TECHNICAL MANUAL

ORGANIZATIONAL, DIRECT SUPPORT, AND
GENERAL SUPPORT MAINTENANCE MANUAL
(INCLUDING REPAIR PARTS AND
SPECIAL TOOLS LIST)

FOR

85' AERIAL LADDER
FIRE FIGHTING TRUCK
NSN 4210-00-965-1254

HEADQUARTERS, DEPARTMENT OF THE ARMY

5 NOVEMBER 1986

COMPLETE MANUAL TABLE OF CONTENTS

COMPLETE MANUAL TABLE OF CONTENTS (Continued)

FOREWORD

Descriptions, instructions and parts listing pertaining to the Model QWT 85 are discussed throughout this manual under the general headings Chassis, Pump and Ladder. Foldout illustrations and schematics are located at the rear of this volume. The foldout format is provided in order that illustrations and schematics may be referred to while the supporting text is being examined and studied.

A detailed description is given in the Introduction of each volume to assist the user in finding the information required to maintain the equipment.

- Operator's Manual (TM 5-4210-227-10)

  This manual is designed to provide the information necessary for a fire fighter or mechanic to properly operate the truck, the pump and the ladder.

- Maintenance Manual (TM 5-4210-227-24&P)

  This manual is divided into 8 volumes and contains the information necessary for an experienced mechanic to maintain and repair all facets of the apparatus. Each volume is individually indexed for ease of reference. This manual contains all the information necessary to obtain assemblies and subassemblies or individual parts, required to repair and maintain the fire truck.

TABULATED DATA

a) Fire Truck

Federal Stock Number:	4210-00-965-1254
Manufacturer's Serial No.:	
Registration Nos.:	CM3653 through CM3664
Manufacturer:	Pierre Thibault Inc.
Model:	QWT 85
Contract Number:	DAAJ10-84-A218
Truck Length:	459”
Truck Width:	108"
Truck Height:	138"
Capacity or Payload:	51,000 GVWR
Shipping Weight:	43,880
Ground Clearance:	10.25"
Weight Loaded:	45,940
Front Axle	19,740
Rear Axle	26,200

b) Chassis

Manufacturer:	Duplex
I.D. Number:	I.C. 1D91 D31
	D6F 1008468
Model:	D350
Wheel Base	230"

c) Engine

Manufacturer:	Detroit Diesel
Model:	8V-71 Turbo
Serial Number:	8VA437868
Fuel:	Diesel

d) <u>Transmission</u>

Manufacturer:	Allison
Model:	HT-740
Serial No.:	2510087501
Capacity:	7 1/2 Gals

e) <u>Firefighting Water Pump</u>

Manufacturer:	Hale
Model:	QSM FHD100
Capacity:	1000 GPM @ 150 psi

f) <u>Front Axle</u>

Manufacturer:	Rockwell International
Model:	FL 941 QX-70
Capacity:	20,000 lbs.
Serial No.:	N766718

f) 1. <u>Front Shock Absorbers</u>

Manufacturer:	Duplex
Model:	7605-1258

f) 2. <u>Front Springs</u>

Manufacturer	Duplex
Model:	7804-6731

g) <u>Rear Axle</u>

Manufacturer:	Rockwell International
Model:	U-170 PX-99
Capacity:	31,000 lbs.
Serial No.:	NW8454892

g) 1. <u>Rear Suspension</u>

Manufacturer:	Hendrickson
Model:	Single Axle RS-SA-340

h) <u>Alternator</u>

Manufacturer:	Delco Remy
Model:	
Amp.:	145

i) <u>Batteries</u>

Manufacturer:	Harris
Model:	7605-0670
Voltage:	12

j) <u>Battery Isolator</u>

Manufacturer:	Sure Power
Model:	1602
Rated Power:	3709 BHP @ 2,100 rpm

k) <u>Steering Gear</u>

Manufacturer:	Sheppard
Model:	7605-5478

l) <u>Power Steering Pump</u>

Manufacturer:	Vickers
Model:	7605-5256

m) <u>Windshield Wipers</u>

Manufacturer:	American Bosch
Model:	WWC-12L
Type:	Electric

n) <u>Radiator</u>

Manufacturer:	Blackstone
Model:	7605-3750

o) <u>Air Cleaner</u>

Manufacturer:	FAAR
Model:	62891-3

p) <u>Driver's Seat</u>

Manufacturer:	Bostrom
Model:	Four-way Adjustable
Type:	Standard

q) <u>Wheels</u>

Front:	
Manufacturer:	Firestone
Size:	22.5 x 16.5
Rear:	
Manufacturer:	Firestone
Size:	20 x 8.5

r) <u>Tires</u>

Front:	
Manufacturer:	Goodyear
Size:	16.5 R 22-5 - 18 P.R.
Capacity:	20,000 lbs.
Rear:	
Manufacturer:	Michelin
Size:	12:00 R 20X - 18 P.R.
Capacity	31,000 lbs.

s) <u>Muffler</u>

Manufacturer:	Nelson
Model:	86130-21

t) <u>AC Inverter</u>

Manufacturer:	Dynamote
Model:	A40-120

u) <u>Siren/PA</u>

Manufacturer:	Code 3
Model:	3100

CAPABILITIES

Fire Truck

Turning Radius - Inside 31.5' - Outside 42.25'

Rated Power: 370 BHP @ 2,100 rpm

Engine Governor Setting: No Load - 2,100; Top Speed 58 mph

Acceleration: 0 - 35 mph - 14 Seconds

Braking: 20 to 0 mph - 15 feet

Angle of Departure: Front - 15 degrees;
Rear - 15 degrees

Pump

Single Stage Centrifugal

Midship Mounted

Driven by the truck engine from the output shaft of transmission

Min discharge - 1000 gpm @ 150 psi

Min discharge - 100 gpm @ 200 psi

Min discharge - 500 gpm @ 250 psi

From dry condition- - take suction and discharge water in 30 sec. with a lift of 10 deg. through 20' of 6” suction hose

12 VDC Priming Pump

Water Tank - 2b0 gals.

Ladder

Basic Weight - 11,560 lbs.

Outrigger Operation Speed

Lower: Front - 9 sec. Rear - 18 sec.

Raise: Front - 9 sec. Rear - 18 sec.

Complete extension, elevation and 90 degrees rotation in 60 sec.

Hydraulic Tank: 45 gals. (Imp.)

TRUCK FIRE FIGHTING LADDER 85'
INDEX TO COMMERCIAL
PUBLICATIONS

TAB INDEX VOLUME 3

MAINTENANCE MANUAL

SECTION I

1. INTRODUCTION/TABULATED DATA

1.1 INTRODUCTION

1.1.1. TM 5-4210-227-24&P, Organizational, Direct Support, and General Support Maintenance Manual for the 85' Aerial Ladder Fire Fighting Truck is divided into eight volumes. These eight volumes are further subdivided into specific sections consisting of both Government and commercial literature. TM 5-4210-227-10, Operator's Manual for the 85' Aerial Ladder Fire Fighting Truck is one separate manual consisting of four separate sections.

1.1.2. This volume consists of 11 sections and is arranged as follows:

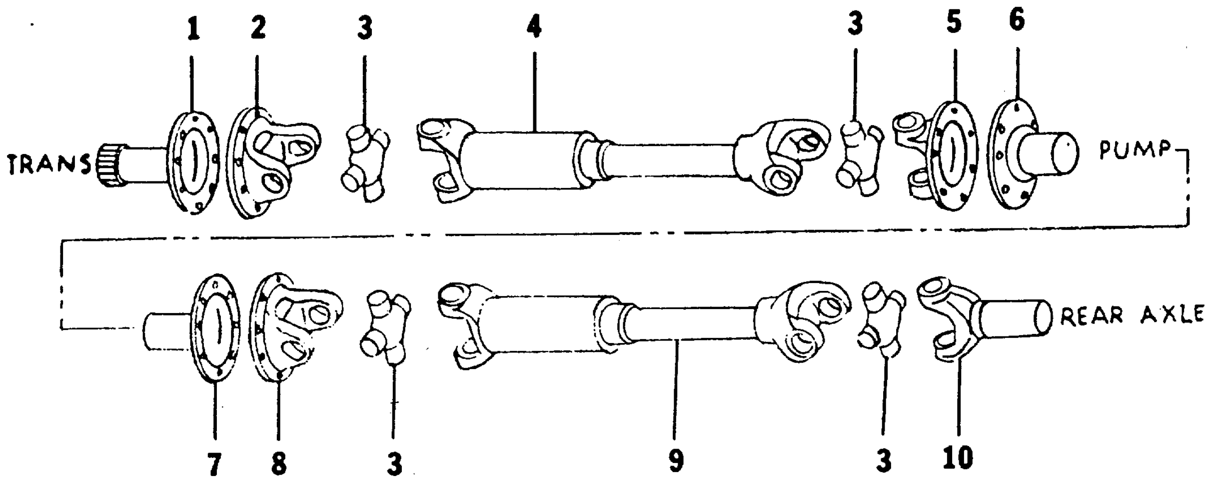
1. Drive Line
2. Front Axle
3. Rear Axle
4. Steering System
5. Fuel System
6. Brake System
7. Electrical System
8. Miscellaneous
9. General Information
10. Installation Instructions
11. Troubleshooting and Service

DUPLEX

Drive Lines

All Models

Section I



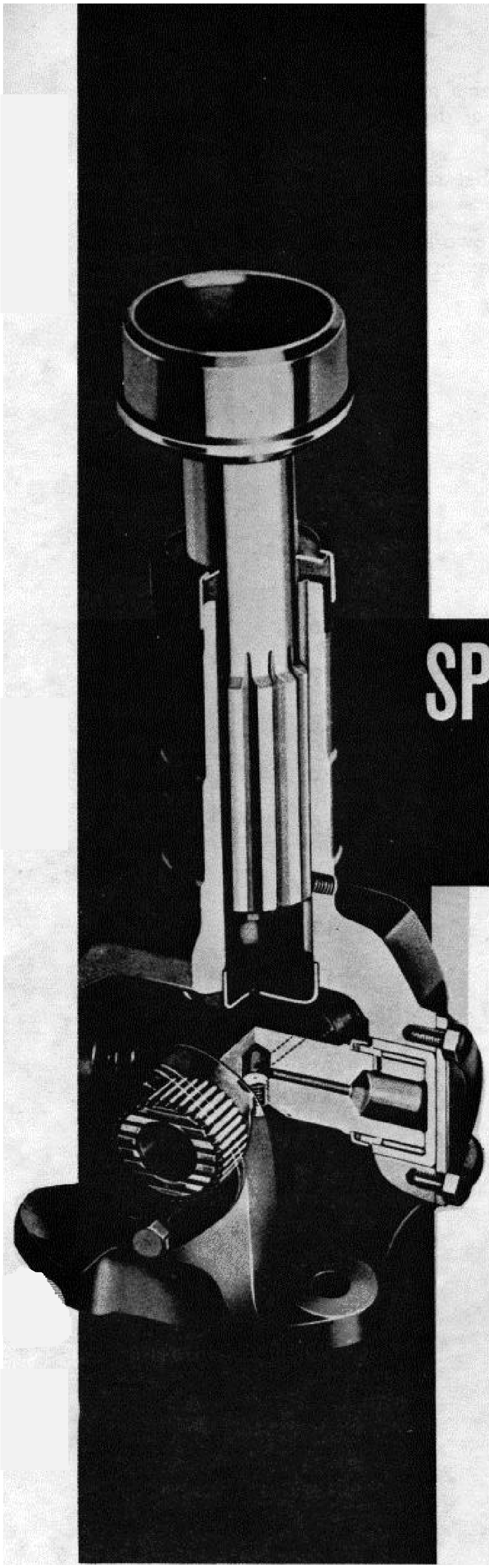
Item	Description
1	Flange — Transmission
2	Flange Yoke
3	Journal & Bearing Kit
4	Front Propeller Shaft without Pump (Center Bearing)
4A	Front Propeller Shaft with Pump
5	Flange Yoke
6	Companion Flange (Pump Input)
7	Companion Flange (Pump Output)
8	Flange Yoke
9	Rear Propeller Shaft with or without Pump
10	End Yoke (Input)
10A	Inter-Axle End Yokes (Tandem Axle Only)
	Inter-Axle Propeller Shaft (Tandem Axle Only)

NOTE: Due to the various propeller shaft combinations, contact Duplex Truck Division for correct replacement parts.

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis, must be supplied when ordering replacement parts.

Section I
DRIVE LINES

SERVICE MANUAL



SPICER UNIVERSAL JOINTS
AND
DRIVESHAFTS

1330 THROUGH 1850 SERIES
MEDIUM AND HEAVY DUTY VEHICLES

DANA CORPORATION
UNIVERSAL JOINT DIVISION

FOREWORD

This manual is presented as a guide in solving problems associated with drive shafts. No attempt has been made to discuss technical consideration of design or theory of vibrating systems.

In discussing installation of drive shafts, no hard and fast rule or fine dividing line has been drawn between satisfactory and unsatisfactory operation.

The limits set forth in this manual correspond with our own standards. Our long experience in the manufacture and installation of drive shafts has proven these standards to be accurate.

INDEX

FUNCTION

In examining the automotive drive line, it would be well to start with a review of drive shaft operation. A critical examination of why it is there and what it must do may be helpful in analyzing its effect on the entire drive line system. A drive shaft's functions can be briefly described as follows:

1. It must transmit torque from the transmission to the axle. This requirement makes it necessary that the drive shaft be capable of transmitting the maximum low gear torque developed by the engine and transmission ratio and any shock loads which may develop. It must also be capable of rotating at the maximum speed required for vehicle operation. This speed is often engine speed increased by an overdrive ratio in the transmission.

2. The drive shaft must operate through constantly changing relative angles between transmission drive shaft and axle.

3. The length of the drive shaft must be capable of changing while transmitting torque. Length changes are caused by necessary axle movement Sue +o torque reaction, road deflections, braking loads, etc.

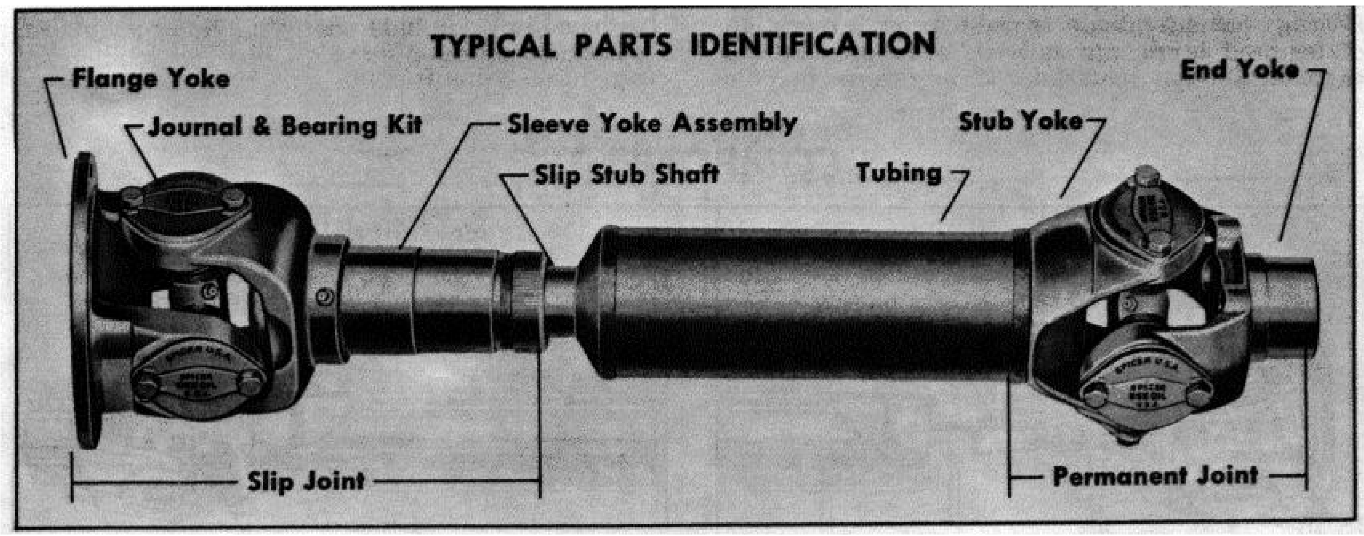


FIGURE 1

CONSTRUCTION

The basic functions having been designated, let's look at conventional universal joint and drive shaft construction.

To transmit required loads, the drive shaft must possess high strength. Forged steel, or high strength cast yokes are generally used to provide necessary strength and the rigidity required to maintain bearing alignment under torque loads and during high speed operation. Special high strength tubing is used to provide maximum torque carrying capacity at minimum practical weight. This tubing must be securely welded to its end members, to provide the necessary torque capacity.

High quality anti-friction bearings are used to withstand required loads while oscillating at high speeds. These bearings on the journal cross carry very high loads for their size. The full complement, roller-type (needle) bearings are generally used because of their high capacity in a limited space. Bearings are individually sealed to provide retention of required lubricants as well as to prevent the entry of foreign material. If lubricants become contaminated with water or abrasive material, needle bearing life is seriously affected.

Abrasive material is a major problem where a vehicle operates under conditions of extreme moisture and dirt. Off-highway installations are especially critical in this respect. Military trucks represent the extreme in this direction and were the first to show the shortcomings in the conventional cork seals used in universal joint bearings. It was found that an improved seal was required for this type of operation. Synthetic rubber-type seals were developed for these installations. These seals have been in use for many years on military vehicles and are now used in most commercial installations. The improved sealing shows increased life and a less critical re-lubrication cycle.

The sliding splines between slip joint and permanent joint must support the drive shaft and be capable of sliding under full torque loads. To provide adequate strength and wear resistance, hardened and ground splines are used. These splines are phosphate coated to resist galling and to reduce sliding friction.

COMPONENTS

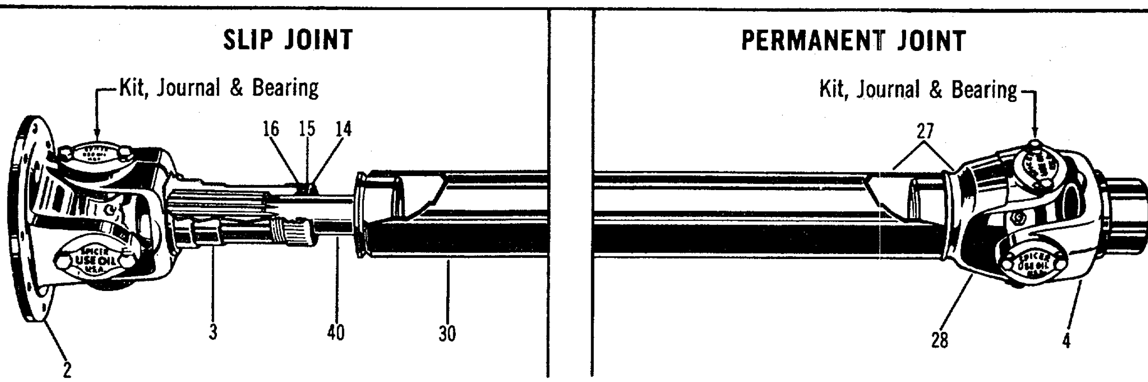


FIGURE 2

TABLE OF NOMENCLATURE

Symbol	Part Name	Symbol	Part Name
2	FLANGE YOKE	27	STUB YOKE & TUBE ASSEMBLY
3	SLEEVE YOKE ASSEMBLY	28	STUB YOKE
4	END YOKE	30	TUBING
5	JOURNAL ASSEMBLY	40	SLIP STUB SHAFT, Welded Tube
6	BEARING ASSEMBLY	53	MIDSHIP STUB SHAFT, Center Bearing
7	SNAP RING	70	CAP & BOLT ASSEMBLY
14	DUST CAP	82	YOKE SHAFT
15	STEEL WASHER	94	U-BOLT ASSEMBLY
16	CORK WASHER		

