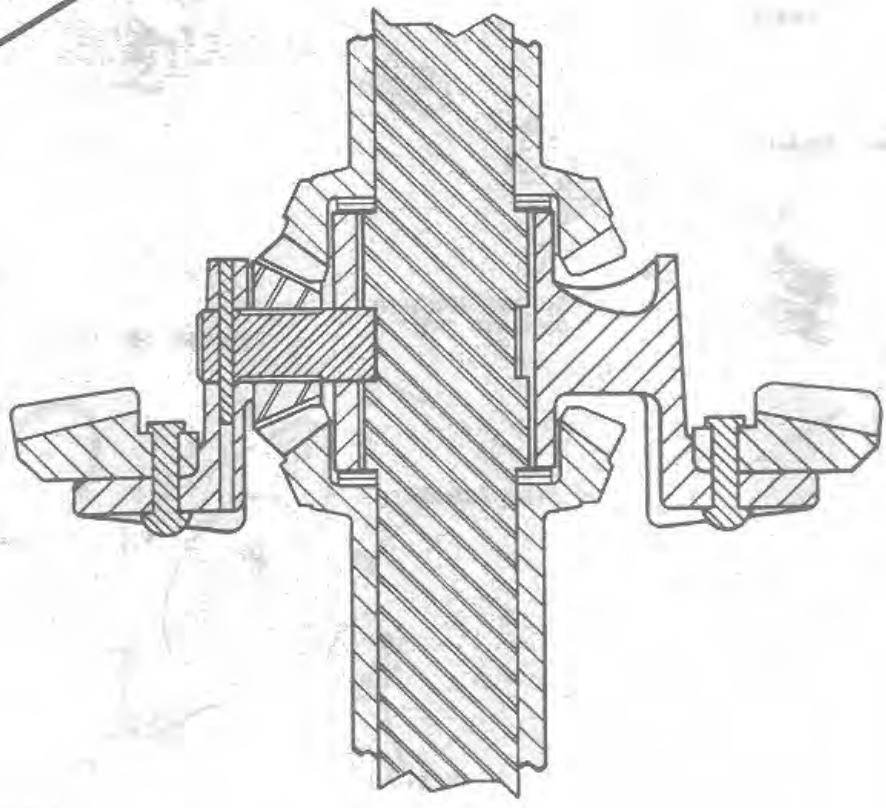
A .005" change in thrust washer thickness will change backlash approximately .0035". *NOTE:* Mark thrust washer and shims if required for location during assembly.

580C LOADER/BACKHOE

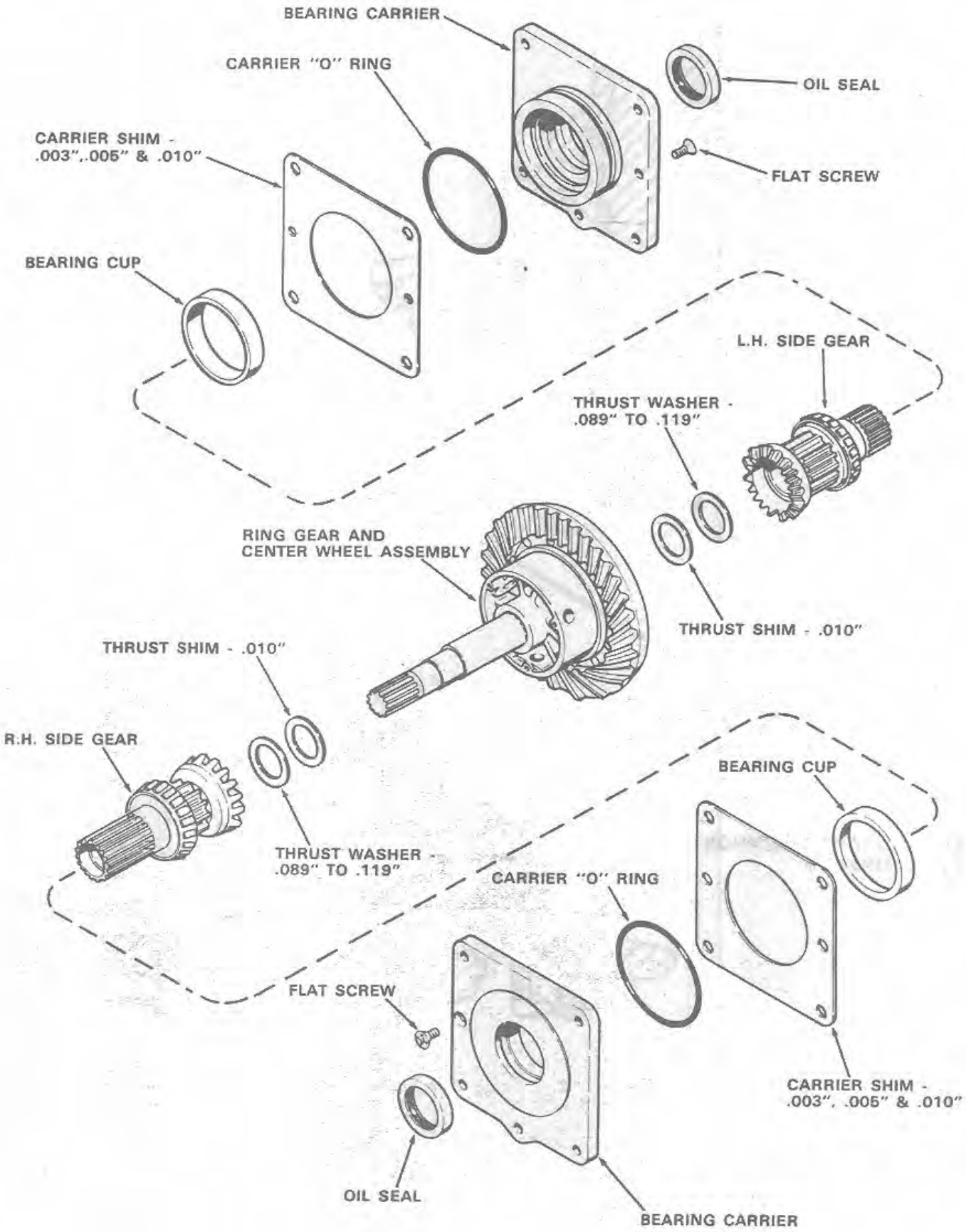




480C LOADER/BACKHOE
580C FORKLIFT



Differential Center Wheel Installation

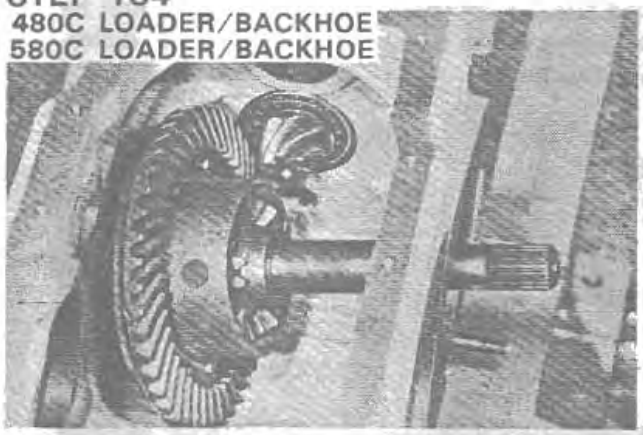


STEP 183

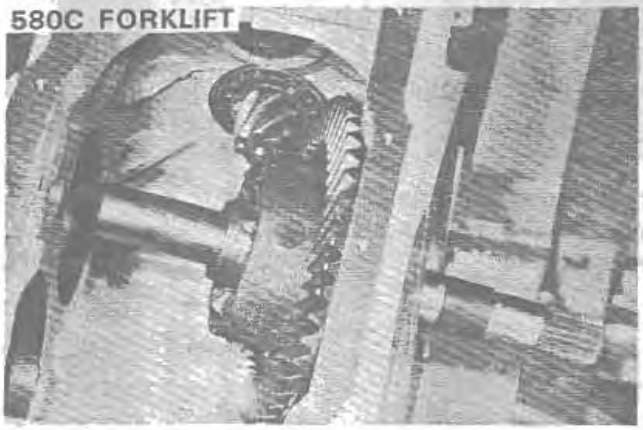
Install center wheel assembly in transaxle housing.

STEP 184

480C LOADER/BACKHOE
580C LOADER/BACKHOE

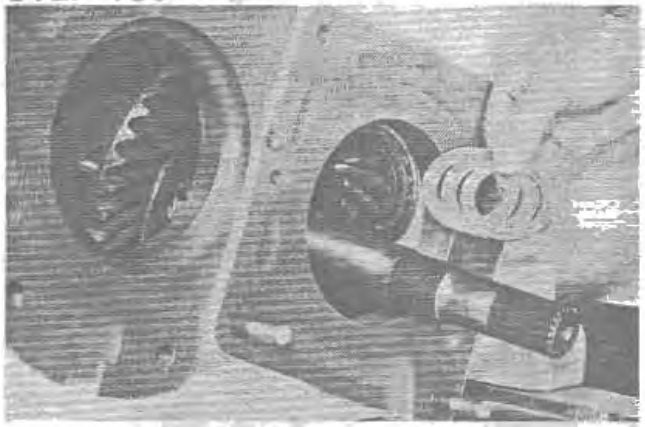


580C FORKLIFT



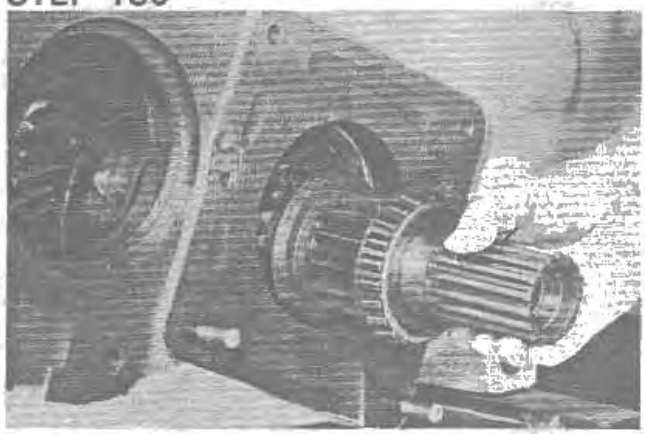
Note location of center wheel to pinion shaft.

STEP 185



Install R.H. thrust washer and shims, if required, see Steps 179 thru 182. *NOTE:* If steel shims are used, they must be installed first - next to center wheel thrust surface.

STEP 186



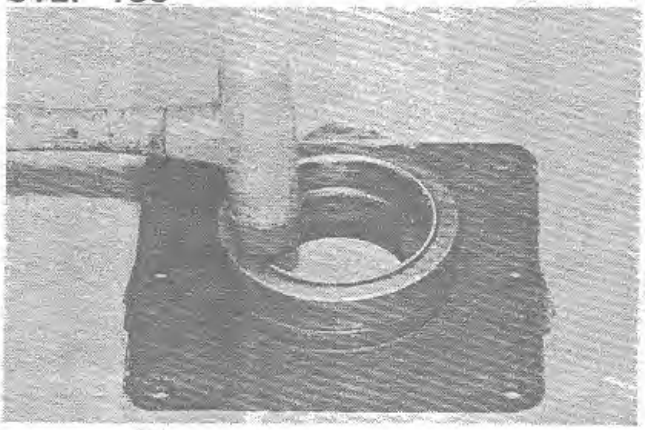
Install R.H. side gear over cross shaft.

STEP 187

Reinstall original shim pack or a nominal amount of shims. *NOTE:* Make sure small center hole is down to allow for oil drainage.

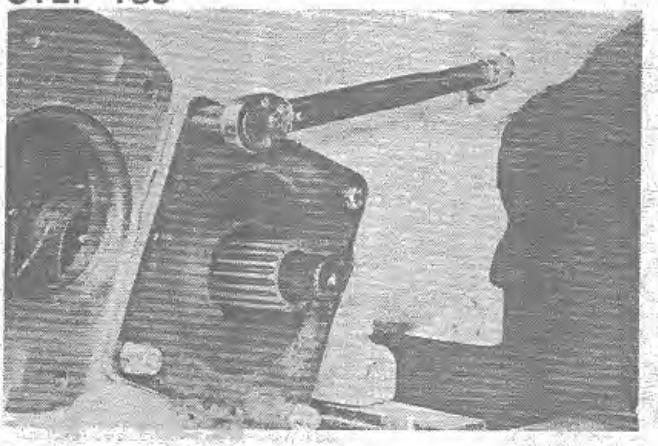
Setting Differential Bearing Preload

STEP 188



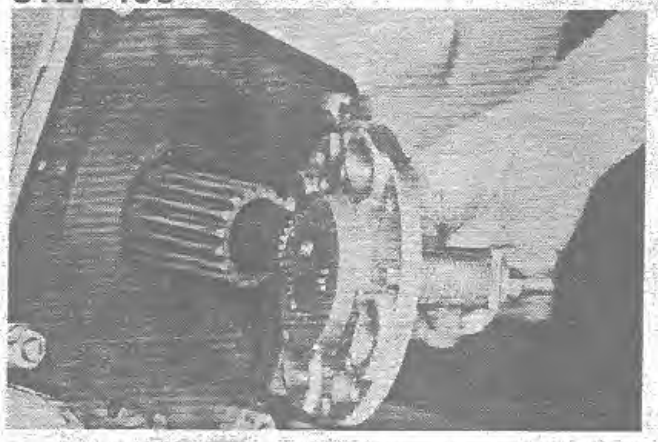
Install bearing cups in side gear bearing carriers until they bottom.

STEP 189



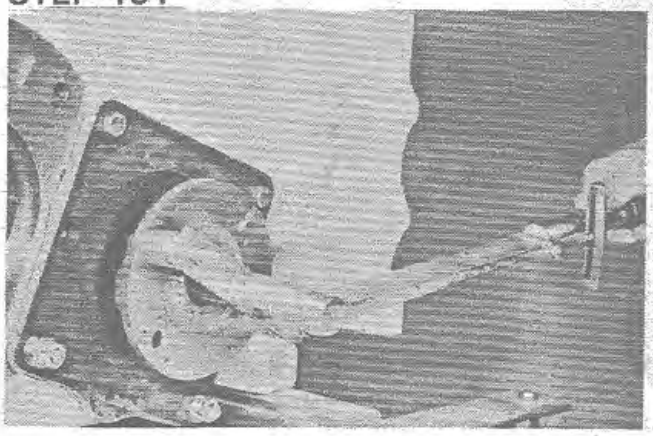
Install both bearing carriers and torque retaining bolts and nuts 70 to 90 ft. lbs. *NOTE:* When torquing up carrier, make sure backlash exist between ring gear and pinion gear.

STEP 190



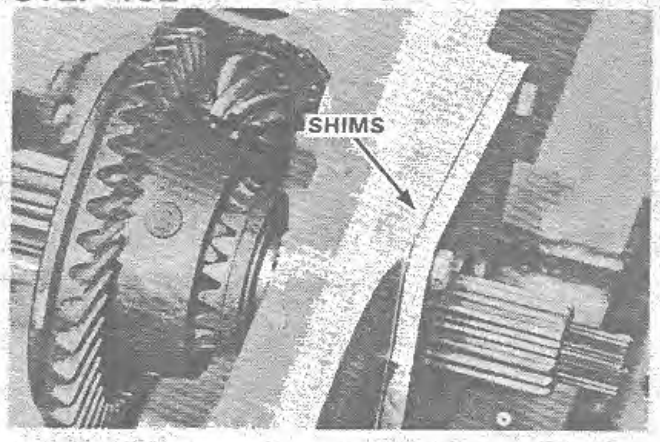
Install special tool, which can be made from a brake disc, see Page 5.

STEP 191



With a torque wrench on special tool, measure the turning torque required to turn one differential side gear with countershaft pinion gear locked against rotation. Turning torque must be 3 to 8 ft. lbs. to properly preload load differential bearings.

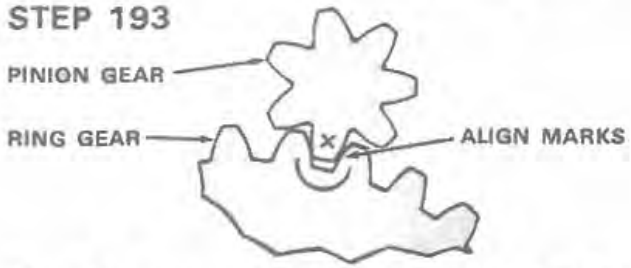
STEP 192



Add or delete shims as necessary between bearing carrier and housing to obtain proper bearing preload.

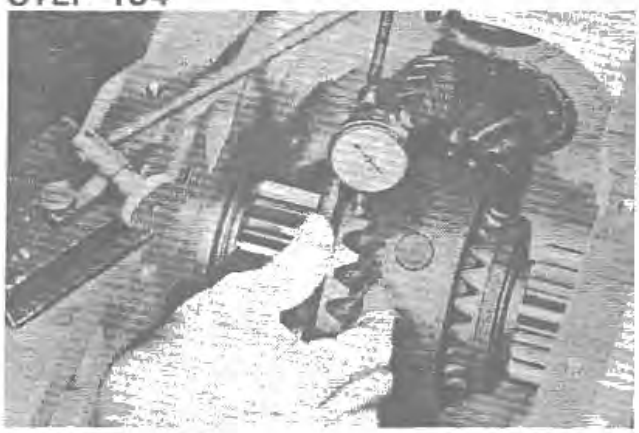
Adjusting Ring Gear to Pinion Gear Backlash

STEP 193



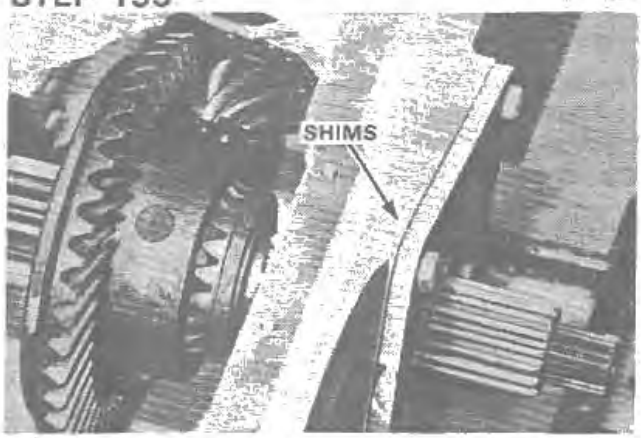
Align the one marked tooth on pinion gear to the two marked teeth on ring gear. These three teeth have been marked to indicate the position of minimum backlash and, as such, must intermesh when setting backlash.

STEP 194



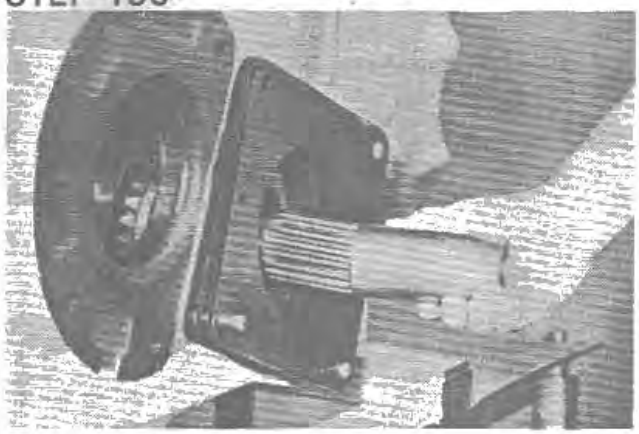
Place a dial indicator on ring gear tooth. With pinion gear locked against rotation, check gear backlash. Backlash must be .005" to .009".

STEP 195



Move bearing carrier shims from right to left side to increase backlash and from left to right side to decrease backlash. *NOTE:* Do not change the total number of shims since total shim thickness is required to maintain differential bearing preload.

STEP 196



Remove bearing carrier and install G15503 protective sleeve over side gear splines. *NOTE:* Coat outside of sleeve with Case FDL.

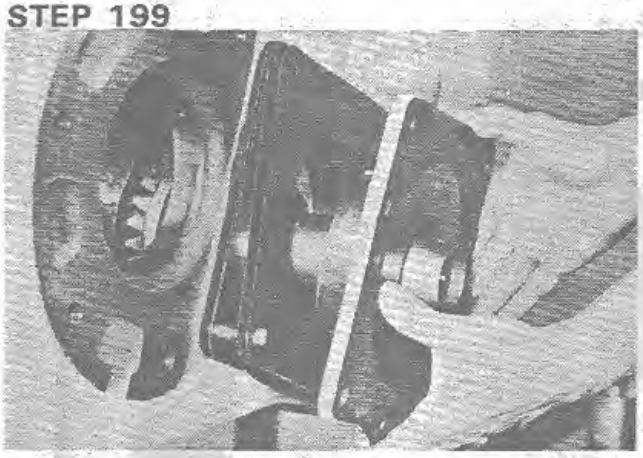
STEP 197

Using G15016 driver, press new seal in bearing carrier. *NOTE:* Coat the inside of seal with Case FDL.

STEP 198

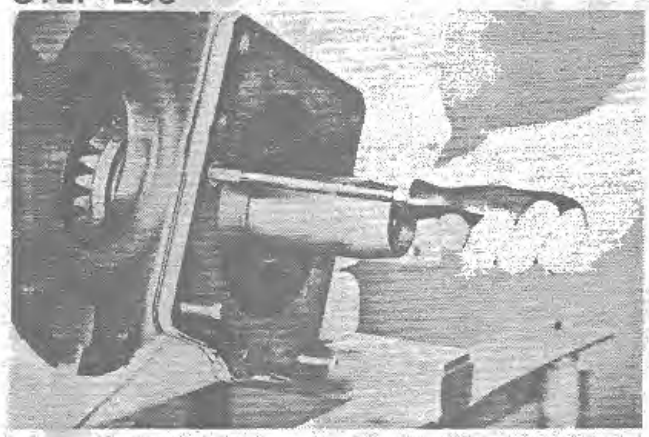
Install new "O" ring in bearing carrier groove.

STEP 199



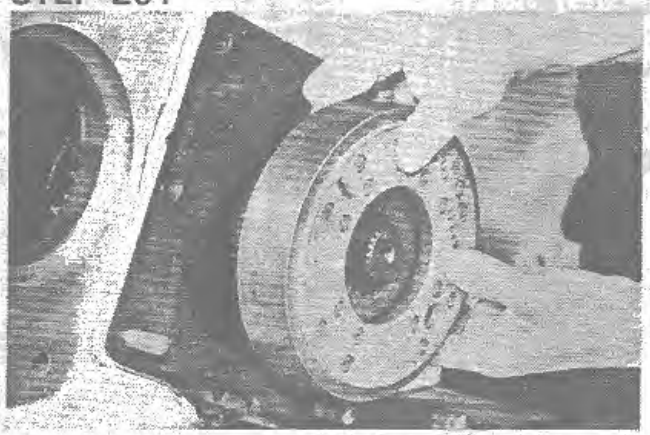
Slide bearing carrier over protective sleeve.

STEP 200



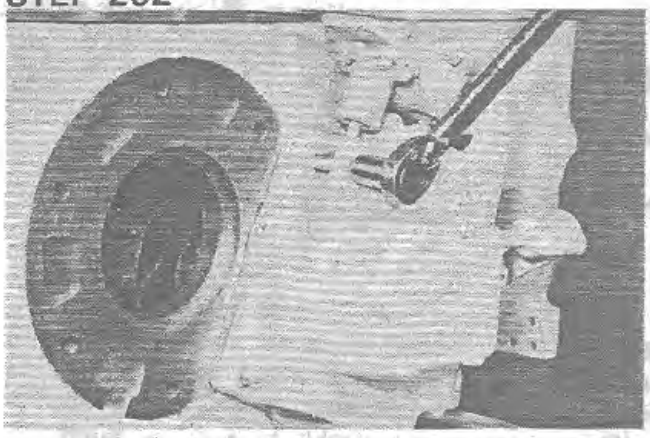
Install carrier retaining screw and pull sleeve out through the carrier assembly.

STEP 201



Install brake drum and disc assembly on side gear. *NOTE:* Brake disc (splined piece) must be installe against bearing carrier.

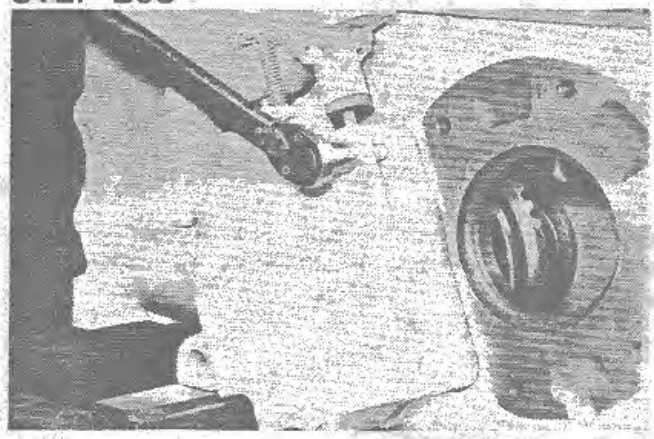
STEP 202



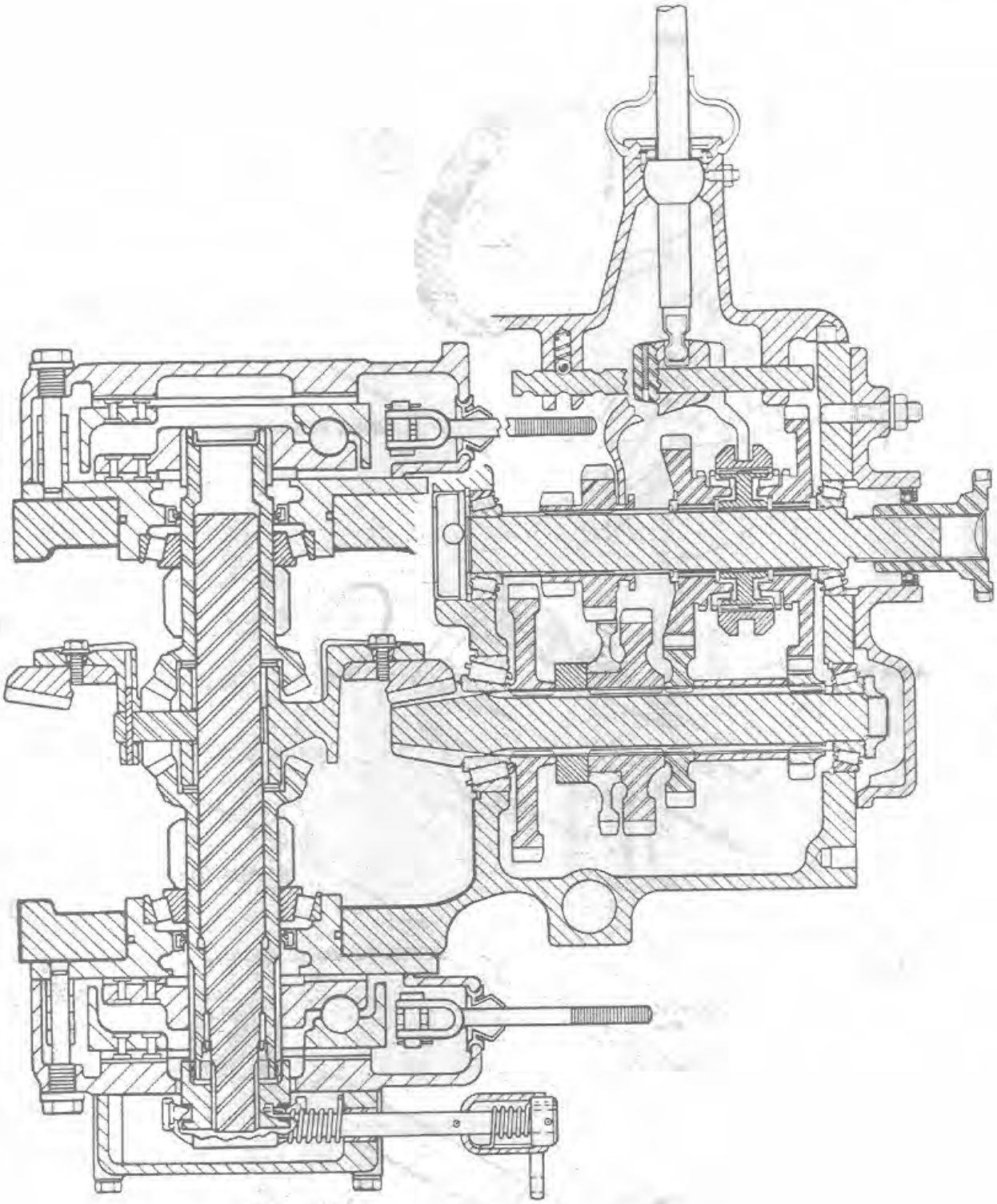
Apply #2 Permatex to the threads of the bolt which is installed in the straight through tapped hole. Install brake housing and torque retaining bolts and nuts 80 to 96 ft. lbs.

NOTE: If brake service is required, refer to Section 7122 for Servicing the Self Adjusting Differential Brakes.

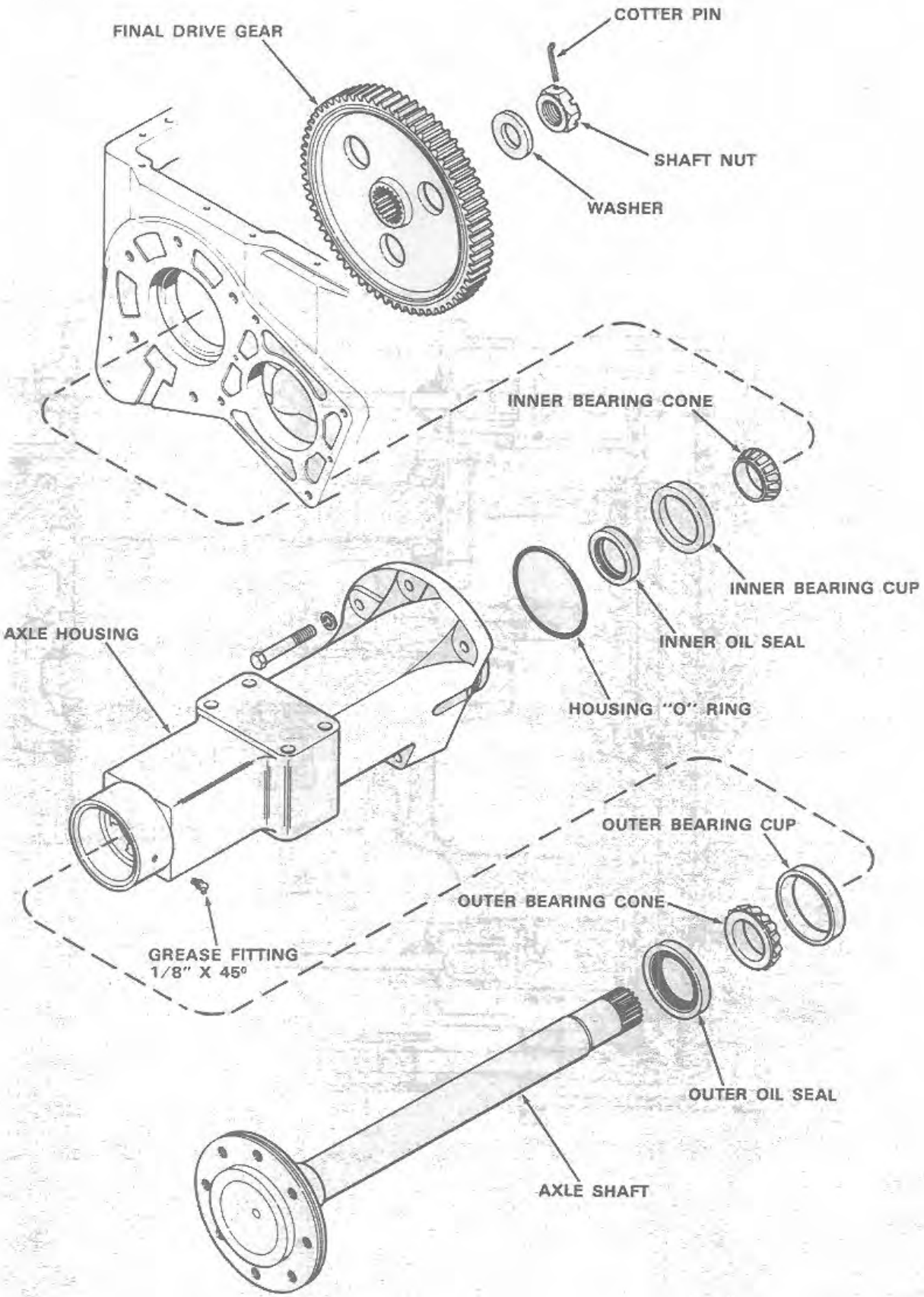
STEP 203



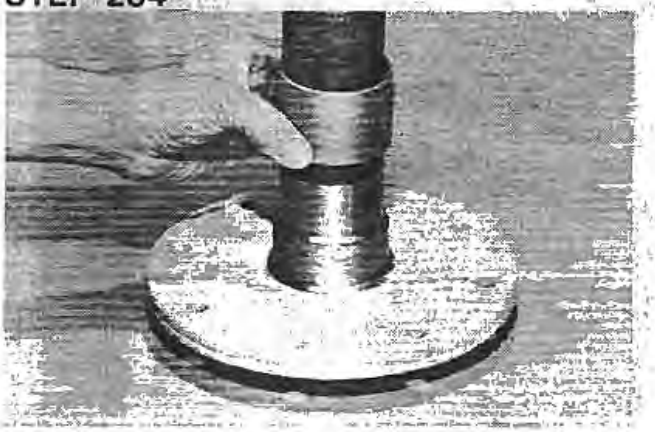
Install the left hand bearing carrier seal and "O" ring following Steps 196 thru 200. Install L.H. brake disc and drum assembly following Steps 201 and 202.



Axle Shaft and Housing Installation

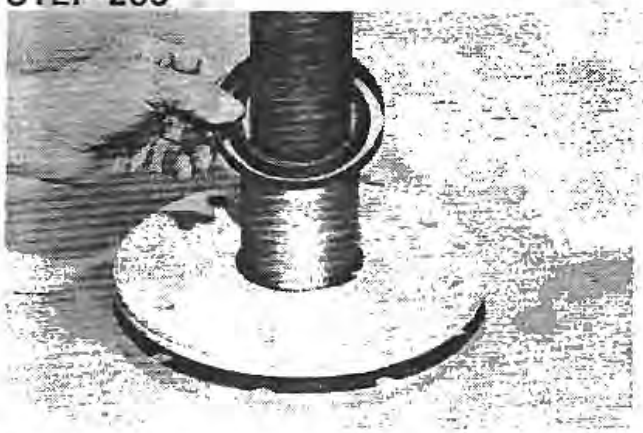


STEP 204



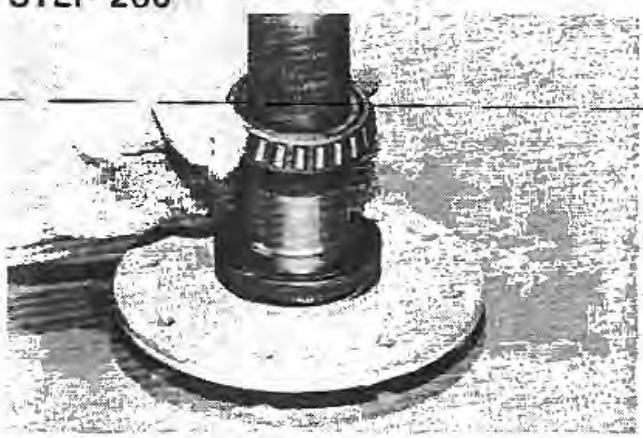
Stand axle shaft on end and place protective sleeve G15043 on axle shaft.

STEP 205



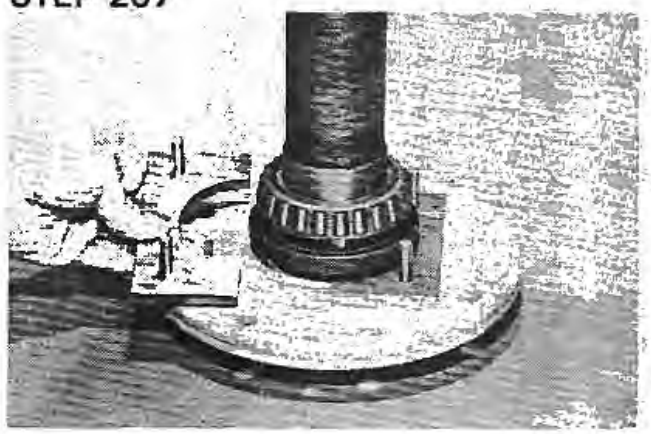
Press new oil seal (lip up) over sleeve and onto axle shaft. *NOTE:* Coat seal lip with #2 lithium gun grease.

STEP 206



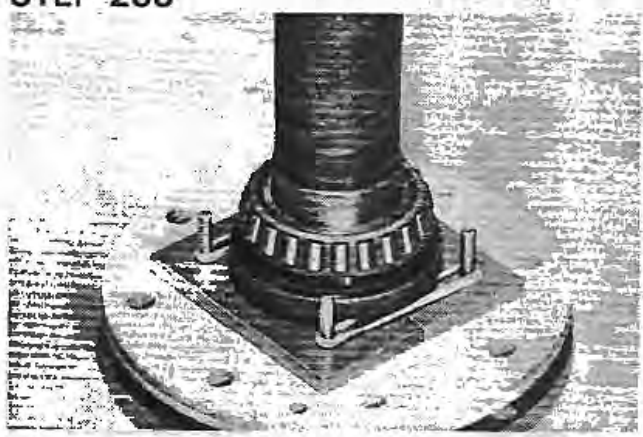
Remove protective sleeve and heat bearing cone on a bearing heater. Install heated bearing on axle shaft. *NOTE:* Bearing must contact shaft shoulder.

STEP 207



Install two G13505 oil seal drivers under the oil seal.

STEP 208



Use rubber bands to hold seal drivers in position.

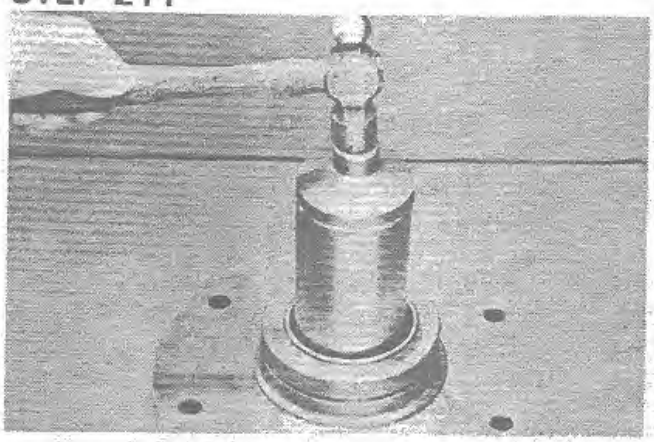
STEP 209

Install axle housing inner bearing cup until it is firmly seated against housing shoulder.

STEP 210

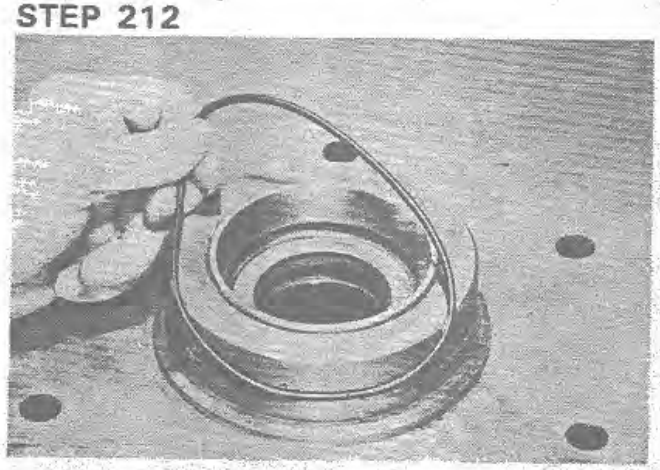
Place inner oil seal in axle housing.

STEP 211



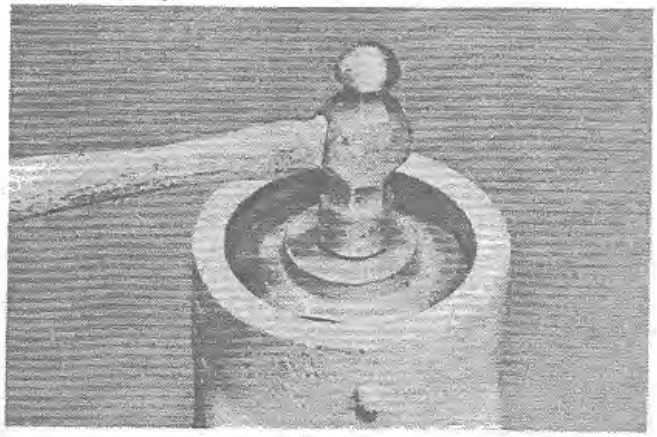
Drive oil seal into position using G13504 driver.

STEP 212



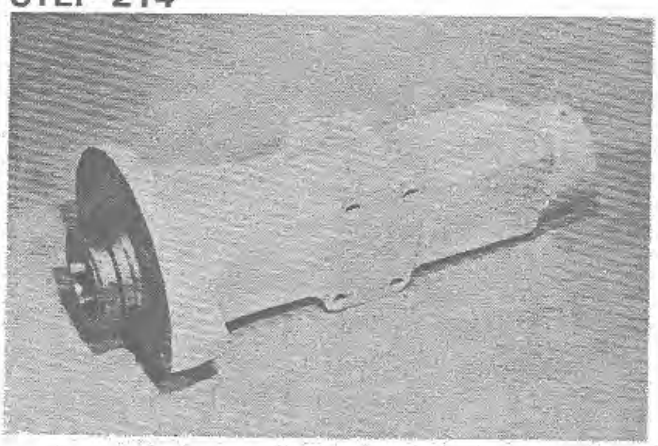
Install a new "O" ring in axle housing groove and lubricate "O" ring with SAE 90EP oil.

STEP 213



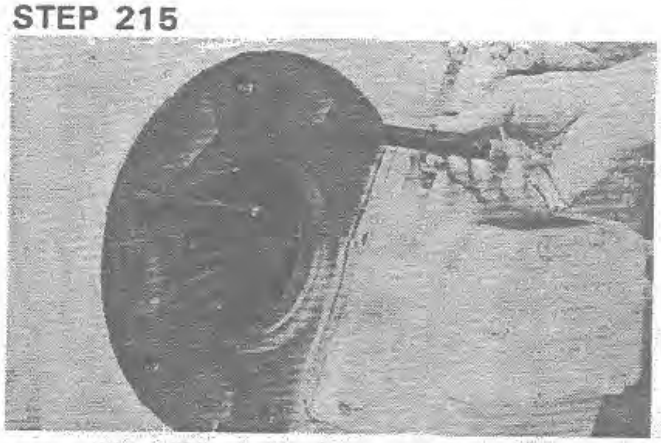
Install axle housing outer bearing cup until it is firmly seated against housing shoulder.

STEP 214



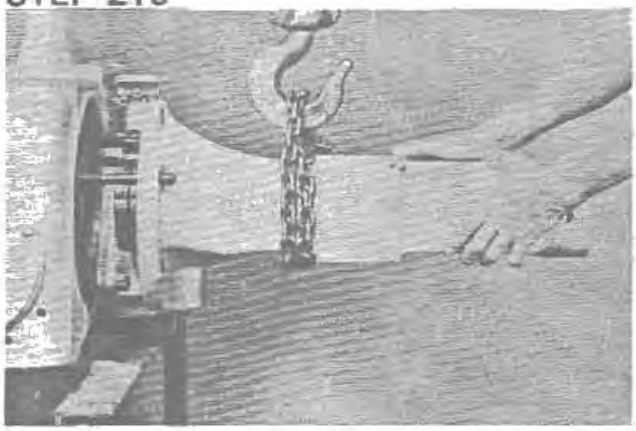
Axle housing ready for installation on transaxle case.

STEP 215



Install two pilot studs in transaxle case.

STEP 216

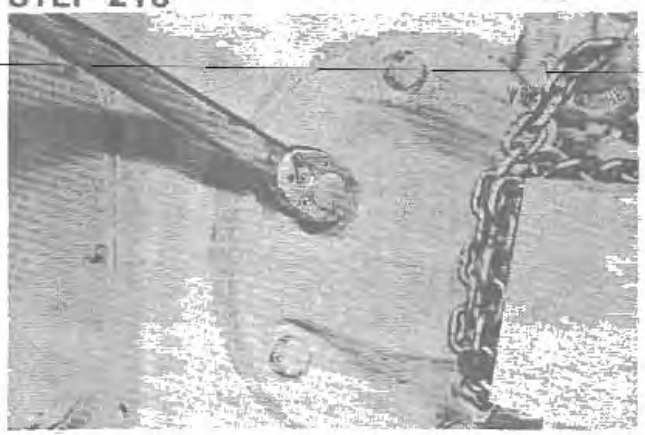


Place the axle housing on the pilot studs and slide housing into place, being careful not to damage "O" ring.

STEP 217

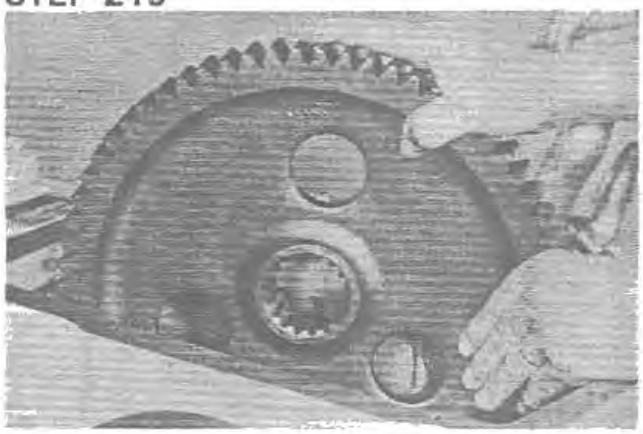
Apply #2 Permatex to the threads of the bolt which is installed in the straight through housing tapped hole.

STEP 218



Install axle mounting bolts. Torque Gr. 5 bolts 150 to 180 ft. lbs. and Gr. 8 bolts 220 to 264 ft. lbs.

STEP 219

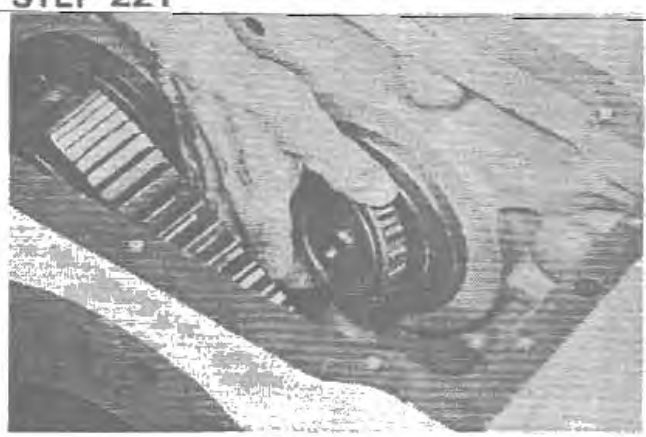


Install final drive gear in transaxle case. *NOTE:* Gear is stamped "Nut Side" for proper positioning.

STEP 220

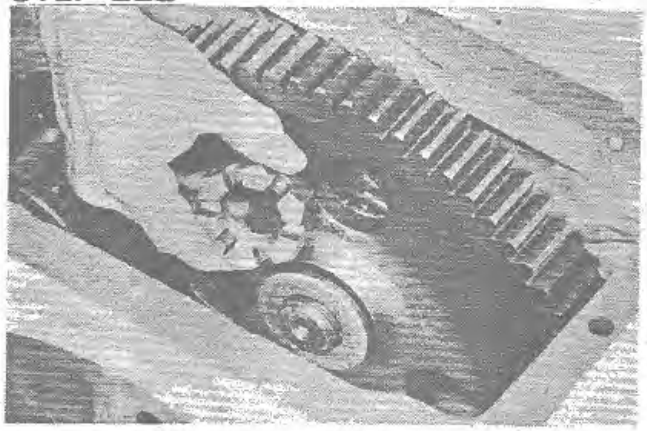
Install axle shaft in axle housing. *NOTE:* After completing Step 223, remove seal drivers. If seal is not flush with housing, use a screwdriver to work seal the rest of the way into housing until flush.

STEP 221



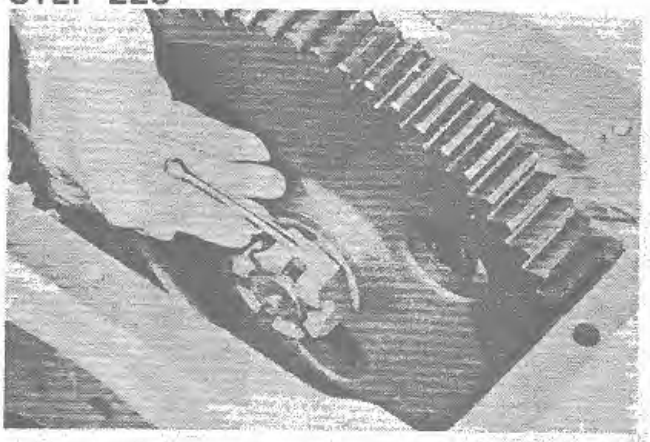
Place inner bearing cone over axle shaft.

STEP 222



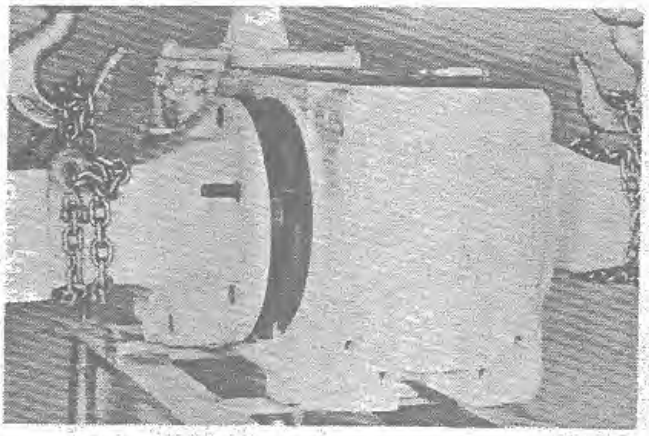
Position final drive gear on axle shaft and install flat washer and retainer nut.

STEP 223



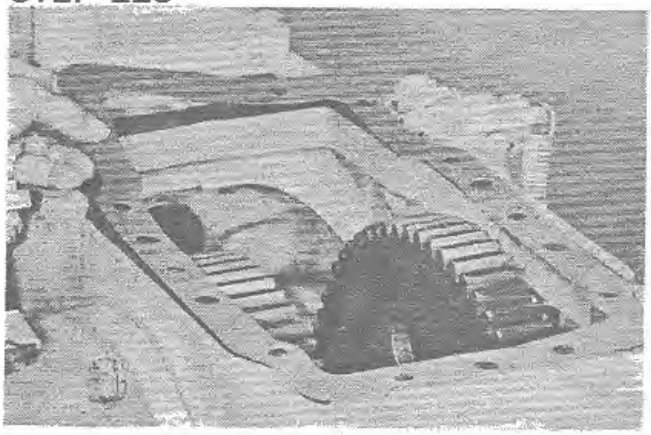
Tighten nut to seat bearing cups and cones. Rotate axle shaft a few turns, then retighten nut until it is snug. After the nut has been "snugged up", tighten the nut one additional notch (1/6 turn) and install cotter pin.

STEP 224



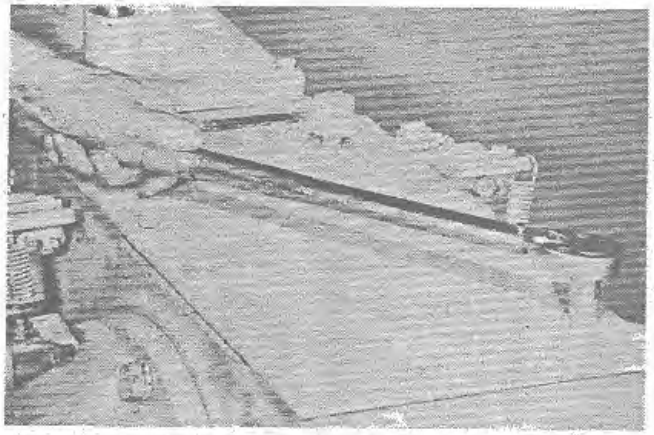
Repeat Steps 213 thru 223 to install the other axle housing and shaft.

STEP 225



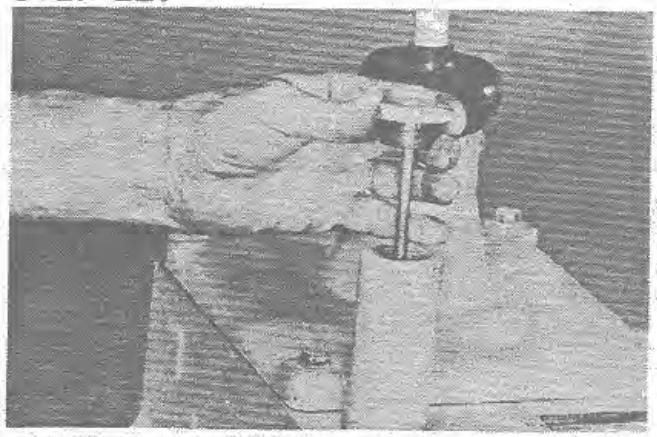
Install a new top cover gasket.

STEP 226

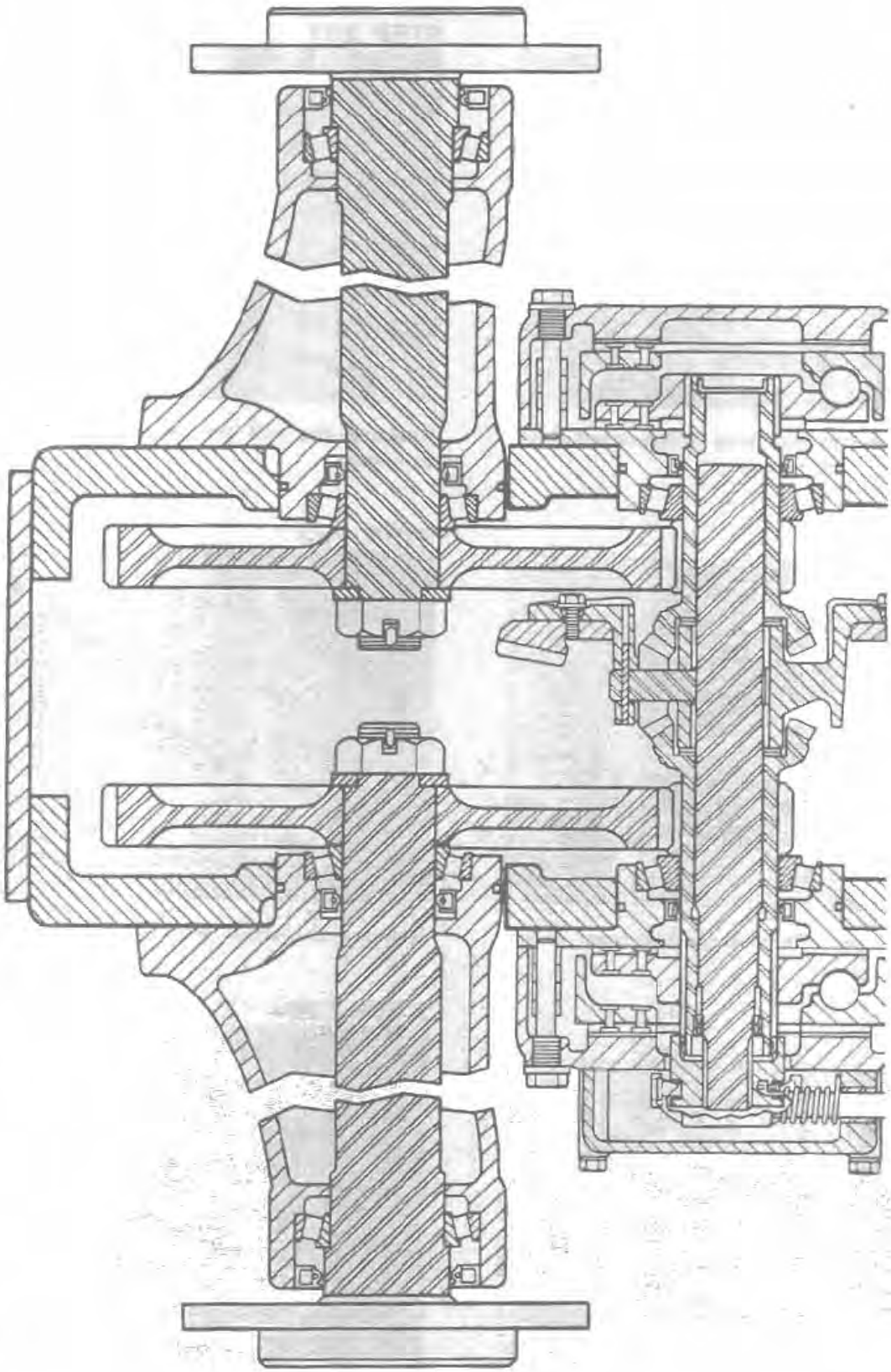


Install top cover and torque retainer bolts 35 to 42 ft. lbs.

STEP 227



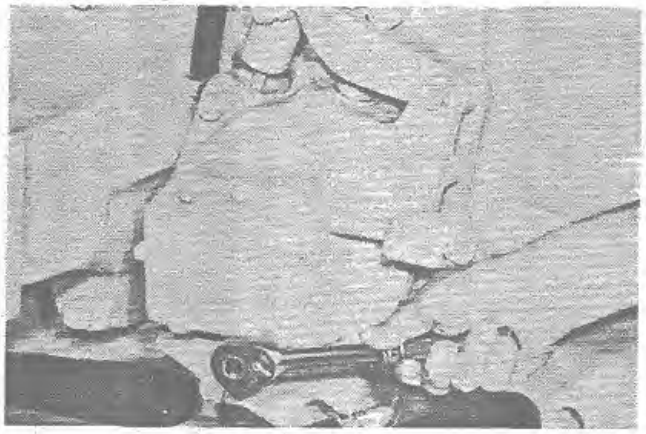
Fill the transaxle housing with 20 quarts of new Case FDL oil and install the housing dipstick.



SERVICING THE DIFFERENTIAL LOCK ASSEMBLY

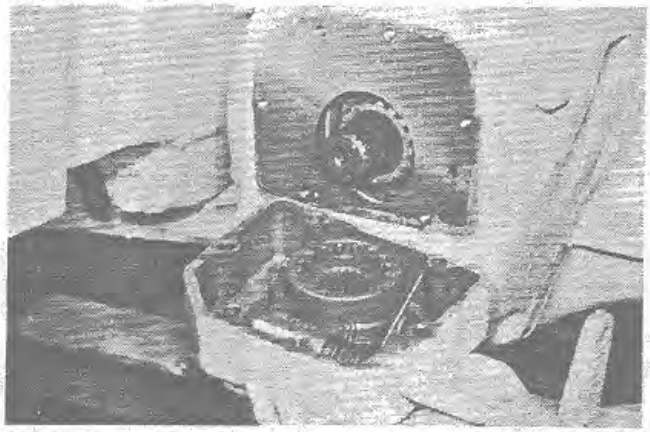
Removal and Disassembly

STEP 228



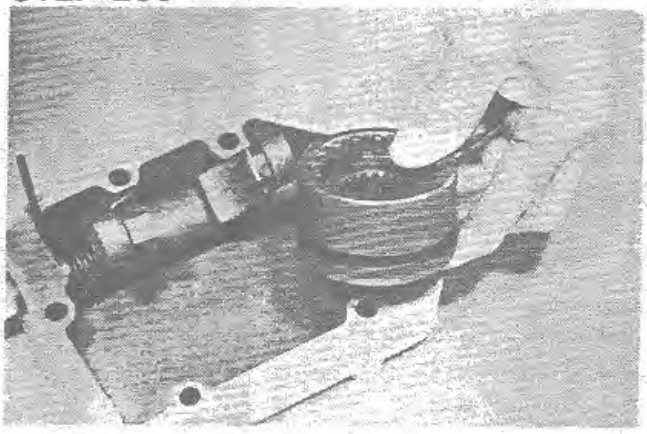
Remove the bolts retaining differential lock cover to R.H. brake housing.

STEP 229



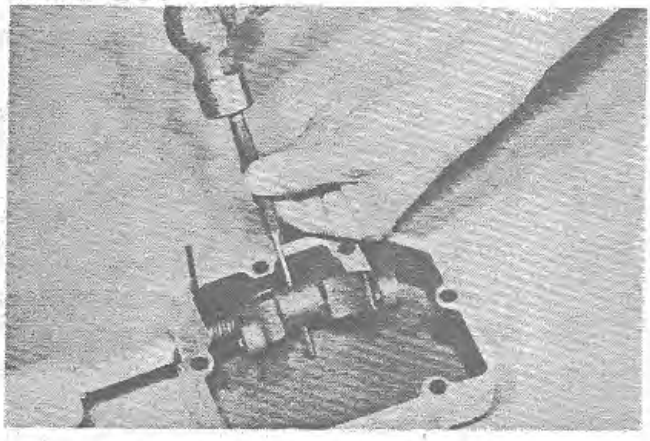
Remove differential lock assembly from brake housing.

STEP 230



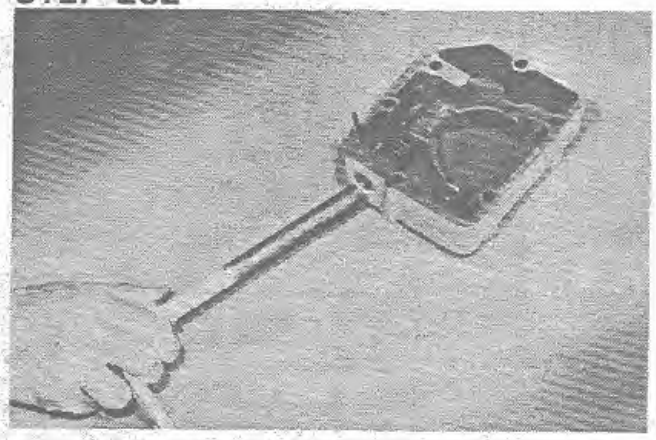
Remove the engaging collar and lever fingers.

STEP 231



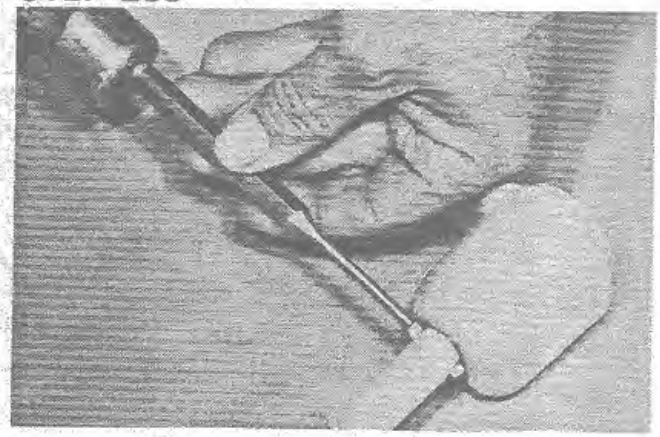
Remove the roll pin securing actuating lever to shaft.

STEP 232



Remove the shaft from the differential cover.

STEP 233

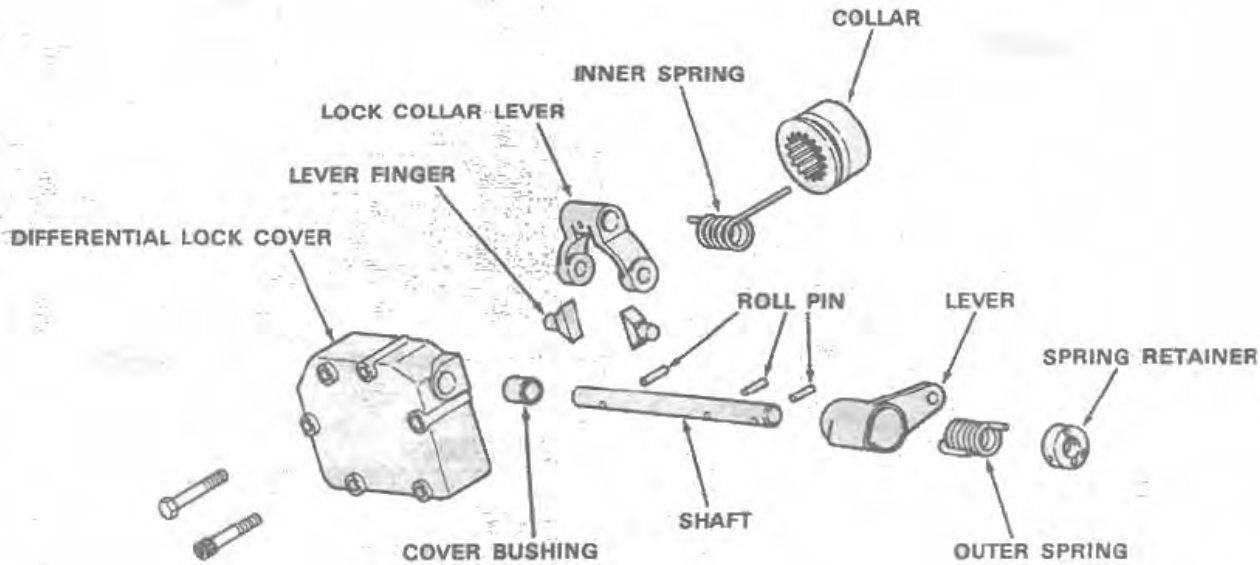


Remove roll pin from shaft.

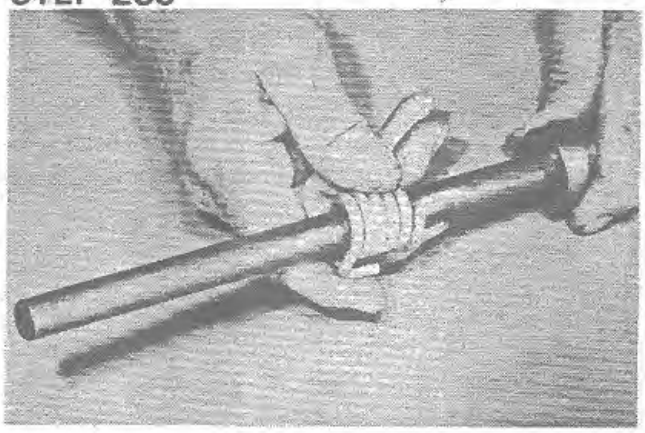
STEP 234

Remove pedal lever from shaft.

Assembly and Installation



STEP 235

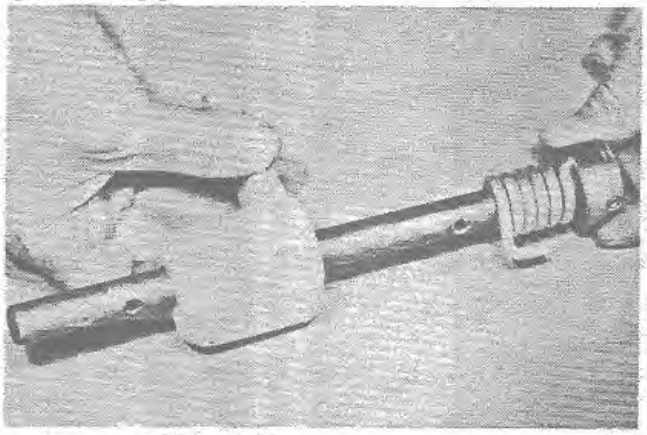


Install pedal lever return spring on shaft.

Outer lever spring specifications:

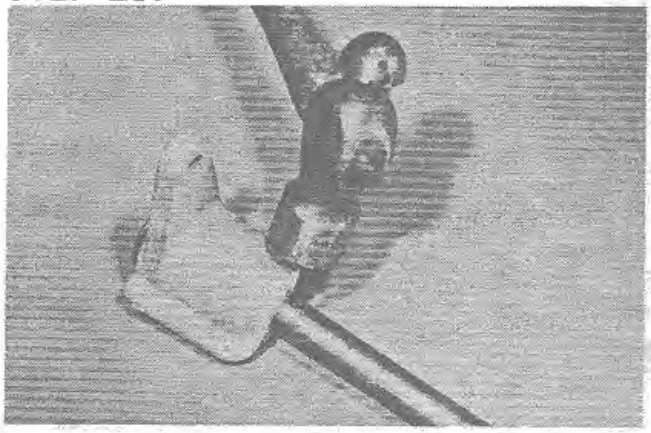
Length	2.06"
I.D.	.651"
Wire dia.	.192"
No. of coils	5
Free angle between wire ends	138°
Torque with wire ends at 112° angle	42 to 95 in. lbs.

STEP 236



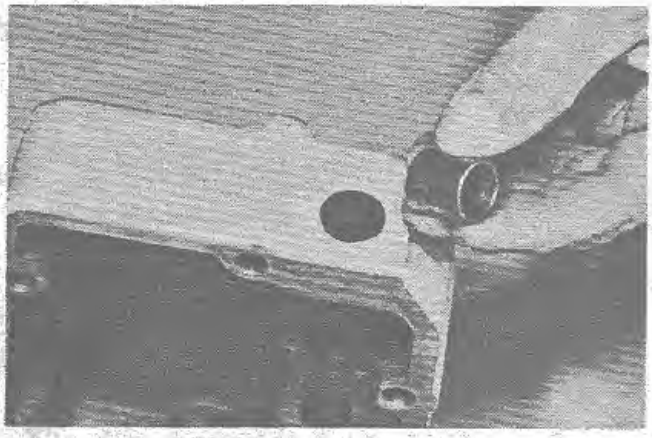
Install the actuating lever on shaft.

STEP 237



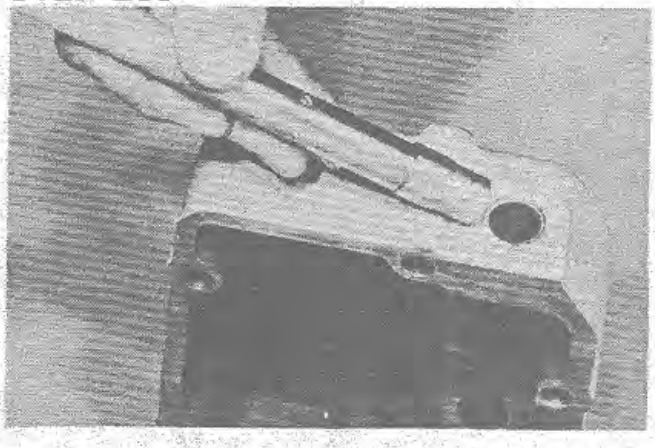
Install a new lever retaining roll pin.

STEP 238



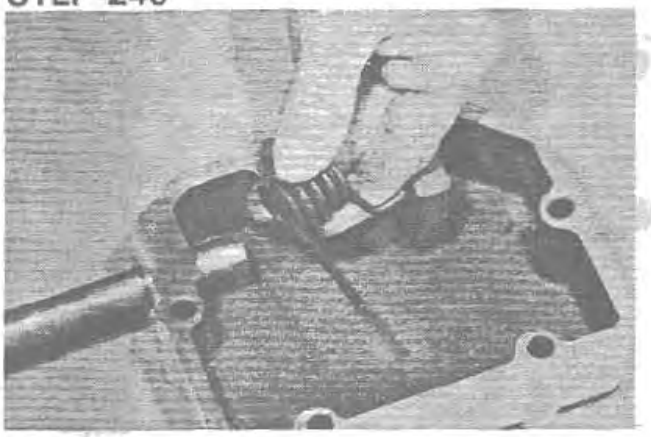
Place new bushing in cover opening.

STEP 239



Press bushing into cover until it is flush with outside edge.

STEP 240

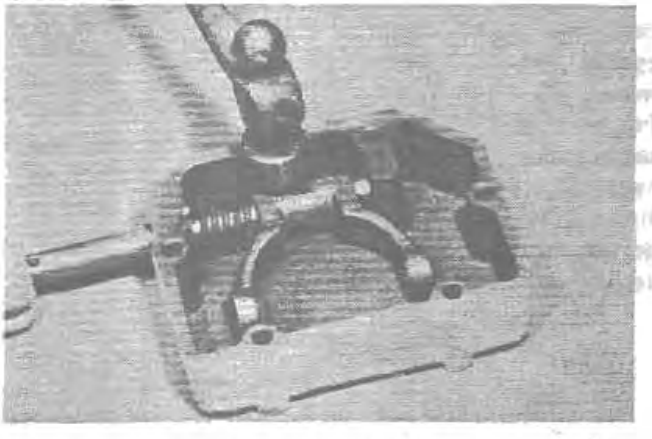


Start shaft into cover and install spring on shaft. *NOTE:* Coat all parts with Anti-Seize Compound (Case No. M20455 or M20456) before install in differential cover.

Inner lever spring specifications:

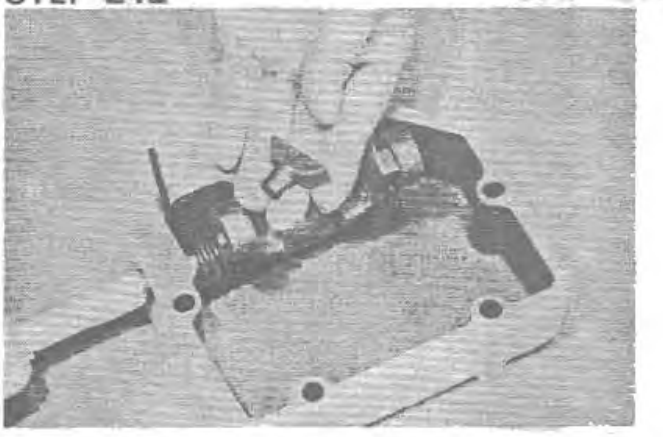
Length	1.81"
I.D.	.708"
Wire dia.	.135"
No. of coils	5-1/2
Free angle between wire ends	81°
Torque with short wire end at 24° angle	18 to 28 in. lbs.

STEP 241



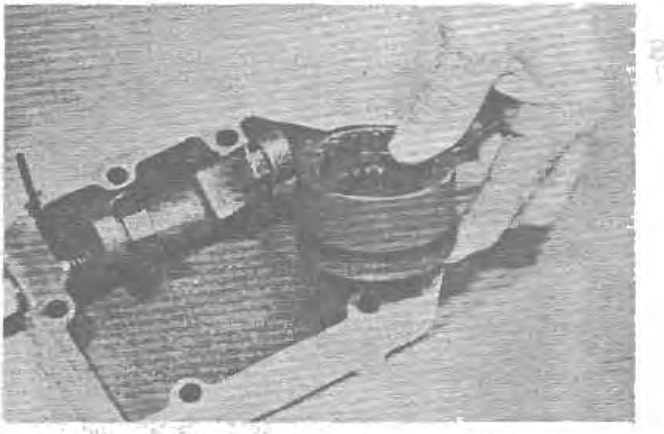
Install actuating lever on shaft and secure in place with new roll pin.

STEP 242



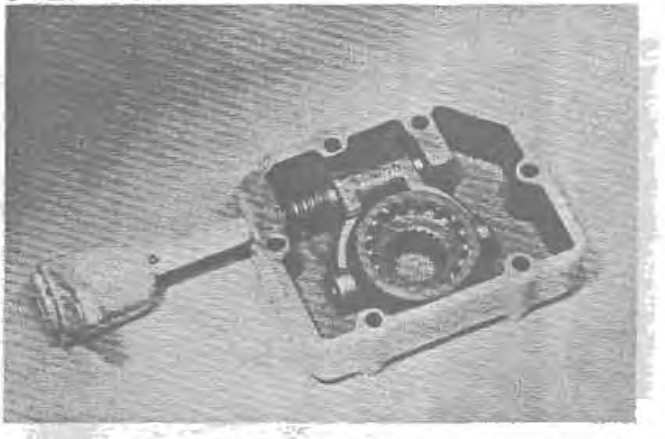
Install lever fingers in actuating lever.

STEP 243



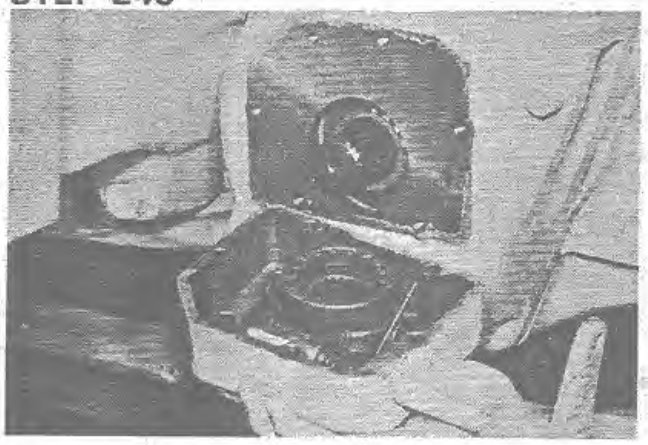
Install collar in differential cover making sure collar engages lever fingers.

STEP 244



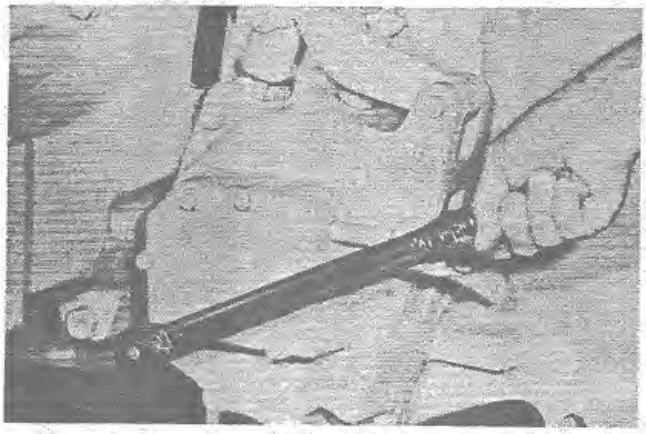
Differential assembly completed and ready for installation on R.H. brake housing.

STEP 245



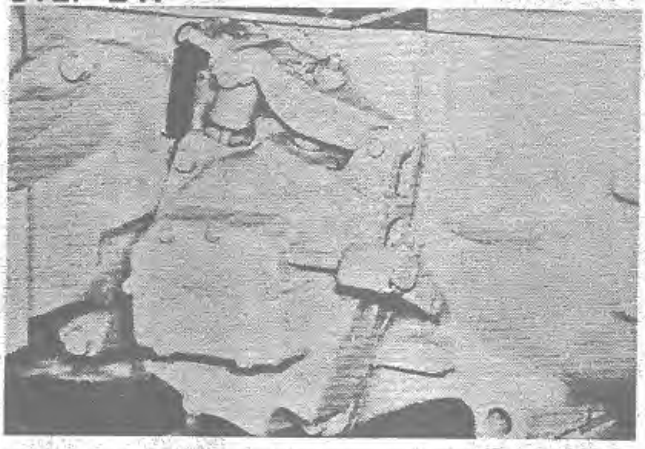
Install differential lock on R.H. brake housing, engaging actuating collar splines with differential cross shaft splines.

STEP 246



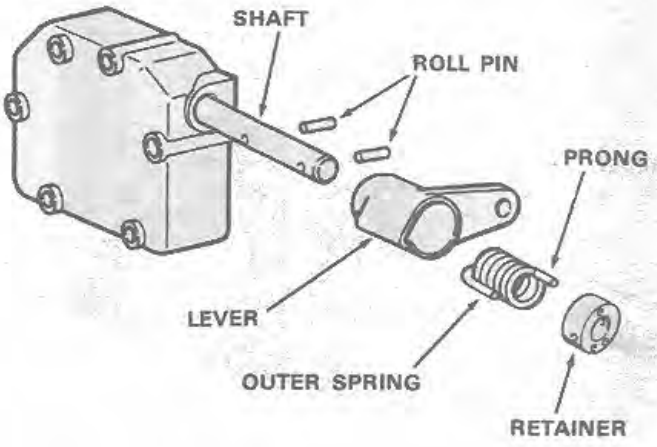
Install cover retaining bolts and torque bolts 17 to 21 ft. lbs.

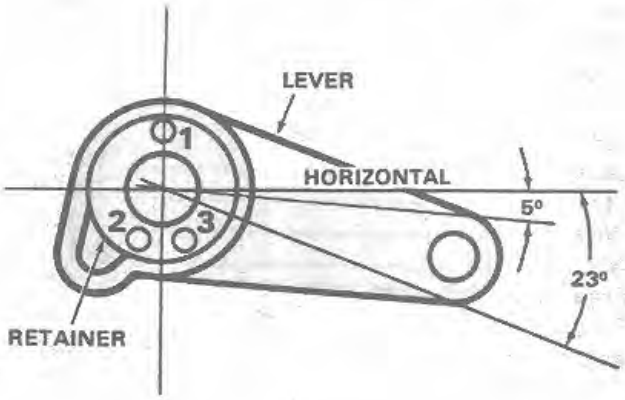
STEP 247



Differential lock assembly installed on R.H. brake housing.

STEP 248





With the outer spring prong in No. 1 hole of spring retainer, move lever upwards to remove all slack from lever. The lever should fall into the below horizontal 5° to 23° tolerance that the diff. lock requires. If not, the retainer is to be removed and turned 180° so holes 2 and 3 are at the top. The spring is then to be used with holes 2 or 3 to achieve the 5° to 23° below horizontal tolerance.

Section 6222

DRIVE SHAFT

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

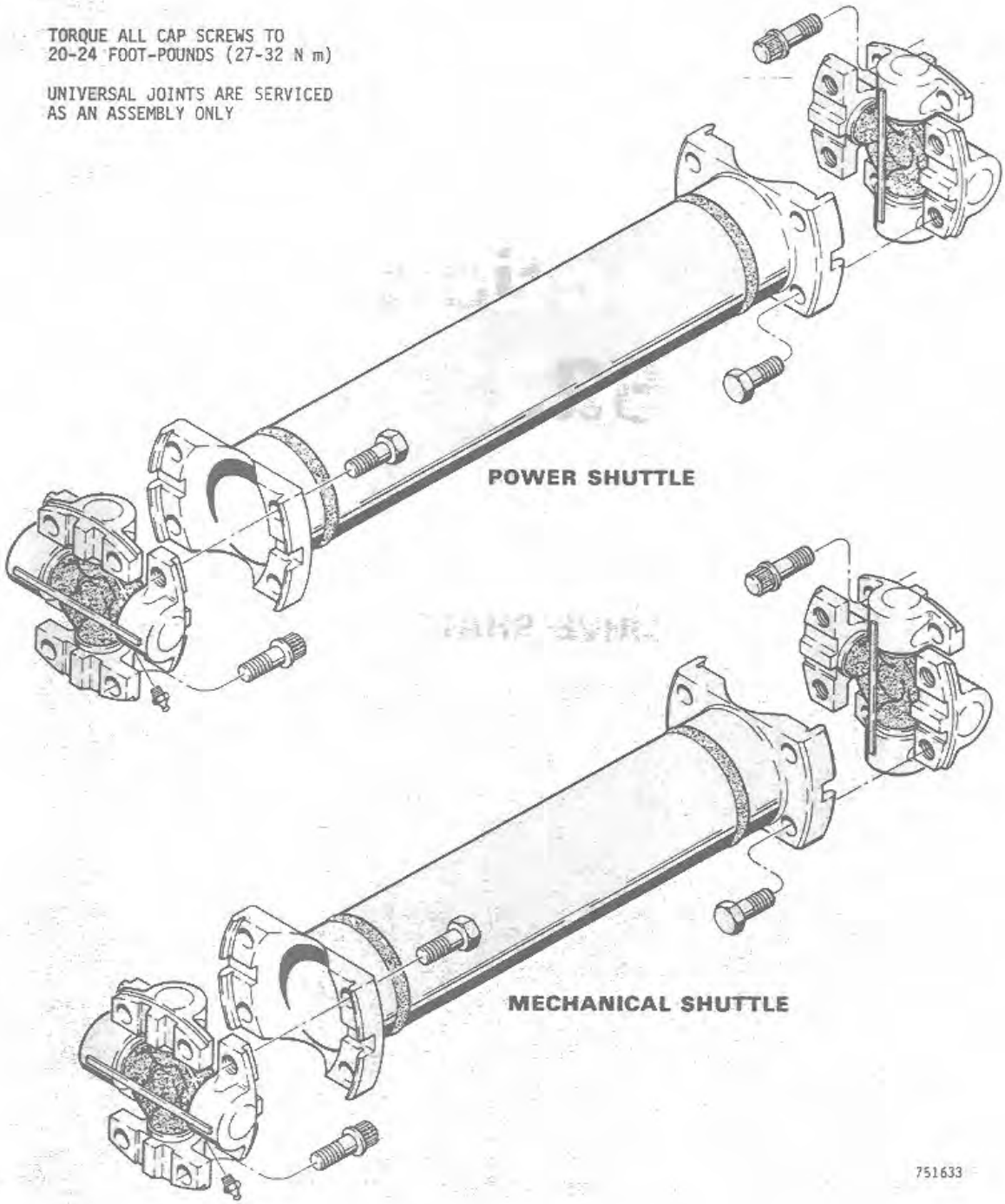


Figure 1 - Drive Shafts

Section 6229

WHEELS AND TIRES

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

Front Tire Pressure

7.50 x 16, 10 PR	56 psi (385 kPa)
11L x 16, 10 PR	48 psi (330 kPa)

Rear Tire Pressure

14.9 x 24, 6 PR, R1 & R3	18 psi (125 kPa)
14.9 x 24, 6 PR, R4	20 psi (140 kPa)
14.9 x 24, 8 PR, R4	24 psi (165 kPa)
16.9 x 24, 6 PR, R3 & R4	18 psi (125 kPa)
16.9 x 24, 6 PR, R4	24 psi (165 kPa)
17.5L x 24, 6 PR, R4	16 psi (110 kPa)
17.5L x 24, 8 PR, R4	22 psi (150 kPa)

Wheel Bolt Torque

Front and rear	115-130 foot-pounds (155-176 N m)

NOTE: After a wheel has been removed and installed, check bolt torque every two hours until torque stabilizes.

Installing Wheels

1. Do not use an impact wrench to turn bolts into place. Damage to the wheel may result. Turn bolts into place by hand or with a hand wrench.
2. Center bolt holes in wheel and hub or axle fairly close before tightening bolts.
3. Alternately torque bolts to specification.

Section 6406

CLUTCH

AND

PRESSURE PLATE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

CLUTCH AND PRESSURE PLATE

Special Tool

The special tool shown in Figure 1, or a shuttle input shaft, must be available to align the clutch plate whenever the clutch plate and pressure plate are being installed. Order part number A37956 from SPS in the usual manner.

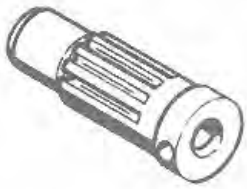


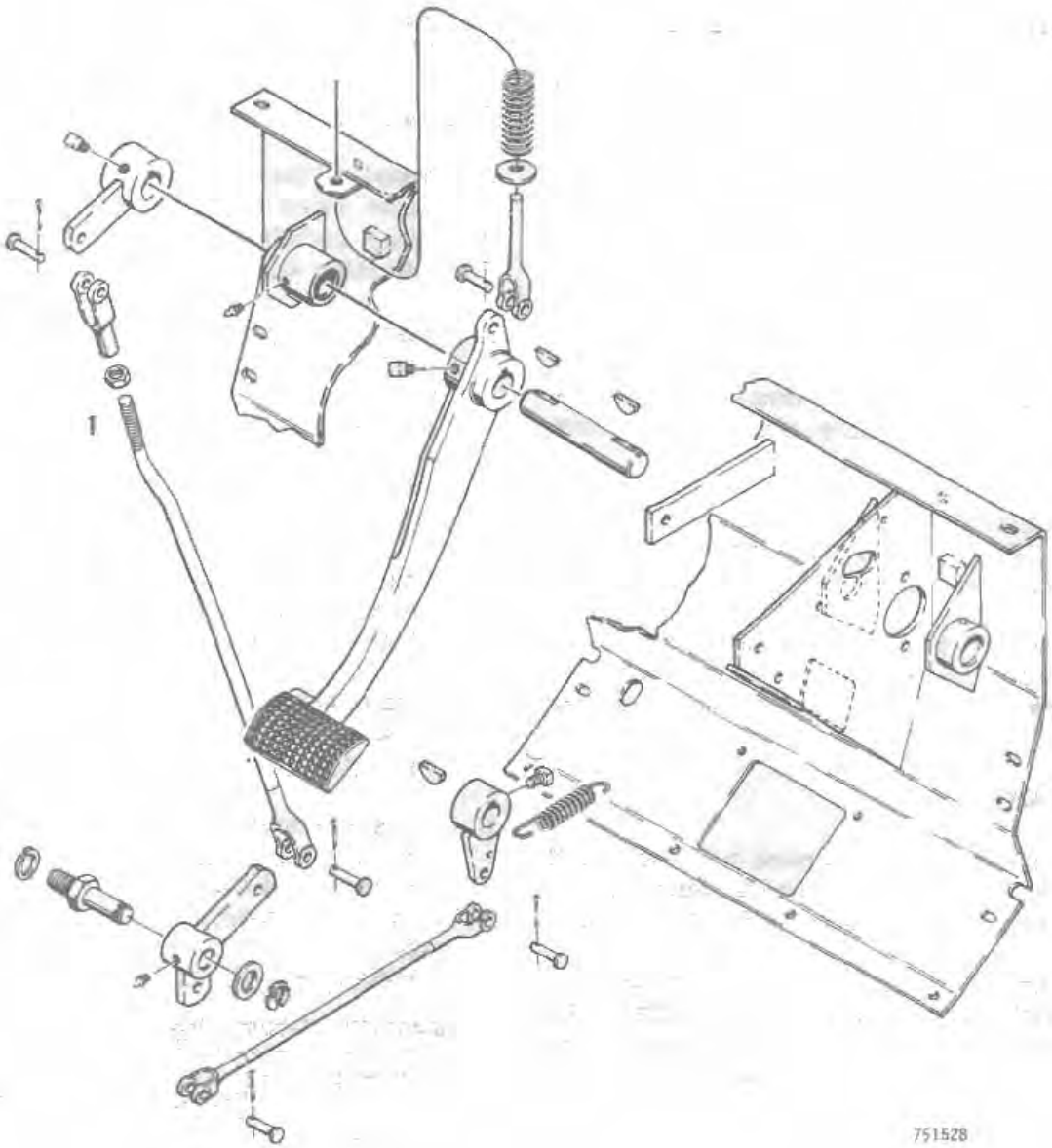
Figure 1 - Special Tool

Removal

1. Disconnect drive shaft from shuttle output flange and remove drive shaft.
2. Disconnect clutch linkage from arm on left side of flywheel housing.
3. Remove cover at front of flywheel housing.
4. Disconnect connect control linkage at rear of shuttle.
5. Disconnect wiring from neutral start switch on left side of shuttle.
6. Support the engine with a jack under the rear of the oil pan.
7. Remove the rear engine mounting bolts.
8. Place a transmission jack under the shuttle/flywheel housing assembly.
9. Remove the engine to flywheel housing nuts, washers and bolts. The flat washers are hardened. If a washer is replaced, use part specified in parts catalog.
10. Move the shuttle/flywheel housing assembly to the rear and lower it to the floor.
11. Remove the pressure plate mounting cap screws and remove the pressure plate and clutch plate.

Installation

1. Before installing the clutch and pressure plate, check the pilot bearing in the flywheel for free rotation. Replace as required.
2. Use the special tool shown in Figure 1 or a shuttle input shaft to position the clutch disc. Then install the pressure plate and secure in place with cap screws and lock washers.
3. Raise shuttle/flywheel housing assembly and move into place against engine.
4. Install lock washers and nuts on studs at top of flywheel housing but do not tighten.
5. Place hardened washer on bolts and install from engine side. Install remaining hardened washer and nuts and tighten all nuts.
6. Install the rear engine mounting bolts.
7. Connect control linkage to rear of shuttle.
8. Connect wiring to neutral start switch.
9. Connect clutch linkage to arm on left side of flywheel housing.
10. Install drive shaft and torque cap screws to 20-24 foot-pounds (27-32 N m).
11. Install cover on front of flywheel housing.
12. Adjust clutch pedal free travel, Figure 2.



1. ADJUST LENGTH OF ROD AS REQUIRED TO OBTAIN 1-1/2" - 2" (38 mm - 51 mm) CLUTCH PEDAL FREE TRAVEL.

Figure 2 - Clutch Pedal and Linkage Installation

PRESSURE PLATE

Disassembly

1. Turn lock nuts up against shoulder on the lever adjusting screws.
2. Apply light pressure against the spring plate until the links are loose and remove links.
4. Release pressure and remove spring plate and springs.
5. Unscrew adjusting screws from pressure plate. Lift pressure plate frame from pressure plate.
6. Do not remove adjusting screw or clip from lever unless one of these parts is to be replaced.
7. Further disassembly of the frame is not recommended because the frame and levers are serviced as an assembly only.

Inspection

1. The pressure plate must be replaced if the clutch surface is badly heat checked or warped more than .015" (0.381 mm).
2. Inspect the pressure plate frame for distortion and signs of cracks. The mounting flanges should be even within .015" (0.381 mm). Also check levers and pins for wear.
3. Check the springs for distortion and signs of cracking; replace if either condition is present. If spring testing equipment is available, check to see if springs meet the following specification: compressed length of 1.685" (42.799 mm) at 95-105 pounds (43.09-47.62 kg).

Assembly

1. Install clips on adjusting screws if these parts were separated or new parts are being installed. Be sure lock nut is on adjusting screw.
2. Install clips on levers and place frame on top of pressure plate. Be sure washers are in place and turn adjusting screws into pressure plate.
3. Place pressure plate as assembled in a press with the plate down.
4. Place springs on pressure plate and spring plate on springs. Be sure spring plate is aligned with levers.
5. Compress the springs enough so the links can be installed in the spring spring plate.
6. Place pressure plate on surface known to be flat. Turn the adjusting screws as required until the distance from the top of the levers to the table is 2" ± .031" (50.8 ± 0.787 mm), Figure 3. Then tighten the lock nuts.

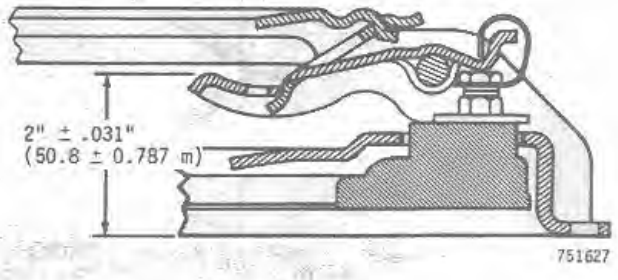
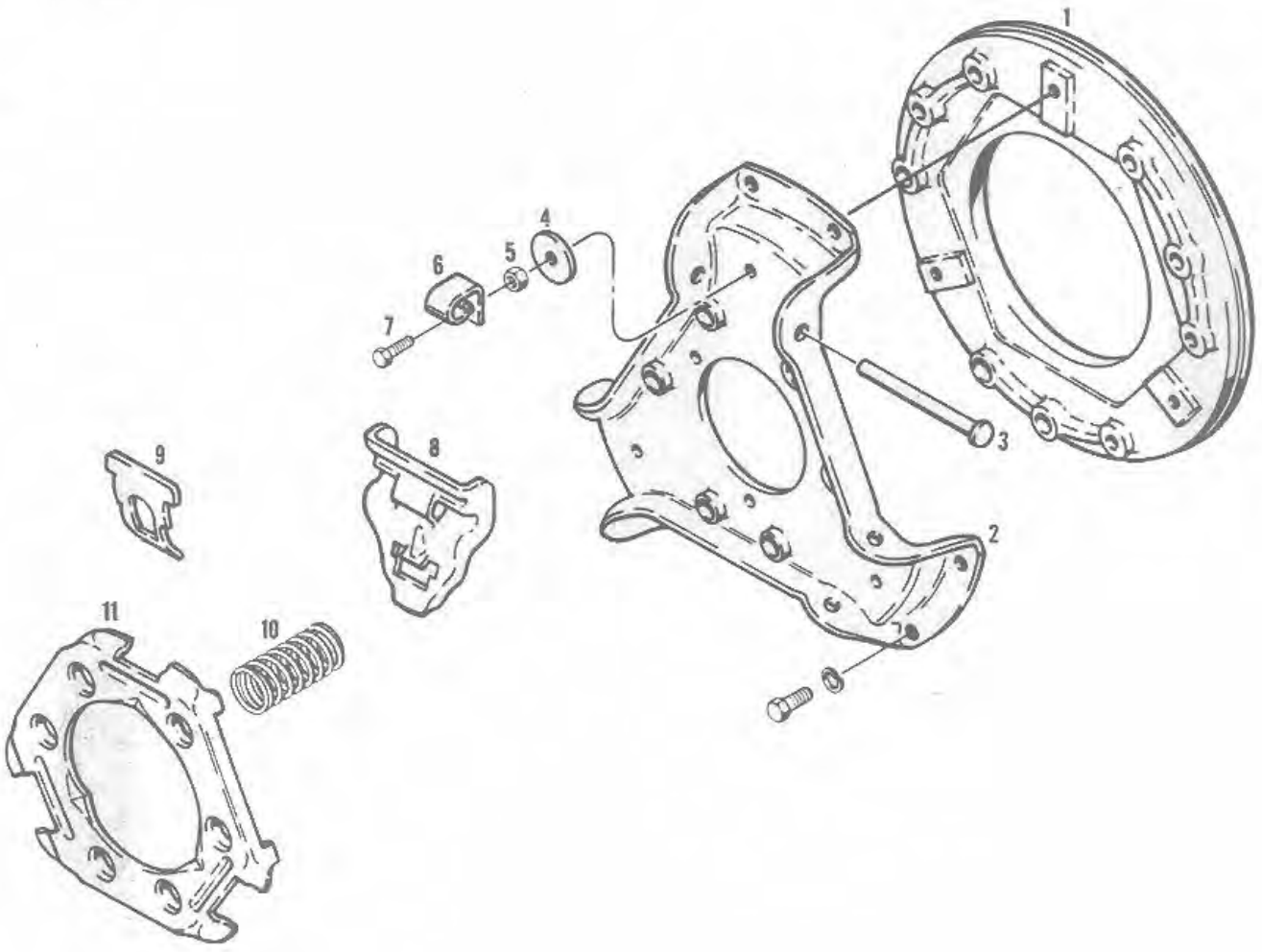


Figure 3



1. PRESSURE PLATE
2. PRESSURE PLATE FRAME
3. PIN (3)
4. WASHER(3)
5. LOCK NUT (3)
6. CLIP (3)
7. ADJUSTING SCREW (3)
8. LEVER (3)
9. LINK (3)
10. SPRING (6)
11. SPRING PLATE

751626

Figure 4 - Pressure Plate

Section 6410

TWO SPEED

MECHANICAL SHUTTLE

J I Case
A Tenneco Company

TENNECO

Rac 9-79116

PRINTED IN U.S.A.

TABLE OF CONTENTS

GENERAL INFORMATION

THIS SAFETY ALERT SYMBOL INDICATES IMPORTANT SAFETY MESSAGES IN THIS MANUAL. WHEN YOU SEE THIS SYMBOL, CAREFULLY READ THE MESSAGE THAT FOLLOWS AND BE ALERT TO THE POSSIBILITY OF PERSONAL INJURY OR DEATH.

CLEANING - Steam clean the complete exterior of the two speed mechanical shuttle housings before any service work is performed. All metallic parts, except bearings, should be cleaned in mineral spirits or by steam cleaning. Do not use caustic soda solution for steam cleaning. All parts should be dried and lightly oiled after cleaning. Oil passages can be cleaned with compressed air. Bearings should be cleaned in mineral spirits and lightly oiled.

INSPECTION - Inspection of all parts should be made when disassembly is required. Any part that shows excessive wear or damage must be replaced. Small nicks or grooves can be removed in most cases with a hone or crocus cloth. Thorough visual inspection for indications of wear, stress, pitting and the replacement of such parts as necessary will eliminate costly and avoidable unit failure.

GEARS - Inspect all gears for wear and damage. Gears which are worn, ridged or scored must be replaced. *NOTE:* If it is necessary to replace either the bevel gear (differential ring gear) or pinion shaft, the bevel gear and pinion shaft must be replaced as a matched set.

SHAFTS - Inspect all shafts for worn, pitted or broken splines. Also, check for damaged bearing and oil seal surfaces on shafts.

OIL SEALS, "O" RINGS AND GASKETS - When installing any parts, always install new gaskets, oil seals and "O" rings. Lubricate rubbing surface of all lip type seals with a lubricant before installation.

BEARINGS - Check bearings for free smooth action. If bearings have a loose fit or rough action, replace the bearing. Always replace cup and cone as a set, never just one part of a bearing. Wash bearings with a good solvent and let air dry. DO NOT SPIN DRY.

To facilitate assembly in many areas, bearings may be heated. This will expand the bearing inner race, eliminating the need of a hydraulic press when installing bearings over shafts.

CAUTION *Always wear asbestos gloves to prevent burning your hands when handling heated parts.*

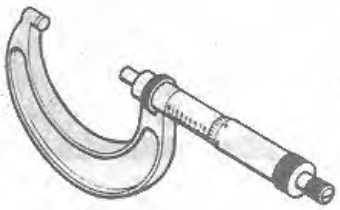
NEEDLE BEARINGS - Always remove any burrs in bore or edge of bore before pressing in needle bearings. Lubricate inside and outside diameter of bearings with a lubricant before pressing into place.

When pressing needle bearings into place, always use a bearing arbor. Place bearing on arbor with stamped end (end with numbers) against stepped shoulder of pressing arbor.

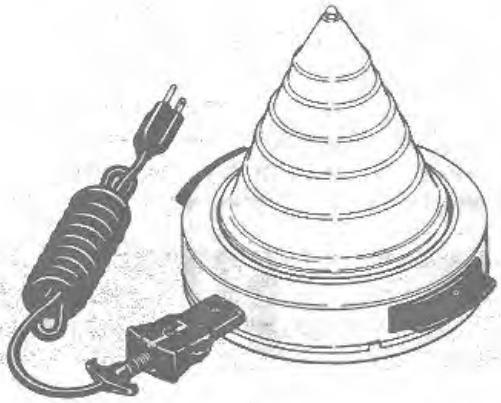
SPECIAL TOOLS

G15044 NEEDLE
BEARING DRIVER

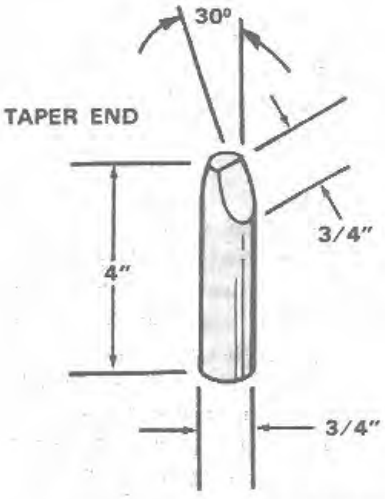
G15021 NEEDLE
BEARING DRIVER



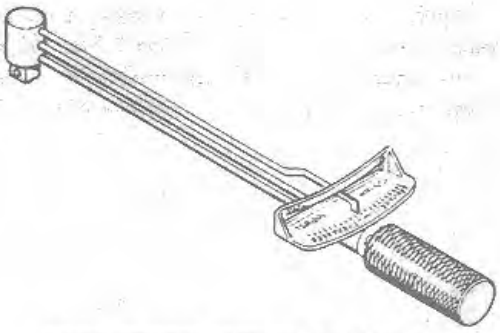
0" TO 1" MICROMETER



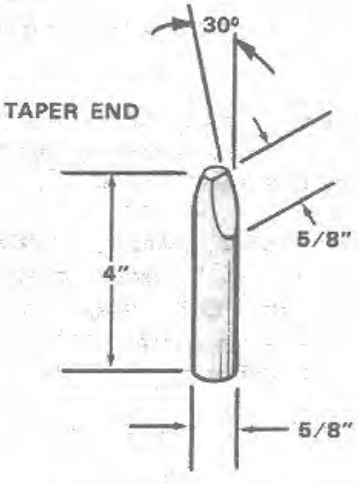
THERMO MOUNTER - MODEL "C"
ELECTRONIC DESIGNS, INC.
5164 N. 62ND STREET
MILWAUKEE, WIS. 53218



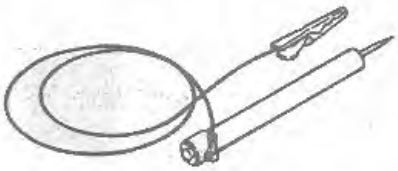
SHUTTLE RAIL PILOT SLEEVE



FOOT POUND TORQUE WRENCH



RANGE RAIL PILOT SLEEVE

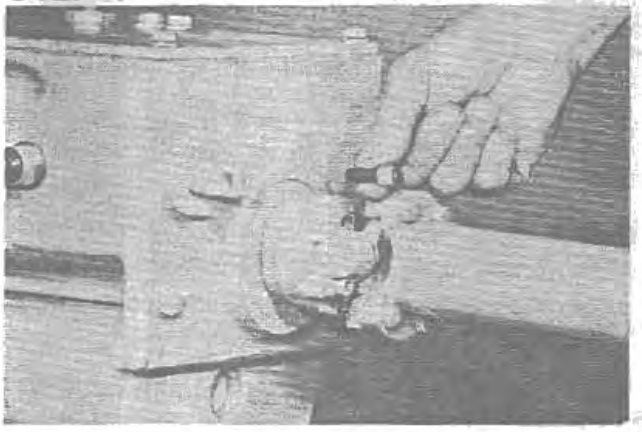


BATTERY POWERED TEST
LAMP OR OHMMETER

SERVICING THE TWO SPEED MECHANICAL SHUTTLE

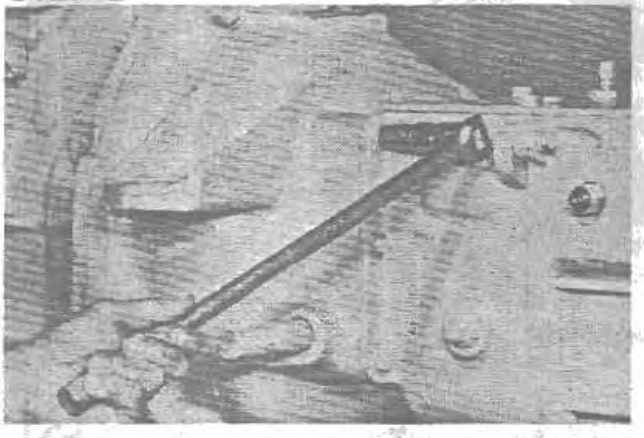
Removal and Separation of Housings

STEP 1



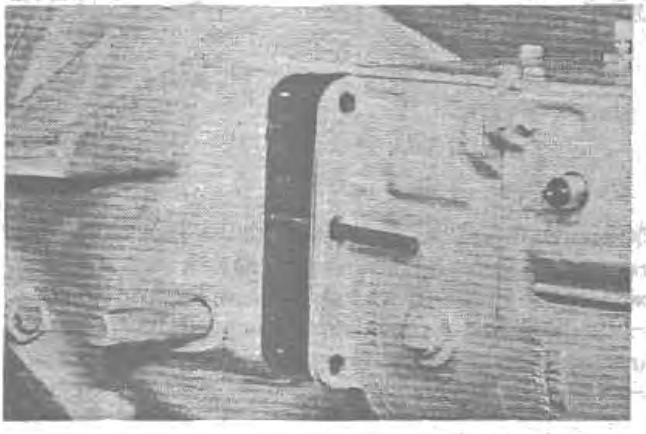
Disconnect drive shaft, wires and linkage to the shuttle boxes.

STEP 2



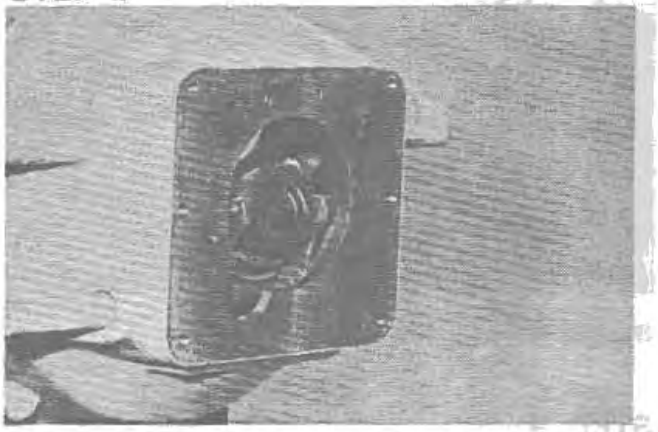
Remove bolts retaining shuttle boxes to engine flywheel housing.

STEP 3



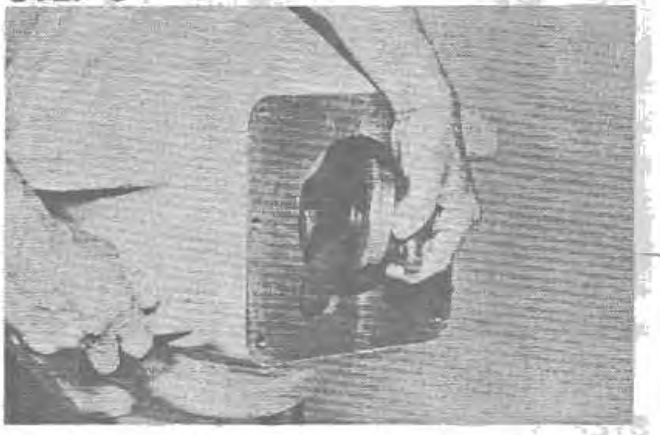
Pull shuttle boxes rearward and down to remove from flywheel housing.

STEP 4



Shuttle boxes removed from flywheel housing.

STEP 5

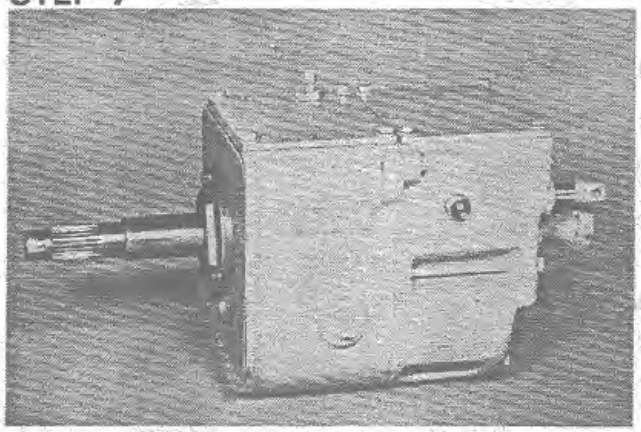


Turn clutch throw-out shaft and remove the throwout carrier.

STEP 6

To service or replace clutch yoke the engine must be removed from the flywheel housing, refer to Section 2050.

STEP 7

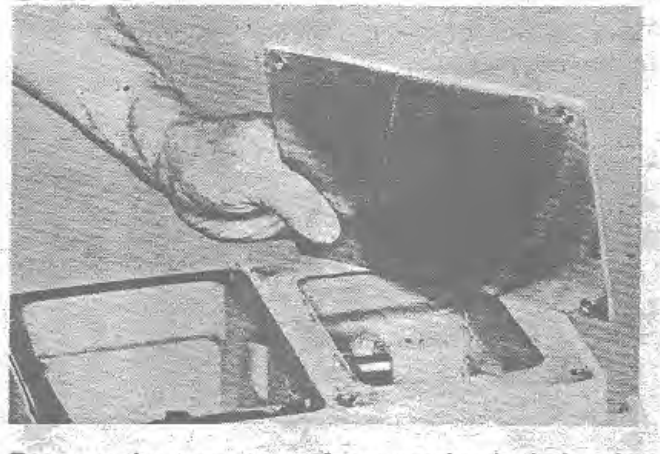


Shuttle boxes removed from unit.

STEP 8

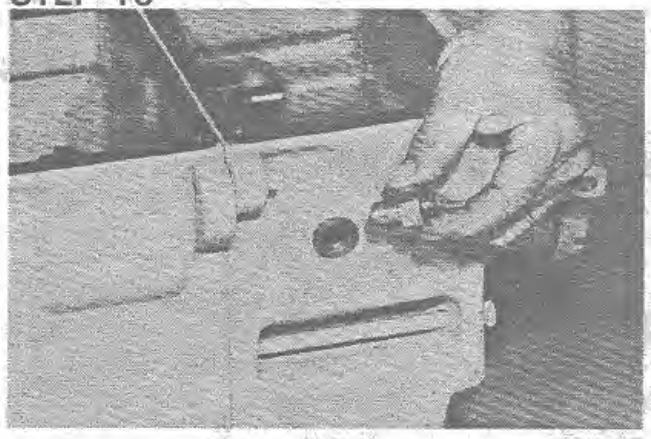
Remove the breather tube from top cover.

STEP 9



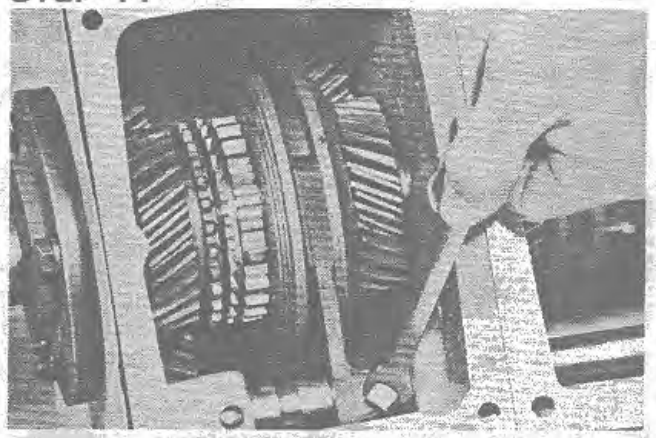
Remove the top covers from mechanical shuttle and dual range housings.

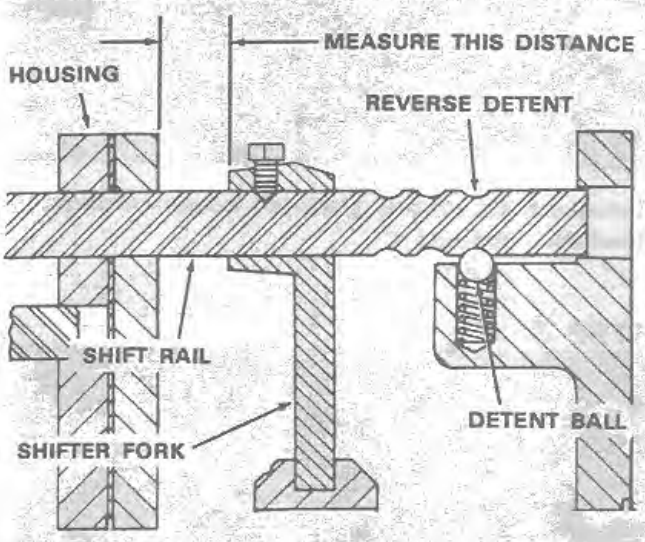
STEP 10



Remove the neutral start switch.

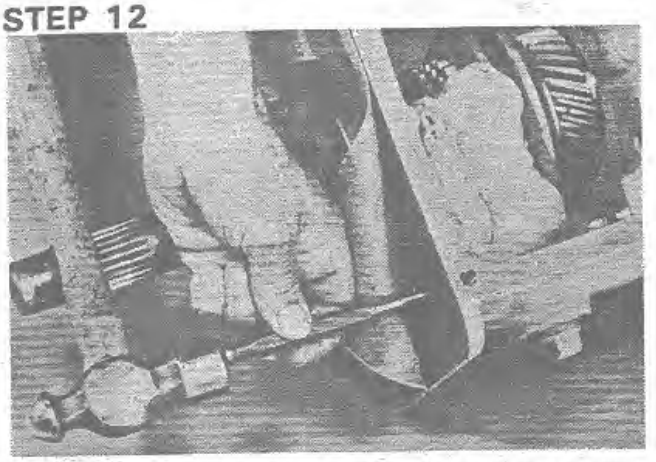
STEP 11





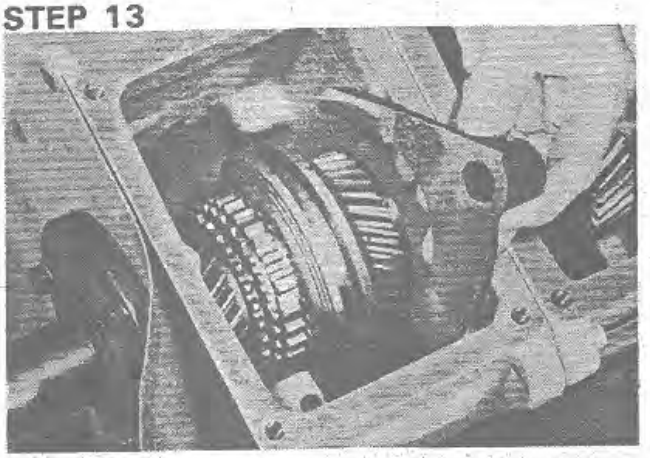
Move shift rail so that the detent ball is in the reverse detent of shift rail. Measure between shift r fork and housing as shown and record mea urement, to use for later installation procedure. Remove lockwire and setscrew securing shuttle fork to shift rail.

STEP 12



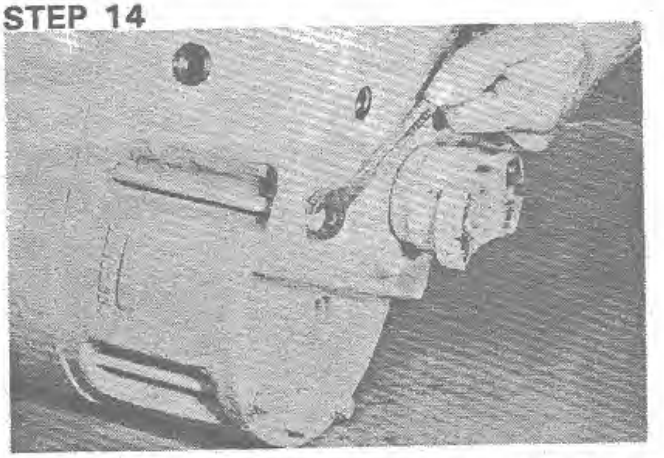
Cover the detent ball opening in transaxle case and drive shift rail from detent section and remove shift rail with steel washer and nylon washers.

STEP 13



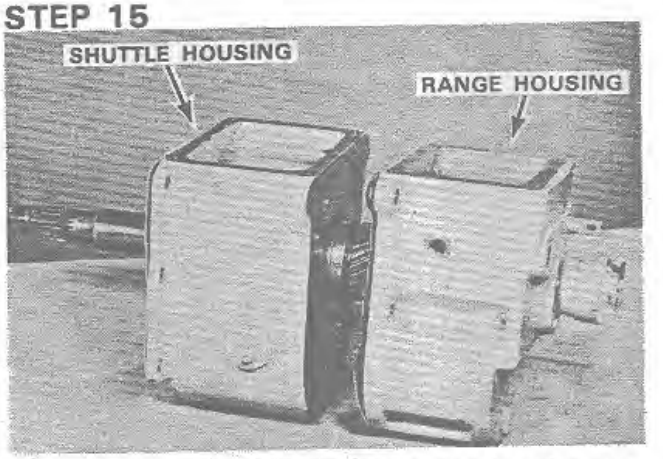
Remove the shuttle shift fork.

STEP 14



Remove the bolts which hold the two housings together.

STEP 15

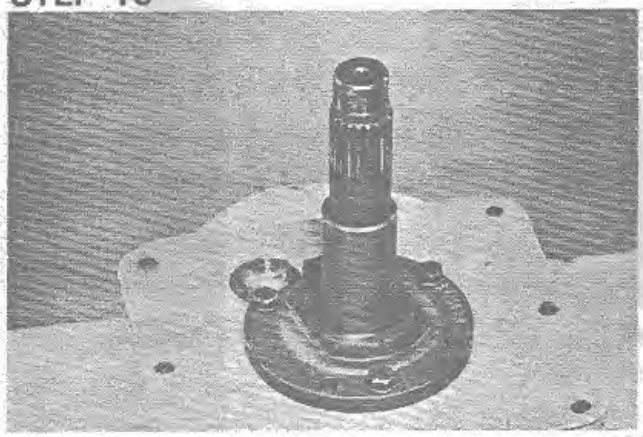


Separate the two housings. To service the mechanical shuttle assembly proceed as follows or proceed to Step 77, Page 22 for servicing the dual range assembly.

Service the Mechanical Shuttle Housing

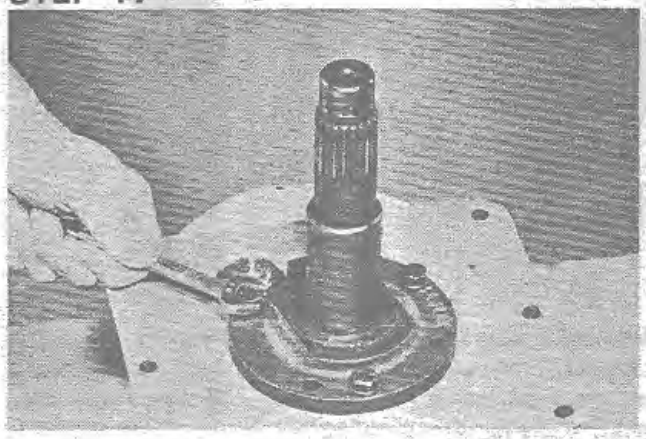
Disassembly

STEP 16



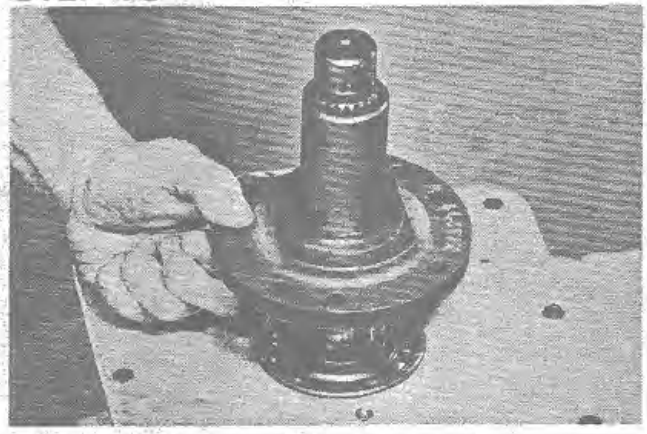
Place the shuttle box on end.

STEP 17



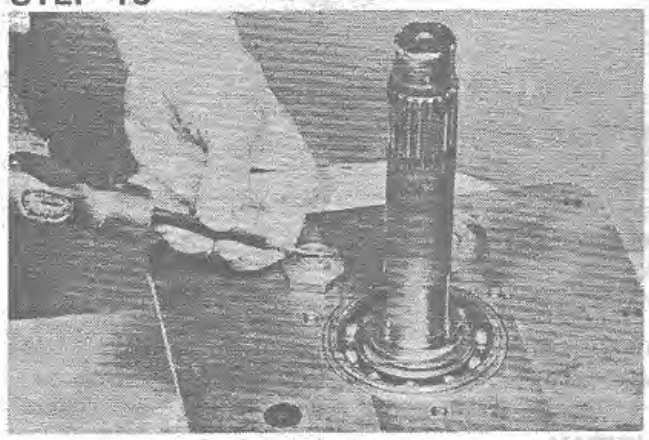
Remove the bolts securing throwout spindle.

STEP 18



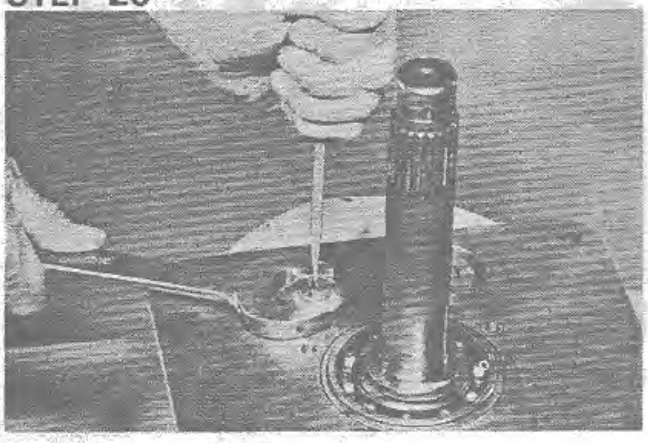
Remove the clutch throwout spindle.

STEP 19



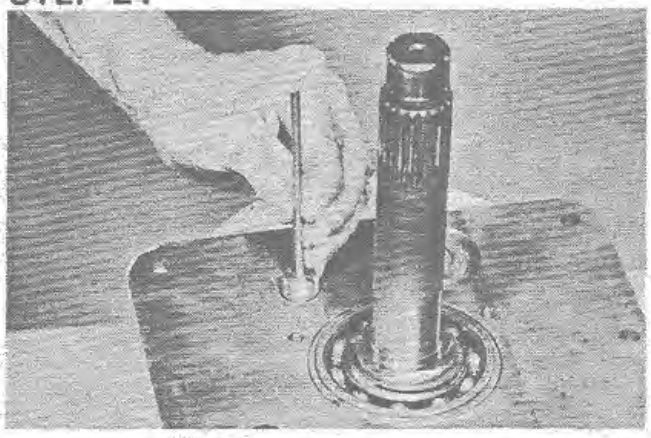
Bend the thin portion of idle shaft locknut back out of the shaft slot.

STEP 20



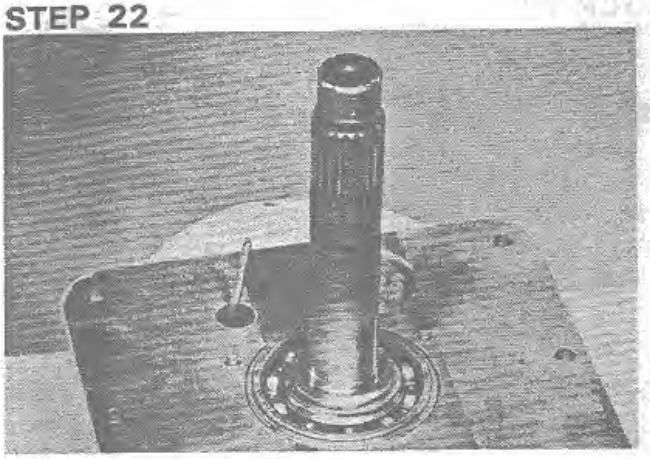
Remove the idle shaft locknut.

STEP 21



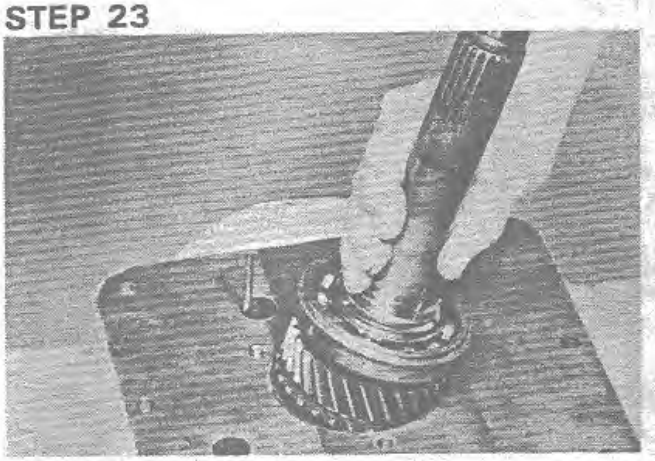
Install a #10-32 x 5" threaded rod in idler shaft end to aid in positioning shaft so that input shaft can be removed.

STEP 22



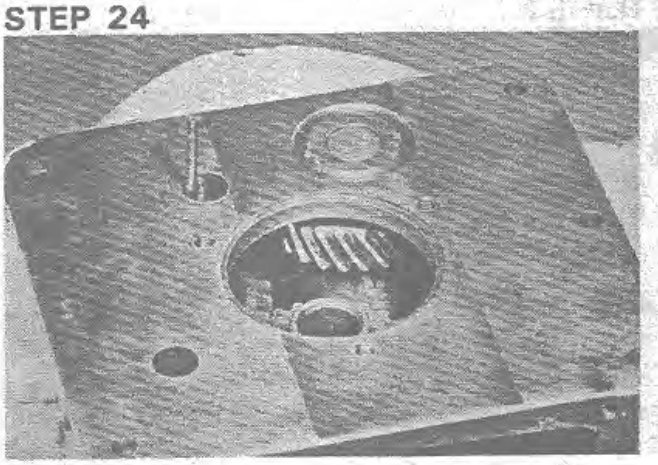
Push idler shaft down into shuttle box.

STEP 23



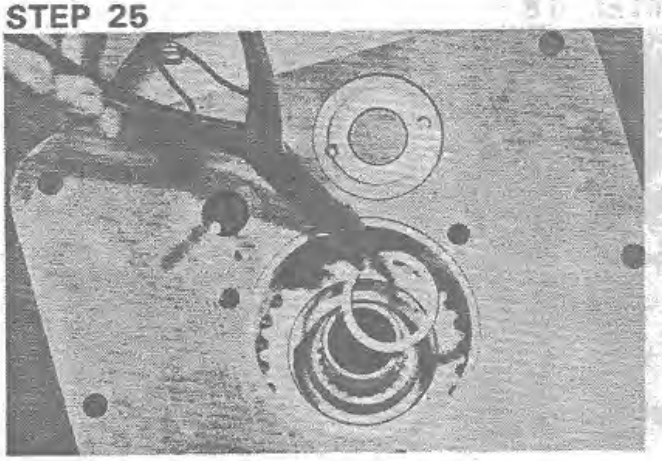
Remove the input shaft assembly.

STEP 24



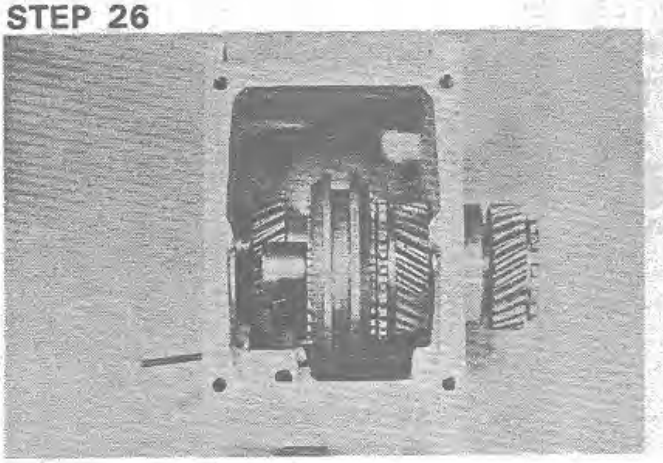
Input shaft removed from shuttle box.

STEP 25



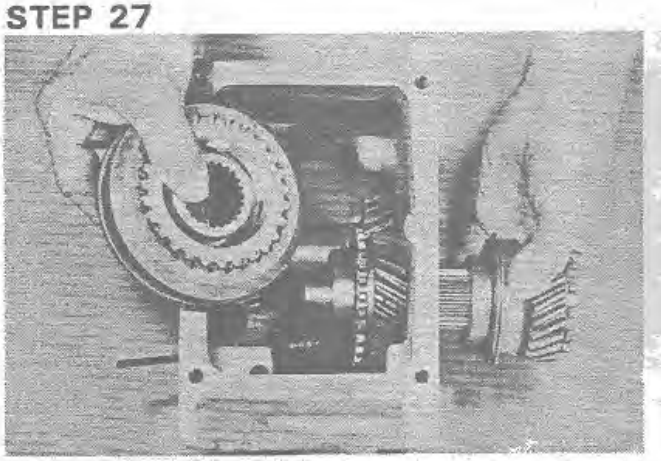
Remove snap ring securing synchronizer and gears to the output shaft.

STEP 26



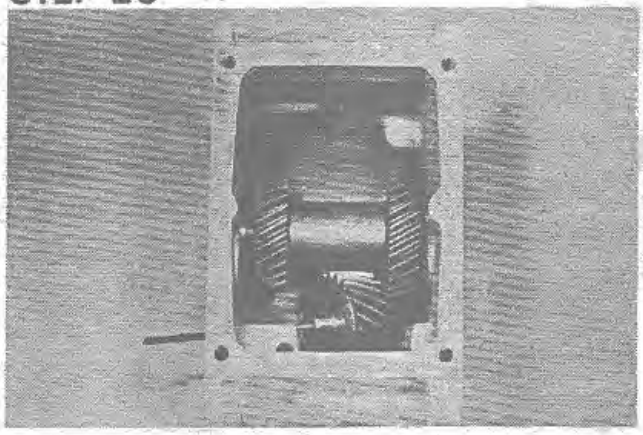
Turn shuttle box up on its bottom or side.

STEP 27



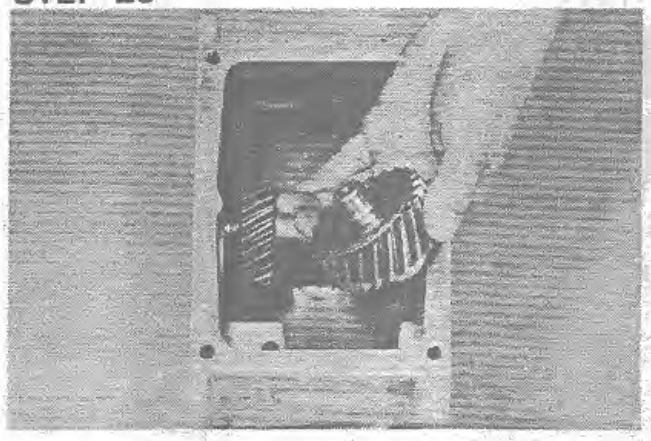
Remove output shaft and gear from shuttle box.

STEP 28



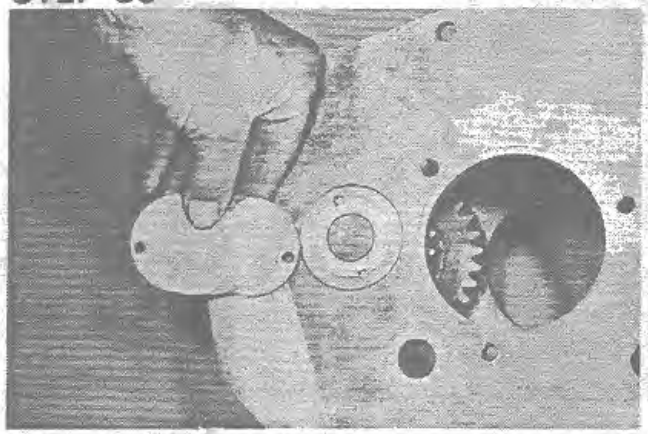
Synchronizer, shuttle gear and output shaft removed from shuttle box.

STEP 29



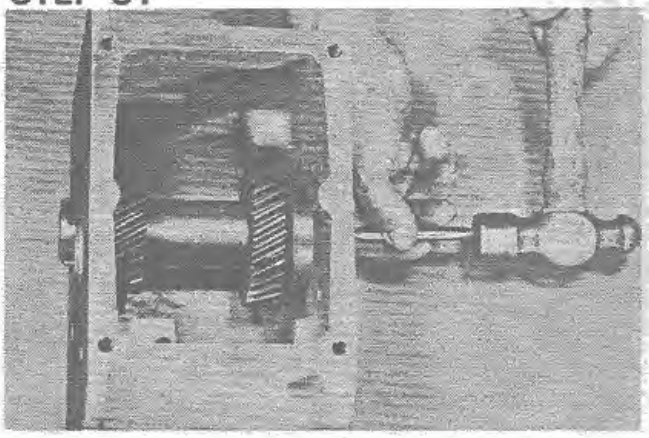
Remove threaded rod from idler shaft and lift out shaft.

STEP 30



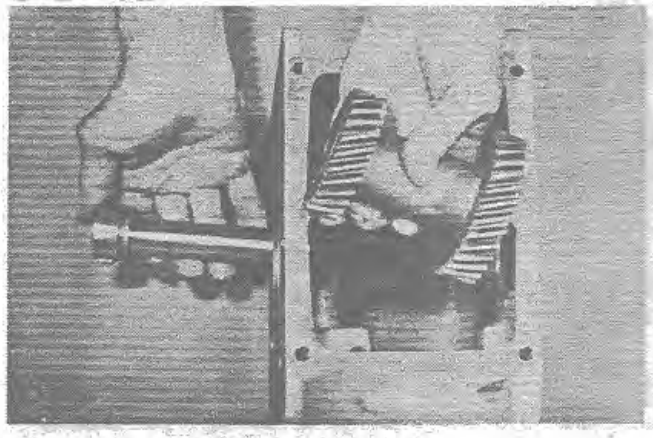
Remove the countershaft collar shims.

STEP 31



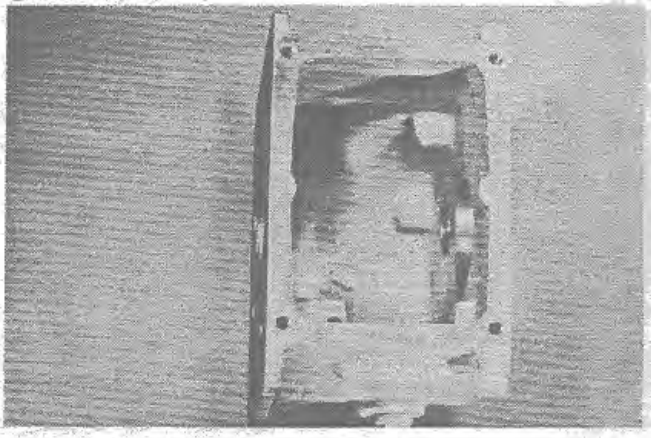
Drive the countershaft from shuttle box.

STEP 32



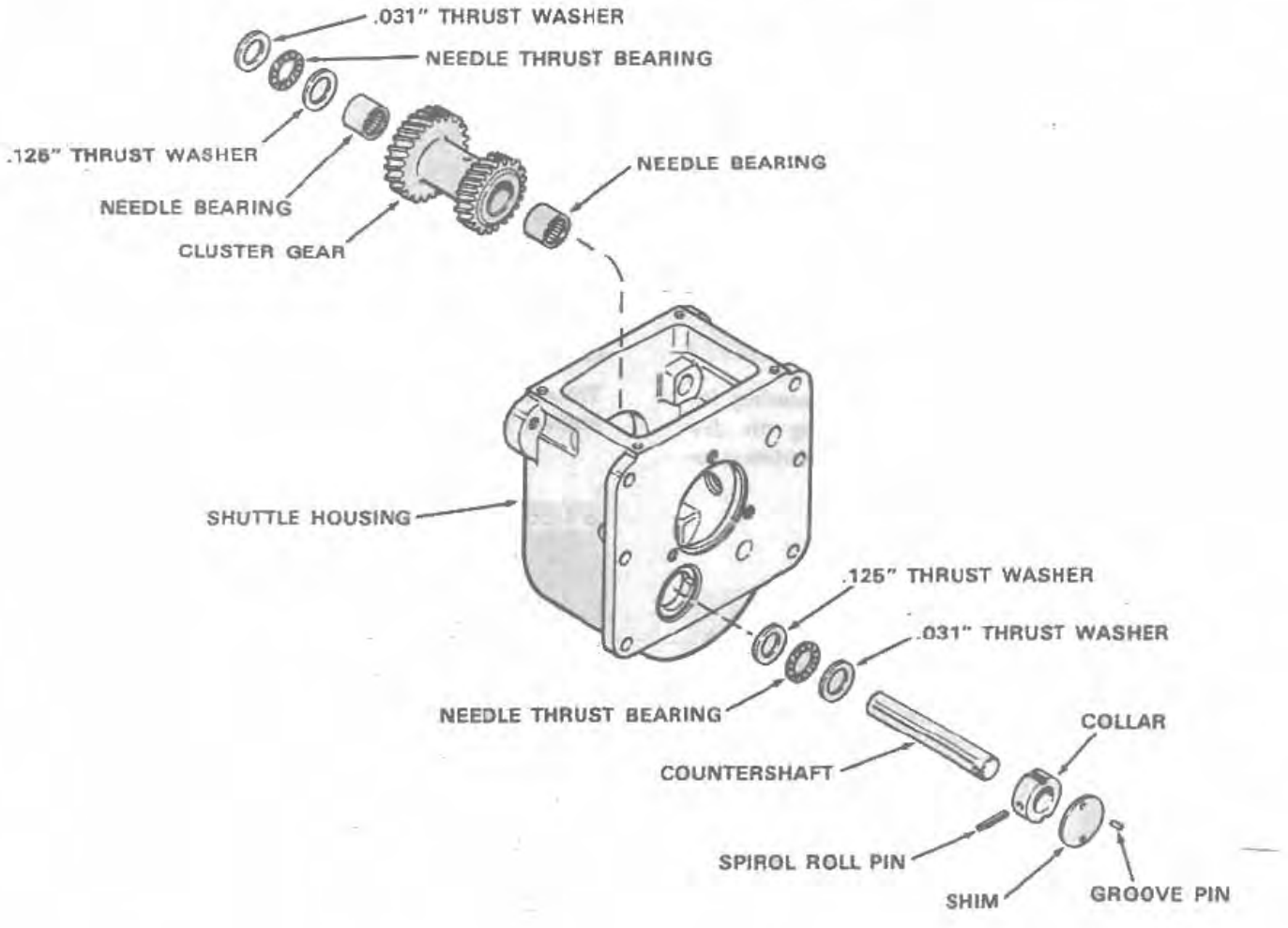
Remove countershaft gear cluster.

STEP 33

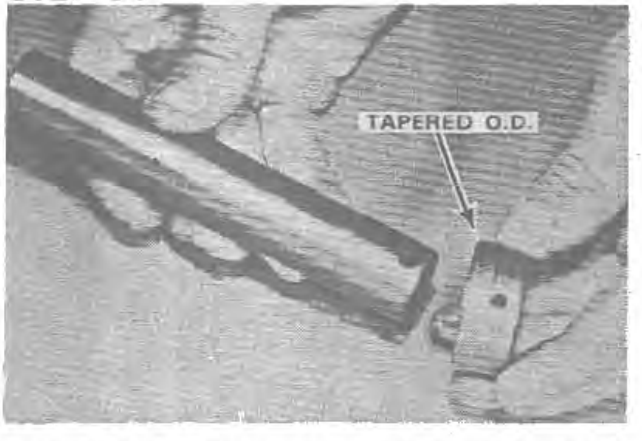


Shuttle box completely disassembled.

Shuttle Countershaft Installation

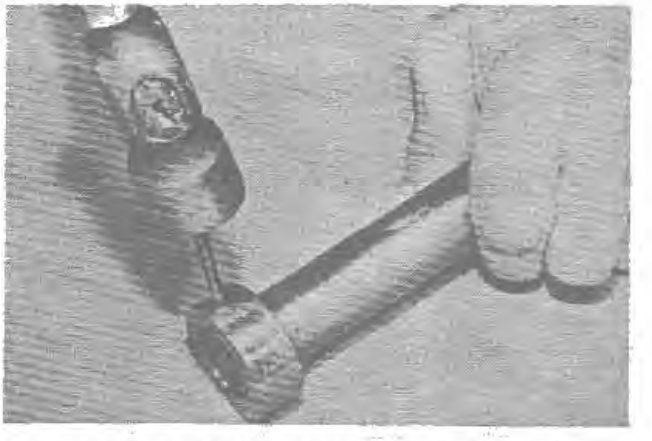


STEP 34



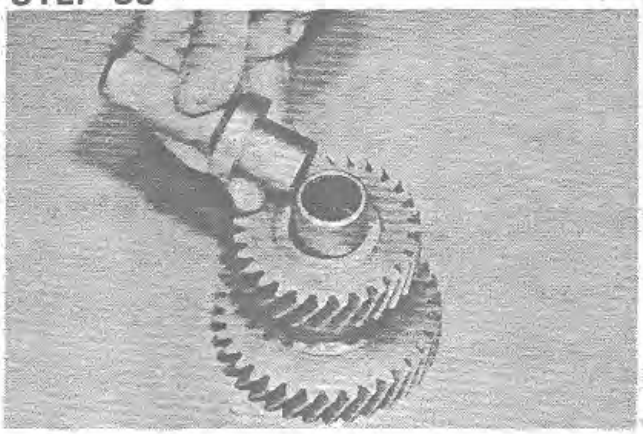
Install collar (tapered O.D. end towards shaft) on countershaft, making sure retaining holes are aligned.

STEP 35



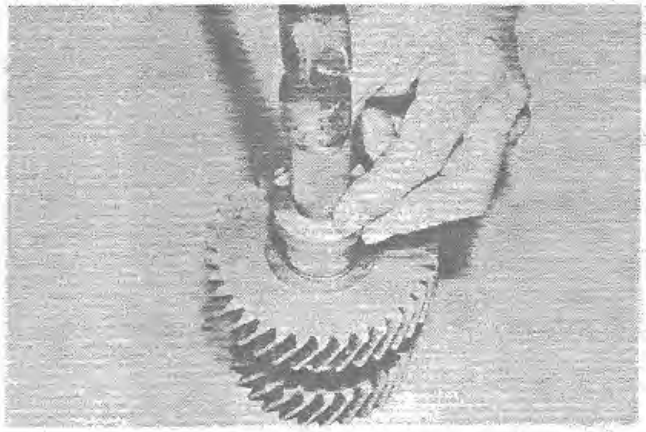
Secure collar to shaft with spirol roll pin.

STEP 36



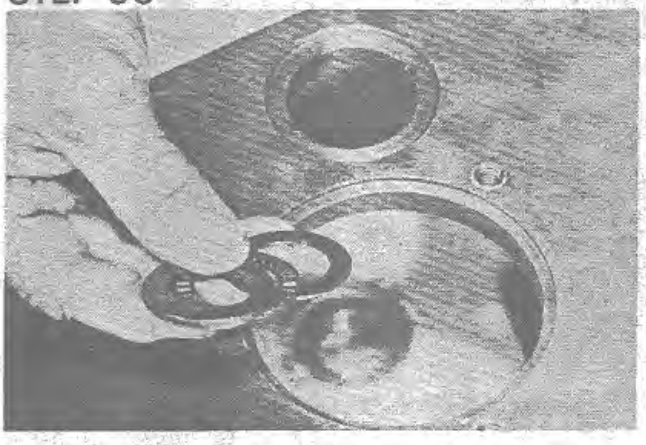
Using G15021 driver, press needle bearing into gear cluster. *NOTE:* Place bearing on driver with stamped end (end with numbers) against stepped shoulder of driver.

STEP 37



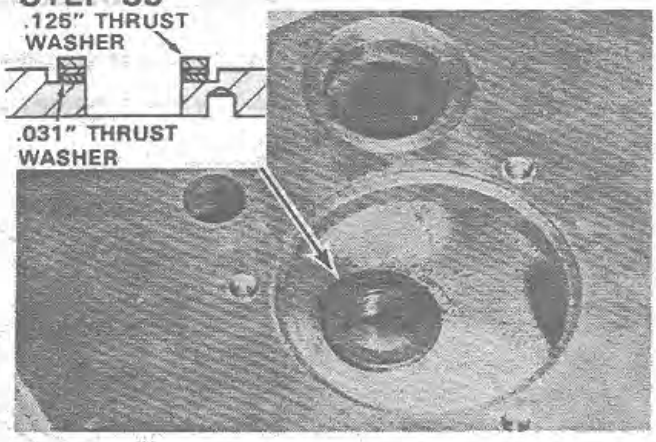
Turn gear cluster over and install a needle bearing in this end also.

STEP 38



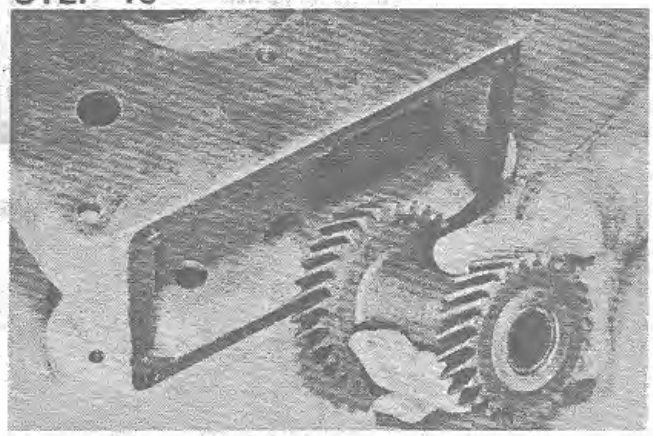
Install a thin (.031") thrust washer, a needle thrust bearing and a thick (.125") thrust washer in case recess. *NOTE:* Thin thrust washer must be installed next to the case.

STEP 39



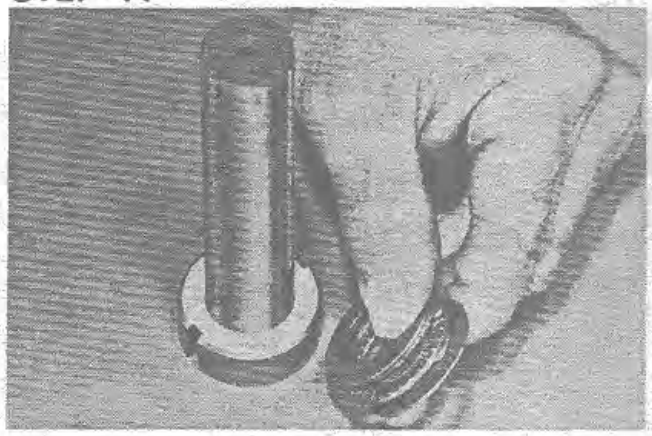
Thrust washers and needle thrust bearing installed in case recess.

STEP 40



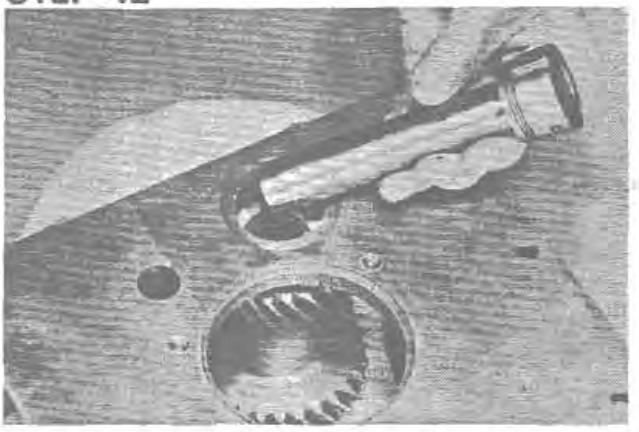
Install gear cluster in shuttle box. *NOTE:* Large gear end on top of thick thrust washer.

STEP 41



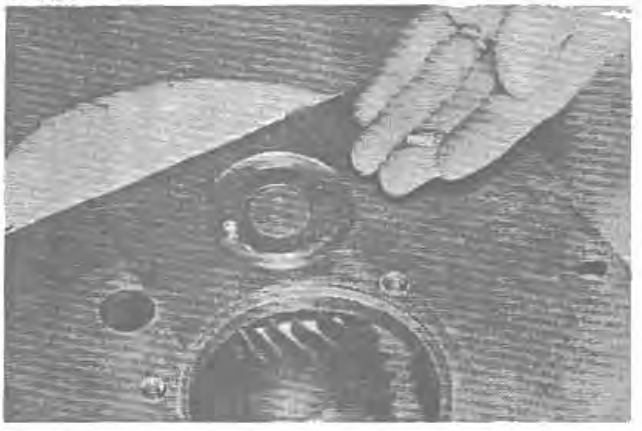
Install a thin (.031") thrust washer, a needle thrust bearing and a thick (.125") thrust washer on countershaft. *IMPORTANT:* The thin (.031") thrust washer must be installed next to the collar.

STEP 42



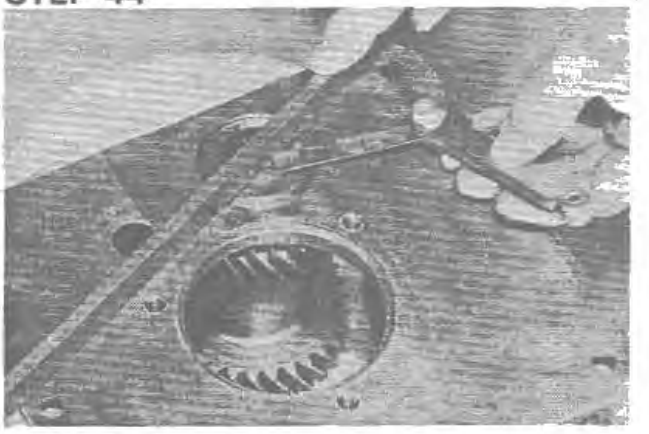
Install countershaft through case opening.

STEP 43



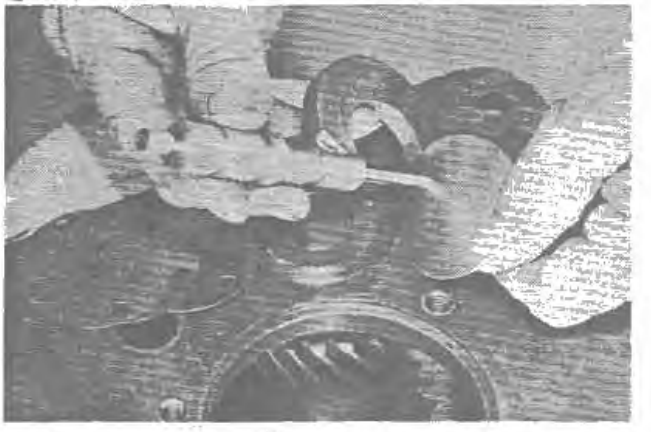
Install two groove pins in collar and case openings. Tap pins down into place until they are flush with collar.

STEP 44

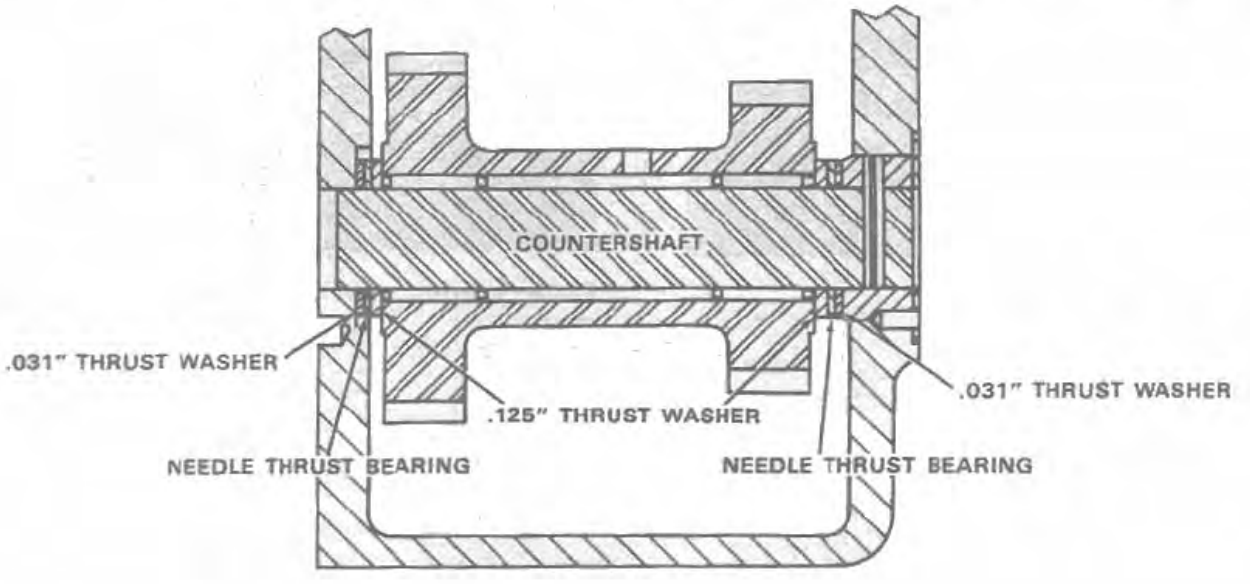


Check shaft end play by using a straight edge and feeler gauge. Measure the distance between straight edge and countershaft collar.

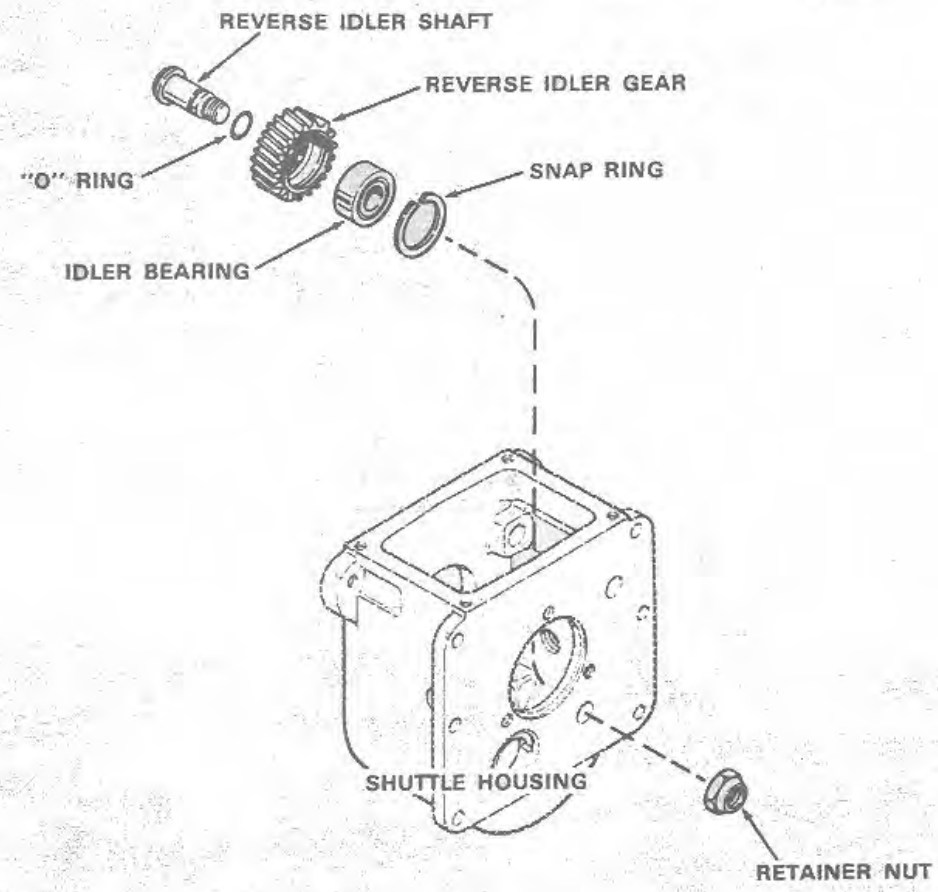
STEP 45



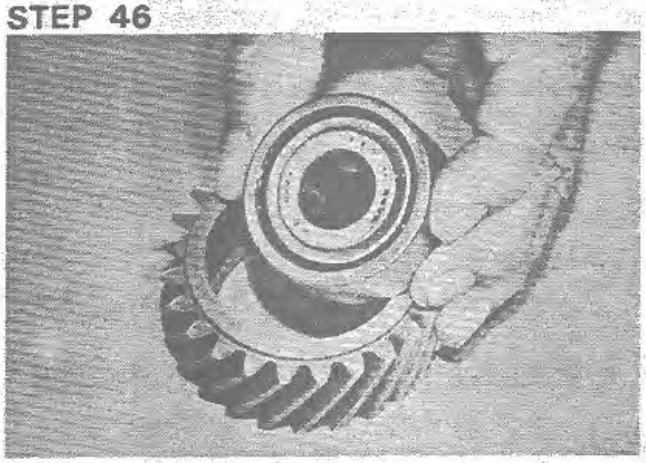
From feeler gauge reading, Step 44, subtract .004 to .009" and provide a shim pack guard to the remainder of feeler gauge reading.



Reverse Idler Shaft Installation

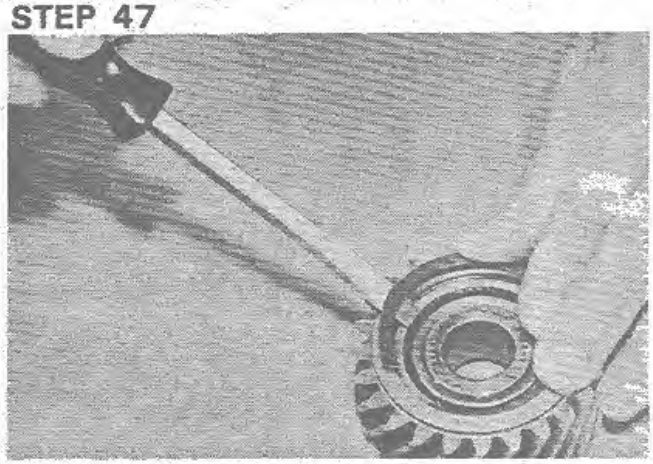


STEP 46



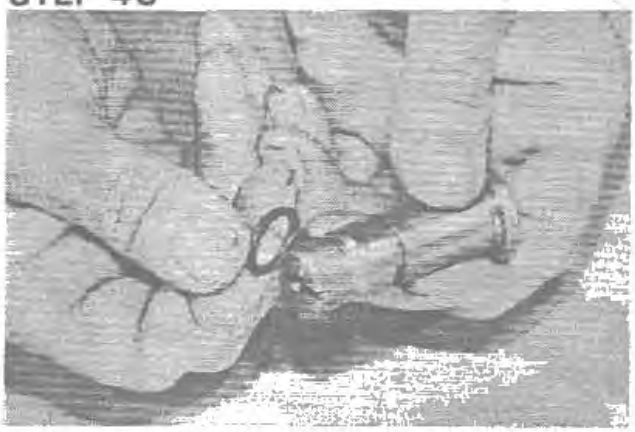
Place bearing in idler gear.

STEP 47



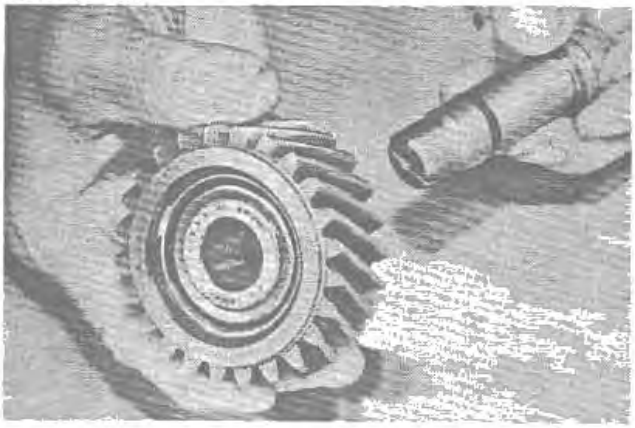
Place bearing retainer snap ring in gear recess.

STEP 48



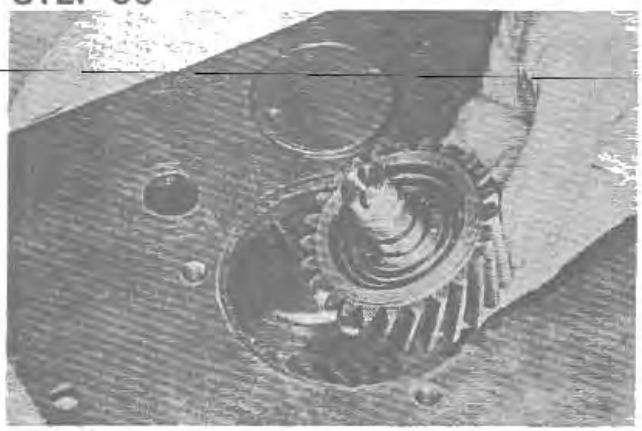
Install a new "O" ring on idler gear shaft. Coat "O" ring and shaft with a thin film of TCH oil.

STEP 49



Place idler gear on shaft. *NOTE:* Snap ring side of gear must be towards threaded shaft end.

STEP 50

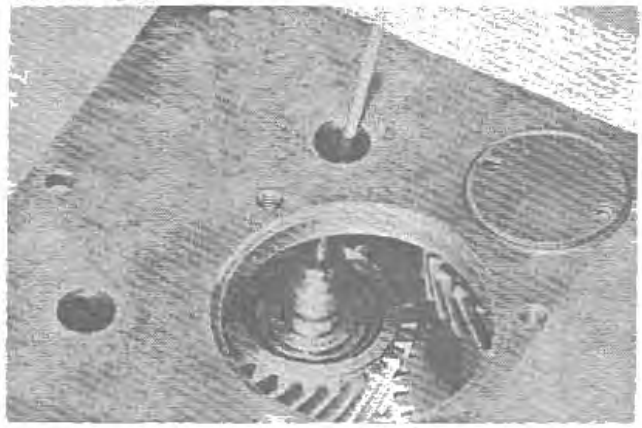


Place idler gear and shaft in shuttle box.

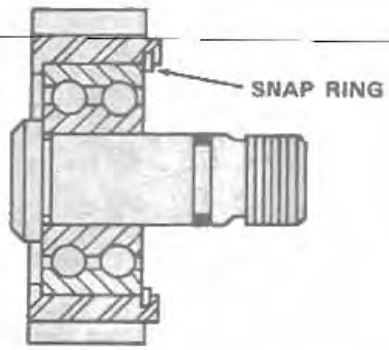
STEP 51

Install a #10-32 x 5" threaded rod in shaft end.

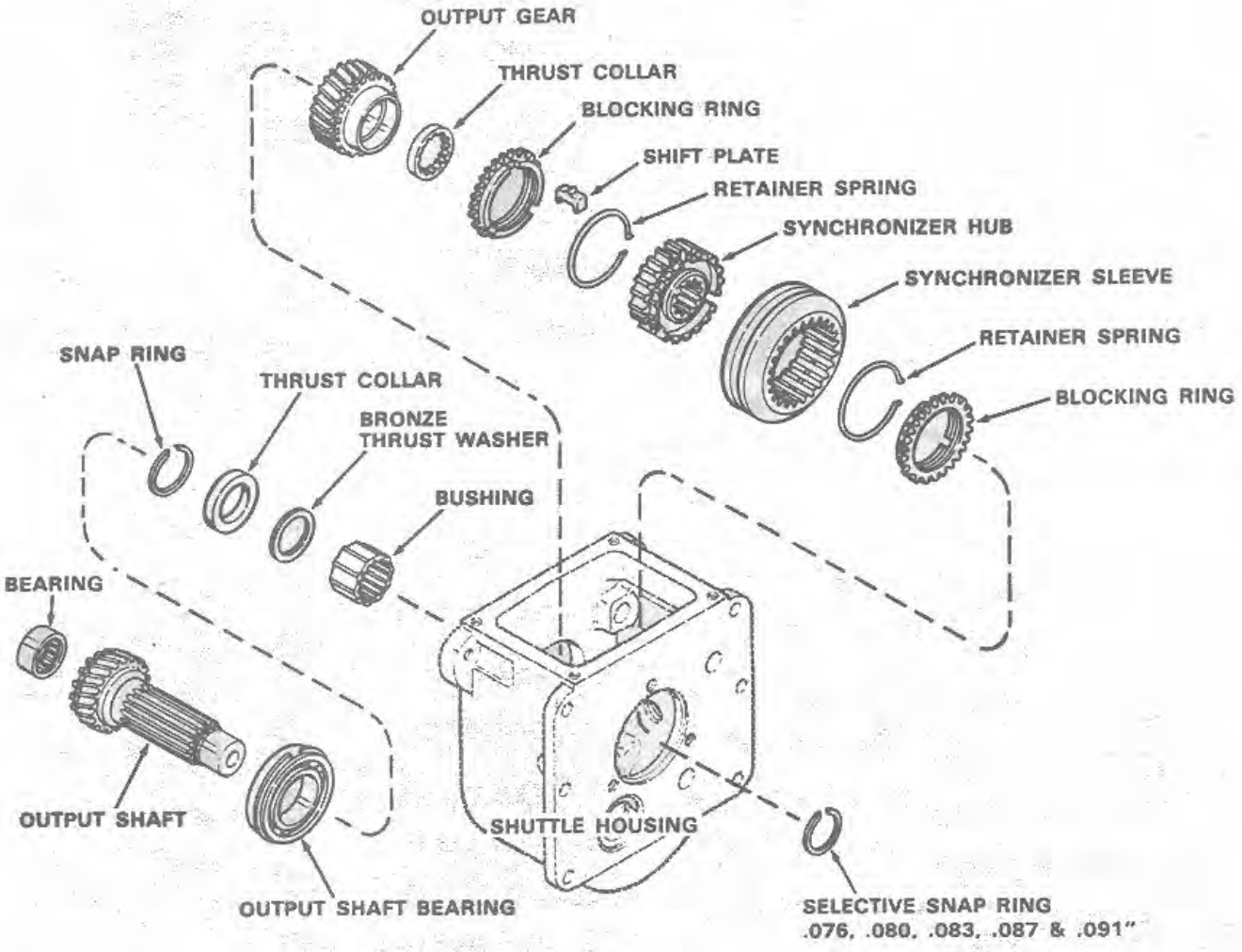
STEP 52



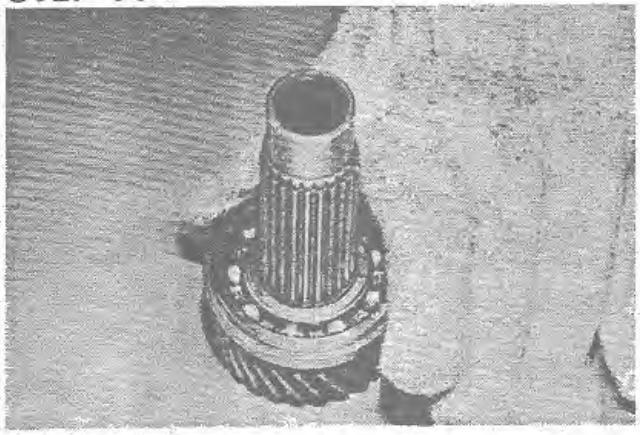
Position idler gear down and to one side of housing. This will allow room for input shaft installation.



Output Shaft Installation

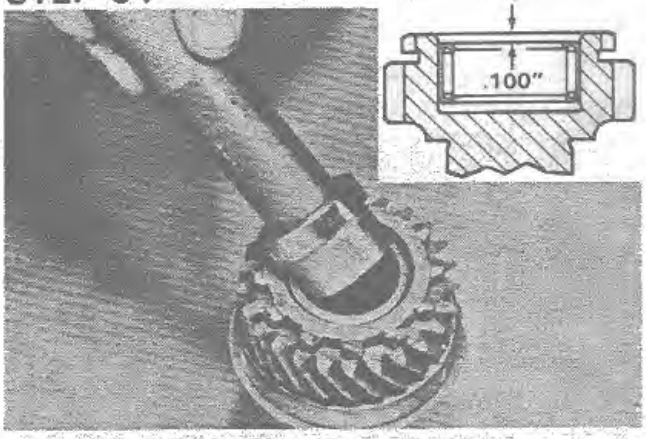


STEP 53



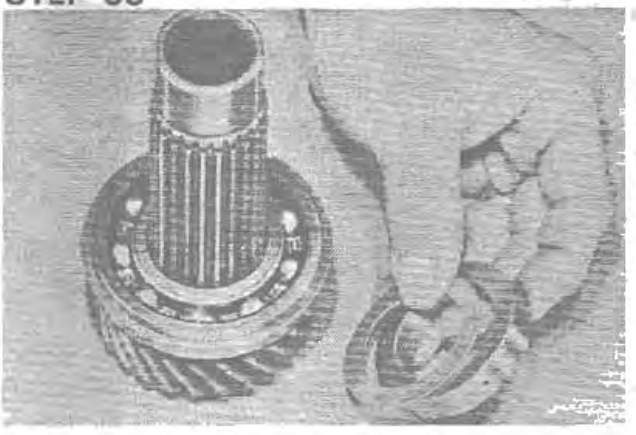
Heat bearing on a bearing heater and install on output shaft. *NOTE:* Snap ring end of bearing must be up.

STEP 54



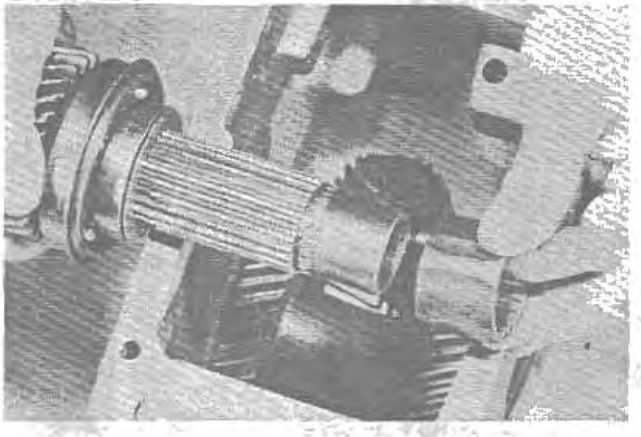
Turn range input shaft over and install needle bearing in shaft bore. *NOTE:* Press needle bearing to a depth of .100" below gear end face. Press on stamped end (end with numbers) when installing needle bearing.

STEP 55



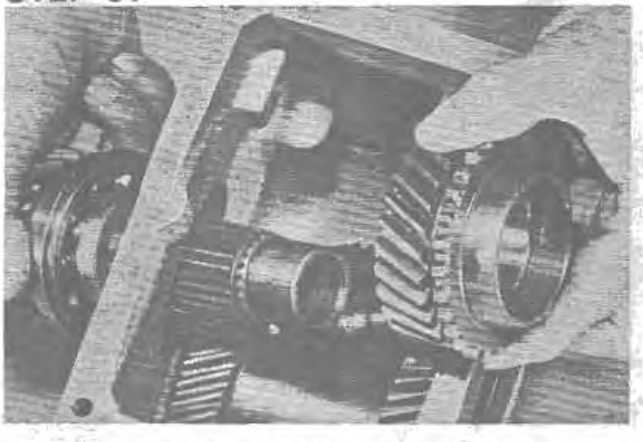
Install thrust collar and bronze washer on output shaft. *NOTE:* Thrust collar must be installed next to bearing.

STEP 56



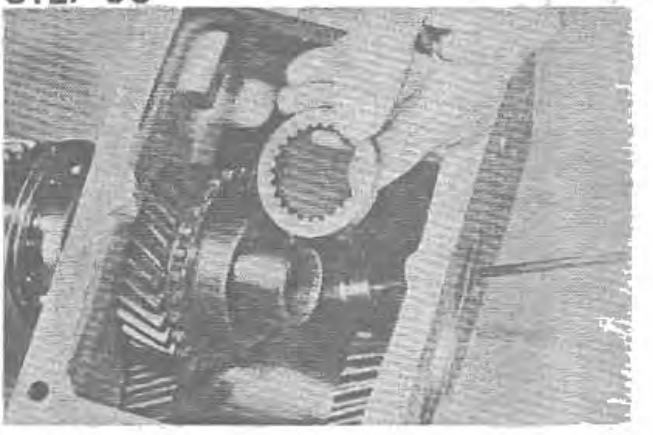
Slide output gear bushing on shaft.

STEP 57



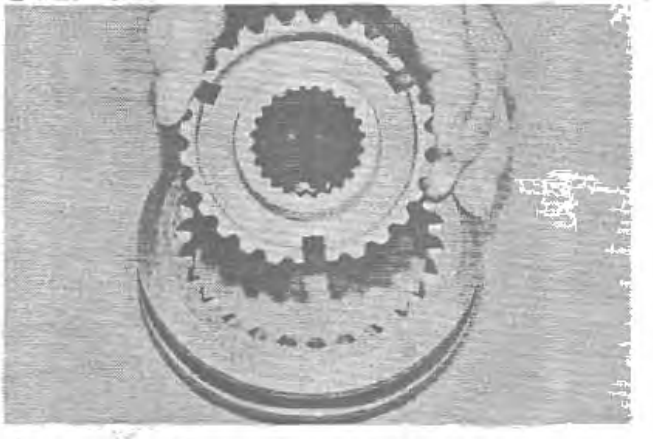
Start the output shaft into shuttle housing and install output gear on shaft.

STEP 58



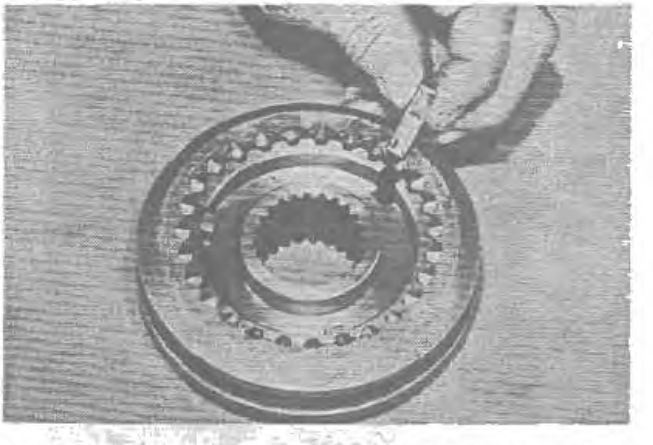
Install the splined thrust collar on output shaft.

STEP 59



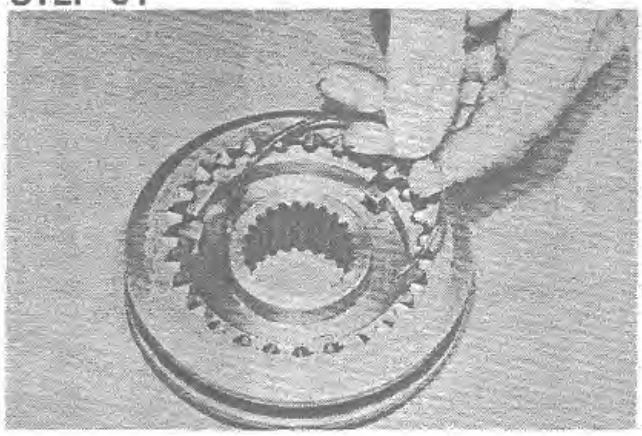
Place synchronizer sleeve inside of hub.

STEP 60



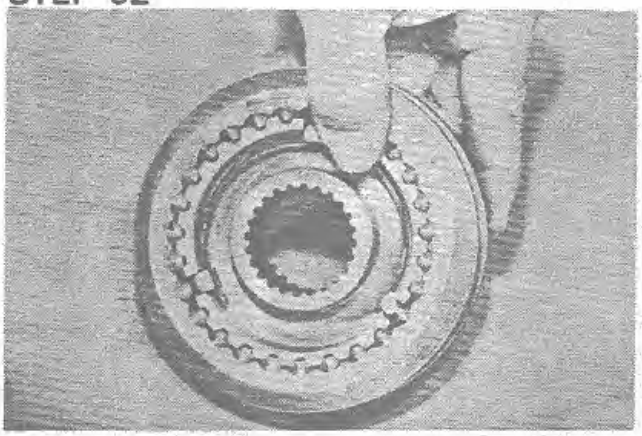
Install the three shifter plates in synchronizer sleeve grooves.

STEP 61



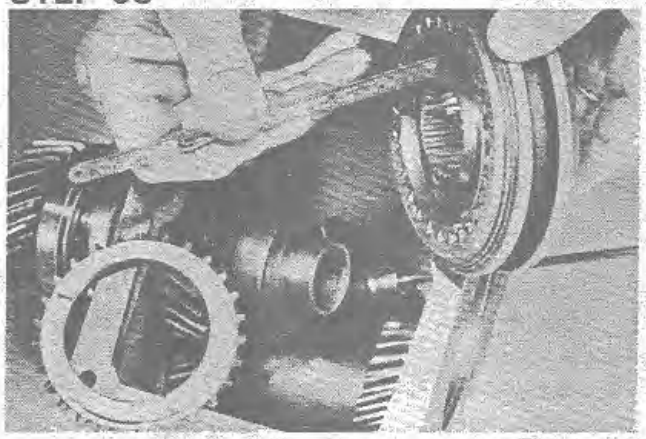
Retain the shifter plates in place with one retainer spring.

STEP 62



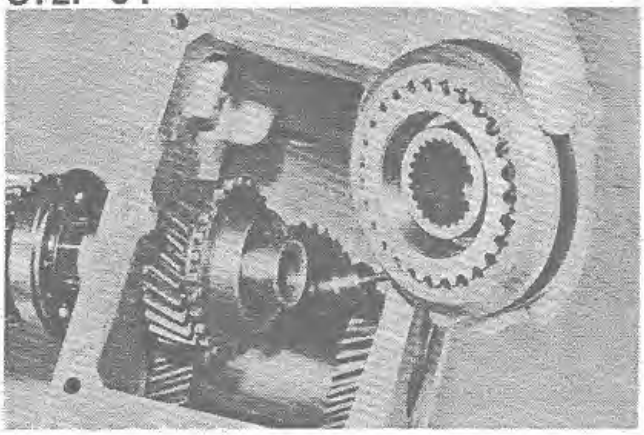
Turn the synchronizer hub and sleeve over and install the other retainer spring.

STEP 63



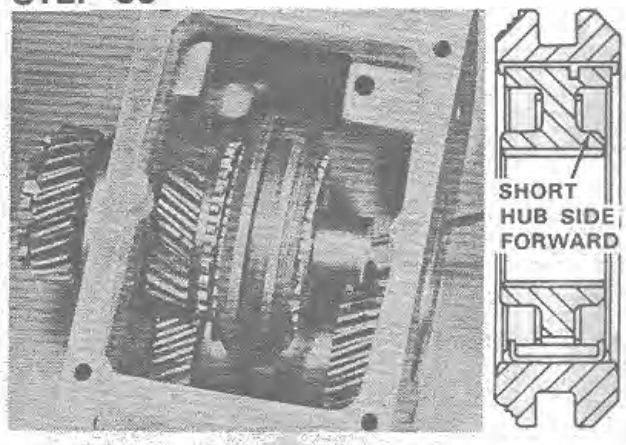
Measure synchronizer sleeve hub length noting which side has short hub length and place blocking rings on synchronizer hub.

STEP 64



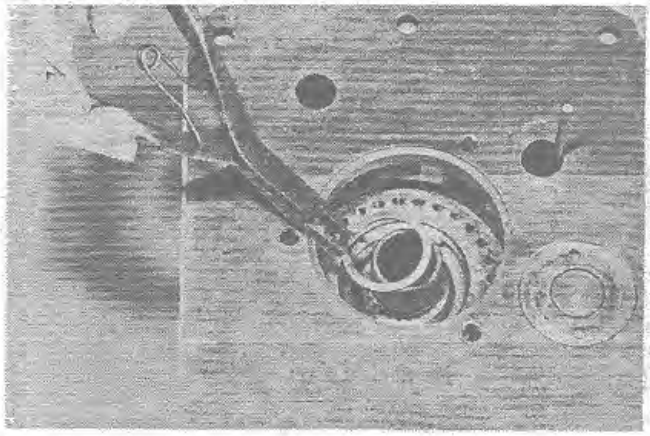
Install synchronizer assembly on shuttle output shaft.

STEP 65



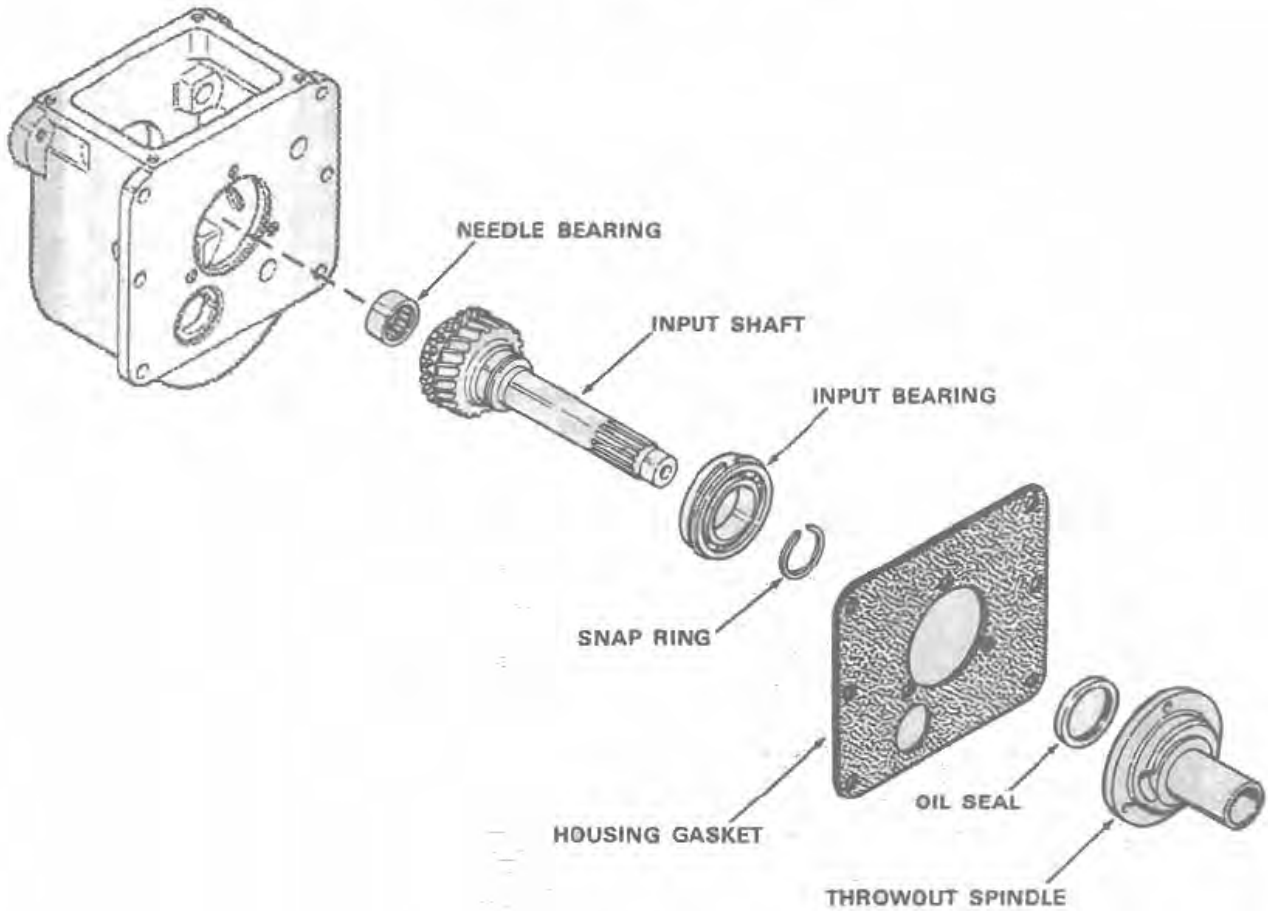
IMPORTANT: Short sleeve hub side of synchronizer must face forward, see Step 63.

STEP 66

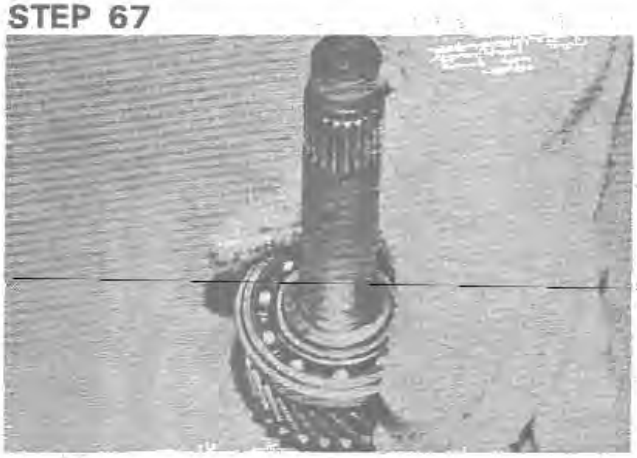


Install synchronizer and shaft retaining snap ring. *NOTE:* Snap ring is provided in .076" .080", .083", .087" and .091" thickness, install snap ring that will provide a minimum amount of synchronizer end play.

Input Shaft Installation

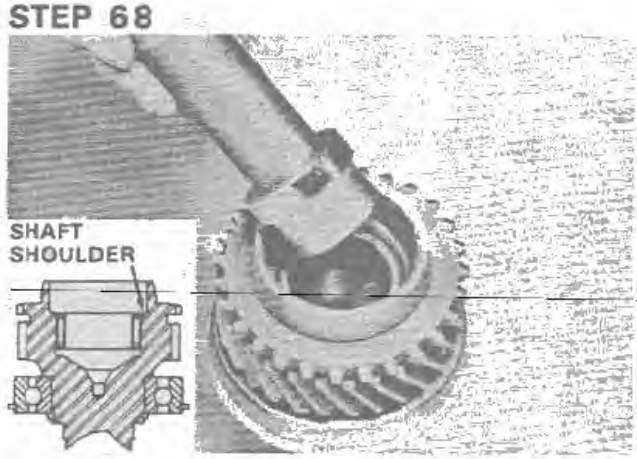


STEP 67



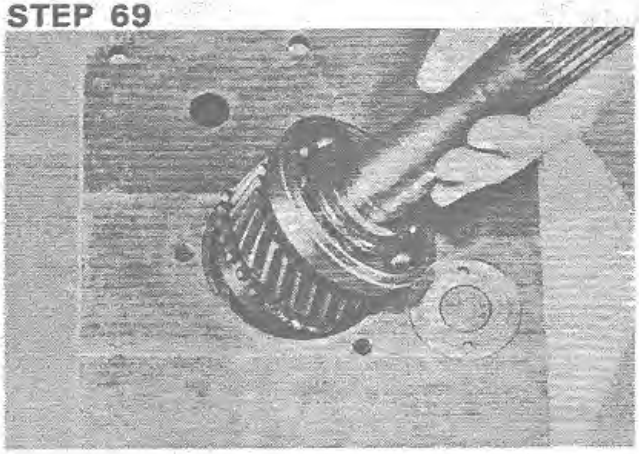
Heat bearing on a bearing heater. Install bearing on input shaft and retain in place with snap ring. *NOTE:* Snap ring end of bearing must be up.

STEP 68



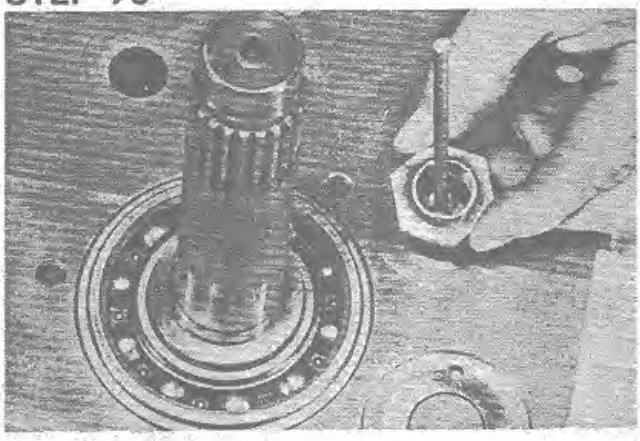
Press needle bearing into input shaft until bearing is even with shaft shoulder. *NOTE:* Press on stamped end (end with number) when installing needle bearing.