COMPONENTS

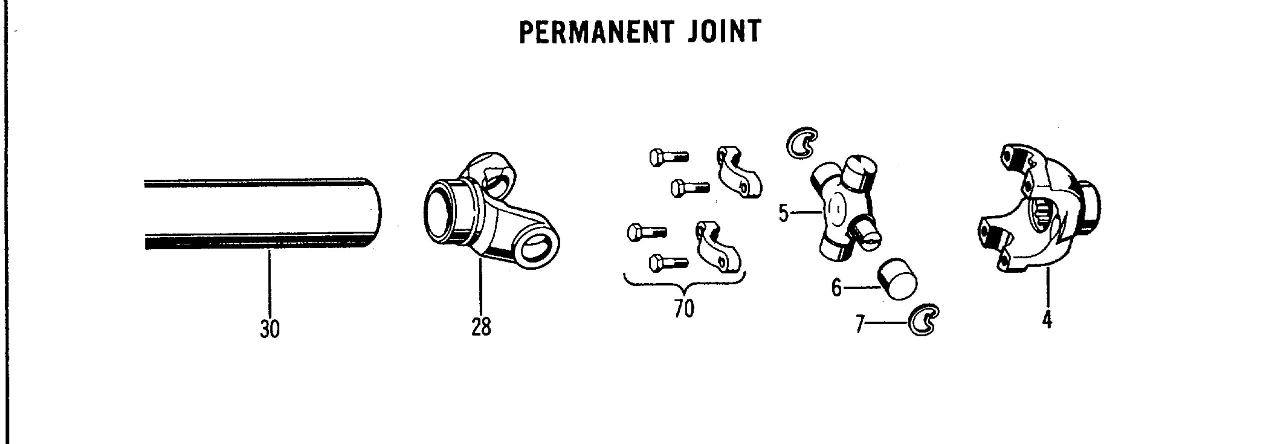


FIGURE 3

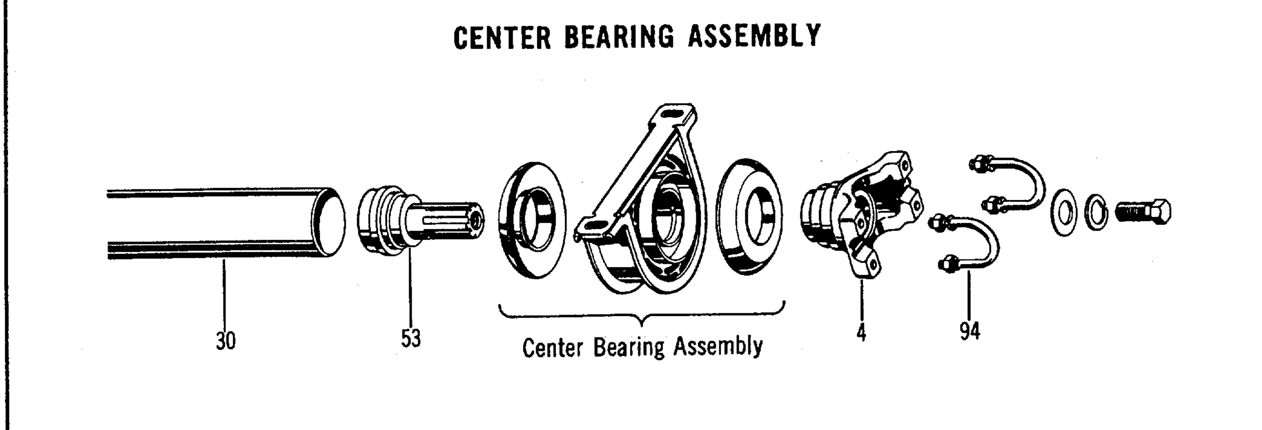


FIGURE 4

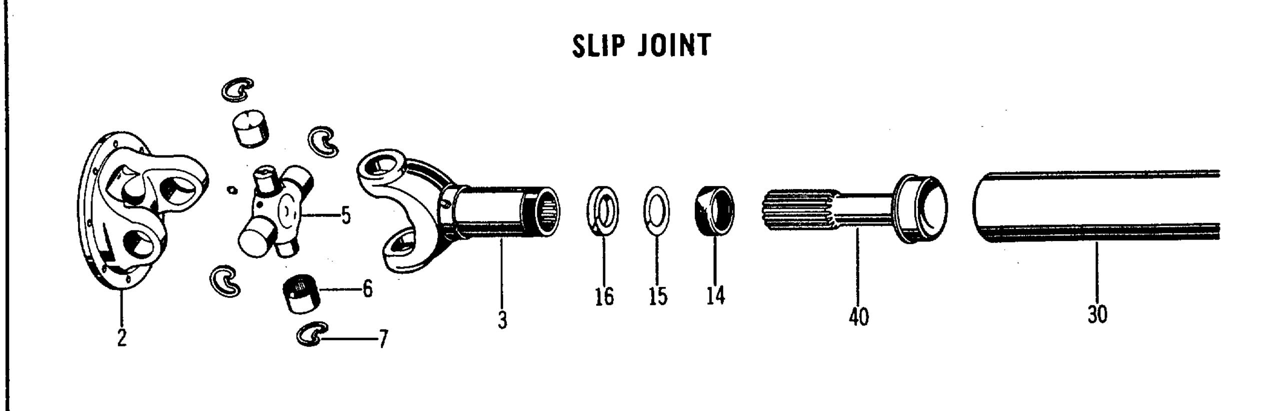


FIGURE 5

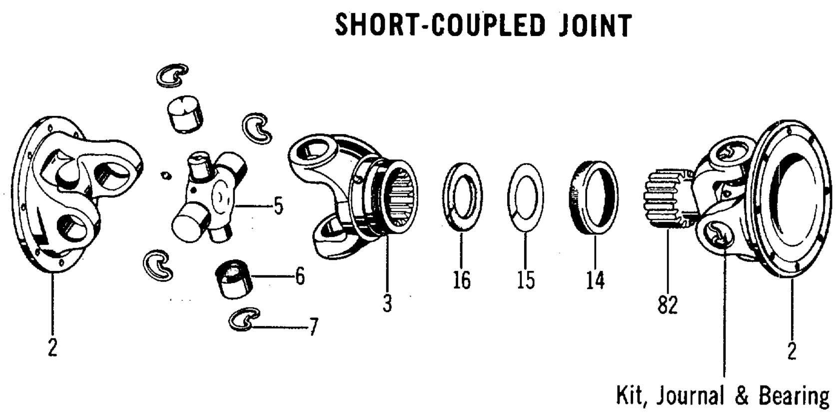


FIGURE 6

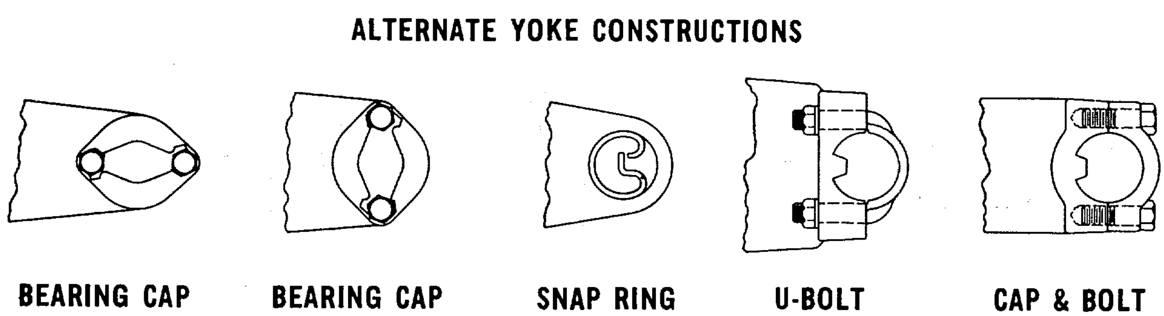


FIGURE 7

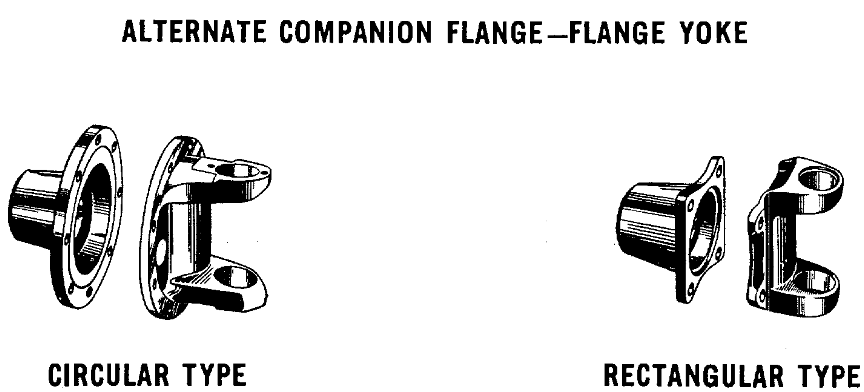


FIGURE 8

UNIVERSAL JOINT SEALS

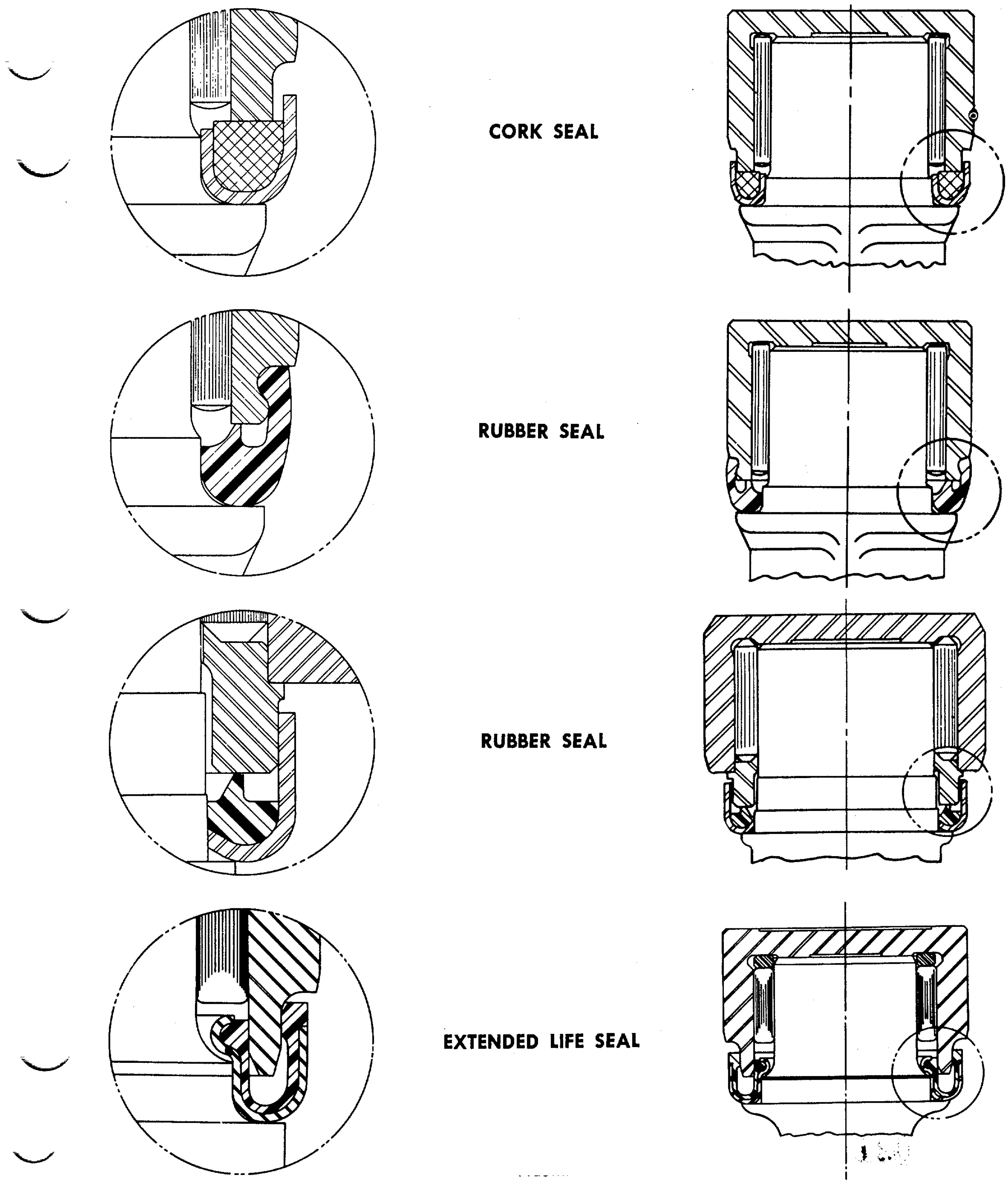
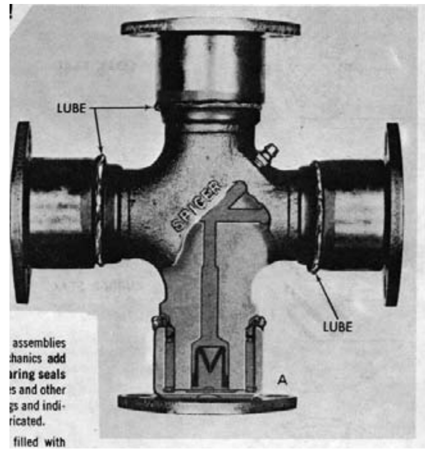


Figure 9

Don't Neglect Spicer
Drive Shaft Lubrication!

Lack of adequate or proper lubrication is among the most common causes of U-Joint and drive shaft failure

Proper servicing of the drive shaft is an essential part of vehicle maintenance and should not be overlooked in routine shop procedure.



Universal Joints

In the Vehicle or Application

To insure proper lubrication of all four bearing assemblies on Spicer universal joints, it is essential that mechanics **add lubricant until it appears at all journal cross bearing seals** (Illustration A). This assures removal of dirt particles and other contaminants that may find their way into the bearings and indicates to the mechanic that the bearings are fully lubricated.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals!

Spicer journal cross seals are designed to relieve. However, if all the seals do not "pop" when being lubed, move the driveshaft laterally in all four directions and pull or push on the drive shaft in the direction opposite to the journal cross seal not relieving while lube gun pressure is being applied to the alemite fitting. An increase in line pressure may also be necessary.

Drive Shaft Assembly

Spicer factory assembled drive shafts are lubricated at the plant prior to shipment. However, shipping, handling and installation of the drive shaft assembly into the vehicle usually results in some loss of lube. Therefore, it is recommended that all universal joints be relubricated after installation of the drive shaft prior to putting vehicle in service

Journal and Bearing Kits

Spicer replacement universal joint kits contain only enough grease to provide needle bearing protection during storage.

It is therefore necessary to completely lubricate each replacement kit prior to assembly into the drive shaft yokes. Each journal cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease; filling all the cavities between the rollers and applying a liberal grease coating on the bottom of each race. After the kits are installed into the driveshaft yokes and prior to placing into service, they should be relubed, through the zerks, using the same grease.

Lubricants

For driveshaft applications involving shaft speeds over 500 RPM, a high quality extreme pressure (EP) grease recommended by lubricant manufacturers for universal joints should be used. Lithium soap base greases meeting *NLGI Grade 1 and Grade 2 specifications are preferred. The use of greases that tend to separate and cake should be avoided.

For driveshaft applications involving shaft speeds below 500 RPM, a mineral oil in the SAE 140 to SAE 250 viscosity range should be used.

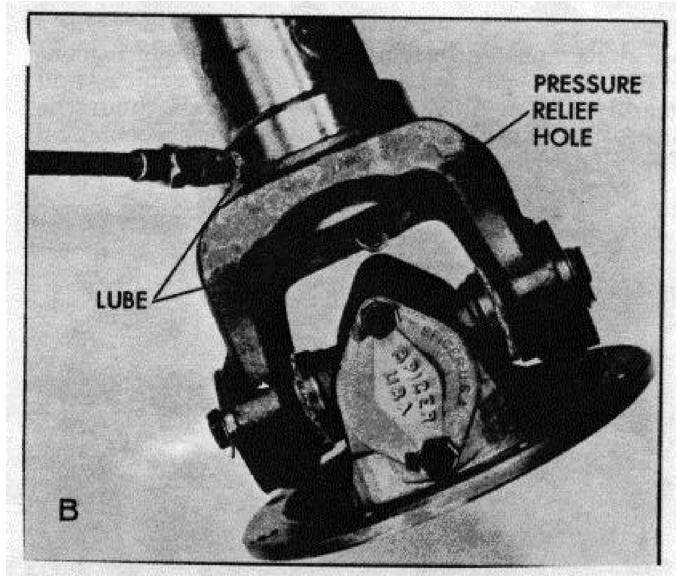
*National Lubricating Grease Institute

Relube Cycles

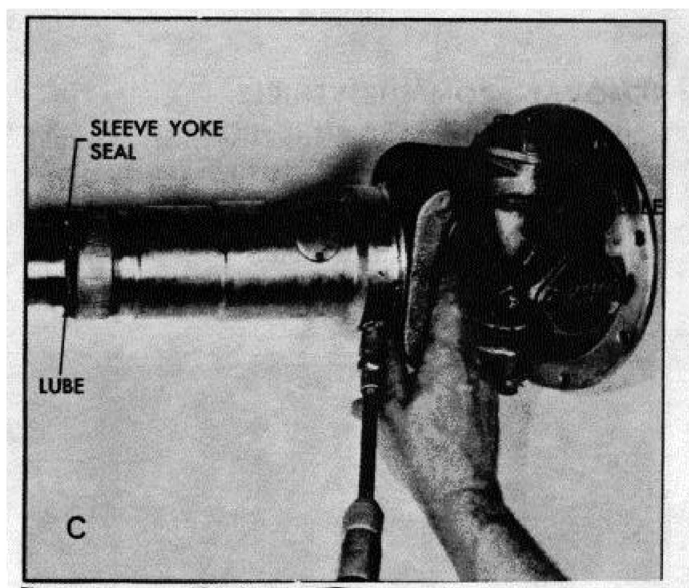
Relubrication cycles for drive shaft universal joints and slip splines will vary with service requirements and operating conditions. The following re-lubrication schedule has been used successfully.

OPERATING CONDITION	RE-LUBE CYCLE	
	Miles	Hours
Normal	6000-8000	150-200
*Severe	2000-3000	50-75

* For applications where conditions such as high speeds, high ambient temperatures or high angles are present.



Relube spline at the intervals prescribed above. Apply grease gun pressure to lubrication zerk **until lubricant appears at pressure relief hole in welch plug** at sleeve yoke end of spline. (Illustration B). At this point, cover pressure relief hole with finger and continue to apply pressure **until grease appears at sleeve yoke seal**. (Illustration C). This will insure complete lubrication of spline.



Sliding Spline Sections

Lubricants

Steel Splines: Driveshaft steel splines should be lubricated with a good extreme pressure grease as recommended by lubricant manufacturers. Extreme pressure grease satisfying NLGI Grade 1 has been adopted as the standard by our factories.

Glidecote TM Splines: Any high grade multi-purpose grease can be used. Greases-recommended by lubricant manufacturers for universal joints have been found satisfactory for Glidecote splines.

Center Bearings

Initial lubrication is done by the bearing manufacturers. **No attempt is made to add or change grease within the commercial bearing itself**. However, when servicing a driveshaft in the field with a new center bearing, it is necessary to fill the entire cavity around the bearing with waterproof grease to shield the bearing from water and contaminants. The quantity should be sufficient to fill the cavity to the extreme edge of the slinger surrounding the bearing.

Lubricants used must be <u>waterproof.</u> Consult your grease supplier for recommendation.

Spicer needle bearing joints are simple in construction, easily removed from the vehicle and readily disassembled and reassembled without the use of any special tools or any special mechanical knowledge.

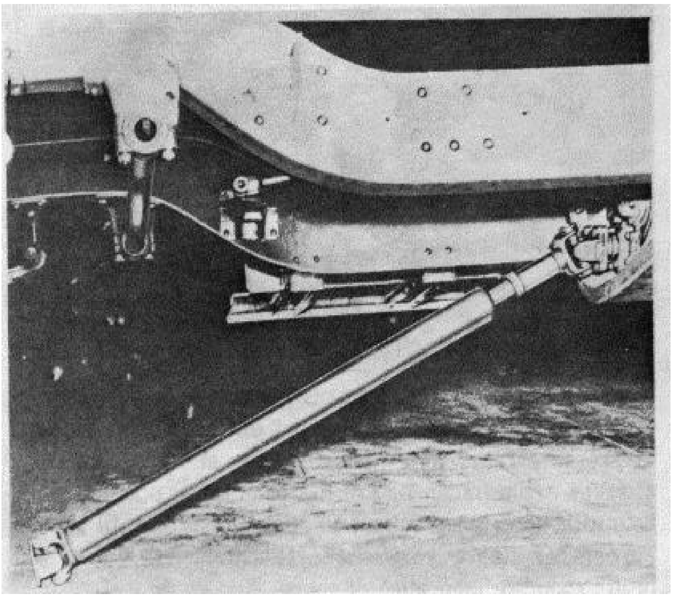


FIGURE 11

REMOVAL FROM THE VEHICLE

1. Double Flange, Yoke Types (Bearing Cap and Snap Ring Construction)

   All Double Flange Yoke Type Joints are removed as a complete assembly by removal of the Companion Flange Bolts, Nuts, and Lock Washers, which allows the assembly to slip out from between the Companion Flanges.