STEP 69



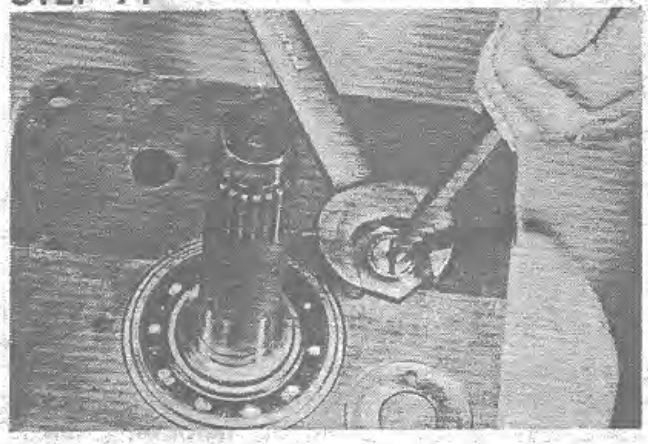
Install input shaft in shuttle housing opening.

STEP 70



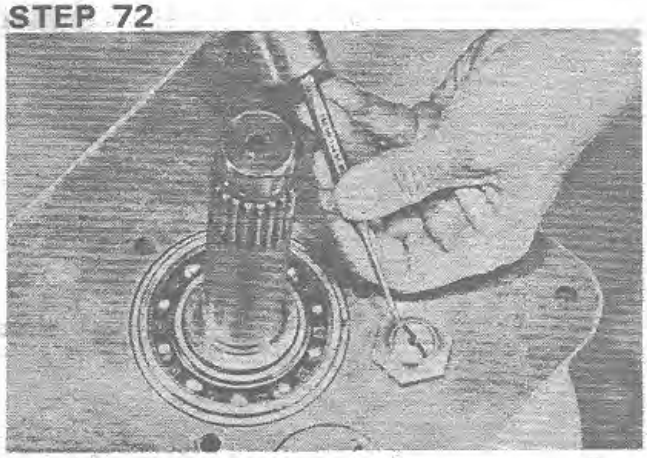
Raise and pull reverse idler gear and shaft into position. Install shaft retaining locknut.

STEP 71



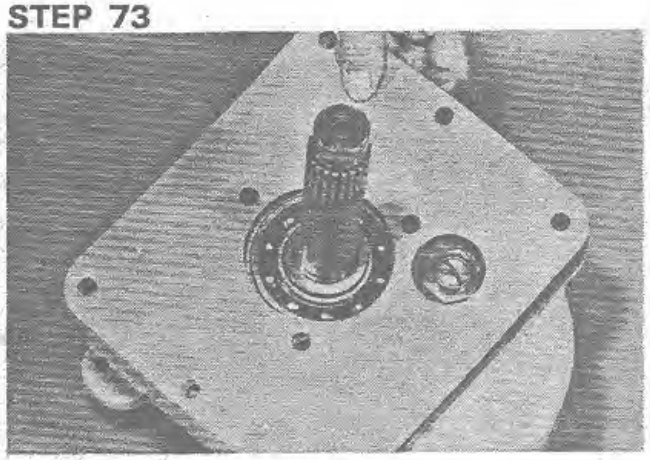
Remove threaded rod and tighten locknut securely.

STEP 72



Stake the thin portion of locknut into shaft slot.

STEP 73

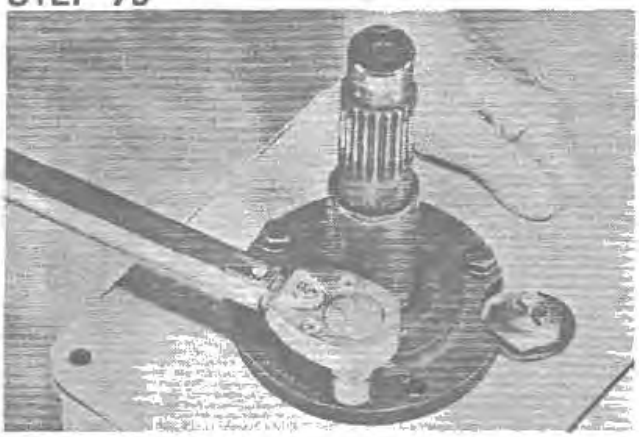


Install a new housing gasket.

STEP 74

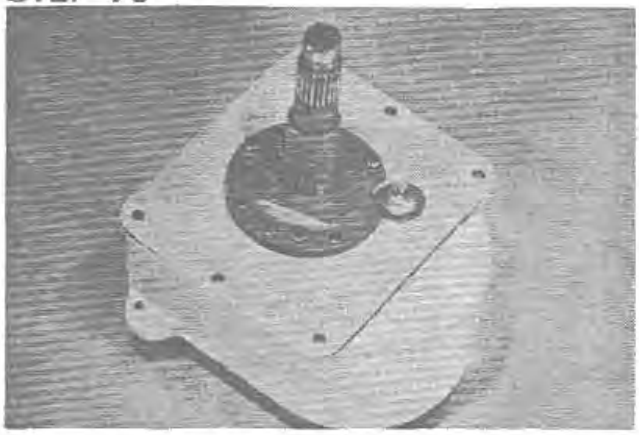
Press a new oil seal in clutch throwout spindle until it bottoms.

STEP 75

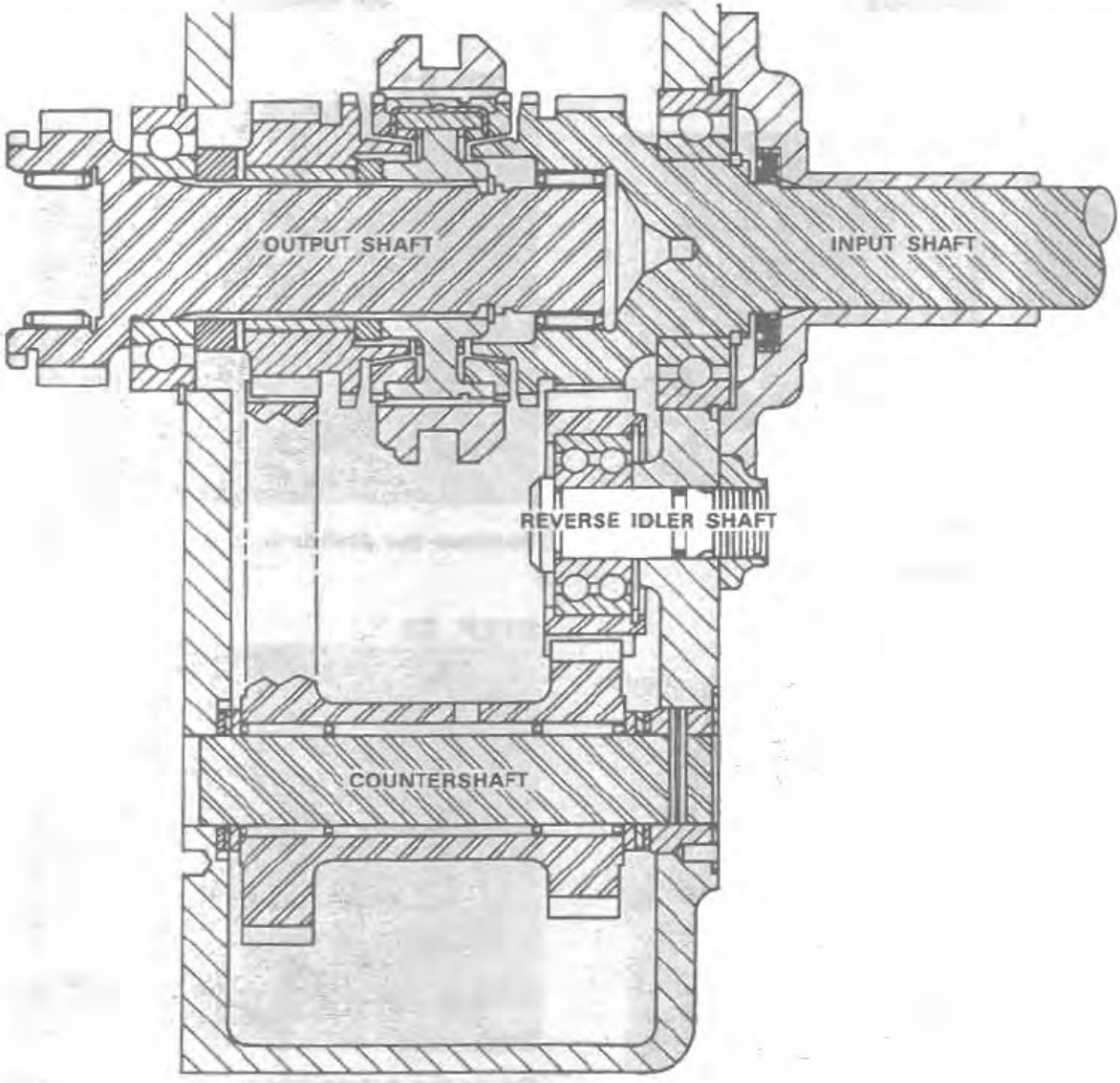


Install the clutch throwout spindle and torque spindle retaining bolts 35 to 42 ft. lbs.

STEP 76



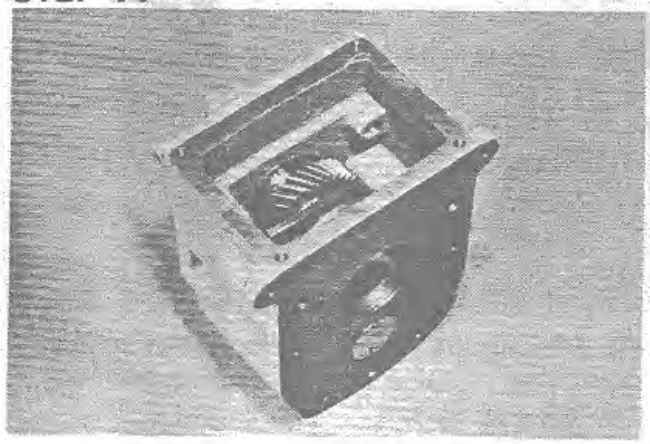
Shuttle housing assembled, see Step 131, Page 34 for joining to range housing and installation of shift rail and fork.



Servicing the Dual Range Housing

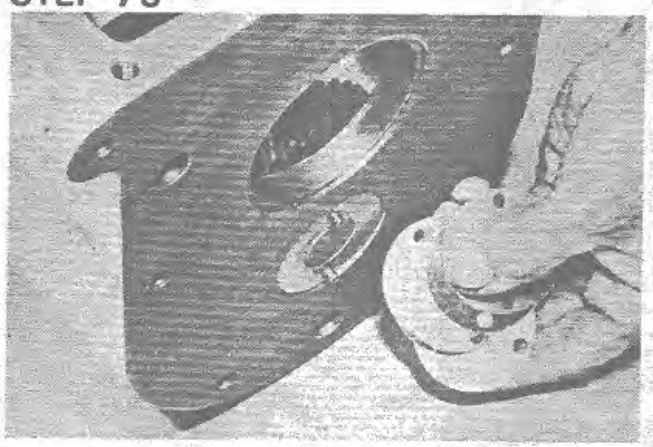
Disassembly

STEP 77



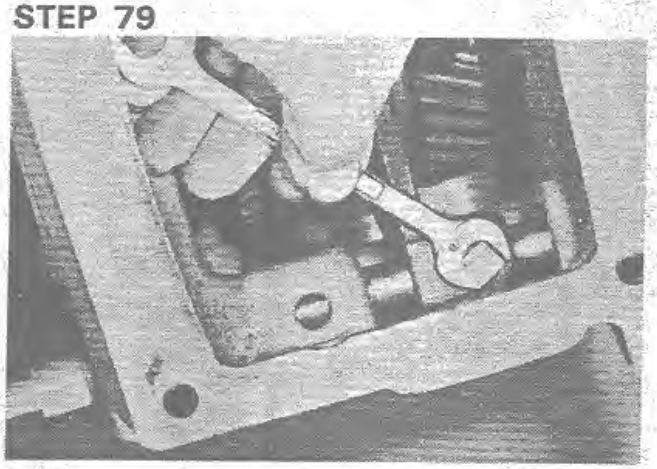
Place the dual range housing on a suitable work surface.

STEP 78



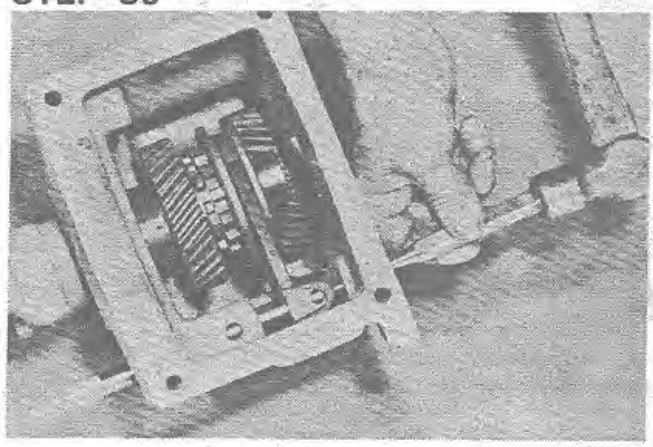
Remove the countershaft shims.

STEP 79



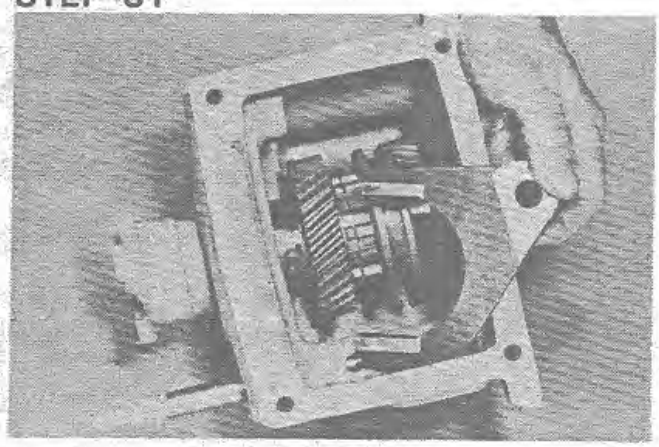
Remove shifter fork retaining set screw.

STEP 80



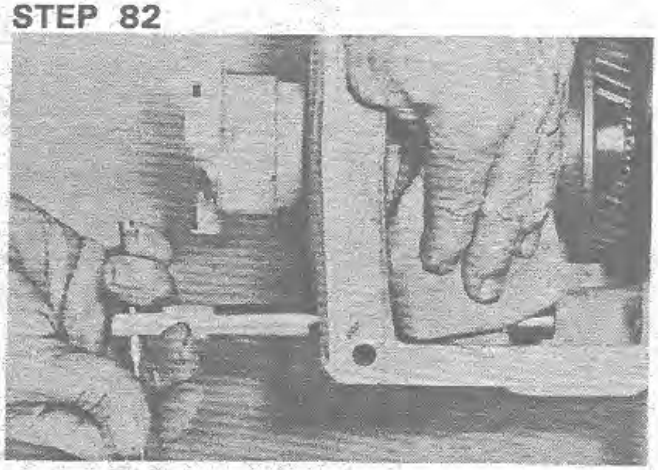
Drive shift rail through shifter fork.

STEP 81



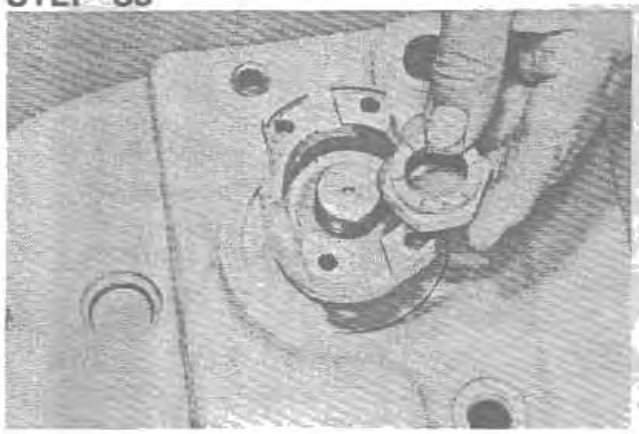
Remove the shifter fork from range housing.

STEP 82



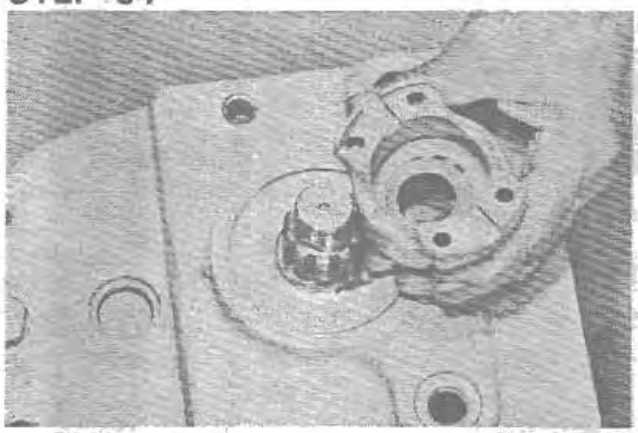
Cover the detent opening when removing shift rail, this will prevent the possibility of detent ball dislodging and sending cup plug flying.

STEP 83



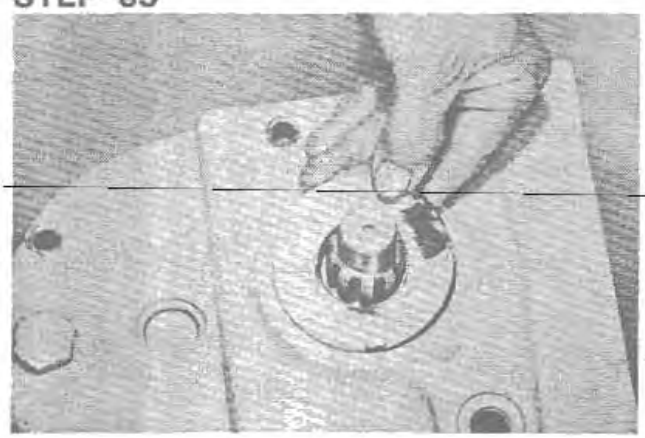
Remove the output shaft yoke retaining nut.

STEP 84



Remove the output yoke and hardened washer.

STEP 85

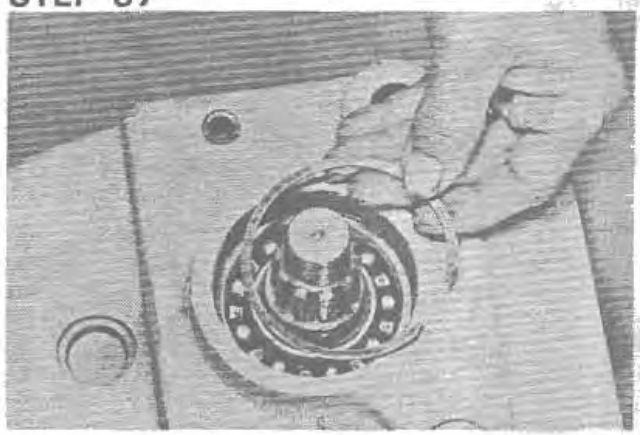


Remove dust cover and oil seal assembly.

STEP 86

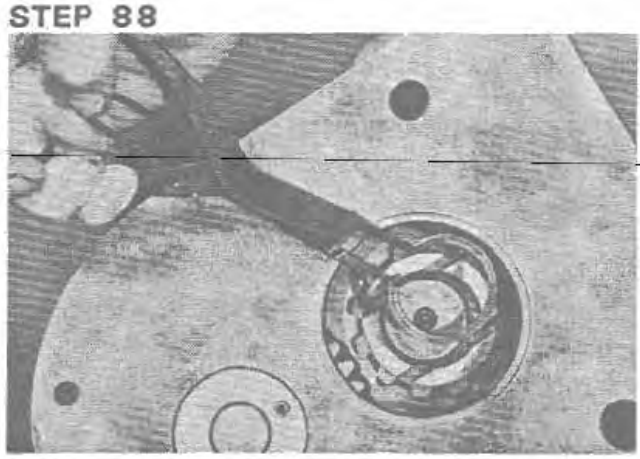
Dust cover and oil seal assembly removed from output shaft.

STEP 87



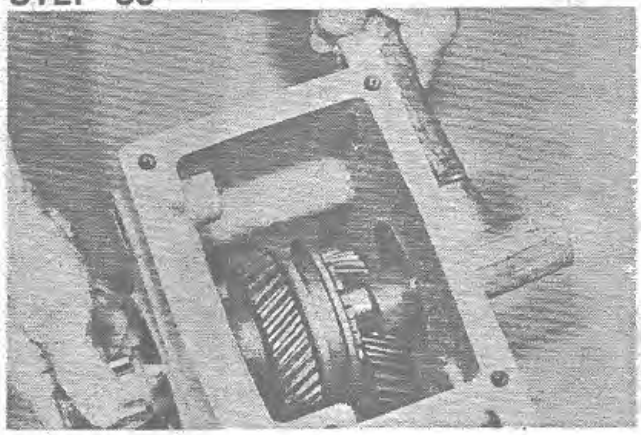
Remove the large snap ring retaining bearing to range housing.

STEP 88



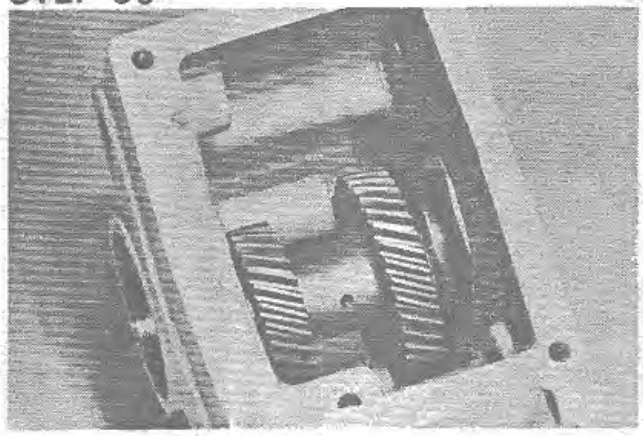
Turn the range housing over and remove the shaft gear retaining snap ring.

STEP 89



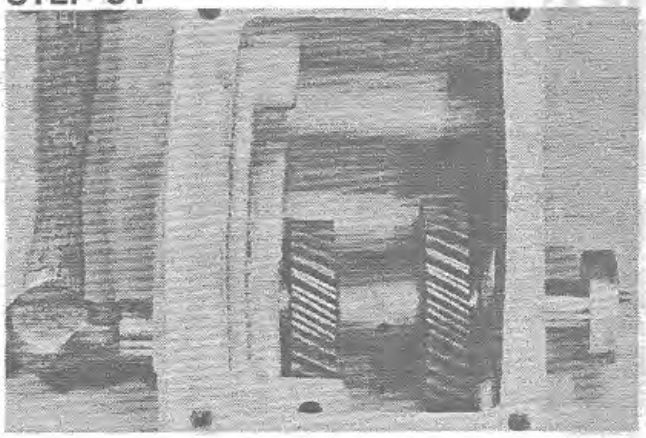
Remove the output shaft and gears from range housing.

STEP 90



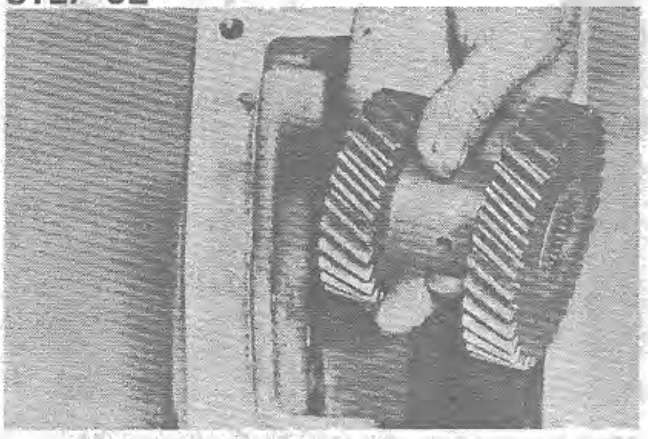
Output shaft and gears removed from dual range housing.

STEP 91



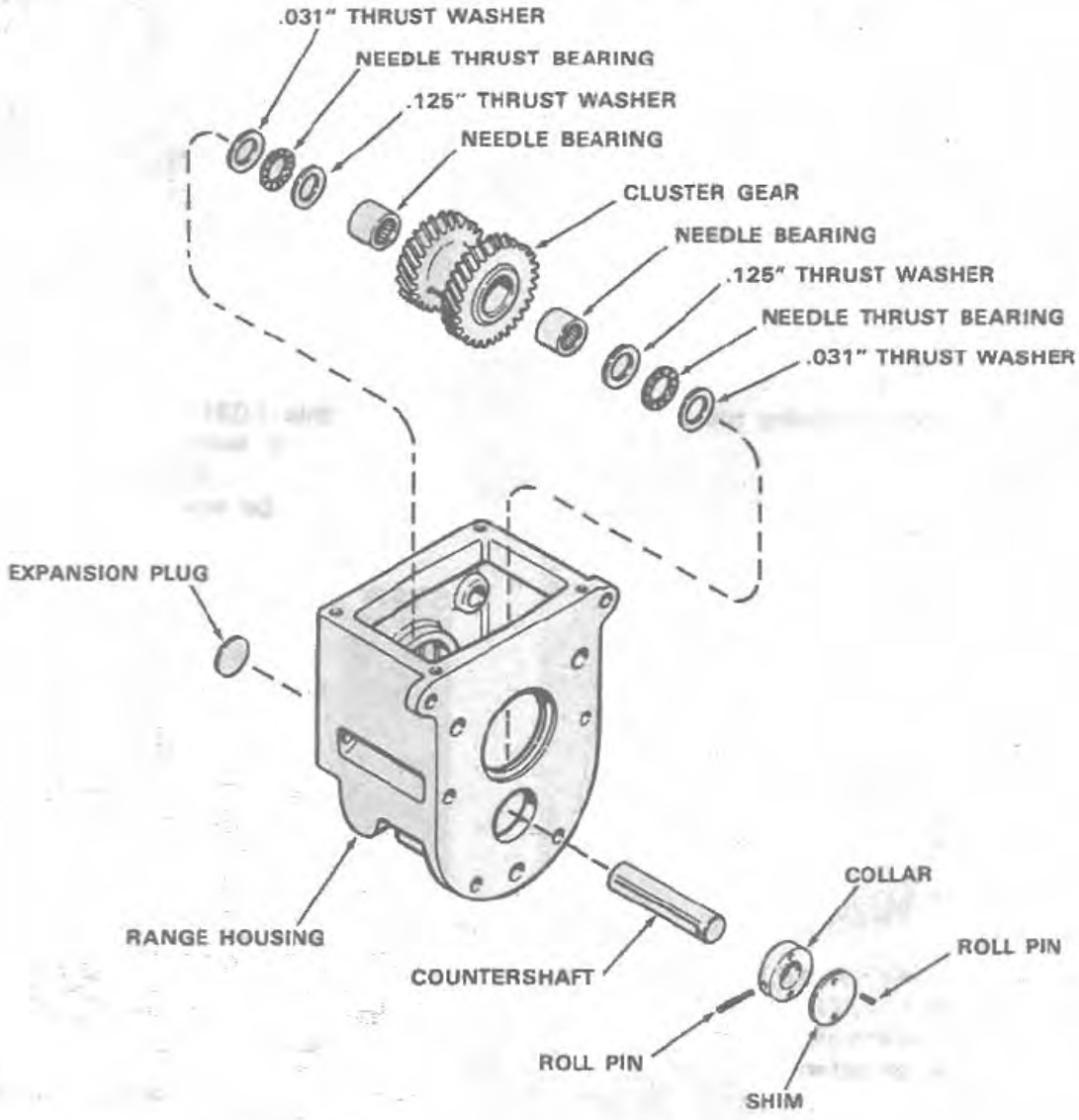
Remove expansion plug and drive countershaft from housing.

STEP 92

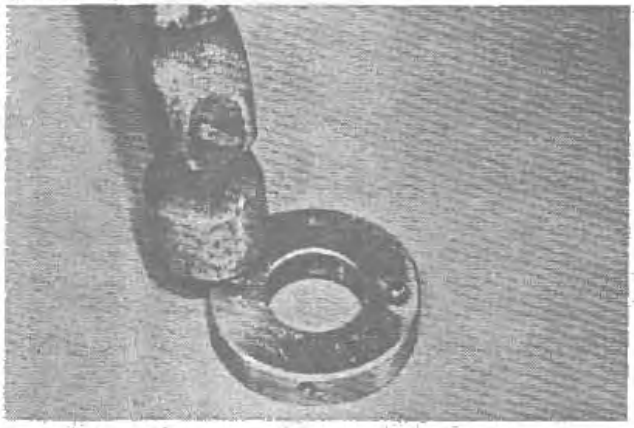


Remove the countershaft gear cluster.

Countershaft Assembly and Installation

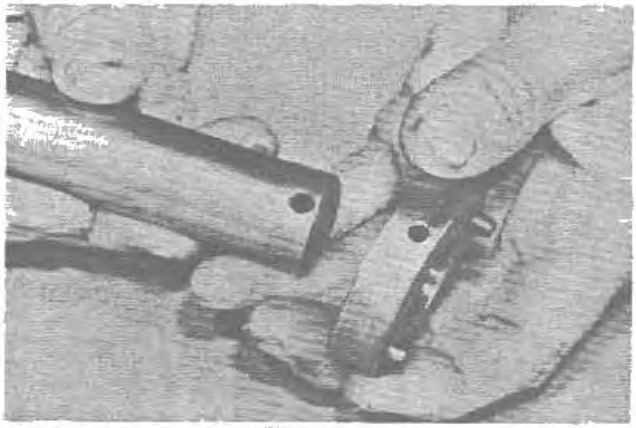


STEP 93



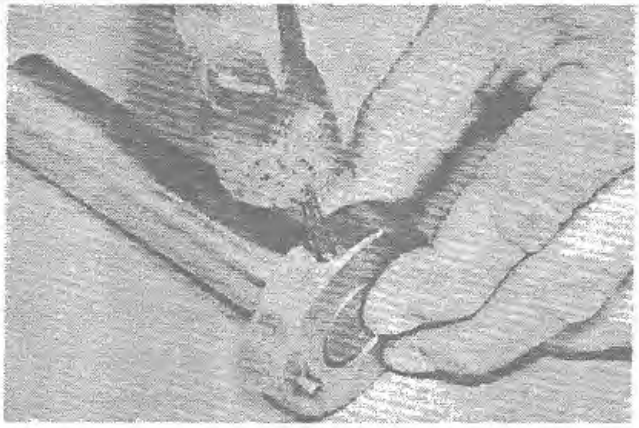
Tap roll pin into countershaft collar until they bottom.

STEP 94



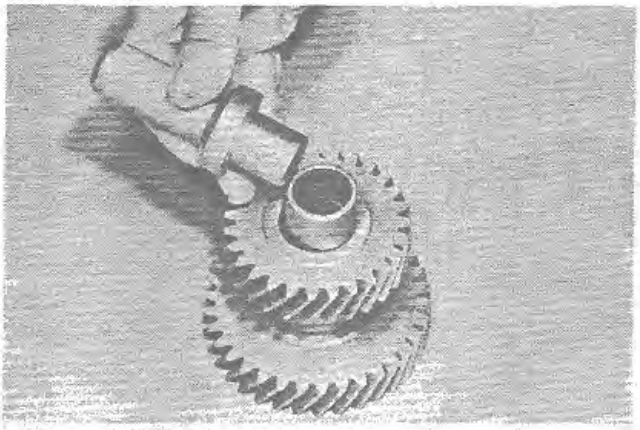
Align retaining holes and place collar on countershaft. Roll pin side of collar away from shaft.

STEP 95



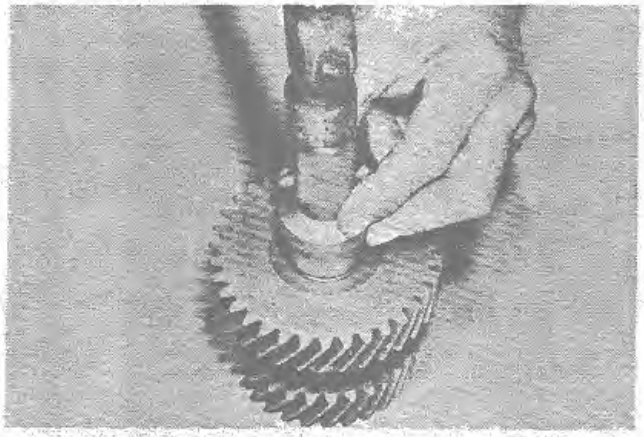
Install collar to shaft retaining roll pin.

STEP 96



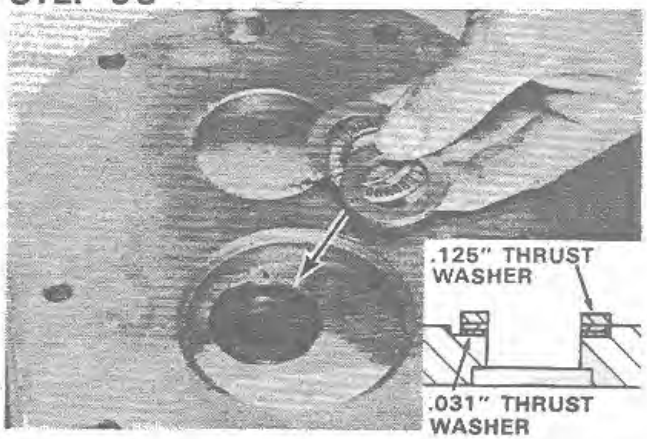
Using driver G15044, install new needle bearing in gear cluster. *NOTE:* Press on the bearing stamped end (end with numbers) until bear- is even with gear chamfer.

STEP 97



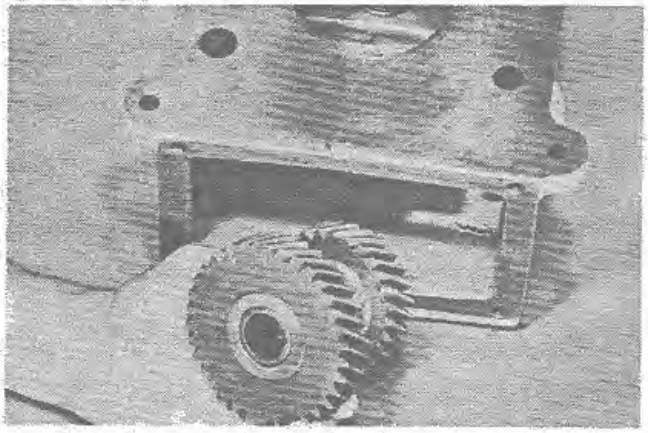
Turn gear cluster over and install another needle bearing in gear bore, see Step 96.

STEP 98



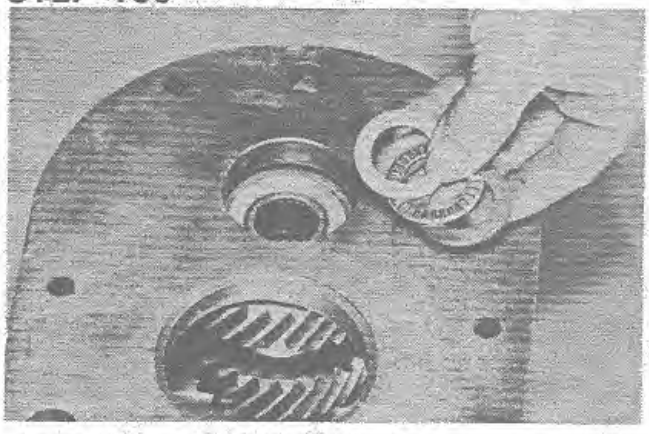
Install a thin (.031") thrust washer, a needle bearing and a thick (.125") thrust washer in housing recess. *NOTE:* Thin (.031") thrust washer must be next to the housing.

STEP 99



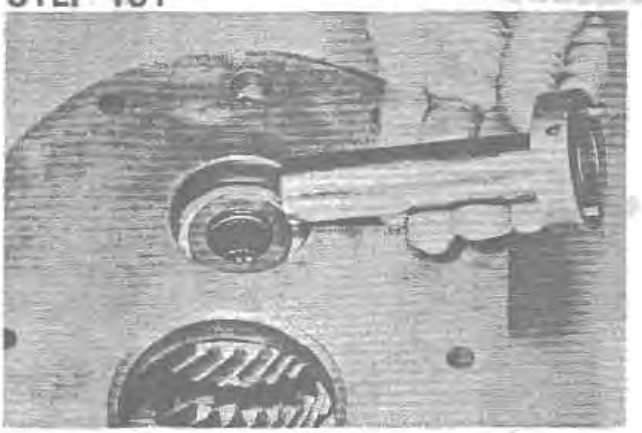
Install the gear cluster (small gear down) in housing on top of the thrust washers and needle bearing.

STEP 100



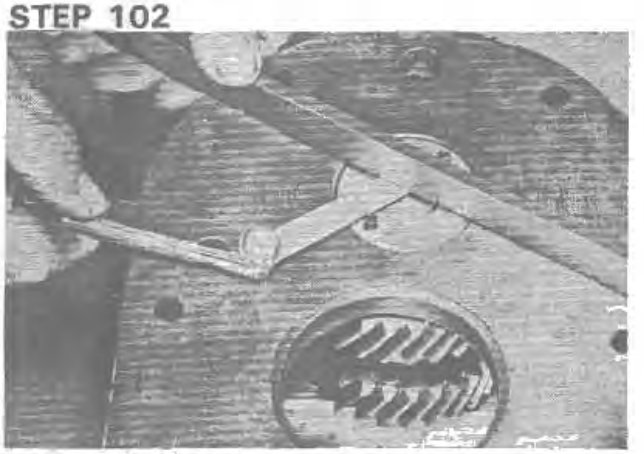
Place a thick (.125") thrust washer, a needle bearing and a thin (.031") thrust washer on gear cluster.

STEP 101



Install countershaft through thrust washers, bearings and gear cluster.

STEP 102

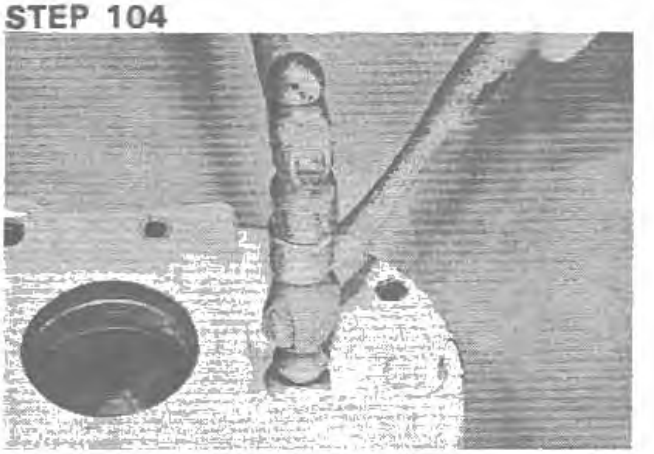


With a straight edge and feeler gauge, measure the distance between the straight edge and countershaft collar.

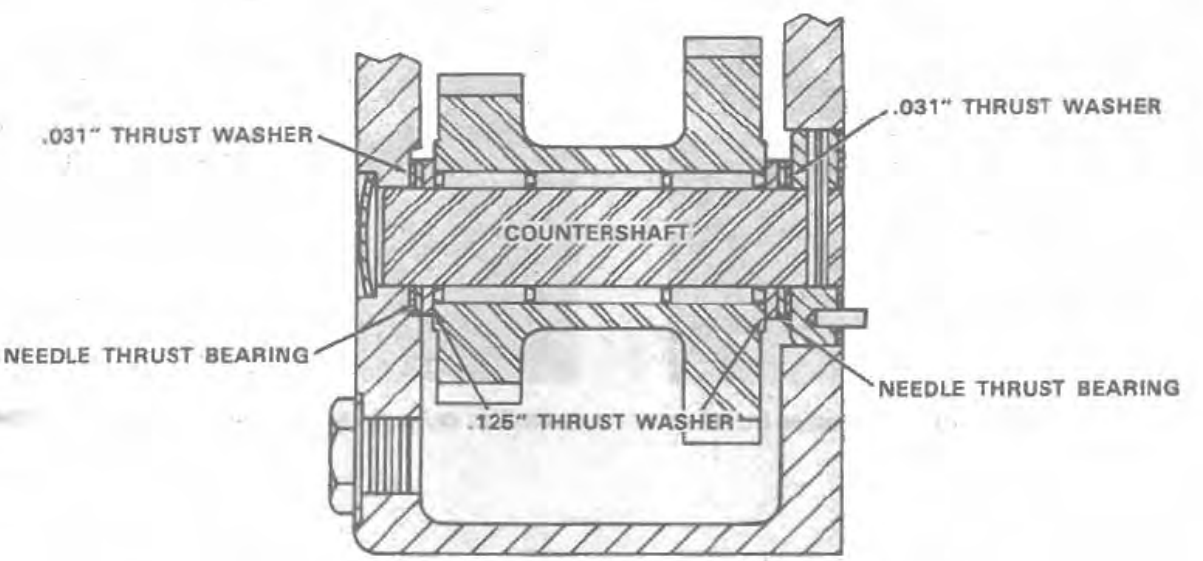
STEP 103

From feeler gauge reading, Step 102, subtract .004" to .009" and provide a shim pack equal to the remainder of feeler gauge reading. Install the shim pack over collar roll pins.

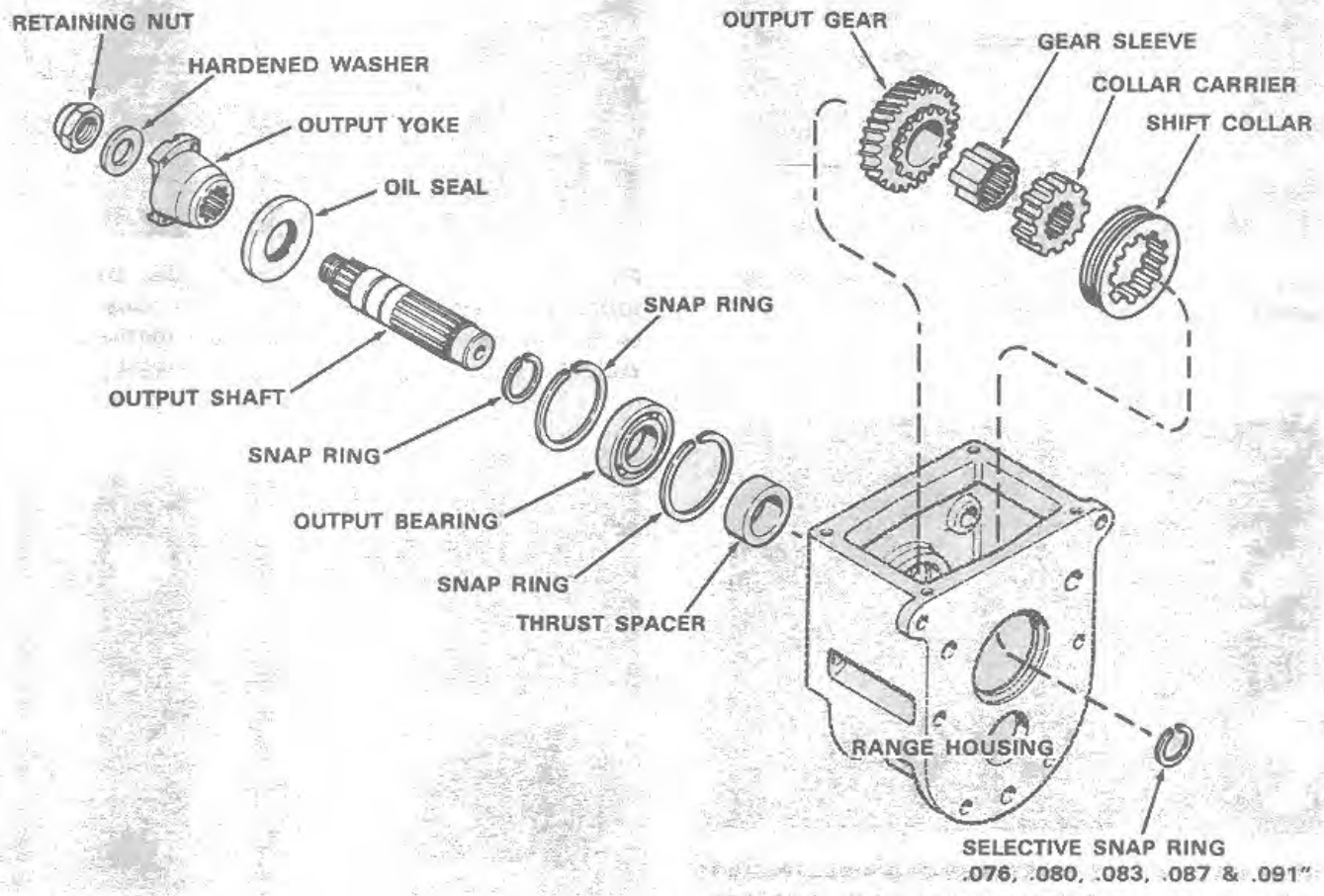
STEP 104



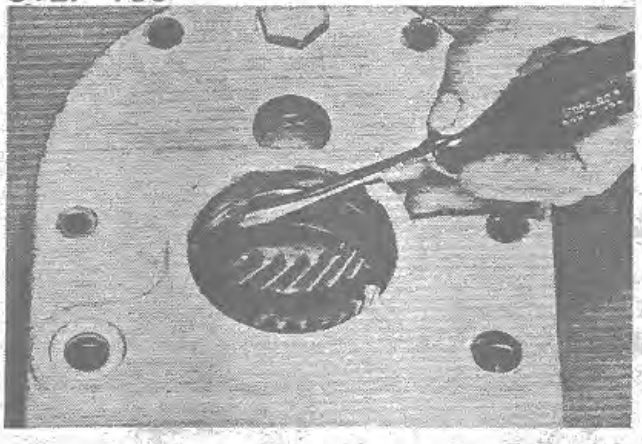
Turn housing over and install a new expansion cup plug in shaft bore.



Output Shaft Installation

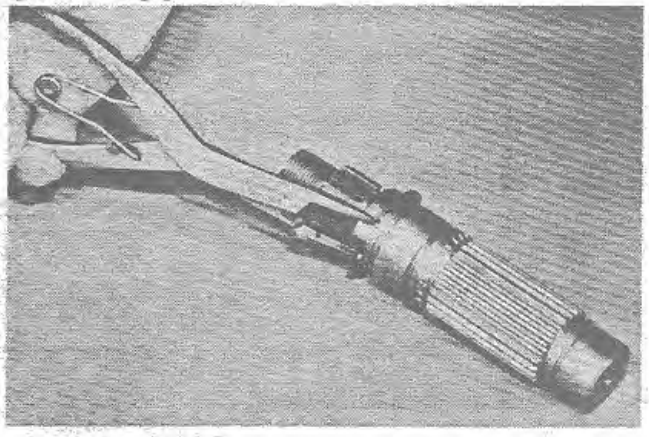


STEP 105



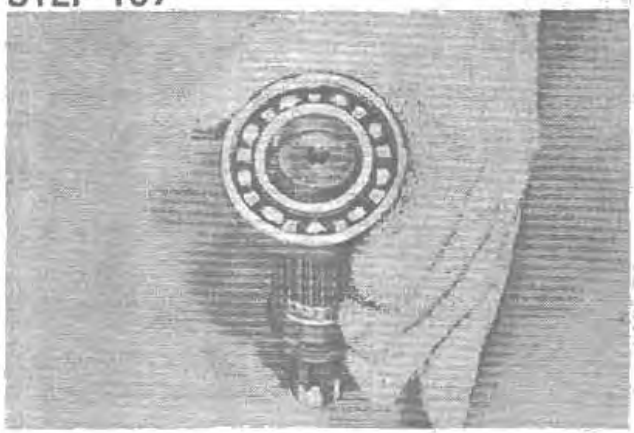
Install a snap ring in output shaft inner housing groove.

STEP 106



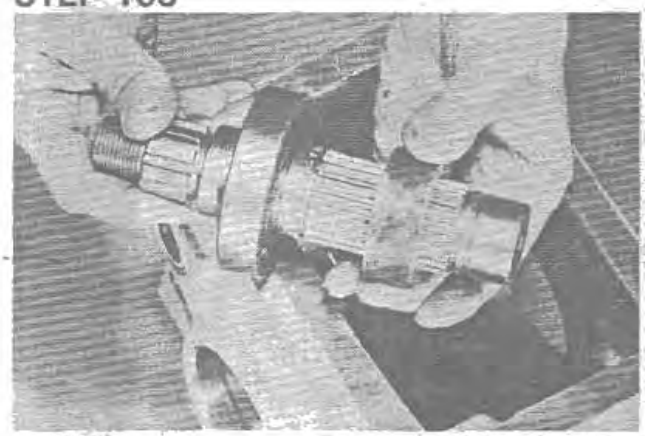
Install a snap ring in output shaft rear groove.

STEP 107



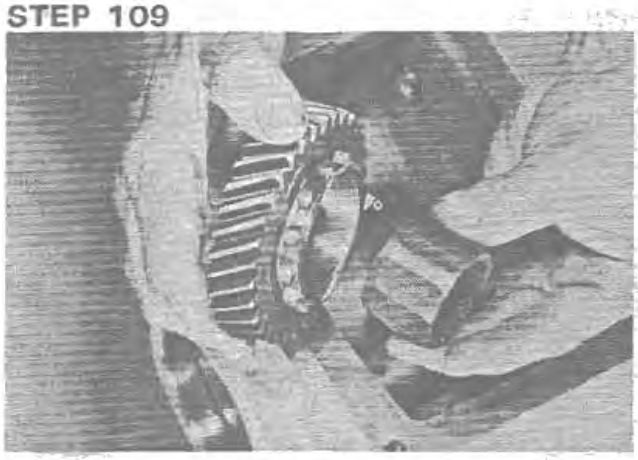
Heat bearing on a bearing heater and install on output shaft, making sure bearing contacts snap ring.

STEP 108



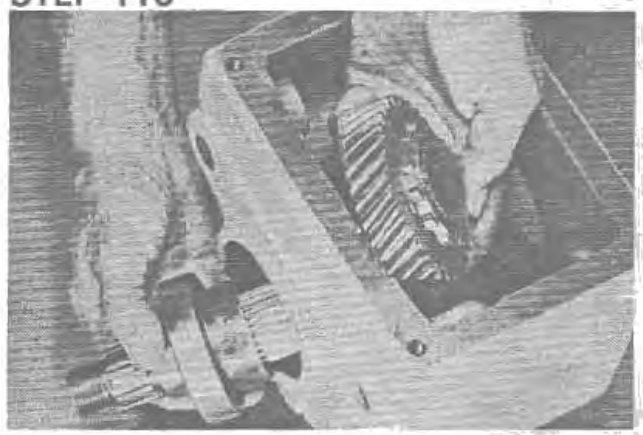
Install the thrust spacer on range output shaft.

STEP 109



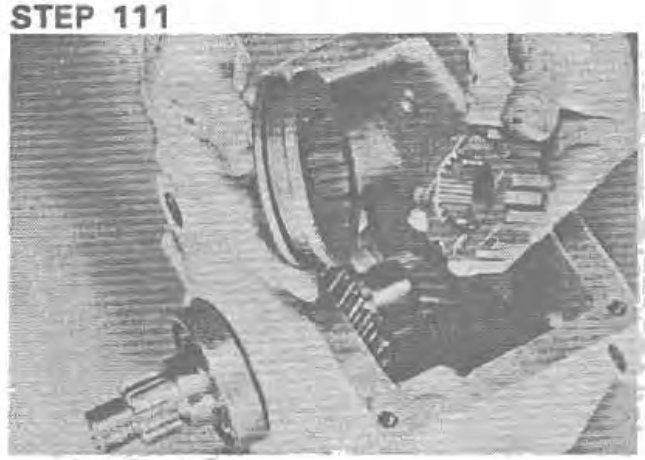
Install the splined sleeve inside of the output gear.

STEP 110



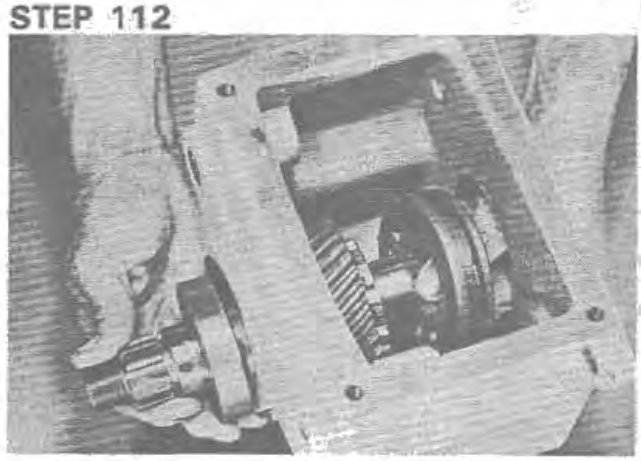
Start the output shaft into range housing and install output gear and sleeve on shaft.

STEP 111



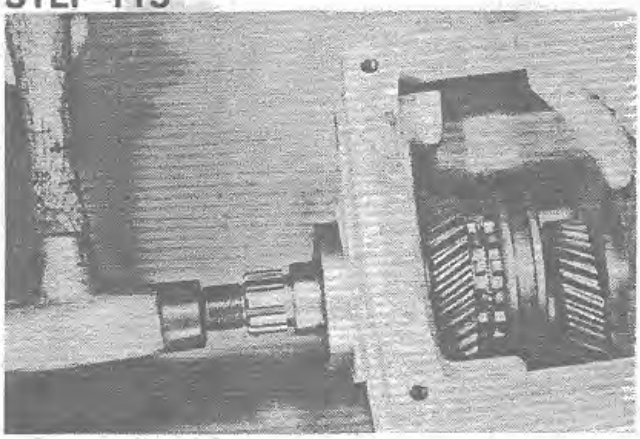
Install the shift collar carrier inside of the shift collar. *NOTE:* Oil groove side of carrier on same side as beveled I.D. of shift collar.

STEP 112



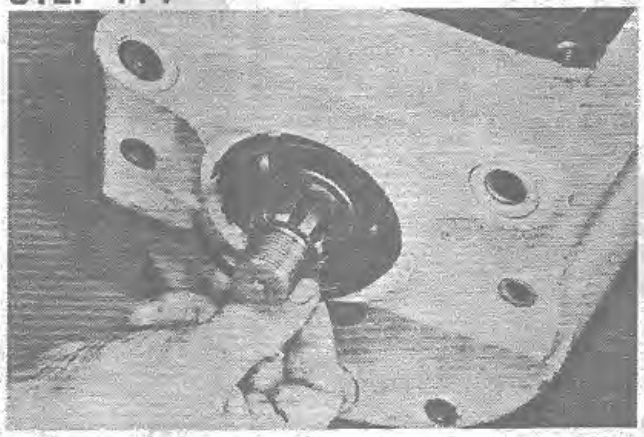
Install shift collar and carrier on range output shaft. *NOTE:* Oil groove side of carrier next to output gear.

STEP 113



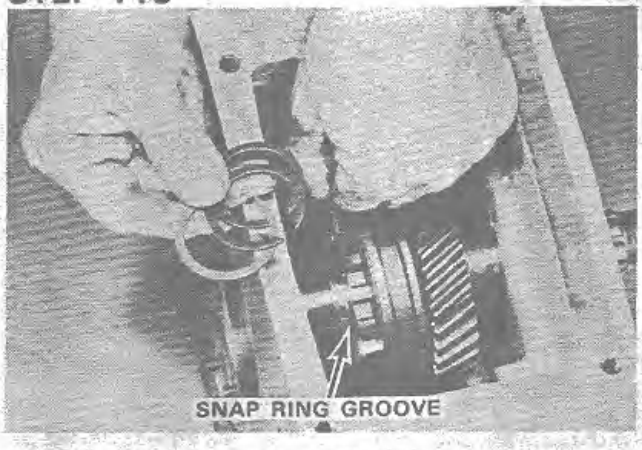
Drive output shaft into housing bore until bearing makes contact with inner retainer snap ring.

STEP 114



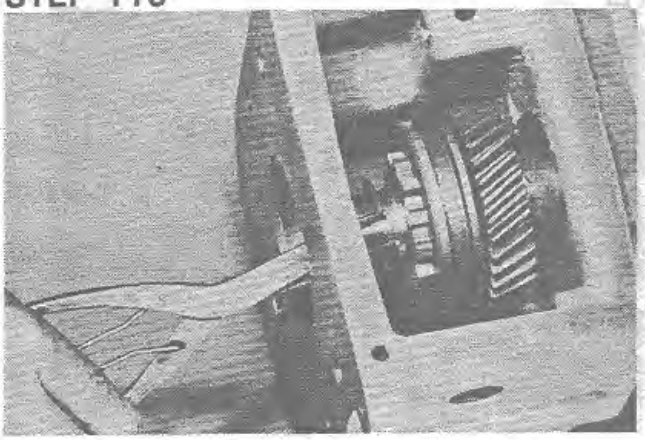
Install outer bearing retainer snap ring in housing groove.

STEP 115



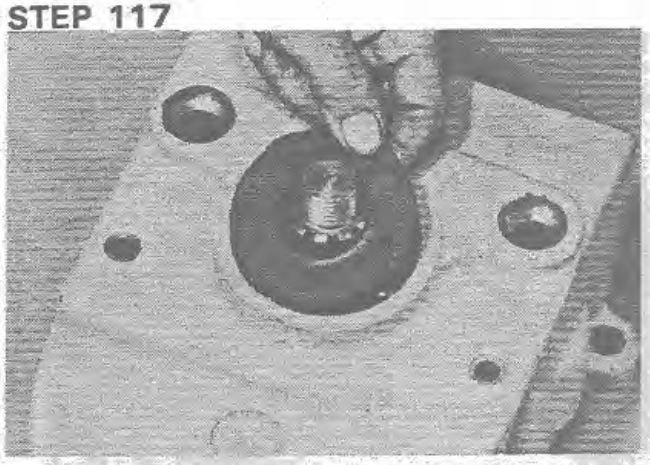
Select a snap ring that will provide a minimum amount of gear backlash. *NOTE:* Snap rings are provided in .076", .080", .083", .087" .091" thicknesses.

STEP 116



Install selected snap ring, Step 114, on range output shaft.

STEP 117

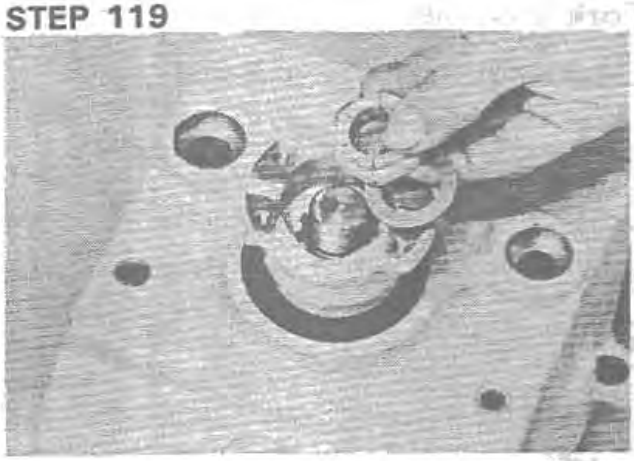


Press a new seal assembly in housing bore, until seal face is .190" below housing face.

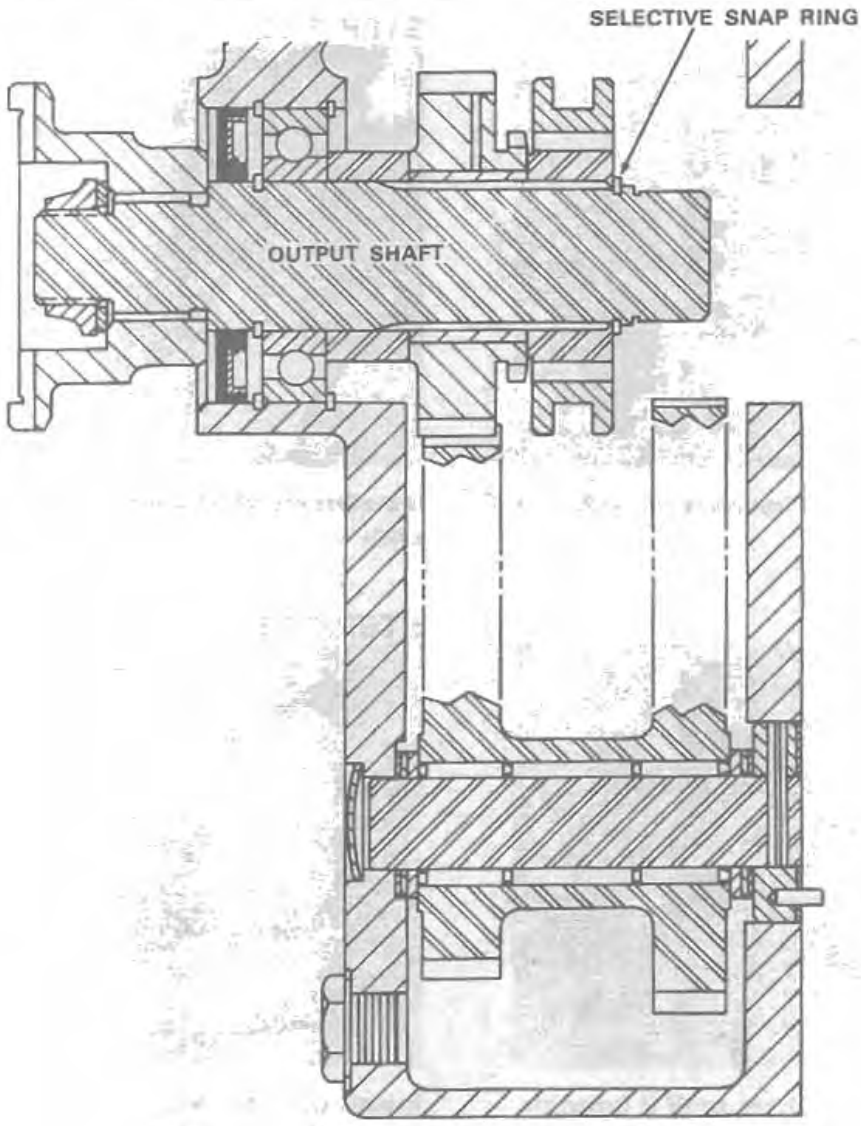
STEP 118

Install range output shaft yoke. *NOTE:* Coat yoke O.D. sealing surface with clean TCH oil.

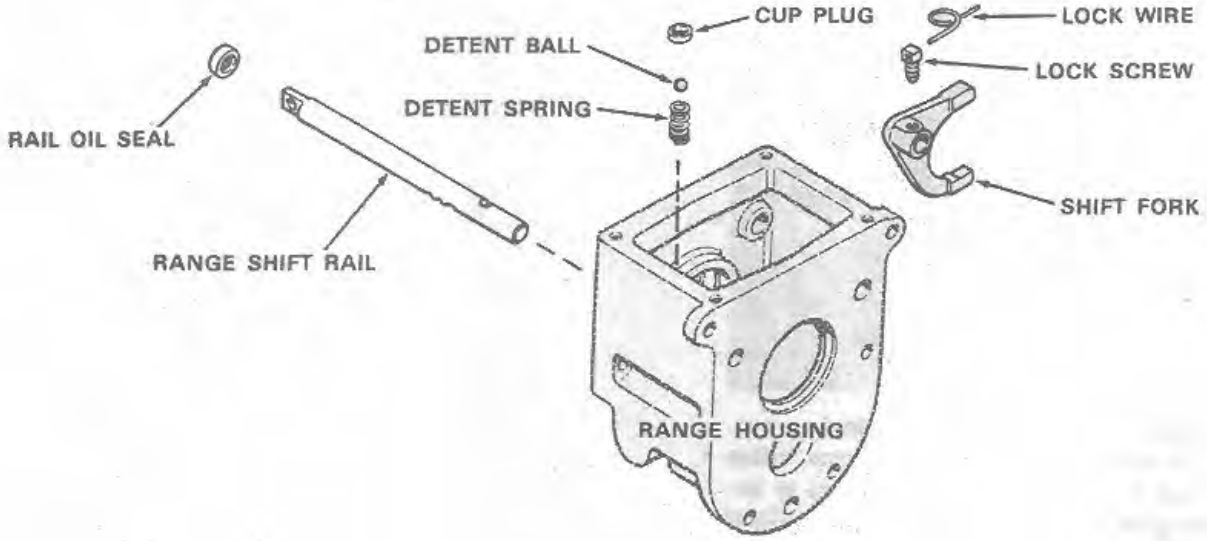
STEP 119



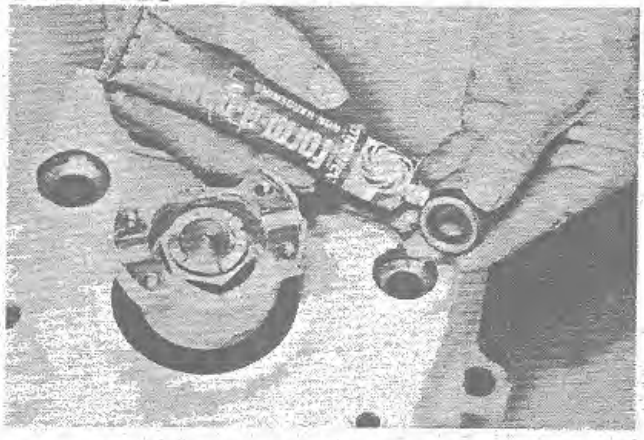
Install hardened washer and yoke retaining nut. *NOTE:* Due to the high retaining torque valve of nut, do not torque nut until housing is installed on engine flywheel housing, see Step 152, Page 39.



Range Shift Rail and Fork Installation

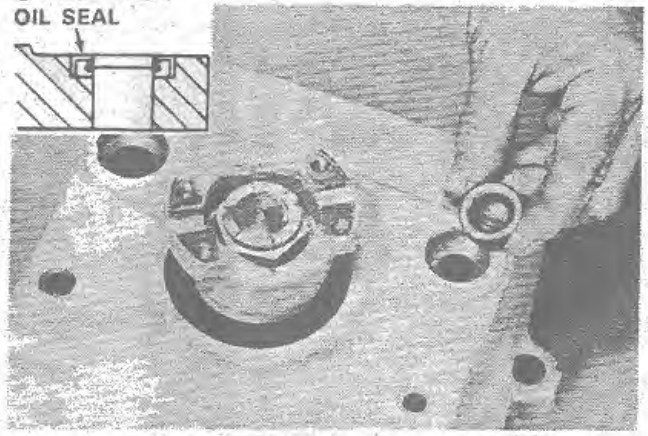


STEP 120



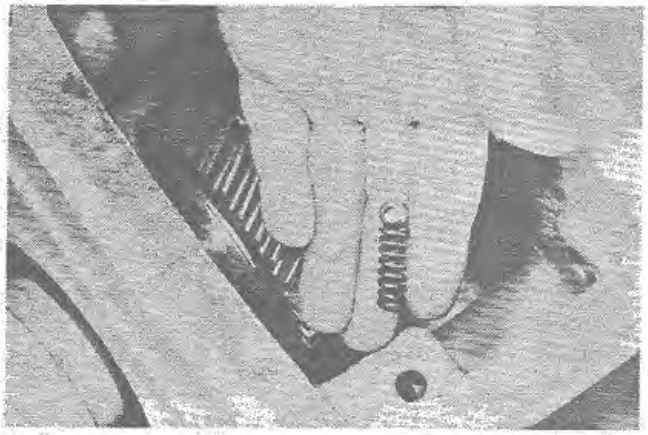
Coat the O.D. of a new range shift rail seal with #2 Permatex.

STEP 121



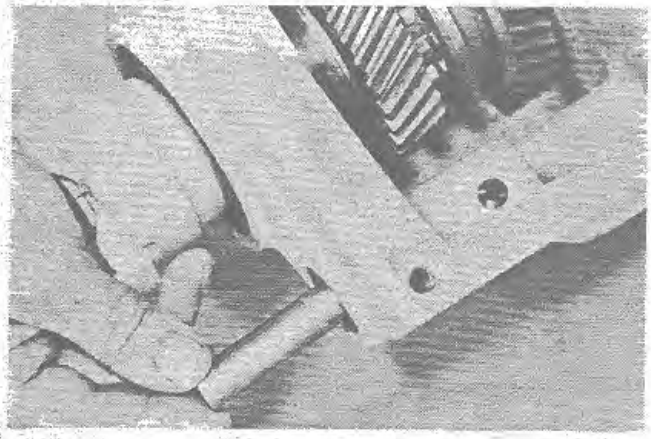
Install rail seal in housing bore until it bottoms.

STEP 122



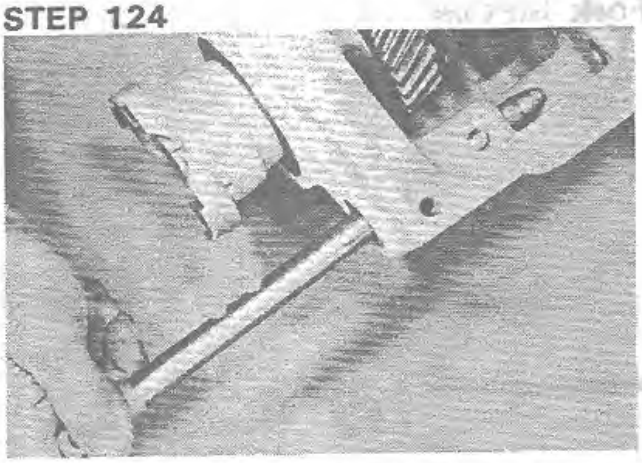
Install rail detent spring and ball in range housing.

STEP 123



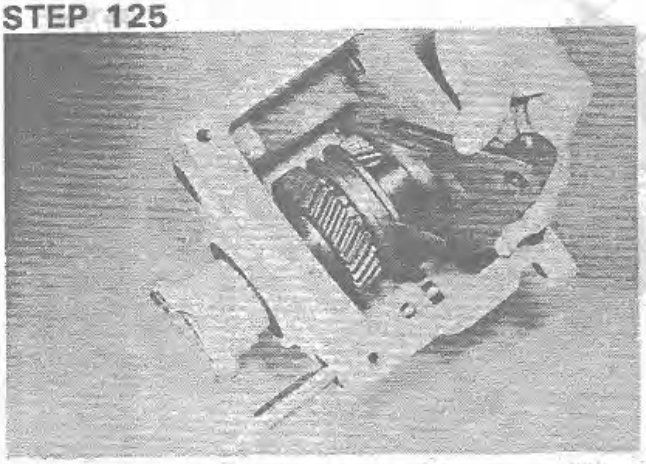
Install pilot sleeve, see Page 4, to retain detent ball in position.

STEP 124



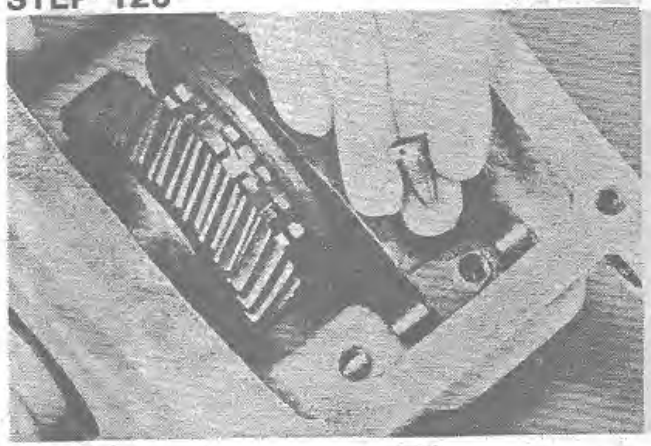
Press range shift rail (flat side down) part way into housing, forcing pilot sleeve out.

STEP 125



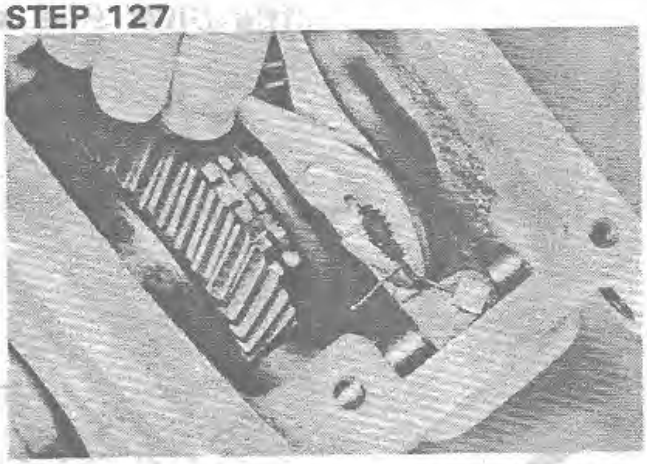
Install range shifter fork in housing and press shift rail through fork, and the rest of the way into housing.

STEP 126



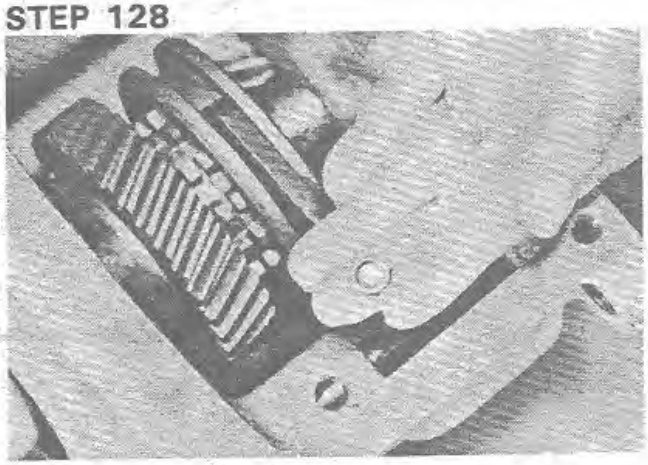
Install fork retaining set screw.

STEP 127



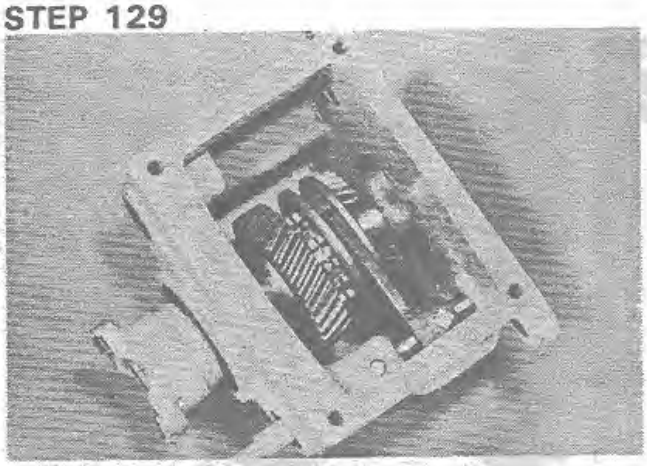
Lockwire set screw in place. Make sure lockwire does not interfere between fork and housing during shifting.

STEP 128



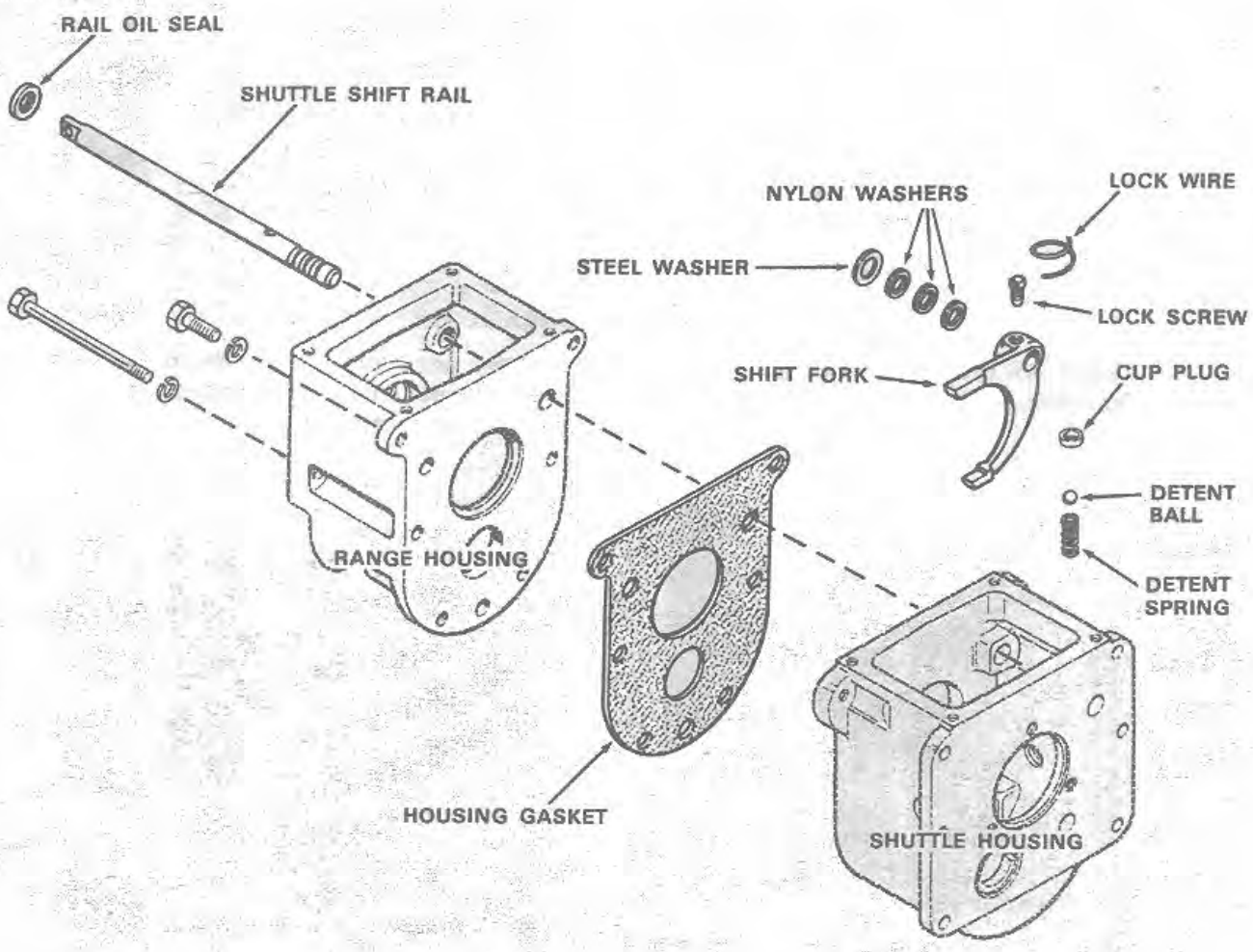
Install cup plug in housing detent opening.

STEP 129

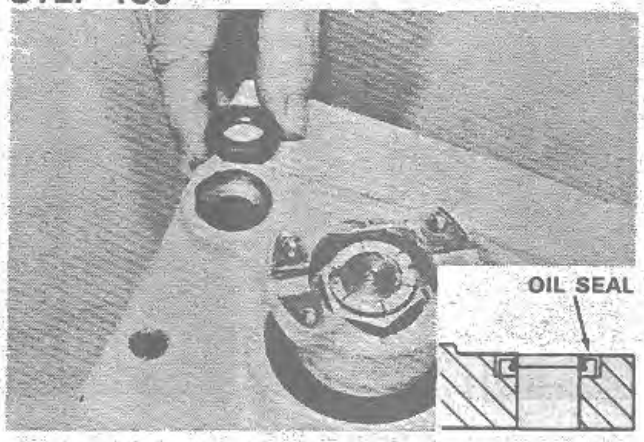


Range housing assembled.

Shuttle Shift Rail and Fork Installation

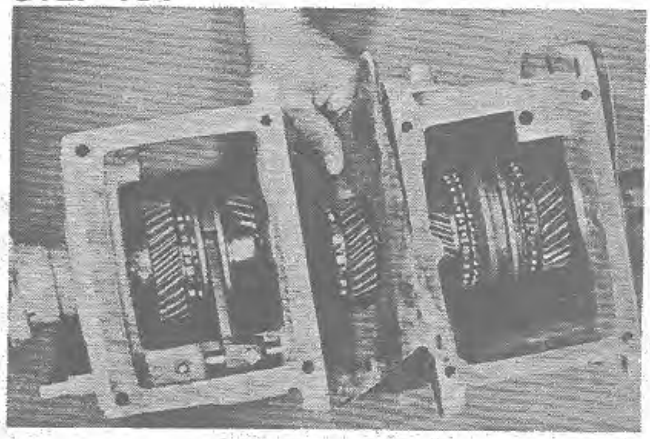


STEP 130



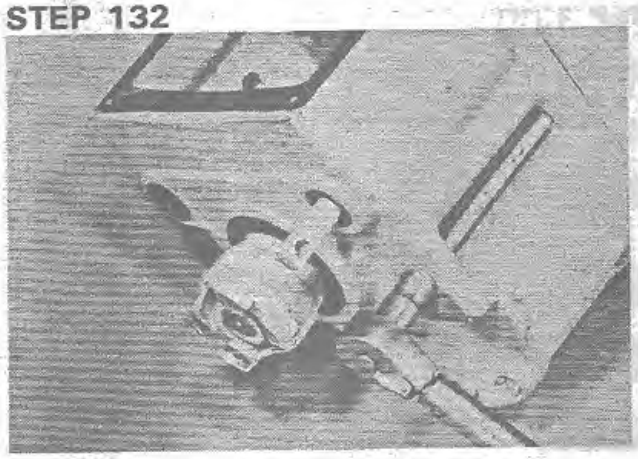
Install a new shuttle shift rail seal in range housing bore until it bottoms.

STEP 131



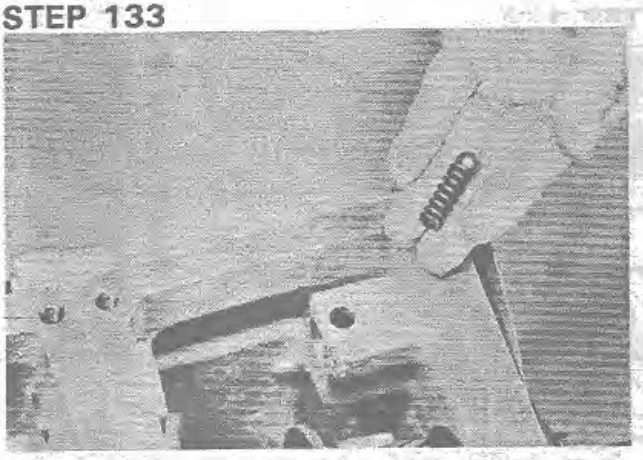
Install a new housing to housing gasket.

STEP 132



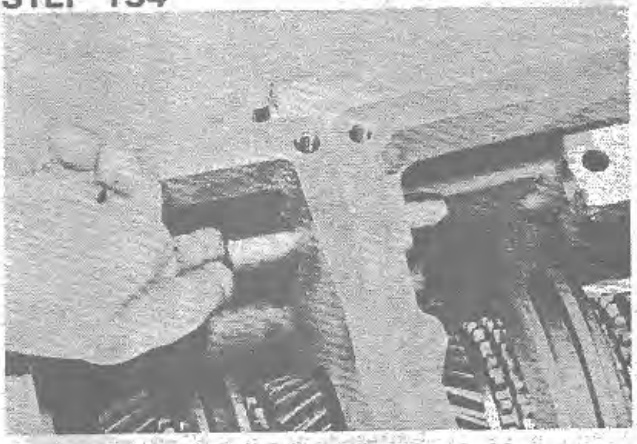
Install housing retainer bolts and torque bolts 35 to 42 ft. lbs.

STEP 133



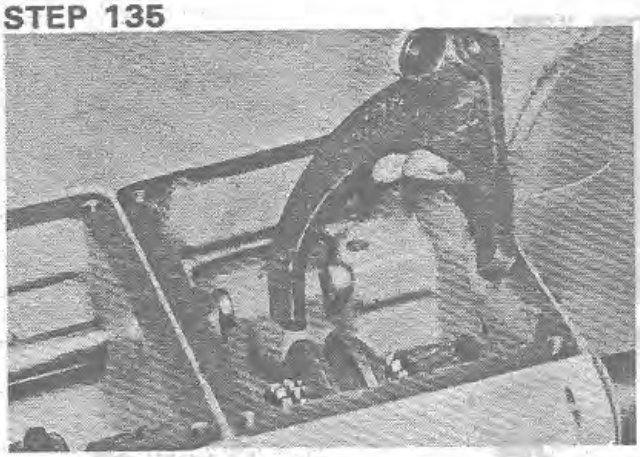
Install shuttle detent spring and ball.

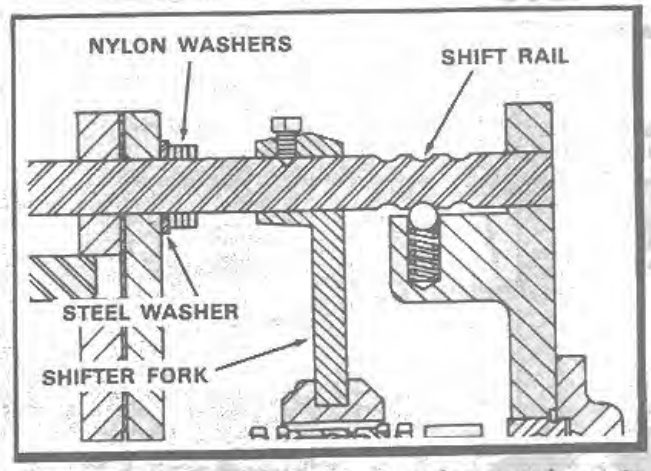
STEP 134



Install pilot sleeve, see Page 4, to retain detent ball in position, see Step 135.

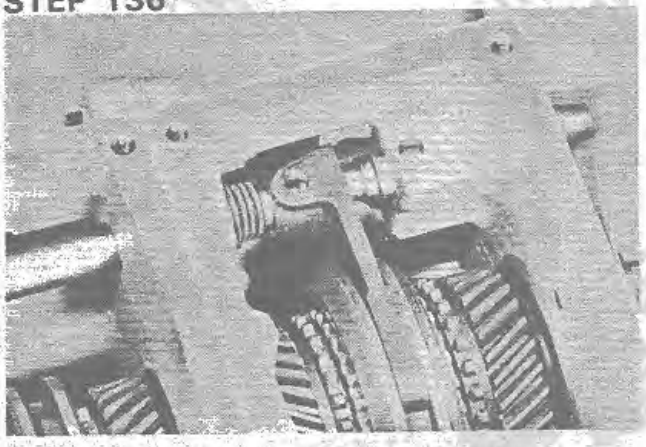
STEP 135





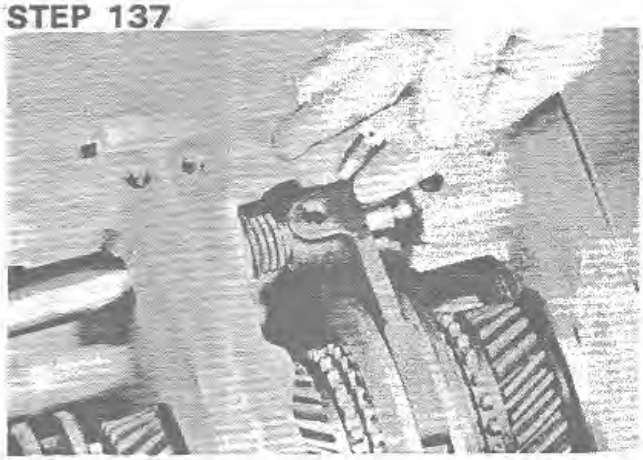
Stack the steel washer and nylon washers to match measurement taken in Step 11 of disassembly. Use only one steel washer and as many nylon washers as required. *NOTE:* Do not over stack measurement. Install shift rail part way into housings and install the steel washer to shaft, then nylon washers as shown in Inset. Install shifter fork on snychronizer unit.

STEP 136

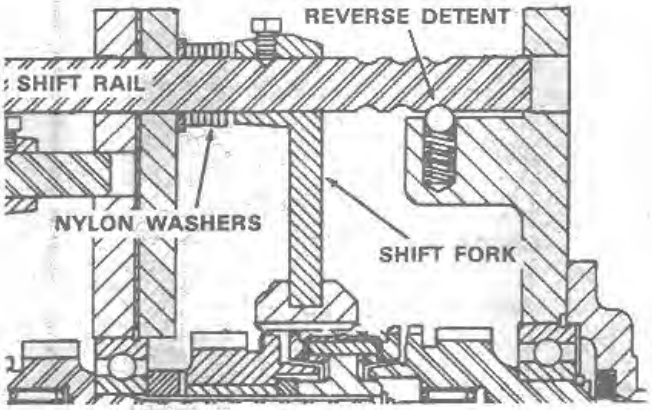


Press shift rail through fork and force pilot sleeve from housing.

STEP 137

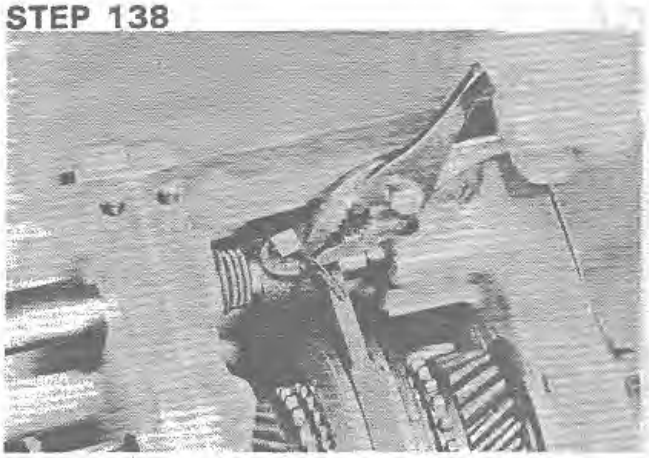


Install shuttle fork retaining set screw.



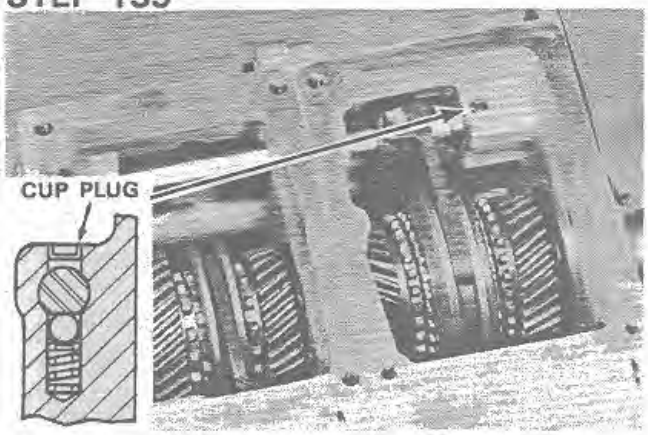
Move the shift rail into reverse detent and check to make sure that there is enough nylon washers to prevent overshift. If it has to be forced into reverse detent a nylon washer may have to be removed.

STEP 138

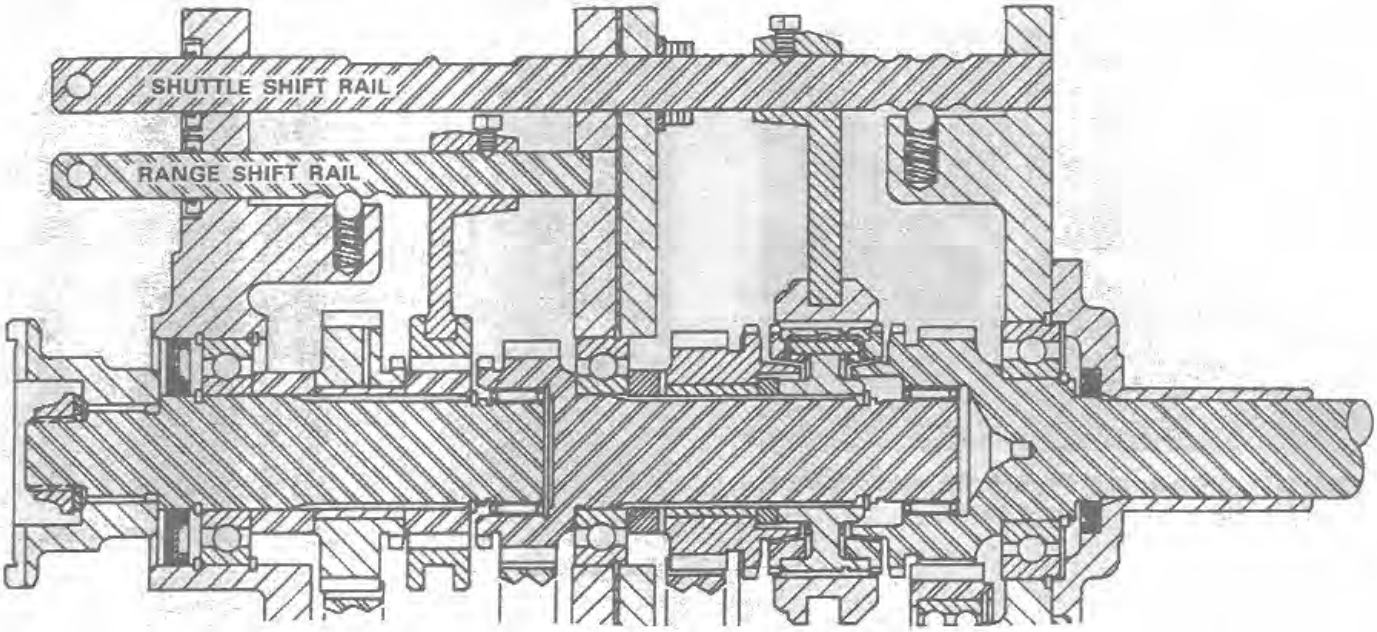


Lockwire set screw in place. Make sure lockwire does not interfere between fork and housing during shifting.

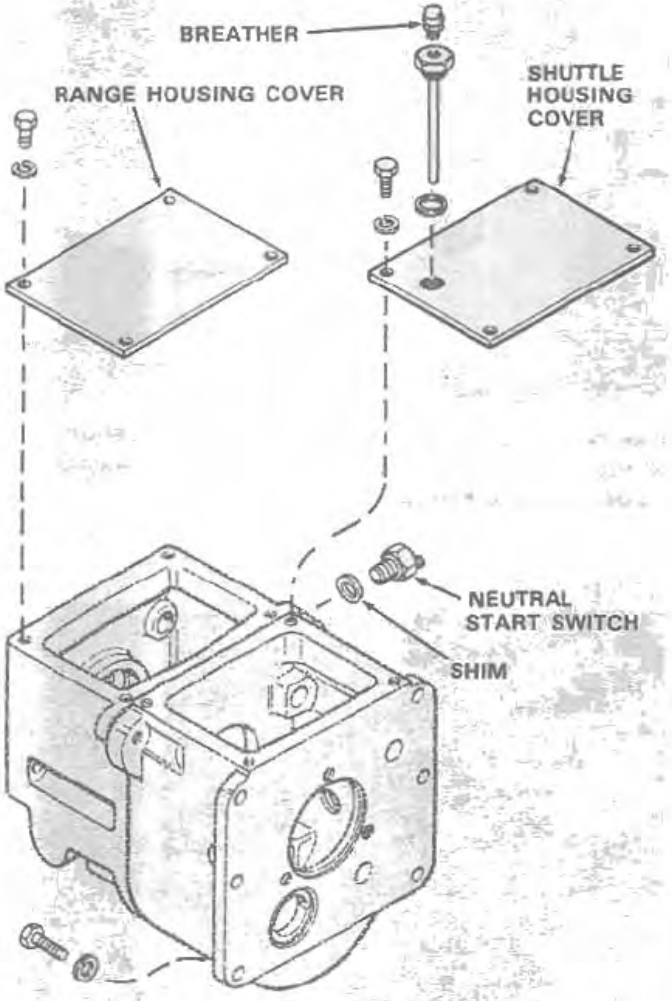
STEP 139



Install cup plug in shuttle housing detent opening.