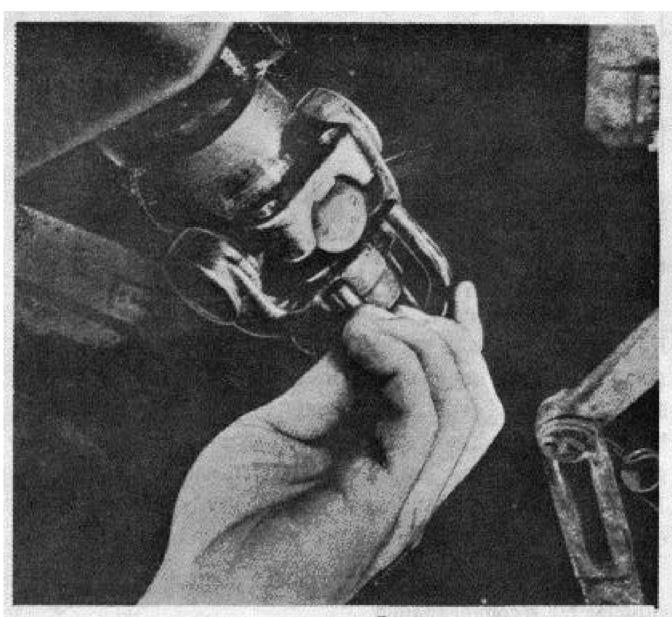


FIGURE 12

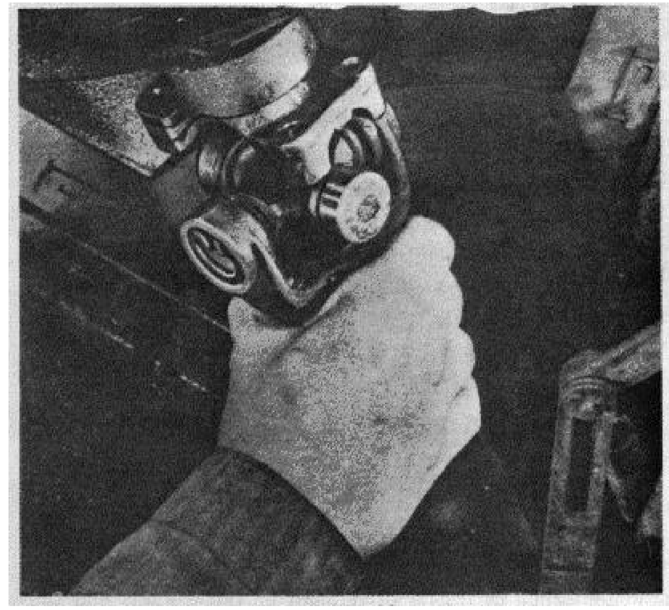


FIGURE 13

2. Double End, Yoke Type (U-Bolt Construction)

   Remove the U-Bolts, Nuts, and Lock Washers from the End Yokes. Slide the Sleeve Yoke toward the shaft to free the Bearings from their seats between the shoulders in the End Yokes. Care should be taken not to drop the two Bearings from the trunnion ends of the Journal Cross at both ends of the drive shaft. The End Yokes remain on the vehicle.

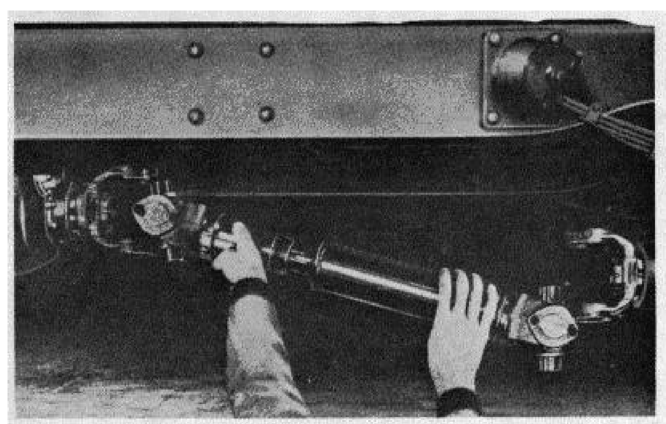


FIGURE 14

3. Double End Yoke Type (Bearing Cap Construction)

   Remove the cap screws, lock plates and bearing and retaining cap sub-assemblies, from the transmission and axle end yokes. Remove the drive shaft with the remaining journal crosses and bearings as a unit. The end yokes remain on the vehicle.

FIGURE 15

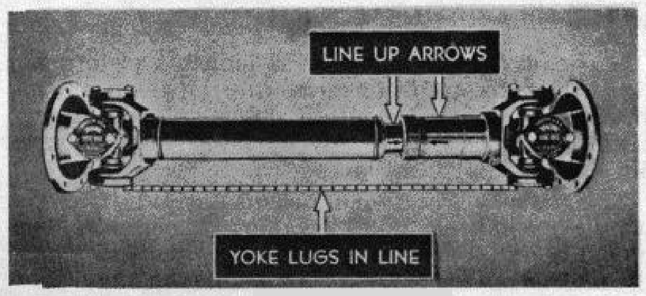


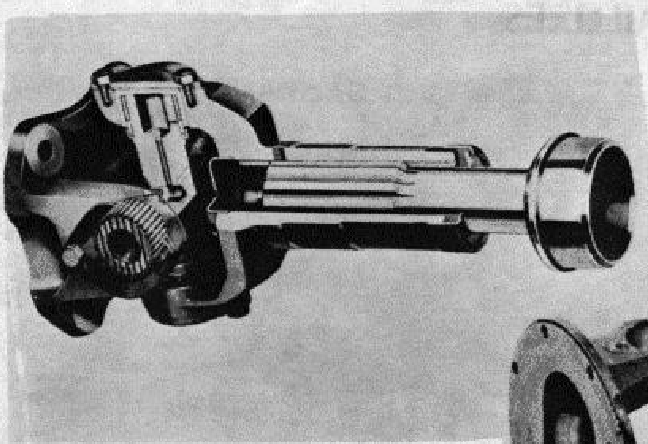
FIGURE 16

REMOVAL OF THE SLIP JOINT

1. Slip Joint (All Types). Unscrew the dust cap from the sleeve yoke and slide the joint off the drive shaft.

2. ARROW MARKS-Make sure arrow marks are stamped on the shaft and sleeve yoke before removing the slip joint. If arrow marks are not readily seen, mark both members so that when reassembled they will be in exactly the same relative position, since the sleeve yoke lugs must be in the same plane as the stub ball yokes to prevent excessive vibration in operation.

BEARING CAP CONSTRUCTION



DISASSEMBLING UNIVERSAL JOINT

1. LOCK STRAP (98) - Bend down the locking lugs with a screwdriver and remove the cap screws (73).

FIGURE 17

2. NEEDLE BEARINGS & RETAINING CAP SUBASSEMBLY (6) Remove by using a large pair of channel lock pliers on retaining cap edges, turn retaining cap and bearing sub-assembly at the same time lifting upward to remove the sub-assembly from the journal trunnion diameter and out of the yoke hole. Turn the joint over and tap the exposed end of the journal cross (5) until the opposite needle bearing is free. Use a soft round drift with flat face about 1/32" smaller in diameter than the hole in the yoke, otherwise there is danger of damaging the bearing.

3. JOURNAL CROSS (5) - Remove by sliding it to one side of the yoke and tilting it over the top of the yoke lug.

FIGURE 18

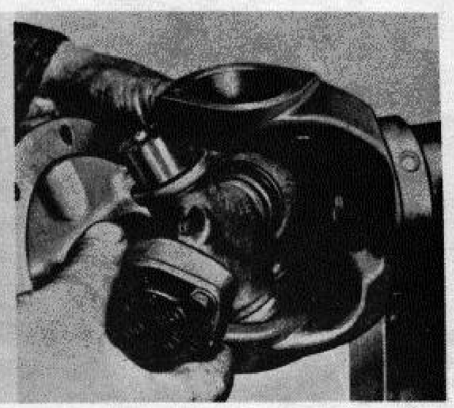


FIGURE 19

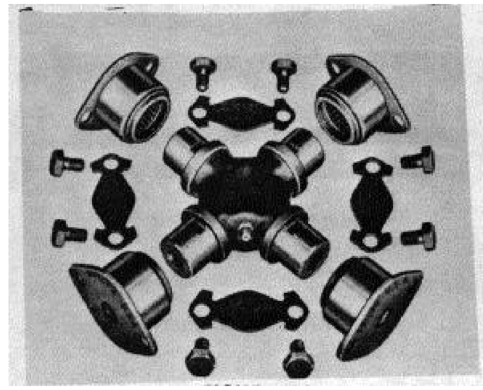
SERVICE INSTRUCTIONS

CLEANING AND INSPECTION

1. Clean All Parts Use a suitable cleaning fluid. Allow the parts to remain in the cleaner for some time to loosen up any particles of grease or foreign matter. Remove any burrs or rough spots from any machined surfaces.

2. Needle Bearings - Do not disassemble. Clean with short stiff brush and blow out with compressed air. Work a small quantity of lubricant (140 S.A.E. Oil) into each bearing cap and turn the needle bearing on the trunnion to check wear. Replace if worn.

3. Journal Cross - Because *worn needle bearings* used with a *new* journal cross or *new needle bearings* used with a worn journal cross will *wear more rapidly* making another replacement necessary in a short time, always replace the journal cross and four needle bearings caps as a unit,



Journal and Bearing Kit -To facilitate the replacement of journals and bearings, a Journal and Bearing Kit is available. The use of the Kit insures having the correct individual parts when required and saves valuable time.

TYPICAL FAILURES

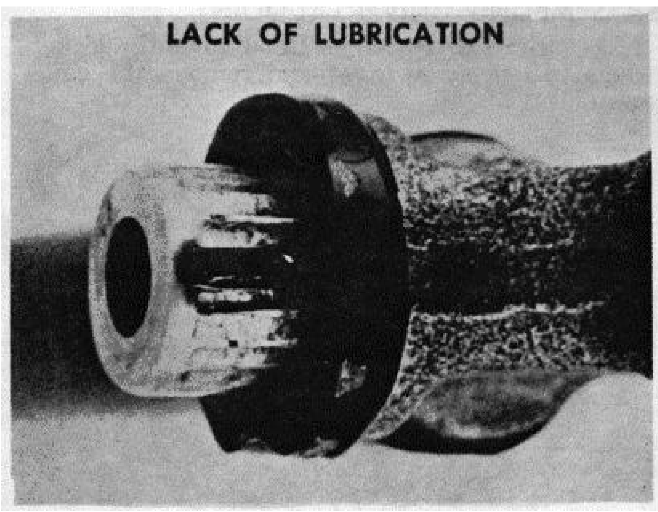


FIGURE 21

FIGURE 22

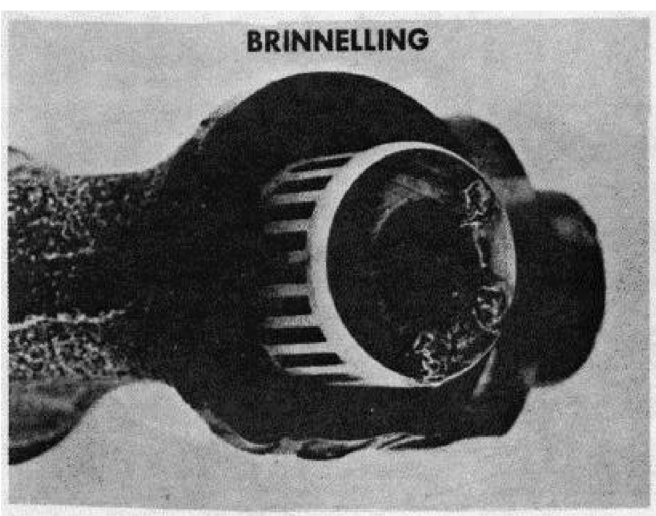


FIGURE 23

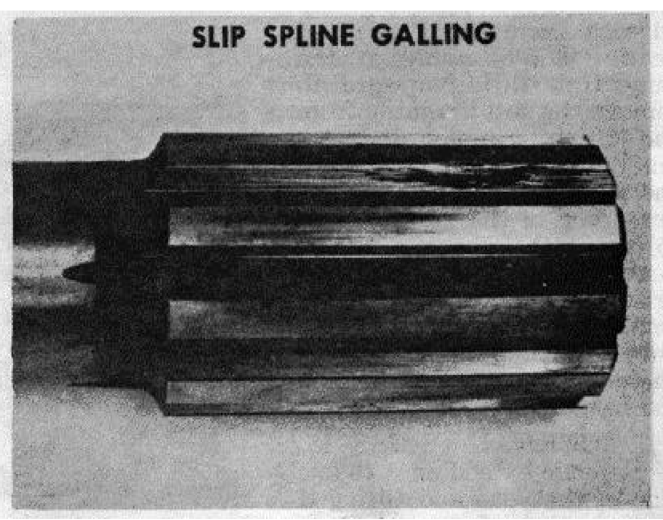


FIGURE 24

BALANCING

The rebuilding of a drive shaft assembly usually consists of replacing worn journal cross and bearings with a new kit. These kits replace the part of a drive shaft most subject to wear in operation. The slight off-center condition present in the journal cross assemblies makes it desirable to balance the assembly after installing new journal and bearing kits.

Generally, unbalance resulting after installation of a journal and bearing kit is equivalent to the unbalance existing after straightening the shaft. If balancing cannot be done, it is advisable to check assembly for smooth operation in vehicle before it is put into operation.

It is sometimes necessary to revise drive shaft lengths when rebuilding a vehicle. This job requires proper facilities to produce a quality assembly. It is necessary to properly assemble fittings into the tube and straighten, before welding, to be sure parts are centralized. This can be done by mounting shaft assembly on center and straightening at fittings until ends of tube run concentric within about .005 TIR. The welding of the tube in the fittings must provide for adequate strength and prevent distortion which could cause excessive runout. It is often desirable to tack weld and recheck for runout before proceeding with final weld. After welding, the entire drive shaft should be straightened to the following limits: (See Fig. 25)

.005 TIR	On shaft neck
.015 TIR	On ends of tubing 3" from welds
.010 TIR	In center of tube

These runouts should be taken with entire drive shaft assembly mounted on master attaching flanges or yokes, selected for dynamic balance to eliminate as much unbalance as possible. During balancing, the drive shaft again should be mounted on these selected flanges or yokes.

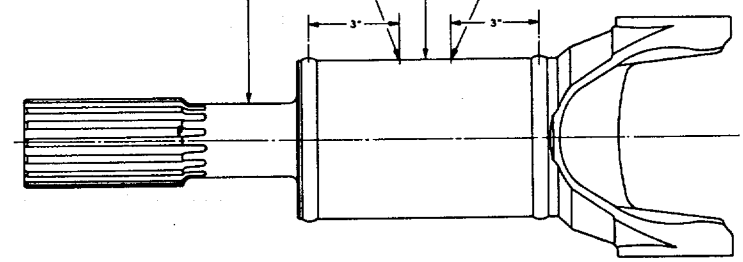


FIGURE 25

ASSEMBLING UNIVERSAL JOINT

1. Seal - If unnecessary to install a new kit make sure that four new seals are installed in the journal retainers.

FIGURE 26

2. JOURNAL CROSS With the relief valve facing the flange yoke, insert one trunnion of the journal cross into the bearing hole in the yoke lug from the inside between the lugs and tilt until the trunnion of the journal cross will clear the hole in the opposite yoke lug.

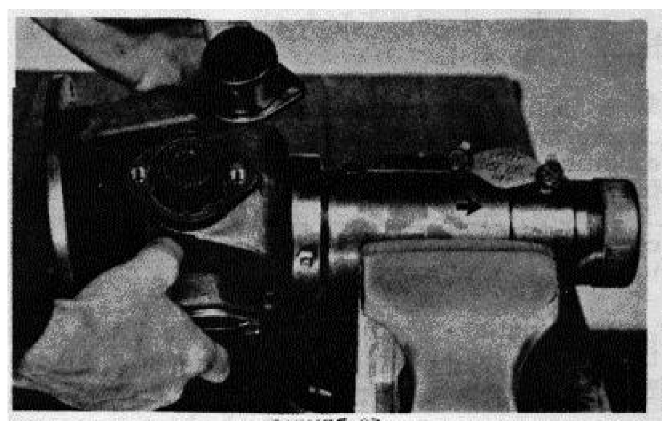


FIGURE 27

3. NEEDLE BEARING AND RETAINING CAP SUB-ASSEMBLY Insert from outside of yoke. Press into place with an arbor press or tap with a soft round drift taking care not to mar any surfaces.

4. LOCK STRAP AND CAP SCREWS Assemble and bend the lugs of the lock strap up against the flat of the cap screw. If the joint appears to bind, tap the lugs lightly to relieve any pressure of the bearing on the end of the journal.

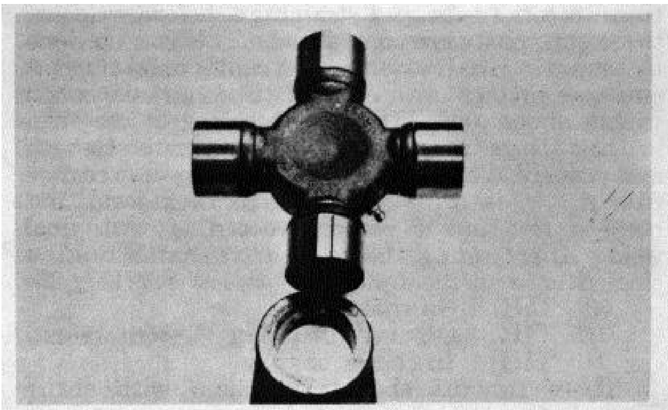


FIGURE 28

1650 SERIES JOURNAL CAPS WITH LOCK FLATS - When installing new journal kit caps into yoke ear holes, the lock flat on two of the journal caps must be kept in alignment with the locking flats near the front of the yoke ears. Proper location of locking flats will assure that the journal cap will not rotate.

The installation of a drive shaft into the vehicle does not present any unusual mechanical difficulties. Before actual installation, the drive shaft should be checked for the following items: 1. No damage or dents on drive shaft tubing which could cause unbalance. If the dents are severe enough they can weaken the tube and a failure might occur under torque load.

2. Splines should slide freely with slight drag from spline seal.

3. Bearings should flex and be free from excessive bind. A slight drag is the most desirable condition on a new universal joint. This drag is from the bearing seals. When rotating, yoke lug deflections cause some additional clearance. Excessive looseness is not desirable due to the resulting unbalance.

4. Mounting flanges and pilots should be free from burrs, paint and foreign substances which would not allow proper seating at assembly.

The drive shaft is mounted using flange bolts, bearing cap screws, or "U" bolts depending upon the size and construction. These bolts must carry high torque loads and should be of quality material and properly torqued. The following reviews requirements on these bolts: 1. Flange Bolts: Flange Bolts should be alloy steel equivalent to SAE Grade 8, high-strength bolts. These bolts used with spring lock washers and nuts provide the capacity required. The nuts should be torqued to the following specifications:

5/16"-24 Thread	22 to 24 lbs. ft.
3/8"-24 Thread	40 to 44 lbs. ft.
7/16"-20 Thread	63 to 70 lbs. ft.
1/2"-20 Thread	98 to 108 lbs. ft.

NOTE

In cap and bolt construction joints (Fig. 7), be sure to torque the cap screws to 100 lbs. ft. These joints are usually the Spicer 1650 Series interaxle assemblies.

2. U-Bolt Style Yokes: On smaller size universal joints, a "U" bolt style end yoke is used. This construction permits easier assembly where the smaller size bearings allow its use. The bearing race is seated in a half round hole and under locating ears. Be sure that mounting faces are cleaned of rust, paint and other foreign material. The "U" bolts are assembled over the bearing races to retain them in the end yokes. Spring lock washers and nuts should be used with these "U" bolts at assembly. The following torque loads are suggested for use with these parts:

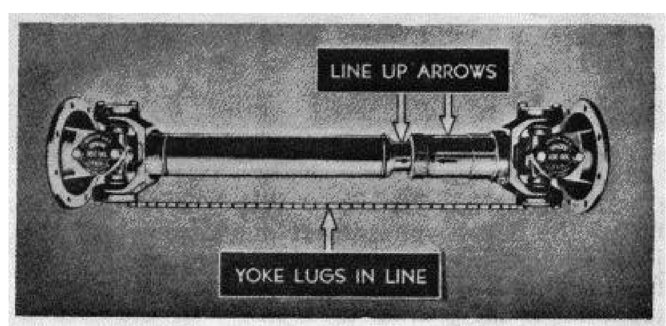
5/16"-24 Thread	14 to 17 lbs. ft.
3/8"-24 Thread	20 to 24 lbs. ft.
7/16"-20 Thread	32 to 37 lbs. ft.

These torque loads are somewhat lighter than normally used with these thread sizes, however, the lower torques are required to prevent bearing race distortion.

ASSEMBLING SLIP JOINT ON SHAFT

Lubricate the splines thoroughly (refer to page 9) and assemble on the Shaft. BE SURE that the arrows or marks on the Shaft and Slip Joint are in line, since the Sleeve Yoke Lugs must be in the same plane as the Stub Ball Yoke lugs to prevent excessive vibration.

The cork washer should be replaced if necessary before assembling with the dust cap and steel washer on the Sleeve Yoke.



UNIVERSAL JOINT PHASING (See Fig. 29)

When U-joints or yokes are assembled to their shafts in the same plane, they are in phase. When they are assembled to the shaft in different planes, they are out of phase. To obtain vibration free operation, check the following.

1. Yokes or flanges between the main and auxiliary transmission must be "In Phase".

2. In the case of a two-piece drive shaft assembly, between the transmission (Main or Auxiliary) and the forward rear axle, the joints on this shaft should be assembled "In Phase", unless otherwise specified by the manufacturer of the vehicle.

3. The inter-axle drive shaft yokes must be "In Phase".

4. If a vehicle has drive shafts that do not have intersecting angles but parallel angles throughout the drive line system, the yokes or flanges must be held parallel to within 1° of each other.

INSTALLING DRIVESHAFT

1. Drive Shaft Assembly Place in a pair of centers and check the Shaft for runout if not previously done during assembly. The runout on the Tube should not be more than .015" indicator reading, and on the neck of the Slip Stub Shaft the runout should not be more than .005" indicator reading. Mark the high and low points on the shaft with chalk and straighten if necessary. Install with the Slip Joint nearest the source of power. Tighten the Flange Bolts evenly after the Nuts and NEW Lock Washers are in place.

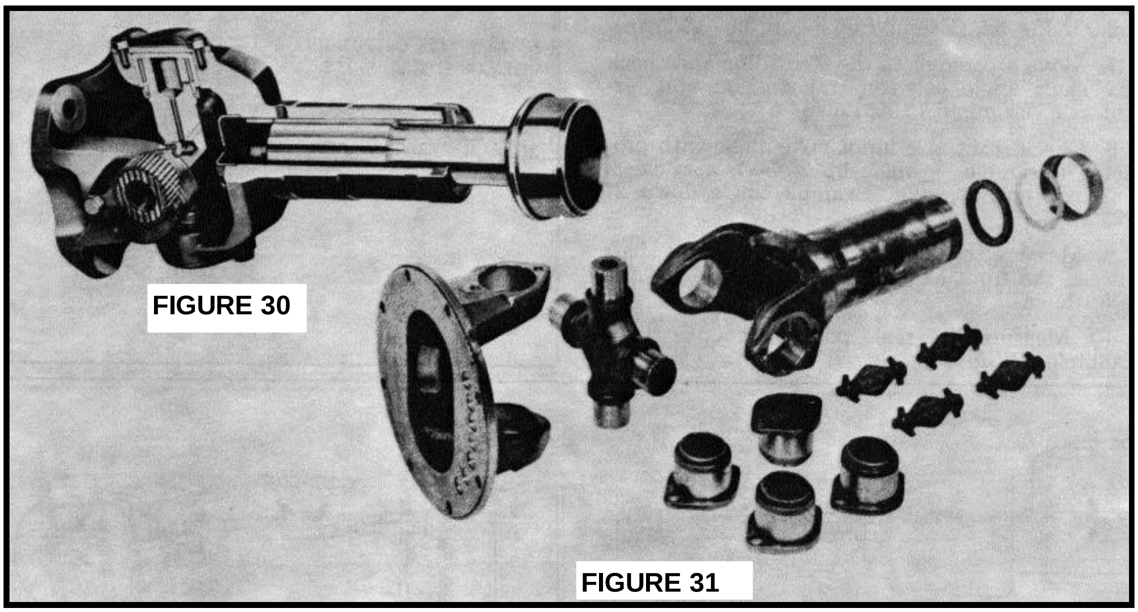


FIGURE 30

FIGURE 31

CHECKING DRIVESHAFT ANGLES

The procedure to check drive shaft angles for proper universal joint operating angles follows:

1. Remember to check drive shaft angles both with the tractor fifth wheel unloaded, and loaded with a trailer.

2. To determine drive shaft angles, a spirit level protractor is required. When angles are read from the 0° mark (for example, measuring inter axle shaft angle 5°), record and use the angle shown on the protractor. When angles are read from either of the 90° marks (vertically) for example, measuring yoke angles, do not record the angle shown on the protractor since the 90° marks must be understood to be the same as 0° on the horizontal plane. Thus, if a vertical reading is 85°, the angle being measured is 5°.

3. All angles should be read within ¼° (15 min.) and they should be measured with the protractor held plumb on a clean, flat surface.

4. Inflate all tires to the pressure at which they are normally operated. Park the tractor on a surface which is as nearly level as possible both from front-to-rear and from side-to-side.

5. The tractor must be in its normal operating position. Do not attempt to level the truck by jacking up the front or rear axles to obtain a level condition

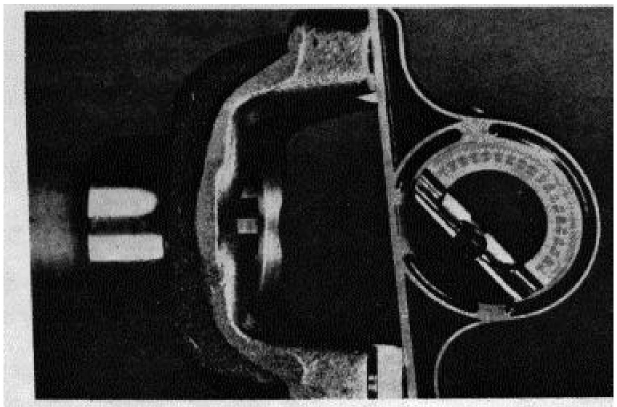


FIGURE 32

6. Check and record the angle on the engine and main transmission. This reading can be taken at the rear of the main transmission on the output yoke, or flange. Record this reading on a sketch similar to Fig. 32. (Example on Figure 32-1° down).

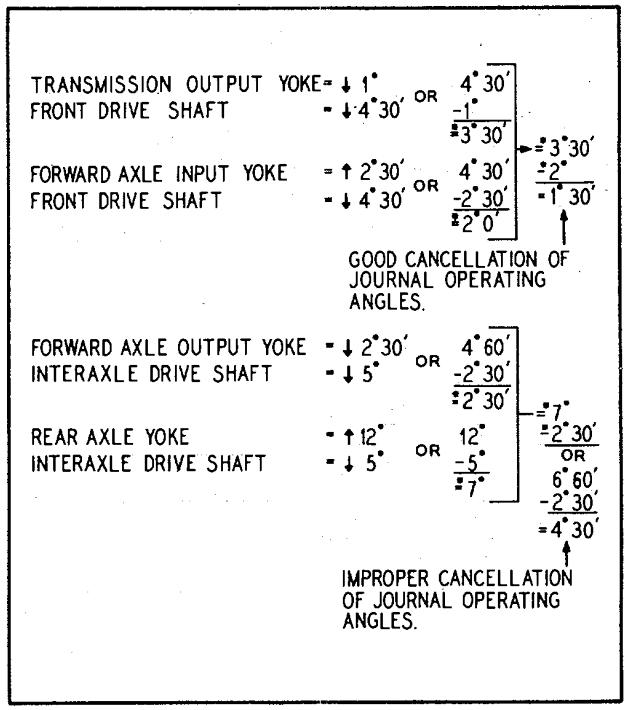
7. Move protractor to the 0° reading and check drive shaft angle between transmission and forward axle (Example 4° 30' down).

8. Check front axle input yoke angle with protractor (Example angle up 2° 30'), also check front axle output yoke (Example angle down 2° 20').

9. Measure the angle of the tandem drive shaft between the front axle and first rear axle (Example 5° down).

10. Measure the rear axle input yoke angle (Example 12°up).

11. With all the above angles recorded, these values are checked to obtain the journal cross operating angles of each drive shaft set to determine if they are operating to within a 3° maximum of each other. If the operating angles or journals exceed 3°, it will cause early wear, and possible seizure of the journal to the needle bearing in the journal cap.



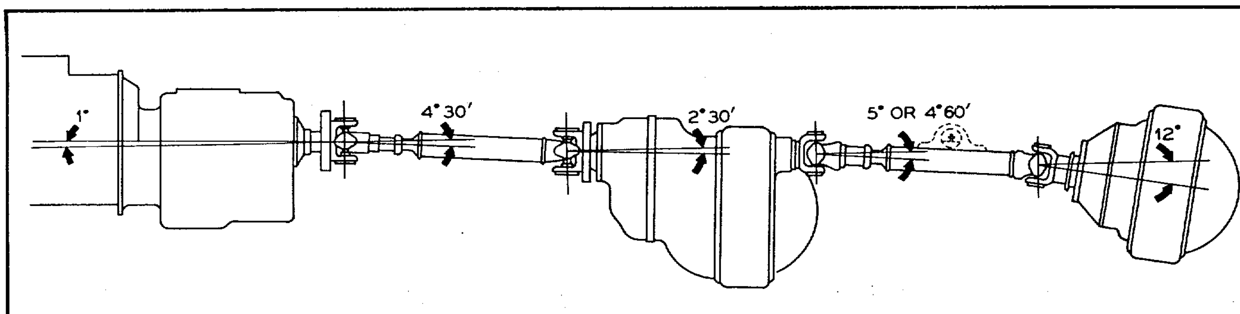


FIGURE 33

TORQUE ARM SHIMMING

The adding or removing of shims' from the rear axle torque arm will change the angle of the interaxle drive shaft. Therefore, it is necessary to take the drive shaft angle and the rear axle yoke angle after each adjustment is made, to determine the journal operating angle.

SHORT COUPLED JOINTS

Short coupled joints must be installed so that the front and rear joints will have equal angles which should not exceed 3°.

For further information write to:

Universal Joint Division
Dana Corporation
P.O. Box 374
Toledo, Ohio 43601

trouble shooting guideline

Section I
DRIVE LINES

DANA

Standard of The Industry

Since 1904

Universal joint failures, as a rule, are of a progressive nature, which, when they occur, generally accelerate rapidly resulting in a mass of melted trunnions and bearings.

Some recognizable signs of universal joint deterioration are:
1) Vibrations Driver should report to maintenance.
2) U-Joint Looseness-End play across bearings.
3) U-Joint discoloration due to excessive heat build-up.
4) Inability to purge all four trunnion seals when re-lubing U-joint.

Item 2) thru 4) should be checked at re-lube cycle and if detected reported to the maintenance supervisor for investigation.

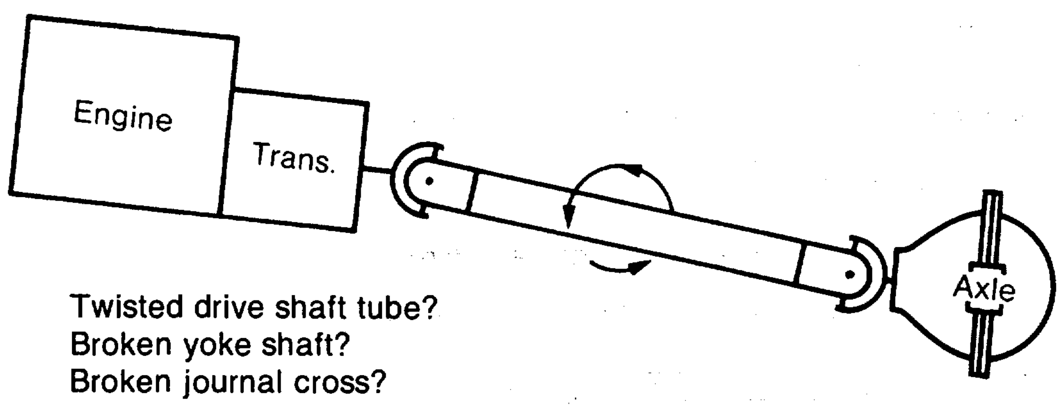
Experience with universal joint failures has shown that a significant majority are related to lubricating film breakdown. This may be caused by a lack of lubricant, inadequate lube quality for application, inadequate initial lubrication or failure to lubricate properly and often enough.

Failures which are not a result of lubrication film breakdown are associated with the installation, angles and speeds and manufacturing discrepancies.

Drive shaft failures through torque, fatigue and bending are associated with overload, excessively high U-joint angles and drive shaft lengths excessive for operating speeds.

The trouble shooting chart in this bulletin is intended to provide service people with an aid to enable them to associate complaints with some of the probable causes and probable corrections. Which through normal vehicle maintenance and recognition of discrepancies may enable them to make necessary corrections to ward off a serious breakdown.

Drive Shaft Torque



Usually a result of torque overload - How much torque can be generated in your application?

Here is how to figure!

L.G.T. = N.E.T. x Trans. L.G.R. x .85 (efficiency factor)

$$\text{D.L.T. (to Slip Wheels)} = \frac{W_R \times \text{C.O.F.} \times \text{R.R.}}{12 \times \text{A.R.}}$$

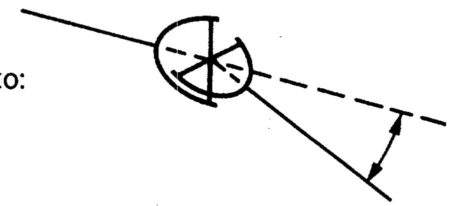
A.R. = Axle ratio	L.G.T. = Low gear torque
C.O.F. = Coefficient of friction (.7)	N.E.T.= Net engine torque
D.L.T. = Drive line torque	R.R. = Tire loaded rolling radius
L.G.R. = Low gear ratio	W_R = Weight on drive axle

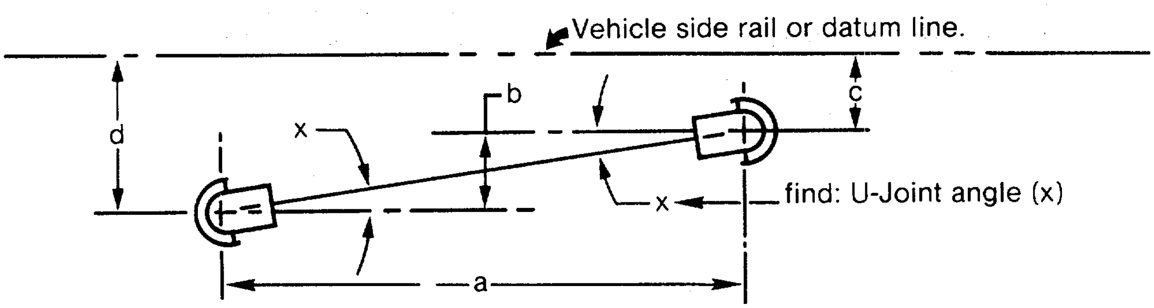
Relate the lesser of above to Spicer U-joint ratings. If your torque exceeds Spicer rating for U-joint size in application switch to a size with a rating compatible to your calculation.

A primary source of problems contributing to:

- Reduced life
- Vibrations
- Drive train component failures

If suspected to be excessive CHECK — Here is how.





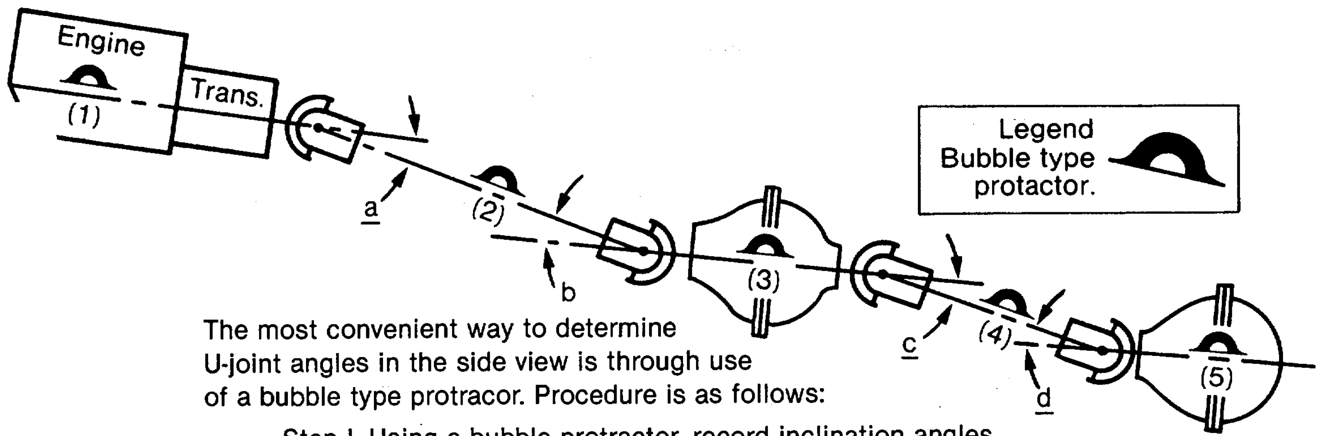
1. From side rail or convenient datum line measure offset dim. c & d.
2. b = d − c
3. Measure dim. **a**
4. With dim. a & b determined thru measurement, calculate U-joint angle by: $\tan x = \frac{b}{a}$

Example: Where a = 40.0″ c = 4.5″ d = 6.0″

$$\therefore b = d - c = 6.0'' - 4.5'' = \underline{\underline{1.5''}}$$

$$\tan x = \frac{b}{a} = \frac{1.5}{40} = .03750$$

tan .03750 = 2° 9′ or (9′ ÷ 60′ = .15) or $\underline{\underline{2.15°}}$



The most convenient way to determine U-joint angles in the side view is through use of a bubble type protracor. Procedure is as follows:

Step I. Using a bubble protractor, record inclination angles of drivetrain components. Set protractor on machined surfaces of engine, transmission, axle or on machined lugs of transmission output and axle input yokes.

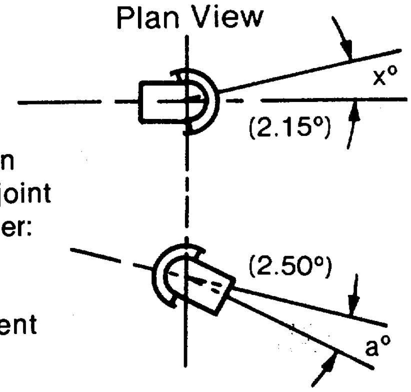
Note: U-joint angles can change significantly in a loaded situation. Therefore, check vehicle loaded and unloaded to achieve the accepted angle cancellation. (See Step IV.)

Example:	(1)	Eng-Trans.	4°30′ Down
	(2)	Main Drive Shaft	7°00′ Down
	(3)	Input 1st Rear Axle	4°00′ Up
	(3a)	Output 1st Rear Axle	4°00′ Down
	(4)	Inter-axle	7°00′ Down
	(5)	Input 2nd Rear Axle	4°15′ Up

Note: If inclination of driveshaft is up and Eng./Trans. is down add to obtain the U-joint angle.

$\angle$ a = (2) – (1) = 7°00′ – 4°30′ = 2°30′
$\angle$ b = (2) – (3) = 7°00′ – 4°00′ = 3°00′
$\angle$ c = (4) – (3a) = 7°00′ – 4°00′ = 3°00′
$\angle$ d = (4) – (5) = 7°00′ – 4°15′ = 2°45′

Plan View



Side View

This is the sum of the U-joint angles in both the plan view and side view (compound angle). The true U-joint operating angle is calculated in the following manner:

$$\text{Compound Angle } (C^\circ) = \sqrt{x^{\circ 2} + a^{\circ 2}}$$

Where x = 2.15° as determined by measurement and calculation in Section I.

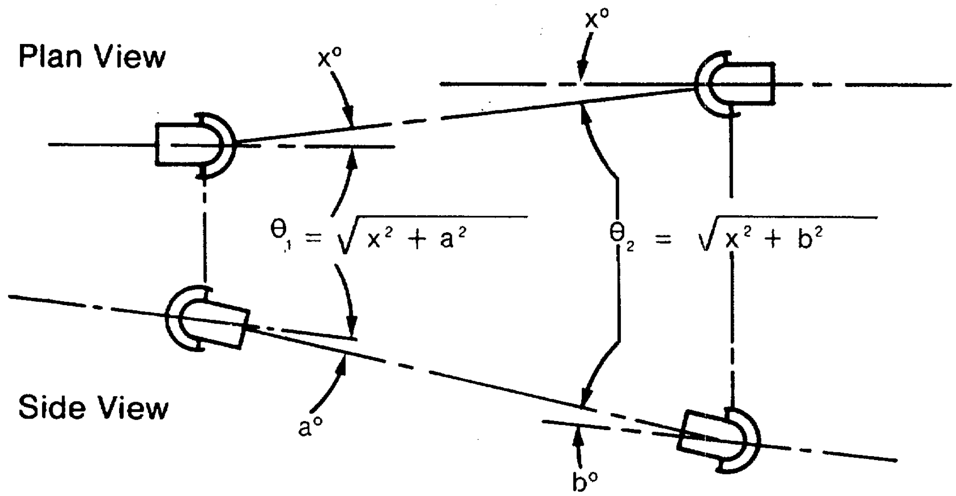
a = 2.5° as determined in Section II.

(a) Output Trans. $C° = \sqrt{2.15^{\circ 2} + 2.5^{\circ 2}} = \sqrt{4.6225 + 6.25} = \sqrt{10.8725} =$

$= 3.297°$ or $\underline{\underline{3°18'}}$

(b) Input axle $C° = \sqrt{x^2 + b^2} = \sqrt{2.15^2 + 3^2}$

$= \sqrt{4.6225 + 9} = \sqrt{13.6225} = 3.69°$ or $\underline{\underline{3°41'}}$



To effectively control the non uniform motion effects of a cardan U-joint operating at an angle, it is necessary to keep U-joint angles on each end of the drive shaft as equal to one another as possible. Good drive shaft installation practice limits the inequality of these angles to be the equivalent of a single U-joint operating at 3°.