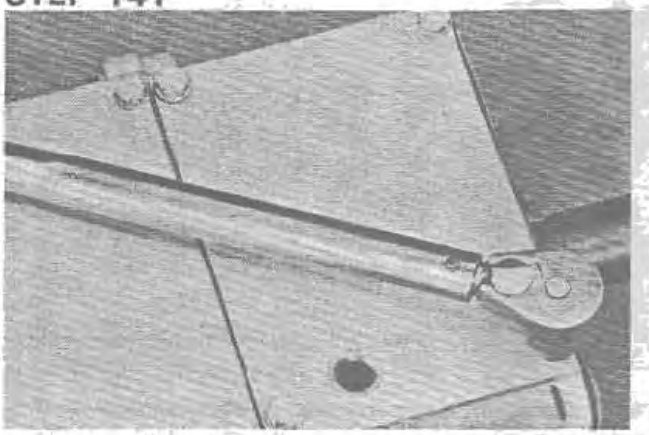
Cover Installation and Mounting to Flywheel



STEP 140

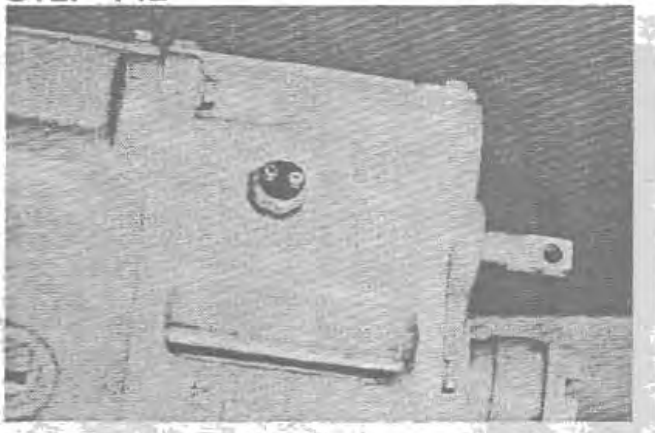
Apply a thin bead of RTV gasket compound (Case No. M20704 or M20705) to housing cover mating surfaces.

STEP 141



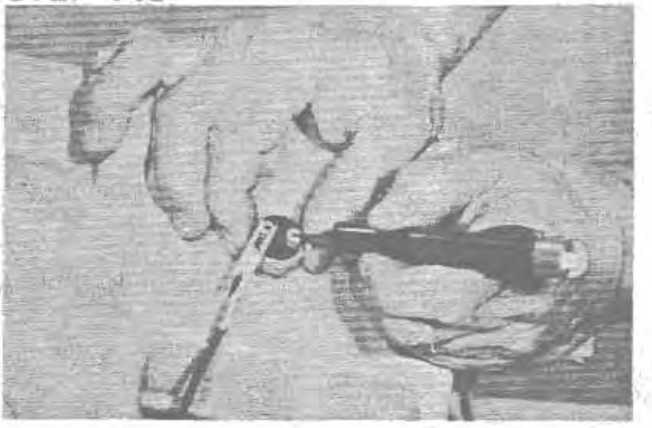
Install housing covers and torque cover retaining bolts 17 to 20 ft. lbs.

STEP 142



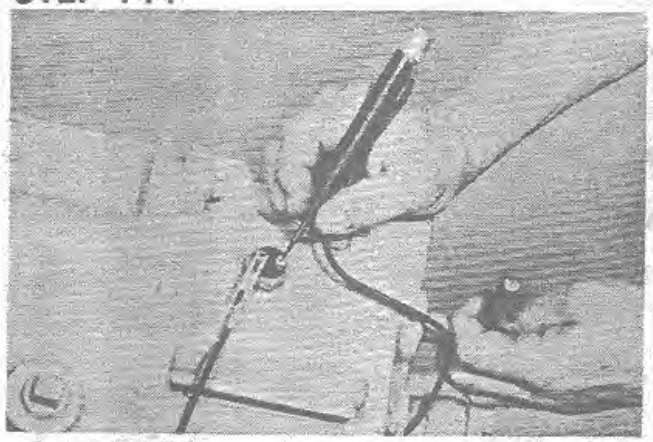
Install neutral start switch in housing and place shuttle shift lever in neutral.

STEP 143



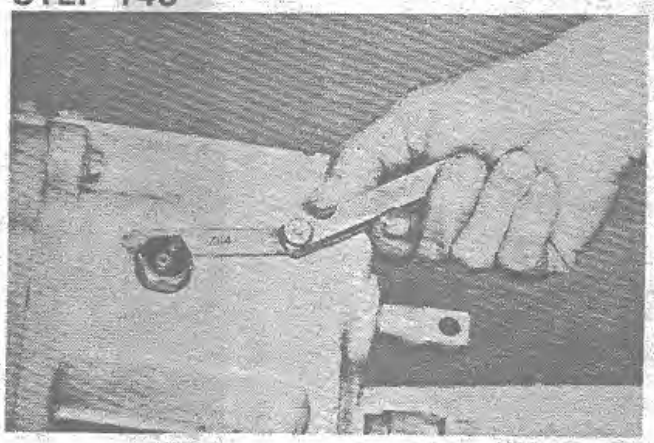
Connect a 12 volt test lamp or an ohmmeter across switch terminals. Turn switch inward until the test lamp lights or ohmmeter registers a reading.

STEP 144



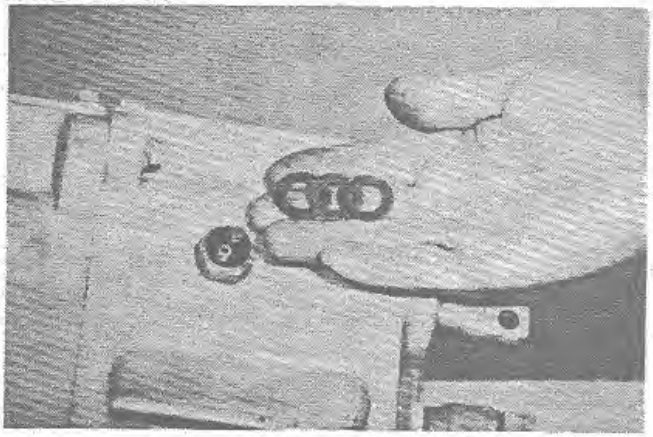
Place the shift lever in gear. Check to see that test lamp goes out when in gear and comes back on when in neutral; the ohmmeter if used, should not register when in gear and should register when in neutral.

STEP 145



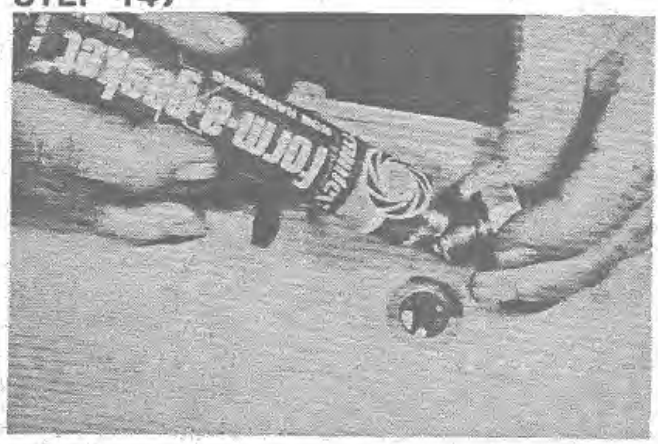
Using a feeler gauge, measure the distance between the switch and housing for the amount of shims required.

STEP 146



Remove the switch and add required shims. Shims are available in two sizes, G49401 (.005") and G49402 (.010").

STEP 147

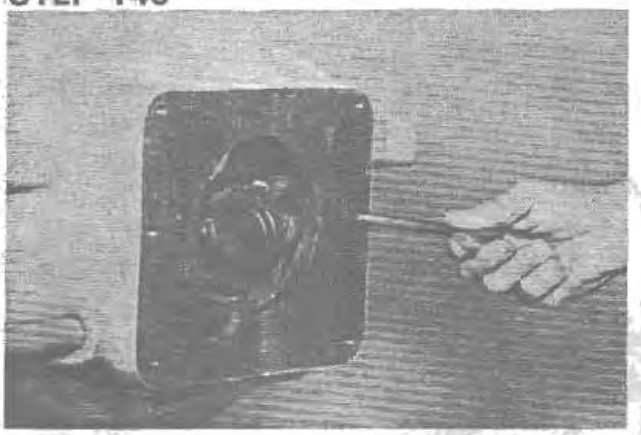


Apply #2 Permatex to neutral start switch threads and install switch in housing.

STEP 148

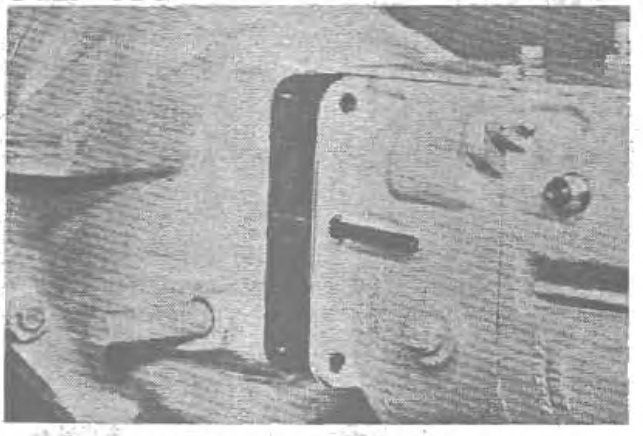
Install breather tube in range housing cover.

STEP 149



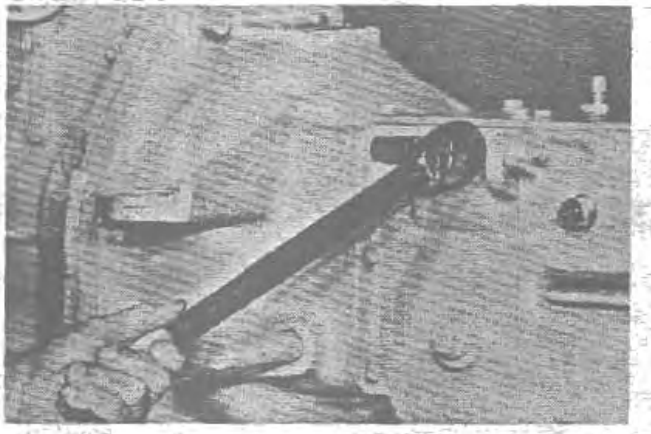
Install pilot studs in flywheel housing.

STEP 150



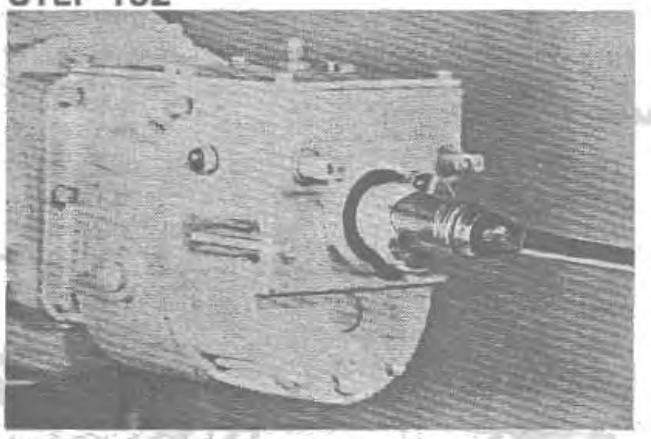
Install shuttle boxes on engine flywheel housing.

STEP 151



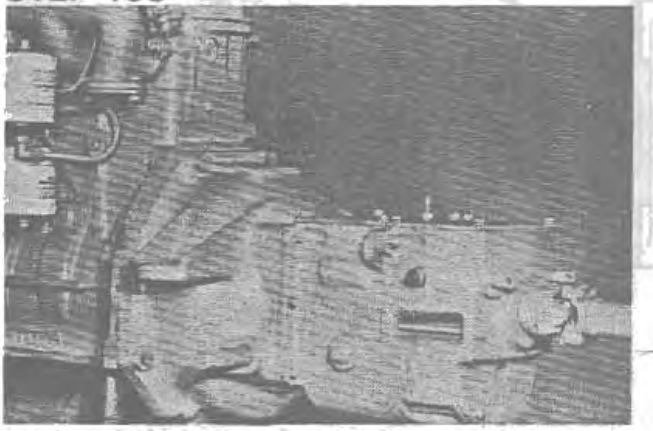
Torque shuttle box to flywheel housing bolts 35 to 42 ft. lbs.

STEP 152

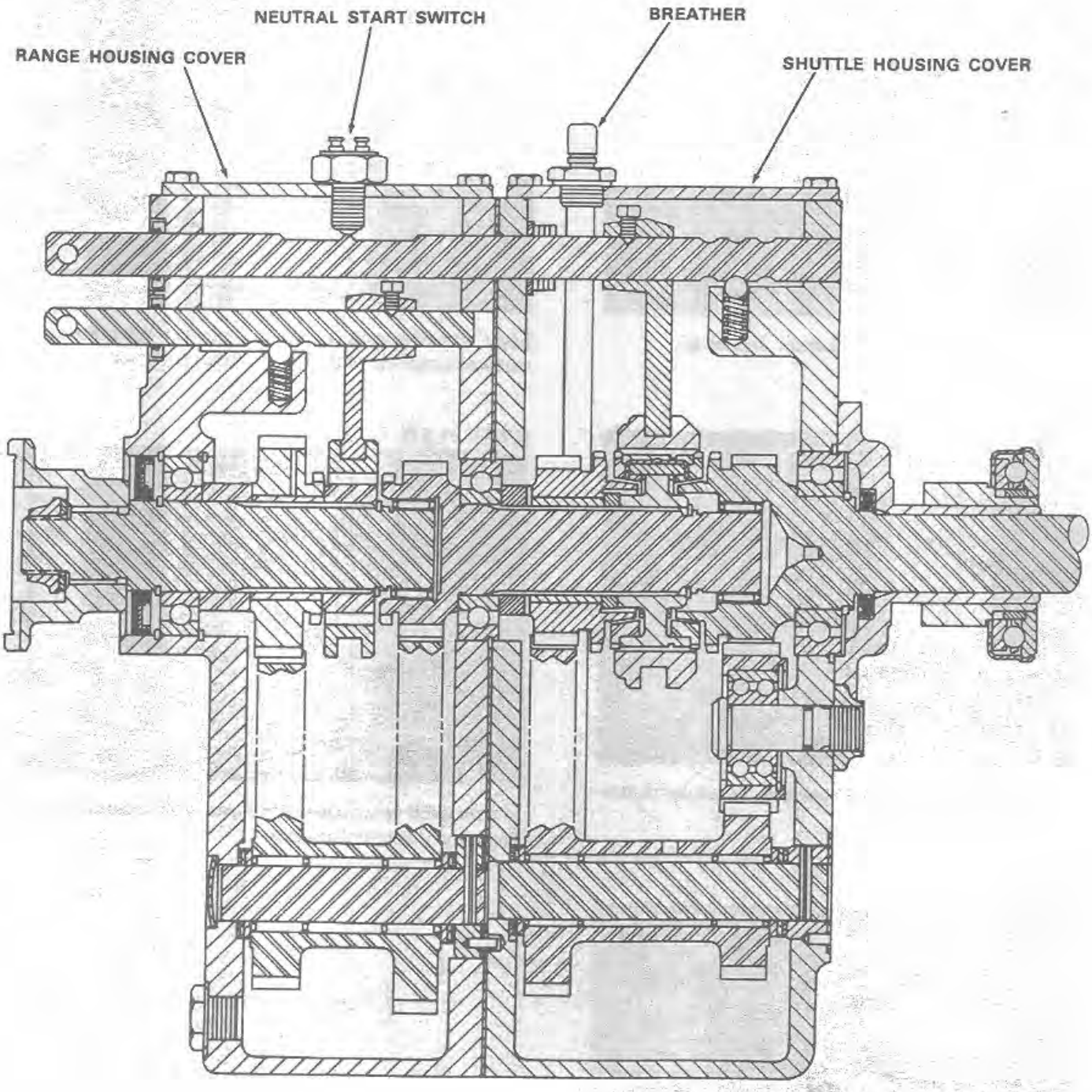


Lock shuttle and range gears up and torque output yoke retaining nut 200 to 240 ft. lbs.

STEP 153



Mechanical shuttle transmission assembled to engine flywheel housing.



Section 7106

BRAKES

(PEDALS TO TRANSAXLE)

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

NOTE: For all other brake service, refer to Section 7025.

MASTER CYLINDERS

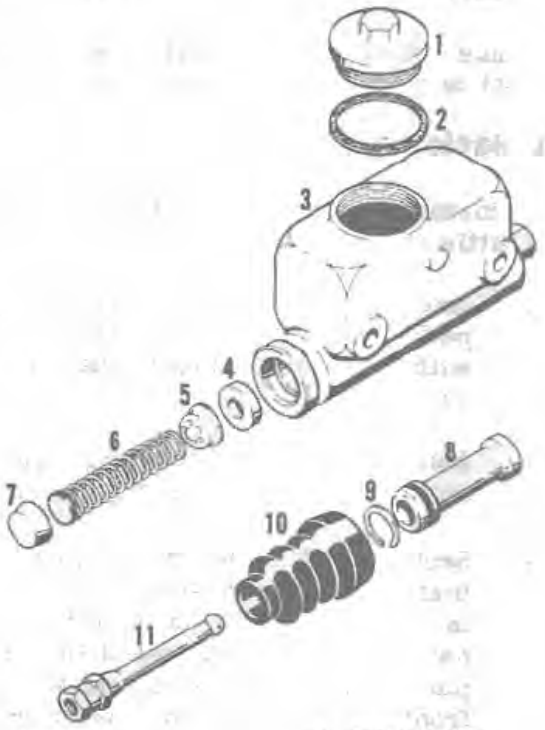
Removal

The following procedure applies to the power shuttle and mechanical shuttle machines. Refer to Figure 2 or 3 depending on which machine you are working on.

1. Remove instrument panel as instructed in Section 8004.
2. Remove stoplight switches and brackets as an assembly if so equipped.
3. Remove cotter pin and clevis pin from master cylinder to be removed. The clevis pin for the right-hand master cylinder on power shuttle machine is held in place with E-clips; remove the inner E-clip to remove clevis pin.

   NOTE: If equipped with stop lights, all clevis pins are E-clip retained.

4. Disconnect brake line from master cylinder to be removed.
5. Remove nuts and lock washers from mounting bolts.
6. Hold master cylinder with one hand and remove the mounting bolts. If bolts are completely removed, the spacers will fall to the floor plate.



1. CAP
2. GASKET
3. MASTER CYLINDER
4. VALVE SEAT
5. CHECK VALVE
6. SPRING
7. PRIMARY CUP
8. PISTON
9. SNAP RING
10. RUBBER BOOT
11. PUSH ROD

Figure 1 - Master Cylinder

Disassembly, Inspection and Assembly

1. Empty master cylinder reservoir and secure master cylinder in a vise.
2. Remove rubber boot from master cylinder and remove boot and push rod assembly.
3. Do not separate the clevis and push rod unless one of the parts is to be replaced. Before separating the parts, measure the overall length and assemble the parts to this demension.
4. Remove snap ring from cylinder bore and remove the piston, primary cup, spring, check valve and valve seat.
5. Inspect the cylinder bore for pitting, scoring and rust. Use a cylinder hone to clean up the cylinder bore if pitting or scoring is light. Replace master cylinder if scoring or pitting is excessive.
6. Inspect the primary cup, piston, check valve and valve seat for wear and damage that could result in leakage. A repair kit containing these parts is available.
7. Inspect spring for signs of cracking and distortion. Replace spring if either condition is present.
8. Lubricate the cylinder bore, piston and prinary cup with clean brake fluid.

9. Install valve seat, check valve, spring, primary cup and piston in cylinder bore. Secure parts in place with snap ring.

10. Place push rod in piston and attach boot to cylinder.

Installation

1. If installing master cylinder on a power shuttle machine:

   a. Engage push rod clevis with brake pedal and install mounting bolts with spacers between the master cylinders.

   b. Install lock washers and nuts on mounting bolts and tighten nuts.

   c. Secure clevis to brake pedal. If installing the right-hand master cylinder, push arm on clutch cutout switch forward and install the clevis pin. The switch arm must be in front of the clevis pin. Secure clevis pin in place using cotter pin or E-clip.

   NOTE: If equipped with stoplights, both clevis pins are E-clip retained.

2. If installing master cylinder on a mechanical shuttle machine:

   a. Start mounting bolts into left-hand master cylinder.

   b. Place the two short spacers between the master cylinder and mounting plate, and start bolts into mounting plate.

   c. Place the remaining spacers between the mounting plate and right-hand master cylinder and push bolts through master cylinder.

   d. Install lock washers and nuts on mounting bolts and tighten nuts.

   e. Attach push rod clevis to brake pedal with pedal with clevis pin and secure pin in place with cotter pin or E-clip if equipped with stop lights.

3. Connect brake line to master cylinder.

4. Fill master cylinder and bleed brake as instructed in Section 7025.

   NOTE: Definition of Brake Pedal Free Travel. Brake pedal free travel is the amount of brake pedal travel before the master cylinder push rod contacts piston in master cylinder.

5. Check to see that the brake pedal has 1/16" - 3/16" (1.6 - 4.7 mm) free travel. If clevis locknut is loose, tighten nut before checking free travel. Brake pedal free travel must remain within this specification with the pedals locked together. If free travel is not as specified, loosen lock nut on clevis and turn push rod as required and tighten clevis lock nut. Then check free travel.

6. Install stoplight brackets and switches if so equipped. Be sure the switch arms are to the front and on top of the clevis pins.

7. Install instrument panel as instructed in Section 8004.

BRAKE SHAFT REMOVAL ON POWER SHUTTLE MACHINES

1. Remove instrument panel as instructed in Section 8004.
2. Remove floor plate.
3. Remove brake lines between master cylinders and connection just below floor plate.
4. Disconnect tubes at steering control valve and close openings with caps and plugs.
5. Disconnect shuttle and throttle linkage from their shafts. Pull shafts up and tape to steering column.
6. Remove double nuts from fuel tank strap studs.
7. Remove firewall retaining screws.
8. Remove brake pedal return springs.
9. Remove pedal shaft bearing retaining nuts and bolts and remove outer bearing.
10. Loosen set screw in master brake pedal. Then remove clevis pin, clevis rod, washer and spring.
11. Remove master brake pedal and bearing from shaft.
12. Loosen set screw in brake pedal lock plate.
13. Move brake pedal lock plate to expose Woodruff key. Do not attempt to drive shaft out of brake pedals without removing the key; the pedals do not have a keyway. Use a chisel to remove key from shaft.
14. Pull shaft from brake pedals and pedal lock.
15. Reverse steps 1 through 14 to install the brake shaft.
16. Bleed brakes as instructed in Section 7025.

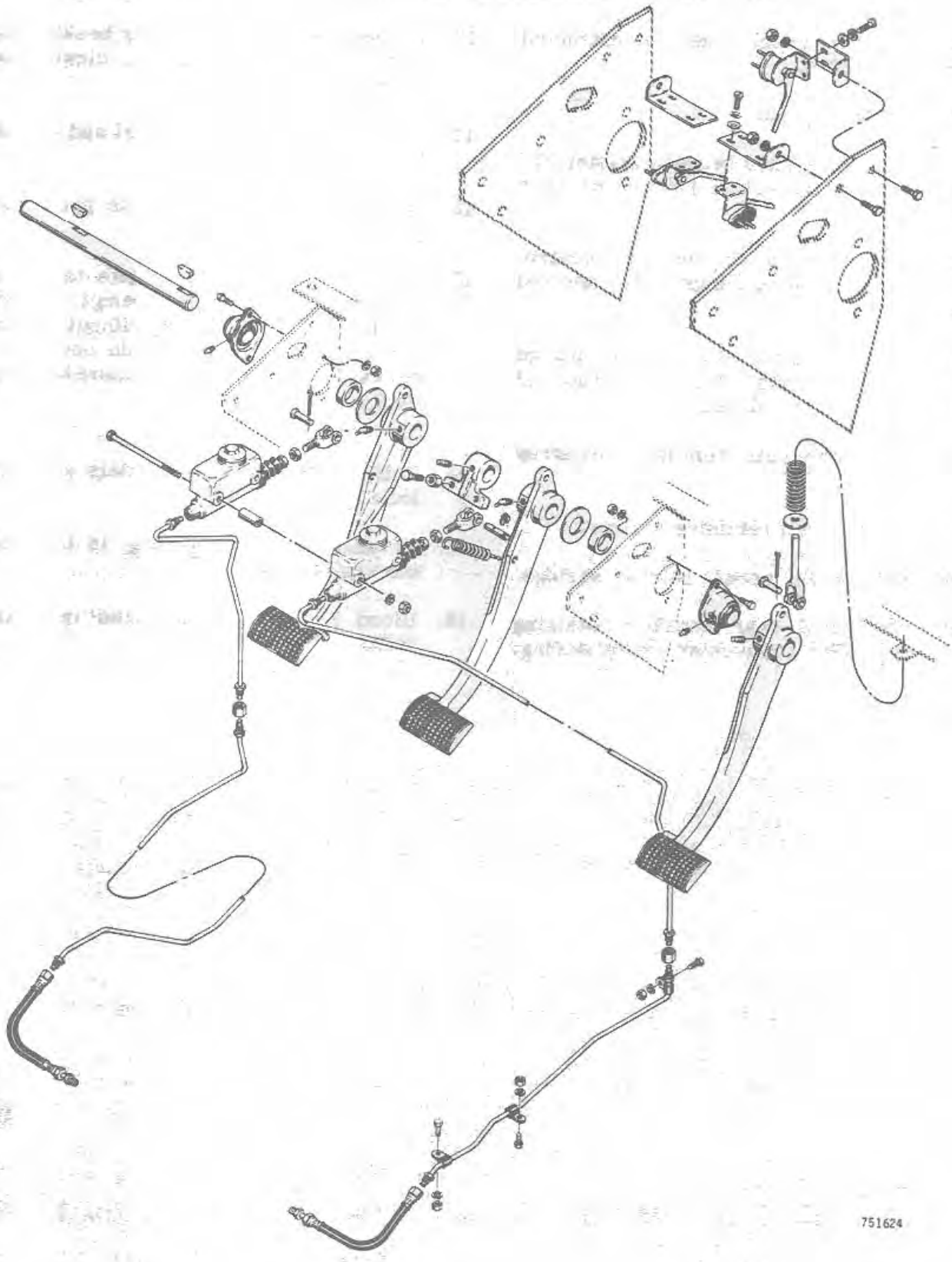


Figure 2 - Brake Pedal and Master Cylinder Installation with Power Shuttle

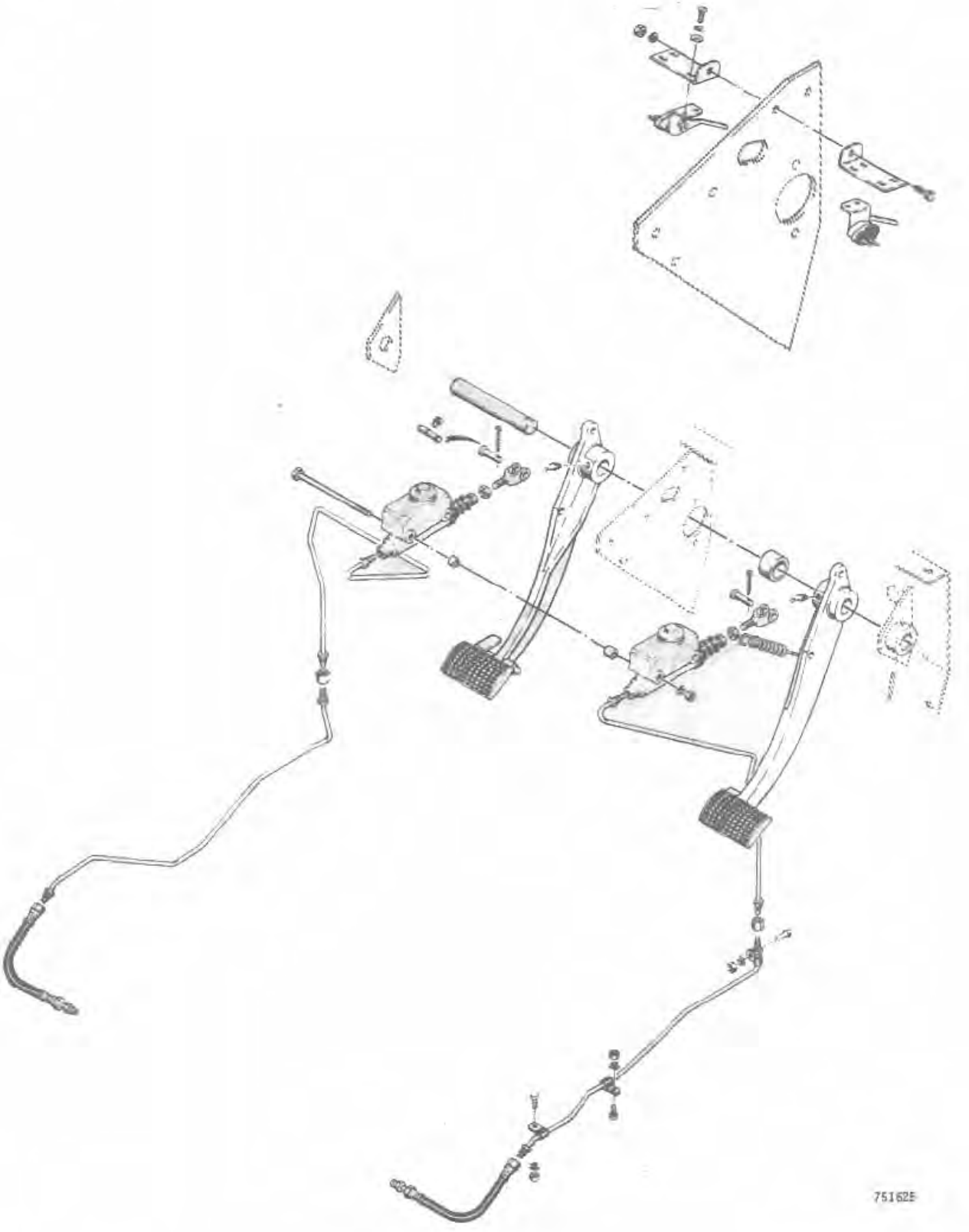


Figure 3 - Brake and Clutch Pedal Installation with Mechanical Shuttle

PARKING BRAKE CONTROL

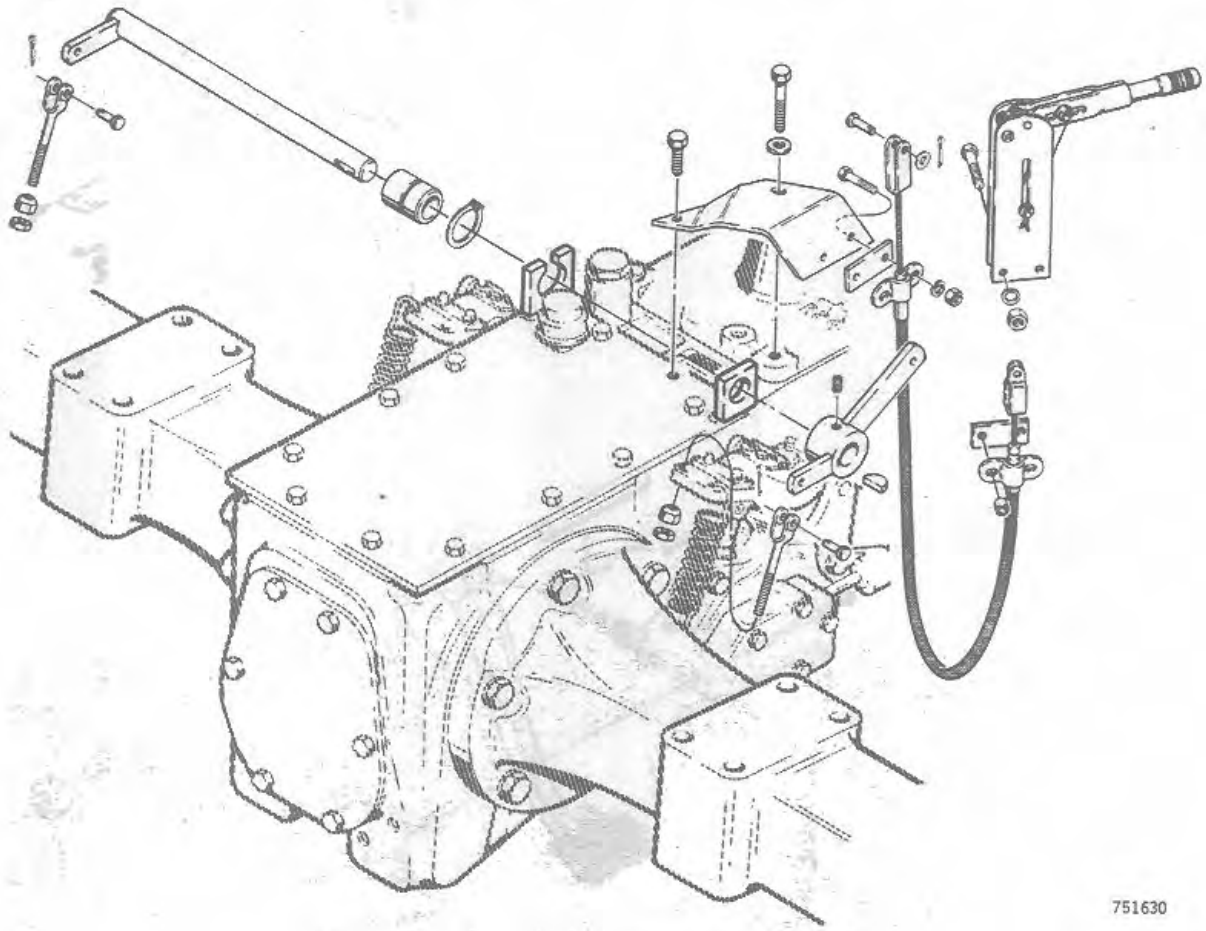


Figure 4 - Parking Brake Control Installation

Section 7122

SELF ADJUSTING

DIFFERENTIAL BRAKES

J I Case
A Tenneco Company

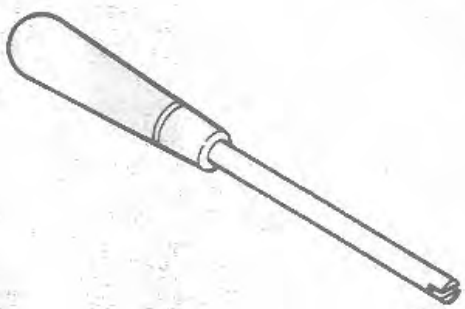
TENNECO

Rac 9-79245

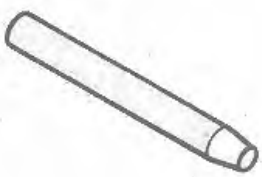
PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIAL TOOLS



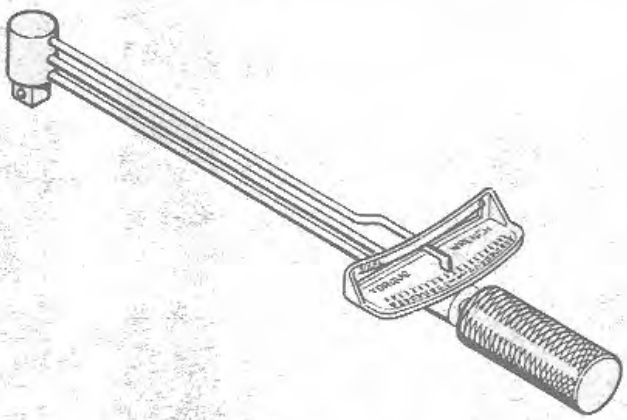
SLOTTED SCREWDRIVER



3/16" RIVET CLINCHER - NO. 6667A-2

9/64" RIVET CLINCHER - NO. 6667A-1

McMASTER-CARR
P.O. BOX 4355
CHICAGO, ILL. 60680

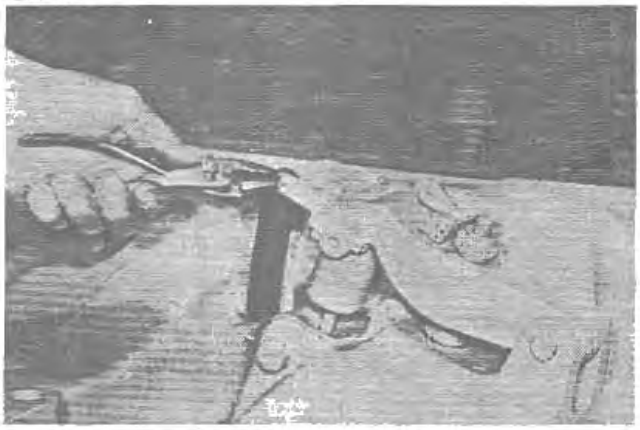


FOOT POUND TORQUE WRENCH

SERVICING THE SELF ADJUSTING DIFFERENTIAL BRAKES

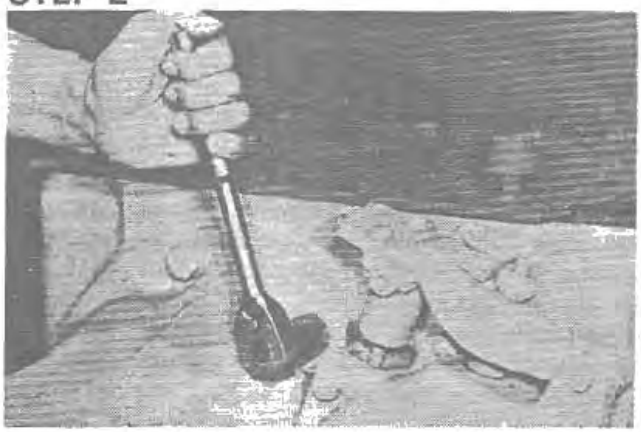
Removal of Brake Housing

STEP 1



Remove the brake lever return spring.

STEP 2

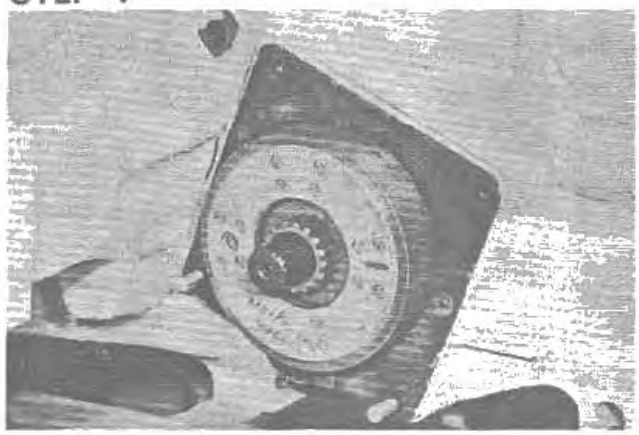


Remove the axle housing bolt securing return spring bracket.

STEP 3

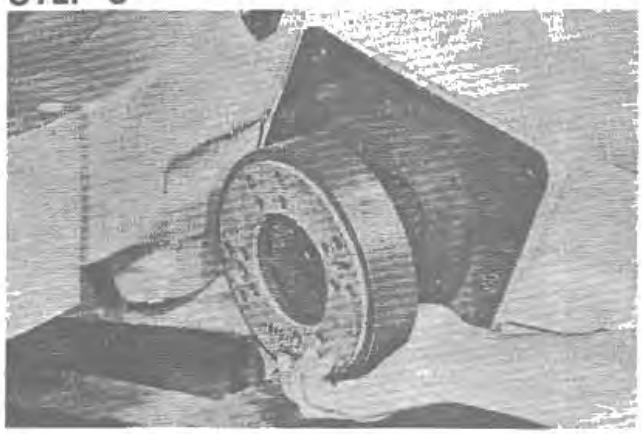
Remove brake housing retaining bolts.

STEP 4



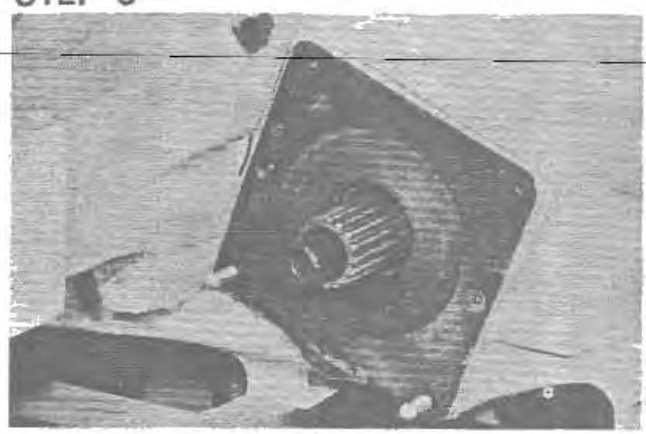
Brake housing removed from transaxle case.

STEP 5



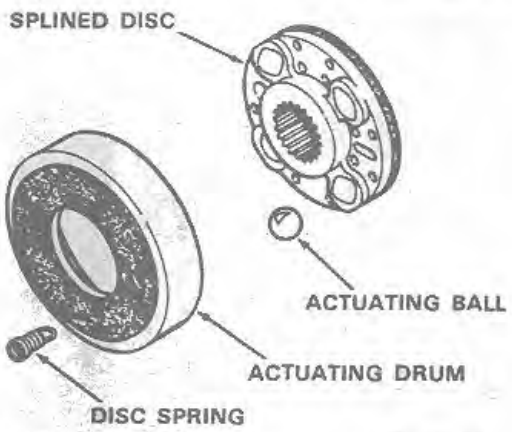
Remove the brake disc assembly from the differential side gear.

STEP 6

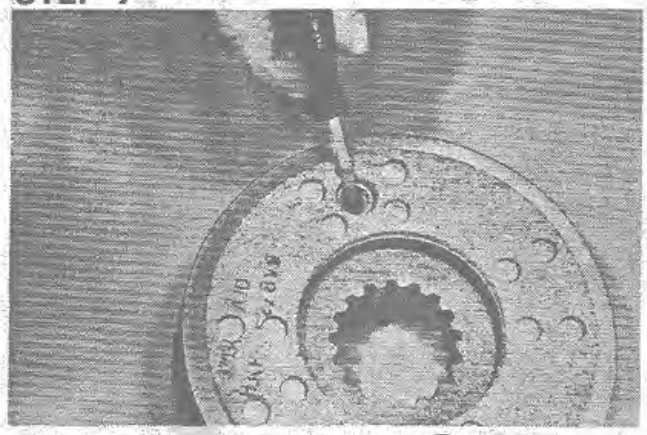


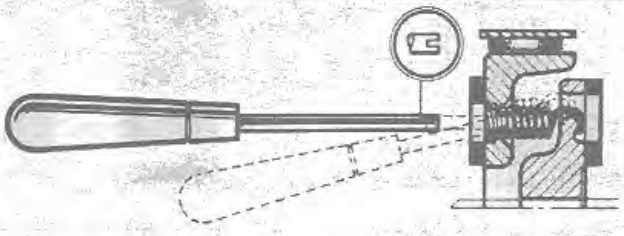
Self adjusting brake assembly removed from transaxle.

Rebuilding Brake Disc Assembly



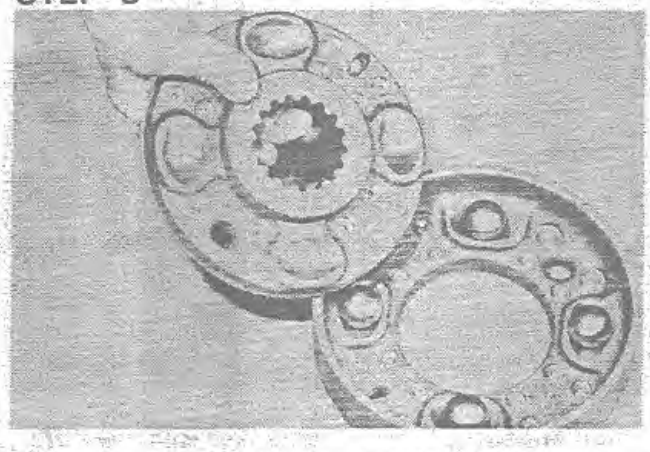
STEP 7





Unhook brake disc springs with a small slotted screwdriver.

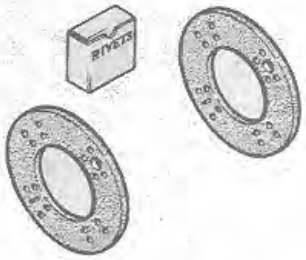
STEP 8



Remove splined disc from actuating drum.

STEP 9

Check discs and lining for excessive wear, warpage, loose linings or oil saturation.

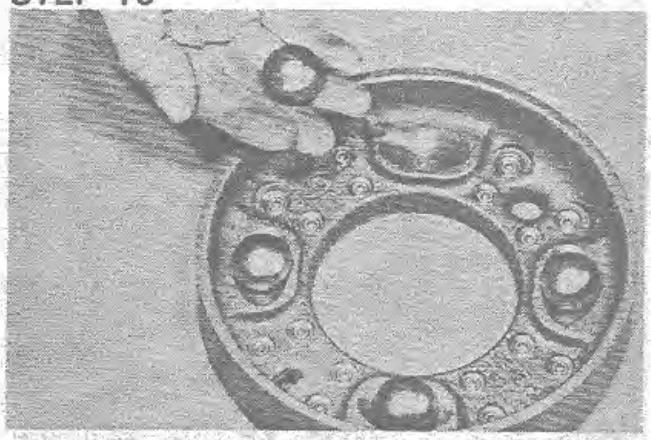


If new linings are to be installed on discs, remove old linings and proceed as follows:

1. Clean the lining mating surfaces.
2. Clamp new linings in place, being careful not to damage linings.
3. Push new rivets through holes from lining side.
4. Form rivet head with a 3/16" tubular rivet clincher, McMaster-Carr No. 6667A-2.

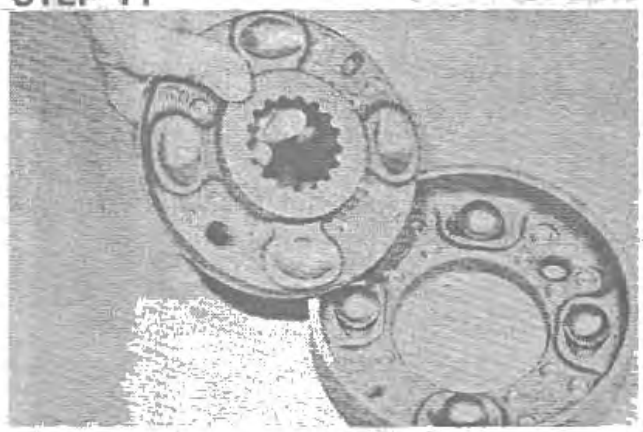
NOTE: If you do not have the proper dies and punches to perform a brake relining job. Take the parts to an automotive center that performs brake relining service, this will prevent damaging linings due to the use of improper tooling, or install new brake disc assembles that have linings already installed.

STEP 10



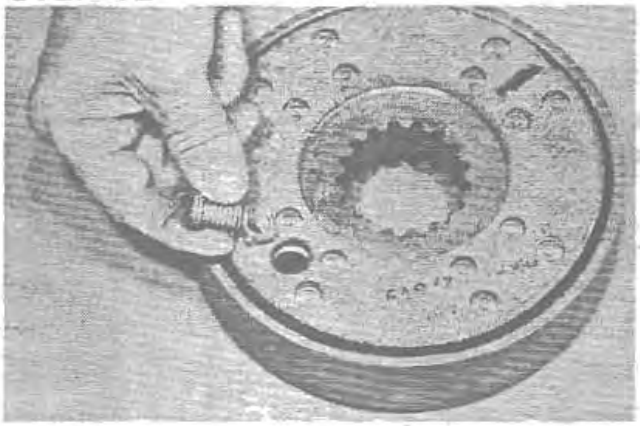
Install the four balls in actuating drum recesses. *NOTE:* Check balls and drum recesses for roughness and replace if necessary.

STEP 11



Install splined disc on actuating drum.

STEP 12

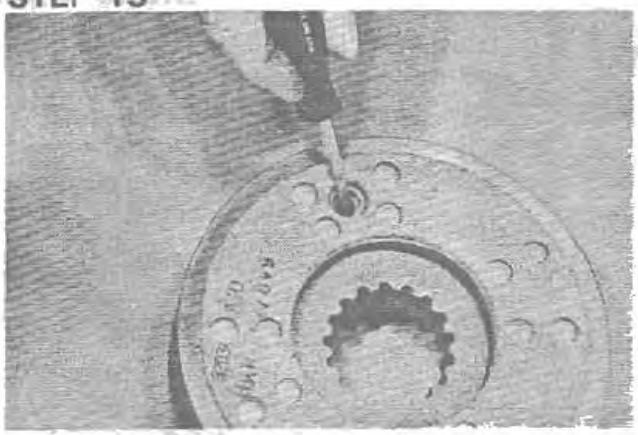


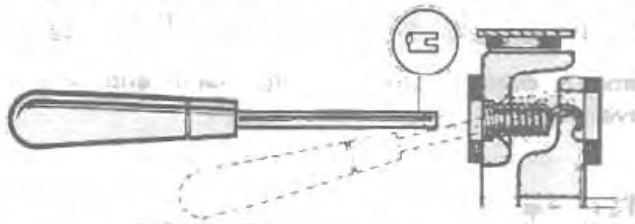
Insert brake disc springs in recess openings.

Brake disc spring specifications:

Free length	1.27"
Wire dia.	.086"
No. of coils	10-1/4 (9 active)
Extend to 1.37"	22.5 to 27.5 lbs.

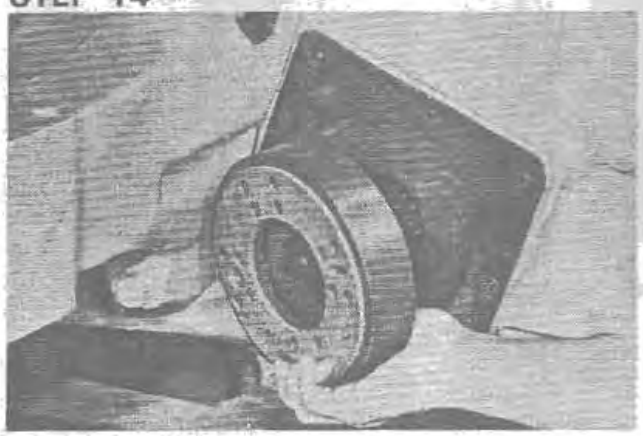
STEP 13





With a slotted screwdriver, hook spring ends over retaining ears.

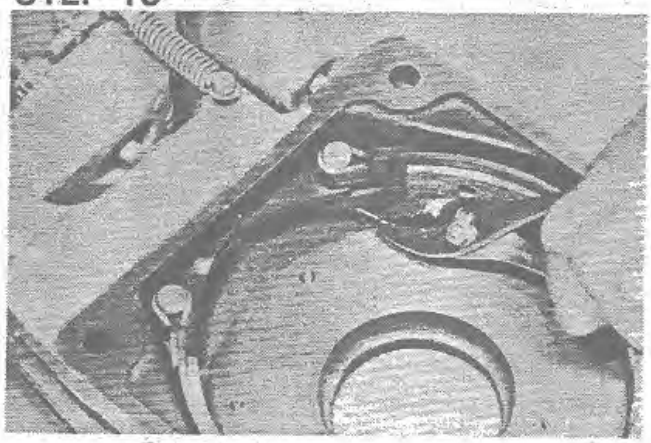
STEP 14



Install brake drum and disc assembly on side gear splines. *NOTE:* Splined disc side must be installed next to transaxle case.

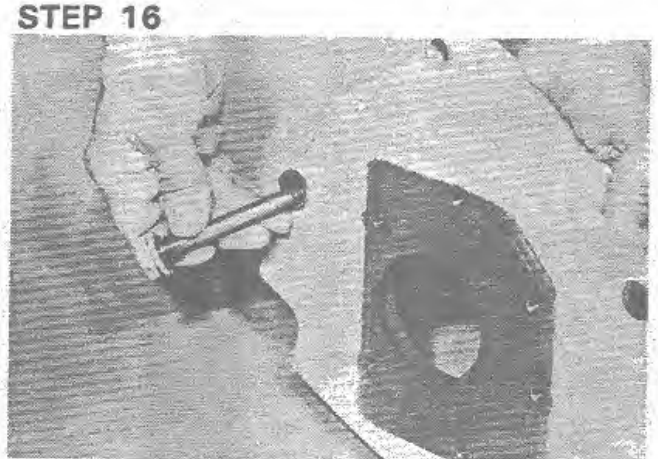
Brake Lining Removal

STEP 15



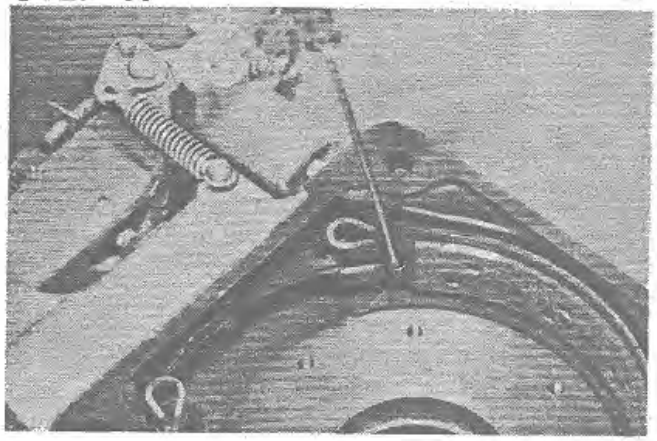
Remove cotter pins securing band and link clevis pins.

STEP 16



Remove brake band anchor bolt.

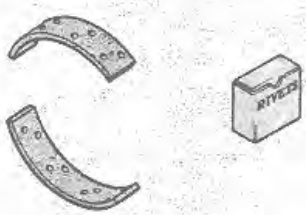
STEP 17



Unhook band return springs and remove bands from brake housing.

STEP 18

Check bands and linings for excessive wear, warpage, loose linings or oil saturation.



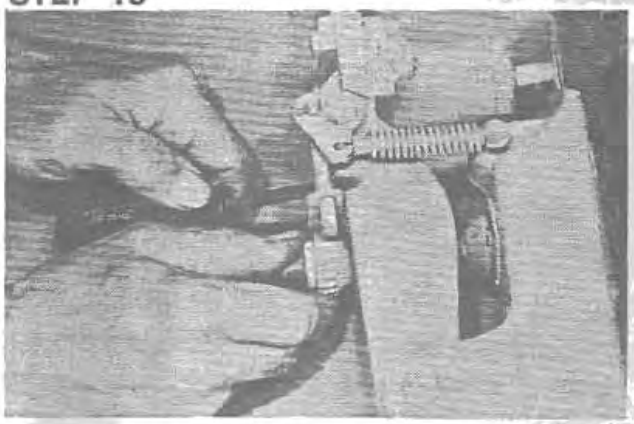
If new linings are to be installed on bands, remove old linings and proceed as follows:

1. Clean the lining mating surfaces.
2. Clamp new linings in place, being careful not to damage linings.
3. Push new rivets through holes from lining side.
4. Form rivet head with a 9/64" tubular rivet clincher, McMaster-Carr No. 6667A-1.

NOTE: If you do not have the proper dies and punches to perform a brake relining job. Take the parts to an automotive center that performs brake relining service, this will prevent damaging linings due to the use of improper tooling, or install new brake band assembles that have linings already installed.

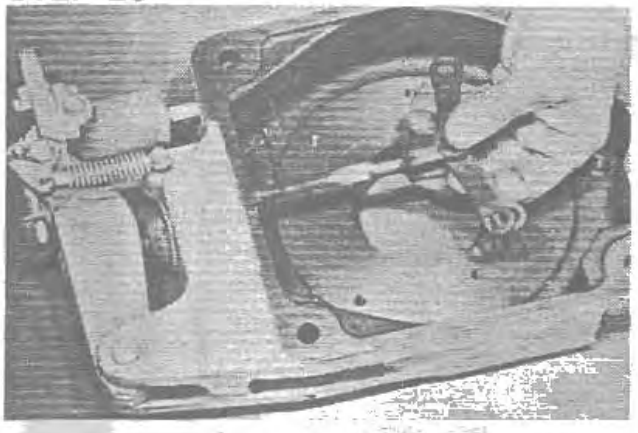
Actuator Removal

STEP 19



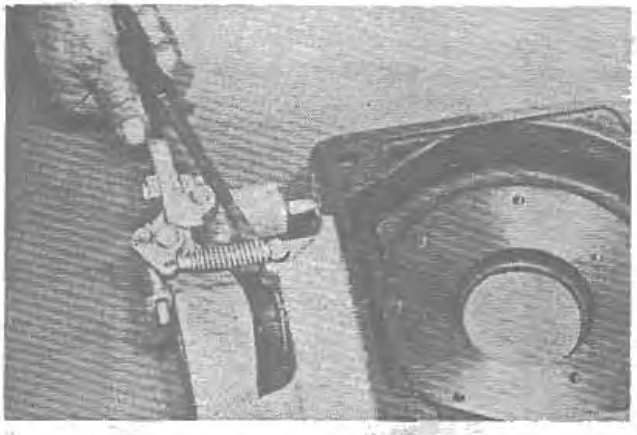
Raise the self-adjusting rod and remove ratchet nut.

STEP 20



Remove the brake actuating rod.

STEP 21



Remove the cam return spring and rod.

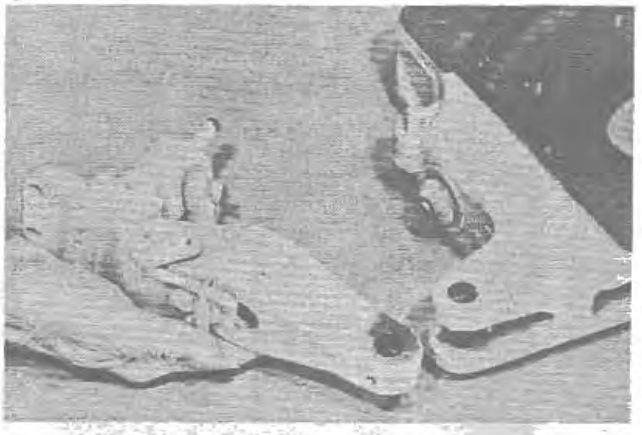
STEP 22

Remove the roll pin retaining brake lever pin.

STEP 23

Remove the brake lever pin from the brake housing.

STEP 24

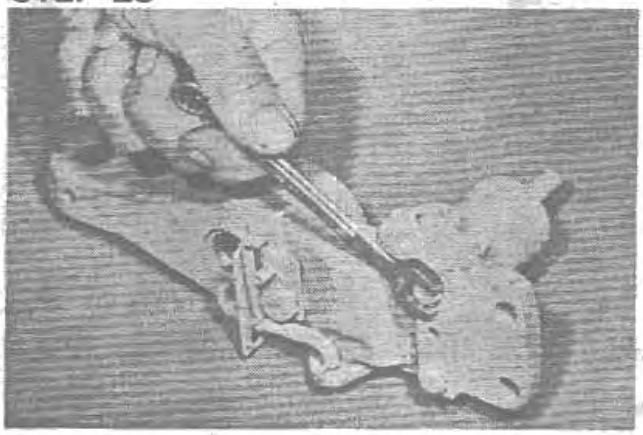


Remove the brake lever from housing.

Rebuilding Hydraulic Brake Cylinder

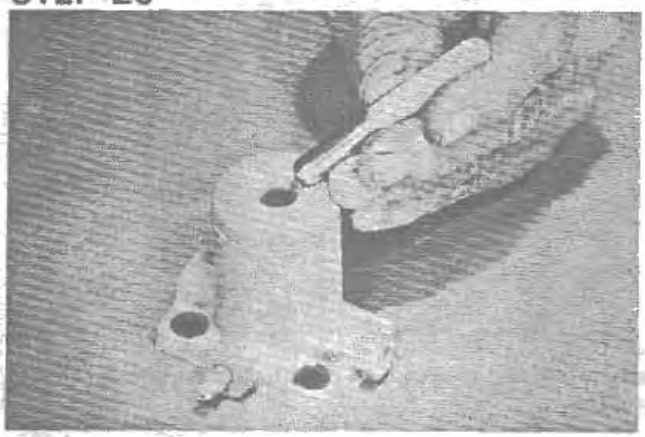
Removal and Disassembly

STEP 25



Remove the bolts securing cylinder to brake lever.

STEP 26

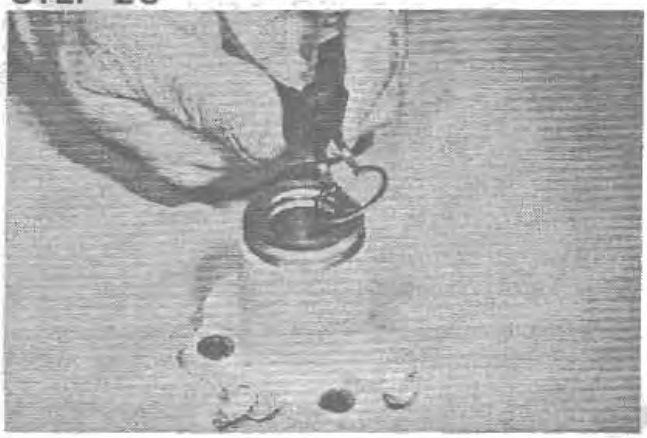


Remove push rod from cylinder body.

STEP 27

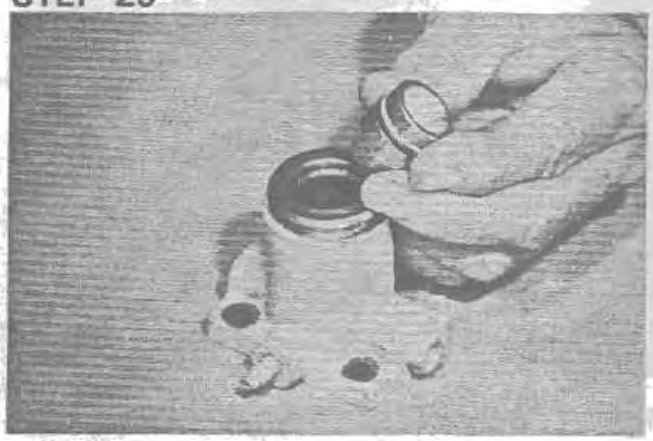
Remove weather seal boot from cylinder body.

STEP 28



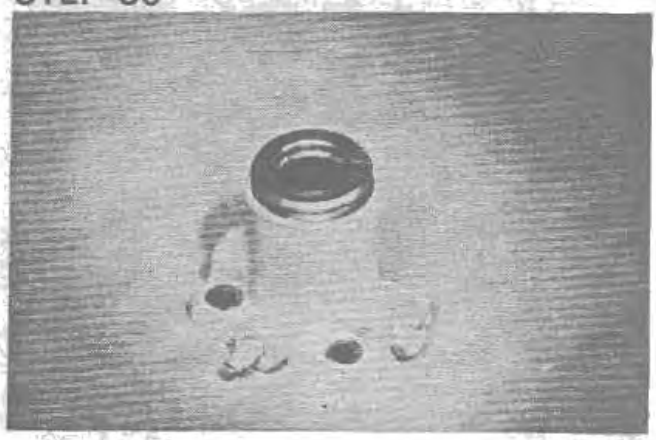
Remove piston retaining snap ring from cylinder body.

STEP 29



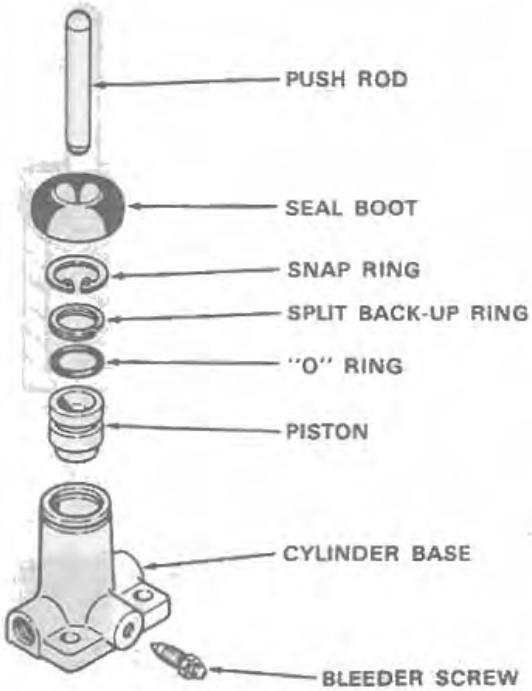
Remove piston assembly from cylinder body.

STEP 30

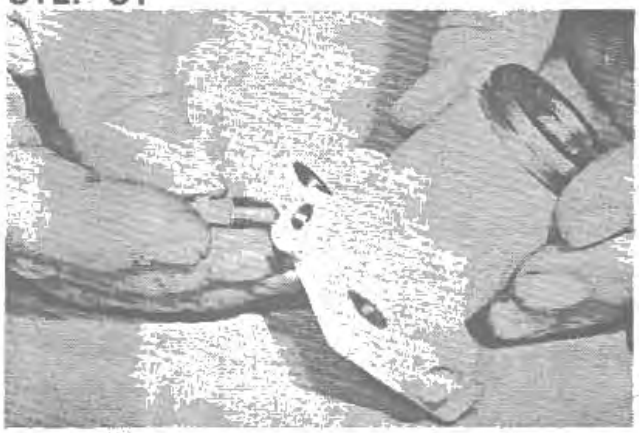


Blow out cylinder body with compressed air and check bore for roughness. Hone cylinder bore if necessary to remove roughness.

Assembly

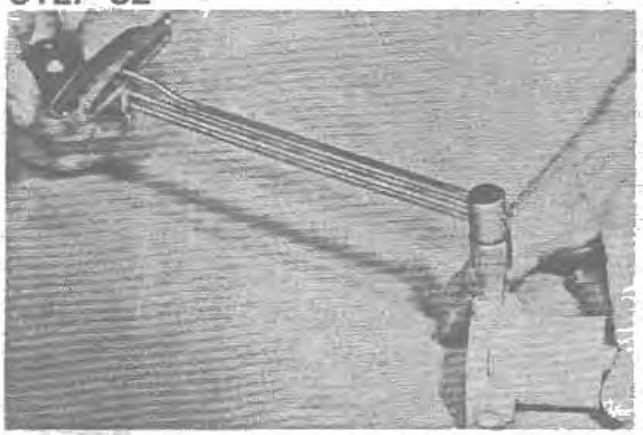


STEP 31



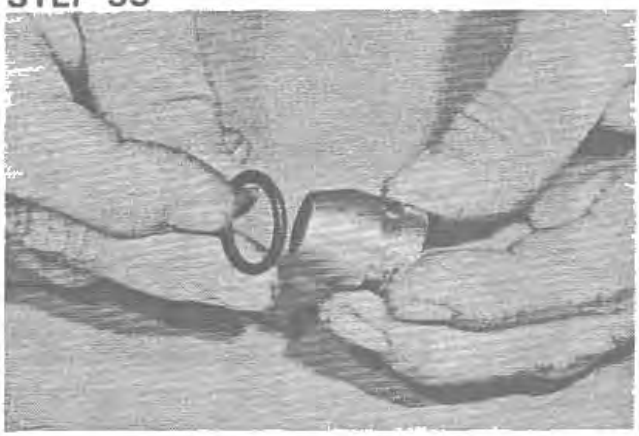
Install bleeder screw in cylinder base.

STEP 32



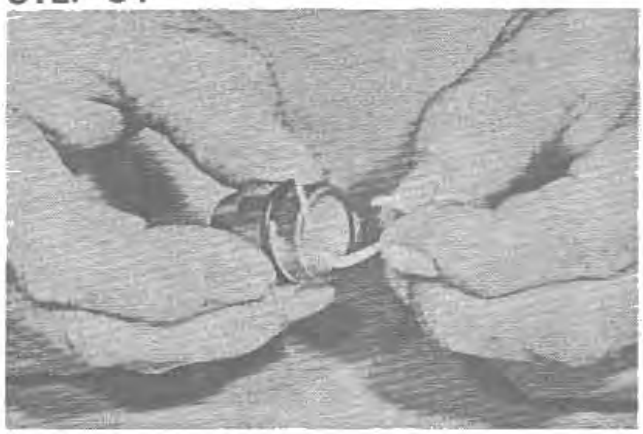
Torque bleeder screw 10 to 50 in. lbs.

STEP 33



Install new "O" ring on cylinder piston.

STEP 34



Install the split backup ring on piston next to the "O" ring.

STEP 35

Clean and lubricate piston and cylinder bore with clean brake fluid. *IMPORTANT:* Do not use oil as an lubricating agent.

STEP 36

Install piston retaining snap ring.

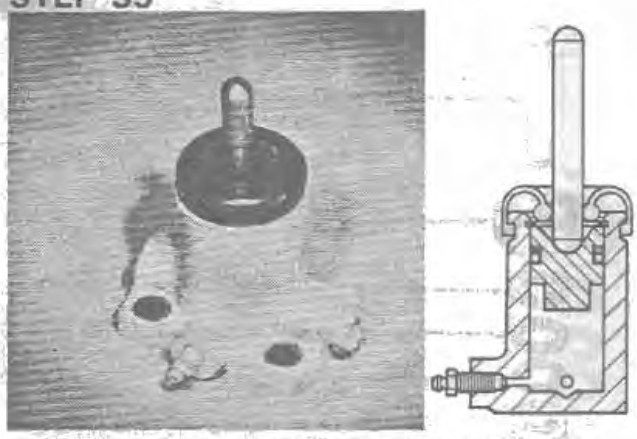
STEP 37

Install a new weather seal boot on cylinder body.

STEP 38

Install push rod through boot opening until it makes contact with piston.

STEP 39

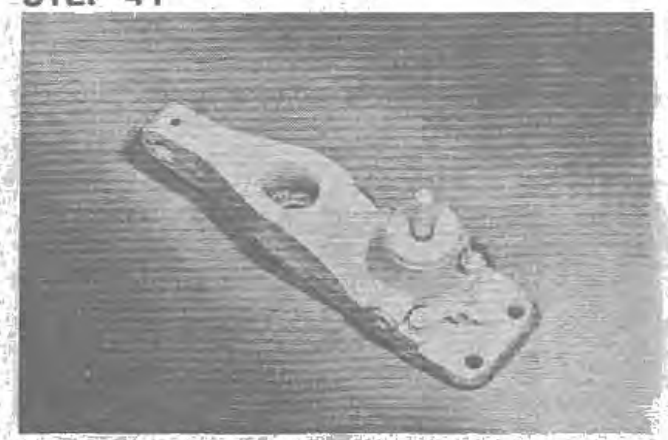


Hydraulic brake cylinder reassembled.

STEP 40

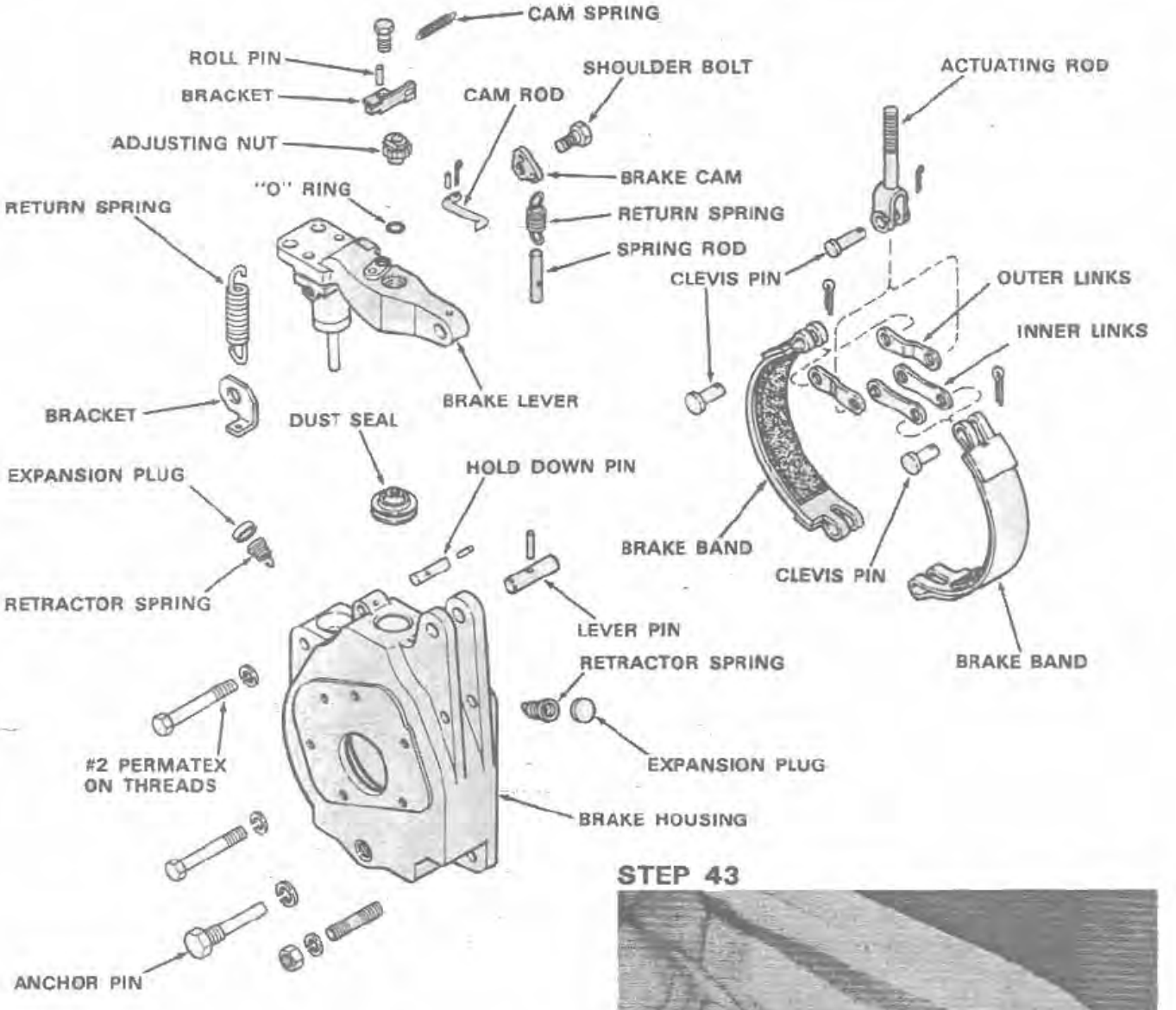
Place brake cylinder on brake lever.

STEP 41



Hydraulic brake cylinder installed on brake lever.

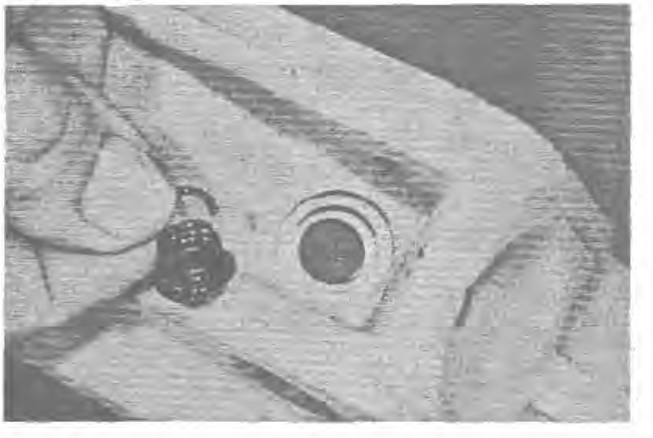
Brake Housing Reassembly



STEP 42

Install a new actuating rod dust seal.

STEP 43

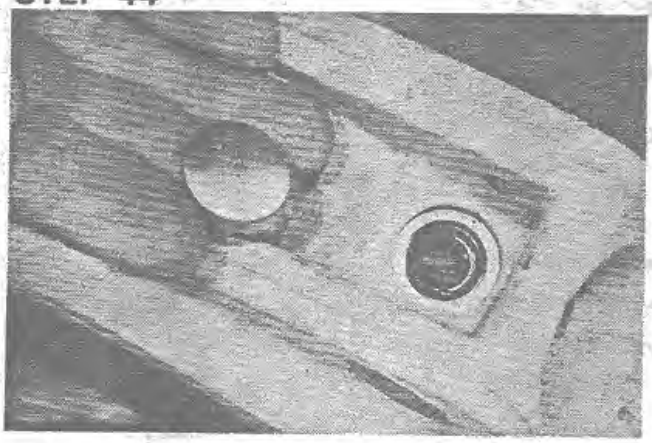


Install band retractor springs in brake cover recesses.

Band retractor spring specifications:

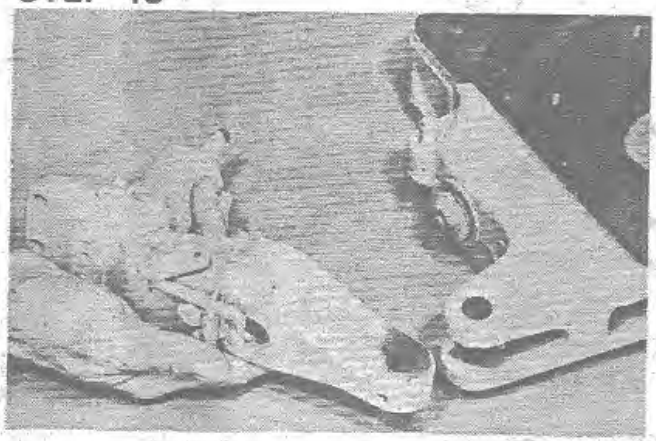
Free length	.66"
Wire dia.	.060"
No. of coils	5-3/4 (4-1/4 active)
Extend to .74"	9 to 11 lbs.

STEP 44



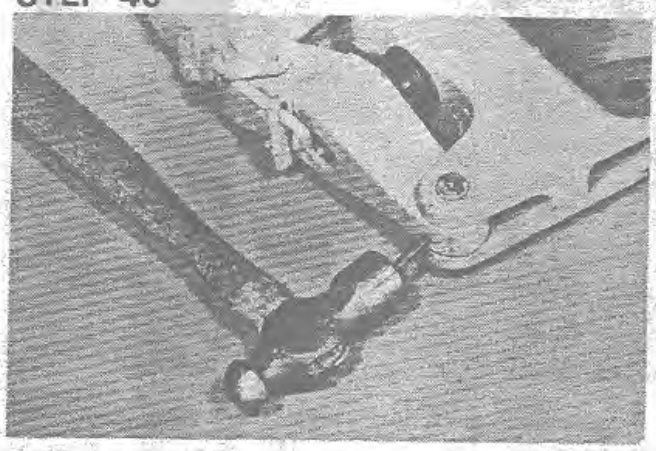
Install expansion plug in spring opening.

STEP 45



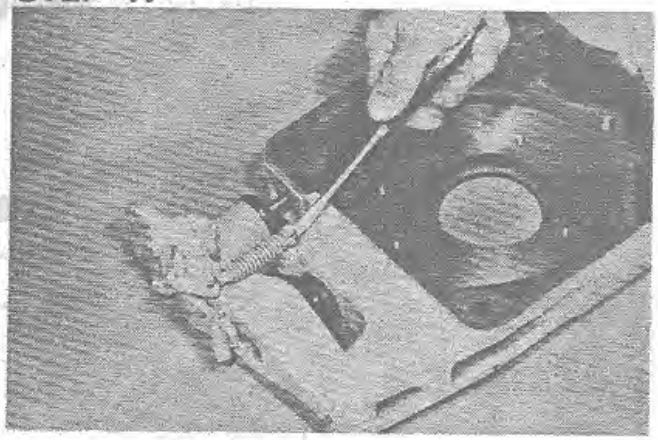
Install brake lever on housing.

STEP 46



Install lever retaining pin, aligning pin hole with lever hole and retain in place with roll pin.

STEP 47

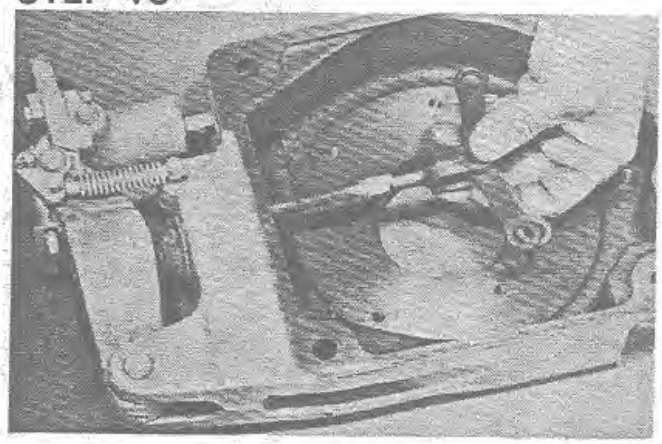


Install cam return spring and rod.

Cam return spring specifications:

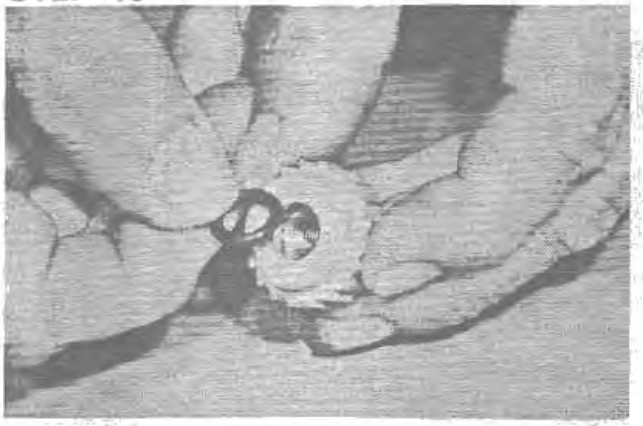
Free length	2.09"
O.D.	.54"
Wire dia.	.086"
No. of coils	15-3/4
Extend to 2.34"	14 lbs.

STEP 48



Install actuating rod with inner and outer band links attached to rod.

STEP 49

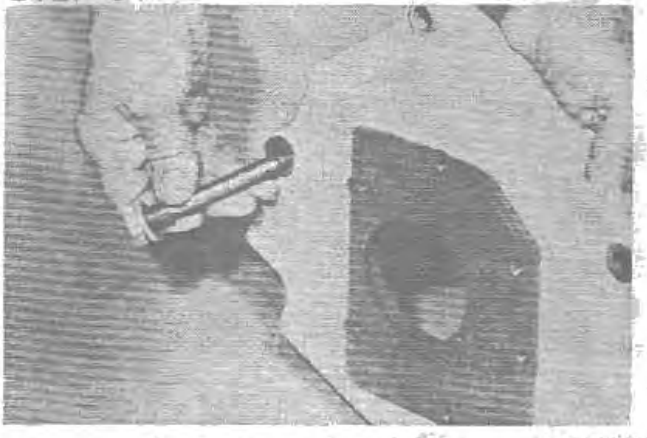


Install a new "O" ring inside of adjusting ratchet nut and install ratchet nut on actuating rod.

STEP 50

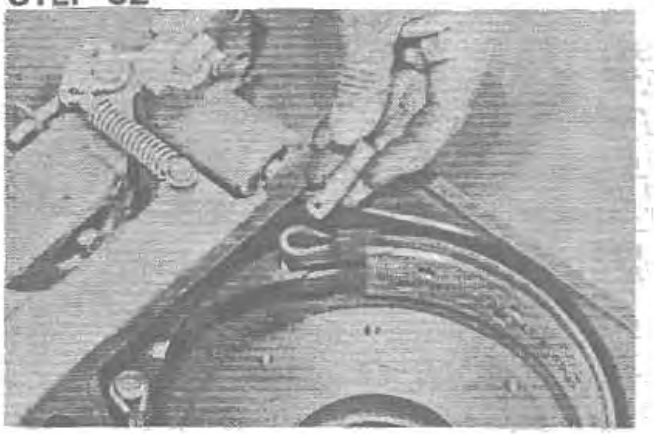
Place brake bands in housing and attach band retractor springs to the band ears.

STEP 51



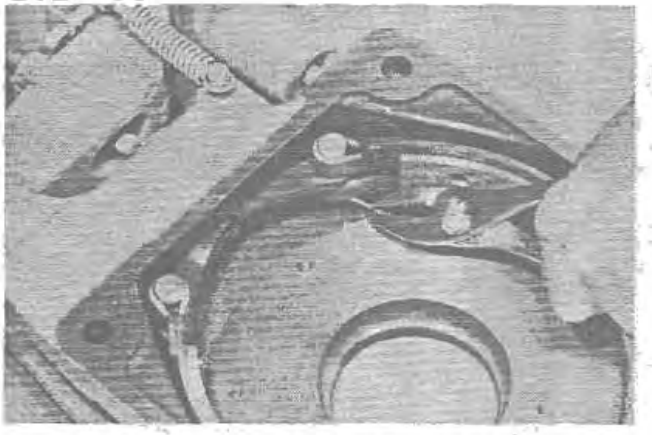
Align pivot ends of bands and install anchor bolt.

STEP 52



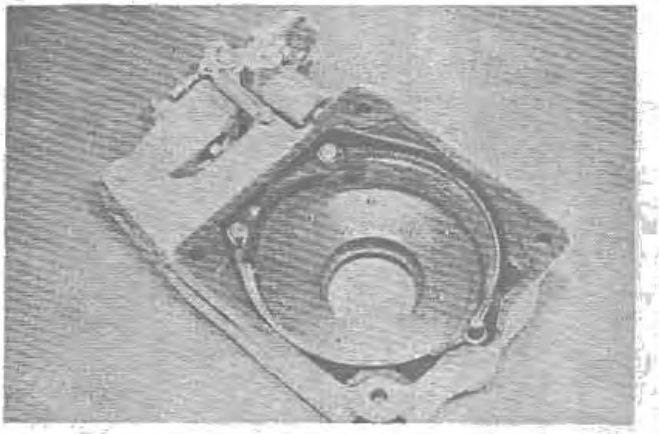
Align bands with attaching links and install retaining clevis pins.

STEP 53



Retain clevis pins in place with new cotter pins.

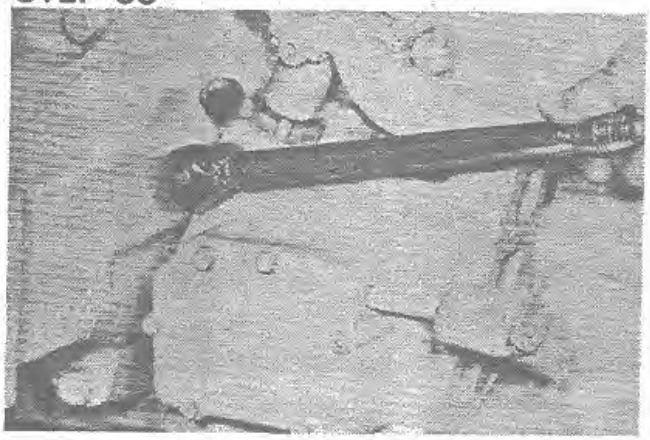
STEP 54



Brake bands installed in brake housing.

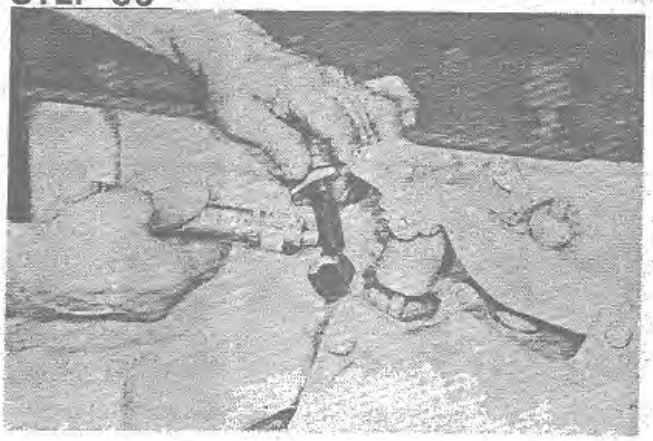
Installation on Transaxle Housing

STEP 55



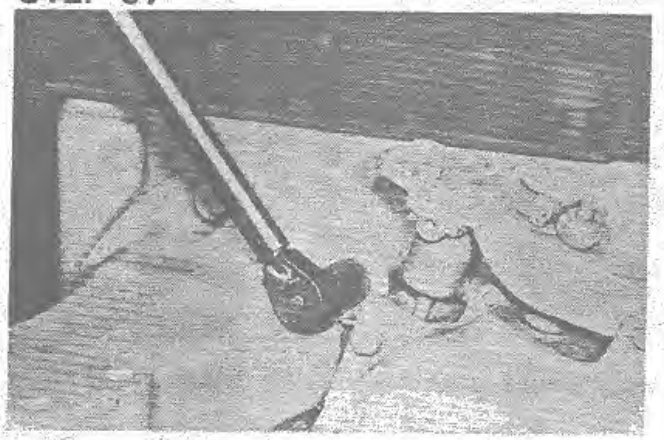
Install brake housing over drum assembly and torque retaining bolts 80 to 96 ft. lbs.

STEP 56



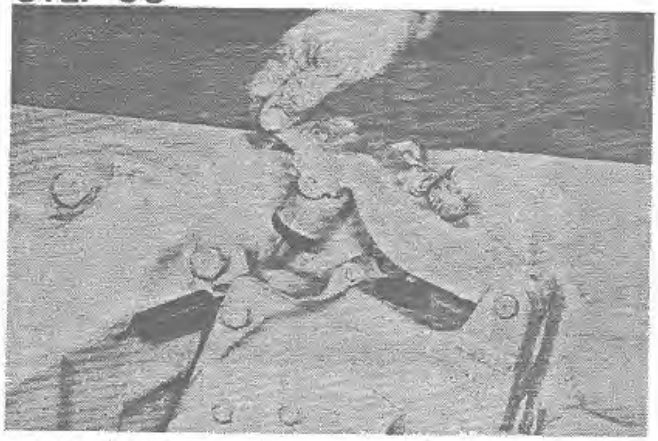
Apply #2 permatex to the first few threads of axle housing bolt.

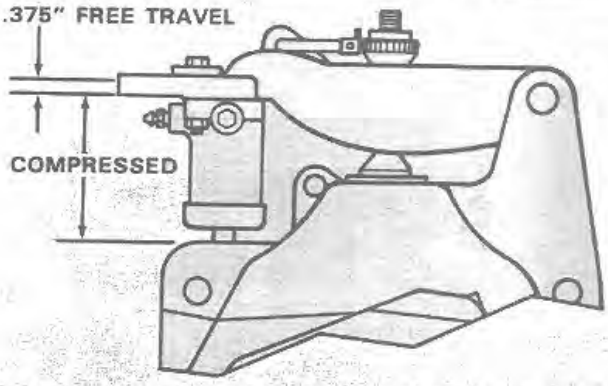
STEP 57



Install axle housing bolt and spring bracket. Torque axle housing bolt as follows: Grade 5 bolt - 150 to 180 ft. lbs., Grade 8 bolt - 220 to 264 ft. lbs.

STEP 58

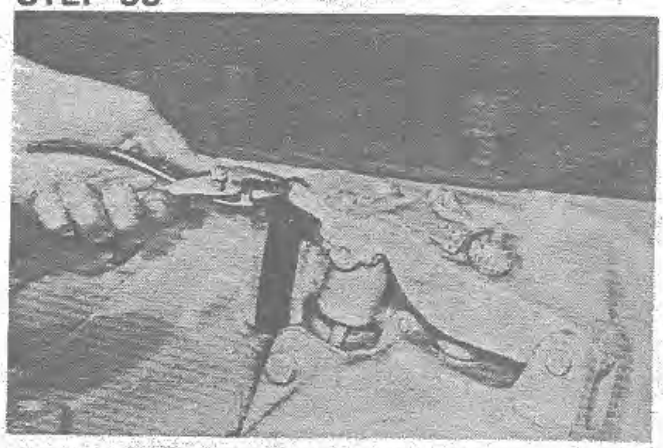




Tighten the self adjusting ratchet by moving brake lever up and down until there is .375" free travel at brake cylinder.

CAUTION *Failure to set free travel at brake cylinder could result in no brake action when depressing brake pedals.*

STEP 59

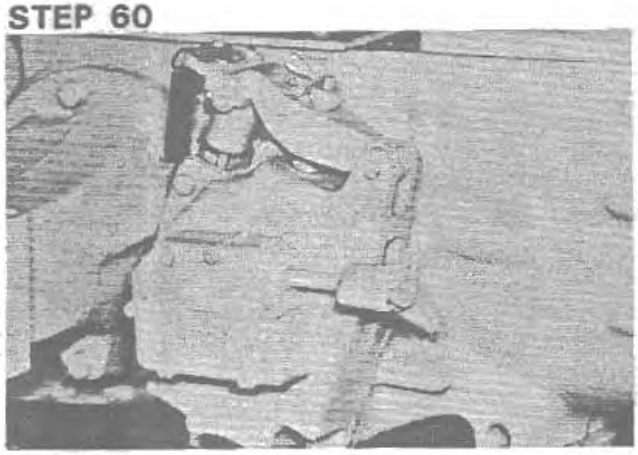


Install brake lever return spring.

Brake lever return spring specifications:

Free length	4"
O.D.	.875"
Wire dia.	.105"
No. of coils	21-1/2
Extend to 6"	34 to 37.5 lbs.

STEP 60



Brake housing installed on transaxle case. Attach linkage and lines to brake cylinder. Refer to Section 7106 for bleeding hydraulic brake cylinder.

Section 8002

TROUBLE SHOOTING

J I Case
A Tenneco Company

TENNECO

C.E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Type of system	12 volt, negative ground
Battery	one 12 volt, to Section 8005
Alternator and voltage regulator	Refer to Section 8007
Starter	Refer to Section 8006
System circuit breaker	40 amperes
Accessory circuit breakers	
Headlights and taillights, backup alarm and horn if not equipped with beacon	15 amperes
Bucket spool magnetic detent and clutch cutout if equipped with power shuttle	10 amperes
Floodlights	15 amperes
Heater and defroster	15 amperes
Windshield wipers	15 amperes
Beacon and horn	15 amperes
Lights	
Cab headlights	No. 4406
Canopy headlights	No. 4411
Floodlights	No. 4411
Combination flood and taillight	
Floodlight	No. 4409X
Taillight	No. 1141
Flasher	No. 1073
Stop and taillight	No. 1157
Beacon	No. 4002
Dipper	No. 4410

TROUBLE SHOOTING CHART

PROBLEM	POSSIBLE CAUSE	REMEDY
Run Down Batteries	Grounded battery cable.	Inspect the cable from the battery positive post to the starting motor. Replace cable if insulation is worn.
	Loose battery cables or broken battery terminal.	Inspect, clean and tighten or replace if necessary.
	Defective battery cell.	Test battery cells. Replace any battery with a dead cell.
	Faulty alternator or regulator causing insufficient charging.	Any of reasons under Alternator Fails To Charge or Low or Unsteady Charging Rate.
	Grounded wiring in charging or starting circuits.	Check all wiring for indication of a ground such as sparks, heat, smoke or discoloration.
	Excessive use of starting motor or other electrical equipment.	Recharge battery.
	Faulty starting circuit.	Inspect starting circuit wiring for ground.
	Dirty battery top causing continued drain on battery.	Check for leakage on dirty battery top, Section 8005. Clean battery.
	Shorted cell in battery.	Test battery, Section 8005. Replace any battery with defective cell.
Starter Not Operating Or Fails to Operate Properly	Faulty 40 amp circuit breaker.	Replace circuit breaker.
	Discharged battery.	Test battery. If necessary, place on slow charger. If battery is continually discharged, test regulator and alternator.
	Faulty battery ground wire.	Check for loose connections, corrosion or breaks.
	Faulty wiring or loose connections in starting circuit.	Use wiring diagram and trace out starting circuit checking for poor connections and broken or shorted wires.
	Faulty key switch, starter button or neutral switch.	Replace parts as required.