To determine the effective cancellation of the universal joint angles in your drive shaft installation use the following:

$$\text{Effective cancellation } (\theta) = \sqrt{\theta_1^2 - \theta_2^2}$$

Where: θ. = 3°18′ true U-joint angle @ transmission output (as determined in Sect. IIIa)

θ. = 3°41′ true U-joint angle @ axle input (as determined in Sect. IIIb)

$$\text{Effective cancellation} = \sqrt{3.297^2 - 3.69^2} = \sqrt{10.87 - 13.61}$$

$$= \sqrt{2.74}$$

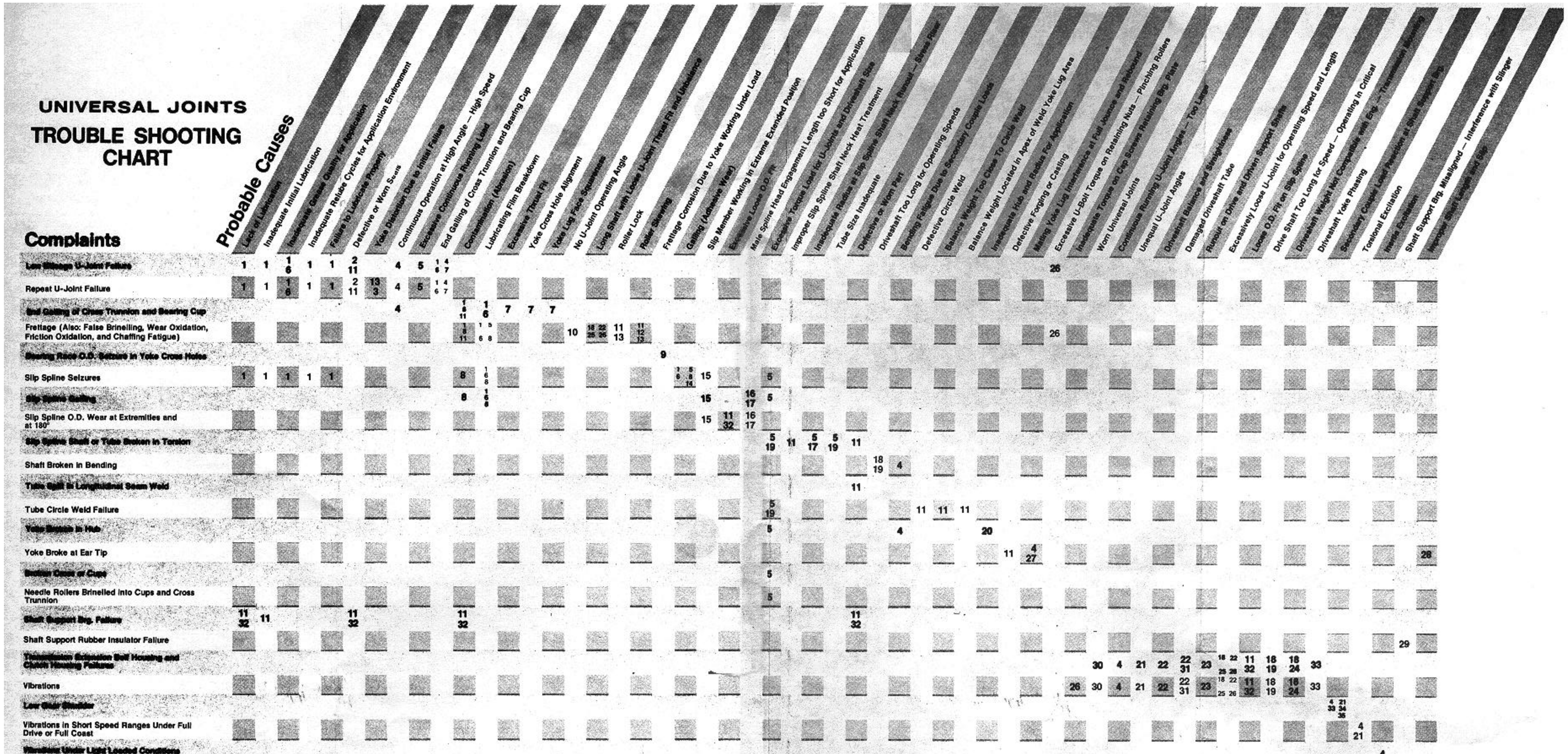
$$= 1.65° \text{ or } \underline{\underline{1°39'}}$$

Cancellation of the two U-joint angles in this illustration is well within accepted limits. If your results exceeds the recommended 3° equivalent, it could be a source of torsional excitation.

Shimming of axle is recommended to equalize the angles.

UNIVERSAL JOINTS

TROUBLE SHOOTING CHART



Probable Corrections

1 See Spicer Universal Joint Lube Specs.

2 Replace Seals on New Kit. Replace Complete Kit if Used.

3 If Yoke Distorted — Replace

4 Reduce U-Joint Continuous Running Angles

5 Replace with Higher Capacity U-Joint & Driveshaft

6 Use Hi-Temp. Grease

7 Check U-Joint Flex Effort. If Sticks, Binds or Grabs — Replace U-Joint Kit. If Replacement Kit Sticks Binds or Grabs — Check Yokes for Span, Lug Squareness, Cross Hole Alignment, etc. If Excessive Replace.

8 Clean & Relubricate Per Lube Specs, If Check on Components Indicate They Are Serviceable — Replace If not.

9 No Immediate Fix. Use of Anti-Seize Lubricants on Bearing O.D. Initially Helps.

10 Re-Align to have a Minimum 1° Running Angle.

11 Replace.

12 Roller Lock — Replace Assy.

13 Yoke Deflections Under Load. Use Larger Joint.

14 Use Spicer "Glidecote" — Slip Spline.

15 Increase Driveshaft Assy. Length to Position Slip Spline Head Towards U-Joint.

16 Check for Male Slip Member with Longer Spline.

17 Design Inadequate for Application.

18 Install Two Piece Driveshaft with Shaft Support Brg.

19 Use Larger Diameter Tube.

20 Design Limitation Due to Axle or Trans. Shaft Requirement.

21 Shim Drive Train Components to Equalize U-Joint Angles.

22 Straighten and Balance.

23 Check with Trans. or Axle Mfg. — Replace Shaft Brg.

24 Revise Power Plant Mounting Scheme.

25 Check U-Joint Flex Effort for Looseness.

26 Torque Bearing Retention Method to Spec.

27 Use Wide Angle Yokes.

28 Check Installed Length and Adjust Driveshaft Length to Provide Proper Slip Conditions.

29 Re-Align Mounting Brkt. to Frame Cross Member to Eliminate Interference.

30 Replace U-Joint Kits.

31 Replace Tube.

32 Normal Wear — Replace.

33 Check O.E.M. Maint. Manual or Alignment Arrows on Slip Yoke and Male Slip Shaft for Correct Yoke Phasing.

34 2 Pc.-3JT Driveshafts Adjust Shaft Lengths to 50-50 or 40-60 Split.

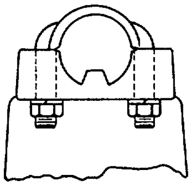
35 Re-Position Shaft Support Bearing.

DRIVETRAIN SERVICE DIVISION DANA DANA CORPORATION

Spicer Universal Joint Kits

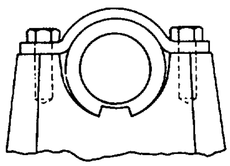
SNAP RING

Series	Spicer Kit No.	Attaching Hardware	Recommended Torque
1000	5-170X	10-7-29	N.A.



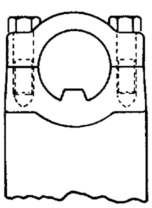
U-BOLT

Series	Spicer Kit No.	U-Bolt Ass'ys.	Recommended U-Bolt Nut Torque
1280	5-200X	2-94-28X	14-17 Ft. Lb.
1310	5-153X	2-94-28X	14-17 Ft. Lb.
1330	5-213X	2-94-28X	14-17 Ft. Lb.
1350	5-178X	3-94-18X	20-24 Ft. Lb.
1410	5-160X	3-94-18X	20-24 Ft. Lb.
1480	5-188X	3-94-28X	32-37 Ft. Lb.
1550	5-155X	3-94-28X	32-37 Ft. Lb.



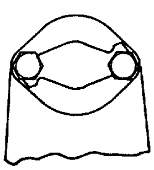
BEARING STRAP

Series	Spicer Kit No.	Strap Kit Ass'y	Recommended Bolt Torque
1210	5-443X	2-70-18X	13-18 Lb. Ft.
1280	5-200X	2-70-18X	13-18 Lb. Ft.
1310	5-153X	2-70-18X	13-18 Lb. Ft.
1330	5-213X	2-70-18X	13-18 Lb. Ft.
1350	5-178X	3-70-28X	30-35 Lb. Ft.
1410	5-160X	3-70-28X	30-35 Lb. Ft.
1480	5-188X	3-70-38X	55-60 Lb. Ft.
1550	5-155X	3-70-38X	55-60 Lb. Ft.
1610	5-438X	5-70-28X	55-60 Lb. Ft.
1710	5-442X	6.5-70-28X	130-135 Lb. Ft.
1760	5-469X	6.5-70-28X	130-135 Lb. Ft.
1810	5-510X	6.5-70-28X	130-135 Lb. Ft.



CAP & BOLT

Series	Spicer Kit No.	Cap & Bolt Ass'ys.	Recommended Bolt Torque
1650	5-165X	5-70-18X	77-103 Ft. Lb.
1850	5-185X	8-70-18X	110-147 Ft. Lb.
1850	5-227X	8-70-18X	110-147 Ft. Lb.
1910	5-316X	N.S.S.	110-147 Ft. Lb.
1950	5-339X	9-70-18X	271-362 Ft. Lb.
2010	5-371X	N.S.S.	102-118 Lb. Ft.
2050	5-340X	9-70-28X	744-844 Ft. Lb.
2110	5-372X	N.S.S.	171-197 Lb. Ft.
2150	5-298X	9-70-38X	744-844 Ft. Lb.
2210	5-373X	N.S.S.	260-298 Lb. Ft.



BEARING PLATE

Series	Spicer Kit No.	Bearing Plate		Recommended Bolt Torque
		Bolts	Lock Plates	
1610	5-279X	5-73-109	98-741	17-24 Ft. Lb.
1710	5-280X	6-73-109	230323	32-42 Ft. Lb.
1760	5-407X	6-73-109	230323	32-42 Ft. Lb.
1810	5-281X	6-73-109	230323	32-42 Ft. Lb.
1880	5-308X	7-73-115	231009	50-66 Ft. Lb.

Open for Complaints, Probable Causes and Probable Corrections.

Spicer Flange Bolt Information

Series	Part Numbers			Diameter, Thread, and Length Under Head	Recommended Torque
	Bolt	**Washer**	**Nut**		
1000/1100	**5-73-414**	**500357-10**	**231421-2**	5/16" - 24 x 7/8"	22-26 Lb. Ft.
1350/1410/1550	**5-73-2216**	"	"	24 x 1"	"
1550*	**5-73-1125**	"	"	24 x 1-9/16"	"
1280/1310	**6-73-316**	**500357-11**	**231421-3**	3/8" - 24 x 1"	40-48 Lb. Ft.
1610	**6-73-1219**	"	"	24 x 1-3/16"	"
1710	**6-73-220**	"	"	24 x 1-1/4"	"
1760	**6-73-220**	"	"	24 x 1-1/4"	"
1610*	**6-73-325**	"	"	24 x 1-9/16"	"
1710*	**6-73-1227**	"	"	24 x 1-11/16"	"
1350/1410	**7-73-219**	**500357-12**	**231421-4**	7/16" - 20 x 1-3/16"	63-75 Lb. Ft.
1810	**7-73-122**	"	"	20 x 1-3/8"	"
1350/1410*	**7-73-126**	"	"	20 x 1-5/8"	"
1810*	**7-73-228**	"	"	20 x 1-3/4"	"
1480/1550	**8-73-122**	**500357-13**	**231421-5**	1/2" - 20 x 1-3/8"	97-116 Lb. Ft.
1650	**8-73-123**	(Bearing Race Cap)		20 x 1-7/16"	"
1480/1550*	**8-73-228**	**500357-13**	**231421-5**	20 x 1-3/4"	"
1880/1910	**10-73-131**	**500358-15**	**231421-7**	5/8" - 18 x 1-15/16"	194-232 Lb. Ft.
1950	**12-73-140**	**500358-17**	**231421-8**	3/4" - 16 x 2-1/2"	341-409 Lb. Ft.
2010	**9.55-73-11**	**---**	**231483**	18mm x 75mm	277-319 Lb. Ft.
2050	**14-73-264**	**500358-19**	**231421-9**	7/8" - 9 x 3-1/2"	543-652 Lb. Ft.
2110	**9.60-73-11**	**---**	**231482**	20mm x 80mm	397-457 Lb. Ft.
2150	**16-73-164**	**500358-21**	**231421-10**	1" - 12 x 4"	810-976 Lb. Ft.
2210	**9.65-73-11**	**---**	**231481**	22mm x 90mm	534-575 Lb. Ft.

*- Tru Stop Brake Applications

Spicer Flange Bolts are **Special Heat Treated Grade 8 Bolts.**
Do not substitute inferior grade bolts.

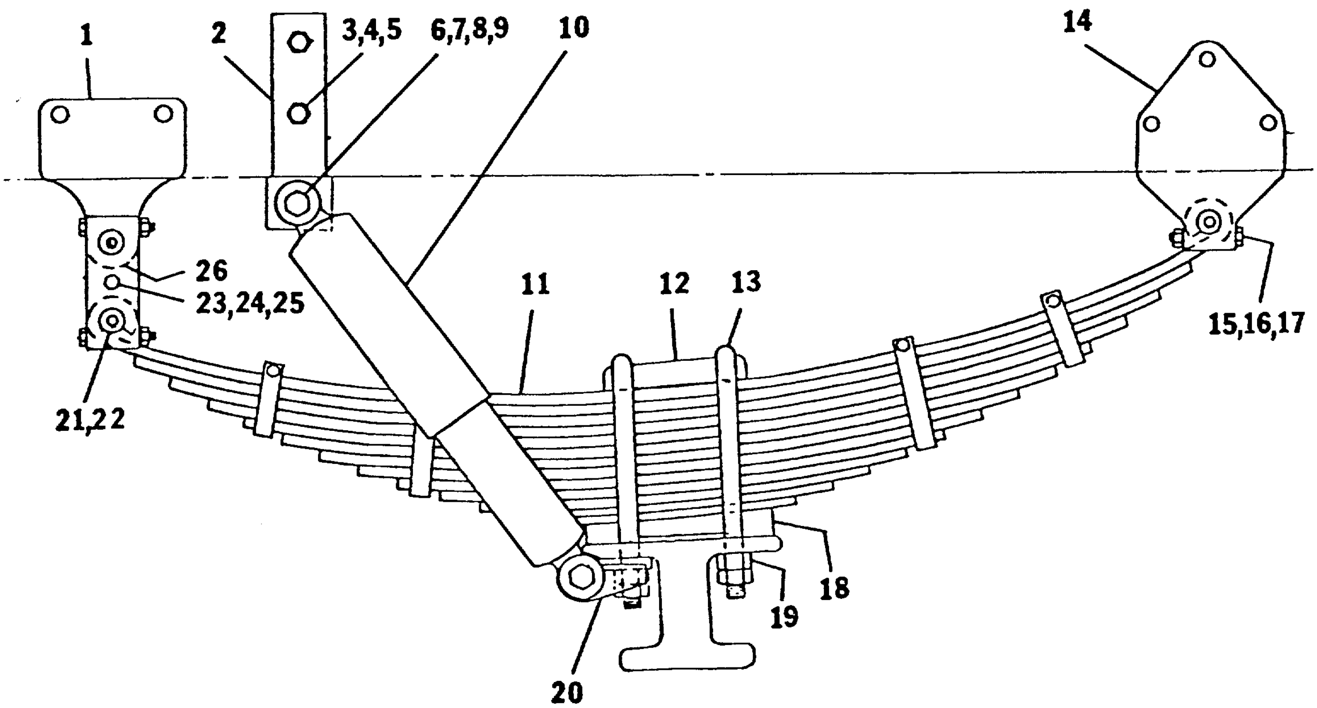
DANA CORPORATION
TOLEDO, OHIO 43692

Form 3119-1 5/84

DUPLEX

Section II
FRONT AXLE

Front Suspension
20,440 Lb. Capacity
All Models



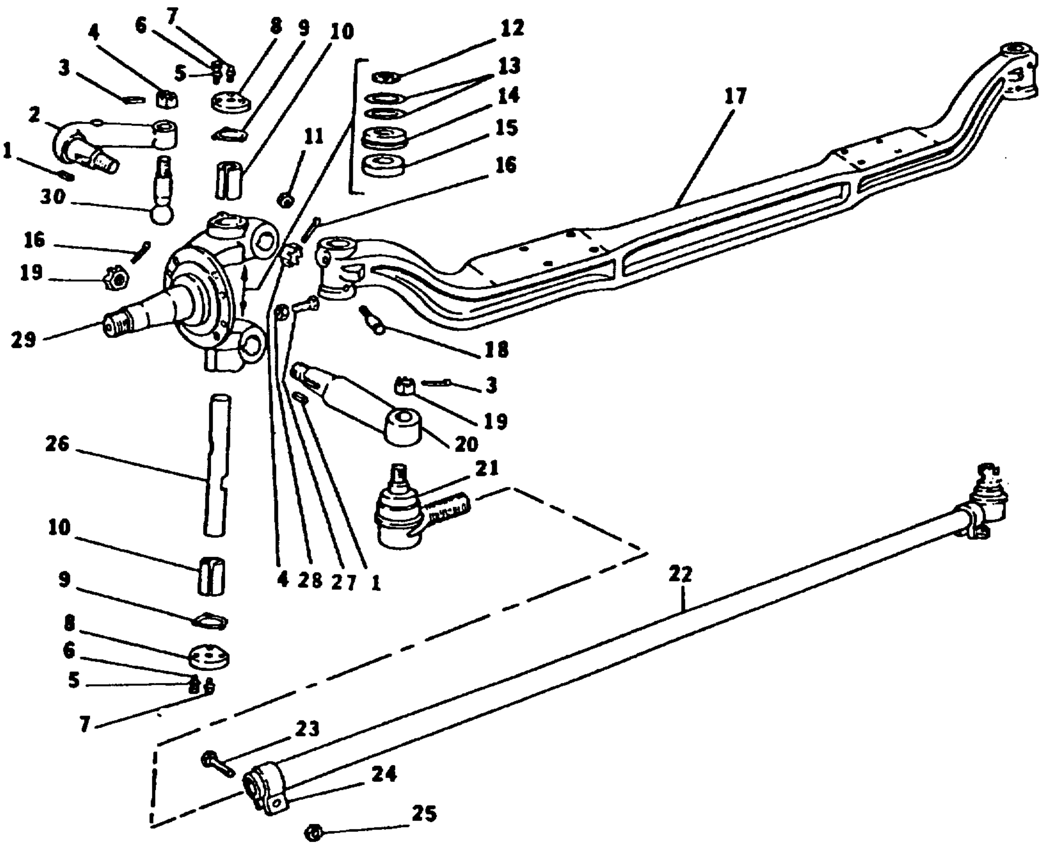
Item	Part No.	Description	Qty.
1	7605-1350	Spring Hanger	2
2	7810-6394	RH Frame Shock Bracket (Shown)	1
	7808-1978	LH Frame Shock Bracket	1
3	7601-7831	H.H.C.S. 1/2-13 x 1-1/2	4
4	7602-7938	Hard Washer 1/2	4
5	8850-1008	Hex Nut 1/2-13	4
6	7604-1781	Mounting Stud	4
7	7810-3750	Rubber Bushing	8
8	7601-7822	Hard Washer 5/8	4
9	7604-6339	Lock Nut 5/8-18	8
10	7605-1258	Shock Absorber	2
11	7804-6731	Spring Assembly	2
12	7801-7734	Spring Clip Seat	2
13	7810-1645	Spring Clip	4
14	7605-0175	Spring Hanger	2
15	8820-1555	H.H.C.S. 7/16-20 x 2-1/2	12
16	8855-1012	Lockwasher 7/16	12
17	8850-1307	Hex Nut 7/16-20	12
18	7801-7662	Spring Seat	2
19	8850-1312	Hex Nut 3/4-16	16
20	7810-6397	RH Axle Shock Mount (Shown)	1
	7808-1979	LH Axle Shock Mount	1
21	7604-1780	Spring Pin	6
22	8867-1001	Lube Fitting	6
23	7604-1706	H.H.C.S. 3/8-24 x 5-1/4	2
24	8851-1106	Castle Nut 3/8-24	2
25	8863-1309	Cotter Pin 3/32 x 3/4	2
26	7800-6279	Bushing	2

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts

SectionII

Front Axle FL-931

All Models



Item	Part No.	Description	Qty.	Item	Part No.	Description	Qty.
1		Key	3			Key - Steering Knuckle DR. Lower	2
2	7605-2007	Steering Arm – LH (Ross Gear)	1	19		Nut - Tie Rod End	2
	7605-1996	Steering Arm – LH (Spicer Gear)	1	20	7605-2009	Arm - Cross Tube L.H. (Ross Gear)	1
3		Cotter Pin	3		7605-2010	Arm - Cross Tube L.H. (Ross Gear)	1
4		Nut – Steering Arm Ball	1		7605-1998	Arm - Cross Tube L.H. (Spicer Gear)	1
5		Lockwasher	12		7605-1999	Arm - Cross Tube L.H. (Spicer Gear)	1
6		Capscrew	12	21		Tie - Rod – End Assembly R.H.	1
7		Grease Fitting	4			Tie - Rod – End Assembly L.H.	1
8		Steering Knuckle Cap	4	22	7605-2000	Cross Tube Assembly (Items 3,19,21,23,24,25)	1
		Knuckle Cap Gasket	4	23		Bolt – Steering Cross Tube	2
9		Brushing – Knuckle	4	24		Clamp Steering Cross Tube End	2
10		Nut – Steering Knuckle Draw Key	4	25		Nut – Steering Cross Tube Clamp	2
11		Seal – Knuckle Pin Upper Assembly	2	26		Knuckle Pin	2
12		Shim – .005	2	27	7605-2001	Stop Screw – Axle Center	2
13		Shim –.010	2	28	7605-2002	Locknut – Stopscrew	2
		Shim –.030	2	29	7605-2003	Knuckle – Steering Assembly L.H.	1
		Shim -.015	2		7605-2011	Knuckle – Steering Assembly R.H. (Ross Gear)	1
14		Seal – Steering Knuckle Lower Assembly	2		7605-2004	Knuckle – Steering Assembly R.H. (Spicer Gear)	1
15		Thrust Bearing	2				
16		Cotter Pin	4	30	7605-2005	Ball – Steering Arm 1-3/4 Dia	1
17	7605-1997	Axle Center	1		7605-2006	Knuckle Pin Kit (Items 5,6,8,9,10,11,12,13 14,15,18,26)	2
18		Key – Steering Knuckle DR. Upper	2				

NOTE: Your chassis Vehicle Identification Number (V.I.N.) or Serial Number on order chassis must be supplied when ordering replacement parts.