PROBLEM	POSSIBLE CAUSE	REMEDY
Starter Not Operating or Fails to Operate Properly (Cont'd)	Engine oil too heavy for outside temperature.	Refer to Lubricants and Fluids Chart in Section 1050, Maintenance and Lubrication.
	High resistance in starter positive or ground circuits.	Test circuits. For procedure and specifications, see page 8002-10.
	Worn starter drive or flywheel ring gear teeth.	Remove starter and inspect teeth.
	Loose starter mounting.	Inspect and tighten.
	Worn brushes or faulty armature or field coil or other defect in starter.	Perform No-Load Test as instructed in Section 8006. If starter fails test, disassemble starter and repair as required.
	Open, grounded, or shorted windings in starter motor solenoid.	Check solenoid, Section 8006. Replace solenoid if required.
Alternator Fails To Charge	Alternator belt loose or broken.	Tighten to specification on page 8007-27 or replace.
	Open or high resistance in charging or ground circuits.	Refer to Alternator and Voltage Regulator Testing. Section 8007.
	Worn brushes or open brush leads or connections.	Replace brushes or replace brush holder assembly.
	Open, ground or short in stator winding.	Refer to Component Tests in Section 8007 Replace stator.
	Faulty regulator.	Refer to Alternator and Voltage Regulator Testing in Section 8007. Replace regulator.
	Shorted or open rectifier diodes.	Refer to Component Tests in Section 8007.
	Open, ground, or short in rotor (field) winding.	Refer to Component Tests in Section 8007. A faulty rotor must be replaced.
	Wires inproperly connected after repairs.	Refer to wiring diagrams in Section 8003.
	Dirty slip rings or poor slip ring connections.	Inspect slip rings. Clean or repair as required.

PROBLEM	POSSIBLE CAUSE	REMEDY
Low or Unsteady Charging Rate	All of reasons under Alternator Fails to Charge.	
Excessive Charging Rate. Lights Burning Out	Improper or loose connections on alternator and regulator.	Check for proper connections and tighten if necessary.
	Faulty regulator.	Refer to Alternator and Voltage Regulator Testing in Section 8007.
Batteries Require Too Frequent Filling	Faulty regulator permitting excessive charging rate.	Refer to Alternator and Voltage Regulator Testing in Section 8007.
Noisy Alternator	Defective or badly worn belts.	Replace belts.
	Misaligned or defective pulleys.	Align fan and alternator pulleys.
	Loose pulley.	Check for sheared key or worn keyway, if used. Tighten pulley nut.
	Worn bearings.	Replace bearings.
	Shorted rectifier diodes.	Refer to Component Tests in Section 8007.
Continuity Test Shows No Voltage Through Wire Harness	Harness plugs not fully engaged.	Make sure plugs are fully engaged.
	One or more studs on plug broken.	Replace harness.
	Incorrect wiring.	Check wiring diagram, Section 8003.
	Open or shorted wire in harness.	Replace harness.

TROUBLE SHOOTING THE CHARGING CIRCUIT

The following checks are listed in ease of performing and as near as possible in the order of malfunction occurrence.

CHECK	DETAILED INSTRUCTIONS
Visual check	1. Check for damaged wiring, loose and corroded terminal and harness plug connection. Repair as required. 2. Check fan belt condition and tension. Adjust or replace belt as required. 3. Check battery fluid level. Refer to Section 8005.
Check condition of battery	1. Clean battery top to eliminate voltage loss. 2. Check specific gravity. Refer to Section 8005. 3. Perform Capacity Test as instructed in Section 8005. 4. Check for battery case damage that would result in fluid loss or admission of dirt into cell(s). 5. Replace missing fill caps. 6. Before continuing trouble shooting, install a battery post adapter, Figure 1, on the negative battery post. Then attach cable to adapter. Test equipment will be connected to the adapter later in the procedure.
Check voltage at alternator	1. Connect voltmeter negative lead to the alternator frame. Connect voltmeter positive lead to the Prestolite alternator Output terminal or the Delco-Remy alternator Bat terminal; battery voltage should be indicated.

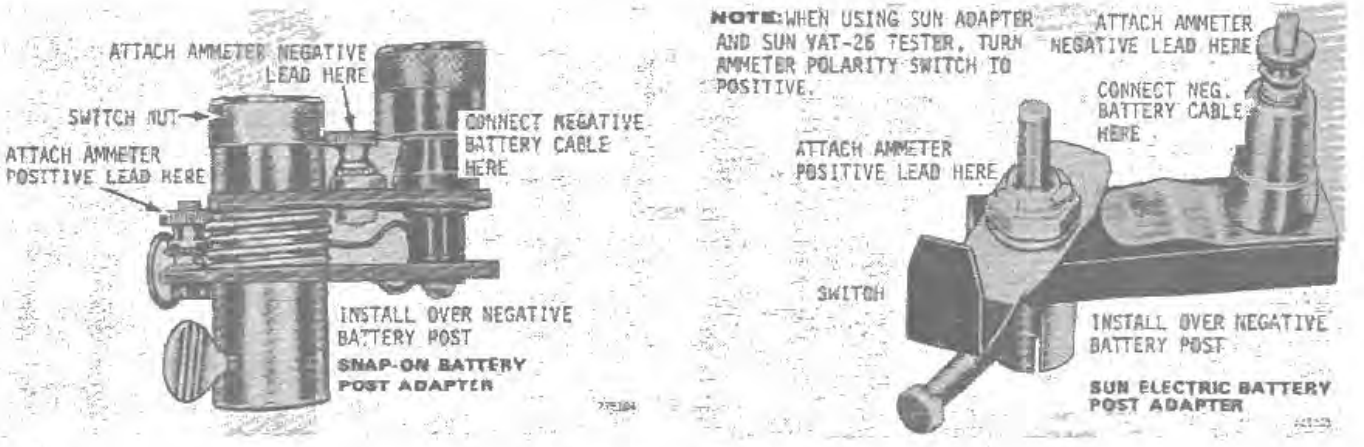


Figure 1 - Battery Post Adapter

CHECK	DETAILED INSTRUCTIONS
Check voltage at alternator (cont'd)	2. If equipped with a Prestolite alternator, turn key switch on and check voltage at the alternator Output, Auxiliary and Field terminals. a. Voltage at the Output terminal should be battery voltage to about 1/2 volt less than battery voltage. b. Voltage at the Auxiliary terminal should be about 2 volts less than battery voltage. c. Voltage at the Field terminal should be about 1-1/2 volts to 2-1/2 volts less than battery voltage. 3. If equipped with a Delco-Remy alternator, turn key switch on and check voltage at the alternator Bat and No. 1 and No. 2 terminals. a. Voltage at the Bat terminal should be battery voltage to about 1/2 volt less than battery voltage. b. Voltage at terminal No. 1 should be about 2-1/2 volts to 3 volts less than battery voltage. c. Voltage at terminal No. 2 should be battery voltage to about 1/2 volt less than battery voltage.
Check alternator output	1. Refer to Section 8007 for instructions. If necessary remove alternator for repair. Continue trouble shooting procedure.
Check wiring and terminal	1. Connect the positive lead of test ammeter to the alternator Output or Bat terminal and the negative lead to the battery post adapter, Figure 1. 2. Connect a carbon pile to the battery terminals. Make sure carbon pile is OFF before making connections. 3. Start engine and run at 1/2 throttle. Adjust carbon pile to obtain a 10 amp charge rate on the test ammeter. 4. Connect voltmeter positive lead to alternator Output terminal and negative lead to positive battery post. The voltage drop should not exceed .3 volt. If voltage drop exceeds .3 volt, clean and Continued on next page

CHECK	DETAILED INSTRUCTIONS
Check wiring and terminal conductivity (cont'd)	tighten cable connections at battery and starter and check voltage drop again. If voltage drop is still excessive, the cable must be replaced. 5. Move voltmeter positive lead to negative battery post and negative lead to the alternator frame. The voltage drop should not exceed .1 volt. If voltage drop exceeds .1 volt, clean and tighten all connections between the starter and battery and check voltage again. If voltage drop is still excessive one or both ground cables must be replaced.
Check voltage regulator	1. Refer to Section 8007 for instructions. 2. Remove battery post adapter after trouble shooting is complete.

TROUBLE SHOOTING THE STARTING CIRCUIT

General Inspection

Many starting problems can be solved by making the following checks:

1. Check for open 40 amp circuit breaker.

2. Determine battery condition. Refer to Section 8005. Charge or replace battery as required. Clean battery posts and cable connectors.

3. Inspect wiring for frayed insulation or other damage. Inspect all connections at the starter solenoid, key switch, starter button and ammeter. Clean and tighten all connections and replace any faulty wiring. Check to see that wiring harness plugs are properly engaged. Also check plugs for damaged or missing pins and corrosion.

4. If the starter still fails to operate after remedying defects, check out the starting circuit.

Starting Circuit Check

The following steps will locate defects in the starting circuit. The circuit may be checked using a 12 volt test lamp or a voltmeter.

1. Apply parking brake and make sure all controls are in neutral and pull fuel shutoff cable out.

2. Refer to Figure 2. Connect a jumper cable to the starter solenoid B and S terminals.

   a. If the starter operated properly, the starter and solenoid are good, and the problem is somewhere between the solenoid and key switch. Proceed to step 3 and check out starting circuit.

   b. If the starter failed to operate, connect the jumper cable to the B and M terminals on the starter solenoid. If the starter operated properly, the solenoid is defective and must be replaced. If the starter still fails to operate, the starter is defective and must be repaired or replaced.

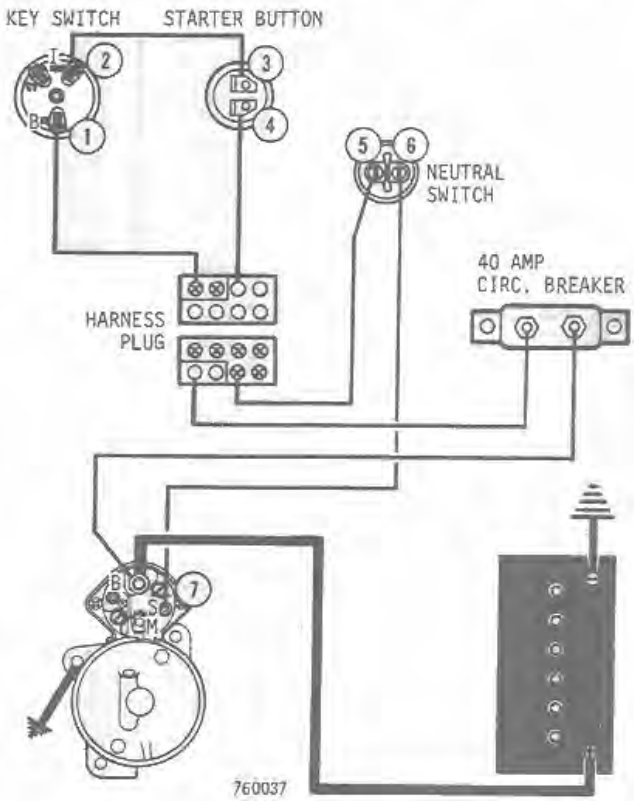


Figure 2 - Starter Circuit

3. Refer to Figure 2 and check for battery voltage at test point 1. No voltage indicates the circuit between the key switch and starter solenoid B terminal is faulty. Check circuit breaker, harness connections and wiring and repair as required.

4. Turn key switch on and check for voltage at test points 2 and 3. Proceed to step 5 if voltage was indicated at each test point.

5. With key switch on, have someone hold starter button in and check for voltage at test points, 4, 5, 6 and 7.

Checking the Insulated and Ground Circuits

For these tests, the starter remains on the engine. A suitable tester (such as a Sun

Battery/Starter Tester) equipped with a voltmeter, ammeter, and means of varying the load will be required.

Specifications

Minimum cranking voltage	9.6 volts
Maximum voltage drop	
Insulated circuit	.5 volt
Each cable	.4 volt
Starter solenoid	.1 volt
Each connection	.0 volt
Ground circuit	.5 volt
Test temperature	60° to 80° F. (15.6° to 26.7° C)

Test 1 - Determining Cranking Voltage

1. Attach positive voltmeter lead to positive battery terminal and negative voltmeter lead to negative battery terminal (ground).

2. Crank engine and record voltage reading.

3. Voltmeter should read at least 9.6 volts. If above the minimum, continue testing. If below minimum, replace or recharge battery.

Test 2 - Insulated Circuit Test

This test will reveal any excessive resistance in the circuit from the battery through the starter solenoid.

1. Refer to Figure 3. Move positive voltmeter lead to the M terminal on starter. Negative voltmeter lead remains on battery.

2. Crank engine and record voltage reading.

3. Subtract this reading from the figure recorded in Test 1. This is the voltage drop in the entire insulated circuit. If drop is .5 volt or less, perform Test 4. If drop is over .5 volt, proceed to Test 3 below.

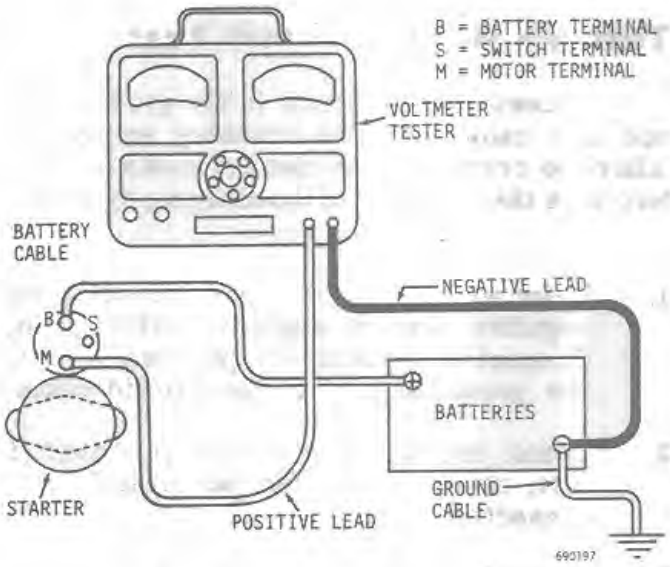


Figure 3 - Insulated Circuit Test

Test 3 - Isolating Insulated Circuit Defects

These two tests will isolate the defect in the insulated circuit which showed up in Test 2.

1. CABLE, BATTERY TO SOLENOID TERMINAL. Connect positive voltmeter lead to positive battery post. Connect negative voltmeter lead to B terminal on solenoid. Crank engine. If voltage drop is .4 volt or less, proceed to step 2. If drop is over .4 volt, replace the cable.

2. SOLENOID. Connect positive voltmeter lead to B terminal on solenoid. Connect negative voltmeter lead to M terminal on solenoid. Crank engine. If drop is over .1 volt, repair or replace solenoid.

Test 4 - Ground Circuit Test

Excessive resistance in the ground circuit can cause sluggish cranking action or failure to crank and can also seriously interfere with the operation of the charging system.

1. Refer to Figure 4. Connect the voltmeter negative lead to negative battery post. Connect the voltmeter positive lead to the grounded end of the ground cable.
2. Crank engine. If voltage drop is over .5 volt, clean and tighten the ground cable connections.
3. Recheck the voltage drop, if still over .5 volt, replace the ground cable.

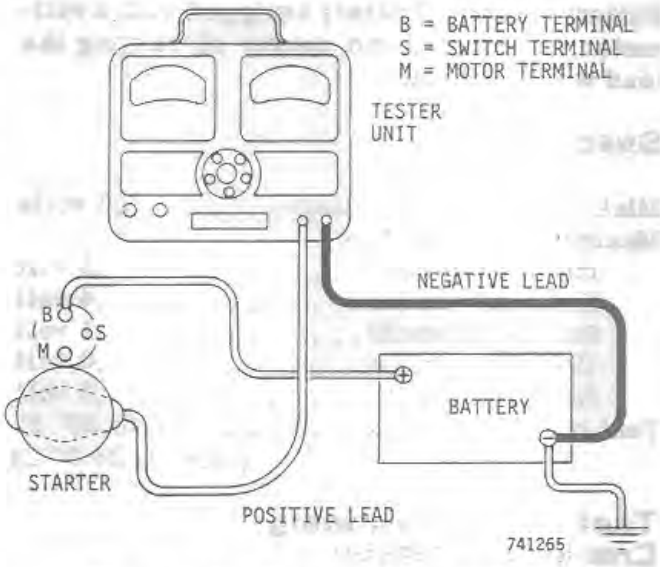


Figure 4 - Ground Circuit Test

Section 8003

WIRING DIAGRAMS

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

The information on this page applies only to Figure 1.

WIRING COLOR KEY

1. Red
2. Yellow-White
3. Yellow
4. Purple
5. Light Green
6. White
7. Yellow-Black
8. Purple-Red
9. Pink
10. Gray
11. Orange
12. Black
13. Red-Black
14. White-Orange
15. Yellow-Red
16. Purple-White
17. Light Blue
18. Blue

COMPONENTS

A. Illumination Light
B. R.H. Turn Signal, Refer to Figure 4 or 5
C. Not Used
D. Hyd. Oil Filter Warning Light
E. Air Cleaner Warning Light
F. Alt. Warning Light
G. Eng. Oil Pressure Warning Light
H. L.H. Turn Signal, Refer to Figure 4 or 5
I. Trans. Oil Temp.
J. Voltmeter
K. Eng. Water Temp.
L. Fuel Level Gauge
M. Battery
N. Turn Signal Switch, Refer to Figure 4 or 5
O. Turn Signal and 4 Way Flasher, Refer to Figure 4 or 5
P. Horn Button, Refer to Section 8015
Q. Connects to Cluster
R. Key Switch
S. Connects to Key Switch
T. Starter Button
U. Clutch Cutout Control
V. Light Switch
W. Flood Light Switch
X. Flasher Switch
Y. Rotating Beacon
Z. Air Filter and Hydraulic Oil Filter Restriction Warning Light Check Switch

AA. Flood Light, Turn Signal & Brake Light 15 Amp Circuit Breaker, Refer to Figure 4 or 5
BB. Clutch Cutout and Return-to-Dig 10 Amp Circuit Breaker
CC. Backup Alarm & Lights 15 Amp Circuit Breaker, Refer to Figure 4 or 5 & Section 8015
DD. Heater and Defroster 15 Amp Circuit Breaker, Refer to Section 8015
EE. Wipers & Rotating Beacon 15 Amp Circuit Breaker, Refer to Figure 4 or Section 8015
FF. Horn and Rotating Beacon 15 Amp Circuit Breaker, Refer to Section 8015
GG. Relay Powers Circuits Controlled by Circuit Breakers DD, EE, and FF
HH. Relay Powers Circuits Controlled by Circuit Breakers AA, BB, and CC
II. Instrument Cluster
JJ. Return-to-Dig Circuit Diode
KK. Neutral Start Switch
LL. Trans. Temp. Sender
MM. Clutch Cutout Circuit Diode
NN. Connects to Trans. Clutch Cutout Solenoid
OO. Not Used.
PP. Connects Upper and Lower Power Shuttle Harness Together
QQ. Warning Switch Circuit Diode (Air Filter Restriction Indicator)
RR. Warning Switch Circuit Diode (Hydraulic Oil Filter Restriction Indicator)
SS. Brake Pedal Actuated Clutch Cutout Switch
TT. Connects to Light Harness, Refer to Figure 4 or 5 or Section 8015
UU. Floor Mounted Clutch Cutout Switch
VV. Engine Oil Pressure Sender
WW. Connects From Engine Harness to Main Harness
XX. 40 Amp Circuit Breaker
YY. Hydraulic Oil Filter Restriction Indicator Switch
ZZ. Fuel Level Sender

AAA. Return-to-Dig Switch
BBB. Starter
CCC. Engine Water Temp. Sender
DDD. Air Filter Restriction Indicator Switch
EEE. Alternator
FFF. Connects to Bucket Spool Detent

The information on this page applies only to Figure 2.

WIRING COLOR KEY

1. Red
2. Yellow-White
3. Yellow
4. Purple
5. Light Green
6. White
7. Yellow-Black
8. Purple-Red
9. Pink
10. Gray
11. Orange
12. Black
13. Red-Black
14. White-Orange
15. Purple-White
16. Light Blue
17. Blue

COMPONENTS

A. Illumination Light
B. R.H. Turn Signal, Refer to Figure 4 or 5
C. Not Used
D. Hyd. Oil Filter Warning Light
E. Air Cleaner Warning Light
F. Alt. Warning Light
G. Eng. Oil Pressure Warning Light
H. L.H. Turn Signal, Refer to Figure 4 or 5
I. Trans. Oil Temp.
J. Voltmeter
K. Eng. Water Temp.
L. Fuel Level Gauge
M. Battery
N. Turn Signal Switch, Refer to Figure 4 or 5
O. Turn Signal and 4 Way Flasher, Refer to Figure 4 or 5
P. Horn Button, See Section 8015
Q. Connects to Inst. Cluster
R. Key Switch
S. Connects to Key Switch
T. Starter Button
U. Clutch Cutout Control
V. Light Switch
W. Flood Light Switch
X. Flasher Switch
Y. Rotating Beacon Switch
Z. Air Filter and Hydraulic Oil Filter Restriction Warning Light Check Switch

AA. Flood Light, Turn Signal & Brake Light 15 Amp Circuit Breaker, Refer to Figure 4 or 5
BB. Clutch Cutout and Return-to-Dig 10 Amp Circuit Breaker
CC. Backup Alarm & Lights 15 Amp Circuit Breaker, Refer to Figure 4 or 5 & Section 8015
DD. Heater and Defroster 15 Amp Circuit Breaker, Refer to Section 8015
EE. Wipers and Rotating Beacon 15 Amp Circuit Breaker, Refer to Figure 4 or Section 8015
FF. Horn and Rotating Beacon 15 Amp Circuit Breaker, Refer to Section 8015
GG. Relay Powers Circuits Controlled by Circuit Breakers DD, EE and FF
HH. Relay Powers Circuits Controlled by Circuit Breakers AA, BB and CC
II. Instrument Cluster
JJ. Return-to-Dig Circuit Diode
KK. Neutral Start Switch
LL. Trans. Temp. Sender
MM. Clutch Cutout Circuit Diode
NN. Connects to Trans. Clutch Cutout Solenoid
OO. Connects Upper and Lower Power Shuttle Harness Together
PP. Warning Switch Circuit Diode (Air Filter Restriction Indicator)
QQ. Warning Switch Circuit Diode (Hydraulic Oil Filter Restriction Indicator)
RR. Brake Pedal Actuated Clutch Cutout Switch
SS. Floor Mounted Clutch Cutout Switch
TT. Connects to Light Harness, Refer to Figure 4 or 5 or Section 8015
UU. Engine Oil Pressure Sender
VV. Connects from Engine Harness to Main Harness
WW. 40 Amp Circuit Breaker
XX. Hydraulic Oil Filter Restriction Indicator Switch
YY. Fuel Level Sender
ZZ. Return-to-Dig Switch

AAA. Starter
BBB. Engine Water Temp. Sender
CCC. Air Filter Restriction Indicator Switch
DDD. Alternator
EEE. Connects to Bucket Spool Detent

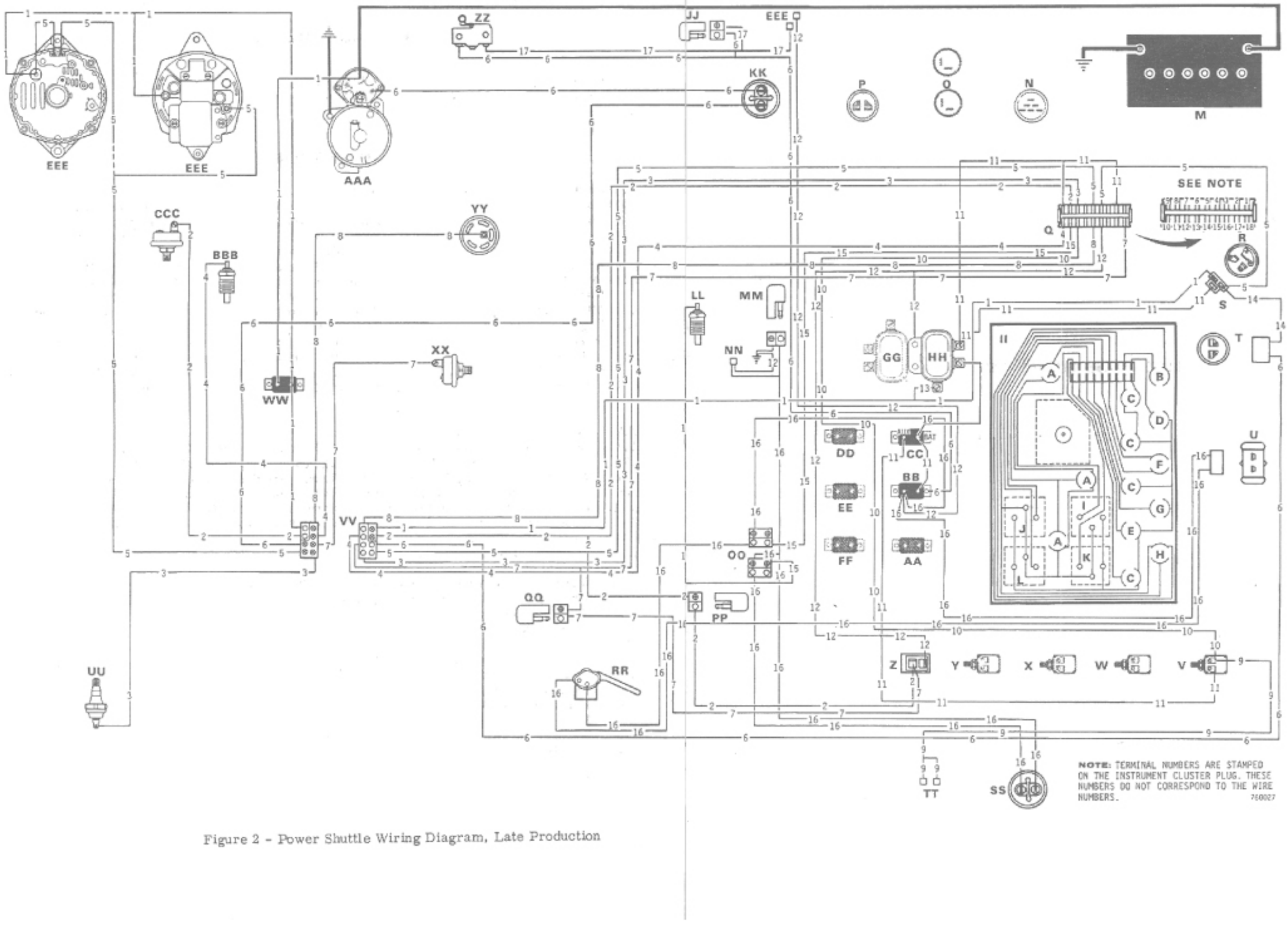


Figure 2 - Power Shuttle Wiring Diagram, Late Production

The information on this page applies only to Figure 3.

WIRING COLOR KEY

1. Red
2. Yellow-White
3. Yellow
4. Purple
5. Light Green
6. White
7. Yellow-Black
8. Purple-Red
9. Pink
10. Gray
11. Orange
12. Black
13. Red-Black
14. White-Orange
15. Blue

COMPONENTS

A. Illumination Light
B. R.H. Turn Signal, Refer to Figure 4 or 5
C. Not Used
D. Hyd. Oil Filter Warning Light
E. Air Cleaner Warning Light
F. Alt. Warning Light
G. Eng. Oil Pressure Warning Light
H. L.H. Turn Signal Refer to Figure 4 or 5
I. Not Used
J. Voltmeter
K. Eng. Water Temp.
L. Fuel Level Gauge
M. Battery
N. Turn Signal Switch, Refer to Figure 4 or 5
O. Turn Signal and 4 Way Flasher, Refer to Figure 4 or 5
P. Horn Button Refer to Section 8015
Q. Connects to Instrument Cluster
R. Key Switch
S. Connects to Key Switch
T. Starter Button
U. Light Switch
V. Flood Light Switch
W. Flasher Switch
X. Rotating Beacon Switch
Y. Air Filter and Hyd. Oil Filter Restriction Warning Light Check Switch
Z. Flood Light, Turn Signal and Brake Light 15 Amp Circuit Breaker, Refer to Figure 4 or 5

AA Return-to-Dig 10 Amp Circuit Breaker
BB Backup Alarm & Lights 15 Amp Circuit Breaker, Refer to Figure 4 or 5 & Section 8015
CC Heater and Defroster 15 Amp Circuit Breaker, Refer to Section 8015
DD Wipers and Rotating Beacon 15 Amp Circuit Breaker, Refer to Figure 4 or Section 8015
EE Horn and Rotating Beacon 15 Amp Circuit Breaker, Refer to Section 8015
FF Relay Powers Circuits Controlled by Circuit Breakers DD, EE, and FF
GG Relay Powers Circuits Controlled by Circuit Breakers AA, BB, and CC
HH Instrument Cluster
II. Return-to-Dig Circuit Diode
JJ Neutral Start Switch
KK Warning Switch Circuit Diode (Air Filter Restriction Indicator)
LL Warning Switch Circuit Diode (Hydraulic Oil Filter Restriction Indicator)
MM Engine Water Temp. Sender
NN Engine Oil Pressure Sender
OO Connects from Engine Harness to Main Harness
PP Alternator and Starter 40 Amp Circuit Breaker
QQ Hydraulic Oil Filter Restriction Indicator Switch
RR Fuel Level Sender
SS Return-to-Dig Switch
TT Starting Motor
UU Connects to Light Harnes, Refer to Figure 4 or 5 or Section 8015
VV Air Filter Restriction Indicator Switch
WW Alternator
XX Connects to Bucket Spool Detent

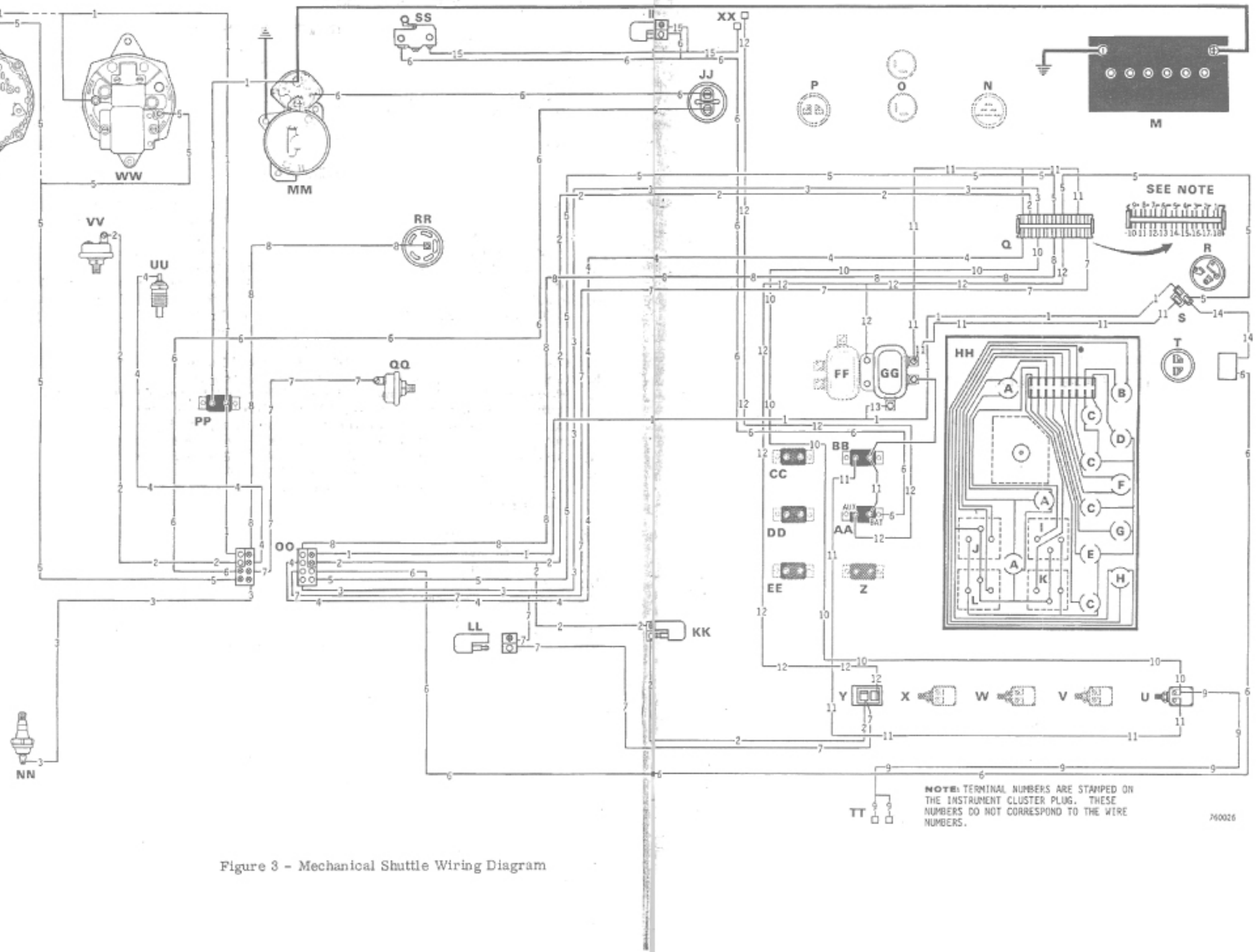


Figure 3 - Mechanical Shuttle Wiring Diagram

The following information applies only to Figure 4.

WIRING COLOR KEY

1. Pink
2. Dark Green
3. Dark Brown-Yellow
4. Dark Brown-Green
5. Green
6. Gray-Black
7. Dark Blue
8. Black
9. Red
10. Orange-Black
11. Dark Brown
12. Tan
13. Gray-White
14. Gray
15. Orange
16. Light Green
17. Orange-Green
18. Orange-White

COMPONENTS

A. Headlights
B. Front Wiper Motor
C. Front Wiper Motor Switch
D. Rotating Beacon Light Switch
E. Four Way Flasher Switch
F. Rear Floodlight Switch
G. Headlight and Taillight Switch
H. Left-Hand Stoplight Switch
I. Right-Hand Stoplight Switch
J. Connects to Turn Signal Switch
K. Turn Signal Switch
L. Connects to Flasher
M. Flasher Unit
N. Rotating Beacon 15 Amp Circuit Breaker
O. Wiper Motor 15 Amp Circuit Breaker
P. Heater and Defroster 15 Amp Circuit Breaker, See Section 8015

Q. Connects to Circuit Breaker O When Heater and Defroster are not Installed
R. Connects from Cab Harness to Wiper and Beacon Harness
S. Floodlight, Turn Signal and Flashers and Stoplight 15 Amp Circuit Breaker
T. Clutch Cutout and Return-to-Dig 10 Amp Circuit Breaker, See Figure 4 or 5
U. Backup Alarm and Lights 15 Amp Circuit Breaker, See Figure 1, 2 or 3 or Section 8015
V. Relay Powers Circuits Controlled by Circuit Breakers N, O and P
W. Relay Powers Circuits Controlled by Circuit Breakers S, T and U
X. Connects from Cab Harness to Optional Light Harness
Y. Connects to Main Harness, See Figure 1, 2 or 3 at Point TT
Z. Rotating Beacon

AA. Four Way Flasher Light
BB. Stoplight and Taillight
CC. Rear Floodlight
DD. Rear Wiper Motor
EE. Connects from Cab Harness to Rear Wiper
FF. Rear Wiper Motor Switch
GG. Connects to Instrument Cluster Plug at Terminal 16
HH. Connects to Instrument Cluster Plug at Terminal 17

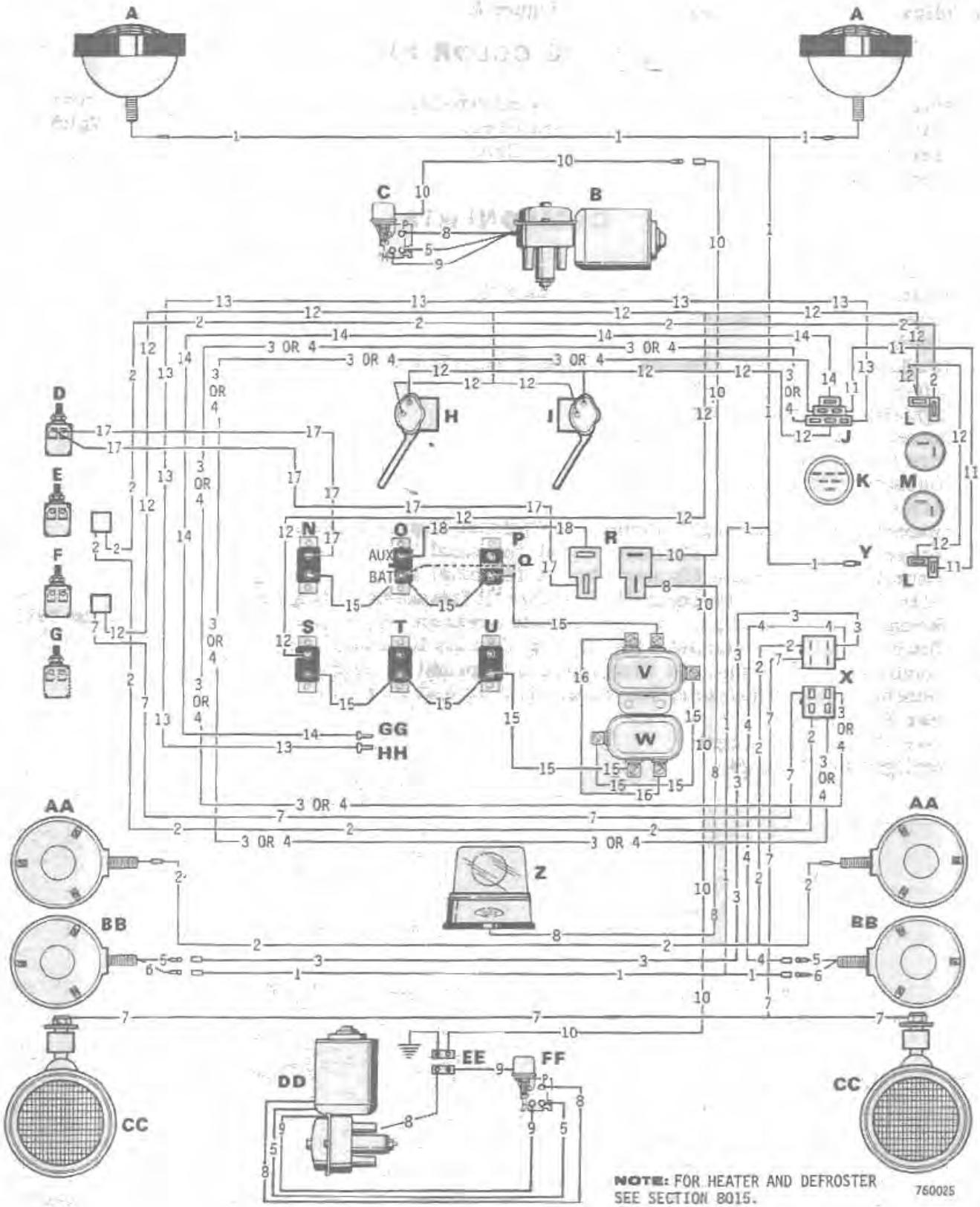


Figure 4 - Cab Wiring Diagram

The following information applies only to Figure 5.

WIRING COLOR KEY

1. Pink
2. Gray-Black
3. Dark Brown-Yellow
4. Green
5. Dark Brown-Light Green
6. Dark Green
7. Dark Blue
8. Tan
9. Dark Brown
10. Gray-White
11. Gray
12. Orange

COMPONENTS

A. Headlights
B. Rotating Beacon Switch, Refer to Section 8015
C. Four Way Flasher Switch
D. Floodlight Switch
E. Headlight and Taillight Switch, Refer to Figure 1, 2 or 3
F. Left-Hand Stoplight Switch
G. Right-Hand Stoplight Switch
H. Connects to Turn Signal Switch
I. Turn Signal Switch
J. Connects to Flasher
K. Flasher Unit
L. Connects from Rear Light Harness to Optional Light Harness
M. Connects to Instrument Cluster Plug at Terminal 16
N. Connects to Instrument Cluster Plug at Terminal 17
O. Relay Powers Circuits Controlled by Circuit Breakers P, Q and R
P. Backup Alarm and Lights 15 Amp Circuit Breaker, See Figure 1, 2 or 3 or Section 8015
Q. Clutch Cutout and Return-to-Dig 10 Amp Circuit Breakers, See Figure 4 or 5
R. Floodlight, Turn Signal and Flashers and Stoplight 15 Amp Circuit Breaker
S. Connects to Main Harness, See Figure 1, 2 or 3 at Point TT
T. Rear Floodlight
U. Four Way Flasher Light
V. Stoplight and Taillight

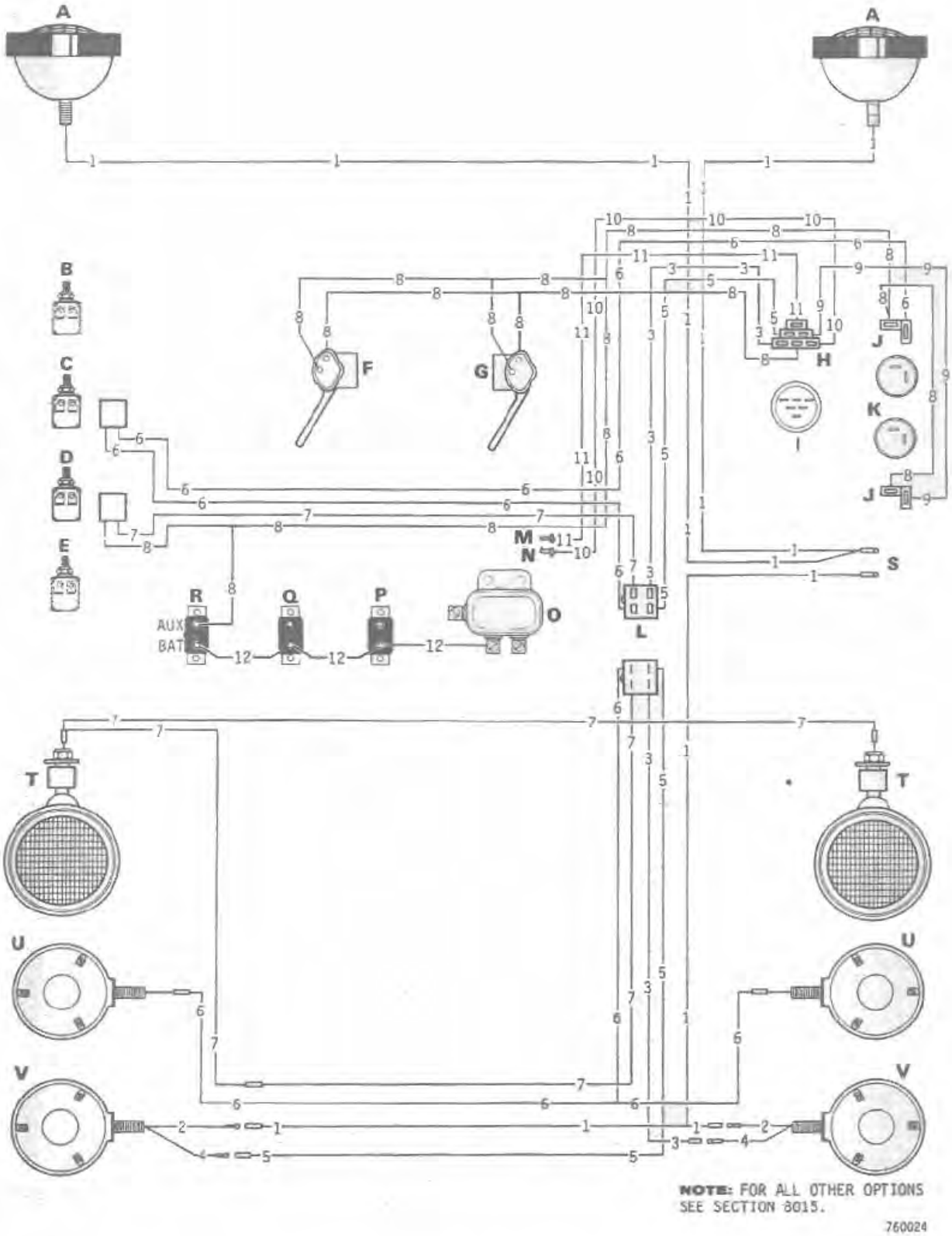


Figure 5 - Canopy Lights Wiring Diagram

Section 8004

INSTRUMENT PANEL

AND

INSTRUMENT CLUSTER

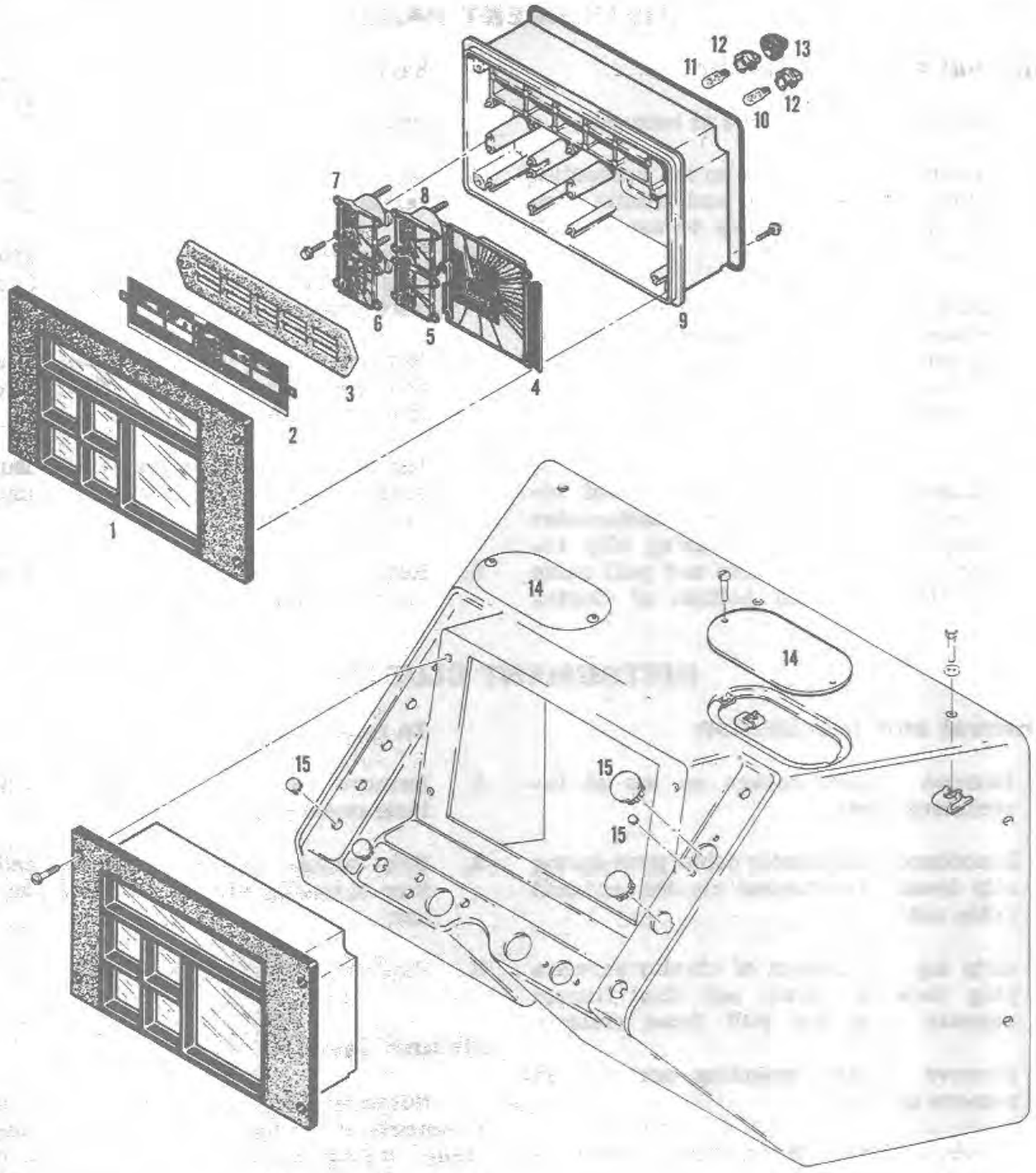
J I Case
A Tenneco Company

C.E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS



1. COVER
2. IDENTIFICATION STRIP
3. GASKET
4. TACHOMETER
5. VOLTMETER
6. FUEL GAUGE
7. WATER TEMP. GAUGE
8. OIL TEMP. GAUGE (POWER SHUTTLE ONLY)
9. CASE ASSEMBLY
10. WARNING LIGHT BULB (NO. 194)
11. ILLUMINATION LIGHT BULB (NO. 168)
12. BULB SOCKET
13. BOOT (ILLUMINATION LIGHTS ONLY)
14. ACCESS COVER
15. BUTTON (USED IN PLACES OF SWITCHES)

Figure 1

INSTRUMENT PANEL

Removal and Installation

1. Disconnect ground cable at battery.
2. Loosen the top clamp on the connecting sleeve on the throttle and shuttle control shafts. Move clamp to expose roll pin and drive out pin.

   NOTE: Heat treated washers may be installed on top of shuttle rod connecting sleeve if equipped with power shuttle. Look for washer(s) to fall out when the instrument panel is removed.

3. Remove access covers on top of instrument panel. Disconnect tachometer cable; push spring retaining clip toward instrument cluster and pull cable out. Grip top and bottom of cluster harness plug between thumb and first finger; squeeze plug and pull from cluster.
4. Remove the four instrument cluster retaining screws and remove cluster.
5. Disconnect harness plugs from switches. Tag harness plugs as required to assure proper installation.
6. Remove fuel shutoff knob. Remove cable housing retaining nut and remove cable from instrument panel.
7. Remove the instrument panel mounting screws and steering column clamp, and remove instrument panel.
8. Reverse the preceeding steps to install the instrument panel.

INSTRUMENT CLUSTER

Removal and Installation

1. Remove access covers on top of instrument panel.
2. Disconnect tachometer cable; push spring clip toward instrument cluster and pull cable out.
3. Grip top and bottom of cluster harness plug between thumb and first finger; squeeze plug and pull from cluster.
4. Remove cluster mounting screws and remove cluster.
5. Reverse steps 1 through 4 to install the instrument cluster.

Replacing Light Bulbs

Each instrument cluster contains six warning light bulbs (No. 194) and three illumination bulbs (No. 168). The bulbs are installed in removable sockets.

To replace a bulb:

1. Remove an access cover on top of the instrument panel.
2. Grip socket of bulb to be replaced and turn it counterclockwise to remove socket.
3. Pull bulb from socket.

Circuit Board

Normally, the circuit board will not be a source of trouble. However, if the instrument cluster is mishandled, damage could occur. If the circuit board requires replacement, the cluster case assembly must be replaced.

Gauge Removal and Installation

1. Remove instrument cluster as instructed on this page.

2. Remove the four lens retaining screws and remove lens.

3. Remove the screws that hold gauge in place and pull gauge straight out of case. Depending on which gauge is being removed, it may be necessary to remove the gauge next to it.

4. Reverse steps 1 through 3 for gauge installation.

Checking Gauge Operation

1. If a gauge fails to operate:

   a. Disconnect wire from the gauge sending unit.

   b. Ground the disconnected wire and turn key switch on. If needle moves to full scale the sending unit is at fault and must be replaced.

   c. If the needle fails to move, the wire to the gauge or the gauge itself is at fault.

   d. Use an ohmmeter and check for continuity between the cluster harness plug and sending unit terminal end.

   e. If wire is good, remove instrument cluster as instructed in this section and replace the gauge.

   f. Before replacing the gauge, check the circuit board to be sure it is not at fault.

2. If gauge operation is erratic or is suspected of being incorrect:

   a. Check for loose or corroded connection at the sending unit.

   b. Check for the possibility of the wire or harness being grounded (short circuited) part of the time.

   c. If steps a and b do not correct the problem, replace the gauge.

Section 8005

BATTERY

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Number and size	Two 12 volt batteries connected in series, negative ground. Group size 30H, SAE No. 9H9A.
Capacity	300 amps at 0° F. (-17° C) 10 second voltage -9.2 V 5 minutes to 1.0 volt per cell
90 second diesel rating	575 amp draw for 90 seconds at 0° F. (-17° C.) to 1 volt per cell
Capacity (load) test draw	200 amps
Full charge specific gravity	1.260 ± .005 (original equipment or Case replacement batteries only).
Plates per cell	17
Slow charging rate	8 amps
Weight with electrolyte	66.6 pounds (30 kg)

CAUTION: Always unhook the battery ground cable first - and hook it up last. 13-7

CAUTION: Never cause sparks to occur or smoke near batteries that are charging or have been recently charged. 13-8

CAUTION: Never wear rings or metal watch bands that may ground a live circuit. 13-9

POISON: Batteries contain sulfuric acid which can cause severe burns. Avoid contact with skin, eyes or clothing. Antidote: EXTERNAL, flush with water; INTERNAL, drink large quantities of water or milk. Follow with milk of magnesia, beaten egg or vegetable oil. Call physician immediately; EYES, flush with water for 15 minutes and get prompt medical attention. Keep out of reach of children. 19-4

CARE AND MAINTENANCE

A battery can be considered a perishable item, therefore it is only natural to assume that proper care and maintenance will aid in obtaining maximum service life.

NOTE: A check sheet will be found on the last page for use in battery inspections. Extra copies can be easily reproduced on any office duplicator.

Electrolyte Level

The electrolyte level should be checked every 50 hours of operation or weekly. Extensive use in hot weather will require more frequent checks because of a more rapid water loss. If the electrolyte level is low, add colorless, odorless drinking water to each cell until the fluid level rises to the split ring at the bottom of the cell opening. Overfilling serves no useful purpose and will result in poor performance, short life and excessive corrosion around the battery.

NOTE: Add water only, not electrolyte, when servicing the battery.

Maintain the electrolyte level above the plates at all times to prevent permanent damage which will result in reduced performance and service life.

Water Usage

Excessive water usage indicates high battery temperature and/or high voltage regulator setting.

No appreciable water use over a period of time indicates an undercharged battery. Poor cable connections or a too low voltage regulator setting may be the cause.

Cleaning

The battery should be inspected periodically for dirt and corrosion, and damage. Dirt, combined with electrolyte or moisture on the top of the battery usually results in a continuous battery discharge because this foreign material produces a path for battery current to follow. Due to the higher voltage involved, 12-volt batteries are more susceptible to energy losses of this nature than 6 volt batteries.

The battery and cable terminals can be cleaned using one of the following methods:

a. Use Case Battery Saver, part number M20376, according to instructions on container. This is a spray and wipe cleaner that requires no water. It also prevents further corrosion.

b. Use soda or ammonia and water and flush battery with clear water. If Case Battery Saver is not available, install corrosion retarding washers under the battery cable terminals. These washers are available from parts supply houses and most discount stores.

It is recommended that the battery be removed and the battery carrier cleaned at the same time.

NONSPILL BATTERY CAPS

Most machines are factory equipped with batteries that have nonspill caps. These prevent personal injury and machine damage from spilled battery fluid if the machine is accidentally upset.

The nonspill cap contains a lead/soft rubber stem valve. When the cap is upside down, the weight of the lead portion holds the rubber stem against the external vent hole to prevent loss of battery fluid.

Figure 1 - Nonspill Battery Cap

It is possible for the external vent hole and valve to become plugged. When this happens, internal battery pressure great enough to split the battery case can occur. Therefore, check for plugged vent hole when checking battery fluid level. Hold cap upside down if unplugging the external vent hole. Shake cap to make sure valve moves freely (rattles in cap). If valve is stuck, rinse cap in water to free the valve and remove dust, etc. from inside the cap. Shake cap vigorously to remove water from inside of cap.

Whenever a cap is removed, check condition of the rubber gasket. If the gasket is damaged to the extent that it will not provide a leakproof seal or the gasket is missing, the cap must be replaced.

Missing or broken nonspill caps MUST be replaced with another nonspill cap. DO NOT use standard caps to replace nonspill caps.

When installing a replacement battery and the battery being removed is equipped with nonspill caps, the replacement battery MUST be equipped with nonspill caps. Use caps from original battery.

BATTERY TESTS

Specific Gravity Check

A hydrometer is used to check the specific gravity (weight) of the battery electrolyte. The specific gravity of the electrolyte indicates the approximate state of charge of the battery. Hydrometers are calibrated to give the true reading when the electrolyte temperature is 80° F. (26.7° C). Therefore, to obtain a correct specific gravity reading, the temperature of the electrolyte must be known. Some hydrometers contain a thermometer while others do not. A separate thermometer is required to check electrolyte temperature if the hydrometer is not so equipped.

NOTE: If water must be added to check specific gravity, fast charge battery for 30 minutes or false readings will be obtained.

1. Remove electrolyte from one cell with the hydrometer. Observe and record the hydrometer reading.

2. Note the electrolyte temperature. Refer to Figure 3 and add or substract four (.004) specific gravity points for each 10° above or below 80° F. (26.7° C). The corrected reading will be a true indication of cell condition.

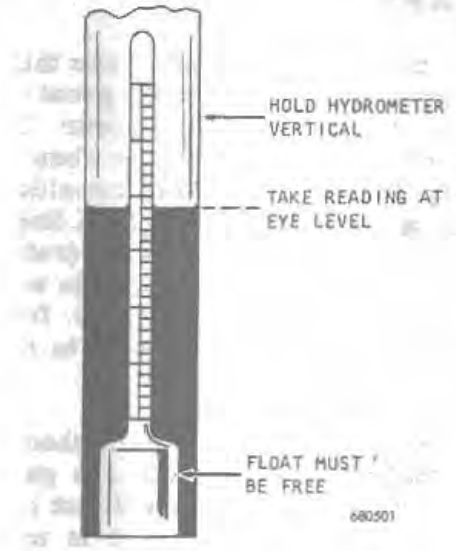


Figure 2 - Checking Specific Gravity

3. Repeat steps 1 and 2 for the remaining cells.

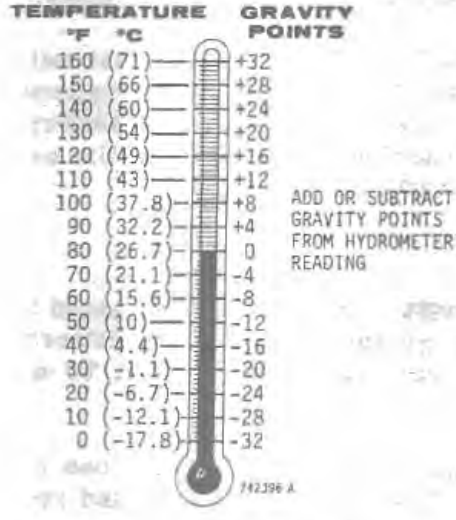


Figure 3 - Temperature Compensation

Interpretation Of Hydrometer Readings

1. The state of charge can be determined by comparing readings to the Specific Gravity Table.

2. If all cells read between 1.200 and 1.260 and the variation between the high and low cell is less than 30 gravity points, the battery is good. It may be necessary to charge the battery prior to putting the battery in service.

3. If all cells read between 1.200 and 1.260 and the variation between the high and low cell is 30 gravity points or more, fully charge battery and recheck specific gravity. If the variation is still 30 gravity points or more after charging, the battery is defective and must be replaced.

State of charge	Specific gravity, 80° F. (26.7° C)	Electrolyte freezes approx.
100%	1.260	-75° F. (-59° C)
75%	1.230	-38° F. (-39° C)
50%	1.200	-17° F. (-26° C)
25%	1.170	1° F. (-17° C)
Discharged	1.110 750165	19° F. (-7.2°C)

Figure 4 - Specific Gravity Table

Capacity (Load) Test

The capacity of a battery is the battery's ability to furnish current and maintain a minimum necessary voltage. If a battery passes the Capacity Test, it is in satisfactory condition. It may, however, need charging to bring it to peak performance.

Test Conditions

The test should not be performed if the electrolyte temperature is below 80° F. (26.7° C) or if the battery's state of charge is less than 75%. Charge the battery as required to meet test conditions.

Test Procedure

1. Refer to Figure 5. Turn the control knob of the tester to the OFF position.

2. Turn the voltmeter selector switch to 8 volts for a 6 volt battery, or to 16 volts for a 12 volt battery.

3. Connect the positive test leads to the positive battery post and the negative test leads to the negative battery post.

4. Turn the control knob clockwise until the ammeter reading is exactly three times the ampere hour rating of the battery. (Example: 180 amperes for a 60 AH battery.) If the ampere hour rating is not known, adjust control knob until ammeter indicates 200 amperes.

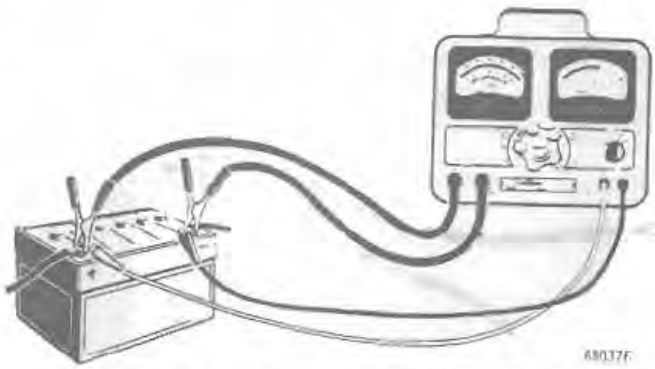


Figure 5 - Capacity (Load) Test Hookup

NOTE: If the battery under test has been designed for use in high temperature climates, adjust the control knob until the ammeter indicates exactly two and a half times the ampere hour rating of the battery. (Example: 150 amperes for a 60 AH battery.)

5. Maintain load for fifteen seconds, note voltmeter reading, then turn control knob to the OFF position.

   a. If the voltmeter indicated 4.8 volts or more for a 6 volt battery, or 9.6 volts or more for a 12 volt battery, the battery has good output capacity. Check specific gravity as instructed on page 8014-5, and if necessary, charge battery before placing back in service.

   b. If voltmeter reading was less than 4.8 volts for a 6 volt battery or 9.6 volts for a 12 volt battery, conduct the Individual Battery Cell Test to determine if battery is discharged or defective.

Individual Battery Cell Test

The following tests should be performed only on batteries that fail the Capacity (Load) Test.

Soft Top Battery or Exposed Cell Connectors

1. Refer to Figure 6. Turn voltmeter selector switch to 8 volts for a 6 volt battery or to 16 volts for a 12 volt battery.

2. Connect a battery charger and voltmeter to the battery. Connect positive leads to the positive battery post and negative leads to the negative battery post.

3. Turn charger on and turn charger time switch past 3 minutes and then back to 3 minutes.

4. Adjust charging level to the highest rate possible without exceeding 75 amperes for a 6 volt battery or 40 amperes for a 12 volt battery.

5. After 3 minutes, when time switch has returned to slow charge, reset switch to fast charge and observe the voltmeter.

   a. If reading is beyond green band or exceeds 7.75 volts for a 6 volt battery or 15.5 volts for a 12 volt battery, the battery is sulfated or worn out and the battery should be replaced.

   b. If reading is within the green band or less than 7.75 volts for a 6 volt battery or 15.5 volts for a 12 volt battery, proceed with step 6.

6. With charger operating on fast charge, set voltmeter switch to 4 volts. Observing polarity, quickly measure cell voltage across each cell with voltmeter.

   a. If the cell readings vary by more than .1 volt, battery has defective cell(s).

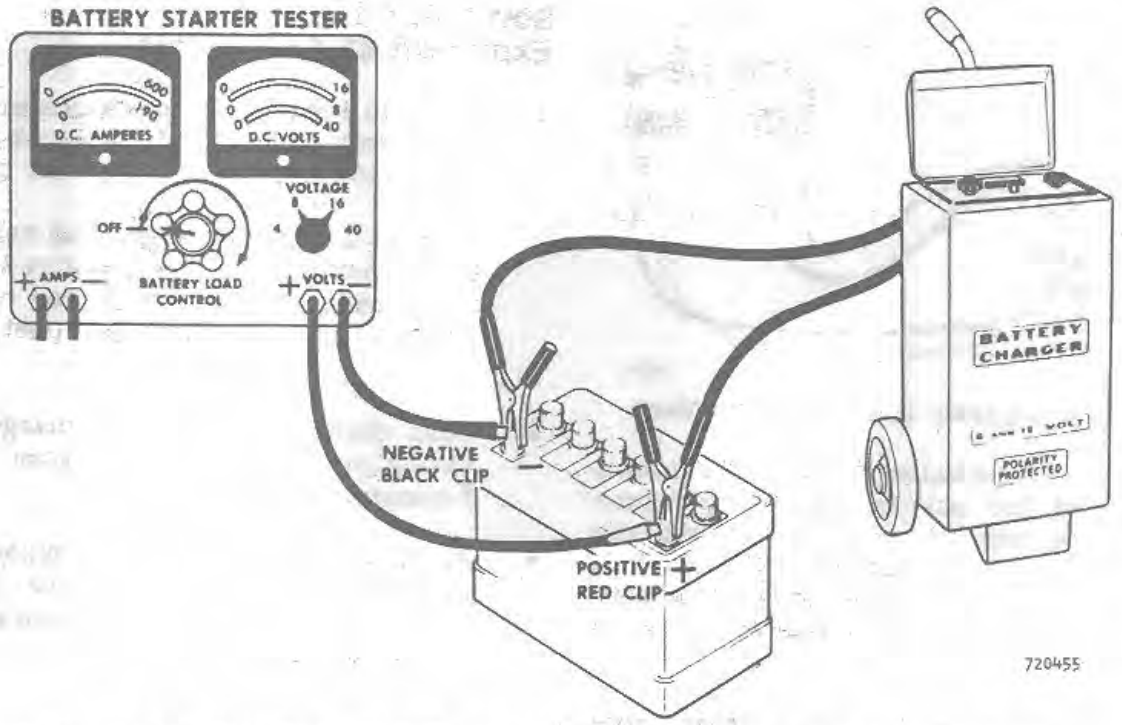


Figure 6 - Cell Test, Soft Top Batteries and Exposed Cell Connectors

b. If the cell readings are within .1 volt and the total voltage is within the limits specified in step 5, the battery is discharged and is in need of recharging.

Hard Top Battery

This test is performed using the cadmium probes and a suitable battery-starter tester, Figure 8. Connect the voltmeter leads to the terminals in the end of the handle, observing polarity color code. Set voltmeter switch to 4 volts and remove the filler vent caps from the battery.

1. Place positive probe in cell No. 1 and negative probe in cell No. 2, Figure 7. Record exact reading.

2. Place positive probe in cell No. 2 and negative probe in cell No. 3. Record the exact reading. If testing a 6-volt battery, proceed to step 6.

3. Place positive probe in cell No. 3 and negative probe in cell No. 4. Record the exact reading.

4. Place positive probe in cell No. 4 and negative probe in cell No. 5. Record the exact reading.

5. Place positive probe in cell No. 5 and negative probe in cell No. 6. Record the exact reading.

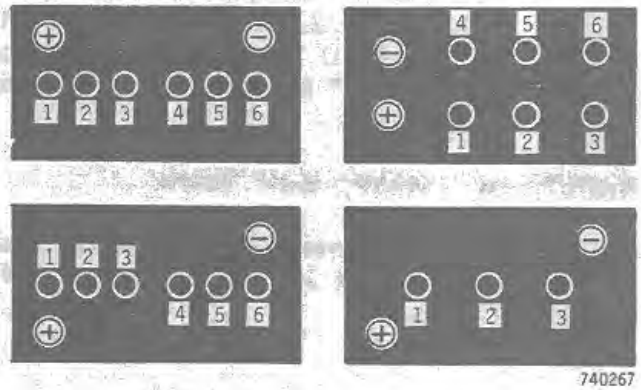


Figure 7 - Battery Cell Sequence

6. Place the positive prod on positive battery post and negative probe in cell No. 1. Record the exact reading.

7. Place positive probe in cell No. 6 (No. 3 for 6 volt battery) and negative prod on negative battery post. If the voltmeter reads to the right of zero, add this reading to the reading obtained in step 6. If the voltmeter reads to the left of zero, reverse the probes and subtract this reading from the one obtained in step 6.

8. If the cells vary over .1 volt, the battery should be replaced.

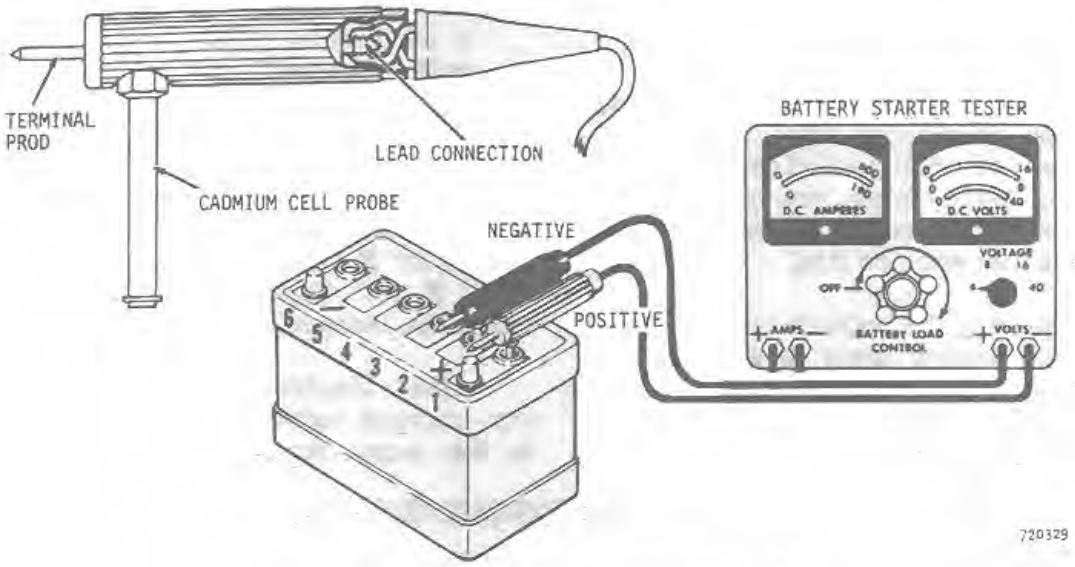


Figure 8 - Cadmium Probes

BATTERY CHARGING

Before charging a battery, check and adjust the electrolyte level as required. Refer to Electrolyte Level, page 8005-5.

Charging rates in the 3-50 ampere range are usually acceptable. It is difficult to specify a definite charging rate or time because of (1) ampere hour ratings vary; (2) temperature of the electrolyte; (3) state of charge at the start of the charge period; and (4) the age and condition of the battery. Refer to chart on page 8014-10 for charging rates and times for fully discharged battery.

It may be said that any battery may be charged at any rate in amperes as long as the electrolyte does not boil over as a result of violent gassing or as long as the electrolyte temperature does not exceed 125° F. (51° C). If the electrolyte boils over or the temperature exceeds 125° F. (51° C), the charging rate must be reduced or temporarily halted to avoid damage to the battery.

NOTE: For the most satisfactory charging, the lower ampere charging rates are recommended.

The battery is fully charged when over a two hour period at a low charging rate, all cells are gassing freely (not boiling over) and no change in specific gravity occurs. The full charged specific gravity is approximately 1.260. Fill each cell until the electrolyte is even with the split ring at the bottom of the cell opening.

ACTIVATING DRY CHARGED BATTERIES

NOTE: Also refer to Nonspill Battery Caps on page 8005-5.

Dry charged batteries are activated by filling each cell with electrolyte (a solution of sulfuric acid and water) with a specific gravity of 1.260. Fill each cell until the electrolyte is even with split ring at the bottom of the cell opening.

Set the battery aside for a few minutes, then check the electrolyte level. If the electrolyte is low, add additional electrolyte, not water. Adding water when activating a dry charged battery may result in poor performance and a short service life.

Prior to putting the battery into service, complete the following tests to assure good battery performance.

1. Five minutes after adding electrolyte, check the terminal voltage. If the voltage is less than 5 or 10 volts, depending on rated voltage, the battery is defective and should be replaced.

2. Check the specific gravity, page 8005-5. If the specific gravity shows more than a 30 gravity point drop or one or more cells gas violently after adding electrolyte, the battery should be fully charged before being put into service.

For the best performance in cold weather (below 32° F. (0° C) or if the electrolyte is not at 60° F. (16° C) or above at time of activation, warm the battery by charging.

After electrolyte has been added to a dry charged battery it should be maintained in the same manner as any other battery.

BATTERY CHARGING GUIDE

(Fully Discharged 6 and 12 Volt Batteries)

Ampere Hour Rating	Recommended Rate and Time					
	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 or less	10 hours	5 hours	2-1/2 hours	2 hours		
Above 50 to 75	15 hours	7-1/2 hours	3-1/4 hours	2-1/2 hours	2 hours	1-1/2 hours
Above 75 to 100	20 hours	10 hours	5 hours	3 hours	2-1/2 hours	2 hours
Above 100 to 150	30 hours	15 hours	7-1/2 hours	5 hours	3-1/2 hours	3 hours
Above 150		20 hours	10 hours	6-1/2 hours	5 hours	4 hours

NOTE 1: Amperes indicate initial rate for constant voltage taper rate charger.

NOTE 2: Reduce or temporarily halt charging rate if electrolyte temperature exceeds 125° F. (51° C) or violent gassing (boiling over) occurs.

NOTE 3: For the most satisfactory charging, the lower ampere charging rates are recommended.

Figure 9 - Battery Charging Guide

BATTERY CHECK SHEET

TEST RESULT	SUMMARY	INDICATION	REMEDY
Visual Inspection			
1. Dirty battery top		Battery OK	Clean
2. Clogged vents		Battery OK	Clean
3. Corrosion		If severe, possible battery defect. Battery OK	Clean and continue testing. Add water
4. Low water level			
5. Cracked case		Defective battery	Replace
6. Other defects noted			
Specific Gravity Check			
Cell No. 1	1. More than 30 gravity points variation between cells	1. Defective, discharged or worn out battery.	1. Recharge battery. Repeat test. If cell readings still vary, replace battery.
Cell No. 2	2. Most cells below 1.230 and even within 30 points	2. Discharged	2. Recharge and make Capacity Test
Cell No. 3	3. Most cells at or near full charge (1.260) and even within 30 points.	3. Charged	3. Make Capacity Test
Cell No. 4	4. Most cells above full charge (1.260)	4. Overcharged	4. Check regulator.
Cell No. 5			
Cell No. 6			
NOTE: Specific gravity readings apply to original equipment or Case supplied replacement batteries only. Other makes may vary.			
Capacity Test			
Load equals 20-hour amp rating x 3 (2.5) or 200 amps			
12-volt battery	Over 9.6 volts	Battery OK	Recharge if necessary
	Under 9.6 volts	Discharged or defective	Make Individual Battery Cell Test
6-volt battery	Over 4.8 volts	Battery OK	Recharge if necessary
	Under 4.8 volts	Battery discharged or defective	Make Individual Battery Cell Test
Individual Cell Test			
Soft top battery or battery with exposed cell connectors only: Terminal voltage after 3 minutes	Over 7.75 volts (6V battery) or 15.5 volts (12V battery)	Battery sulfated or worn out	Replace
	Under 7.75 volts (6V battery or 15.5 volts (12V battery)	Battery discharged or defective	Measure individual cell voltages
All Batteries			
Cell No. 1	Cell readings vary over .1 volt	Battery defective	Replace
Cell No. 2			
Cell No. 3	Cell readings even within .1 volt	Battery discharged	Charge battery
Cell No. 4			
Cell No. 5			
Cell No. 6			

720427

Section 8006

STARTER

AND

STARTER SOLENOID

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

STARTER

Specifications

Case part number	R29870
Delco-Remy part number	1109149
No-Load test at 80° F. (26.7° C)	
Volts	9
Amperage draw, including solenoid	40-140
Revolutions per minute	8000-13000
Rotation viewed from drive end	clockwise
Pinion clearance	.010"-.140" (0.254-0.356 mm)

Lubrication

Interval	When starter is disassembled
Lubricant	Light engine oil

No-Load Test

Pre-Test Checks

1. With the starter removed from the engine, check the pinion for freedom of operation by turning it on the armature shaft.

2. Check the armature for free rotation by prying against the pinion with a screwdriver. If the armature does not rotate freely, disassemble the starter and repair as required before performing the No-Load Test.

Test Equipment

This test can be performed using a Sun Electric Battery/Starter Tester or equivalent, or by using individual test equipment as illustrated in Figure 1. The ammeter must be capable of indicating 300 amperes. A tachometer to measure armature rpm and a switch (knife type) are also required.

Test Procedure

1. Connect the starter and ammeter in series with a fully charged 12 volt battery as shown in Figure 1.

2. Connect the voltmeter to the solenoid M terminal and the starter frame.

3. Connect the switch to the B and S terminals on the solenoid.

4. Make sure carbon pile is off and connect carbon pile to battery.

5. Close the switch and adjust the carbon pile until the voltmeter indicates 9 volts. Observe the tachometer and ammeter and record the readings.

   NOTE: Do not operate the starter more than 30 seconds at a time without pausing to allow it to cool for at least two minutes.

6. Open the switch and turn off the carbon pile.

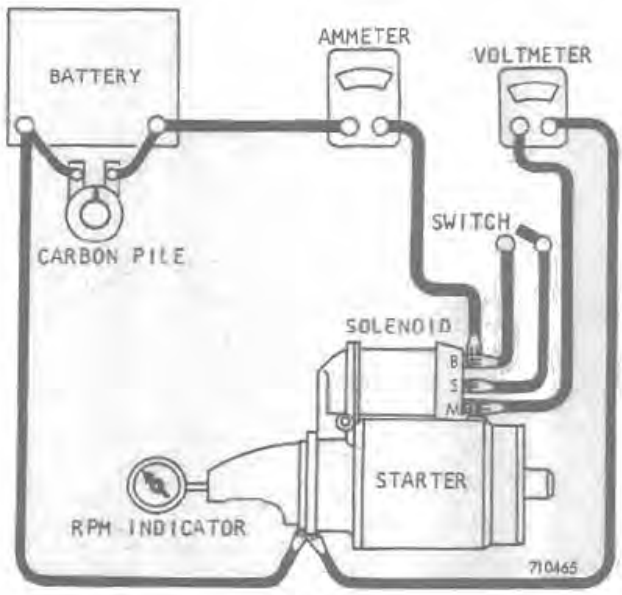


Figure 1 - No-Load Test Hookup, Delco-Remy

INTERPRETING RESULTS OF TEST

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.

2. Low free speed and high current draw indicates:

   a. Too much friction--tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

   b. Shorted armature. This can be further checked on a growler after disassembly.

   c. Grounded armature or fields. Check further after disassembly.

3. Failure to operate with high current draw indicates:

   a. A direct ground in the field terminal or field windings.

   b. "Frozen" bearings (this should have been determined by turning the armature by hand).

4. Failure to operate and no current draw indicates:

   a. Open field circuit. This can be checked after disassembly by inspecting internal connections and testing circuit with a test lamp.

   b. Open armature coils. Inspect the commutator for badly burned bars after disassembly.

   c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

5. Low no-load speed and low current draw indicates:

   a. High internal resistance due to poor connections, damaged leads, dirty commutator and causes listed under No. 4.

6. High free speed and high current draw indicates shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

Servicing the Starter

Removal

1. Disconnect battery ground cable at battery.
2. Disconnect wiring from starter solenoid.
3. Remove the three starter mounting cap screws and lockwashers. Remove starter. Refer to Figure 2 and proceed with disassembly.

Disassembly

1. Prior to disassembly, check pinion clearance as instructed on page 8006-8.
2. Disconnect the field coil connector from the solenoid M terminal.
3. Remove the thru bolts. Then remove the end plate and field frame from armature.
4. Remove the solenoid and lever pivot bolt from drive housing.
5. Remove the center bearing plate retaining screw and remove armature from drive housing. Then remove thrust washer from armature shaft.
6. Remove starter drive retainer and snap ring.
   a. Place a hollow driving tool on retainer and drive retainer toward armature to expose snap ring.
   b. Remove snap ring and starter drive retainer from armature shaft.
   c. Remove starter drive and center bearing plate from armature shaft.
7. Remove brush holder pins, disconnect brush leads and remove brush holders and springs.

Inspection

All parts except the starter drive should be cleaned using mineral spirits and a brush. Use a clean, dry cloth and wipe the starter drive.

DO NOT clean the armature, fields or starter drive in degreasing tank, or with grease dissolving solvents.

BRUSHES AND BRUSH HOLDERS

1. If brush wear is more than half when compared to a new brush, the brushes should be replaced.
2. Brush holders should be clean and the brushes must not bind in the holders.
3. Check brush spring tension to make sure the springs hold the brushes firmly against the commutator. If springs are distorted or discolored they should be replaced.

ARMATURE

1. Test armature as instructed under Armature Tests.
2. Place armature in a lathe and turn down commutator until all indications of wear are removed.
3. Undercut insulation between commutator bars 1/32" wide and 1/32" deep. Use 00 sandpaper to remove any burrs from commutator.

FIELD COILS

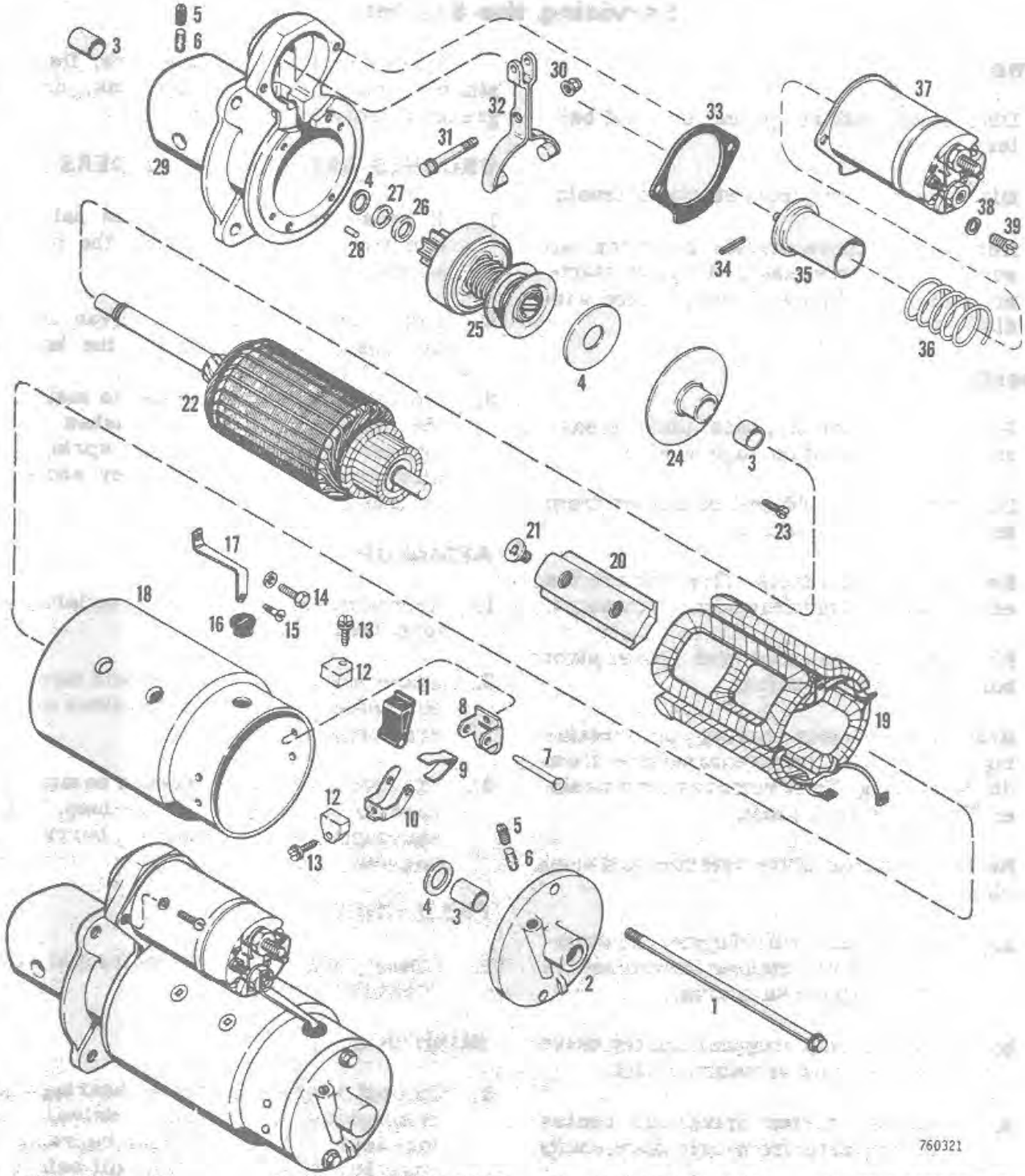
1. Check field coils as instructed under Field Coil Tests.

BUSHINGS

1. Inspect bushing in center bearing plate, commutator end frame and drive housing for wear. If bushing is to be replaced, soak bushing in 30 weight oil before installation.

Assembly

1. Lubricate bushing in commutator end frame, drive housing and center bearing plate.
2. Place center bearing plate, large thrust washer and starter drive on armature shaft.



1. THRU BOLT
2. COMMUTATOR END PLATE
3. BUSHING
4. THRUST WASHER
5. PLUG
6. OIL WICK
7. PIVOT PIN (2)
8. BRUSH HOLDER BRACKET (2)
9. BRUSH SPRING
10. GROUNDED BRUSH HOLDER
11. INSULATED BRUSH HOLDER
12. BRUSH (4)
13. BRUSH SCREW
14. MOTOR TERMINAL CAP SCREW
15. SCREW
16. INSULATOR
17. FIELD CONNECTOR
18. FIELD FRAME
19. FIELD COIL
20. POLE SHOE (4)
21. POLE SHOE SCREW (8)
22. ARMATURE
23. BEARING PLATE RETAINING SCREW
24. CENTER BEARING PLATE
25. STARTER DRIVE
26. STARTER DRIVE RETAINER
27. SNAP RING
28. LOCATING PIN
29. DRIVE HOUSING
30. SELF-LOCKING NUT
31. LEVER PIVOT BOLT
32. SHIFT LEVER
33. GASKET
34. ROLL PIN
35. PLUNGER
36. PLUNGER SPRING
37. STARTER SOLENOID
38. LOCK WASHER
39. SCREW

Figure 2 - Exploded View of Starter

3. Place the starter drive retainer on the armature shaft with the cupped surface facing the snap ring.

4. Place snap ring on end of armature shaft. Place a piece of wood over snap ring and force the snap ring onto the shaft with a light hammer blow. Then slide snap ring down into groove.

5. To force the retainer over the snap ring, place a suitable washer over snap ring and squeeze retainer and washer together with pliers.

6. Remove washer and install thrust washer on armature shaft.

7. Install armature in drive housing and reinstall shift lever and solenoid. Install center bearing plate retaining screw.

8. Assemble field frame assembly to drive housing using care not to damage brushes.

9. Position commutator end frame on field frame and install thru bolts. Tighten thru bolts securely.

Installation

1. Position starter against flywheel housing and secure in place with capscrews.

2. Connect wiring to starter solenoid.

3. Connect ground cable to battery.

Armature Tests

Armature Ground Test

1. Place armature in growler of tester. Turn on power, Figure 3.

2. Touch one test probe to armature core, the other probe to commutator. If test lamp glows, the armature winding or commutator is grounded.

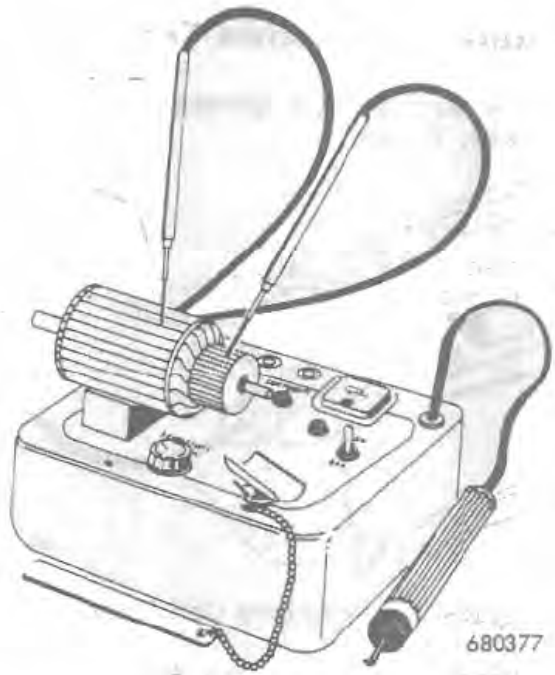


Figure 3 - Armature Ground Test

Armature Short Test

1. Have armature in same position as previous test. Turn on power, Figure 4.

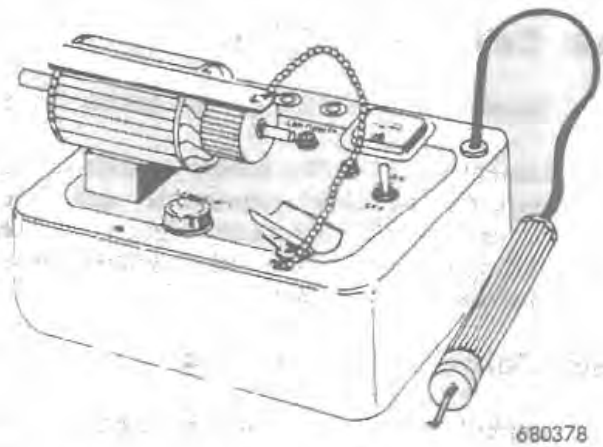


Figure 4 - Armature Short Test

2. Using steel blade provided with tester, hold the blade parallel with and touching the armature core segment.

3. Slowly rotate the armature one or more revolutions. If the armature is shorted, the steel blade will vibrate.

Armature Coil Balance Test

1. Have armature in growler and turn on power, Figure 5.

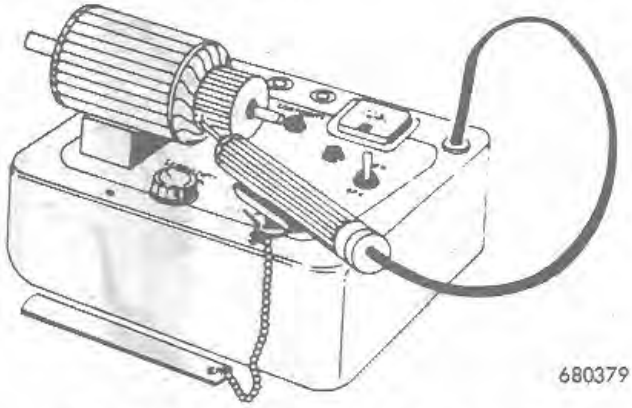


Figure 5 - Armature Coil Balance

2. Follow directions provided with tester and test the commutator bars for abnormal readings which will indicate a short, open, or poor connection. A satisfactory commutator will give uniform readings.

Field Coil Tests

Field Coil Ground Test

1. Disconnect field coil ground connections.

2. Connect a 12 volt battery and a test lamp to the field connector and field frame. If the test lamp lights, a field winding is grounded and the field windings must be replaced.

Field Coil Continuity Test

1. Connect a 12 volt battery and a test lamp to each end of the field winding. If the test lamp does not light, a winding is open and the field windings must be replaced.

Pinion Clearance

The pinion clearance cannot be adjusted but should be checked prior to disassembly and after assembly.

If clearance is excessive before disassembly, parts wear is the probable cause. Inspect parts carefully after disassembly.

If clearance is excessive after assembly, improper assembly is the probable cause.

To check pinion clearance:

1. Disconnect the motor field coil connector from the solenoid M terminal and INSULATE IT CAREFULLY.

2. Connect a battery of the same voltage as the solenoid from the solenoid switch terminal to the solenoid frame, Figure 8.

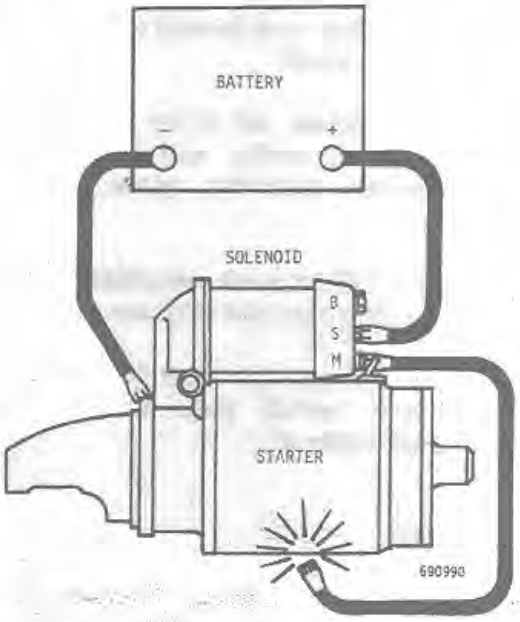


Figure 6 - Circuit for Checking Pinion Clearance

3. Temporarily connect a jumper lead from the solenoid motor terminal to the solenoid frame. This will shift the pinion into cranking position and it will remain so until the battery is disconnected.

NOTE: Check pinion clearance quickly to avoid damage to solenoid windings.

4. Push the pinion back towards the commutator end to eliminate slack movement.

5. Measure the distance between pinion and pinion stop, Figure 7.

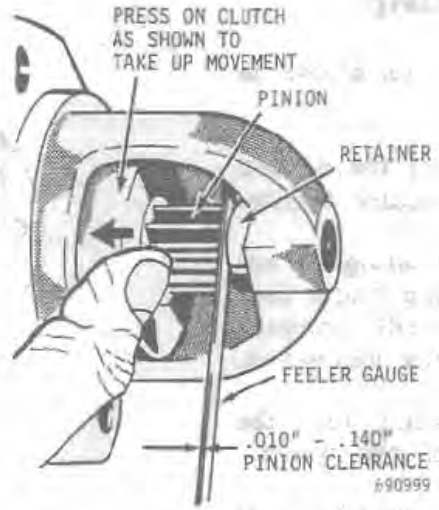


Figure 7 - Measuring Pinion Clearance

STARTER SOLENOID

Specifications

Case part number	G44891
Delco-Remy part number	1114356
Current draw	
Hold-in winding	14.5-16.5 amps @10 volts
Pull-in winding	13-15.5 amps @5 volts

Solenoid Tests

The solenoid can be tested on or off the starter. If the solenoid remains on the starter, disconnect the field coil lead from the solenoid M terminal and insulate (tape) the field coil lead to prevent the starter from operating.

Test No. 1 - Hold-In Winding

1. Make the test connections as shown in Figure 8.
2. Close the switch and adjust the carbon pile until voltmeter indicates 10 volts.
3. Record ammeter reading, turn carbon pile off and open the switch.
4. Compare ammeter reading with the test specifications.
   a. A high reading indicates a shorted or grounded winding.
   b. A low reading indicates excessive resistance.