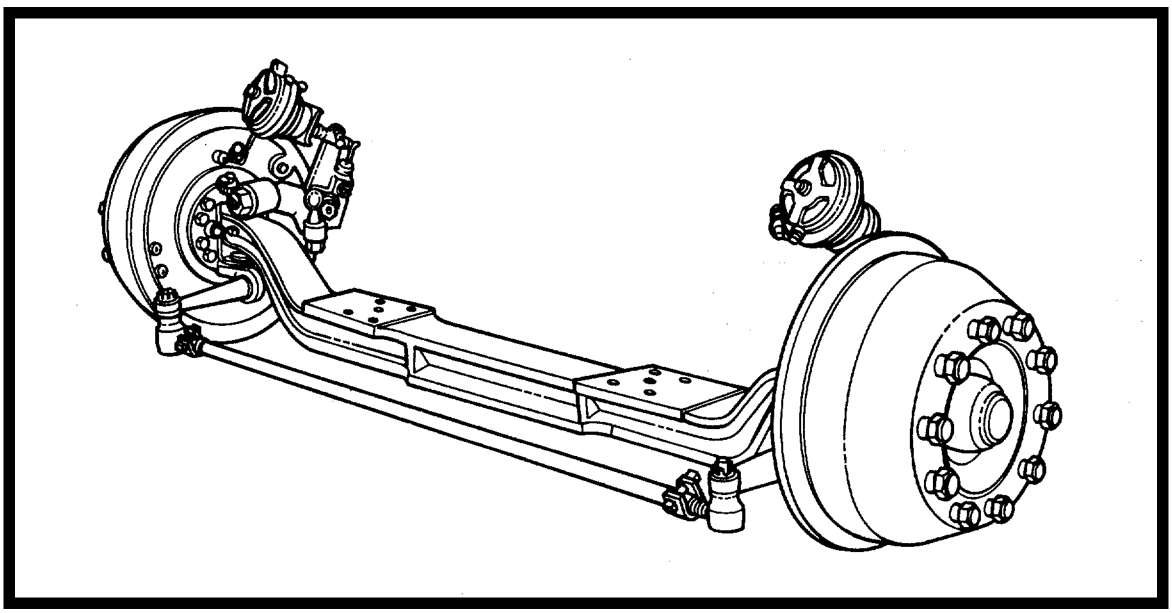
Section II
FRONT AXLE

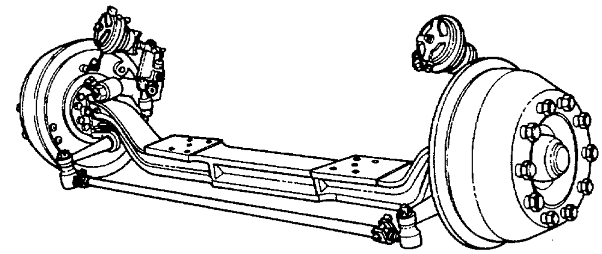
Rockwell

Field Maintenance Manual No. 2

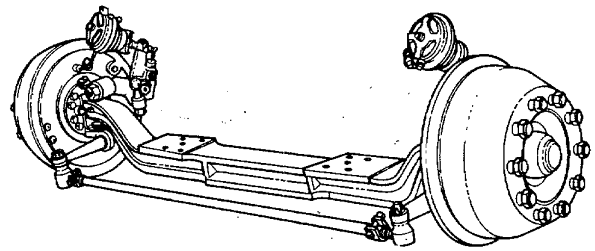
Non-Driving Front Axles

All Models
Conventional and Sealed Knuckle Pins



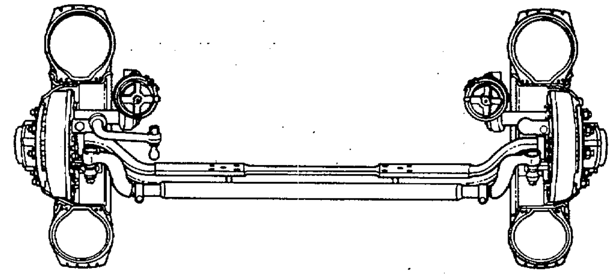


STANDARD I-BEAM AXLE



ALUMINUM BEAM AXLE

TUBULAR AXLE



CENTER-POINT™ STEERING AXLE

BASIC CAPACITY

C — 7000 lbs.
D — 9000 lbs.
F — 12,000-13,200 lbs.
G — 14,300-14,600 lbs.
L — 16,000-20,000 lbs.
U — 29,000 lbs.

LETTER DESIGN-VARIATION

If letter appears here it indicates a major design change
A — Aluminum Beam

BRAKE TYPE

(Refer to Technical Aid Section #6 Aid #59)

FRONT AXLE

BASIC SERIES

SPECIFICATION NUMBER

F F - 9 3 1 - P - X 1

MAJOR VARIATION

1 — Straight sealed knuckle pin and new tie rod assembly
2 — Sealed knuckle pin construction
3 — Larger centers and knuckles
4 — Easy Steer™ design
5 — Tubular center
7 — Center-Point™ steer design

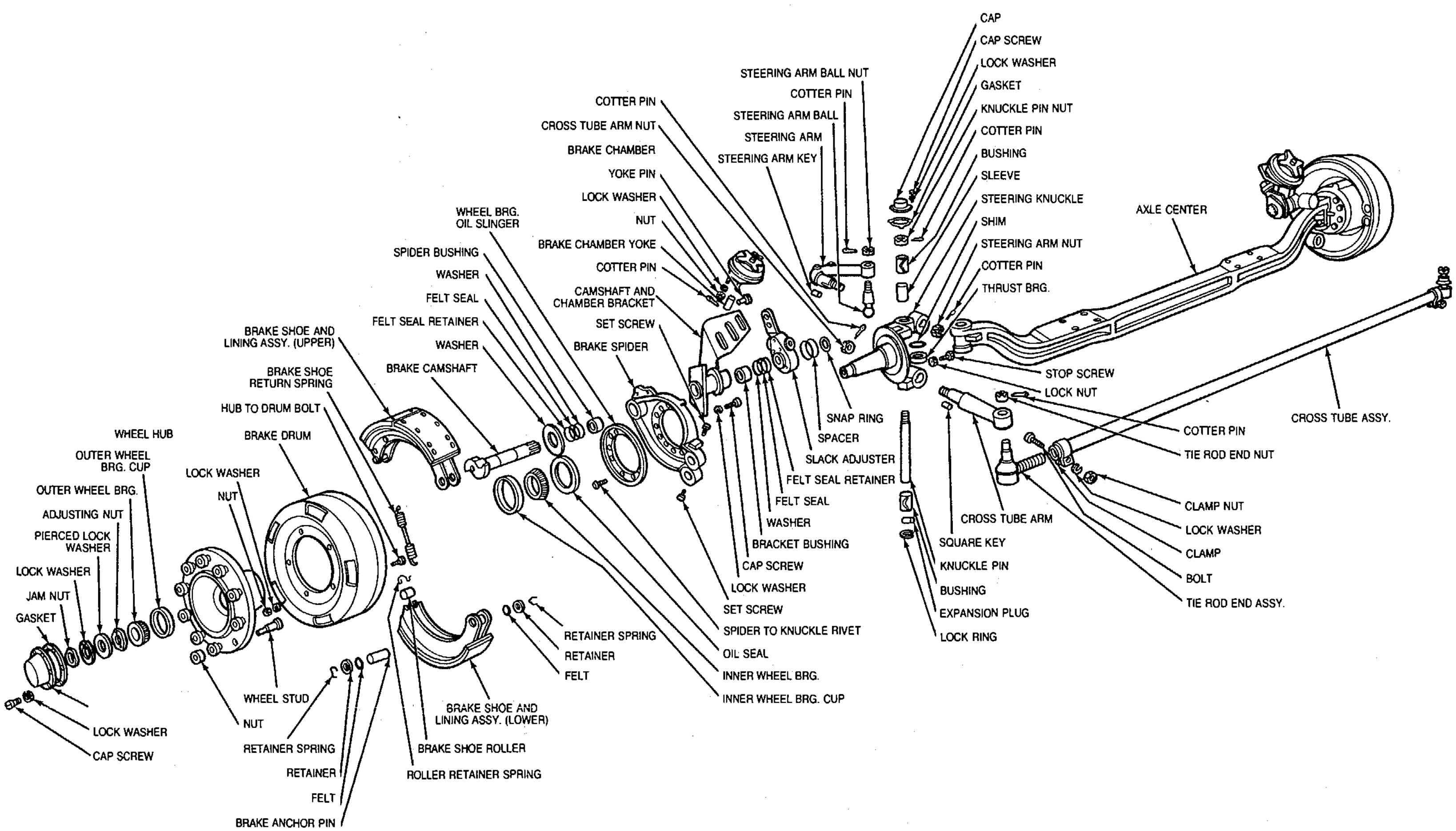
NUMBER DESIGN VARIATION

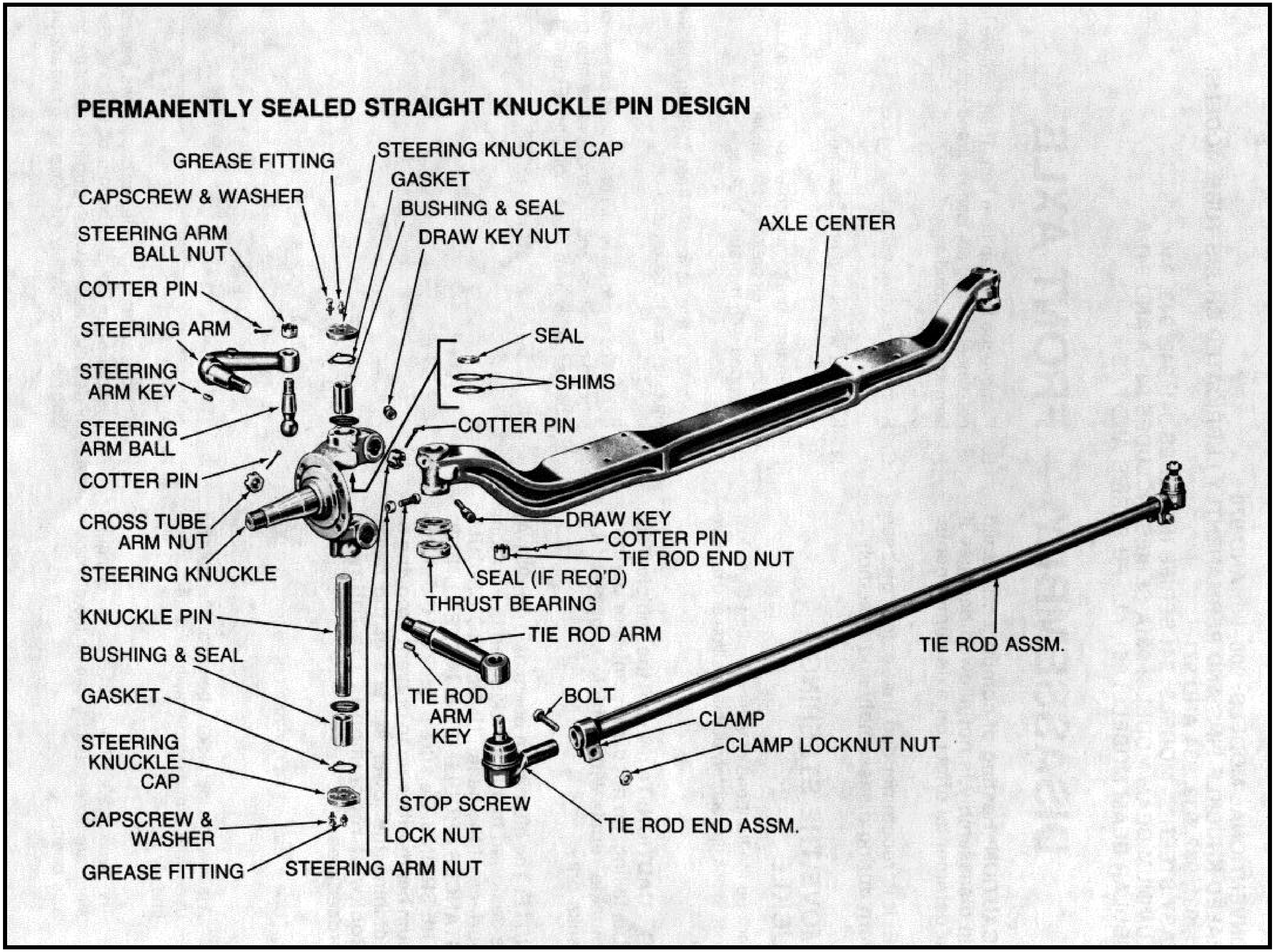
0 — Tapered knuckle pin
1 — Straight knuckle pin
2 — Special spindle and wheel ends
3 — 5″ drop from spindle intersection to pad
4 — Special spindle and 5″ drop
5 — Special spindle and wheel end

TABLE OF CONTENTS

SERVICE NOTE: For safety purposes and to maintain the mechanical integrity of components being serviced, it is of utmost importance to follow completely all the procedures including all "caution" and "important" items throughout this manual.

TAPERED KNUCKLE PIN DESIGN




PERMANENTLY SEALED STRAIGHT KNUCKLE PIN DESIGN
GREASE FITTING
STEERING KNUCKLE CAP
GASKET
CAPSCREW & WASHER
BUSHING & SEAL
STEERING ARM BALL NUT
DRAW KEY NUT
AXLE CENTER
COTTER PIN
STEERING ARM
SEAL
STEERING ARM KEY
SHIMS
STEERING ARM BALL
COTTER PIN
COTTER PIN
CROSS TUBE ARM NUT
DRAW KEY
COTTER PIN
TIE ROD END NUT
STEERING KNUCKLE
SEAL (IF REQ'D)
THRUST BEARING
KNUCKLE PIN
TIE ROD ARM
TIE ROD ASSM.
BUSHING & SEAL
GASKET
TIE ROD ARM KEY
BOLT
CLAMP
CLAMP LOCKNUT NUT
STEERING KNUCKLE CAP
STOP SCREW
CAPSCREW & WASHER
LOCK NUT
TIE ROD END ASSM.
GREASE FITTING
STEERING ARM NUT

NON-DRIVING FRONT AXLES

- **CONVENTIONAL MODELS: 900, 901 AND 970**
- **SEALED KNUCKLE PINS AND PERMANENTLY LUBRICAT ED CROSS TUBE MODELS: 921, 931, 932, 933, 934 AND 971**
- **"EASY STEER" TM MODELS: 941 SERIES INCLUDES 941, 942, 943, 944**
- **ALUMINUM BEAM MODELS: 931A SERIES INCLUDES 931-A AND 941-A**
- **TUBULAR BEAM MODELS: 951, ALL FU SERIES AND FAE**

DISASSEMBLY - FRONT AXLE

CAUTION: Heating of components to aid in disassembly is not allowed because it has a detrimental effect on axle components.

NOTE: It is recommended that safety glasses be worn during disassembly and assembly.

REMOVE THE STEERING KNUCKLE

A. Jack up the front end of vehicle so that tires clear floor. Block up securely at this position and remove jacks.

CAUTION: To prevent the vehicle from falling, do not disassemble or perform knuckle repair with vehicle supported by jacks only.

NOTE: The aluminum beam axle (FF-931-A) is designed to allow jacking on the bottom surface of the beam. UNDER NO CIRCUMSTANCES SHOULD IT BE JACKED UNDER THE SPRING. Be sure to jack up the aluminum beam with care to prevent grooving or notching the lower surface of the beam. Rockwell recommends the following procedures:

1. Use a jack with a minimum of 10 tons (20,000 lbs.) capacity.

2 A jack with a low pick-up height of 8" should be used with a minimum power raise of approximately 5".

3. The Walker 93660 or 93662 jacks, or equivalent, are acceptable for use on the aluminum axle beam.

B. Remove the hub cap from hub. Then, remove jam nut, wheel bearing adjusting nut and lock washers from knuckle spindle.

C. Remove the outer wheel bearing cone.

D. Remove wheel and hub assembly.

E. Disconnect brake air chamber lines on units equipped with air brakes, or hydraulic lines on units equipped with hydraulic brakes.

F. Remove brake assembly from steering knuckle if knuckles are to be rebuilt.

G. If knuckles are to be rebuilt or tie rod to be serviced, remove cross tube end nut and disassemble cross tube assembly from cross tube arm (Figure 1).

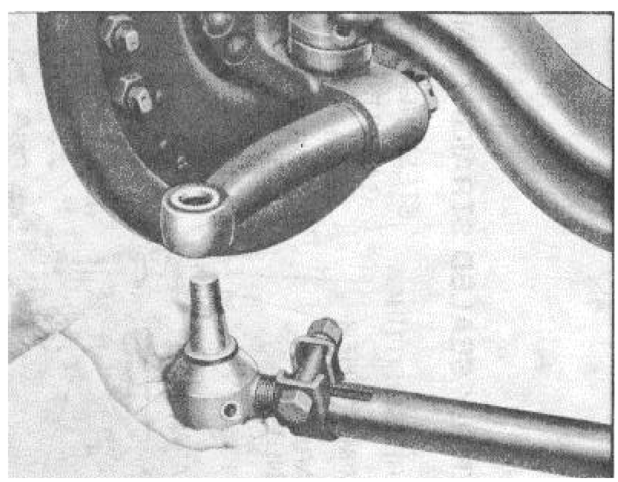


Figure 1

H. Remove steering knuckle cap capscrews, caps and gaskets from top and bottom of knuckle. Some models may have a welsh plug in place of the lower king pin cap assembly. Remove snap ring and plug.

I. Depending upon type of axle being serviced, proceed as follows:

a. Straight knuckle pin models (901, 921, 931, 941 and 951) continue from here.

b. Tapered knuckle pin models (900, 910, 930 and 970) start on page 7.