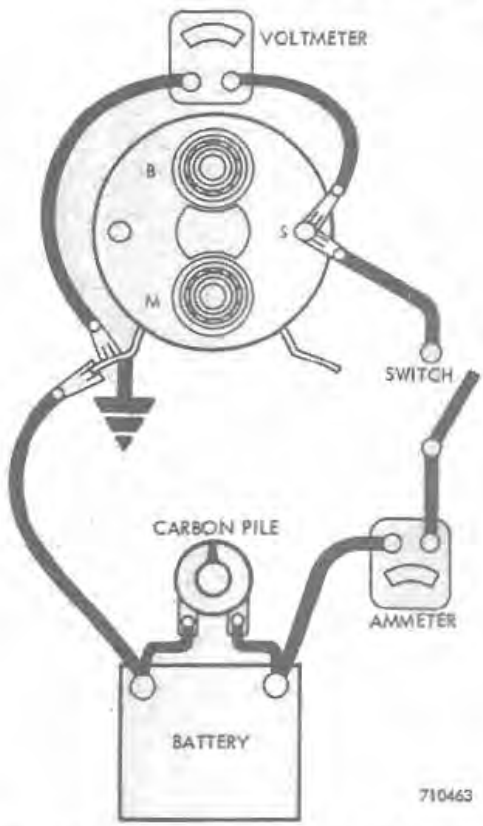


Figure 8 - Hold-in Winding Test

Test No. 2 - Pull-In Winding

1. Make the test connections as shown in Figure 9.

2. Close the switch and adjust the carbon pile until the voltmeter indicates 5 volts.

   NOTE: To prevent over heating, do not energize the pull-in winding more than 15 seconds. Current draw will decrease as the winding temperature increases.

3. Record the ammeter reading, turn the carbon pile off and open the witch.

4. Compare ammeter reading with the test specification.

   a. A high reading indicates a shorted or grounded winding.

   b. A low reading indicates excessive resistance.

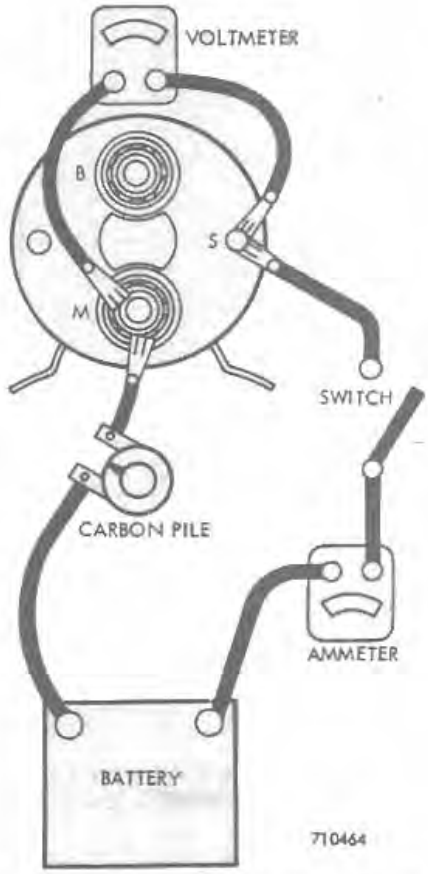


Figure 9 - Pull-in Winding Test

Section 8007

ALTERNATOR

J I Case
A Tenneco Company

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

SPECIFICATIONS

Prestolite Alternator

Alternator rated output	14.2 volts, 35 amps at 80° F. (26.7° C.) Output will decrease slightly as temperature increases and increase slightly as temperature decreases.
Voltage regulator	Fully transistorized and nonadjustable
Torque specifications	
Pulley nut	30-35 foot-pounds (41-47 N m)
Brush holder screws	25-30 inch-pounds (2.8-8.3 N m)
Auxiliary terminal nut - 10-32	25-30 inch-pounds (2.8-3.3 N m)
Output terminal nut - 14-28	70-80 inch-pounds (8-10 N m)
Tie bolts	35-40 inch-pounds (4.0-4.5 N m)

Delco-Remey Alternator

Alternator rated output	13 volts, 37 amps at 75° F (23.9 C) Output will decrease slightly as temperature increases and increases slightly as temperature decreases.
Voltage regulator	Fully transistorized and nonajustable.
Torque specifications	
Pulley nut	40-50 foot-pounds (54-68 N m)
Bat terminal nut	25-40 inch-pounds (2.8-4.5 N m)

ALTERNATOR AND VOLTAGE REGULATOR TESTING

The alternator and voltage regulator remain on the machine while testing to use the circuit conductors and accessories that are a permanent part of the charging system. This results in more accurate problem identification.

Preliminary Checks

Before testing the charging system check the following:

a. Battery: The battery should be at least 75% of full charge. Refer to Specific Gravity Check in Section 8005.

b. Connections: All connections of charging system components should be tight and free of corrosion, oxidation and other foreign matter that would cause a poor connection.

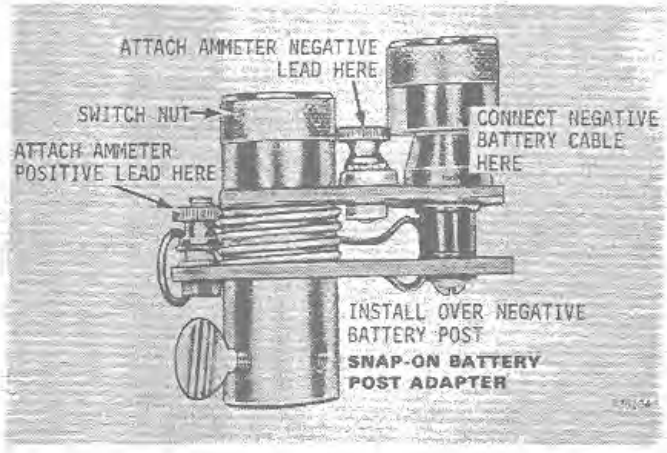
c. Drive belt: The drive belt should be free of grease or oil which may cause slippage under load. Check for proper belt tension as instructed on page 8007-27.

Test Equipment

NOTE: The following test equipment, except the test lamp, are self-contained in Sun Electric's Volt-Ampere Tester, model VAT-26 and Snap-on's Heavy Duty A.V.R. Tester, model MT 540C. The following test illustrations will show individual component hookups but test may be performed using the self-contained test equipment making connections as instructed and according to the test equipment manufacturers instructions.

The following test equipment will be needed to test the charging system.

1. Battery post adapter, Figure 1.
2. D.C. voltmeter, 0-40 volt scale.
3. D.C. ammeter, 0-100 amp scale.
4. Rheostat, 0-50 ohms resistance, 50 watts.
5. 1/4 ohm, 25 watt resistor, Sun Electric RES-1 or equivalent with leads for connection in the alternator output circuit.
6. Carbon pile, Sun Electric Y-20 or equivalent, capable of 600 amp load, knob controlled.
7. 120 volt test lamp with a 25 watt bulb.
8. 12 volt test lamp with number 57 bulb. Used during bench testing.
9. Ohmmeter, Simpson 260 or equivalent. Used during bench testing.



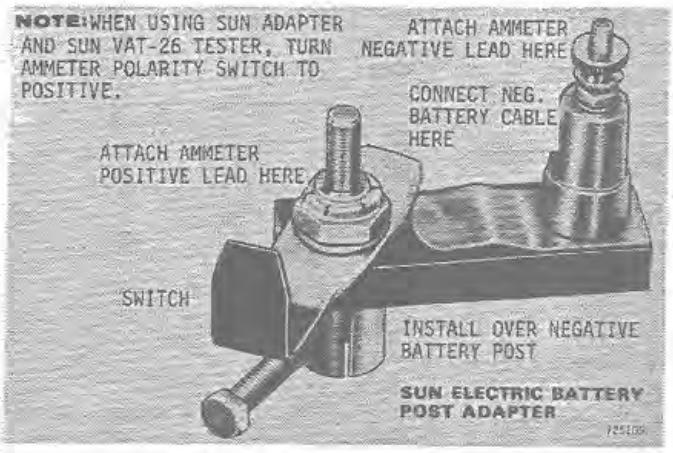


Figure 1 - Battery Post Adapter

Prestolite Alternator Tests

Test No. 1 - Alternator Output

1. Remove ground cable from battery. Install battery post adapter, Figure 1, on negative battery post and connect cable to adapter.

   NOTE: Before completing step 2, close switch on Sun adapter or turn switch nut up several turns on Snap-on adapter.

2. Connect test ammeter to battery post adapter as indicated in Figure 1.

3. Connect voltmeter positive lead to the output terminal and the negative lead to the alternator frame.

4. Connect carbon pile (or load control) to the battery terminals. Make sure carbon pile is OFF before making connections.

5. Start engine and run at full throttle and open battery post adapter switch. Adjust the carbon pile until the voltmeter indicates 14.2 volts. The test ammeter should indicate 35 amps.

6. Turn off carbon pile and stop engine.

7. If the output was not as specified, remove alternator, disassemble and test alternator components.

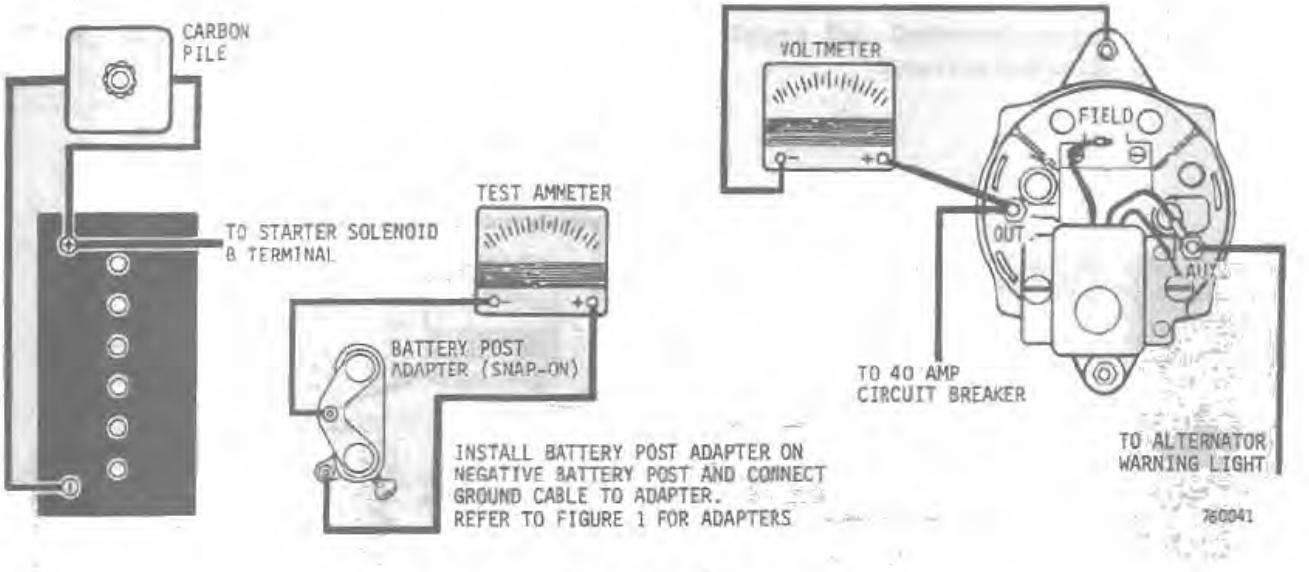


Figure 2 - Alternator Output Test Hookup

Test No. 2 - Voltage Regulator Setting

1. Remove ground cable from battery. Install battery post adapter, Figure 1, on negative battery post and connect cable to adapter.

   NOTE: Before completing step 2, close switch on Sun adapter or turn switch nut up several turns on Snap-on adapter.

2. Connect test ammeter to adapter as indicated in Figure 1.

3. Disconnect wire from alternator output terminal and connect the 1/4 ohm resistor between the output terminal and wire.

4. Connect positive voltmeter lead to the alternator output terminal and negative lead to the alternator frame.

5. Start engine and run at 3/4 throttle for a few minutes to allow component temperatures to stabilize.

6. With the engine running at full throttle, observe the voltmeter. The voltmeter should indicate 14.2 volts (slightly lower at temperatures above 80° F. (26.7° C) or slightly higher at temperatures below 80° F. (26.7° C.) for all machines.

   a. If the voltage reading was less than 14.2 volts the regulator is defective and must be replaced.

   b. A voltage reading over 14.2 volts may be caused by a poor ground between the regulator and the alternator frame or a defective regulator. Make repairs as required.

7. After completing the test, remove the 1/4 ohm resistor and connect wire to output terminal.

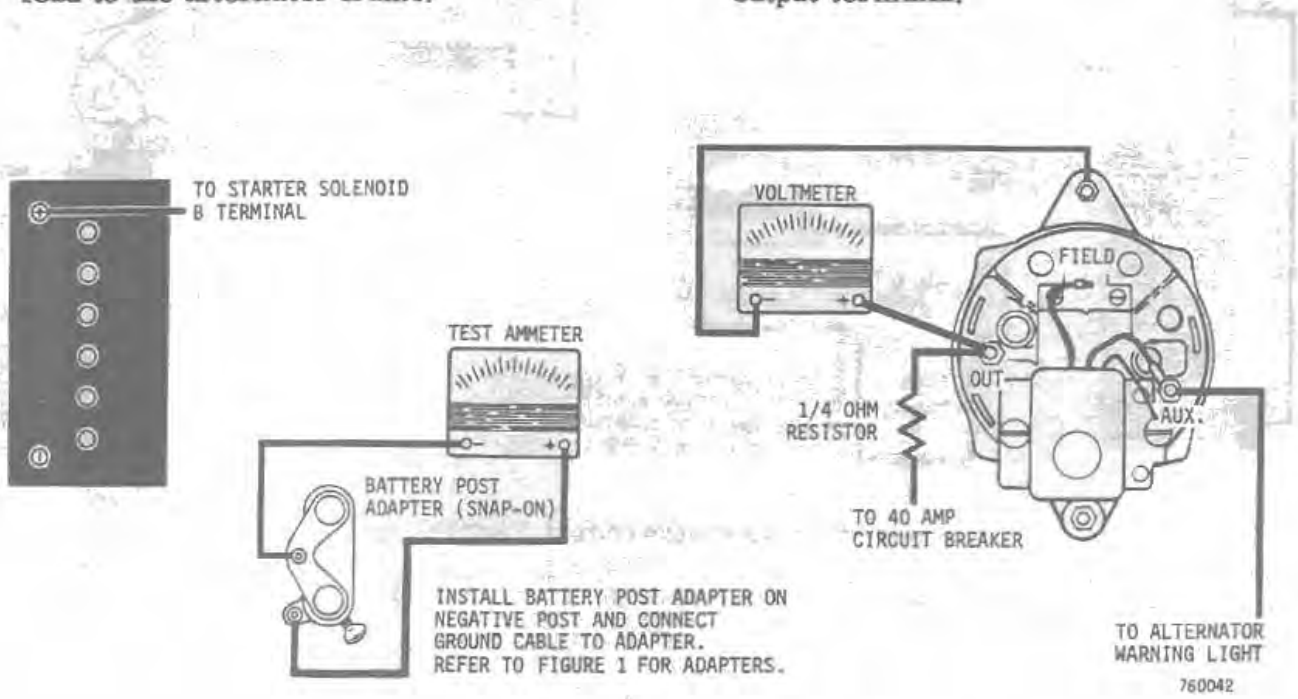


Figure 3 - Voltage Regulator Setting Test Hookup

Delco-Remy Alternator/Voltage Regulator Test

1. Remove ground cable from battery. Install battery post adapter, Figure 1, on negative battery post and connect cable to adapter.

   NOTE: Before completing step 2, close switch on the Sun adapter or turn the switch nut up several turns on the Snap-On adapter.

2. Connect test ammeter to battery post adapter as indicated in Figure 1.

3. Connect carbon pile (or load control) to the battery terminals. Make sure carbon pile is OFF before making connections.

4. Start engine and run at half throttle and open battery post adapter switch. Then adjust carbon pile to obtain maximum current output (amperes). Record test ammeter reading and turn carbon pile off.

5. If output was within 10 amps of the specified output (37 amps), the alternator and voltage regulator are good. Low output within 10 amps could be caused by poor connections in the charging circuit. Check and clean circuit connections as required.

6. If output was not within 10 amps of the specified output (37 amps) ground the field winding (rotor) by inserting a screwdriver into test hole in rear housing, Figure 4. The screwdriver should contact tab in hole and rear housing. Do not insert screwdriver more than one inch or unnecessary damage will result. With the engine running at half throttle, adjust the carbon pile to obtain maximum current output. Record test ammeter reading and turn carbon pile off.

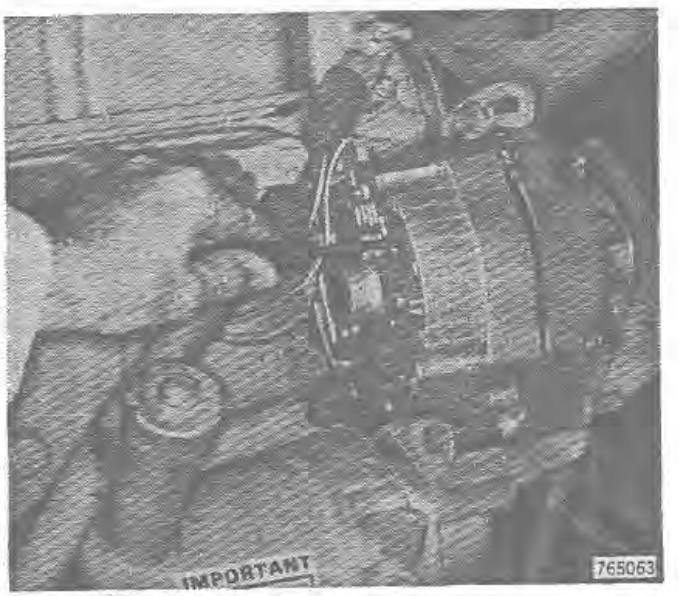


Figure 4

7. If output in step 6 was within 10 amps of the rated output (37 amps), remove alternator, separate the front and rear housings and perform rotor tests as instructed on page 8007-22. If rotor tests good, replace the voltage regulator.

8. If output in step 6 was not within 10 amps of the rated output (37 amps), remove and disassemble the alternator, and check the rotor, diode trio, rectifier bridge and stator as instructed under Component Tests starting on page 8007-20.

PRESTOLITE ALTERNATOR

The Alternator Charging Circuit

The charging circuit consists of the battery, alternator, voltage regulator, key switch, 40 amp circuit breaker, alternator warning light and related wiring. The circuit is schematically illustrated in Figure 5.

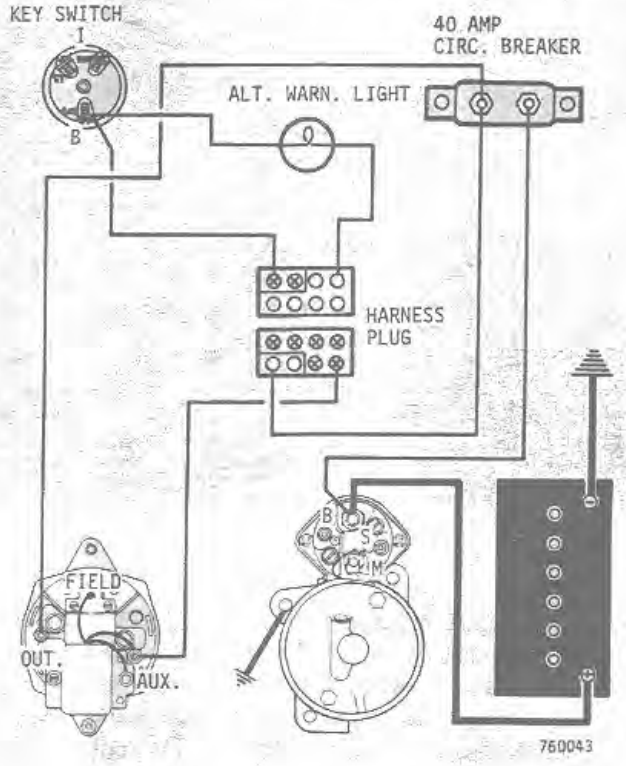


Figure 5 - Charging Circuit

The alternator components are the front housing, stator, rotor and rear housing which contains the rectifier diodes.

By rotating the rotor inside the stator, an alternating current is induced in the stator windings. This alternating current is then rectified (changed to D. C.) by the rectifier diodes and delivered to the output terminal.

Diodes have a high resistance to current flow in one direction and a low resistance in the opposite direction. They are connected to permit current flow from the alternator to the battery in the low resistance direction. The high resistance of the opposite direction prevents the flow of current from the battery to the alternator.

Residual magnetism in the rotor (field) is negligible, therefore, a starting field current must be supplied from an external source. Initially the battery is connected to the field winding through the key switch and regulator and supplies field current until the alternator output overcomes the starting field current. When this occurs, the field winding is energized by the alternator through the voltage regulator and the warning light indicates a charging condition. This eliminates the need of the external field current source and results in an almost complete elimination of the voltage drop between the alternator and the auxiliary terminal where system voltage is sensed.

The alternator output is regulated by varying the field current. This is accomplished through the use of a completely transistorized voltage regulator which turns on and shuts off the field (rotor) and maintains a predetermined voltage.

Disassembly

1. Scribe an alignment mark on the front and rear housings to assure proper assembly. Then remove voltage regulator from rear housing.

2. Remove the thru bolts using a 3/16" (4.8 mm) six point socket. Separate the front housing and rotor assembly from the rear housing and stator assembly. It may be necessary to drive the rear housing from the rear bearing. Use a drift punch and light hammer. Place punch near thru bolt bosses on rear housing.

   NOTE: Use care when handling the stator and rear housing to prevent damage to the winding insulation, stator and diode leads.

3. Remove brush holder assembly from rear housing.

4. Secure pulley in soft jawed vise and remove nut and lock washer. Then remove pulley, fan, Woodruff key and spacer.

5. Place front housing in a press with rotor down. Properly support housing and press rotor out of front housing bearing. Do not allow rotor to drop. Then remove felt retainers and felt from rotor shaft.

6. Remove bearing from rotor shaft only if inspection indicates need for replacement. Provide suitable support for the bearing and press bearing from shaft.

7. Remove snap ring from front housing. Support the front housing on the bearing boss and press bearing from housing, Figure 6.

8. The stator leads must be unsoldered from the diodes to accurately test the stator and diodes. Use a press to remove and install the diodes. The output and auxiliary terminals must be removed to remove the diode/heat sink assembly.

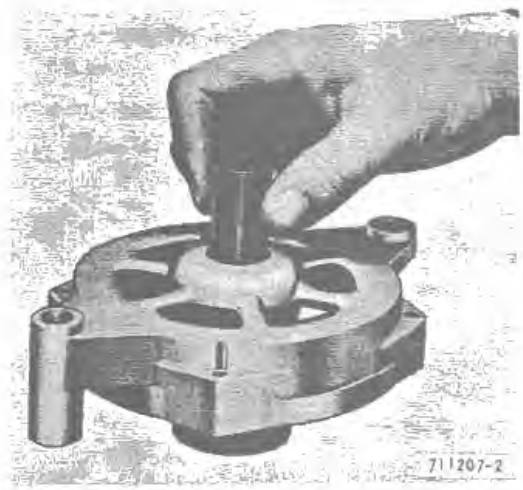


Figure 6 - Removing Front Housing Bearing

Inspection

1. Clean the front and rear housings in cleaning solvent and wipe the remaining parts with a solvent dampened cloth.

2. Inspect front and rear housings for cracks and other defects.

3. Inspect rotor and stator for discolored windings. Discolored windings may be the result of shorted windings or overheating.

4. Inspect brushes for wear and oil contamination. When brushes are worn to 1/4" (6.4 mm) or less, they must be replaced. The complete brush holder assembly must be replaced when brushes require replacement.

5. Check brush spring tension. The spring tension should be great enough to hold the brush firmly against the slip ring.

6. Check bearings for free rotation, flat spots and cracked races.

7. Discard any cracked insulator.

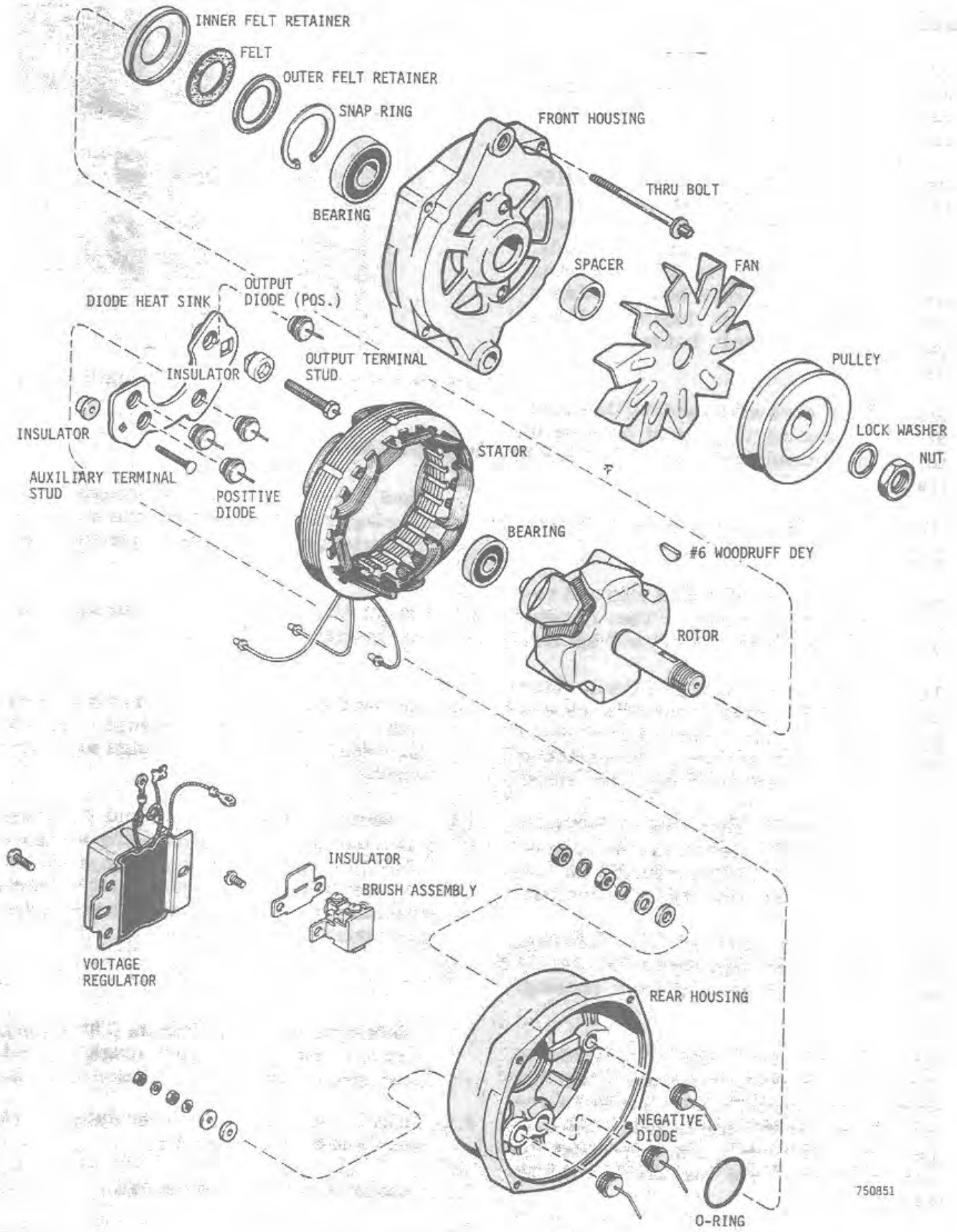


Figure 7 - Alternator

8. Check for loose diodes in heat sink and rear housing.

9. Clean brush contact surface on slip rings with crocus cloth.

Component Testing

Rotor Short Test

1. Refer to Figure 8 and set up test as illustrated. Set rheostat at maximum resistance before making connections.

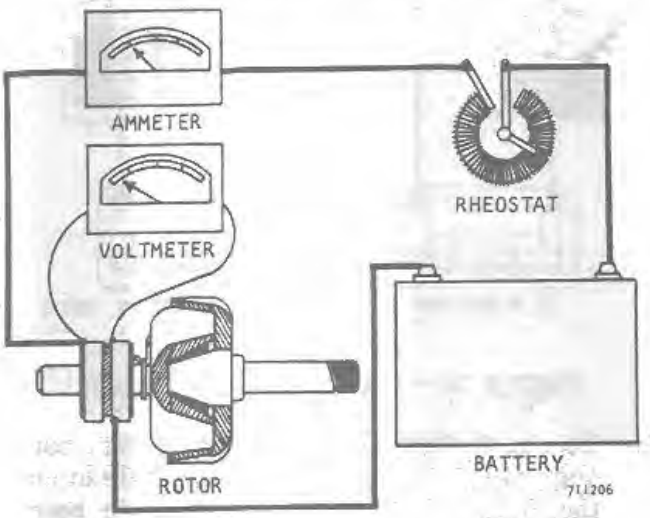


Figure 8 - Rotor Short Test Hookup

2. Slowly reduce resistance until the voltmeter indicates 10 volts.

3. Note the ammeter reading. The ammeter should indicate 2.4-2.6 amperes. Excessive amperage indicates shorted windings and a zero reading indicates an open winding.

Rotor Ground Test

Place one test probe on a slip ring and the other probe on the rotor core as illustrated in Figure 9.

Stator Ground Test

1. Unsolder stator leads if this has not been done.

   NOTE: When unsoldering or soldering stator leads, grasp diode lead with pliers between the diode and soldered connection to prevent heat damage to the diode.

Figure 9 - Testing Rotor for Ground

2. Touch one probe of the 110 volt test lamp to the stator frame and the other probe to a stator lead. Repeat for the remaining stator leads. If the test lamp lights, the stator is grounded and must be replaced.

Stator Open Test

Touch one probe of the 12 volt test lamp to the stator common connection, Figure 10, and the other test probe to a stator lead. Repeat for the remaining stator leads. If the bulb fails to light, a winding is open and the stator must be replaced.

Shorted Stator

Shorted windings in the stator are difficult to detect. If the rotor and rectifier diodes are not the cause of failure, and the stator is not open or grounded, replace the stator.

Testing Rectifier Diodes

Diodes may be tested with a 12 volt test lamp, ohmmeter or a commercial diode tester. If a commercial diode tester is available, test the diodes according to the equipment manufacturer's instructions.

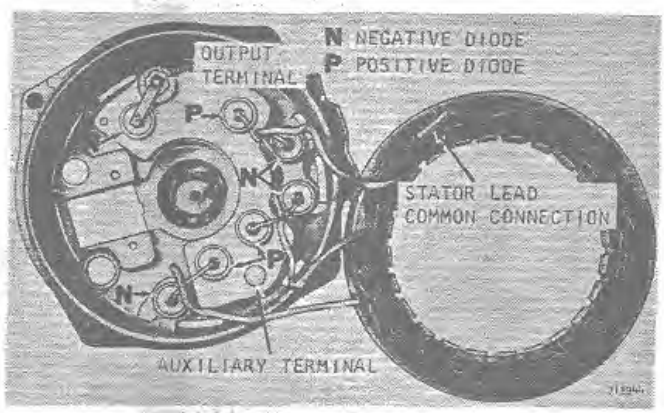


Figure 10 - Diode Location

1. Unsolder stator leads from diodes if this has not been done.

   NOTE: When unsoldering or soldering diodes, grasp the diode lead with pliers between the diode and soldered connection to prevent heat damage to the diode.

2. To check the diodes with a 12 volt test lamp:

   a. Connect a 12 volt battery and the test lamp to each positive diode as illustrated in Figure 11. Refer to Figure 10 for diode location. The lamp should light in one direction only. If the lamp fails to light or lights in both directions the diode is defective and must be replaced.

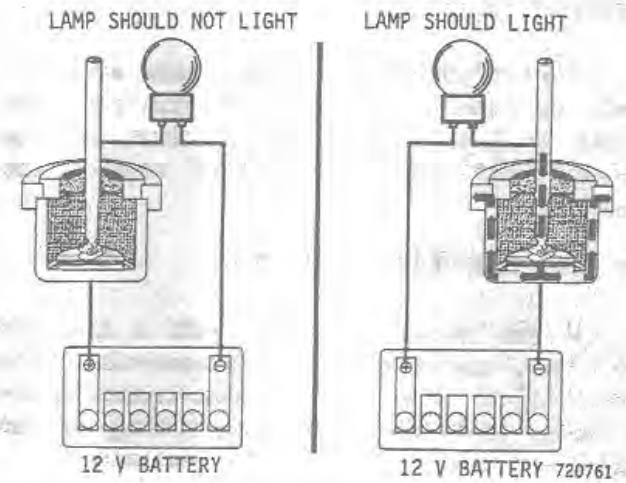


Figure 11 - Positive Diode Check

   b. Connect 12 volt battery and the test lamp to each negative diode as illustrated in Figure 12. Refer to Figure 10 for diode location. The lamp should light in one direction only. If the lamp fails to light or lights in both directions, the diode is defective and must be replaced.

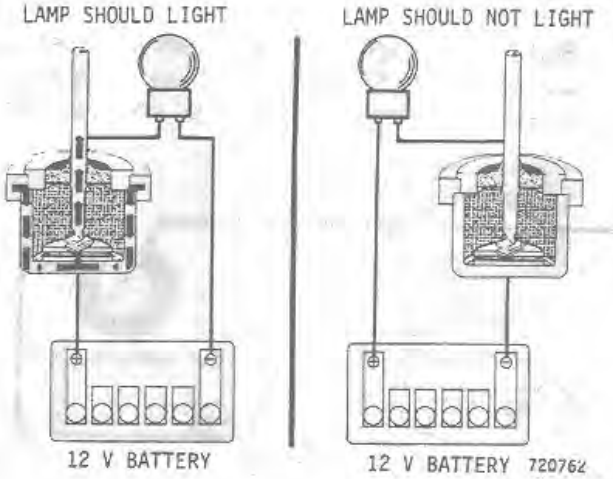


Figure 12 - Negative Diode Check

3. To check diodes with an ohmmeter, connect one test lead to the diode lead and the other test lead to the diode body. Note the reading and reverse the test leads. The diode is good if there was a high and low reading for each diode. If both readings were the same, the diode must be replaced.

Assembly

1. Press bearing into front housing and secure in place with snap ring.

2. Press bearing onto slip ring end of rotor. If the bearing is open on one side, install bearing with sealed side toward the rotor core. Pack bearing with a good grade of high temperature bearing grease.

3. Place inner felt retainer on rotor shaft. Then place felt and outer felt retainer in the inner felt retainer.

4. Start front housing onto rotor shaft. Place this assembly in a press, rotor down, and press housing onto shaft until seated. Use a driver that fits over the shaft and contacts the inner bearing race.

5. Install spacer on rotor shaft. Then place Woodruff key in keyway and install the fan and pulley. Secure parts in place with lock washer and nut. Torque nut to specification on page 8007-3.

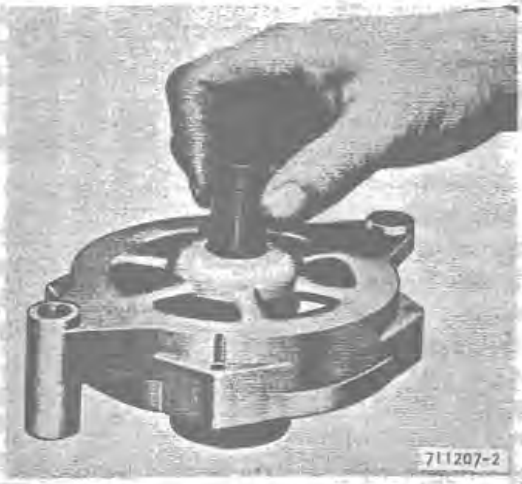


Figure 13 - Installing Front Housing Bearing

6. Make sure O-ring is in bearing bore in the rear housing. Stand front housing on pulley and start rear housing/stator assembly onto bearing. Align marks made on front and rear housing and start the four tie bolts into place. Alternately tighten two opposing bolts to draw the housings together. Tighten the remaining bolts and torque all tie bolts to specification on page 8007-3.

7. Install brush holder assembly in rear housing. Place cover on flat surface of rear housing bearing boss. Then set brush holder on cover and push brush holder down and into rear housing. Listen for click as each brush contacts the slip rings. Install cover over field terminal and secure parts in place with screws.

8. Secure voltage regulator to rear housing with screws. The black lead should be attached to regulator mounting screw. The brown lead is connected to the auxiliary terminal and the green lead to the field terminal.

DELCO-REMY ALTERNATOR

The Alternator Charging Circuit

The alternator charging circuit consists of the battery, alternator with self contained voltage regulator, key switch, 40 amp circuit breaker, alternator warning light and related wiring. The circuit is schematically illustrated in Figure 14.

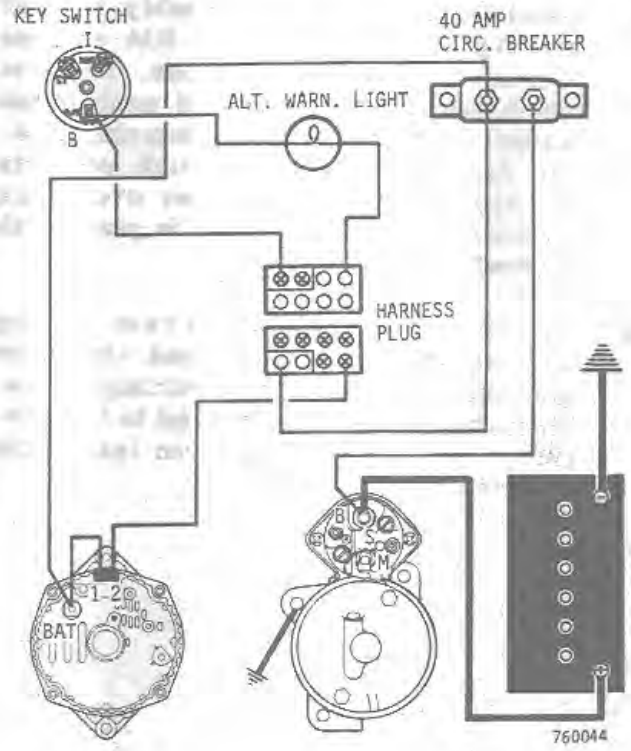


Figure 14 - Charging Circuit

The alternator components are the front housing, rotor, rear housing, diode trio, rectifier bridge and stator.

By rotating the rotor inside the stator, an alternating current is induced in the stator winding. This alternating current is then rectified (changed to D.C.) by the rectifier diodes in the rectifier bridge and delivered to the Bat (output) terminal.

Diodes have a high resistance to current flow in one direction and a low resistance in the opposite direction. They are connected to permit current flow from the alternator to the battery in the low resistance direction. The high resistance of the opposite direction prevents the flow of current from the battery to the alternator.

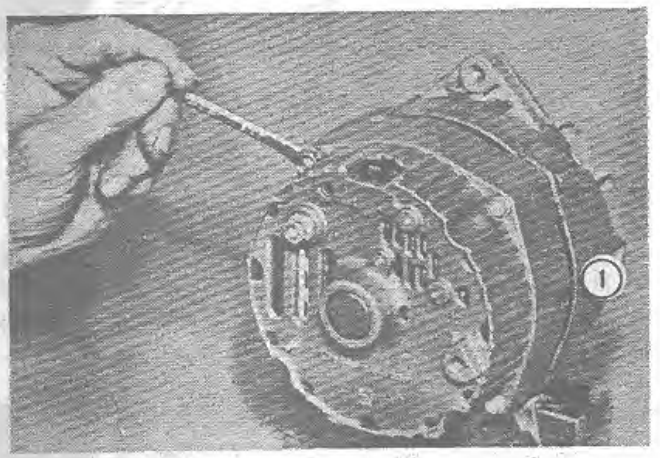
Magnetism in the rotor (field) is very slight, therefore, a starting field current must be supplied from an external source to start the alternator charging. Initially the battery is connected to the field winding through the key switch and regulator, and supplies field current until the alternator output overcomes the starting field current. When this occurs, the field winding is energized by the alternator through the voltage regulator and the alternator warning light indicates a charging condition. This eliminates the need of the external field current source and results in an almost complete elimination of the voltage drop between the alternator Bat terminal and terminal No. 1 where system voltage is sensed.

The alternator output is regulated by varying the field current. This is accomplished through the use of a completely transistorized voltage regulator which turns on and shuts off the field and maintains a predetermined voltage.

The condenser mounted inside the rear housing is used to absorb transient over voltages that may damage the diode trio or the diodes in the rectifier bridge. Whenever the diode trio or the rectifier bridge is found to be defective, it is suggested that the condenser be replaced as a protective measure.

Disassembly

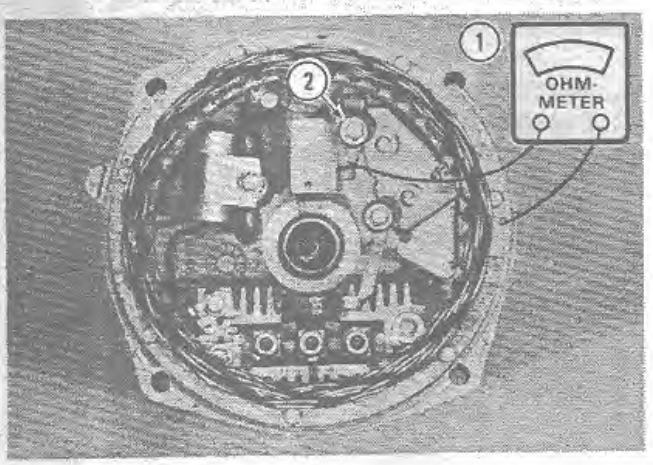
1. Make an alignment mark on the front and rear housing to assure proper assembly. Then remove the four tie bolts and separate the housings. Be sure the stator and rear housing are moved as an assembly.



1. Alignment Marks

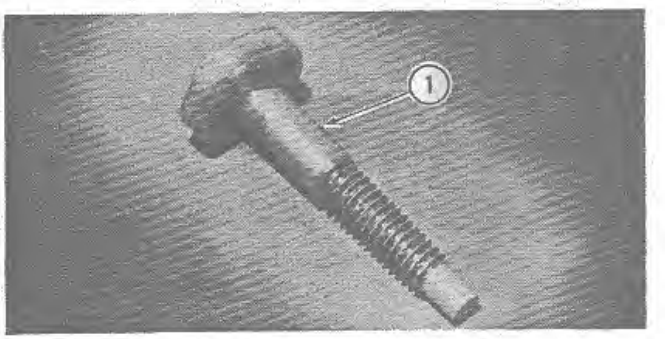
Figure 15

2. Before disassembling the rear housing, connect an ohmmeter, set on the lowest scale, to the brush lead clip and rear housing as illustrated in Figure 16 and note the ohmmeter reading. Reverse the ohmmeter leads and note ohmmeter reading. There must be one high and one low reading. If both readings were the same, remove the brush lead clip screw and check insulator for damage. If the insulator is good, the voltage regulator is damaged and must be replaced.



1. Ohmmeter
2. Brush Lead Clip Screw

Figure 16

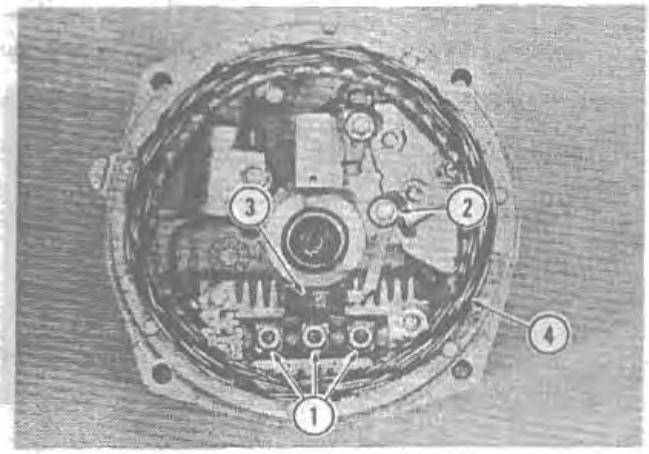


1. Insulator

Figure 17

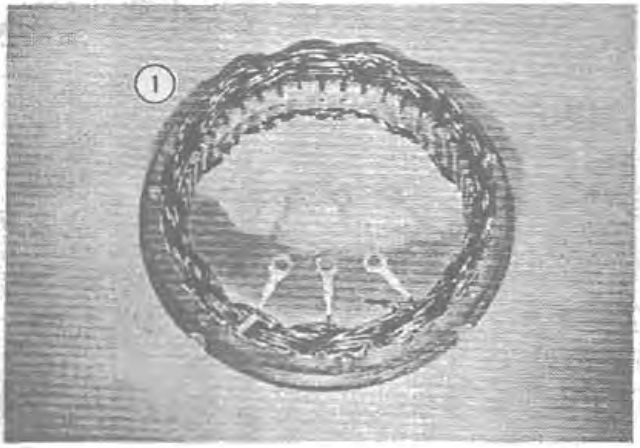
3. Check insulator on both insulated screws for wear or damage that could result in the connected parts being grounded.

4. Remove nuts from rectifier bridge terminals and insulated screw from long leg of diode trio. Then remove stator and diode trio from rear housing.



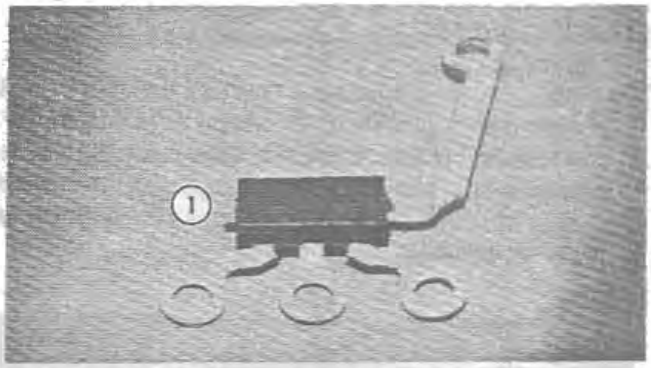
1. Nut
2. Insulated Screw
3. Diode Trio
4. Stator

Figure 18



1. Stator

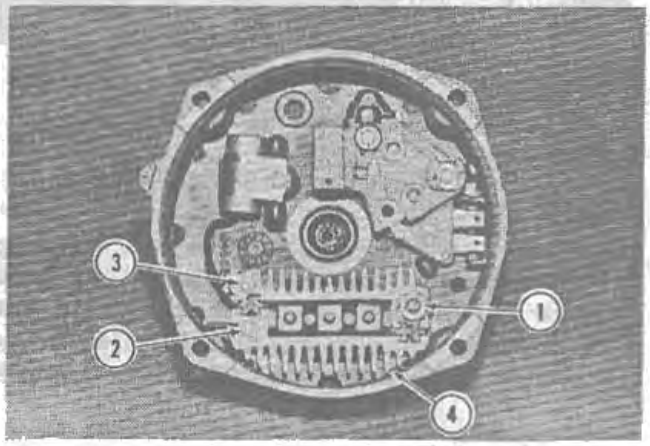
Figure 19



1. Diode Trio

Figure 20

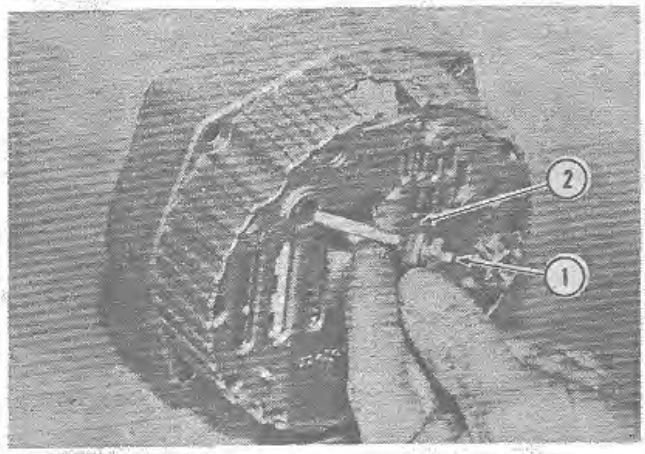
5. Remove nut from Bat terminal, rectifier bridge retaining screw and condenser lead screw. Then remove rectifier bridge from rear housing.



1. Bat Terminal Nut
2. Rectifier Bridge Screw
3. Condenser Lead Screw
4. Rectifier Bridge

Figure 21

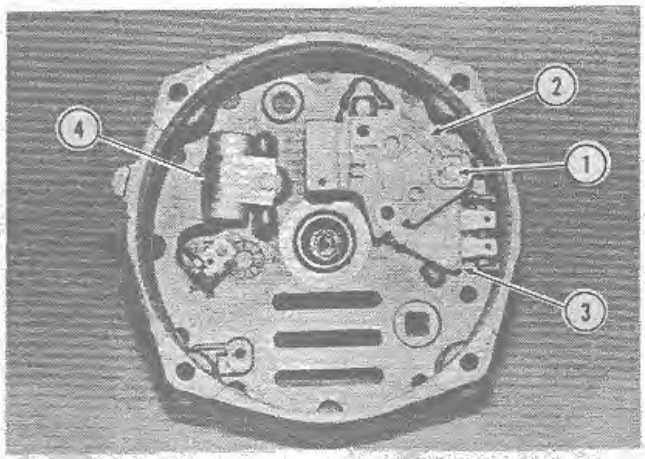
6. Remove Bat terminal and insulator from rear housing. Discard insulator if it is damaged in any way.



1. Bat Terminal 2. Insulator

Figure 22

7. Remove the grounding screw holding the brush holder assembly and voltage regulator and remove these parts from the rear housing. Then remove condenser (capacitor) from rear housing.

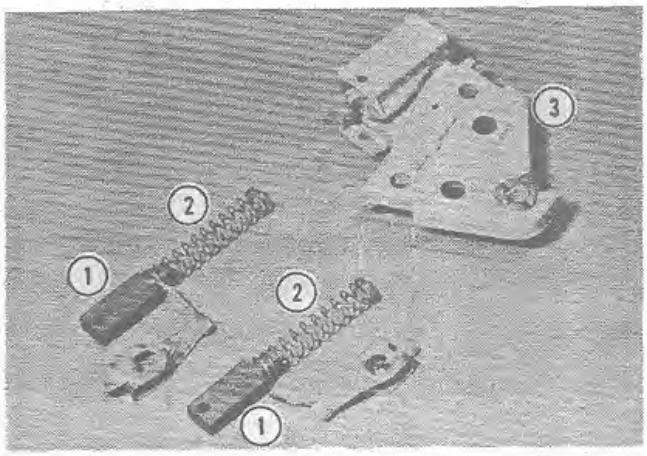


1. Grounding Screw
2. Brush Holder Assembly
3. Voltage Regulator
4. Condenser (Capacitor)

Figure 23

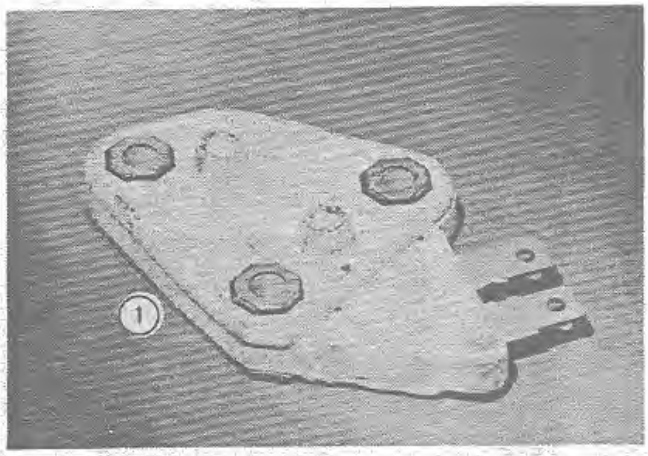
8. If the brushes measure 13/32" (10.3 mm) from the shoulder to the slip ring surface, the complete brush holder assembly must be replaced.

NOTE: Check with local Delco-Remy parts supplier to see if brushes can be purchased separately.



1. Brush Assembly 3. Brush Holder
2. Brush Spring

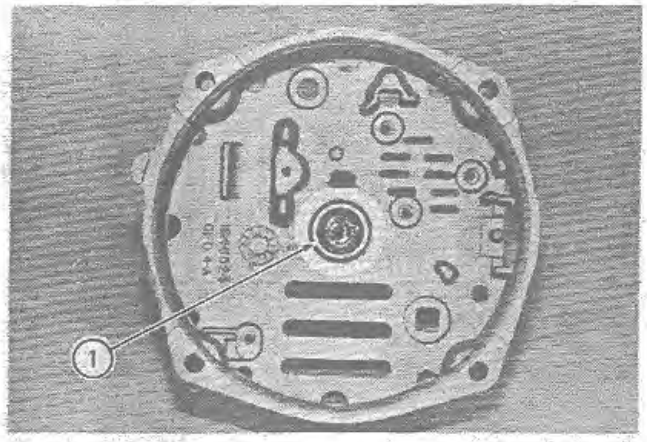
Figure 24



1. Voltage Regulator (Regulators May Vary in Appearance but are Completely Interchangeable)

Figure 25

9. Do not remove bearing from rear housing unless it is to be replaced. Reasons for replacement are; worn or damaged seal and/or bearing rollers, and lack of lubricant. DO NOT attempt to lubricate bearing.



1. Bearing

Figure 26

10. To remove bearing from rear housing, support housing under bearing bore with a piece of pipe or other suitable support. The support must be long enough to prevent the housing from touching the work bench or press bed. Then use a suitable driver and press or drive bearing from housing.

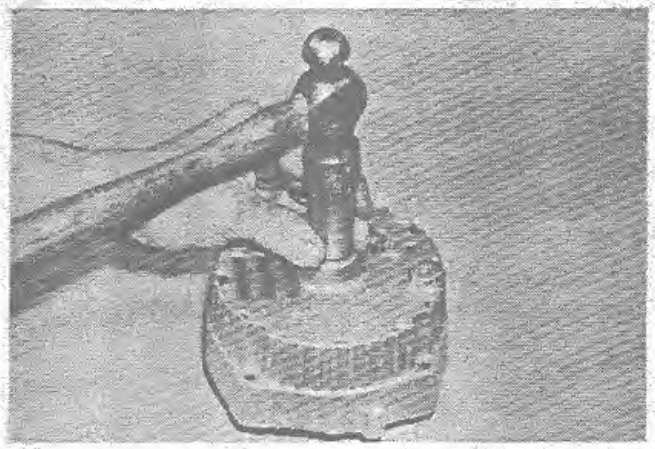
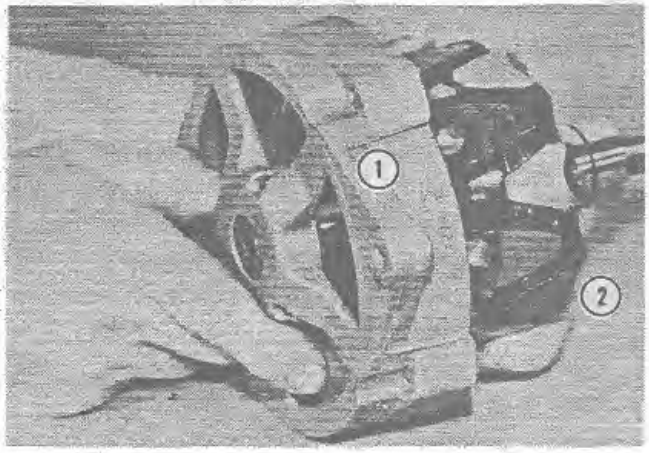


Figure 27

11. Secure pulley in a soft jawed vise and loosen nut.

12. Remove nut, lock washer, pulley, fan and spacer from rotor shaft.

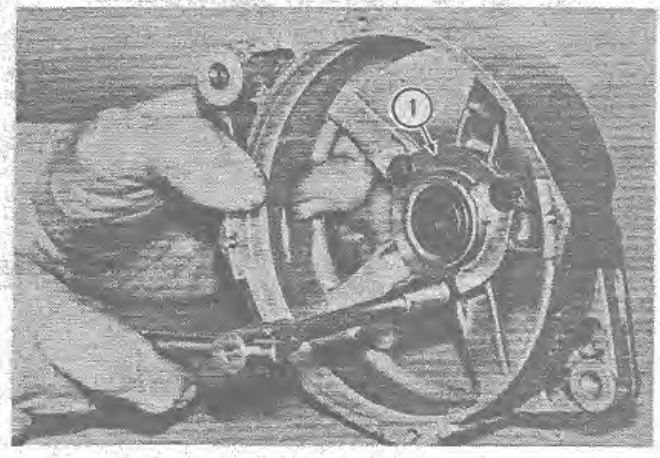
13. Remove front housing from rotor.



1. Front Housing
2. Rotor

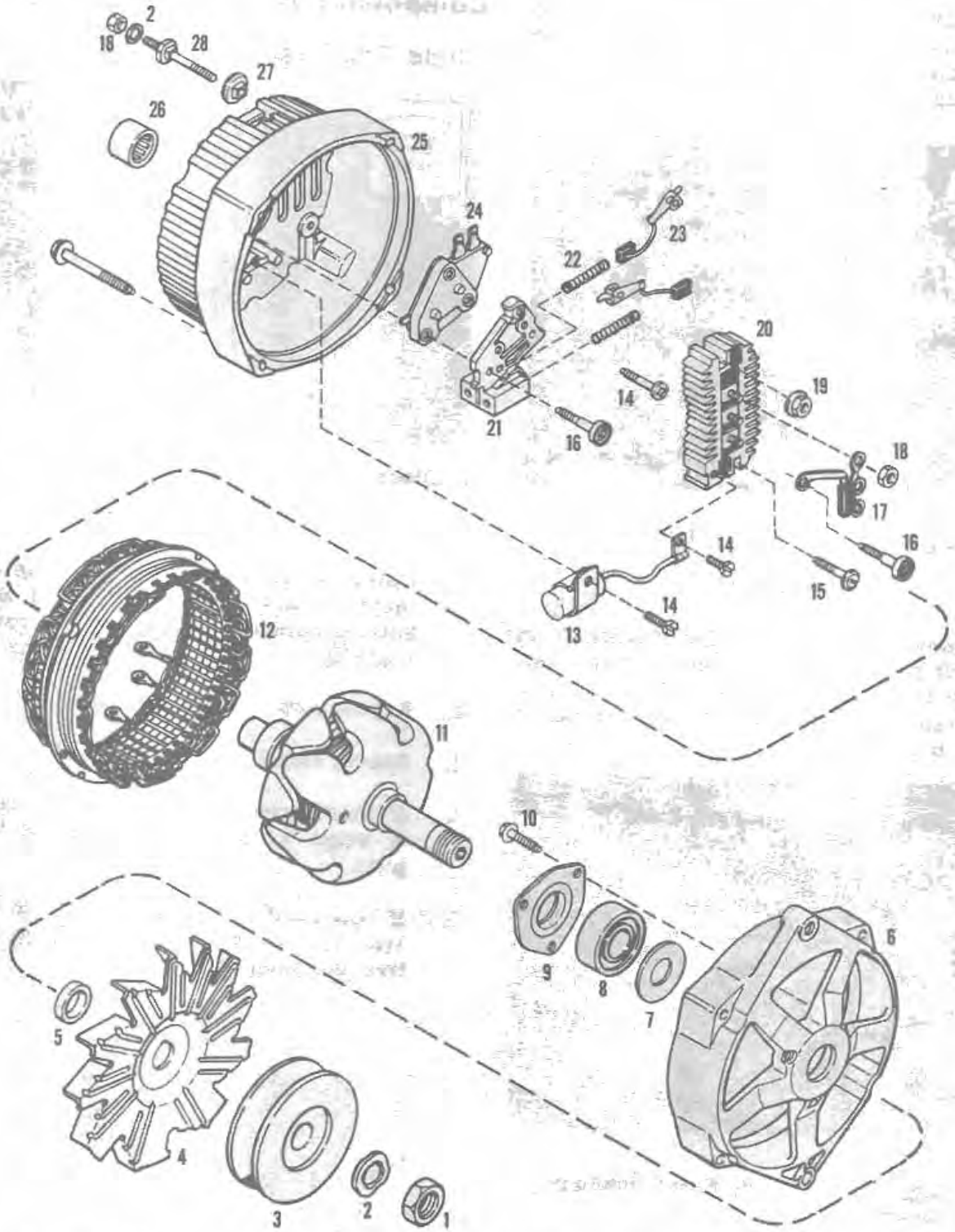
Figure 28

14. Remove bearing retainer cap screws. The flanges of the screw heads are upset to lock the screws in place; discard screws and replace with new parts.



1. Bearing Retainer

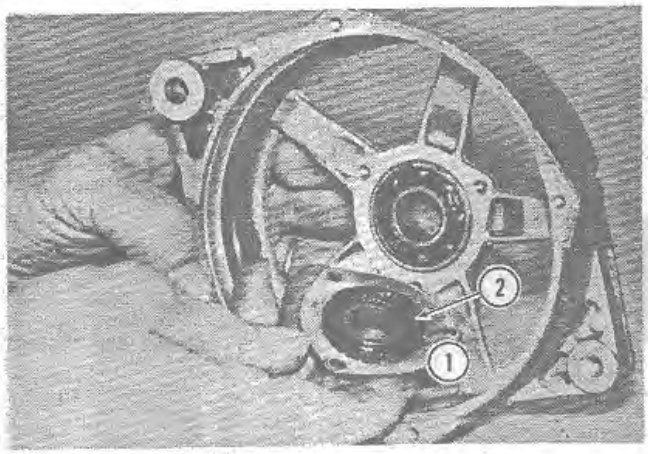
Figure 29



1.	PULLEY NUT	8.	BALL BEARING	15.	WASHER HEAD SCREW	22.	BRUSH SPRING
2.	LOCK WASHER	9.	BEARING RETAINER	16.	INSULATED SCREW	23.	BRUSH ASSEMBLY
3.	PULLEY	10.	CAP SCREW	17.	DIODE TRIO	24.	VOLTAGE REGULATOR
4.	FAN	11.	ROTOR	18.	NUT	25.	REAR HOUSING
5.	SPACER	12.	STATOR	19.	FLANGE NUT	26.	NEEDLE BEARING
6.	FRONT HOUSING	13.	CONDENSER	20.	RECTIFIER BRIDGE	27.	INSULATOR
7.	FLAT WASHER	14.	SCREW	21.	BRUSH HOLDER	28.	BAT TERMINAL

Figure 30

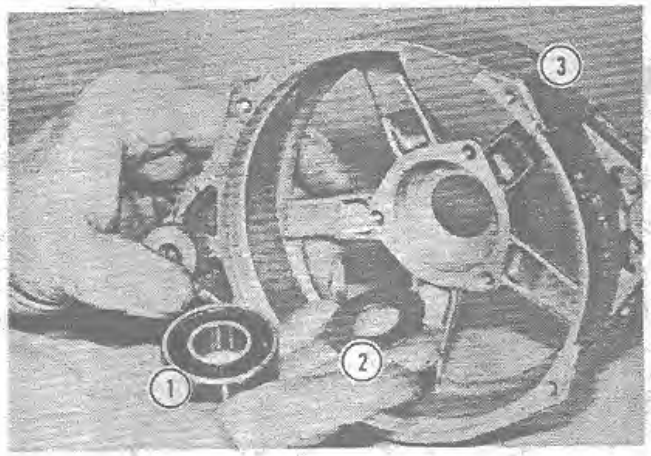
15. Remove bearing retainer. A felt seal is installed in the retainer. Replace the retainer if the felt seal is worn or damaged, or hard.



1. Bearing Retainer 2. Felt Seal

Figure 31

16. Remove bearing and flat washer from front housing. If necessary, press bearing from housing. Be sure to use a suitable support under the center of the housing.

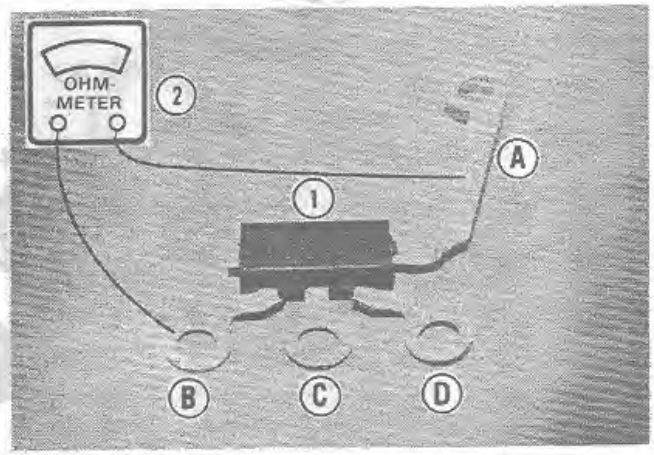


1. Bearing
2. Flat Washer
3. Front Housing

Figure 32

Component Tests

Diode Trio Test



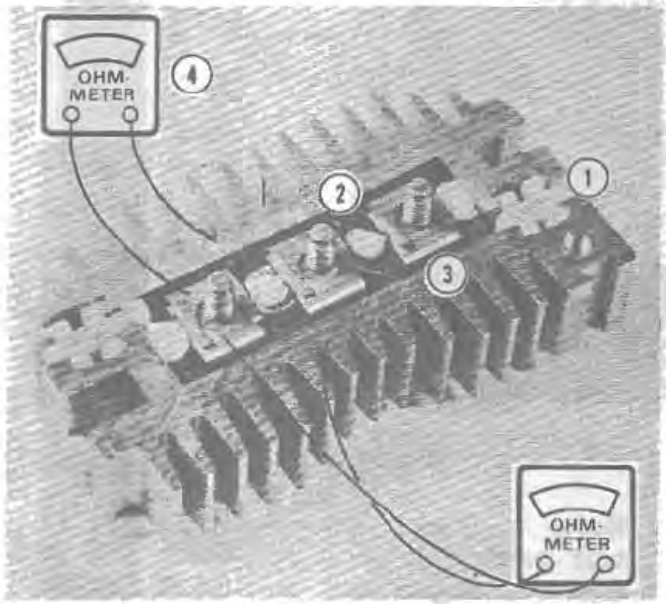
1. Diode Trio 2. Ohmmeter

Figure 33

1. Refer to Figure 32. Connect the ohmmeter leads to points A and B and note ohmmeter reading. Then reverse leads and note ohmmeter reading.
2. Repeat step 1 at points A and C.
3. Repeat step 1 at points A and D.
4. If there was one high and low reading in steps 1, 2 and 3, the diode trio is good.
5. If both readings were the same in either step 1, 2 or 3, the diode trio is defective and must be replaced.

Rectifier Bridge Test

The rectifier bridge has three diodes connected to the grounded heat sink and terminals, and three diodes connected between the insulated heat sink and terminals. If one diode is defective, the complete rectifier bridge must be replaced.



1. Rectifier Bridge
2. Grounded Heat Sink
3. Insulated Heat Sink
4. Ohmmeter

Figure 34

1. Refer to Figure 34. Connect the ohmmeter leads to the grounded heat sink and one of the metal diode connectors and note the ohmmeter reading. Then reverse the leads and note the ohmmeter reading. DO NOT connect ohmmeter lead to the terminals as a false reading may result.

2. Repeat step 1 for the remaining grounded heat sink diodes.

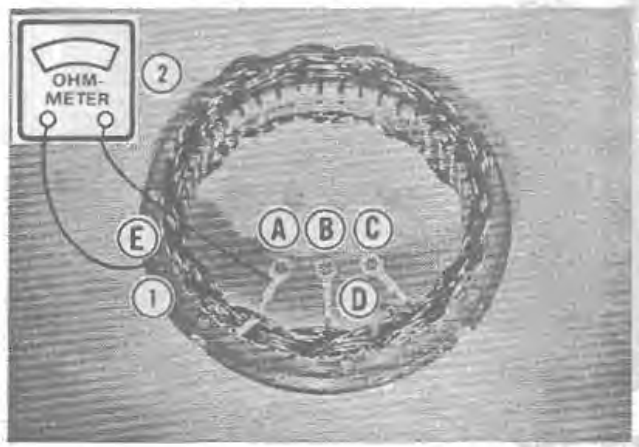
3. Refer to Figure 34. Connect the ohmmeter leads to the insulated heat sink and one of the metal diode connectors and note the ohmmeter reading. Then reverse the leads and note the ohmmeter reading.

4. Repeat step 3 for the remaining insulated heat sink diodes.

5. If each pair of ohmmeter readings indicated one high and one low reading, the rectifier bridge is good.

6. If one pair of ohmmeter readings was the same, that diode is defective and the rectifier bridge must be replaced.

Stator Tests



1. Stator 2. Ohmmeter

Figure 35

1. Refer to Figure 35. Connect an ohmmeter to points D (common connection) and E (stator laminations). If the ohmmeter needle moves, it indicates a grounded winding and replacement of the stator.

2. Connect ohmmeter leads to points A and D and note ohmmeter reading.

3. Connect ohmmeter leads to points B and D and note ohmmeter reading.

4. Connect ohmmeter leads to points C and D and note ohmmeter reading.

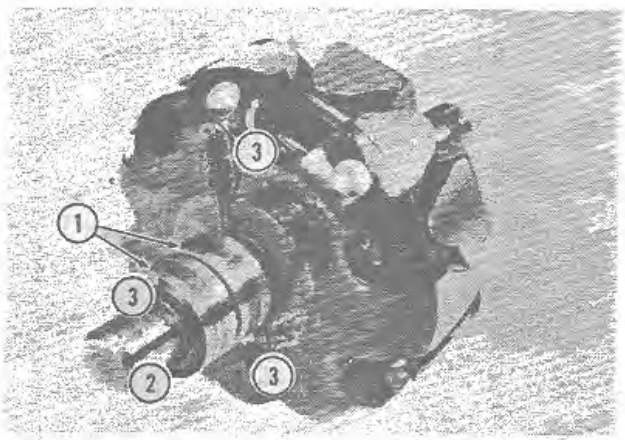
5. If the ohmmeter needle failed to move in either step 2, 3 or 4, a winding is open and the stator must be replaced.

cont'd on next page

6. A short circuit in the windings is difficult to detect. If the diode trio, rectifier bridge, rotor and voltage regulator all checked out good, and the reason for alternator disassembly was low output, shorted stator windings are indicated. Replace the stator.

NOTE: A shorted stator can cause the warning light to come on at lower engine speeds.

Rotor Inspection



1. Slip Ring
2. Bearing Area
3. Slip Ring to Winding Connection

Figure 36

1. Inspect rotor shaft in bearing area for wear pitting and flat spots.

2. Check for loose rotor windings. If windings are loose; replace the rotor.

3. Check for broken slip ring connections.

4. Clean dirty slip rings using 400 grit or finer emery cloth. The rotor must be rotated to prevent flat spots on the slip rings.

5. If slip rings are rough or out of round they should be cleaned up in a lathe to .002" (0.05 mm) maximum indicator reading. Remove only enough material to make slip rings smooth and round. Finish with 400 grit or finer emery cloth.

Rotor Short Test

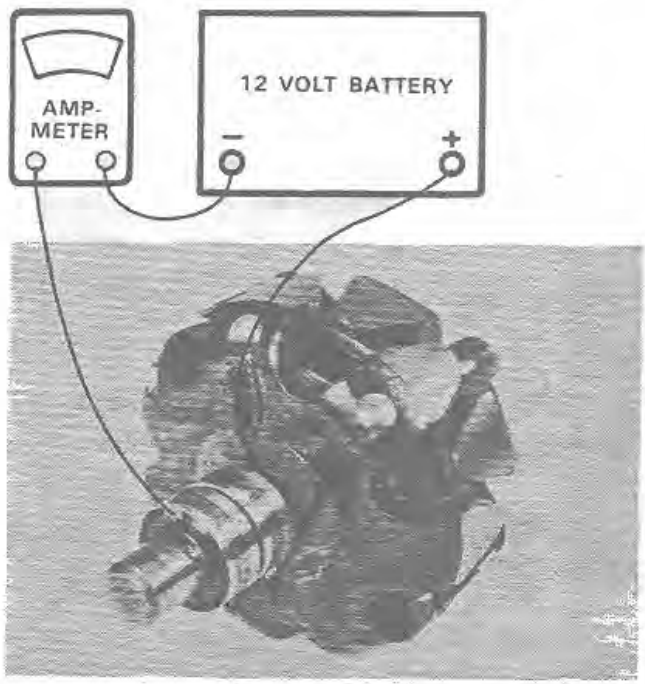


Figure 37

1. Refer to Figure 37. Connect a new 12 volt battery or a used battery that is known to be good, and an ammeter to the side of each slip ring and note the ammeter reading. The connections to the slip rings must be made on the side to prevent damage to the brush surface on the rings.

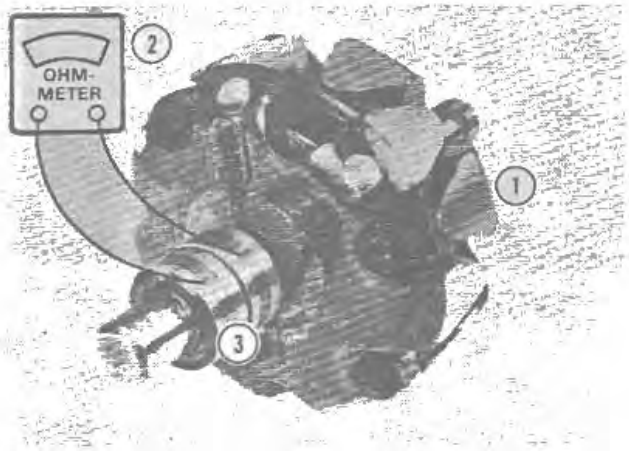
2. The ammeter should indicate 4 to 4.5 amps with a rotor temperature of 80° F (26.7° C). The reading will be slightly higher if the temperature is lower or slightly lower if the temperature is higher.

3. A reading above the specified amperage indicates a shorted winding and replacement of the rotor.

4. A reading below the specified amperage indicates excessive resistance and replacement of the rotor.

5. An alternate method of checking for a shorted winding is to connect an ohmmeter to the slip rings as shown in Figure 38. The ohmmeter should indicate 2.7 to 3 ohms at 80° F (26.7° C).

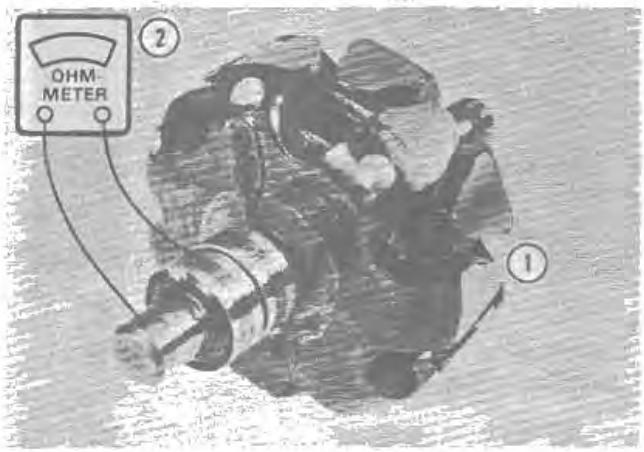
The ohmmeter reading will also vary when tested at higher or lower temperatures. A reading higher or lower than specified indicates replacement of the rotor.



1. Rotor
2. Ohmmeter
3. Slip Ring

Figure 38

Rotor Ground Test



1. Rotor
2. Ohmmeter

Figure 39

Connect an ohmmeter to a slip ring and the rotor shaft and observer ohmmeter. If the ohmmeter needle moves, the winding is grounded and the rotor must be replaced.

Assembly

1. If bearing was removed from rear housing, press or drive in a new bearing. The housing must be supported under the bearing bore and the support must be long enough to prevent the housing from touching the bench or press bed. Drive bearing in until flush with outer end of bearing bore.

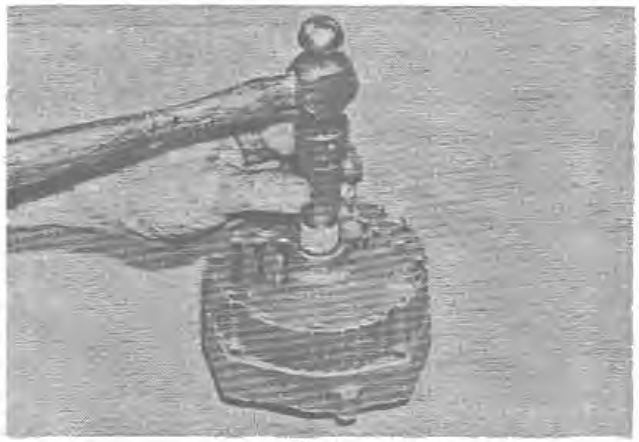
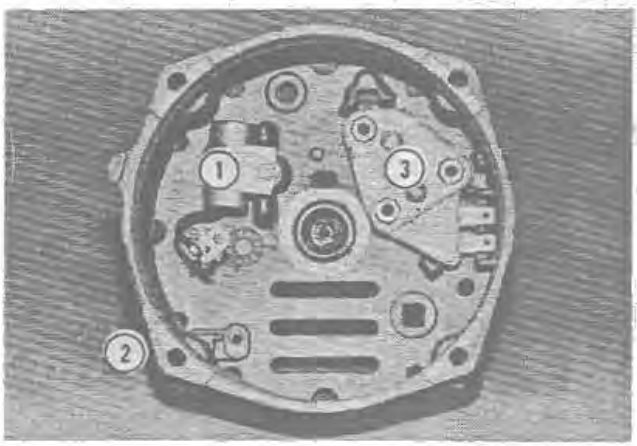


Figure 40

2. Secure condenser to rear housing and place voltage regulator in housing as illustrated in Figure 4.



1. Condenser
2. Rear Housing
3. Voltage Regulator

Figure 41

3. If brushed were removed from holder, install brushes as illustrated in Figure 42. Then push brushes into holder and hold brushes in place by inserting a tooth pick or piece of wire through holes in brushes and holder. The wire or tooth pick should be installed so it can be removed after the front and rear housings have been assembled.

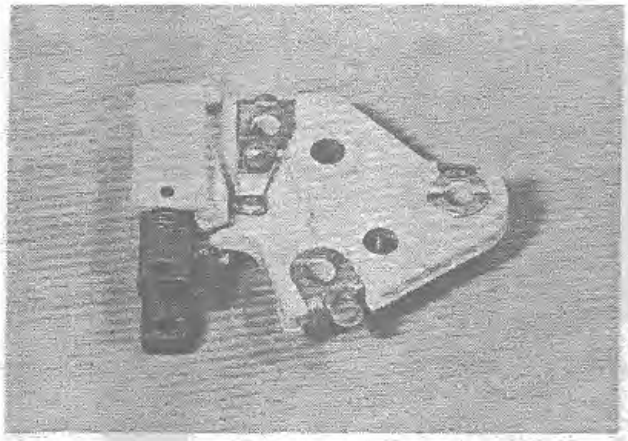
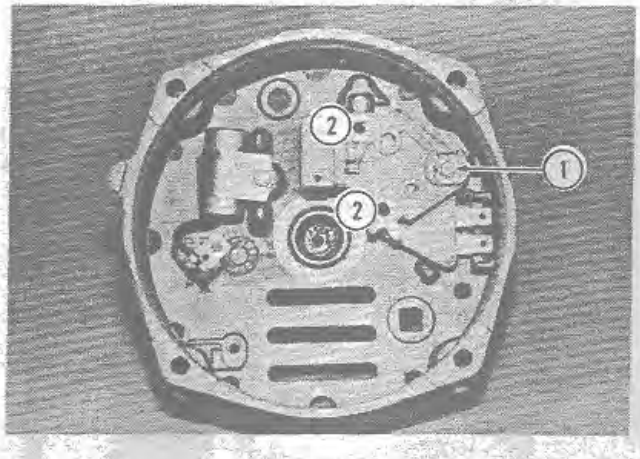


Figure 42

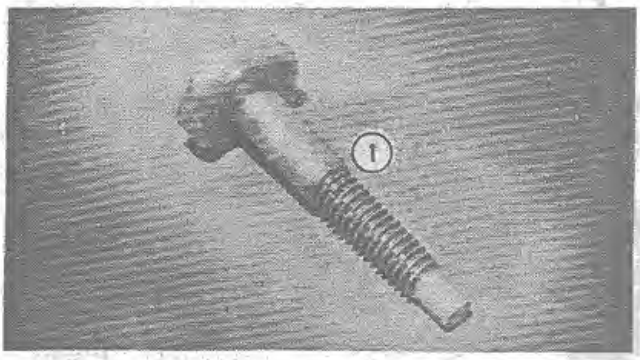
4. Place brush holder assembly on top of voltage regulator and install the ground screw as illustrated in Figure 4.



1. Ground Screw
2. Insulated Screw Holes

Figure 43

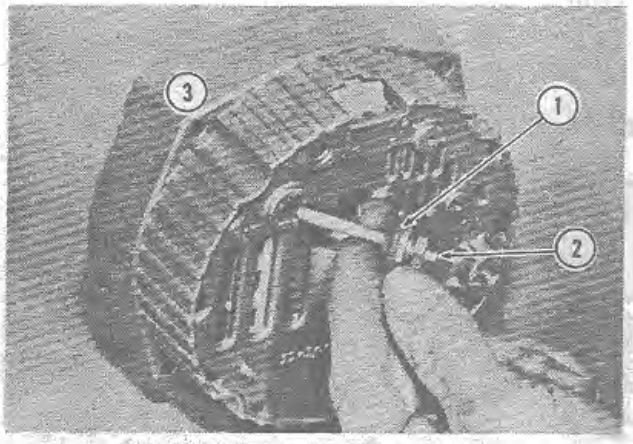
5. Install insulated screw in top hole in brush holder. Do not install the remaining insulated screw at this time.



1. Insulated Screw

Figure 44

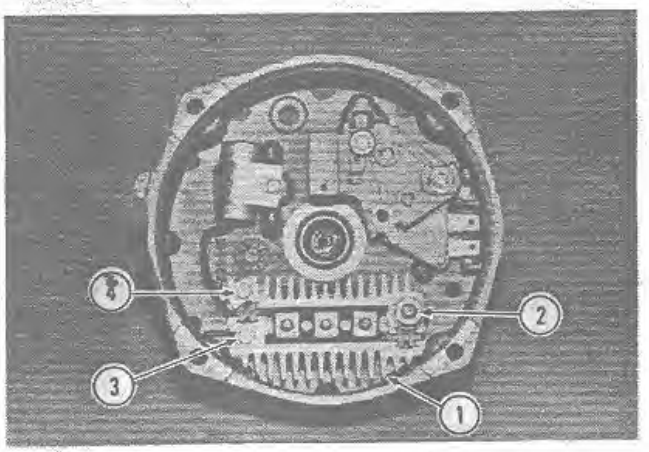
6. Install insulator on Bat terminal and install terminal assembly in rear housing.



1. Insulator
2. Bat Terminal
3. Rear Housing

Figure 45

7. Place rectifier bridge in rear housing as illustrated in Figure 46. Secure bridge in place with nut on Bat terminal and ground screw with attached washer. Then secure condenser lead to rectifier bridge.



1. Rectifier Bridge
2. Bat Terminal Nut
3. Ground Screw/Washer Assembly
4. Condenser Lead Screw

Figure 46

8. Install diode trio on rectifier bridge terminals.

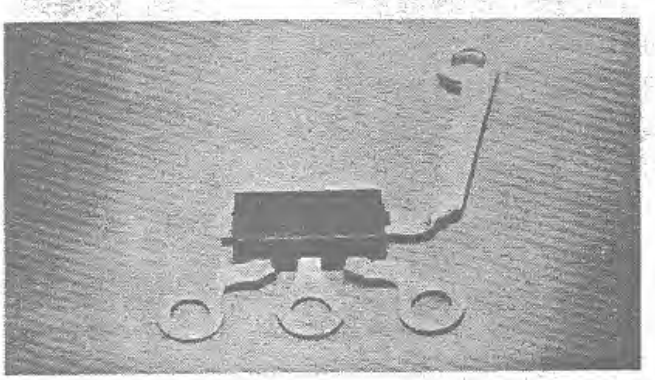


Figure 47

9. Install stator in rear housing and place leads on rectifier bridge terminals.

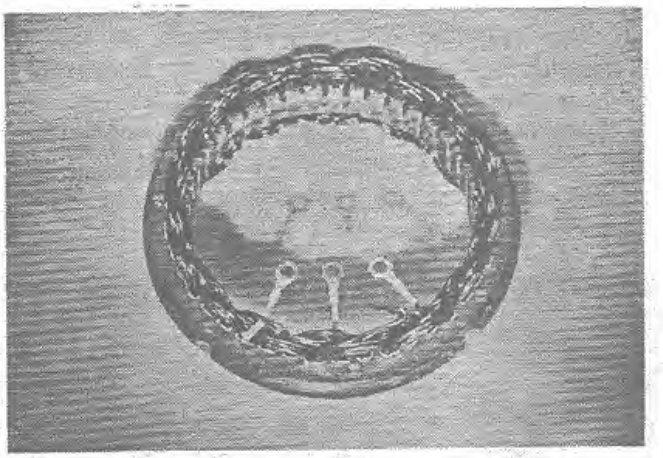
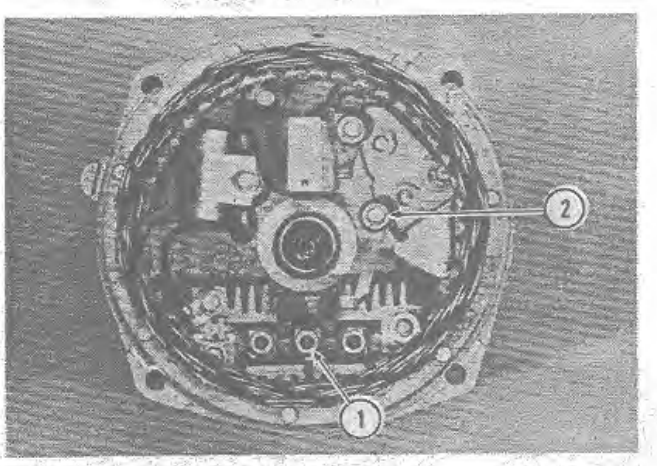


Figure 48

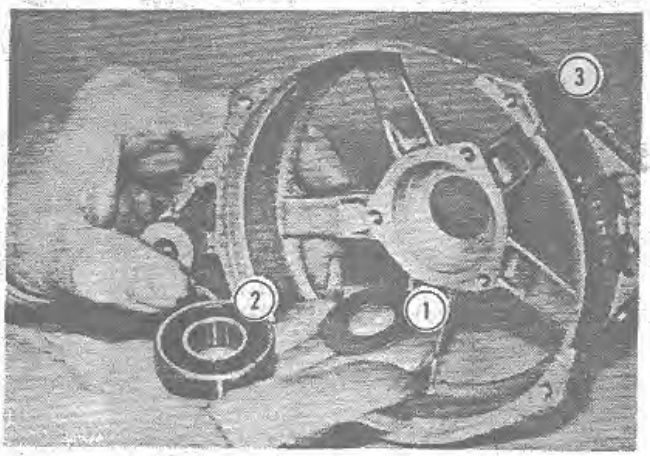
10. Install nuts on rectifier bridge terminals and install the remaining insulated screw, Figure 44, in location shown in Figure 49.



1. Terminal Nut 2. Insulated Screw

Figure 49

11. Install flat washer and bearing in front housing. Sealed side of bearing must be toward washer. If original bearing is being used, fill bearing 1/4 full of Texaco RB grease or equivalent. Overfilling may result in overheating and early bearing failure. After bearing has been installed, fill cavity made by the bearing and bearing retainer with the specified grease.



1. Flat Washer
2. Bearing
3. Front Housing

Figure 50

12. Install bearing retainer in front housing using new cap screws. Use a hammer and punch and bend flange on screw heads down to lock them in place.

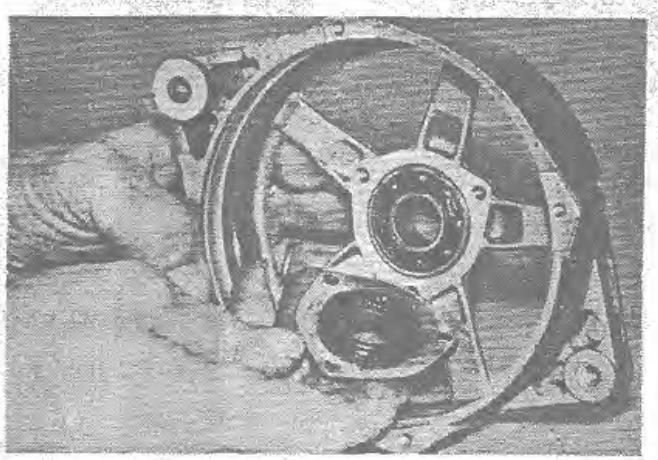


Figure 51

13. Installl rotor in front housing and fan spacer on rotor shaft.

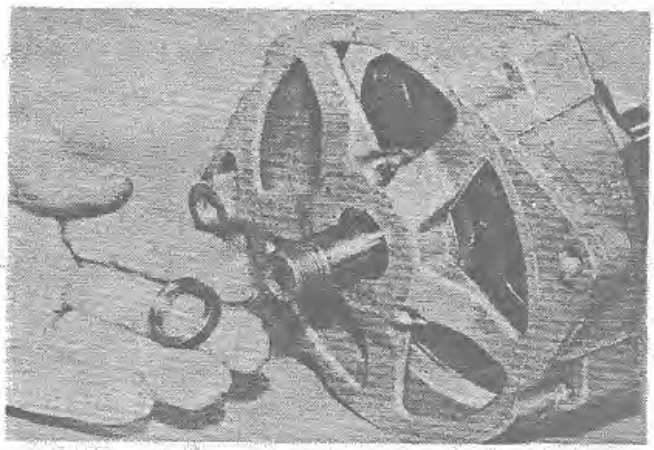


Figure 52

14. Install fan and pulley on rotor shaft.

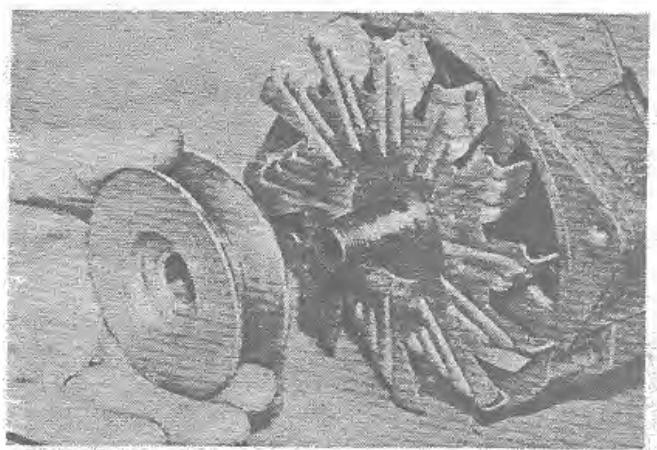
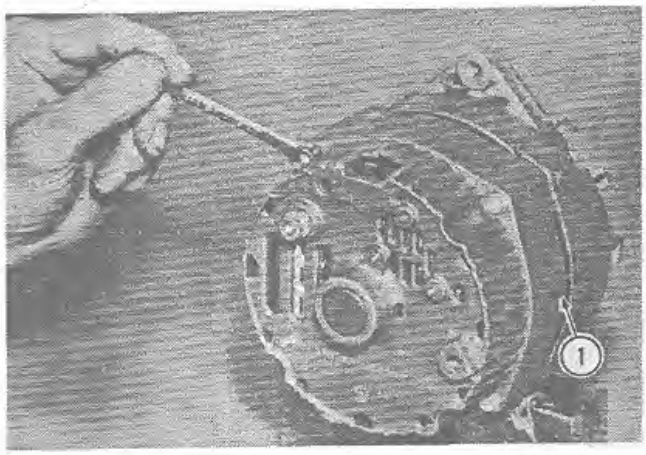


Figure 53

15. Secure pulley in place with lock washer and nut. Torque nut to specification on page 8007-3.

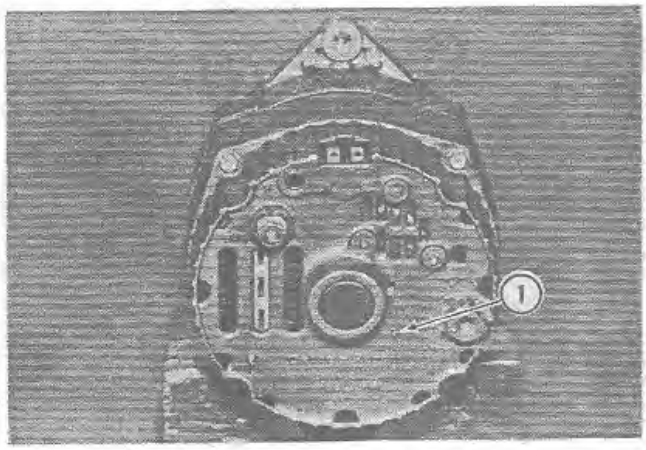
16. Assemble front and rear housings, alignment marks lined up. Install tie bolts and torque to specification on page 8007-3.



1. Alignment Marks

Figure 54

17. Remove tooth pick or wire from brush holder.



1. Tooth Pick or Wire

Figure 55

ALTERNATOR BELT ADJUSTMENT

The alternator drive belt should be checked for looseness and wear after every 100 hours of operation. The proper belt adjustment will result in 1/2" (14.7 mm) belt deflection when measured between the alternator and fan pulleys. If the belt is too pump bearings will result. If the belt is too loose, the belt will slip resulting in wear and low or no alternator output.

NOTE: When adjusting the alternator belt, pry against the front housing only.

Section 8015

ELECTRICAL ACCESSORIES

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

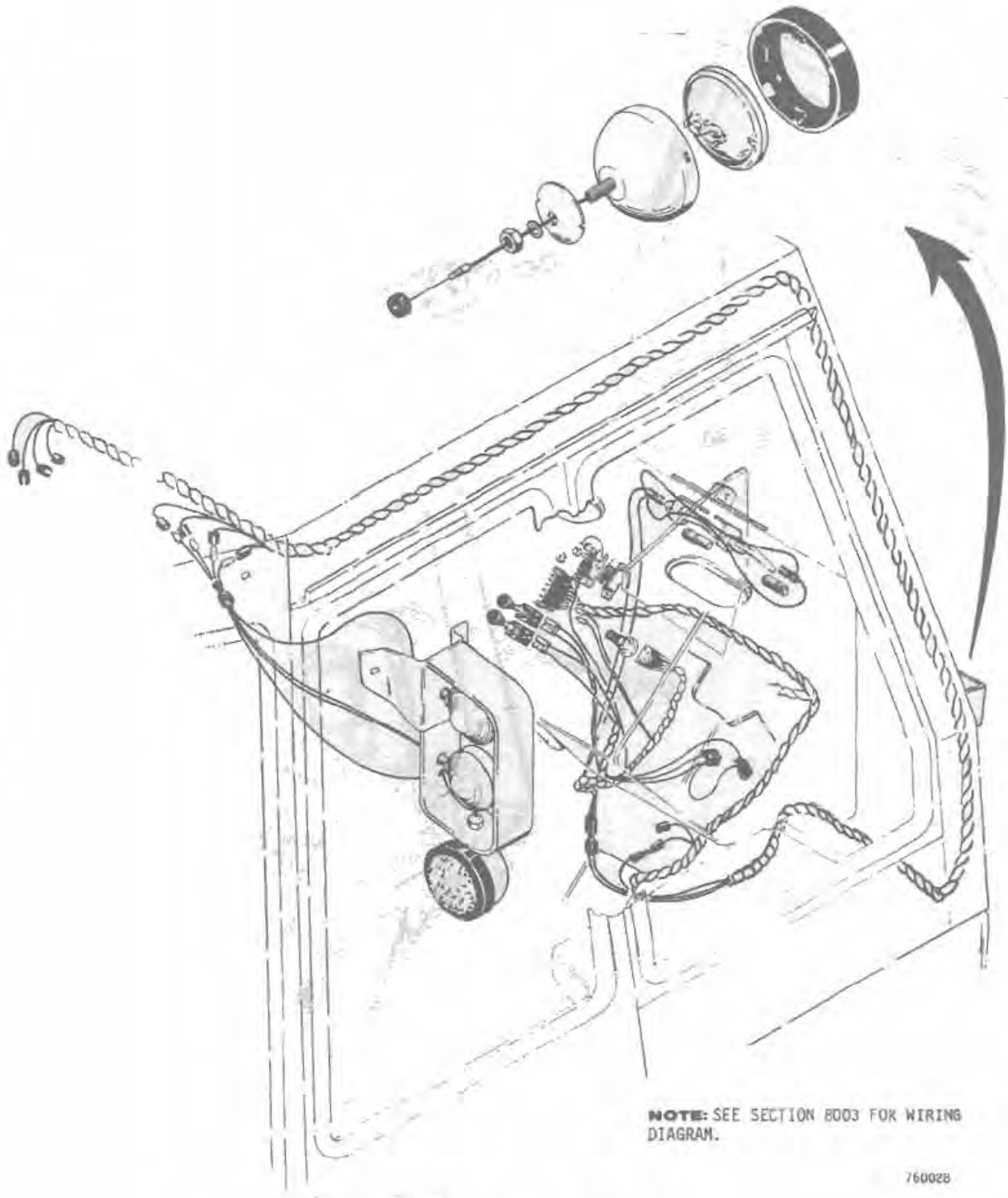


Figure 1 - Cab Lights with Dual Rear Floodlights

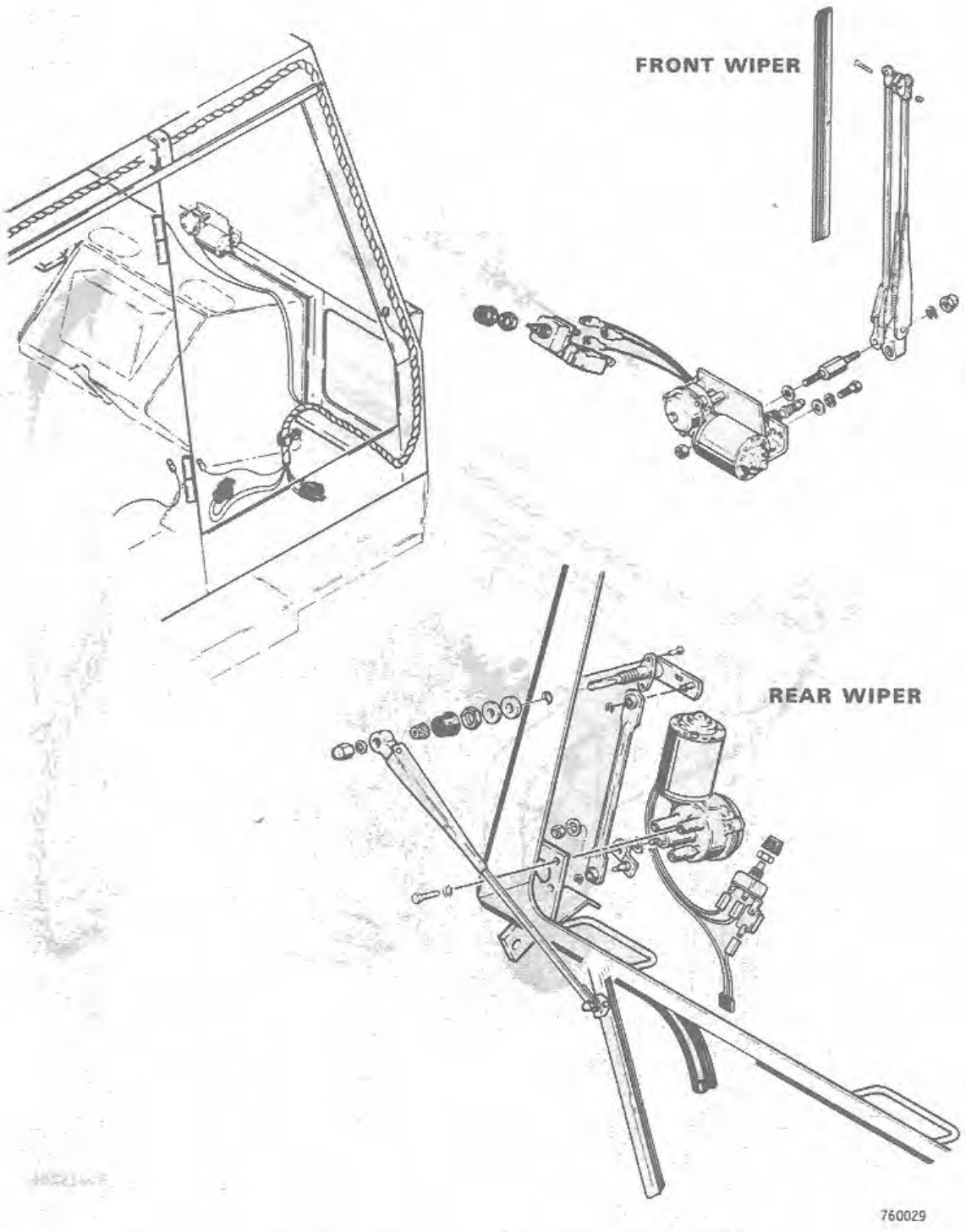


Figure 2 - Front and Rear Wiper Installation

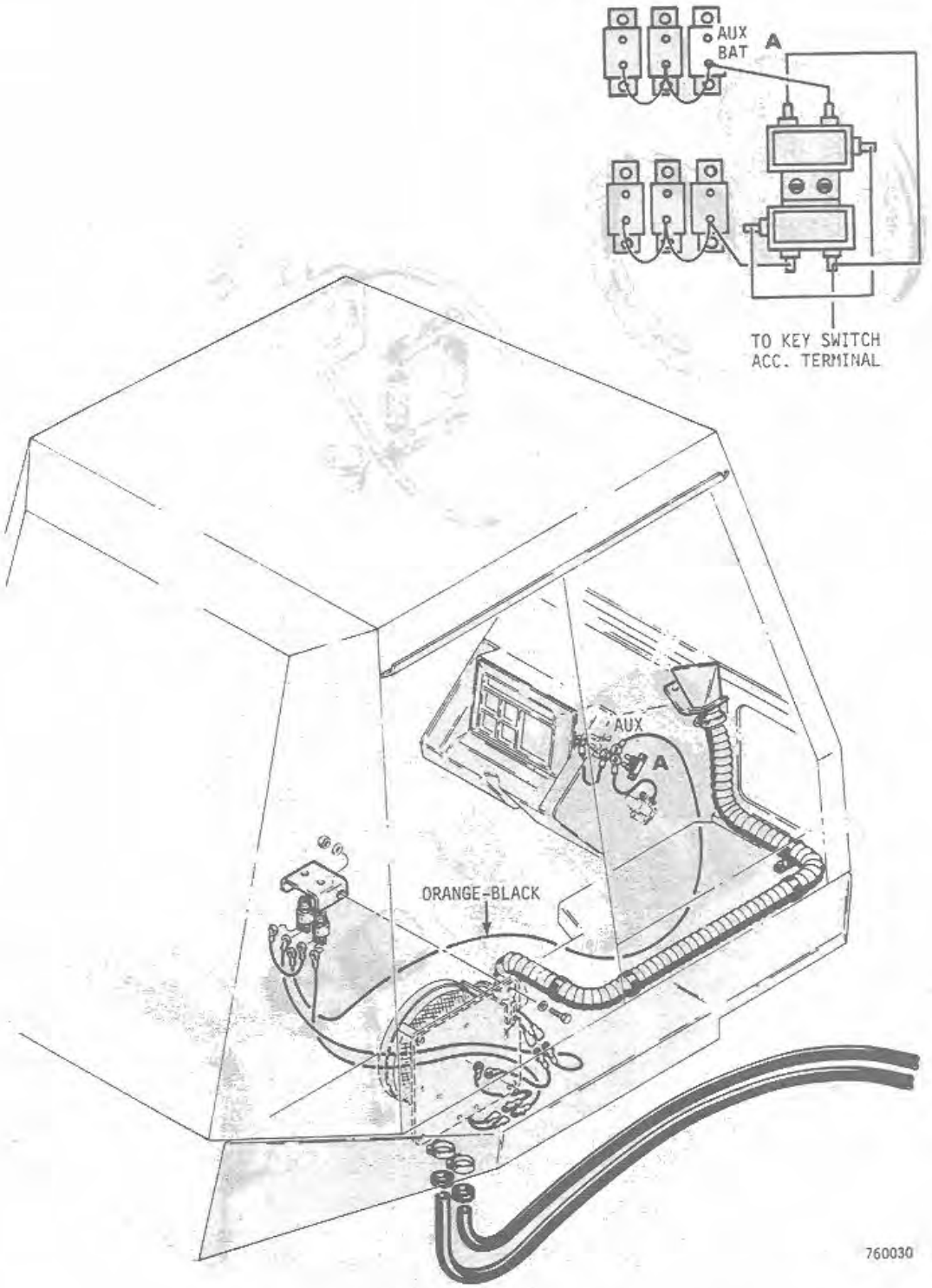


Figure 3 - Cab Heater and Defroster Installation

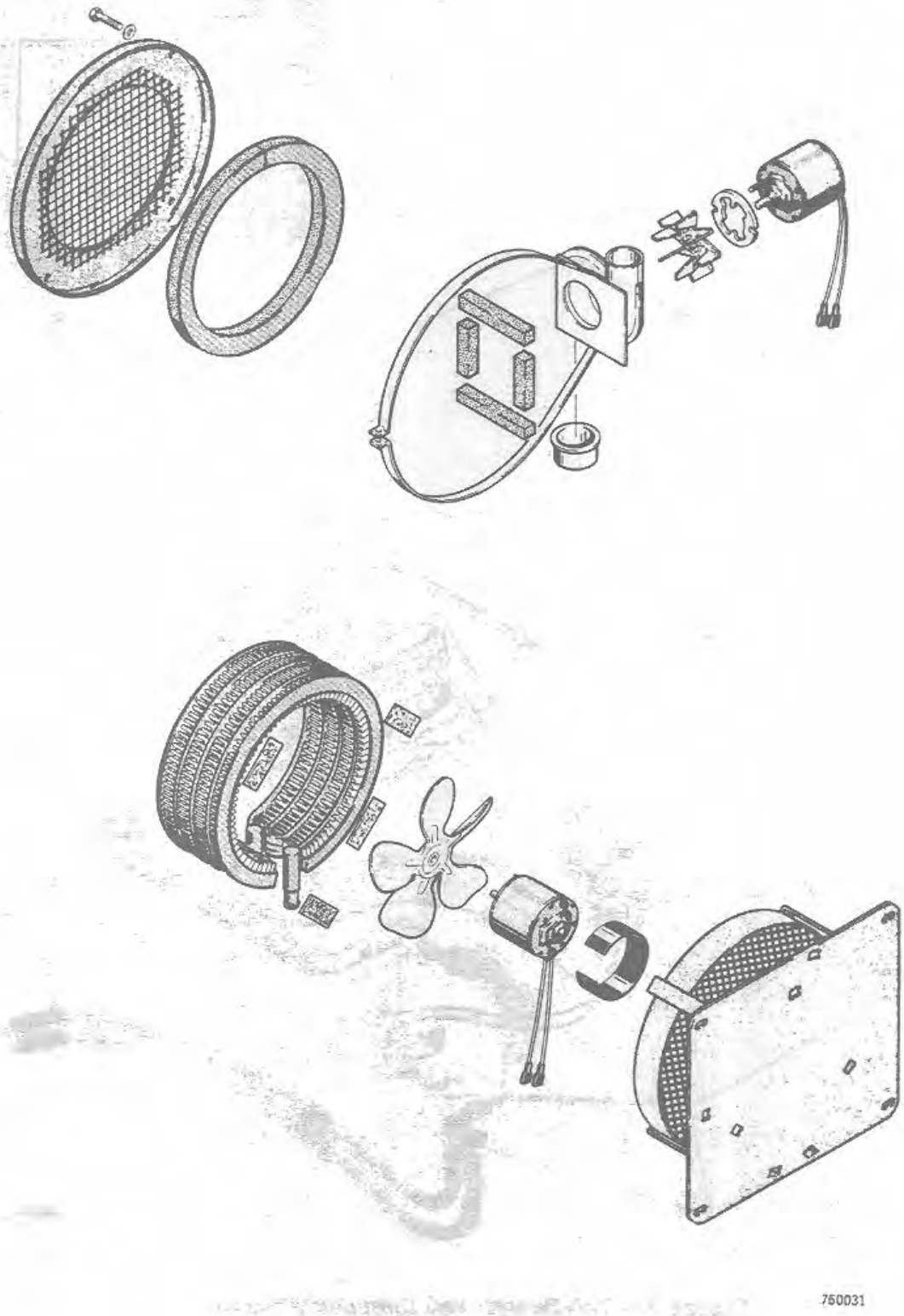


Figure 4 - Heater and Defroster

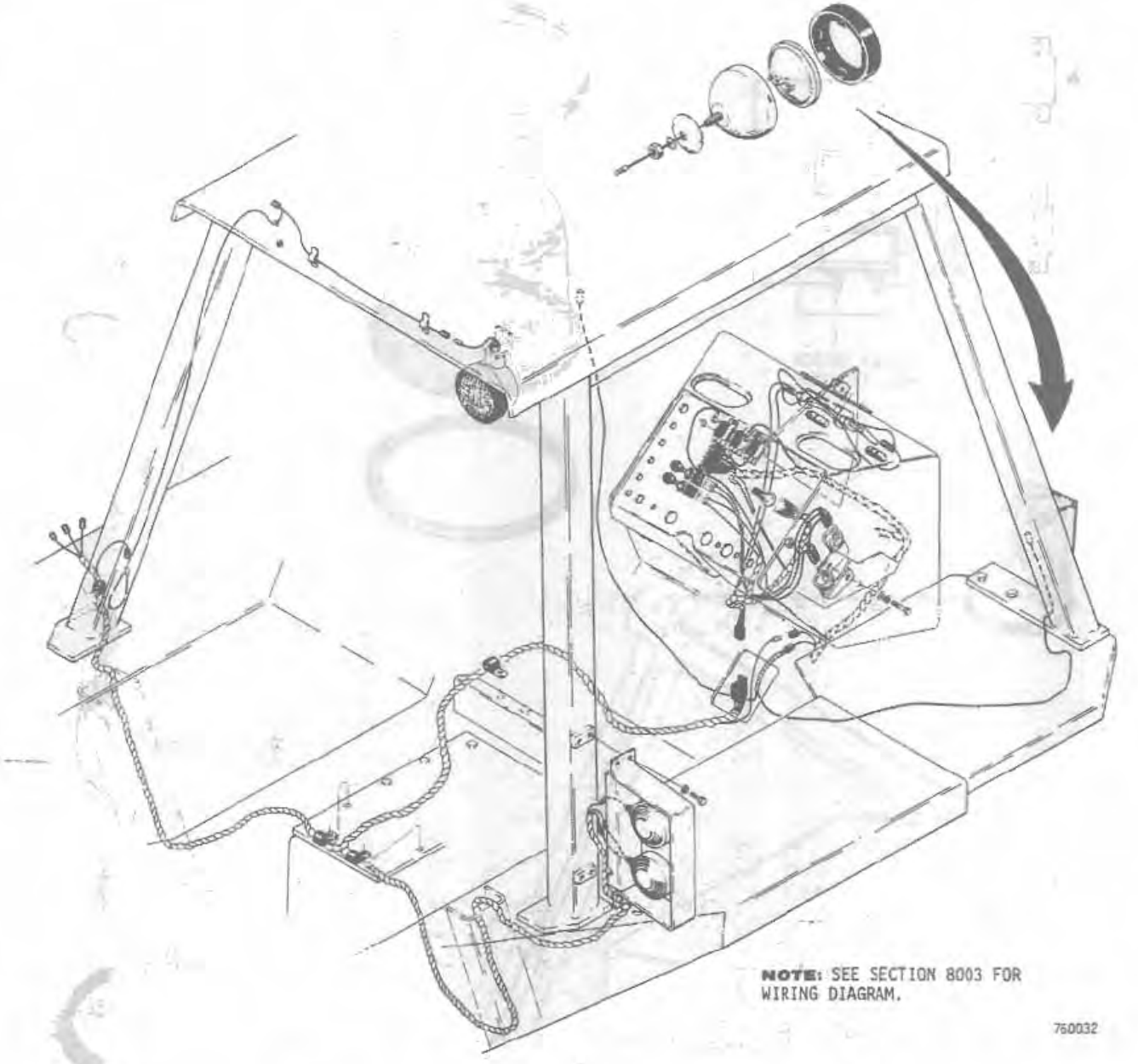


Figure 5 - Canopy Lights with Dual Rear Floodlights

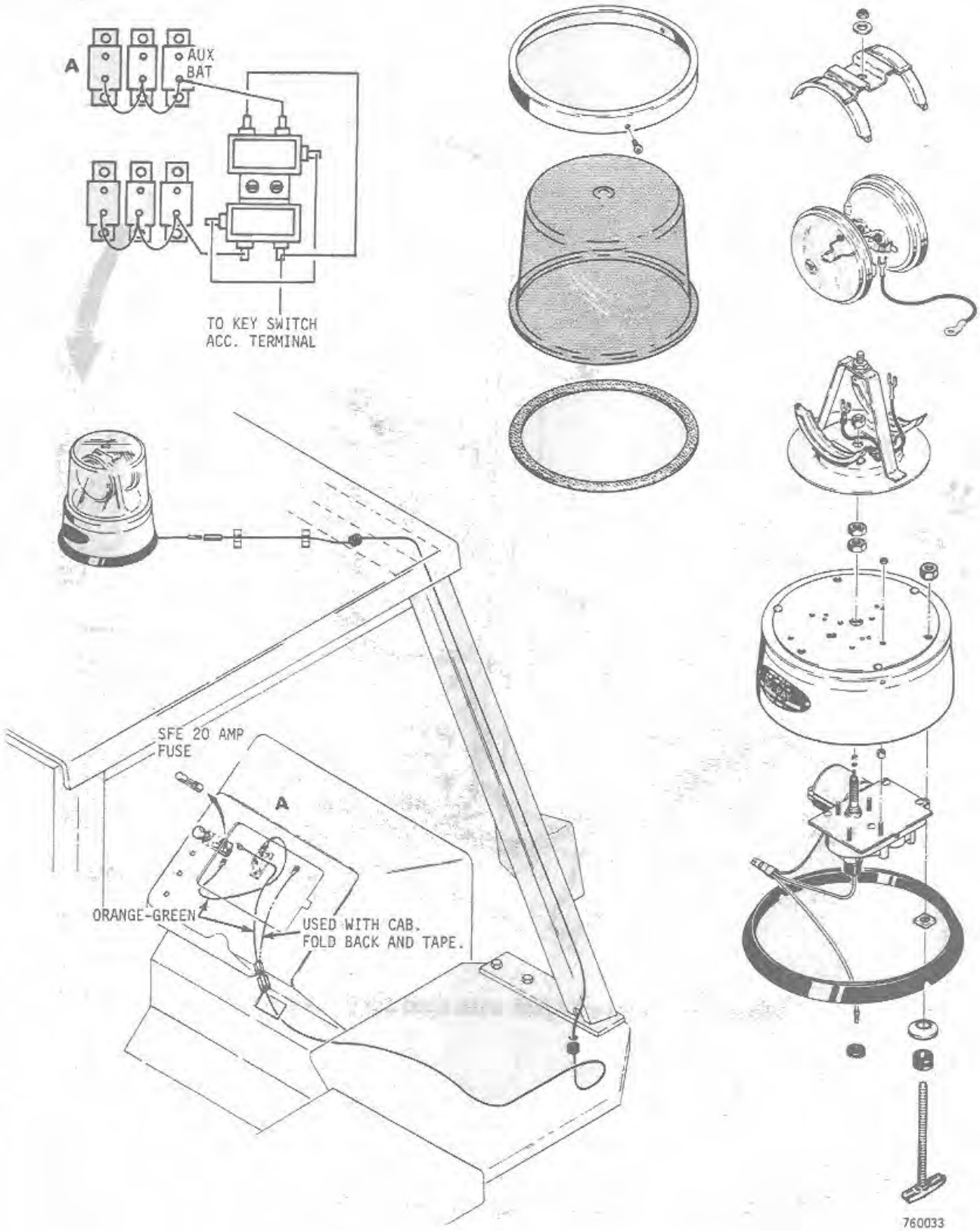


Figure 6 - Canopy Rotating Beacon Installation

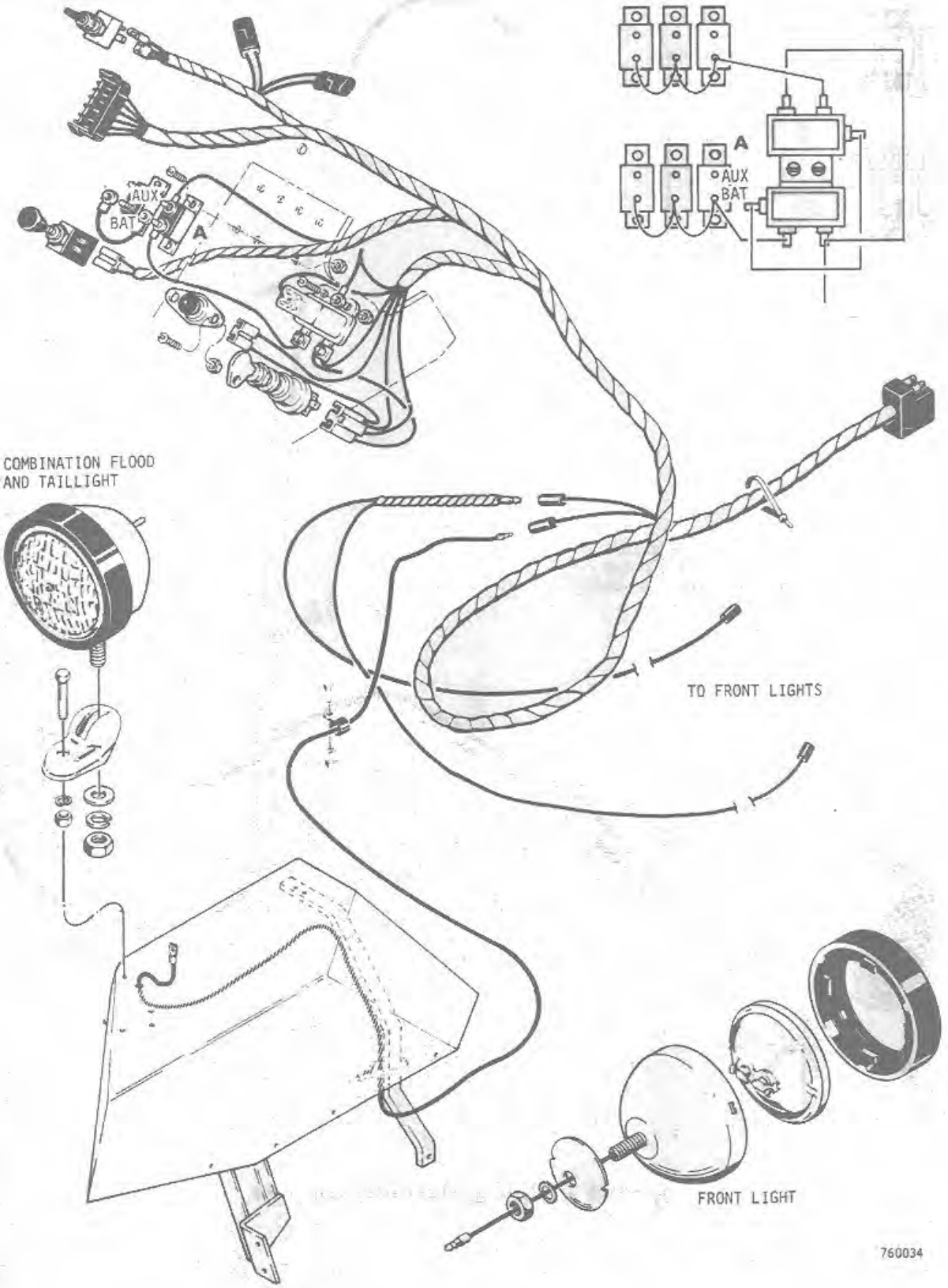


Figure 7 - Cab or Canopy Lights with Single Rear Floodlight

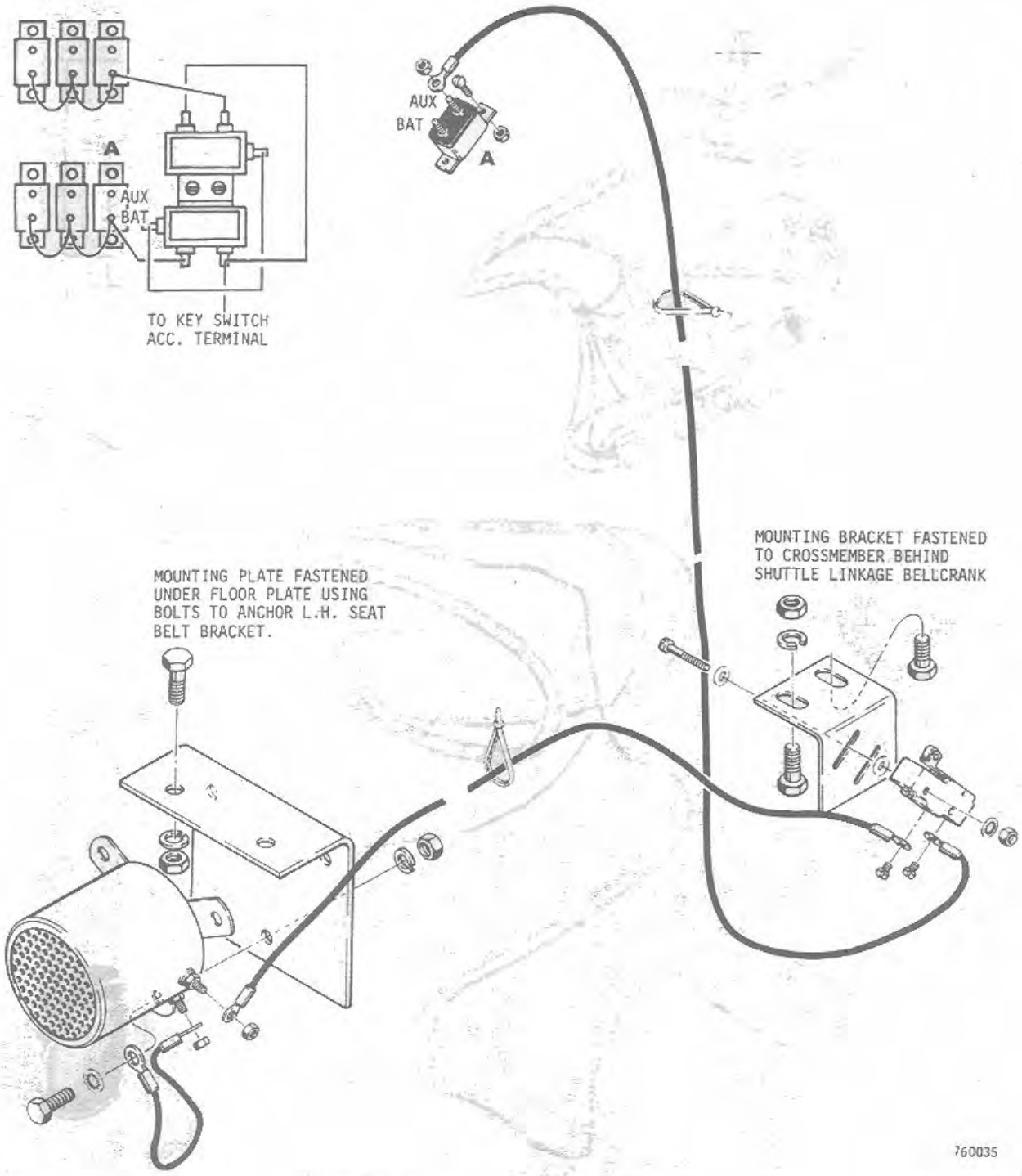


Figure 8 - Backup Alarm Installation

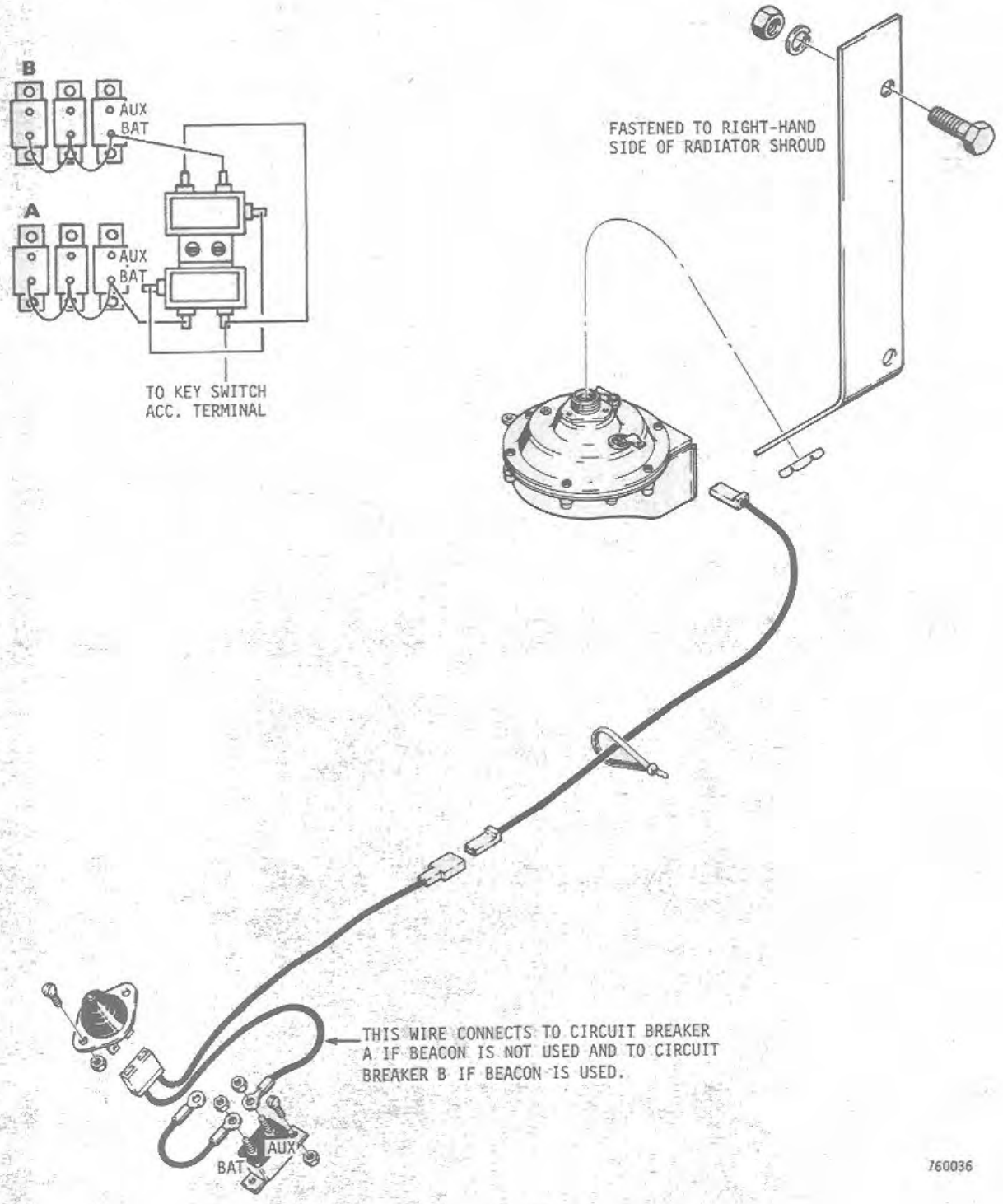


Figure 9 - Horn Installation

Section 9010

LOADER

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

STANDARD BUCKET

Cutting Edge Removal and Replacement

NOTE: If the bucket is not to be removed, disconnect the wiring from alternator and voltage regulator. Also block the bucket in position to prevent personal injury.

1. Remove bucket teeth if so equipped. Use carbon arc rod or an acetelyne cutting torch to remove welds.

2. Remove all cutting edge welds using carbon arc rod. If carbon arc rod is not available an acetelyne cutting torch may be used but care should be taken to keep distortion to the minimum.

3. Cut off the wrap around ends of the cutting edge. Cut through from the inside corners of the bucket.

4. Remove the cutting edge and grind off any remaining weld and/or excess metal to provide a smooth surface for the new cutting edge.

5. Place cutting edge on bucket, using C-clamps to hold it in position. Using a weld rod meeting A.W.S. specification E-7018, fill opening made in each corner.

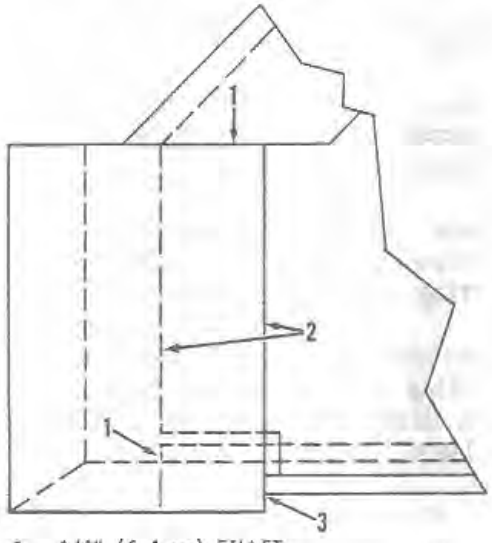
6. Refer to Figure 1 and weld cutting edge to bucket. Use weld rod specified in step 5. When welding cutting edge to front of bucket:

   a. Start at one end of the bucket and weld toward the center until one rod is used.

   b. Repeat at the center of the bucket. On succeeding center welds work out from both sides of center.

   c. Repeat step 6a at the other end of the bucket.

   d. Continue welding in this manner until the cutting edge is completely welded.



1. 1/4" (6.4 mm) FILLET
2. 3/16" (4.8 mm) FILLET
3. 1/4" (6.4 mm) FILLET 5" (127 mm) WELDS ON 10" (254 mm) CENTERS

751655

Figure 1 - Cutting Edge Welds

CLAM BUCKET

Clam Cutting Edge Removal and Replacement

NOTE: If the bucket is not be be removed, disconnect the wiring from the alternator and regulator. Also block the bucket in position to prevent personal injury.

1. Remove all cutting edge welds using carbon arc rod. An acetelyne cutting torch may be used but care should be taken to keep distortion to the minimum.

2. Remove the cutting edge. If necessary, cut off the wrap around corners of the cutting edge to aid in removal.

3. Grind any remaining weld off the clam to provide a smooth surface for the new cutting edge.

4. Place cutting edge on clam using C-clamps to hold it in position. Position cutting edge as shown in Figure 2.

5. Weld cutting edge to bucket using E-7018 welding rod. Refer to Figure 2. To prevent distortion weld the cutting edge as follows:

   a. Start at one end of bucket and weld toward center until one rod is used.

   b. Repeat at center of bucket. On succeeding welds work out from both sides of center.

   c. Repeat step 5a at other end of bucket.

   d. Continue welding in this manner until the cutting edge is completely welded.

Blade Cutting Edge Removal and Replacement

NOTE: If the bucket is not to be removed, disconnect the wiring from the alternator and regulator. Also block the bucket in position to prevent personal injury.

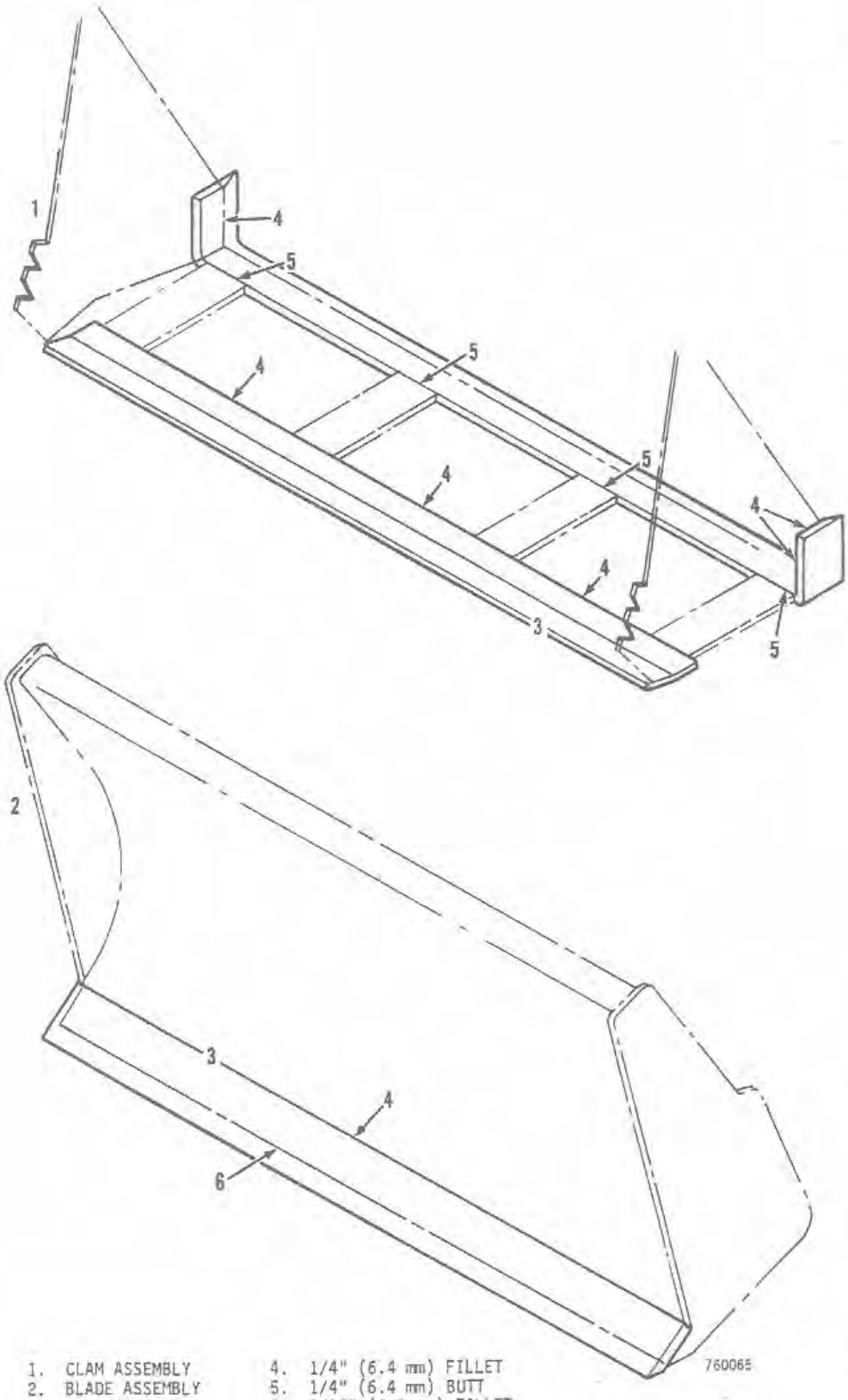
1. Remove all cutting edge welds using carbon arc rod. An acetelyne cutting torch may be used but care should be taken to keep distortion to the minimum.

2. Remove cutting edge.

3. Grind the remaining weld off the blade to provide a smooth surface for the new cutting edge.

4. Place cutting edge on blade using C-clamps to hold it in position.

5. Weld cutting edge to blade as shown in Figure 2. Use E-70 or welding rod.



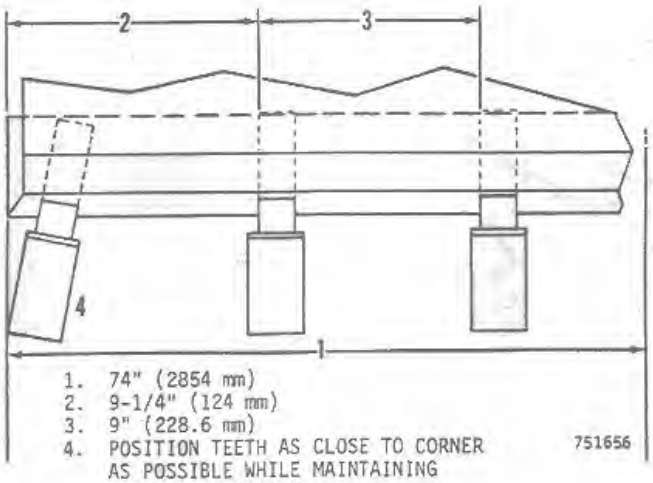
1. CLAM ASSEMBLY
2. BLADE ASSEMBLY
3. CUTTING EDGE
4. 1/4" (6.4 mm) FILLET
5. 1/4" (6.4 mm) BUTT
6. 3/16" (4.8 mm) FILLET

Figure 2 - Cutting Edge Welds

BUCKET TEETH

Tooth Shank Removal and Installation

1. Remove all shank welds using carbon arc rod or an acetelyne cutting torch.
2. Remove shank and grind off any remaining weld on the cutting edge.
3. Refer to Figures 3 and 4 for location and weld specifications. Use a weld rod meeting A.W.S. specification E-7018 and weld shank to cutting edge.

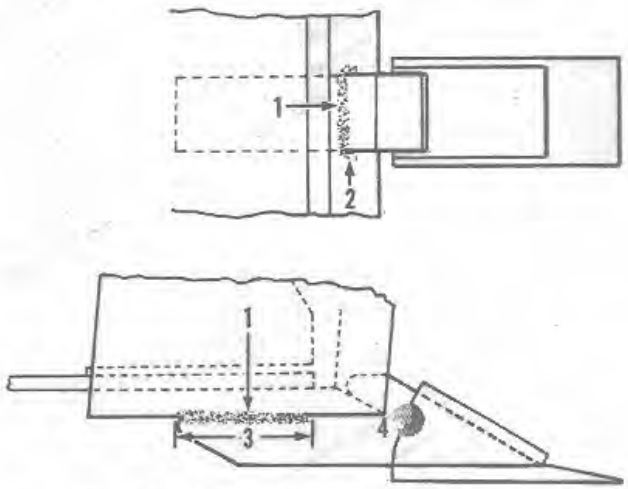


1. 74" (2854 mm)
2. 9-1/4" (124 mm)
3. 9" (228.6 mm)
4. POSITION TEETH AS CLOSE TO CORNER AS POSSIBLE WHILE MAINTAINING OVERALL DIMENSION.

Figure 3

Tooth Replacement

1. Refer to Figure 4. Use a suitable tool and raise the peened portion on each side of the tooth and remove tooth from shank. The peened area may be heated with a torch to aid in removal.
2. Slide the new tooth onto the shank as far as it will go and peen each side into depression in shank.



1. 3/8" (9.5 mm) FILLET - TWO PASS WELD
2. WRAP CORNER 3/8" (9.5 mm)
3. 2-1/2" (63.5 mm)
4. PEENED DOWN PORTION

Figure 4

RETURN-TO-DIG

General

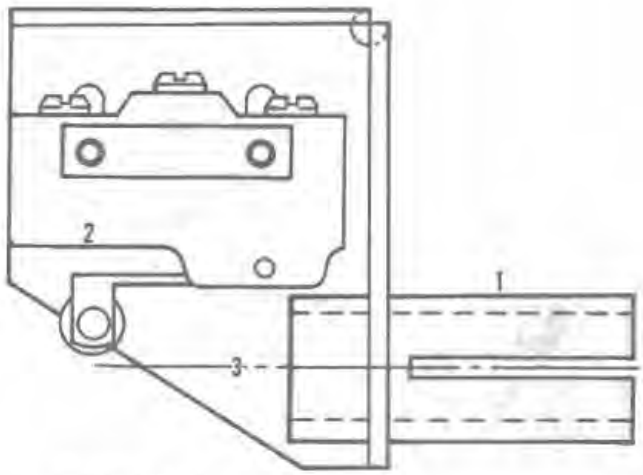
Return-to-dig is a feature that returns the bucket to a level (digging) position after the bucket has been dumped. This is accomplished by combining the Float and Rollback positions. The control lever is held in Float by a spring loaded mechanical detent and in Rollback by an electromagnet (magnetic detent).

The magnetic detent is energized when the key switch is in the On position and the switch roller is out of contact with the actuator rod.

When the actuator rod moves the switch arm, the electrical supply to the magnetic detent is broken and the bucket spool returns to Neutral from Rollback. The control lever will remain in the Float position until manually returned to Neutral.

Adjustment

1. Rest loader bucket flat on the floor or in the desired position.
2. Loosen switch bracket clamp and remove switch bracket assembly. Do not disconnect wires from switch.
3. Check to see that switch roller is slightly above the centerline of the rod guide bore, Figure 5. Reposition switch as required.
4. Reinstall switch bracket assembly. Slide bracket onto rod guide until switch roller is about half way up tapered surface on actuator rod. Then tighten bracket clamp.
5. Start engine and run at low idle. Raise loader arm to full height and completely dump the bucket.
6. Increase engine speed to full throttle and place control lever in Float and Rollback. The bucket should be in the desired position when it touches the floor.
7. If the bucket rolls back too far, move the switch bracket forward.
8. If the bucket does not roll back far enough, move the switch bracket to the rear.



1. SWITCH BRACKET
2. SWITCH
3. CENTERLINE

751658

Figure 5

ANTIROLLBACK

General

The anti-rollback linkage is installed between the bucket cylinder bellcrank and control valve lever, Figure 11. The purpose of this linkage is to prevent the bucket from rolling back too far when loader arm is raised to full height.

When the linkage is properly adjusted, the side cutting edge on the short lip bucket will be level and rolled back (tilted upward) about 15° on the long lip bucket. The linkage is adjusted at the factory and should rarely require adjustment.

Operation

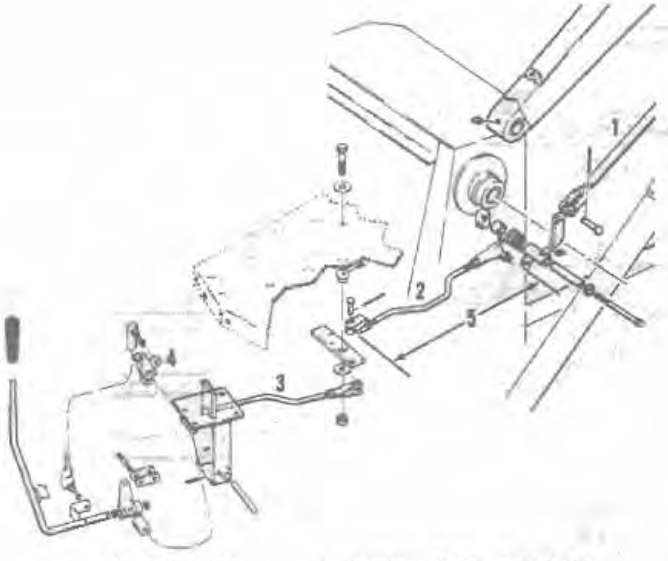


Figure 6

Assume that the bucket is at ground level and rolled all the way back. Refer to Figure 6. As the loader arm is raised to full height, the actuator tube causes the input rod to be pulled forward. This in turn moves the leveling rod into contact with the bucket spool bellcrank. As the bellcrank is moved to the rear, the bucket spool is moved slightly (feathered) into the Dump position causing the bucket to roll forward and keep the side edges of the bucket nearly parallel to the ground.

Adjustment

1. Adjust the length of the input rod to 12-3/4" (324 mm) from center of clevis pin hole to center of ball joint. The offset in the rod should be centered in the hole where it passes through the fender. Adjust rod length at both ends.

2. Raise the loader arm until the bucket hinge pin is about 21"-22" (533-584 mm) above the floor and roll the bucket all the way back.

3. Check to see that the leveling rod touches the bellcrank. Adjust length of push rod as required.

4. Raise the bucket to full height. The side cutting edges should be:

   a. Level if equipped with a short lip bucket.

   b. Rolled back (tilted upward) about 15° if equipped with a long lip bucket.

5. If bucket position is not as specified, shorten the input rod to roll the bucket back more or lengthen the input rod to roll the bucket forward.

LOADER ARM

Removal

NOTE: If the machine is to be used with the loader arm removed, the backhoe MUST be removed. Refer to Section 9100.

1. Completely retract the backhoe bucket and dipper. Then lower boom until bucket rests on the floor.
2. Raise loader arm slightly above hood level and block in place using a suitable support under the bucket or loader arm crossmember.
3. Remove the lift cylinder rod eye pivot pins. Have someone available to prevent the cylinder from falling when the pin is removed.
   a. If chain hoist can be used, attach hoist to bucket and lower bucket to the floor.
   b. If chain hoist cannot be used, reinstall the rod eye pins and lower the bucket to the floor. Then remove the pins.
4. Rest bucket flat on the floor and disconnect the hose to the bucket cylinders (and clam cylinders if so equipped) at the rear of the loader arm.
5. Remove the antirollback actuator tube and bellcrank pivot bolt and related parts.
6. Disconnect return-to-dig wiring harness at limit switch on loader arm. Cut harness tie straps and place harness out of way.
7. Attach chain hoist to loader arm in front of muffler. Remove slack from chain.
8. Remove snap rings and washers from loader arm pivot shaft and drive shaft out of frame. Have someone available to hold shaft as it is driven out.
9. Start engine and back machine out of loader arm. Use care if backhoe was not removed.
10. If machine is to be used without the loader, disconnect lift cylinder hoses at manifold tubes on each side of machine and remove the lift cylinders. Install plug part number 218-776 in manifold tubes.
11. Install cap nut part number 218-755 on the bucket and clam cylinder hoses.

Installation

1. Loader arm installation is the reverse of removal.
2. Refer to the various illustrations in this section to aid in installation and assure correct hydraulic line connections.

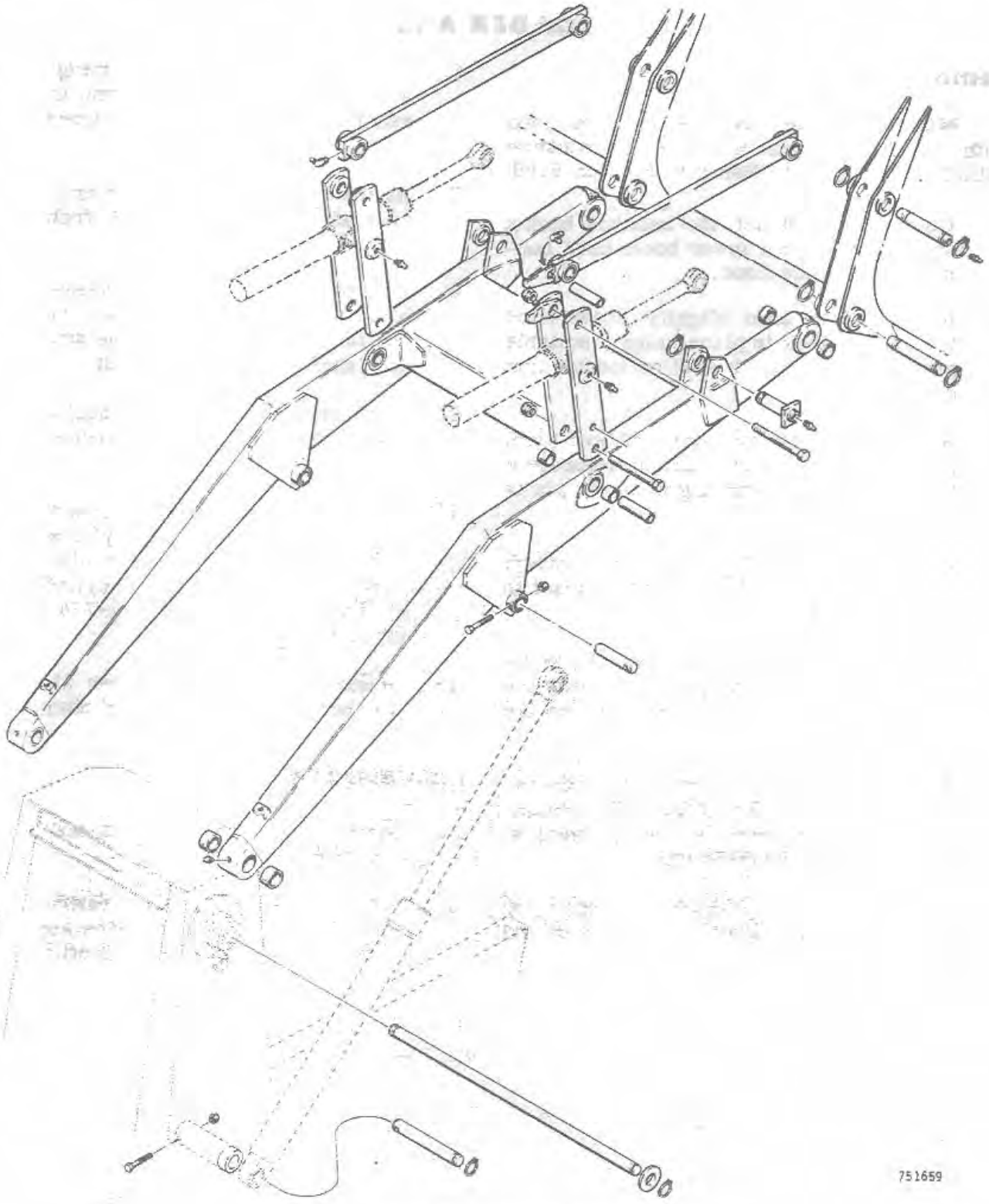


Figure 7 - Loader Arm

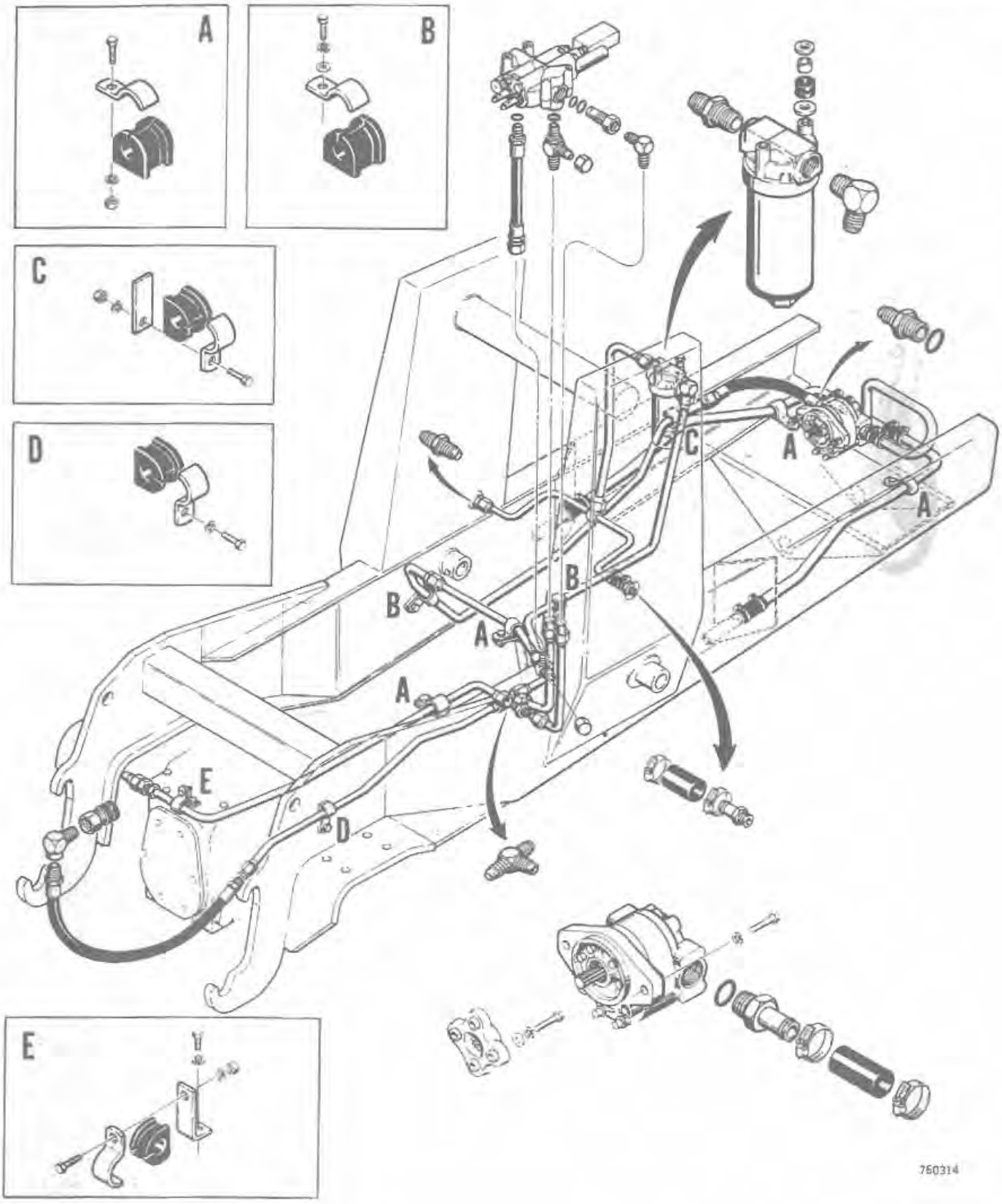


Figure 8 - Basic Hydraulic Installation

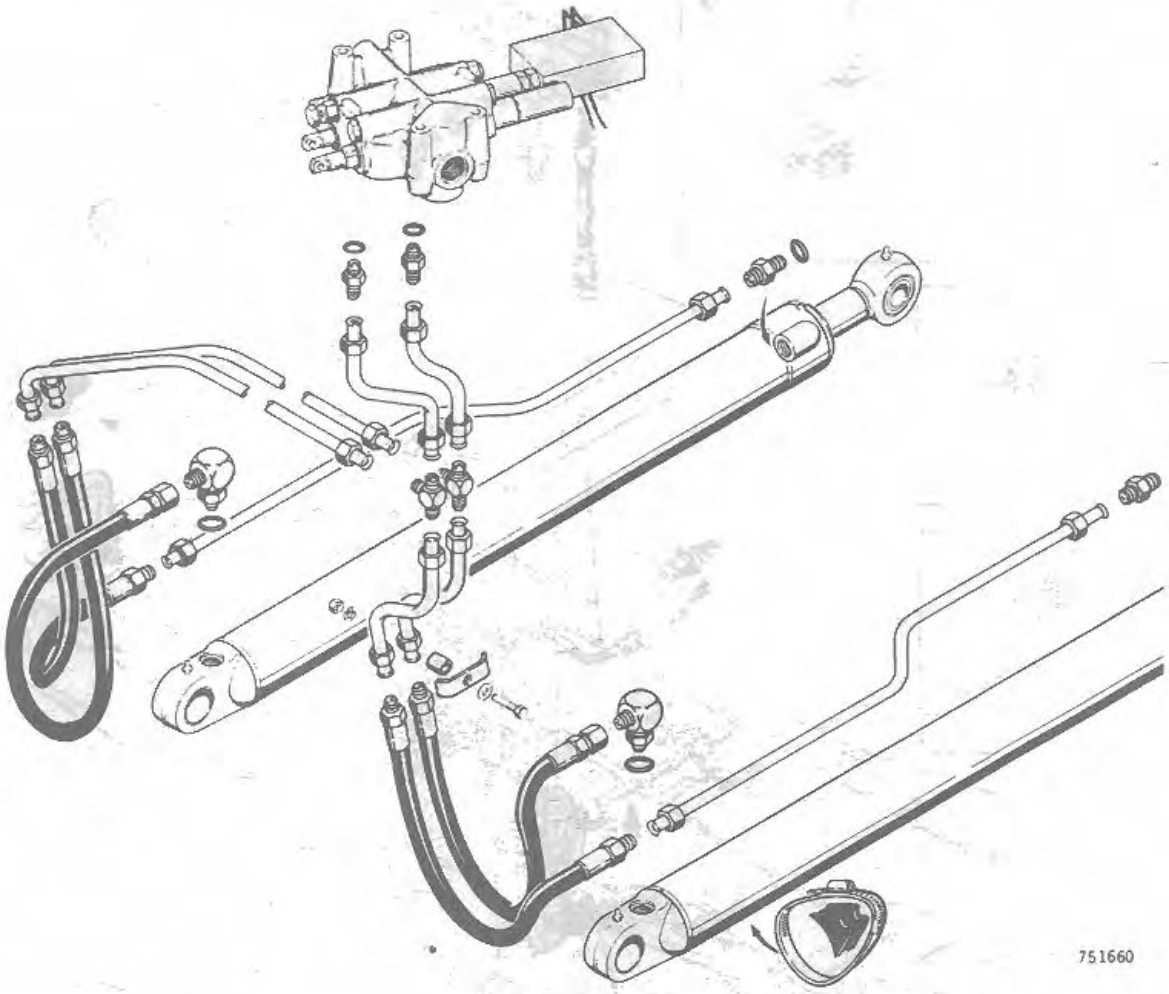


Figure 9 - Lift Cylinder Hydraulic Installation

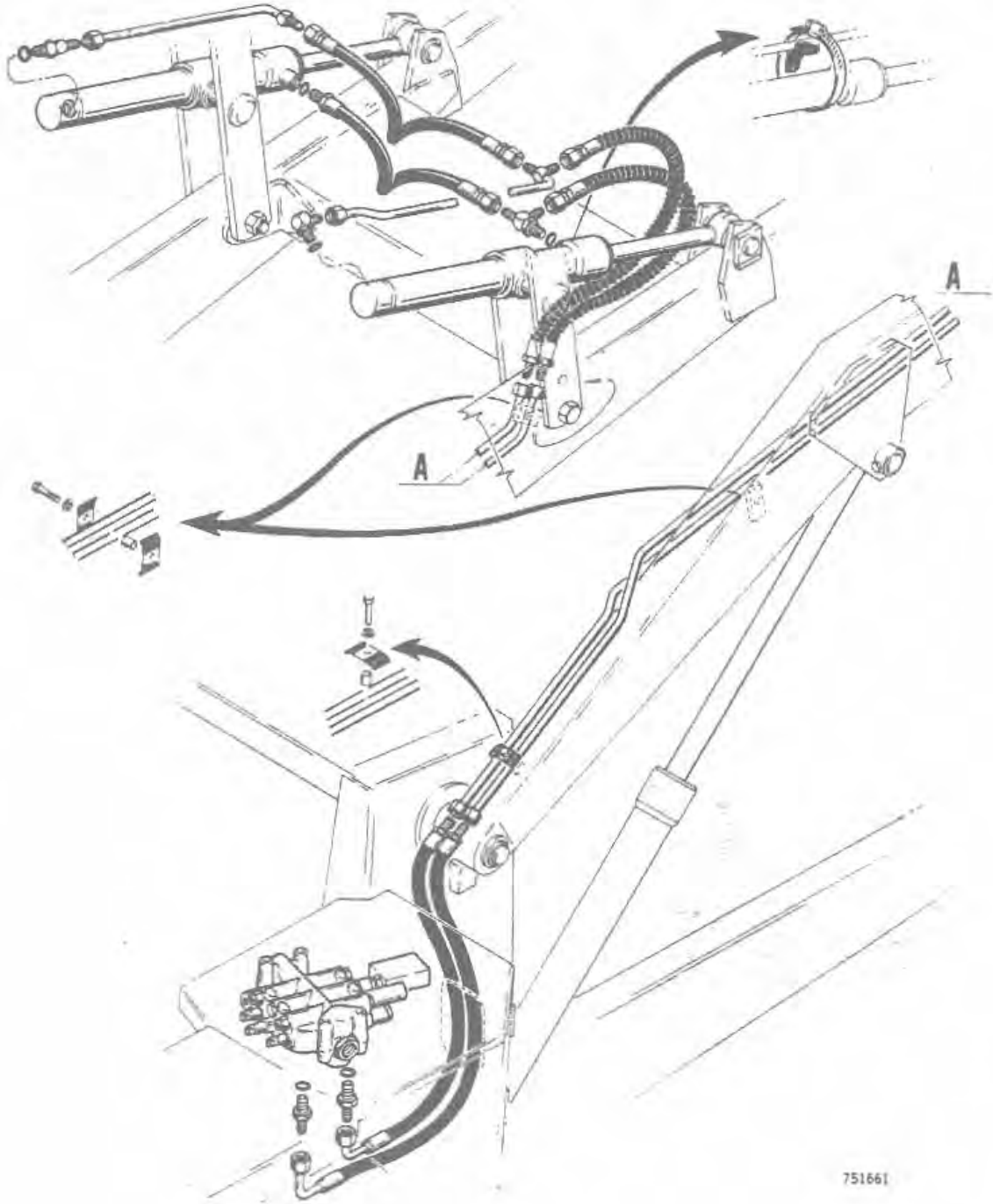


Figure 10 - Bucket Cylinder Hydraulic Installation

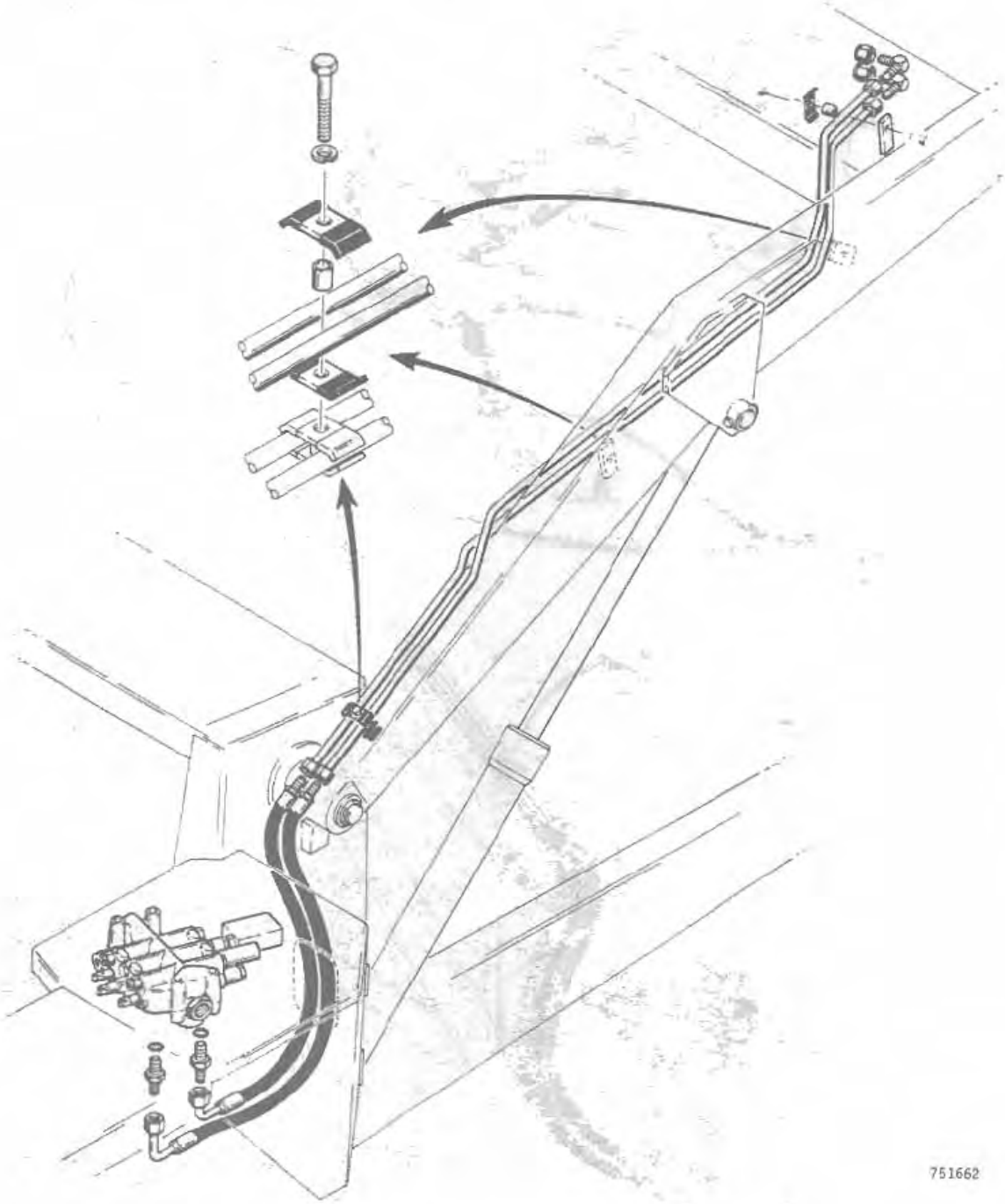
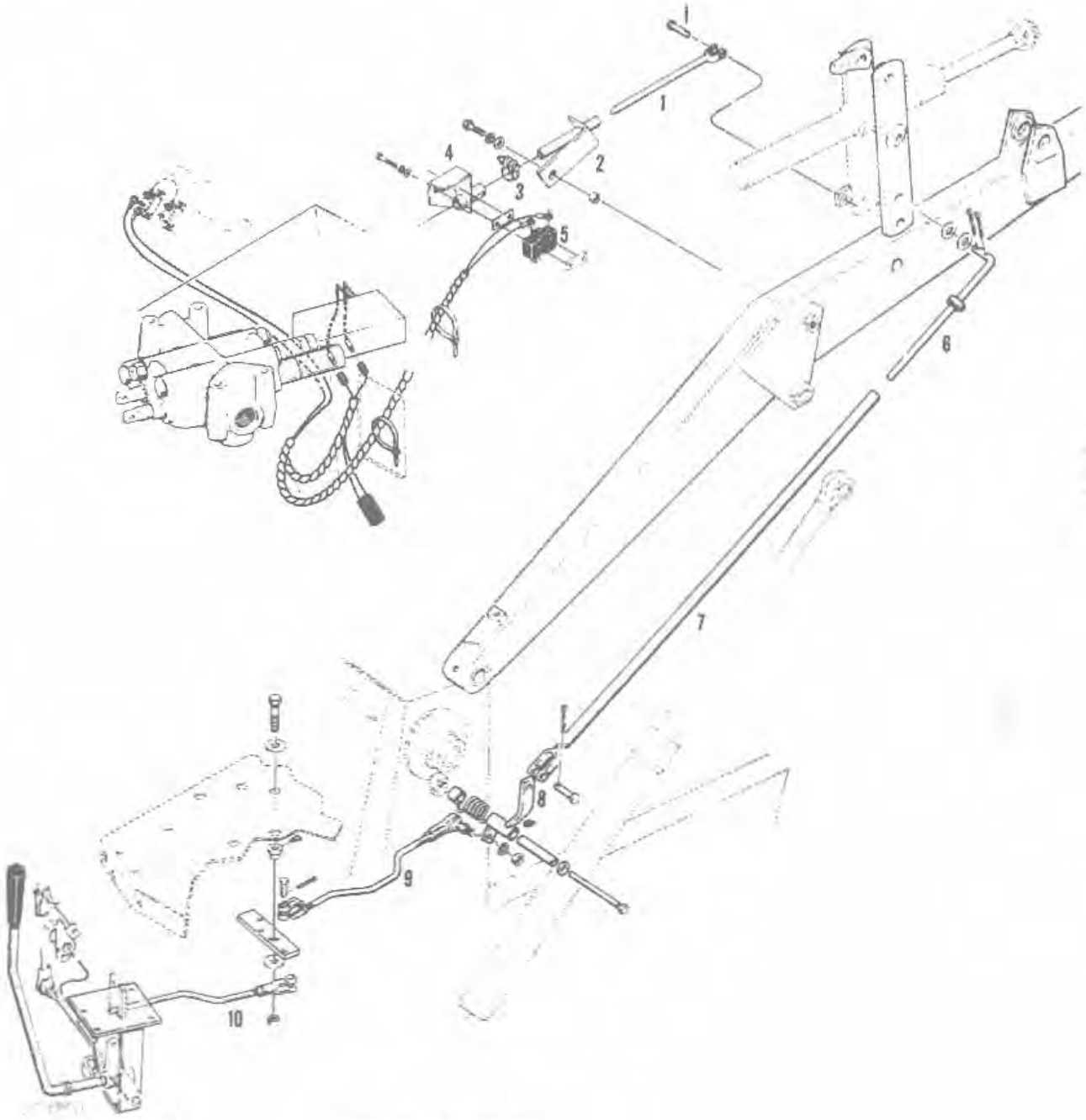


Figure 11 - Loader Arm Auxiliary Hydraulic Installation



RETURN-TO-DIG PARTS

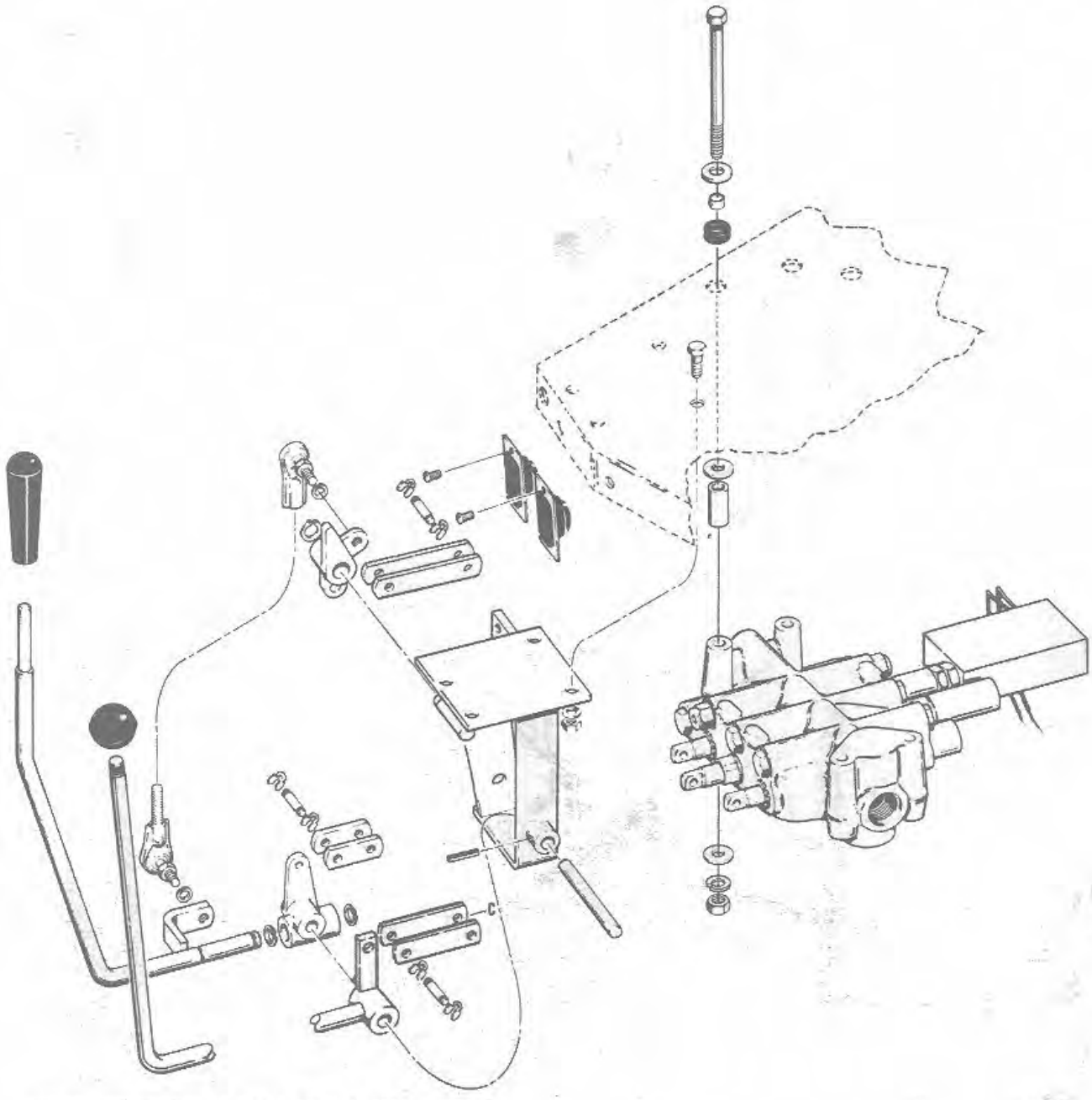
1. ACTUATOR ROD
2. ROD GUIDE
3. CLAMP
4. SWITCH BRACKET
5. SWITCH

ANTIROLLBACK LINKAGE

6. PUSH ROD
7. ACTUATOR TUBE
8. LINKAGE BELLCRANK
9. INPUT ROD
10. LEVELING ROD

761663

Figure 12 - Return-to-Dig and Antirollback Linkage



NOTE: SPACER USED IN PLACE OF CLAM SPOOL LEVER ON TWO SPOOL VALVE CONTROL LEVER INSTALLATION.

751664

Figure 13 - Control Lever Installation

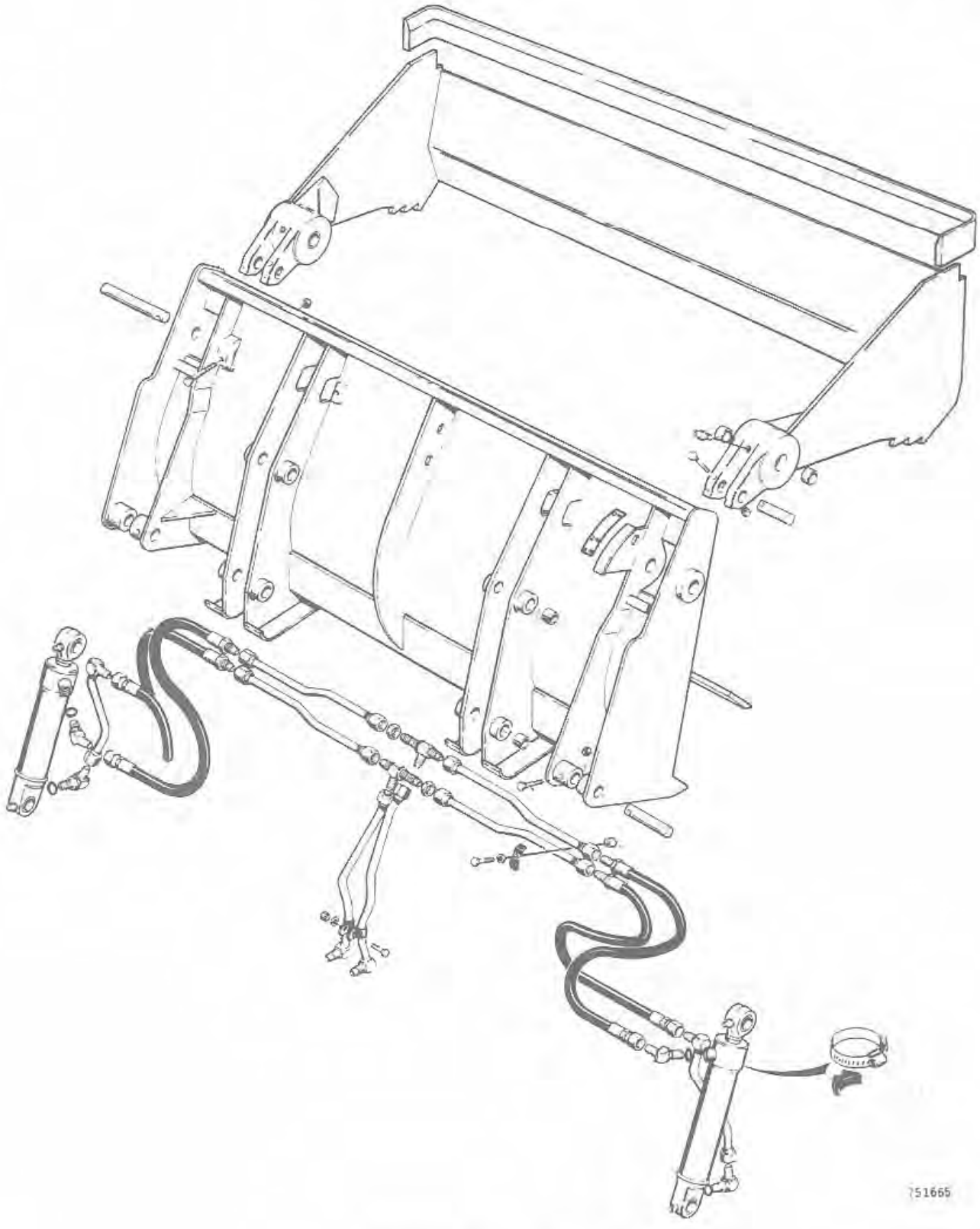
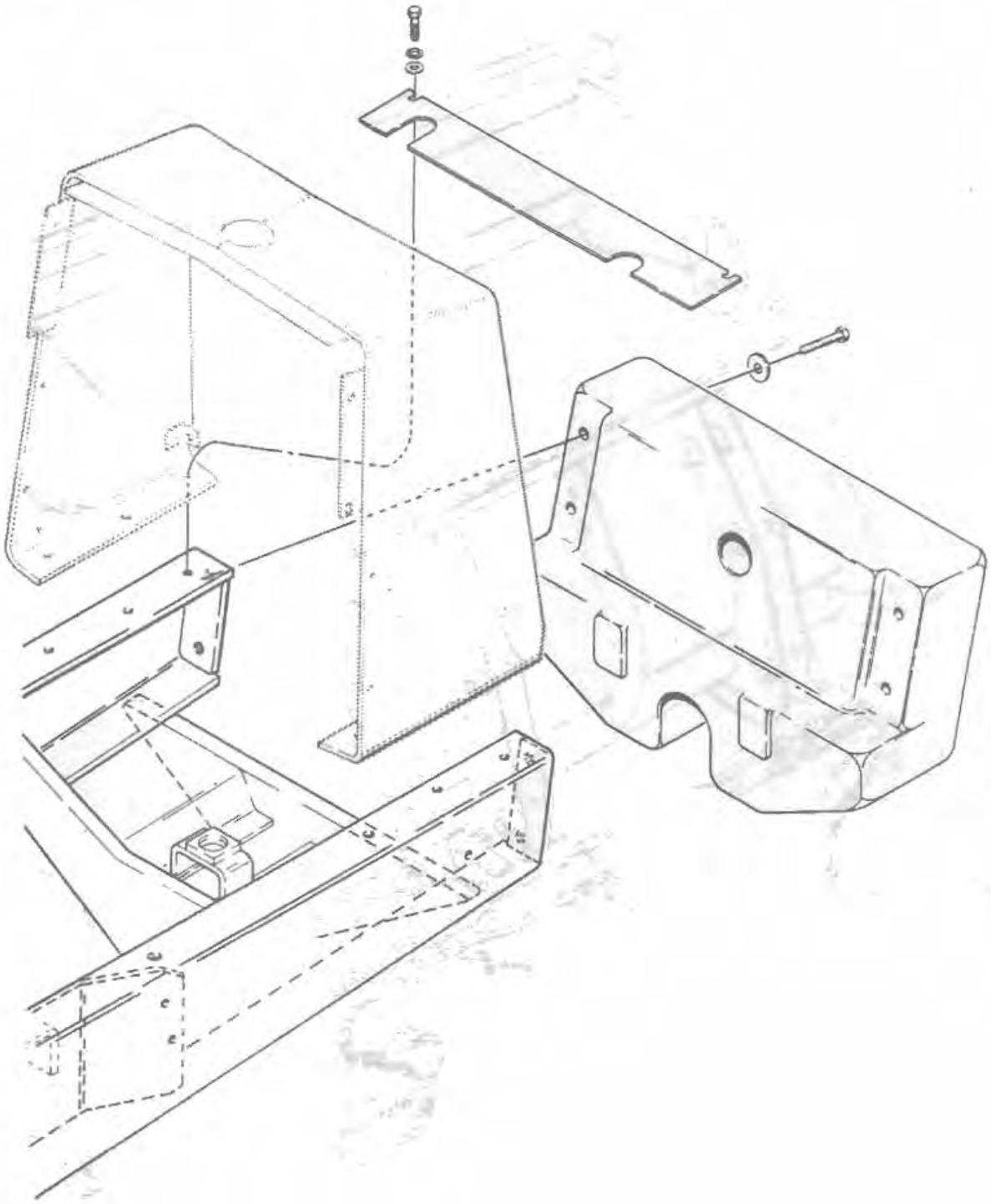


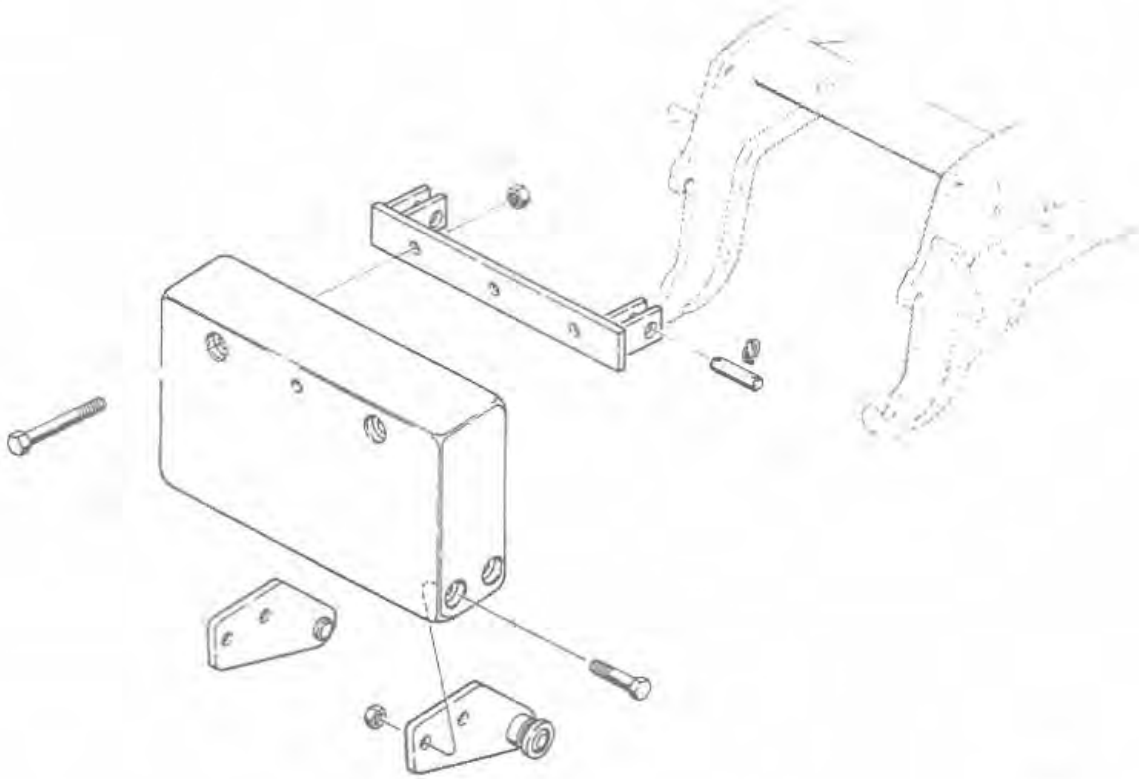
Figure 14 - Clam Bucket



NOTE: FRONT COUNTERWEIGHTS WEIGHT 500 AND 700 POUNDS (227 AND 317 kg). USE SUITABLE LIFTING EQUIPMENT WHEN REMOVING AND INSTALLING COUNTERWEIGHT.

751666

Figure 15 - Front Counterweight Installation



751667

NOTE: COUNTERWEIGHT WEIGHS APPROXIMATELY 1425 POUNDS (646 kg). USE SUITABLE LIFTING EQUIPMENT WHEN REMOVING OR INSTALLING COUNTERWEIGHT.

Figure 16 - Rear Counterweight Installation

Section 9033

THREE POINT HITCH

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

REMOVAL AND INSTALLATION

Removal

1. Park the machine on a level surface and lower the implement. If equipped with a cab, remove the rear closure panels around the hitch.

2. At the rear of the tractor there are two tension rod assemblies. Loosen the upper and lower nuts on each tension rod. Then remove the klik pins from the upper mounting pins.

3. Use the lift and pitch control levers as required to remove the weight of the hitch from the upper mounting pins. Then drive the mounting pins out.

4. Remove the hitch from the lower support arms. Use a chain hoist or:

   a. If the rear mounted implement weighs less than 500 pounds (227 kg), use a hoist or jack to lift the hitch out of the lower support arms. Raise the hitch until the control valve mounting arm clears the tension rod.

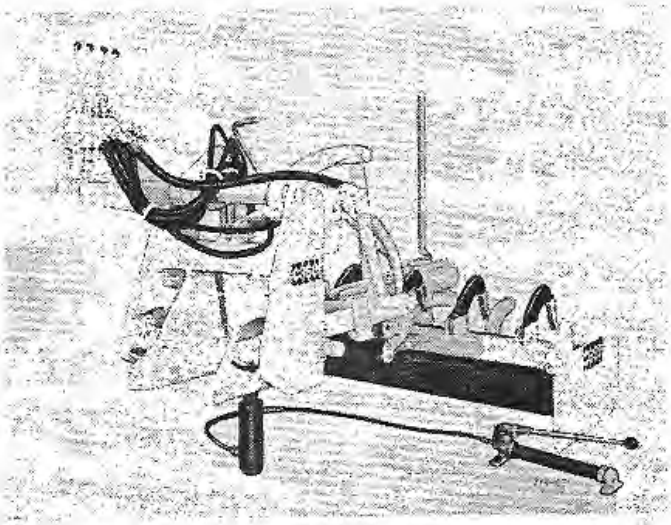


Figure 1 - Hitch Raised With Jack

   b. If the rear mounted implement weighs more than 500 pounds, (227 kg), use the lift cylinder to raise the hitch out of the lower support arms. Slowly move the lift control lever into the Lower position and the hitch will be raised out of the lower support arms.

5. Carefully drive the tractor forward about one foot. Stop the engine and disconnect the pressure and return hoses at the quick disconnect couplings.

6. Connect the return hose to the pressure tube on the tractor. Be sure the coupling is fully engaged. Carefully drive the tractor away from the hitch.

7. If the hitch is to be left standing for an extended period of time, block up the hitch as shown in Figure 2 to prevent loss of position.

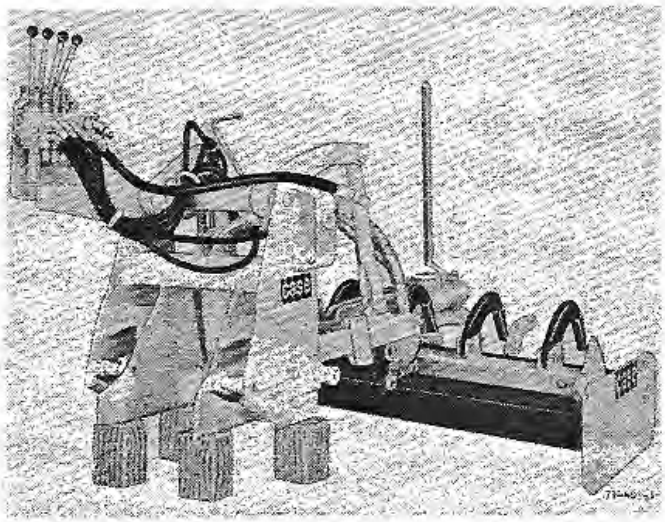


Figure 2 - Hitch Prepared for Storage

Installation

1. Back the tractor into the hitch until the hitch mounting frame enters the lower support arms. Stop the engine and connect the hydraulic lines to and from the control valve.

2. Carefully back the tractor completely into the hitch. Then lower the hitch into the lower mounting arms.

3. Use the lift and pitch control levers as required and align the mounting frame with the upper support arms.

4. Drive the upper mounting pins in and secure in place with klik pins.

5. Make sure the lower tension rod nuts do not contact the upper support arms and torque the upper nuts to 140-170 foot-pounds (189-230 N m).