STRAIGHT KNUCKLE PINS
(901, 921, 931, 941, 951, 970 & 971
Series Models)

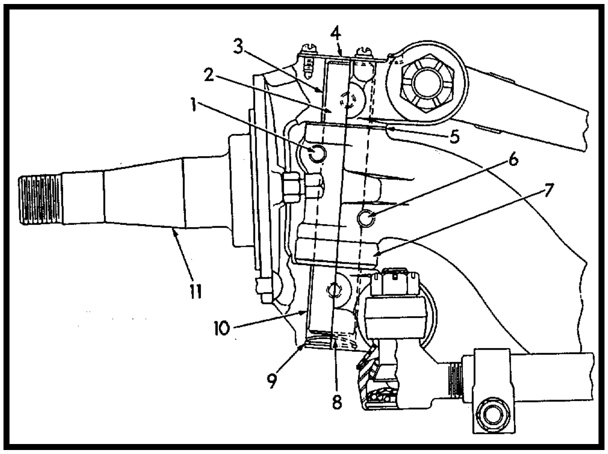


Figure 2

1.	Draw Key - Upper	7.	Thrust Bearing
2.	Knuckle Pin	8.	Expansion Plug
3.	Knuckle Bushing-Upper	9.	Expansion Plug Lock Ring
4.	King Pin Cap	10.	Knuckle Bushing Lower
5.	Shims		
6.	Draw Key - Lower	11.	Knuckle/Spindle

A. **Straight Knuckle Pin Removal (Figure 3)**

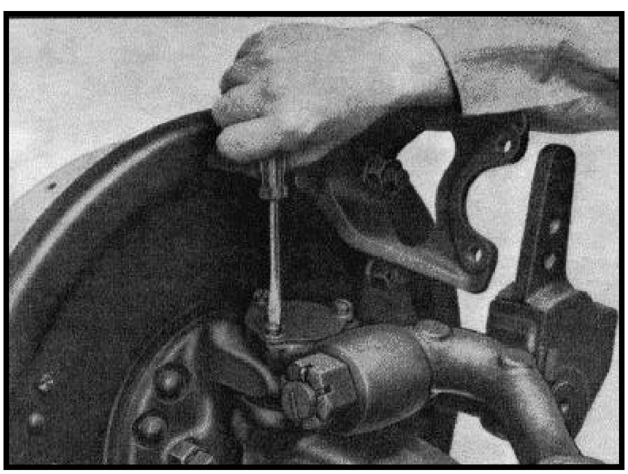


Figure 3

Straight knuckle pins may be removed from the bottom of the knuckle where adequate clearance is provided; however, on some models such as those with riveted backing plates, less work is involved by tapping the knuckle pin out the top of knuckle. In either case the adjacent parts, such as air chambers, hydraulic lines or fittings, etc. that might cause an obstruction to the knuckle pin, must be removed first. Refer to brake manual for brake disassembly.

B. **Draw Key Removal (Two per King Pin)**

1. Plain draw keys should be driven out from the small end ("D" shaped) using a steel drift and a brass hammer (Figure 4).

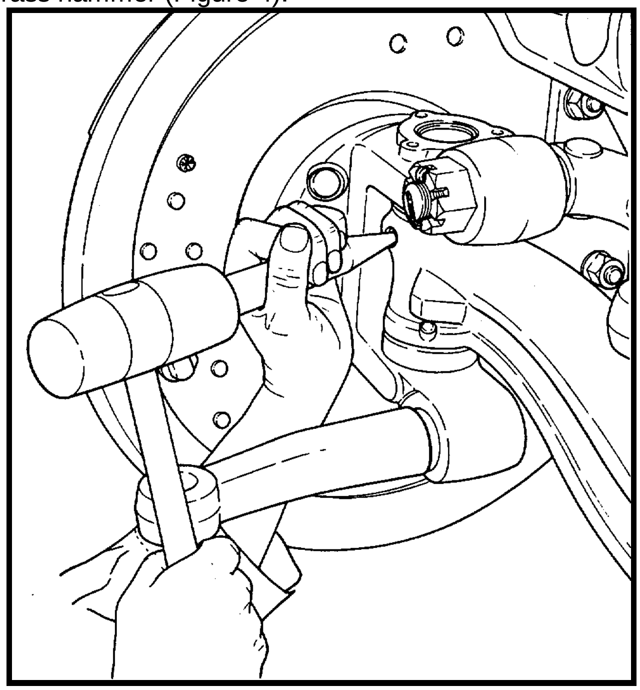


Figure 4

2. Threaded draw keys (current model axles) should be removed as follows:

   a. Loosen locknut and turn it out to the end of the threads. The end of the nut should be flush with the draw key end.

   b. With a brass drift and a hammer, firmly strike the end of the nut to loosen the draw key.

   NOTE: Failure to strike the draw key square may result in a damaged key causing removal difficulties.

   c. Remove the nut and key from the axle center.

NOTE: Aluminum beam axles do not have machined draw key flat on the king pin (Figure 5).

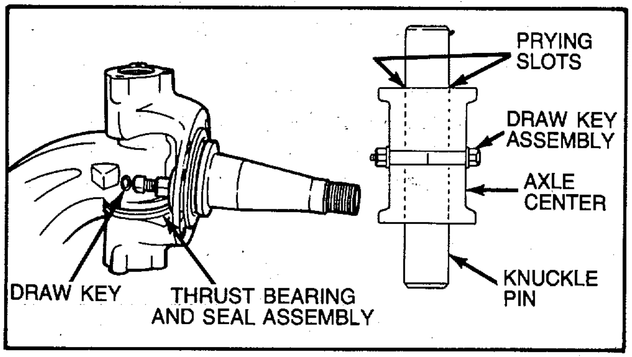


Figure 5

C. Disassembly of Draw Key Wedges Aluminum Beam Axles

1. Remove the locking nut, washers and capscrew from the draw key wedges.

2. Wedges can then be removed using a wooden or rawhide mallet or by using the prying slots provided on the wedges.

D. Tap out the knuckle pin by use of a bronze drift (Figure 6).

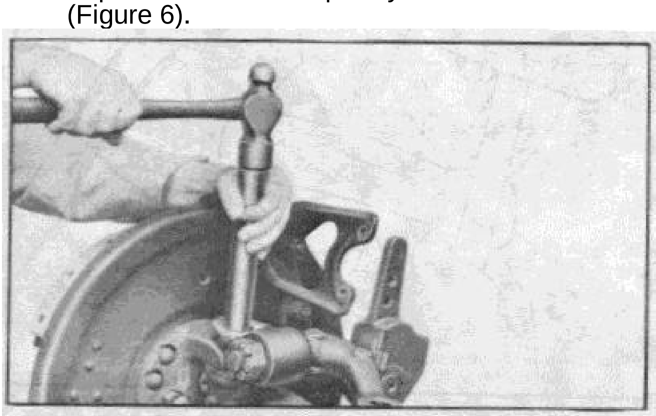


Figure 6

NOTE: If bushings are not to be replaced precautions must be taken not to damage the bushings while removing the king pin. Grind off any flaring on the end of the drift which will contact the pin. Wrap tape around the drift 1/16" thick for the first inch from the end of the drift. This step is especially important for Delrin and easy steer bushings.

⚠ **CAUTION: Do not strike these hardened steel pieces directly with a steel hammer. Personal injury from chips or splinters may result.**

E. Lift off the knuckle assembly, thrust bearing and shims. Retain shims, thrust bearing and seal for assembly.

NOTE: Aluminum beam axles employ an integral thrust bearing and lower seal assembly. DO NOT SEPARATE THE SEAL FROM THE THRUST BEARING.

TAPERED KNUCKLE PINS
(900, 910, 930 and 970 Models)

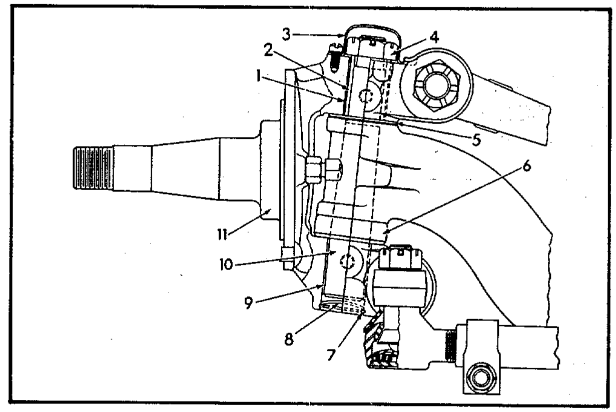


Figure 7

1. Knuckle Upper Bushing
2. Knuckle Pin Sleeve
3. Upper Dust Cap
4. Knuckle Pin Nut
5. Shims
6. Thrust Bearing
7. Expansion Plug Lock Ring
8. Expansion Plug
9. Knuckle Lower Bushing
10. Tapered Knuckle Pin
11. Knuckle/Spindle

A. Tapered knuckle pins must be removed from the bottom side of the knuckle.

1. On some models it will be necessary to remove the brake components to provide clearance for knuckle pin removal. Refer to brake manual for brake disassembly (Figure 8).

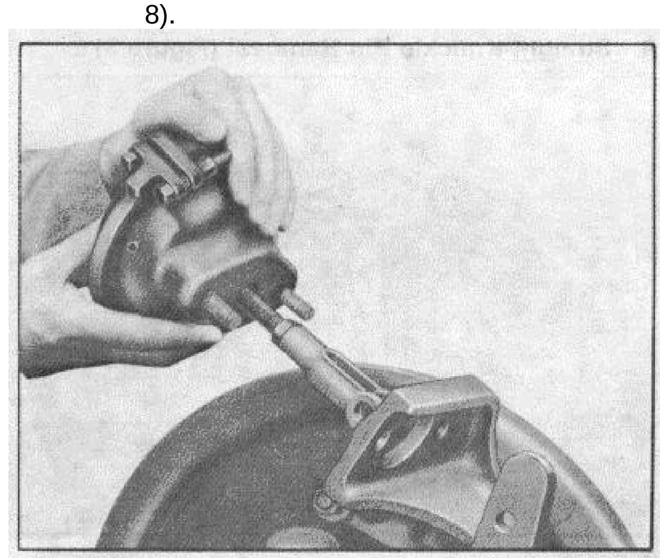


Figure 8

B. Remove the knuckle pin cover capscrews, cover and cover gasket.

C. Knuckles employing lower expansion plugs and lock rings:

1. Remove the lock ring with a pair of snap ring pliers.

2. Dislodge and remove expansion plug with a small drift.

D. Remove knuckle pin cotter key and nut (Figure 9).

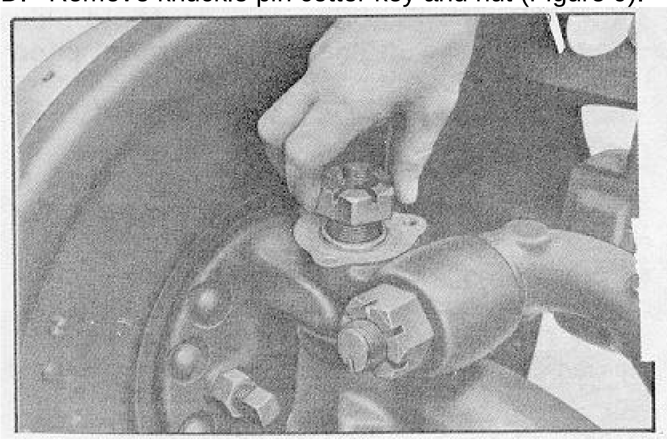


Figure 9

E. Drive knuckle pin out by use of drift on upper end. Bronze drift should be used to avoid any damage to threads (Figure 10).

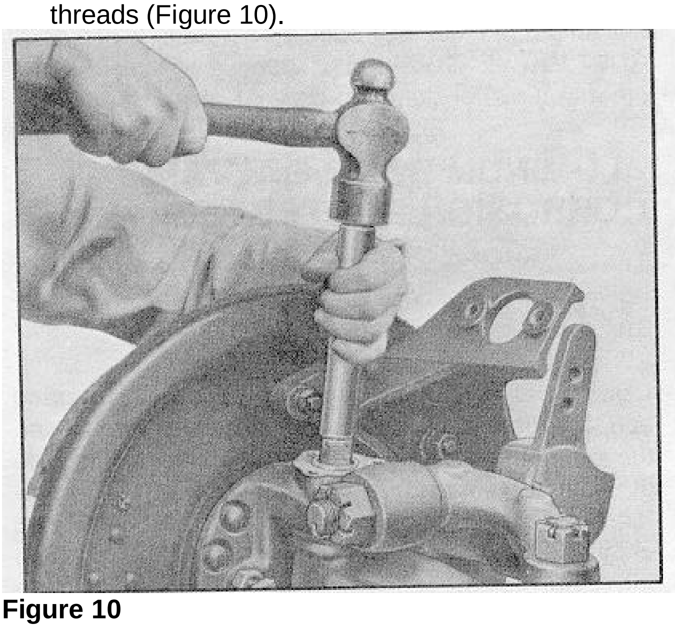


Figure 10

CAUTION: Do not strike these hardened steel pieces directly with a steel hammer. Personal injury from chips or splinters may result.

F. Remove the knuckle pin sleeve and lift off steering knuckle, thrust bearing, spacing washers, and backplate assembly (Figure 11).

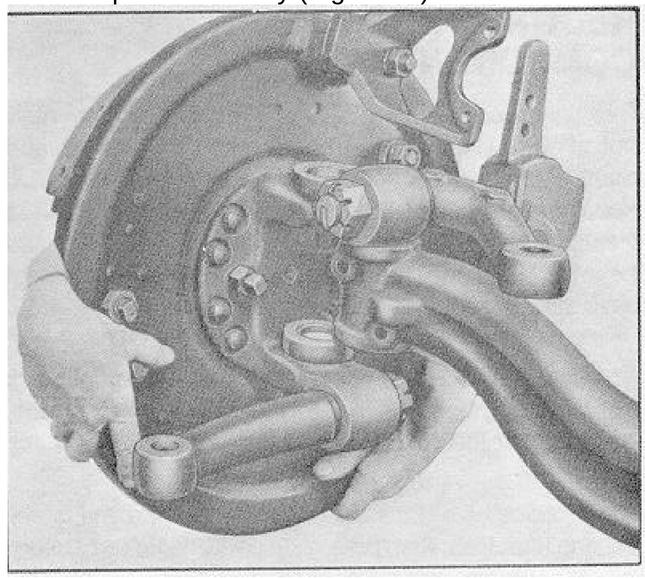


Figure 11

G. Inspect the grease seals for tears, rips and deterioration. Do not remove the seals from the steering knuckle unless replacement is necessary or if the knuckle is to be rebushed. If a seal must be removed, pry it out with a screwdriver (Figure 12).

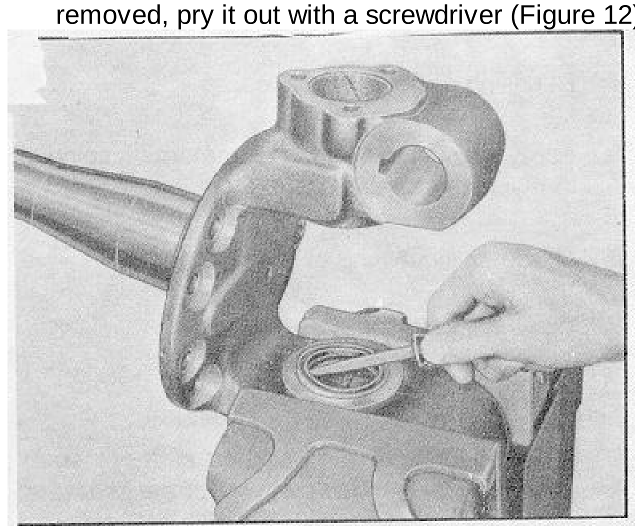


Figure 12

H. Bushing Removal

1. Delrin bushings require no tools for removal Bronze and Easy Steer bushings require a 5ton press and a simple tool. See assembly section for details. Fixture the knuckle rigidly with the king pin hole vertical. Press the bushings out slowly with frequent stops to check alignment of the tool with the bushing bore and with the press ram face.

RECONDITIONING OF COMPONENTS

Repair or reconditioning of any front axle components is not allowed. Rockwell strongly recommends replacement of any component which is damaged or out of specification. All of the major components are heat treated and tempered and cannot be bent, welded, heated or repaired in any fashion without experiencing a strength or fatigue life reduction.

This is a partial list of operations strictly prohibited on front axle components. For further items or explanation contact your local Rockwell Technical Representative.

1. Welding of, or to, steering arms, tie rod arms, steering knuckles, king pins, axle centers, tie rod assemblies, hubs, drums or brakes.
2. Hot or cold bending of spindles, steering arms, tie rod arms, bull studs, axle centers or tie rod assemblies for any reason.
3. Redrilling and bushing of axle center king pin holes.
4. Redrilling of draw key holes.
5. Spray welding of bearing diameters on spindles or in machined bores.
6. Milling or machining of any component.
7. Relocation of tie rod clamps.

CLEANING

Parts having ground and polished surfaces such as knuckle pins, knuckle pin sleeves, bearings and spindles, should be cleaned in a suitable solvent such as kerosene or diesel fuel.

CAUTION: Exercise care to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners. GASOLINE SHOULD NOT BE USED AS A SOLVENT.

DO NOT clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates or phosphates.

ROUGH PARTS

Rough parts such as cast brackets and some brake parts, may be cleaned in hot solution tanks with mild alkali solutions, providing these parts are not ground or polished. The parts should remain in the tank long enough to be thoroughly cleaned and heated. This will aid the evaporation of the rinse water. The parts should be thoroughly rinsed after cleaning to remove all traces of alkali.

CAUTION: Exercise care to avoid skin rashes and inhalation of vapors when using alkali cleaners.

DRYING

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless, absorbent paper towels or wiping rags free of abrasive material, such as lapping compound, metal filings or contaminated oil. Bearings should never be dried by spinning with compressed air.

CORROSION PREVENTION

Parts that have been cleaned, dried, inspected and are to be immediately assembled, can be coated with light oil to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good RUST PREVENTIVE and wrapped in special paper or other material designed to prevent corrosion.

ALUMINUM BEAM GALVANIC CORROSION PROTECTION

The following recommendations are for protection against galvanic corrosion of the steel-aluminum contact points on aluminum beam axles:

Using an aluminum spacer between the steel spring and the axle beam will eliminate galvanic corrosion on the axle beam. If it is necessary for the steel spring to be in direct contact with the aluminum axle, it is recommended that the spring pad area be treated with a zinc chromate paint. The entire spring pad, as well as the inner surface of the dowel and U-bolt should be covered.

The U-bolt should be. used with flat washers that are cadmium plated and dichromate converted per Federal Specification QQ-P-416, Type II. The clearance space between the U-bolt and the holes in the axle spring pad should be filled with a rust preventive compound, such as.Texaco Compound L, to prevent water from standing in this space.

INSPECTION

It is impossible to overstress the importance of careful and thorough inspection of steering knuckle components prior to assembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary, will eliminate costly and avoidable front end difficulties.

A. Inspect the steering knuckles, king pins, steering arms and tie rod arms and replace if indications of weakness, cracks or excessive wear is found. Cracks can be located by die check, magnetic particle or fluorescent particle inspection performed by a qualified technician.

B. Check spindle bearing diameters for size and condition. Replace spindle if bearing diameters are under specification, discolored from heat or severely scored.

C. If tie rod arm or steering arm has been removed, inspect tapers for fretting pits. If the tapered hole in the knuckle is fretted and pitted replace both the knuckle and the arm. If only the arm taper is fretted, replace only the arm.

D. If the king pin has worn through the bushing and into the knuckle, replace the knuckle.

E. Check the tightness of the steering connections such as cross tube arms, steering arm, etc.

F. For units with sealed knuckle pins, check knuckle pin seal for rips, tears and excessive wear. Do not remove the seals from the steering knuckle unless replacement is necessary or the knuckle is to be rebushed.

G. Remove the thrust bearing seal from the thrust bearing case and inspect the seal for wear, rips and tears. On aluminum axles with integral seals, do not remove seal.

H. Check thrust bearing.

1. Check knuckle pin bushings for wear, flaking or scoring. Compare diameter with correct specification, if the bushing diameter is .010" greater than the new bushing dimension, replace the bushings.

J. Check axle center bore for condition and size. Replace center if bore is .001" greater than specification.

IMPORTANT: Any indication of looseness in the total steering linkage arrangement under normal steering loads is sufficient cause to immediately check all pivot points for wear, regardless of accumulated mileage. Steering linkage pivot points should be checked each time the axle assembly is lubricated.

TIE ROD AND TIE ROD END INSPECTION

A. Check seals visually for any indication of damage, also check to make sure that the seal is securely seated on the socket. If the cross tube end has a grease fitting, replace damaged seals. Ends not having greasing provisions, the entire tie rod end should be replaced if seals are damaged or loose.

IMPORTANT: Rockwell does not recommend attempts to salvage damaged ends by repacking and replacing the boot seal on non-greasable ends.

B. 1. Check the turning torque value between the ball stud and the ball cavity. If torque value is less than five (5) inch pounds, the cross tube end assembly should be serviced.

2. No lateral or vertical movement should be found in any tie rod assembly when checked by hand. Leverage or prying with a tool can produce vertical movement in most tie rod ends which is inherent in their design. Use of tools for checking free play is not recommended.

3. Permanently lubricated and extended lube end assemblies should be replaced if found below specifications. Serviceable models should be rebuilt.

C. Any tie rod tubes found to be cracked, bent, dented or severely gouged should be replaced.

REBUILDING TIE ROD END ASSEMBLIES

Some older models contain tie rod assemblies which are rebuildable. These are however limited in the number of rebuilds. A determination must first be made of the condition of the socket forging. Those excessively worn must not be used again, but replaced. These can be replaced with new rebuildable or non-rebuildable end assemblies.

WHEEL BEARING INSPECTION

Wheel bearings should be very closely inspected at the time of knuckle inspection or when knuckle repair is being made.