6. Tighten the lower tension rod nuts until snug and retorque the upper nuts to 450-550 foot-pounds (590-744 N m).

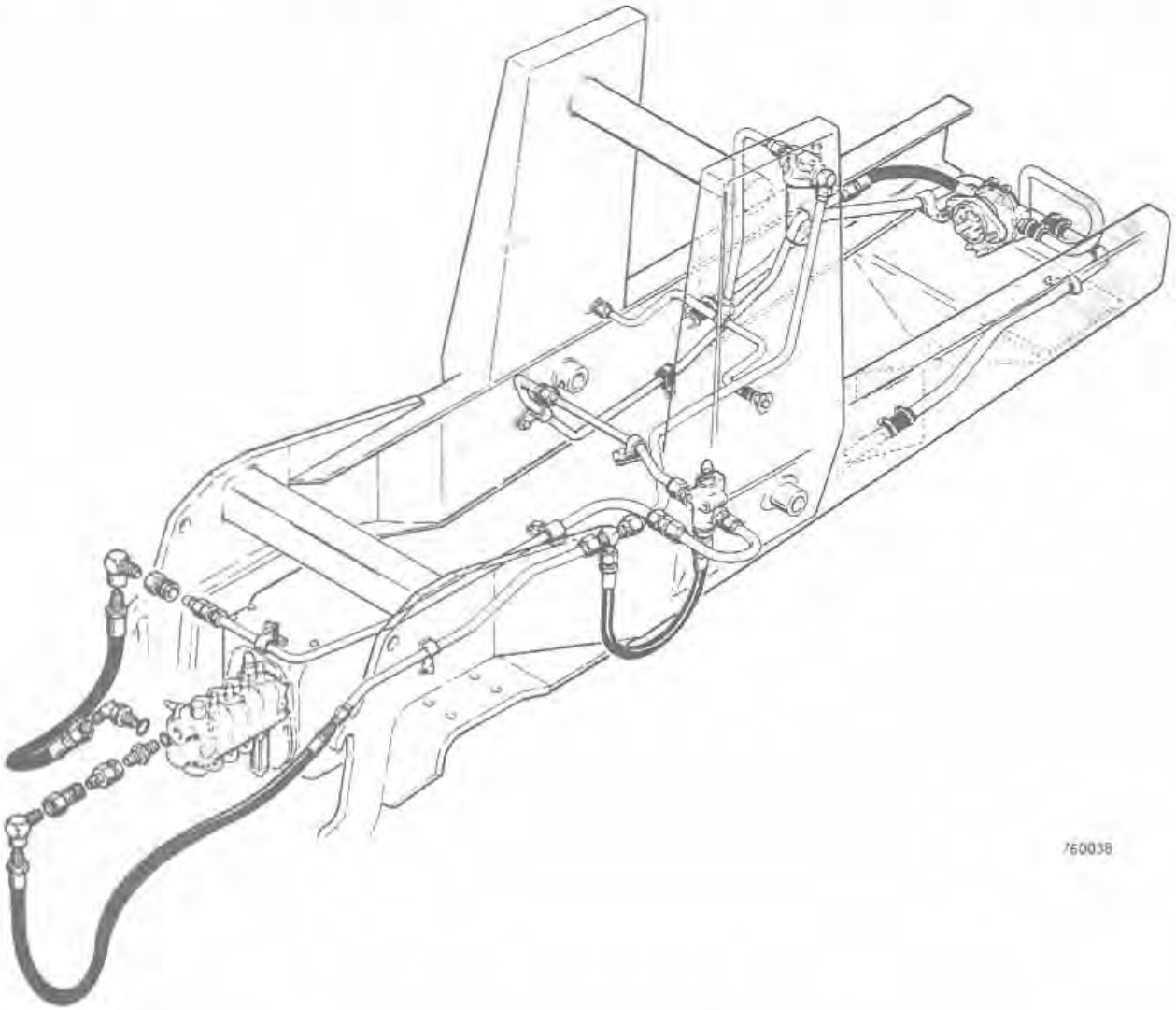
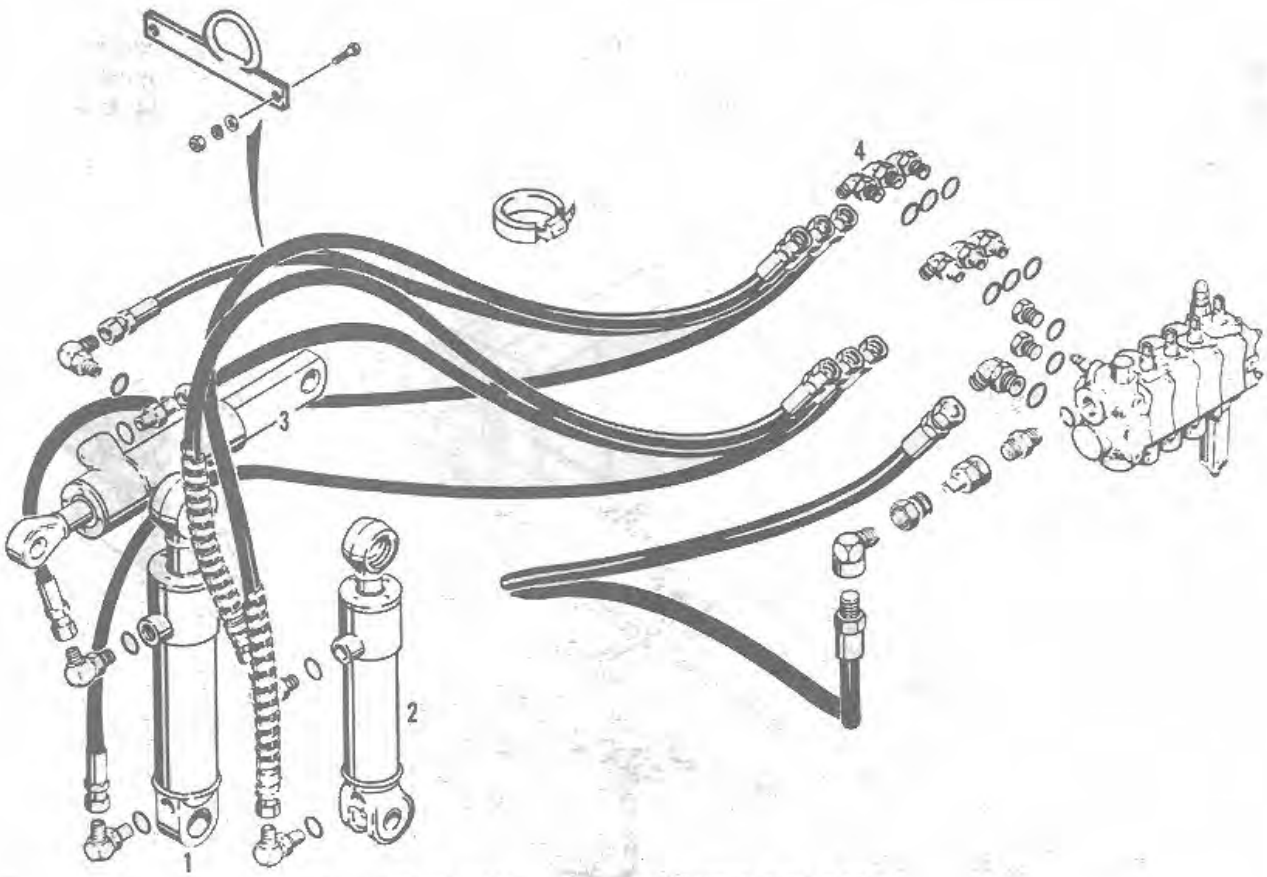


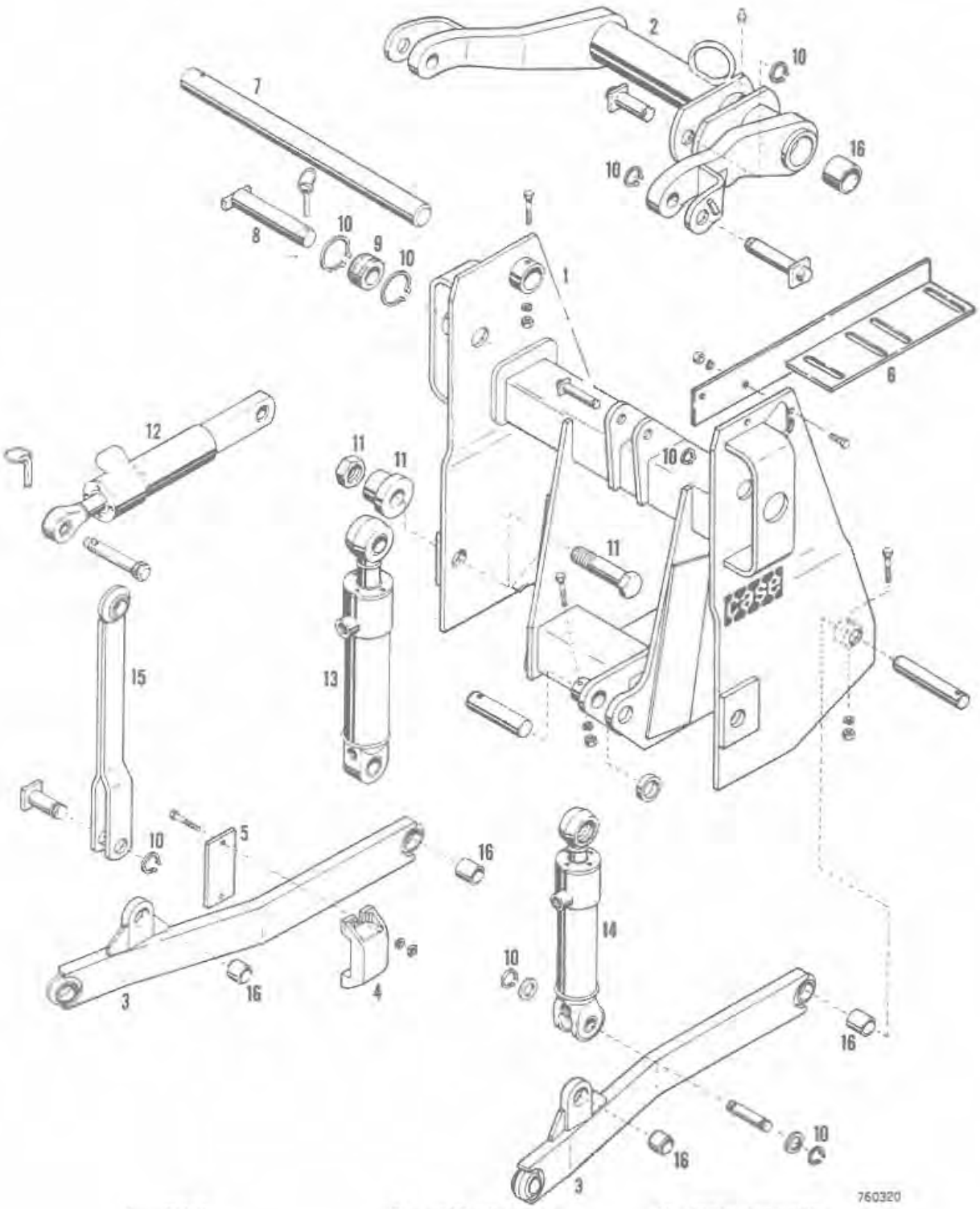
Figure 3 - Three Point Hitch Only Basic Hydraulic Installation



1. LIFT CYLINDER
2. TILT CYLINDER
3. PITCH CYLINDER
4. RESTRICTED FLOW ELBOWS. LETTER R STAMPED ON ELBOW

760039

Figure 4 - Three Point Hitch Cylinder Hydraulic Installation



1. FRAME
2. LIFT ARM
3. DRAFT ARM
4. ANTISWAY BLOCK (2)
5. BLOCK RETAINER
6. CONTROL VALVE MOUNTING BRACKET
7. LIFT ARM SHAFT
8. UPPER MOUNTING PIN (2)
9. SPACER (2)
10. SNAP RING
11. LOWER MOUNTING PIN PARTS (2 EACH)
12. PITCH CYLINDER
13. LIFT CYLINDER
14. TILT CYLINDER
15. STRUT
16. BUSHING

Figure 5 - Three Point Hitch

Section 9061

ROPS CAB AND CANOPY

J I Case
A Tenneco Company

TENNECO

C.E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

ACCIDENTAL UPSET

The ROPS is an energy absorbing safety device. Once it has been subjected to an upset or some other form of impact (such as striking an overhead abutment during travel) it should be replaced so that you will have the same degree of protection originally provided.

The ROPS and mounting, operator's seat and mounting, seat belts, and any accessories, wiring, etc. within the ROPS should be very carefully inspected after an upset, and all broken or damaged parts should be replaced immediately. DO NOT ATTEMPT TO STRAIGHTEN OR WELD THE ROPS.

MAINTENANCE AND INSPECTION

Every 500 hours or twice yearly, whichever comes first, the following should be performed.

1. Check torque on the ROPS mounting bolts and retorque to specifications if required. See Figure 2.
2. Inspect the operator's seat, seat mounting, and seat belt. Tighten bolts to specifications. Replace damaged or worn parts.

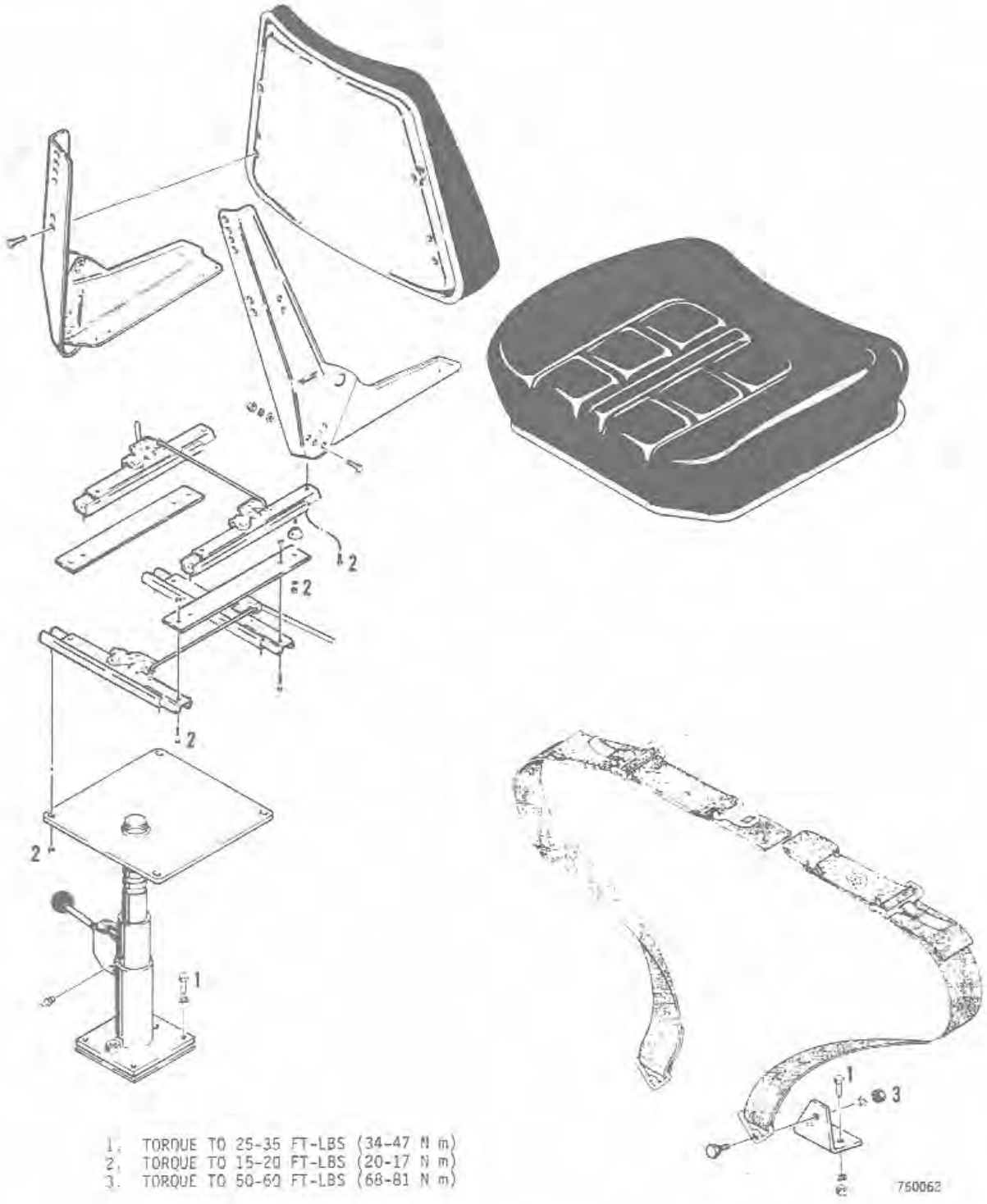
SAFETY PRECAUTIONS

WARNING: Do not make any field modifications to ROPS such as welding accessories to, or drilling holes in it. 40-14

WARNING: Do not install attachments that will cause the total gross weight of the machine to exceed the weight shown in the "for maximum gross vehicle weight" column of the ROPS label. 40-15

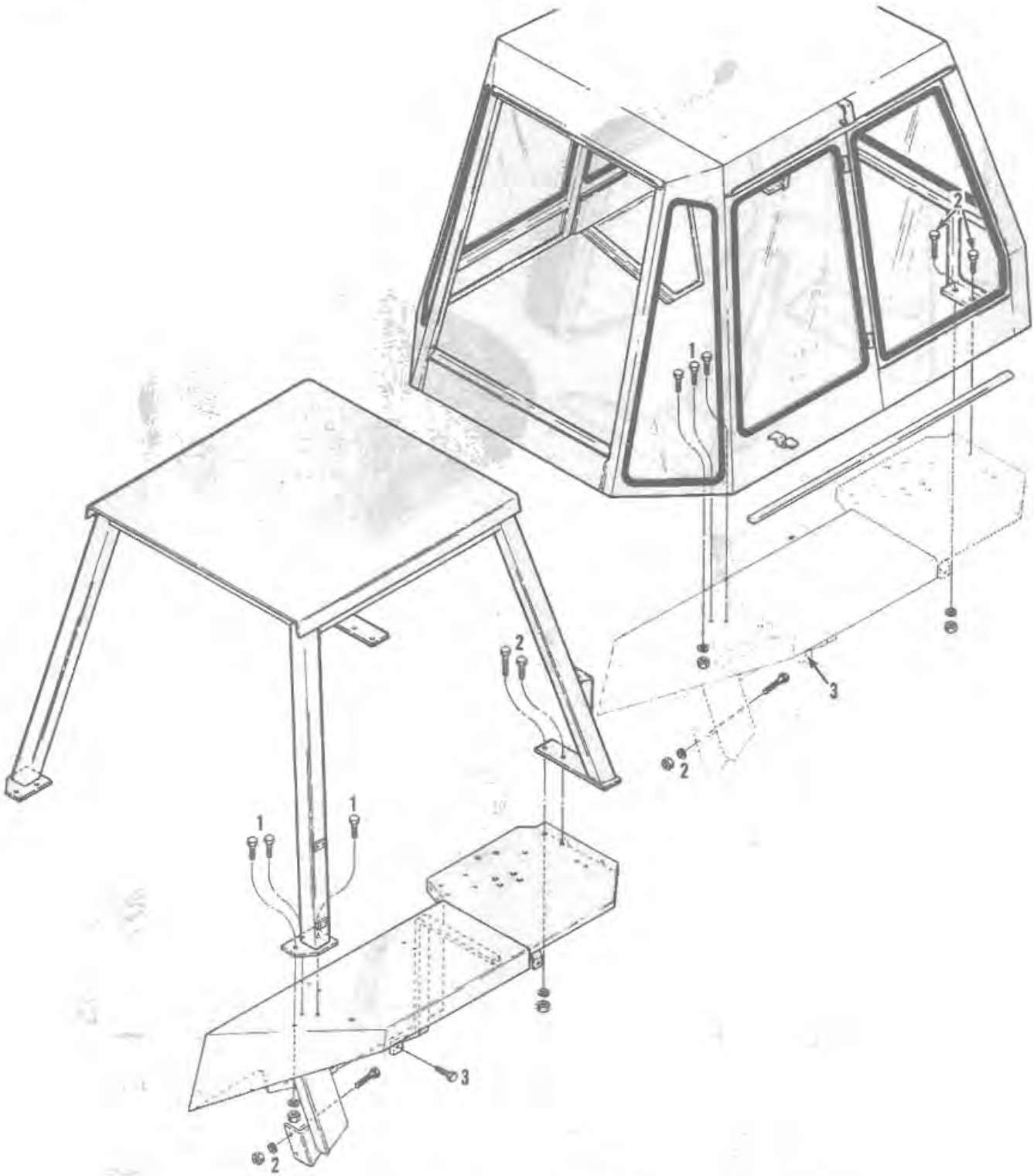
WARNING: Special hardware is often used for mounting and anchoring operator protective devices. Replacement parts must be those listed in the Case Parts Catalog. 40-16

CAUTION: The battery must be equipped with nonspill caps. If the fuel tank cap is replaced, use part specified in parts catalog. 40-17



1. TORQUE TO 25-35 FT-LBS (34-47 N m)
2. TORQUE TO 15-20 FT-LBS (20-17 N m)
3. TORQUE TO 50-60 FT-LBS (68-81 N m)

Figure 1



1. TORQUE TO 100-120 FT-LBS (135-163 N m). GRADE 8 BOLTS; DO NOT SUBSTITUTE
2. TORQUE TO 200-240 FT-LBS (271-325 N m). GRADE 8 BOLTS; DO NOT SUBSTITUTE
3. TORQUE TO 65-85 FT-LBS (88-115 N m)

760073

Figure 2

Section 9100

BACKHOE

J I Case
A Tenneco Company

TENNECO

C. E. Div. 9-66015

February 1976

PRINTED IN U.S.A.

TABLE OF CONTENTS

BACKHOE REMOVAL

1. Park the machine on a hard level surface and lower the loader bucket to the ground (floor).

2. Form a tripod with the backhoe as illustrated in Figure 1. Lower the stabilizers until they touch the ground (floor).

Figure 1

3. At the rear of the machine there are two tension rod assemblies that hold the backhoe in place. Remove the filler plate between the floor plate and the backhoe mounting frame or remove plugs in filler plate to gain access to the upper tie rod nuts, Figure 2.

Figure 2

4. Loosen the upper tie rod nut on each side. The nuts are torqued to 450-550 foot-pounds (610-745 N m) and may be difficult to loosen.

5. Remove the upper mounting pin retaining bolts. Disconnect the dipper light wire if so equipped.

6. Start the engine and run at low idle. Raise or lower the boom and stabilizers as required to remove weight of backhoe from the upper mounting pins and remove the mounting pins.

7. If machine is equipped with a canopy, use the stabilizers and raise the backhoe mounting frame out of the lower support arms.

8. If machine is equipped with a cab, proceed as instructed to prevent unnecessary damage to the cab.

   a. Disconnect rear window wiper wiring and raise the rear window.

   b. Remove lower panel across rear window.

   c. Start engine, run at low idle and raise stabilizers about one foot (300 mm) above the ground (floor).

   d. With the engine running at low idle, raise the boom slowly to pivot the backhoe mounting frame away from the machine. Pivot the mounting frame far enough to avoid contact between the cab and swing pedal guards.

   e. Use the stabilizers and raise the backhoe mounting frame out of the lower support arms.

9. Carefully move the machine forward about one foot (300 mm) and disconnect the supply and return lines.

10. Connect return hose to supply tube at rear of machine as illustrated in Figure 3.

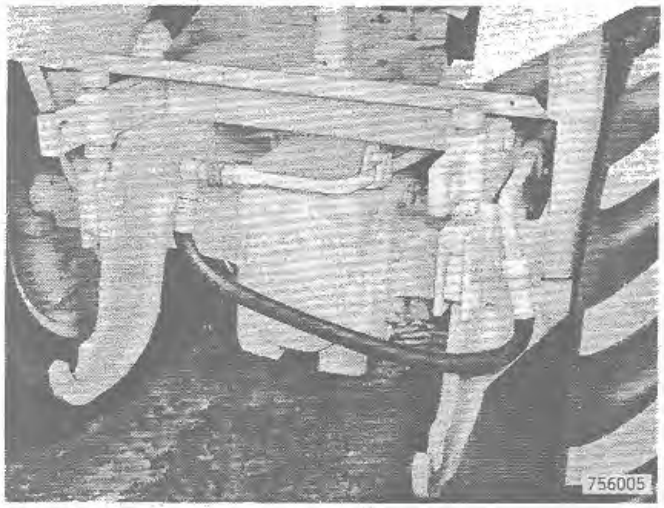


Figure 3

BACKHOE INSTALLATION

1. Line up machine with backhoe and back-up close to the backhoe mounting frame.

2. Stop engine and connect the supply and return lines.

   NOTE: If machine is equipped with a cab, be sure the backhoe mounting frame is pivoted away from the machine as required for removal before completing step 3.

3. Very carefully back the machine into the backhoe. If necessary, raise the mounting frame with the stabilizers. Lower the mounting frame onto the lower support arms.

4. Carefully raise or lower the boom (which pivots the mounting frame in or out) as required to align the mounting pin holes in the mounting frame with the upper support arms.

5. Drive the upper mounting pins into place. Raise the mounting frame with the stabilizers as required to aid in pin installation. Secure pins in place with nuts and bolts.

6. Make sure the lower tension rod nuts do not touch the upper mounting arms and torque the upper nuts to 140-170 foot-pounds (190-230 N m). Then tighten lower nuts until snug and retorque upper nuts to 450-550 foot-pounds (610-745 N m).

7. Reconnect dipper light wire if so equipped.

SWING TOWER REMOVAL AND INSTALLATION

Removal

1. Completely extend the backhoe and rest the bucket on the floor. Place a suitable support under the boom and dipper pivot to help stabilize the backhoe.

2. Move the boom, dipper and bucket control levers in both directions to equalize circuit pressure. Then remove the front cover from the control tower.

3. Number or otherwide identify the control valve ports and hoses to assure proper assembly. Then disconnect the bucket and dipper hoses from the control valve and the boom hoses from tubes from control valve. Also remove hose clamp from inside the swing tower. Plug or cap all openings.

4. Install cap (part no. 218-335) on hose to closed end of boom cylinders to hold swing tower in proper position.

5. If equipped with an extendable dipper, remove the hose guard on bottom of boom and disconnect hoses from tubes. Then free the hoses from the swing tower.

6. Remove the swing cylinder rod pivot pin retainer from bottom of swing tower. Drive the pivot pins out the bottom of the swing tower.

7. Remove the boom latch mechanism from the swing tower and install a rod (1" dia. x 18") (25 mm dia. x 457 mm) in the boom latch pivot pin holes. Attach a chain to the outer ends of the rod. Then attach a chain hoist to the chain and remove the slack.

8. Remove the snap rings from the swing tower pivot pins and remove the pins.

9. Raise the swing tower to take weight off bottom pivot. Then slowly and carefully move the tractor forward.

10. Provide additional support for the boom; Use a chain hoist or block up. Remove the retaining bolts from both boom cylinder pivot pins. Then remove a pivot pin and lower the boom cylinder (repeat for the remaining boom cylinder).

11. Remove the retainer from each boom pivot pin and remove the pins. Then remove swing tower from boom.

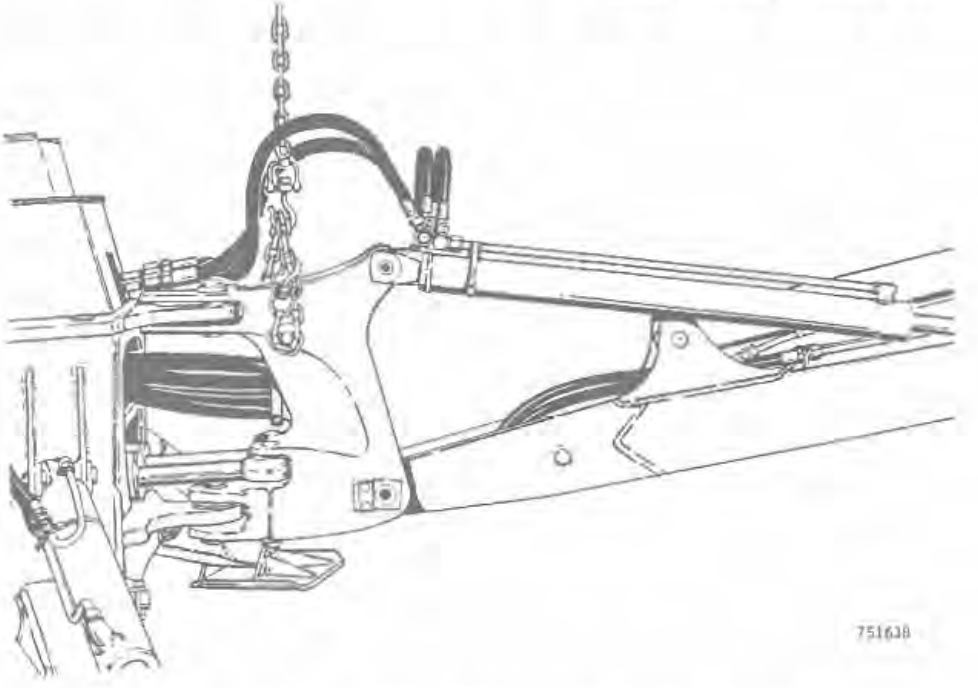


Figure 4 - Removing/Installing Swing Tower

Installation

1. Attach chain hoist to swing tower and position swing tower to boom. Then install the boom pivot pins. Secure pins in place with pin retaining hardware.

2. Position a boom cylinder to the swing tower and install the pivot pin. Coat one side of a washer with grease and position on outside of swing tower ear. Make sure hole in pin and cylinder are aligned and drive pin in until holes are aligned. Secure pin in place with bolt. Repeat for the remaining boom cylinder.

3. Back the tractor into position to mount the swing tower to the mounting frame. Install the upper and lower swing tower pivot pins and secure in place with snap rings.

4. Remove chain hoist and rod from swing tower.

5. Align swing cylinder rod eyes with swing tower and install pivot pins through bottom of swing tower. Secure pins in place with pin retainer.

6. Install boom latch mechanism.

7. Connect hoses to control valve and tubes. If hoses and ports were not identified, refer to Figures 15 and 17 for proper connections.

8. Reinstall front cover on control tower.

DISASSEMBLING THE BACKHOE

NOTE 1: This procedure outlines the complete disassembly of the backhoe. There may be occasions when complete disassembly is not required, therefore use the steps necessary to remove the affected component(s). Refer to Section 4090 when removing cylinders for repair.

NOTE 2: Shims are used at pivot points to reduce side play. When disassembling the backhoe, note the number and location of these shims for proper parts positioning during assembly.

Refer to Figures 14 and 15 to aid in disassembly.

Bucket Removal

1. Lower the bucket with bottom of bucket flat on the floor.

2. Remove a snap ring and washer from the two pivot pins that must be removed. One attaches the bucket to the dipper arm and one attaches the linkage to the bucket cylinder rod eye.

Dipper Arm Removal

1. Remove bucket as instructed under Bucket Removal.

2. Extend the dipper arm and lower the boom until the end of the dipper arm rests on the floor.

3. Move the bucket control lever in both directions to equalize circuit pressure. Provide support (chain hoist) for the bucket cylinder and remove a snap ring and washer from the cylinder pivot pin. Then remove pivot pin.

4. Free the bucket cylinder from the dipper arm and disconnect hoses at bucket cylinder and lower bucket cylinder to the floor. Then disconnect bucket hoses at tubes secured to boom and close all openings with clean caplugs.

5. If the backhoe is equipped with the standard dipper arm:

   a. Attach a chain hoist to the dipper arm. Move the dipper control lever in both directions to equalize circuit pressure.

   b. Place a block of wood under the dipper cylinder to provide support when the rod pin is removed. Then remove a snap ring and washer from the dipper cylinder rod pivot pin and remove pivot pin.

   c. Remove a snap ring and washer from the dipper arm pivot pin and remove pivot pin.

   d. Lift the dipper away from the boom and lower the dipper arm to the floor.

6. If the backhoe is equipped with a hydraulically extendable dipper arm:

   a. Attach a chain hoist to the dipper arm. Them move control lever in both directions to equalize circuit pressure.

   b. Disconnect hoses to the extension cylinder at the tubes secured to the boom and close openings with clean caplugs.

   c. Place a block of wood under the dipper cylinder to provide support when the rod pin is removed. Then remove a snap ring and washer from dipper cylinder rod pivot pin and remove pivot pin.

   d. Remove a snap ring and washer from the dipper arm pivot pin and remove pivot pin.

   e. Lift the dipper away from the boom and lower the dipper arm to the floor.

Boom Removal

1. Remove the bucket and dipper arm as previously instructed.

2. Attach a chain hoist to the dipper cylinder. Then remove the dipper cylinder pivot pin retaining bolt and pivot pin.

3. Remove the hose clamp inside the boom. Then remove the hose guard from the bottom of the boom if equipped with an extendable dipper arm.

   NOTE: As the remaining hoses are disconnected, number each hose and its connecting point to assure proper assembly.

4. Carefully move the dipper cylinder away from the cylinder mounting bracket, and disconnect hoses from cylinder. Close openings with clean caplugs.

5. Provide suitable support for the boom and move the boom control lever in both directions to equalize circuit pressure.

6. Disconnect hoses from each boom cylinder as required and close openings with clean caplugs. Then remove the pivot pin retaining bolts from each cylinder and rod pivot.

7. Attach a chain hoist to a boom cylinder. Remove the cylinder pivot pin. Then drive the rod eye pivot pin into the rod eye to free rod from pin and lower cylinder to the floor. Repeat for the remainng boom cylinder.

8. Attach a chain hoist to the boom and disconnect the remaining hoses from the boom.

9. Remove the boom pivot pin (2) retaining hardware and remove the pivot pins. Then lower boom to floor.

ASSEMBLING THE BACKHOE

NOTE: Install shims in same location and quantity as noted during disassembly.

Refer to Figures 14 and 15 to aid in assembly.

Boom Installation

1. Attach a chain hoist to the boom and lift boom into position to attach to the swing tower.

2. Align the boom with the swing tower and install the boom pivot pins. Secure the pins in place with the pin retaining hardware, Figure 15.

3. Position a boom cylinder to the swing tower and install the pivot pin. Coat one side of washer with grease and place on outside of swing tower ear. Make sure hole in pin is aligned with hole in cylinder and drive pin in until the holes are aligned. Then install the pin retaining bolt. Repeat for the remaining boom cylinder.

4. Align the cylinder rod eye with the rod pivot pin. Make sure the bolt hole in the pin and eye are aligned and drive pin into the rod eye until the holes are aligned. Secure the pin in place with bolts and nuts.

5. Connect hoses to the boom cylinders and tubes attached to the boom. If hoses were not numbered or otherwise identified during disassembly, refer to Figure 15 for proper connections.

6. The boom can now be raised or lowered hydraulically. Position the boom in a suitable position, and with the aid of a chain hoist position the dipper cylinder over the boom.

7. Connect the hoses to the dipper cylinder and position cylinder in mounting bracket. Install pivot pin and secure in place with bolt and nut.

8. Install hose clamp inside of boom, making sure hoses are properly positioned.

9. If equipped with an extendable dipper, connect hoses to tubes on bottom of boom and install hose guard.

Dipper Arm Installation

1. Attach a chain hoist to the dipper arm and position the dipper on the boom. Use the same number of shims between the boom and dipper as were removed. Install the dipper arm pivot pin and secure in place with washers and snap rings.

2. Coat the sides of the dipper cylinder rod eye with grease and place a washer on each side of the rod eye. Align the rod eye with the dipper arm and install the pivot pin. Secure the pin in place with washers and snap rings.

3. Position the boom and dipper arm to aid in installing the bucket cylinder. Attach a chain hoist to the bucket cylinder and position cylinder over dipper arm. Connect hoses to bucket cylinder and tubes attached to the boom.

4. Coat the sides of the cylinder eye with grease and place a washer on each side of the eye. Then carefully move the cylinder into position and install the pivot pin. Secure the pin in place with washers and snap rigs.

5. If equipped with an extendable dipper arm, connect the extension cylinder hoses to the tubes secured to the boom.

Bucket Installation

1. Position bucket to dipper arm and install pivot pin. Secure pin in place with washers and snap rings.

2. Extend or retract the bucket cylinder to align the cylinder rod eye with the upper and lower bucket control links. Coat the sides of the rod eye with grease and place a washer on each side of the rod eye. Align bucket links with rod eye and install pivot pin. Secure pivot pin with washers and snap rings.

DIPPER EXTENSION

Removal

1. Remove bucket as instructed on page 9100-7.

2. Make sure dipper extension is fully retracted and position boom and dipper to aid in removal of dipper extension.

3. Remove snap rings and washers that secure bucket links to dipper extension and remove bucket links.

WARNING: Keep fingers clear of sliding collar when completing step 4 as the collar will drop when the pin is removed. 39-8

4. Remove pin that attaches sliding collar to dipper extension.

5. The dipper extension weighs approximately 230 pounds (104 kg) and is approximately 7 feet (2133 mm) long. Pull the dipper extension out of the dipper arm about half way and attach a chain hoist to the extension.

6. Continue pulling the extension from the dipper arm while being alert for an unbalanced condition when the extension is free of the dipper arm. Lower the extension to the floor.

Installation

1. Block up rod end of extension cylinder in dipper arm about 1 inch (25 mm) with a small piece of wood. Also make sure the rod eye is straight up and down.

2. Attach a chain hoist to the dipper extension and push the extension into the dipper arm about half way. If necessary, drive the extension into the dipper arm.

3. Start the engine and SLOWLY extend the extension cylinder to bring rod eye into alignment with hole in dipper extension. If the rod eye contacts one of the bosses inside the dipper extension and pushes the extension out, move the extension sideways to align rod eye with bosses.

WARNING: DO NOT put fingers in pin hole while extending the extension cylinder. 39-9

4. After the rod eye is aligned with the pin hole, grasp the sliding collar and move the collar into alignment with hole in dipper extension.

   NOTE: Use care in moving sliding collar as the weight of the collar will cause it to slide downward on the dipper arm when the pin end is raised.

5. Install the collar and rod eye retaining pin. Then install the bucket links on pin with links on top of bucket pivot bosses. Secure pin with washers and snap rings.

6. Install bucket as instructed on page 9100-9.

Replacing Dipper Extension Wear Strips

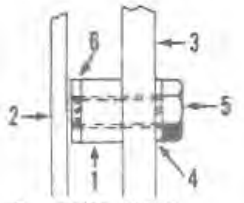
1. Remove dipper extension.

2. Use a chisel to break wear strip welds. Then remove remaining weld with a grinder to provide a flat surface for the new wear strips.

3. Refer to Figure 6 for location and weld specifications and weld wear strips to extension. USE E-7018 welding rod.

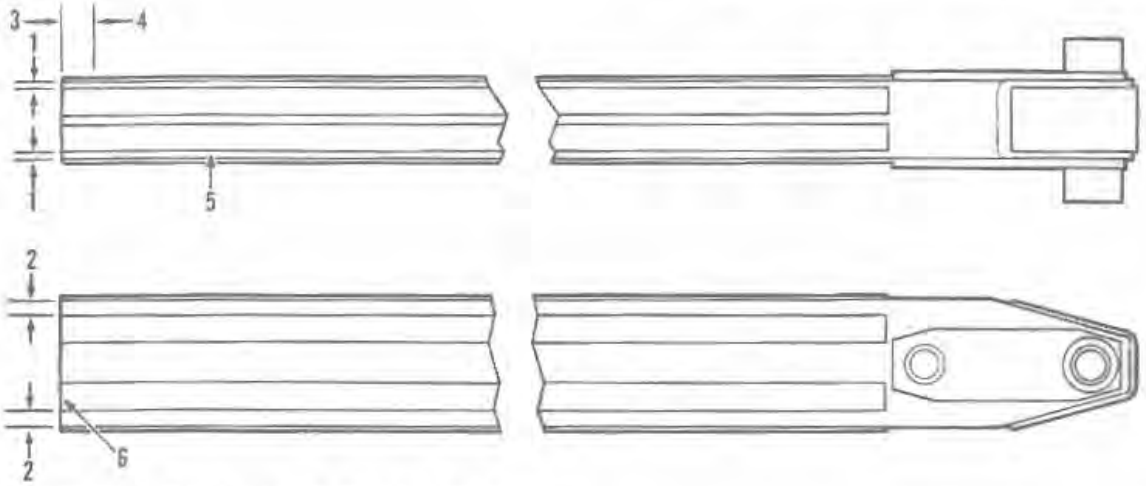
Guide Blocks

Guide blocks are attached to the sliding collar to reduce clearance between the collar and dipper housing. The blocks are held in place with cap screws and lock washers. Whenever installing guide blocks, make sure chamfered side is toward the dipper housing, Figure 5.



1. GUIDE BLOCK
2. DIPPER HOUSING
3. SLIDING COLLAR
4. LOCK WASHER
5. CAP SCREW 751639
6. CHAMFERED EDGE

Figure 5 - Guide Block Installation



1. 1/2" (17 mm) 2. 1" (25 mm) 3. 2" (50 mm)
4. 1/8" (3 mm) FILLET WELD ON EACH OF ALL STRIPS AND BOTH ENDS.
5. 1/8" (3 mm) FILLET WELD 1" (25 mm) LONG ON 7" (178 mm) CENTERS. BOTH SIDES ALL STRIPS.
6. BREAK THIS CORNER ON STRIPS AT THIS END.

751640

Figure 6 - Wear Strip Location and Weld Specifications

BUCKET CUTTING EDGES AND TEETH

NOTE: If bucket is not removed for repair, disconnect alternator leads and unplug voltage regulator.

Wrap Around Cutting Edge

Removal and Installation

1. Remove the bucket teeth if so equipped. Use carbon arc rod or an acetelyne cutting torch to remove welds.
2. Remove all cutting edge welds using carbon arc rod or an acetelyne cutting torch.
3. Cut through the corner of the bucket and cutting edge.
4. Remove the cutting edge and grind off any remaining weld and/or excess metal to provide a smooth surface for the new cutting edge.
5. Place cutting edge on bucket, using C-clamps to hold it in position. Using a weld rod meeting A.W.S. specification E-7018, fill opening made in each corner.
6. Refer to Figure 8 and weld cutting edge to bucket. Use weld rod specified in step 5.
7. Install bucket teeth. Refer to Figures 7 and 9 for location and weld specifications.
8. If old tooth shanks are to be used, remove any remaining weld before reinstalling.

Side Cutting Edges

Removal and Installation

1. Remove all cutting edge welds using carbon arc rod or an acetelyne cutting torch.
2. Remove the cutting edge and grind off any remaining weld and/or excess metal to provide a smooth surface for the new cutting edge.
3. Place cutting edge on bucket, using C-clamps to hold it in position.
4. Refer to Figure 8 and weld cutting edge to bucket. Use a weld rod meeting A.W.S. specification E-7018.

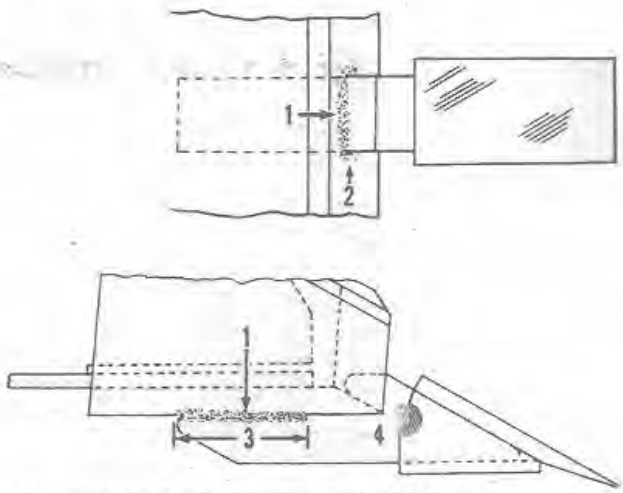
Bucket Teeth

Tooth Shank Removal and Installation

1. Remove all shank welds using carbon arc rod or an acetelyne cutting torch.
2. Remove shank and grind off any remaining weld on the cutting edge.
3. Refer to Figures 7 and 9 for location and weld specifications. Use a weld rod meeting A.W.S. specification E-7018 and weld shank to cutting edge.

Tooth Replacement

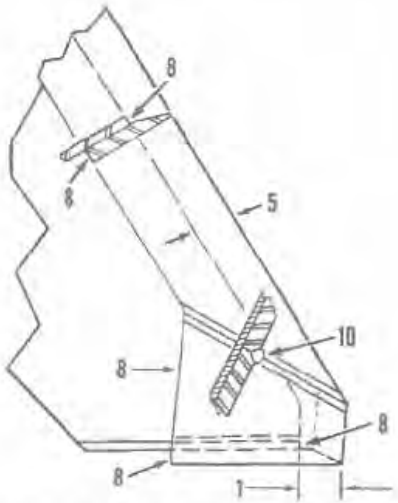
1. Refer to Figure 7. Use a suitable tool and raise the peened portion on each side of the tooth and remove tooth from shank. The peened area may be heated with a torch to aid in removal. On heavy duty buckets, drive out pin.
2. Slide the new tooth onto the shank as far as it will go and peen each side into depression in shank or drive pin into place on heavy duty buckets.



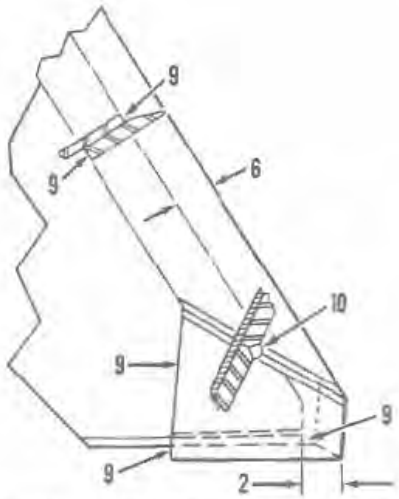
1. 3/8" (9.5 mm) FILLET - TWO PASS WELD
2. WRAP CORNER 3/8" (9.5 mm)
3. 2-1/2" (63.5 mm)
4. PEENED DOWN PORTION

751657

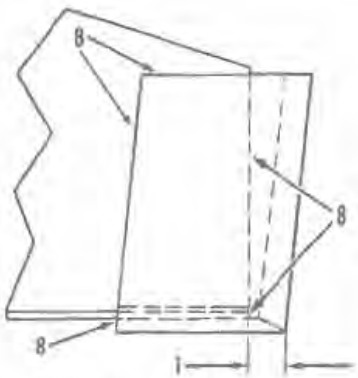
Figure 7 - Bucket Tooth and Shank Installation



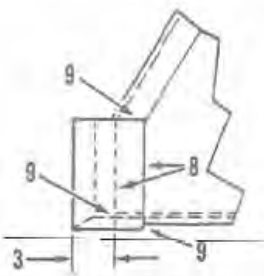
STANDARD TRENCHING BUCKET



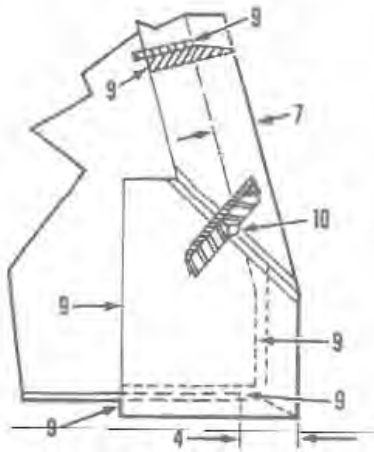
HEAVY DUTY TRENCHING BUCKET



BELLHOLE BUCKET



SHOVEL BUCKET

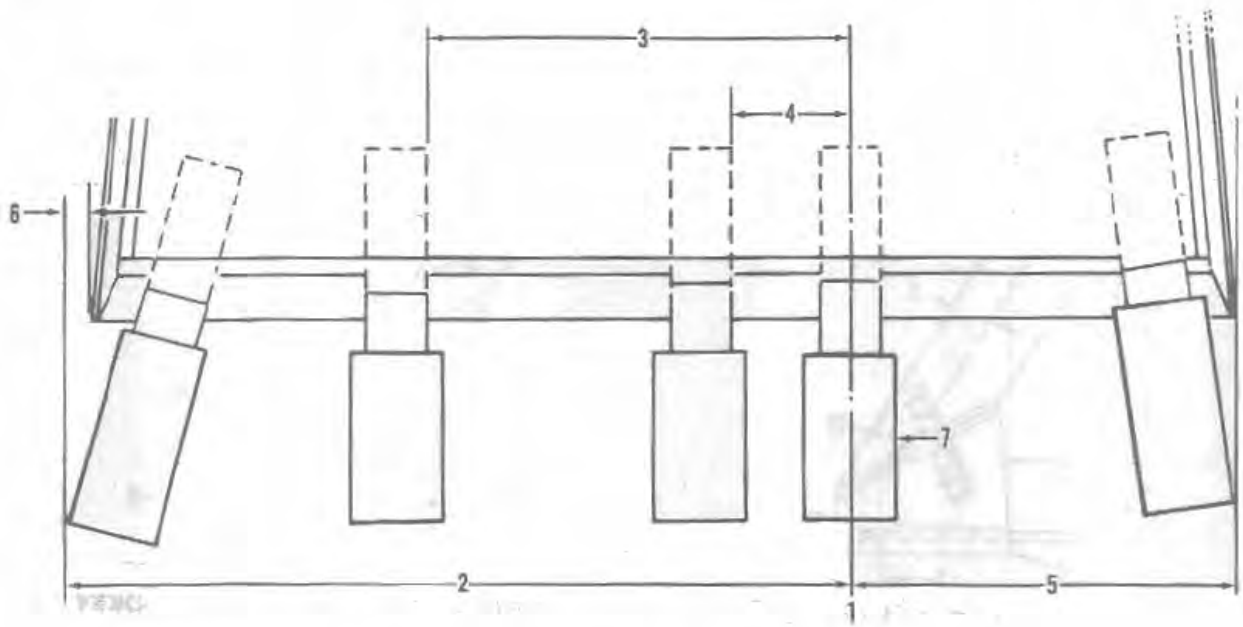


DITCHING (V) BUCKET

1. 1-7/16" (36.5 mm)
2. 1-7/8" (47.6 mm)
3. 2-3/8" (60.3 mm)
4. 1-1/2" (38.1 mm)
5. 1-3/16" (30.2 mm)
6. 1-7/16" (36.5 mm)
7. 1-5/16" (33.3 mm)
8. 3/16" (4.8 mm) FILLET
9. 1/4" (6.4 mm) FILLET
10. 5/16" (8 mm) TWO PASS WELD

751641

Figure 8 - Cutting Edge Weld Specifications

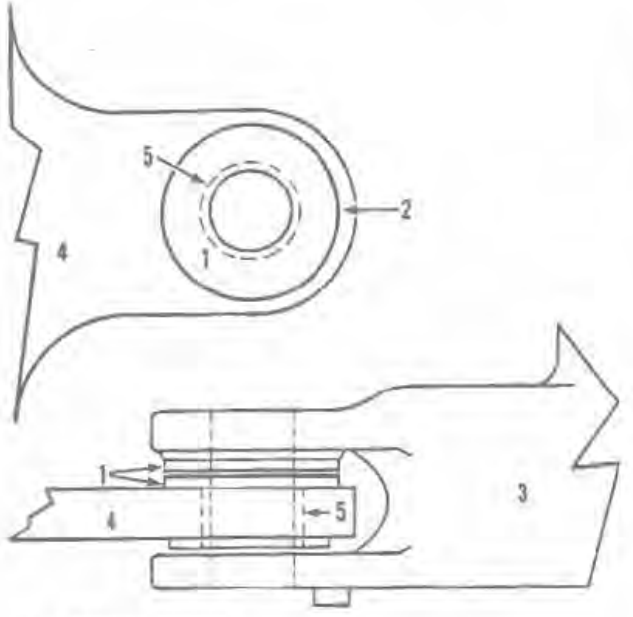


1. CENTER LINE
2. 18" (457 mm) BUCKET - 9-5/8" (244.5 mm), 19-1/4" (489 mm) OVERALL
   24" (610 mm) BUCKET - 12-5/8" (321 mm), 25-1/4" (642 mm) OVERALL
   30" (762 mm) BUCKET - 15-5/8" (397 mm), 31-1/4" (794 mm) OVERALL
   36" (914 mm) BUCKET - 18-5/8" (473 mm), 37-1/4" (946 mm) OVERALL
3. 18" (457 mm) BUCKET - 2-1/8" (54 mm)
   24" (610 mm) BUCKET - 3-1/8" (79.4 mm)
   30" (762 mm) BUCKET - 6-1/2" (165 mm)
   36" (914 mm) BUCKET - 9-3/4" (248 mm)
4. 36" (914 mm) BUCKET - 2-3/4" (70 mm)
5. 12" (305 mm) BUCKET ONLY - 6-1/8" (156 mm), 12-1/4" (312 mm) OVERALL
   POSITION TOOTH SHANK AS CLOSE TO CORNER AS POSSIBLE AND MAINTAIN OVERALL DIMENSION.
6. ALL BUCKETS EXCEPT 12" (305 mm) BUCKET - 1/2" (12.7 mm). POSITION TOOTH SHANK AS CLOSE TO CORNER AS POSSIBLE WHILE MAINTAINING THE 1/2" (12.7 mm) AND OVERALL DIMENSIONS.
7. CENTER TOOTH USED ON 12" (305 mm) AND 30" (762 mm) BUCKETS ONLY

751642

Figure 9 - Bucket Tooth Location

SWING PIVOT BUSHINGS AND BEARING WASHER



1. BEARING WASHER
2. TACK WELD IN FOUR PLACES 90° APART
3. SWING TOWER
4. MOUNTING FRAME
5. BUSHING

751641

Figure 10

Bushings are used in the top and bottom mounting frame pivot ears and the bearing washers are used at the bottom pivot; one on top of the mounting frame and one on the swing tower, Figure 10.

Replacing Bushing and Bearing Washers

1. Separate swing tower from mounting frame as instructed on page 9100-5.

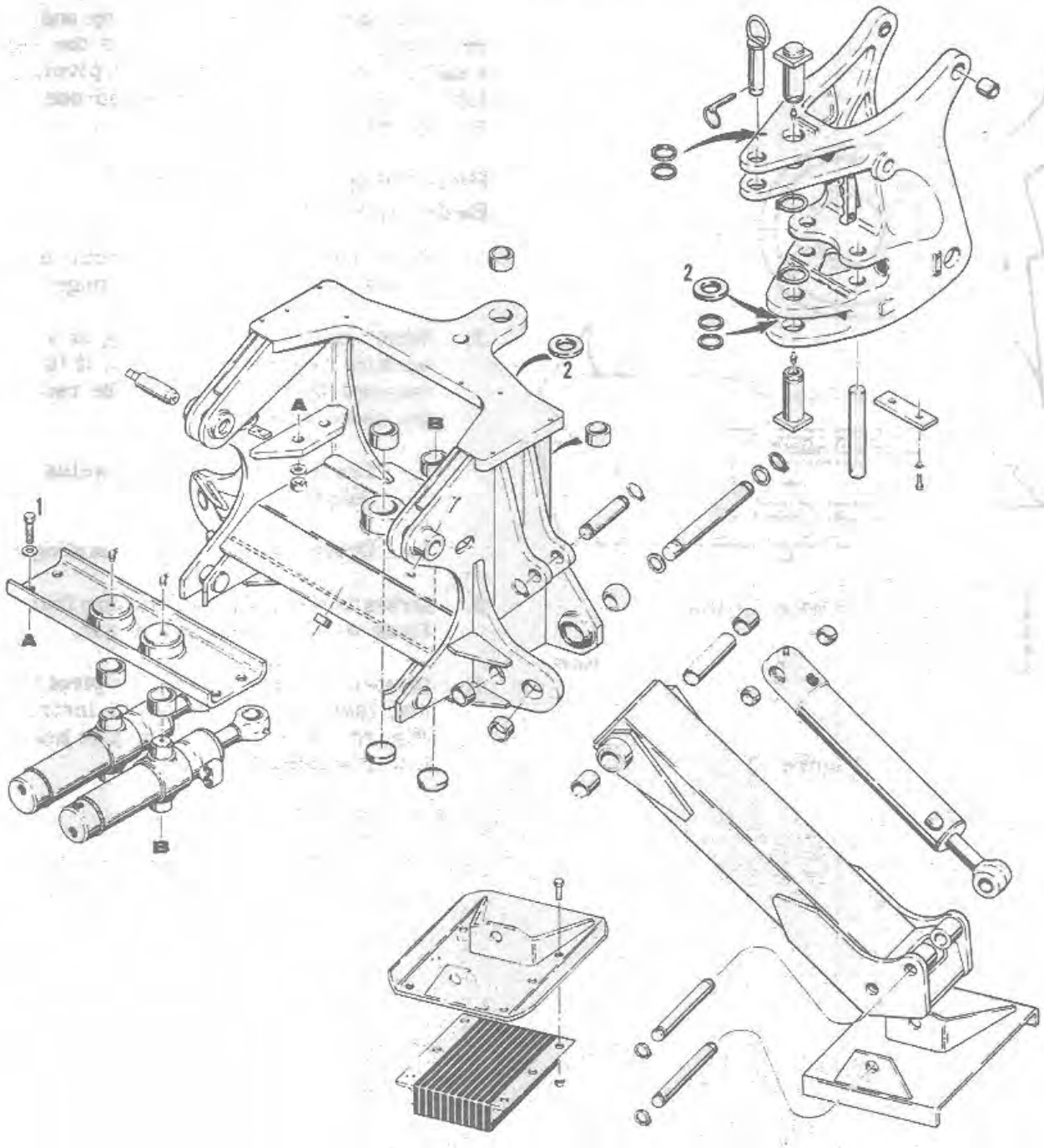
2. When replacing the bushing or a bearing washer at the lower pivot, it is recommended that all the parts be replaced at the same time.

   a. Break washer tack welds with a chisel.

   b. Drive bushing out of mounting frame.

3. Drive bushings into mounting frame until flush with bottom of pivot ear.

4. Center bearing washer on pivot pin hole and tack weld in place as instructed in Figure 10. Use a C-clamp to hold swing tower washer in place.



1. TORQUE TO 520-640 FOOT-POUNDS (706-867 N m)
2. PIVOT BEARING WASHER. REFER TO PAGE 9100-15.

Figure 11 - Mounting Frame, Swing Cylinders and Stabilizers

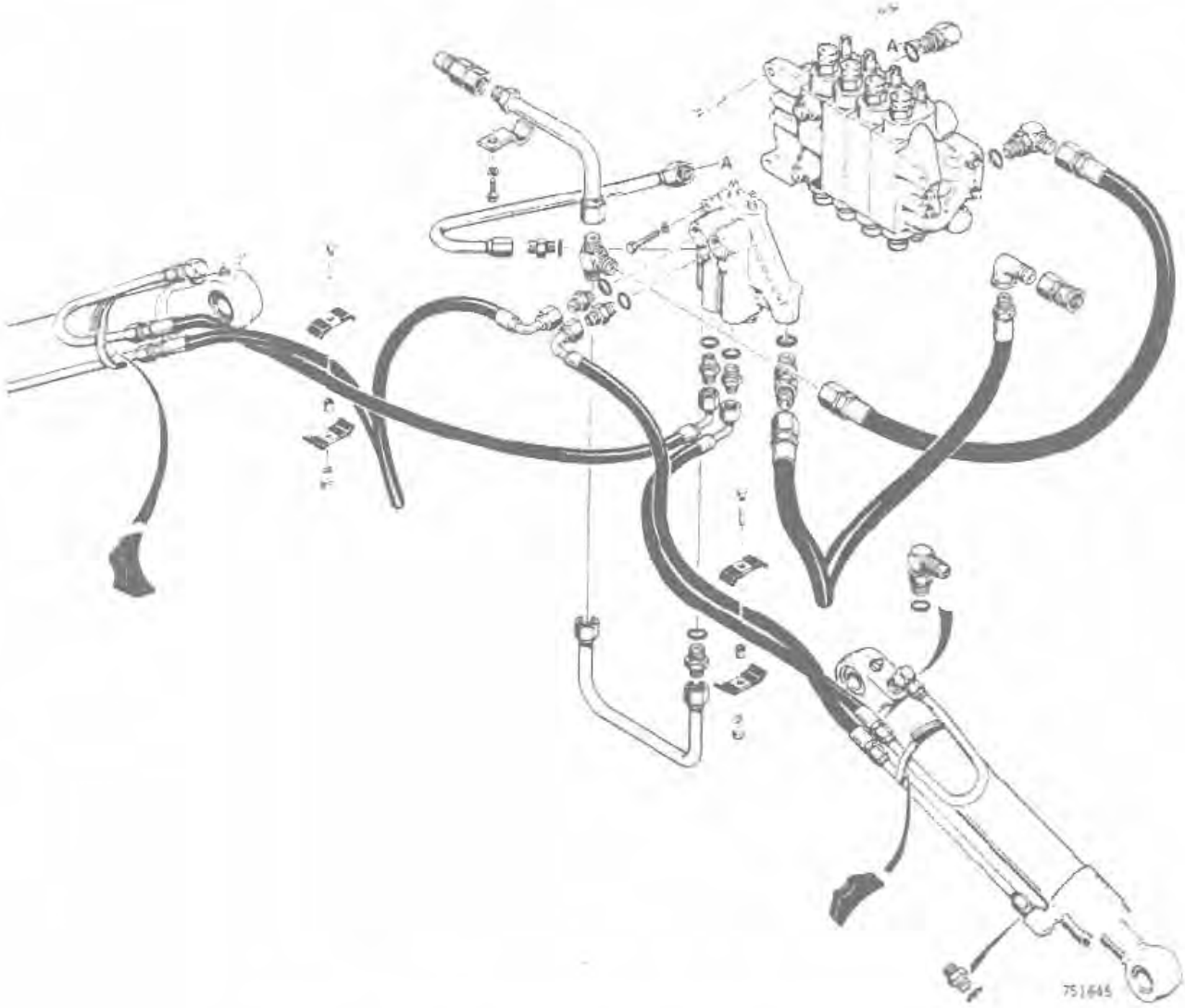
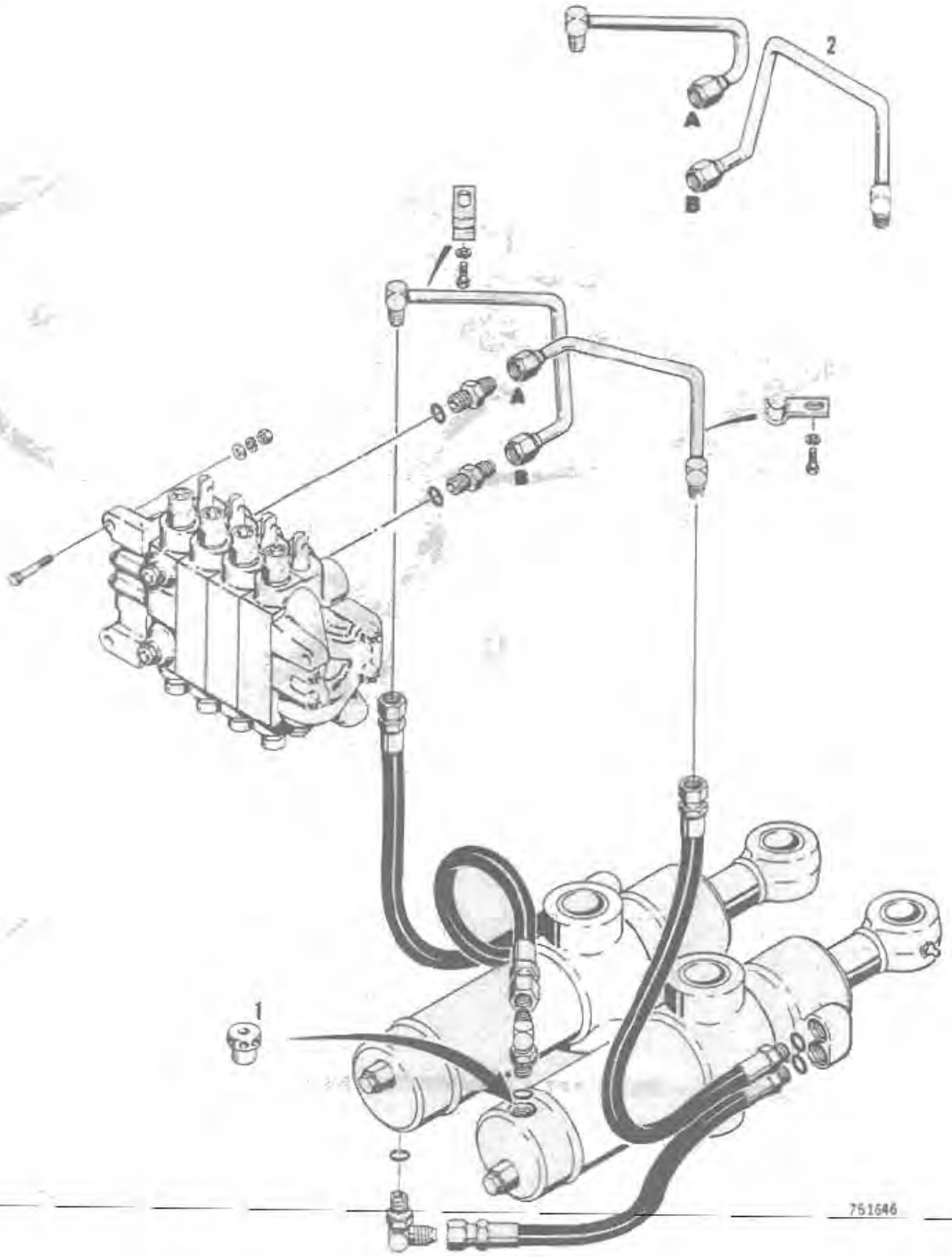


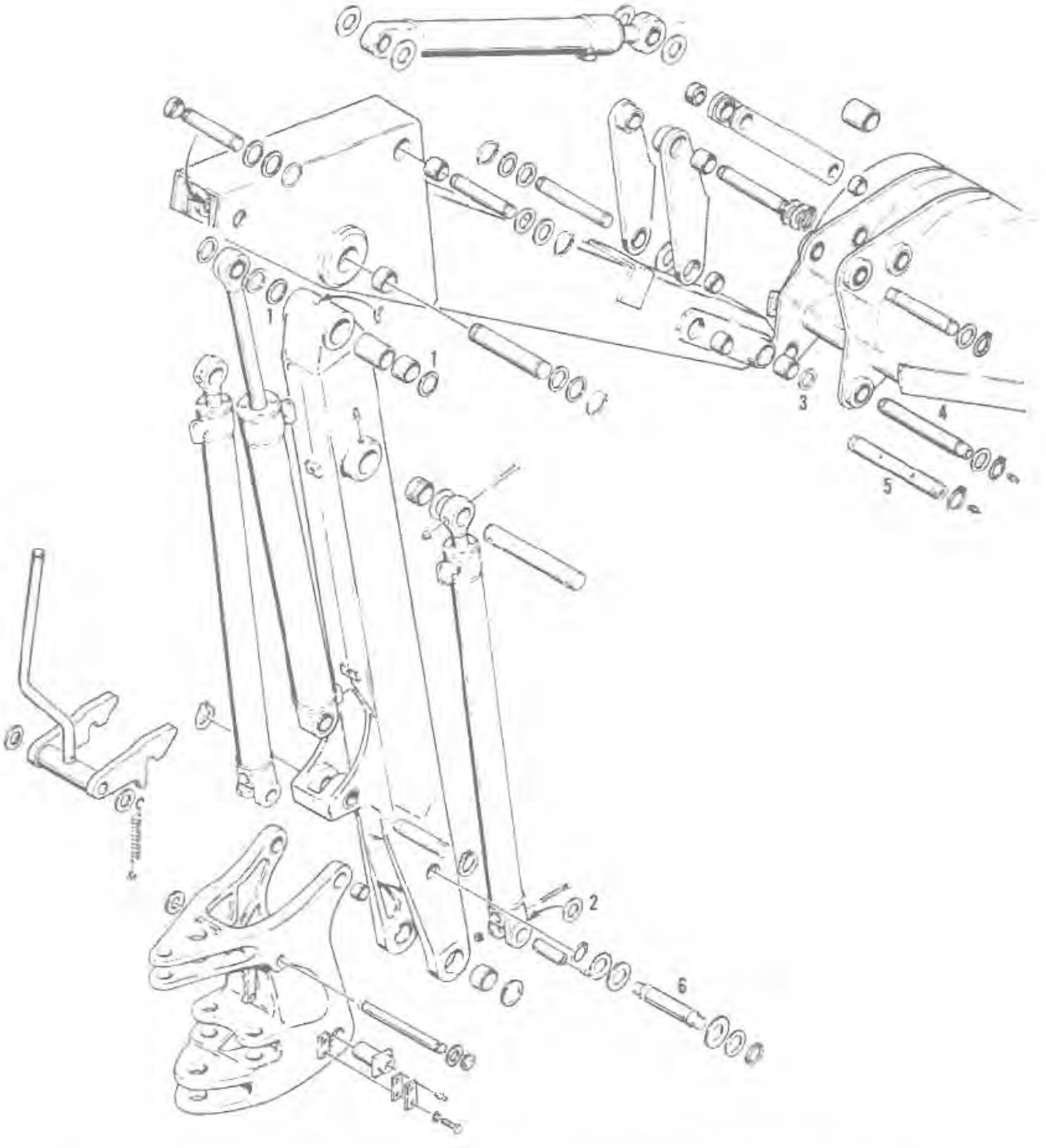
Figure 12 - Stabilizer Cylinder Hydraulic Installation



1. RESTRICTOR MUST BE INSTALLED IN EACH CYLINDER, SMALL END FIRST.

2. TUBES USED WITH HAND SWING CONTROLS.

Figure 13 - Swing Cylinder Hydraulic Installation



1. USE AS REQUIRED TO LIMIT DIPPER TO BOOM MOVEMENT TO .070" (1.78 mm) OR LESS
2. USE BETWEEN BOOM CYLINDER AND OUTSIDE OF SWING TOWER AS REQUIRED, BOTH CYLINDERS
3. USE AS REQUIRED TO LIMIT BUCKET TO DIPPER MOVEMENT TO .25" (6.4 mm) OR LESS
4. BUCKET PIN - ALL EXCEPT 12" (305 mm)
5. 12" (305 mm) BUCKET PIN
6. USE WASHERS AS REQUIRED TO CENTER PIN IN BOOM WITH MINIMUM END PLAY

751647

Figure 14 - Exploded View of Backhoe

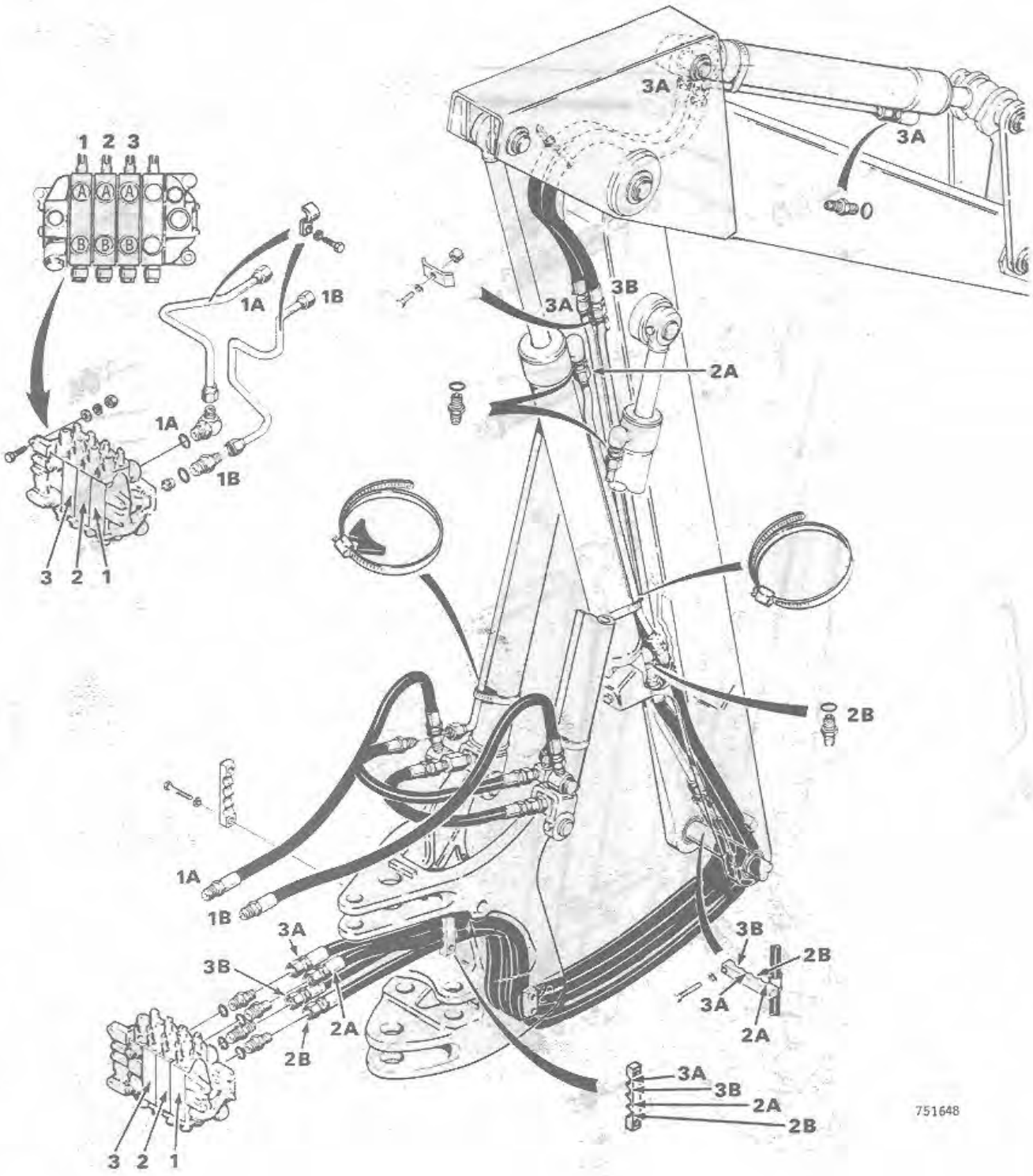
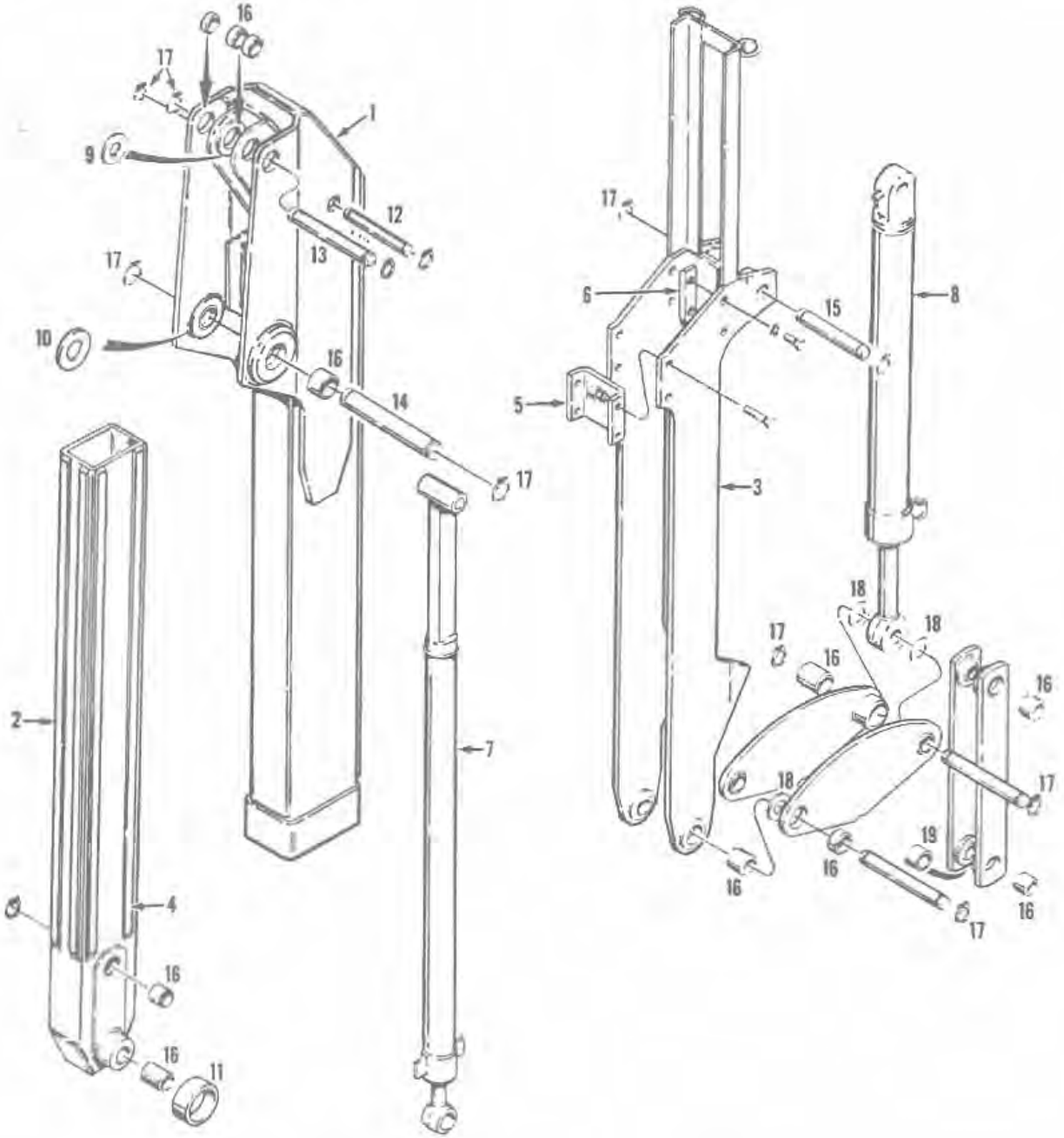


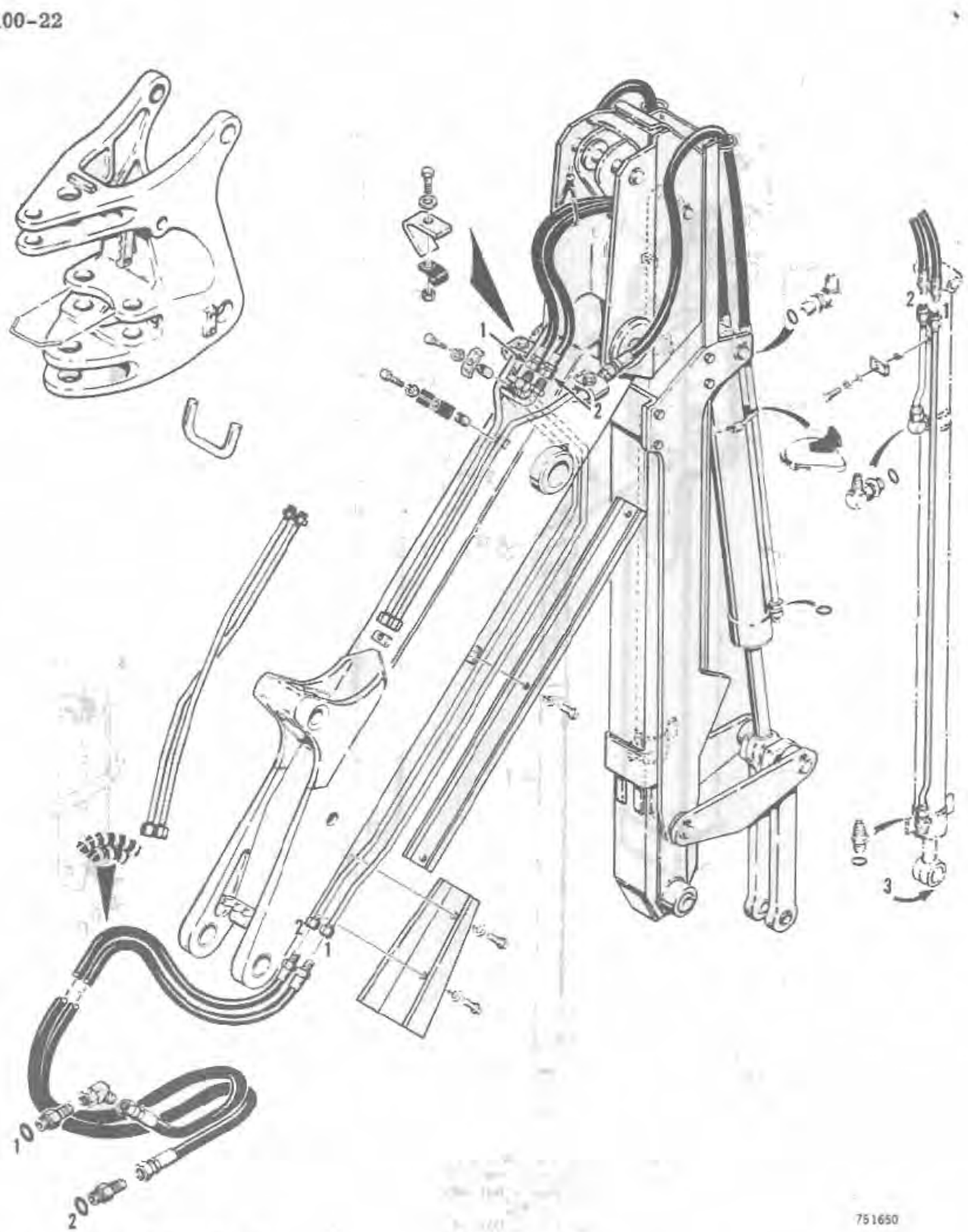
Figure 15 - Boom, Dipper and Bucket Cylinder Hydraulic Installation



1. DIPPER HOUSING
2. DIPPER EXTENSION
3. SLIDING COLLAR
4. WEAR STRIP (8)
5. GUIDE PLATE
6. GUIDE BLOCK (2)
7. EXTENSION CYLINDER
8. BUCKET CYLINDER
9. WASHER. USE ONE EACH SIDE OF DIPPER CYLINDER ROD EYE AND BETWEEN SNAP RINGS AND HOUSING AS REQUIRED.
10. USE AS REQUIRED TO OBTAIN .070" (1.78 mm) MAXIMUM CLEARANCE BETWEEN BOOM AND DIPPER
11. SPACER. USED WITH STANDARD BUCKETS ONLY
12. EXTENSION CYL. PIN
13. DIPPER CYL. PIN
14. DIPPER PIVOT PIN
15. BUCKET CYL. PIN
16. BUSHING
17. SNAP RING
18. FLAT WASHER
19. SPACER

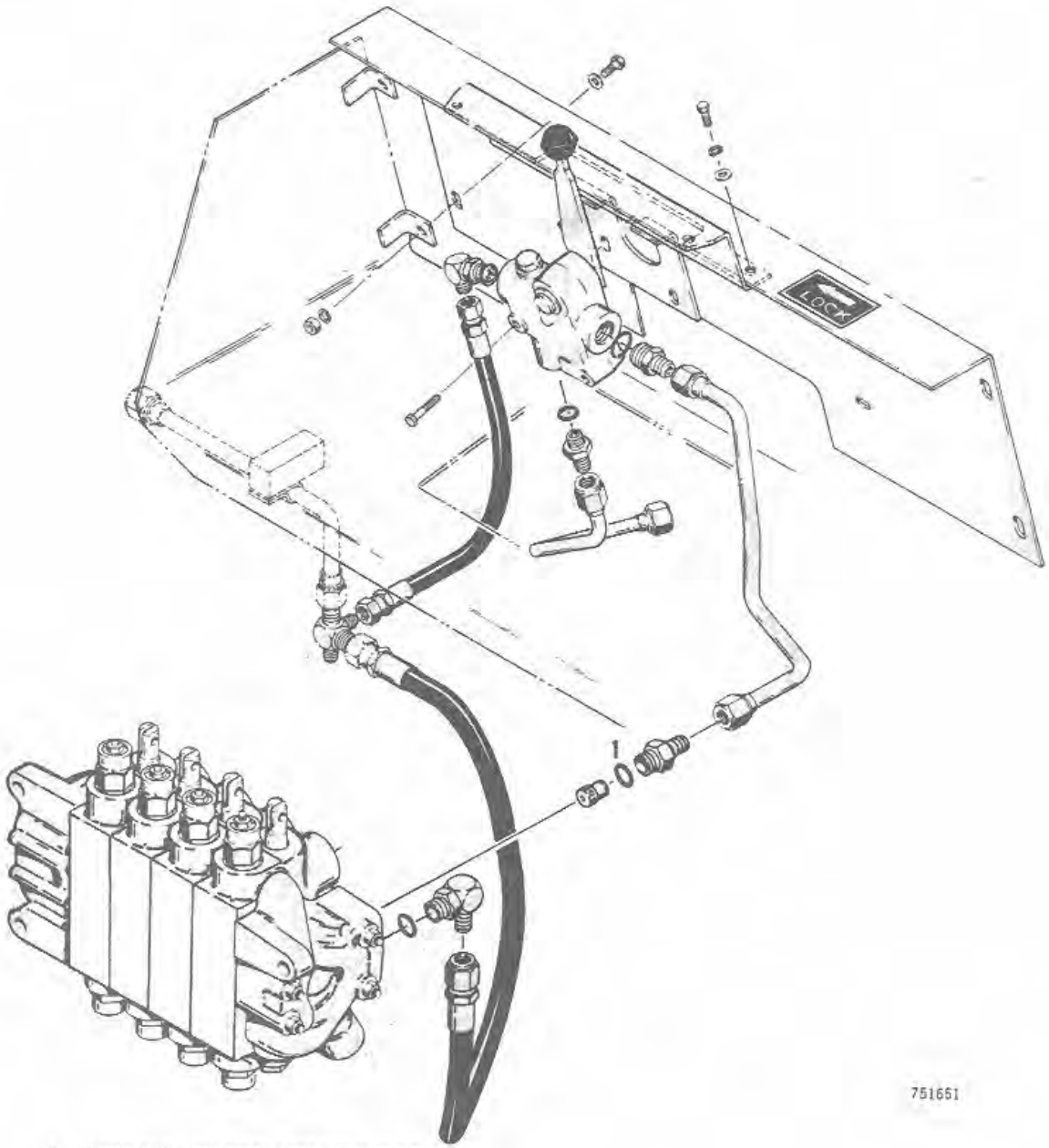
751649

Figure 16 - Exploded View of Extendable Dipper



1. CONNECTED TO VALVE A PORT
2. CONNECTED TO VALVE B PORT
3. CYLINDER ROTATED 180° FOR CLARITY

Figure 17 - Extension Cylinder Hydraulic Installation



1. CONNECTED TO BOOM SECTION B PORT

Figure 18 - Boom Lock Hydraulic Installation

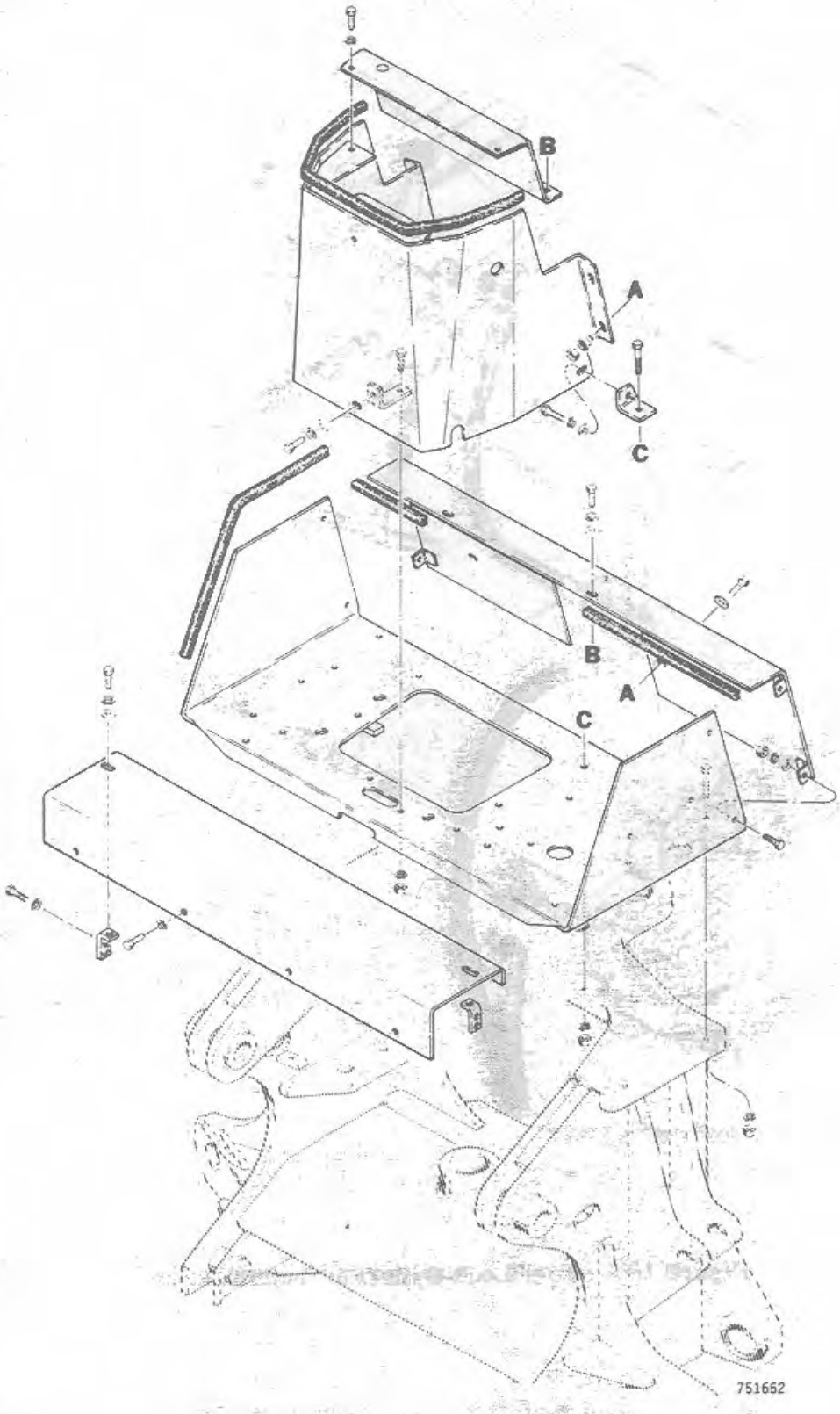
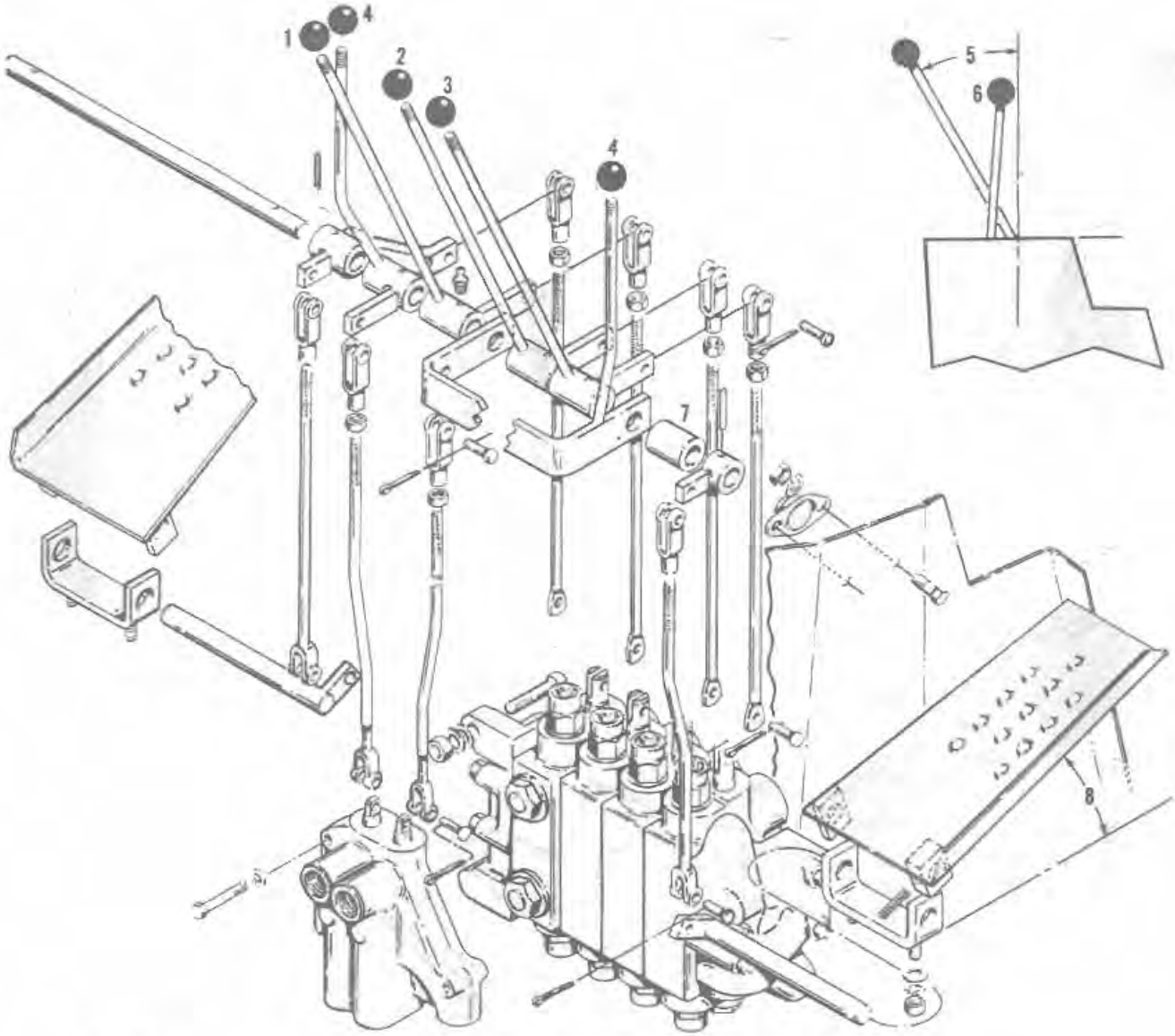


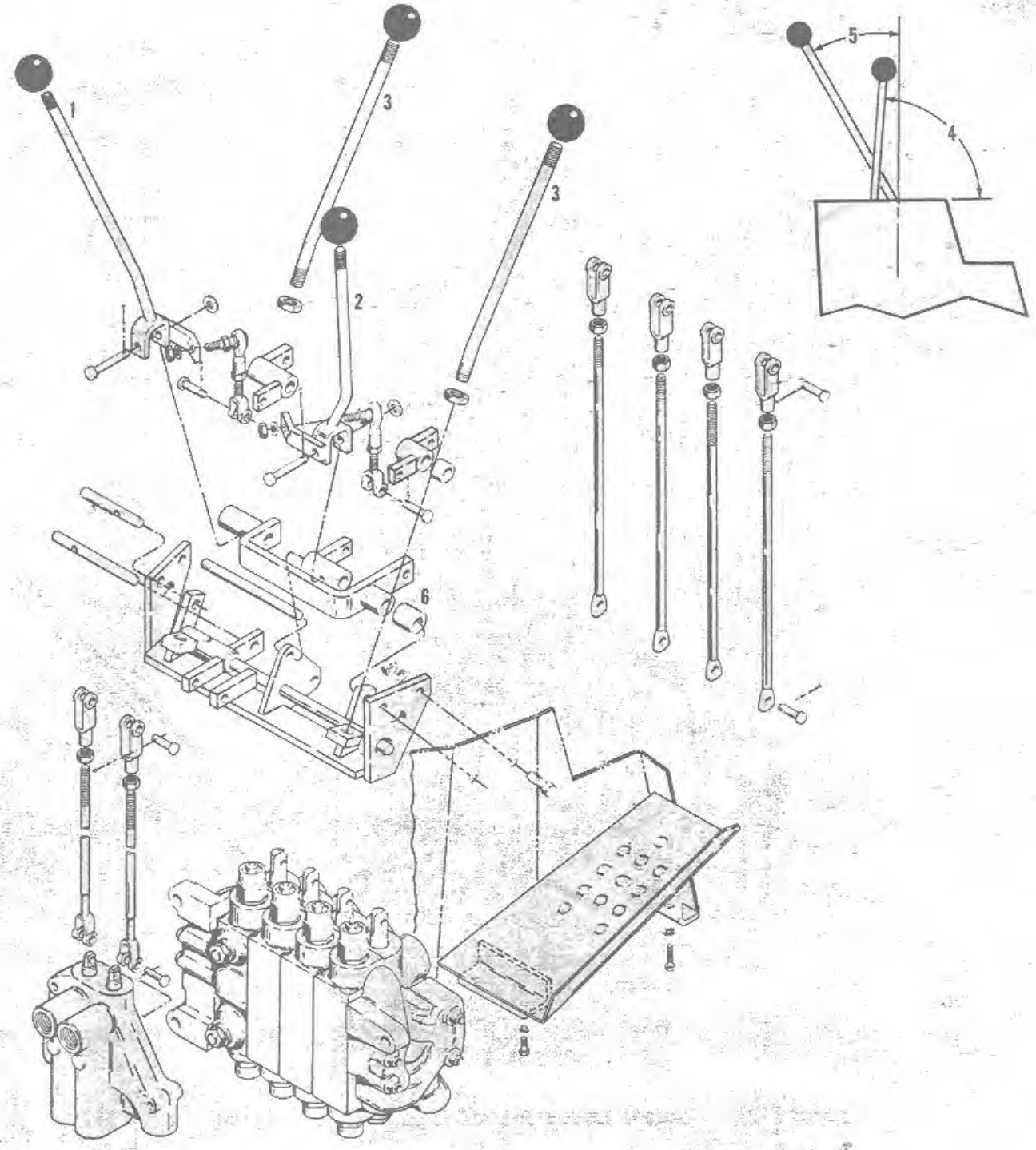
Figure 19 - Control Tower Installation



1. BUCKET
2. DIPPER
3. BOOM
4. STABILIZER
5. 24° - ADJUST BUCKET, DIPPER AND BOOM CLEVIS RODS TO OBTAIN PROPER POSITION
6. ADJUST LENGTH OF STABILIZER CLEVIS ROD TO POSITION LEVER STRAIGHT UP AND DOWN
7. IF EQUIPPED WITH EXTENDAHOE, CONTROL LEVER IS INSTALLED IN PLACE OF SPACER
8. 15° - ADJUST LENGTH OF SWING PEDAL CLEVIS ROD TO OBTAIN PROPER POSITION

751683

Figure 20 - Control Lever Installation with Foot Swing



1. BOOM AND SWING
2. BUCKET AND DIPPER
3. STABILIZER
4. 86° - ADJUST LENGTH OF STABILIZER CLEVIS ROD TO OBTAIN PROPER POSITION
5. 29° - ADJUST LENGTH OF CLEVIS ASSEMBLY ATTACHED TO CONTROL LEVERS 1 AND 2 TO OBTAIN PROPER POSITION
6. IF EQUIPPED WITH EXTENDAHOE, CONTROL LEVER IS INSTALLED IN PLACE OF SPACER

751654

Figure 21 - Control Lever Installation with Hand Swing