Inspect wheel bearing cones and cups. Replace if rollers or cups are worn, pitted or damaged in any way. If wheel bearing cups are to be replaced, remove from hubs with a suitable puller. To avoid hub damage don't use drifts and hammers.

Remove all the old grease from the wheel bearings, spindle, hub cavity, and hub cap.

(The old grease may contain moisture which would lead to an early bearing failure if not removed.) Use kerosene or diesel fuel and a stiff brush. Gasoline and heated solvents should be avoided.

Allow the cleaned parts to dry, or dry them with a clean absorbent cloth or paper. Clean and dry hands and all tools used in the service operation. Grease will not adhere to a surface which is wet with solvent, and solvent may dilute the lubricant.

Bearings must be replaced if any of the following conditions exist:

1. Large ends of rollers worn flush to recess or radii at large ends of rollers worn sharp (Figure 13).

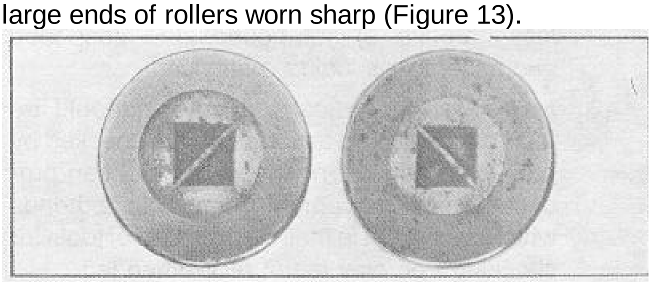


Figure 13

2. (a) Visible step wear, particularly at the small end of the roller track.

(b) Deep indentations, cracks or breaks in bearing cup and/or cone surfaces (Figure 14).

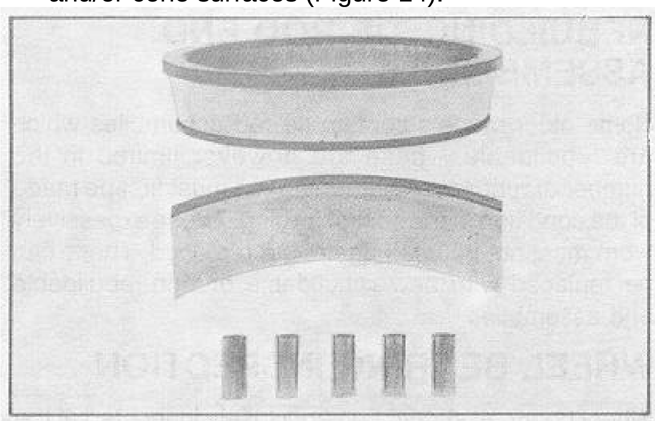


FIGURE 14

3. Bright rubbing marks on the dark phosphate surfaces of the bearing cage (Figure 15).

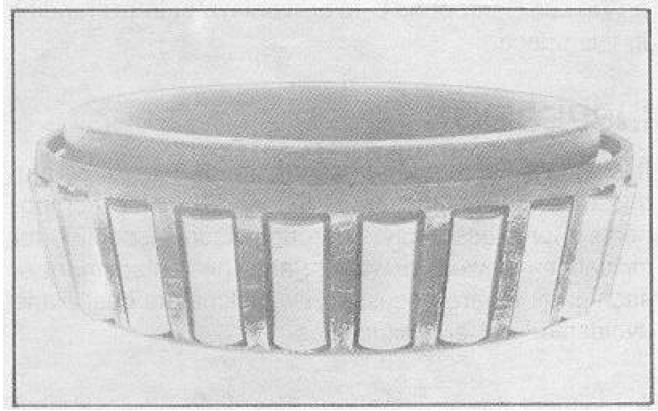


Figure 15

4. Etching or pitting on functioning surfaces (Figure 16).

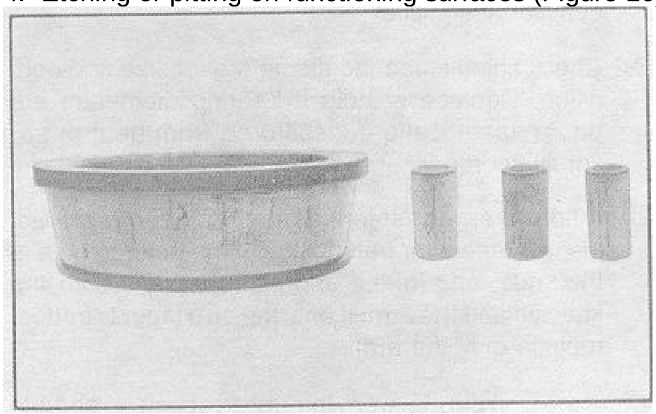


Figure 16

NOTE: Repeat bearing failures are a result of out of round hubs or spindles or indicate a poor assembly or adjusting practice.

5. Spalling or flaking on bearing cup and/or cone surfaces (Figure 17).

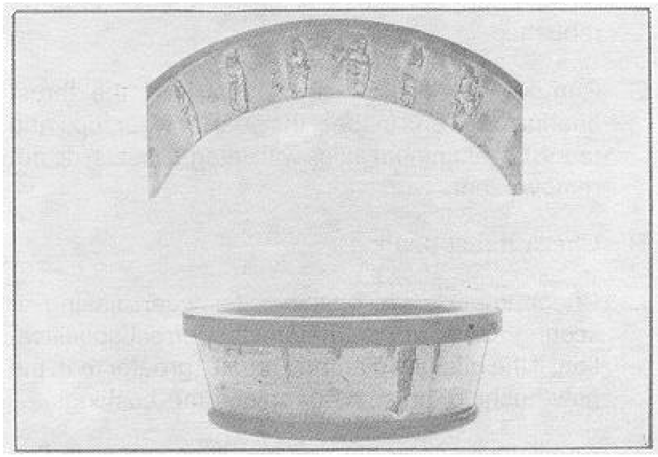


Figure 17

REPAIR AND CHECK PROCEDURES FOR ALUMINUM BEAM AXLES

Rockwell disapproves of heating, welding, bending, altering or drilling the aluminum axle center.

Repair of the spring seat howl hole is permitted, if necessary. Our recommendation is to drill out the dowel hole so that the new diameter is no more than .5" larger than the original diameter. Install an aluminum bushing (aluminum alloy 7075-T73 or 7075-T76) with an interference fit of .000" to .003". The bushing should be shrunk by freezing prior to installation in the enlarged hole. Pressing the bushing into place at ambient temperature is not recommended. Under no circumstances should the axle center dowel hole be expanded by heating during installation of the bushing.

NOTE: If brakes require service, refer to RKc6kwell Field Maintenance Manual No. 4 for CamMaster, Brakes. (Also Disc.)

ASSEMBLE FRONT AXLE

REPLACEMENT OF BRONZE OR STEEL BACKED BRONZE STEERING KNUCKLE BUSHINGS

A tool used for removal of old and the installation of new steering knuckle bushings is shown below. The tool can be made from a piece of round bar stock which is machined with a step to serve as a pilot. This tool is not required for Delrin bushings.

BUSHING REMOVAL AND INSTALLATION TOOL (Figure 18)

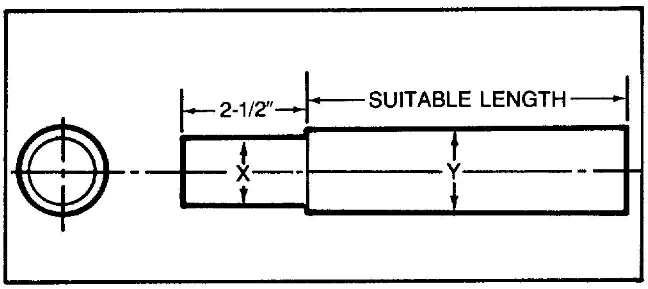


Figure 18

Dimension "X" is 0.010" less than the bushing bore.

Dimension "Y" is 0.010" less than the steering knuckle bore.

See page 15 for dimensions.

A minimum press capacity of 5 tons is required to remove bronze and easy steer bushings.

IMPORTANT: Fixture the knuckle firmly on the bed of the press to avoid knuckle slippage during bushing removal or Installation.

A. The worn bushings are pressed out of the knuckle, employing tool shown.

B. The new bushings will be installed with the same tool. The pilot of this tool prevents collapse or distortion of bushing during installation.

BUSHING INSTALLATION

STANDARD BRONZE BUSHINGS

Before installation, the bushings on some models must be properly oriented.

The grease hole in the bushing must line up with the grease hole in the knuckle. The circumferential grease groove should be positioned toward the end of the king pin.

First press bushing into knuckle approximately 1/8", relieve press pressure and check alignment of tool and bushing. The bushing can now be pressed in until it is flush with the top machined surface of the knuckle. For those designs that have king pin seals, the bushing can be pressed in until it is .135" to .165" from the inside machined surface of the knuckle. This applies to both upper and lower bushings. Do not install seals until after the reaming operation is completed (Figure 19).

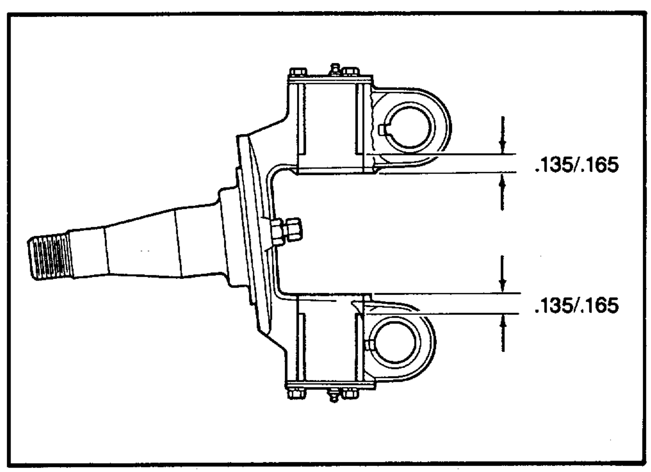


Figure 19

EASY STEER BUSHING INSTALLATION

Steel Beam Axle FF-941, FG-943, FG-941, FF-942, FF-943, FF-944 Models (Figure 20)

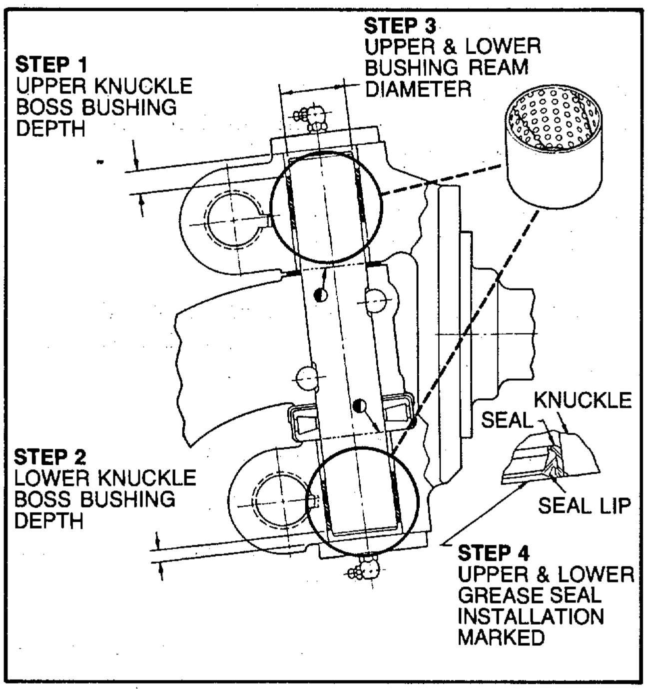


Figure 20

A. Press **upper** bushing into knuckle approximately 1/8" and relieve pressure. Bushing can now be pressed to the desired depth of .352"1.382" from the top of the machined surface.

B. Place knuckle bottom side up and follow same procedure as step #1 to a depth of .352"1.382" from the bottom machined surface.

C. Ream bushings to specified diameter (see page 15).

D. Assemble the upper and lower grease seals as per instructions on page 16 after reaming.

Aluminum Beam Axles 941-A Models

A. Press **upper** bushing into knuckle approximately 1/8" and relieve pressure. The bushing can now be pressed to the desired depth of .445"1.475".

B. Place knuckle bottom side up and follow same procedure as step #1 to a depth of .290"1.320".

C. Ream bushings per specifications on page 15.

All other Models

For all other models follow the bronze bushing sealed king pin design installation procedure for installation and use chart page 15 for new bushing diameter.

NOTE: Easy Steer retrofit kit may contain king pin seals which are not part of the original design of the axle assembly. The Easy Steer bushings are to be installed .135" to .165" from the inner knuckle yoke faces. The grease hole in the bushing must line up with the grease hole in the knuckle.

BUSHING SIZING METHODS D

ELRIN BUSHINGS
(No Sizing Required)

BRONZE BUSHINGS
(Recommended Method)

Reaming -this is the only method of sizing bushings which gives accurate size and alignment of bores as good as a new factory finished part. Single purpose piloting reamers per the illustration and charted dimensions are the best.

An acceptable but less accurate reamer is a multipurpose adjustable piloting reamer. One reamer, through trial and error, can accurately be sized to fit several axle sizes. This is not a preferred method since the cutter cannot be gaged for diameter and bushing bore alignment is not very accurate. It is however, a more universal and affordable tool.

Methods Not Recommended

Burnishing- burnishing bars and balls are seldom the correct size and do not provide alignment of the upper and lower bushing bores.

Honing -although this is the most universal method of sizing bushings, it is not recommended because it does not provide good bushing bore alignment. Bushing bore size is good with this method.

EASY STEER BUSHINGS

Reaming -as with bronze bushing, a new axle finish can only be accomplished with a reamer. See details under "Bronze Bushings."

Methods Not Recommended

Burnishing- the Easy Steer bushing material is too resilient to be sized with burnishing bars or balls.

Honing -this method does not work well with the Easy Steer bushing material and does not provide proper alignment of the bores. This can be used as a last resort but must be done dry (no lubricant) and with new stones.

REAMING PROCEDURE

REAM UPPER BUSHING FIRST (Figure 21)

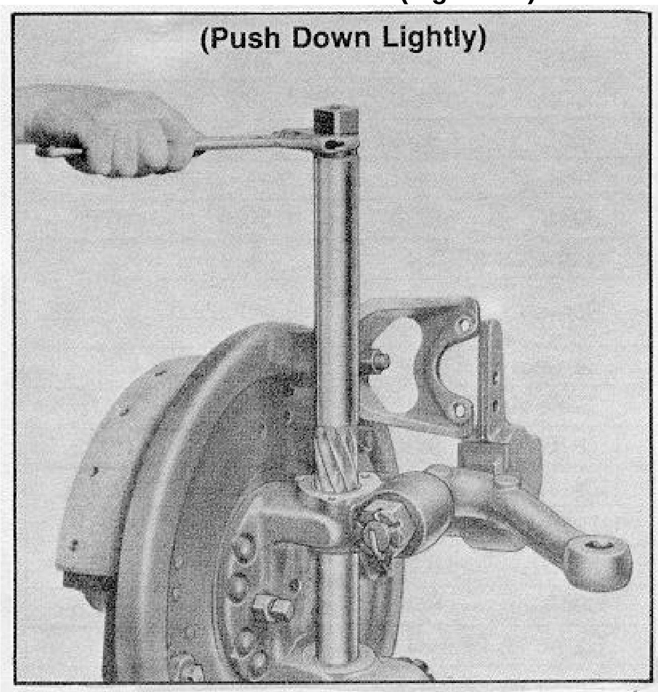


Figure 21

1. Position the knuckle in a vise with soft metal shims to protect the knuckle. It is preferable to have the king hole vertical.

2. Gently slide the reamer pilot through the upper bushing until the reamer cutters begin to engage the upper bushing.

3. Begin rotating the reamer and applying a light downward pressure with your hand at the same time. Do not force the reamer by applying too much downward force. The reamer can be rotated at any speed but should be done smoothly.

4. After the reamer sizes most of the upper bushing, support the reamer so that it does not drop to the bottom bushing as it completes the cut.

5. After the upper bushing has been sized, gently slide the reamer through until it engages the bottom bushing. Repeat steps 3 and 4 for the bottom bushing.

6. Slide the reamer out through the bottom. If the reamer must be pulled back up through the bushing do so only while rotating the reamer in reverse. Any other way will damage the bushings.

7. Clear bushing debris from bores before installing seals.

REAM LOWER BUSHING SECOND (Figure 22)

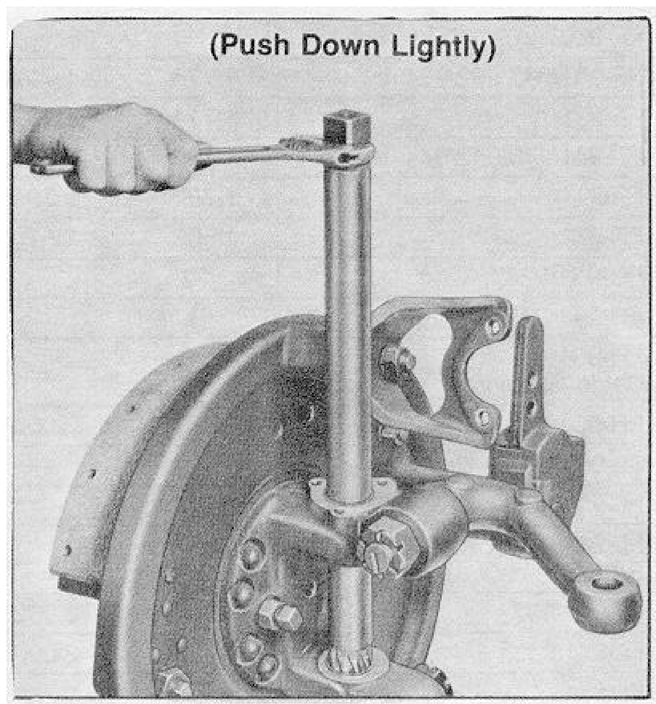


Figure 22

REAMING SPECIFICATIONS

Axle Model	Reamer Tool Dimensions (All Dimensions in Inches)				Bushing Removal and Installation Tool Dimensions (All Dimensions in Inches)	
	'A' (±0.001)	'B' (±0.0005)	'C' (±0.001)	'D'	'X' (±0.001)	'Y' (±0.001)
FC-901, 900 and FC-901 'Easy Steer' Retrofit	1.2205	1.2355	1.2305	6.75	1.218	1.315
FD-900/901/903	1.422	1.4370	1.4315	8.50	1.417	1.552
FD-901/903 'Easy Steer' Retrofit	1.420	1.435	1.430	8.50	1.417	1.552
FD-931	1.596	1.6100	1.6045	8.50	1.595	1.725
FD-941	1.5940	1.6085	1.6035	8.50	1.595	1.725
FE-900	1.596	1.6100	1.6045	8.30	1.595	1.725
FE-970 Delrin Bushing(1)	—	—	—	—	—	—
FE-970	1.596	1.6100	1.6045	8.30	1.595	1.725
FF-901/903	Same as FF-931					
FF-901/903 'Easy Steer' Retrofit	Same as FF-941					
FF-921	Same as FF-931					
FF-930	Same as FF-931					
FF-931/933/932/934	1.774	1.7970	1.7915	9.30	1.780	1.912
FF-931-A	1.774	1.7970	1.7915	10.25	1.780	1.912
FF-941/943/942/944	1.780	1.7955	1.7905	10.25	1.780	1.912
FF-941-A	1.780	1.7955	1.7905	10.25	1.780	1.912
FF-971	1.596	1.6100	1.6045	8.90	1.595	1.725
FG-931/933	Same as FF-931					
FG-941/943	Same as FF-941					
FH-901 Delrin Bushing(1)	—	—	—	—	—	—
FH-901/903	1.987	2.0025	1.9965	10.1	1.987	2.116
FL-901 Delrin Bushing(1)	—	—	—	—	—	—
FL-901/903	Same as FH-901					
FL-901/903 'Easy Steer' Retrofit	Same as FL-941					
FL-931/933	1.987	2.0025	1.9965	10.1	1.987	2.116
FL-941/943	1.985	2.0005	1.9955	10.1	1.987	2.116
FL-951	Same as FL-931					
FL-951 'Easy Steer'	Same as FL-941					
FQ-901/921	2.0495	2.0645	2.0590	11.315	2.047	2.179
FU-901/910/915/ 900/930/935	Same as FQ-901					
FAE-951	1.0145	1.110	1.115	5.8	1.104	1.223
16931	Same as FF-931					
17100	Same as FF-931					

NOTES: (1) On Models equipment with Delrin bushings, the reamer and the removal/installation tool are not required.

GREASE SEAL INSTALLATION

IMPORTANT: Do not install seals until bushings have been reamed; seals will be damaged during reaming.

BRONZE BUSHING KNUCKLES

A. Place steering knuckle bottom side up in a vise equipped with soft metal protectors. Position upper knuckle boss (top end down) between jaws of vise and lock securely.

NOTE: Seals must be oriented as shown.

Reversal of a seal will prevent purging of grease.

B. With the top end of the knuckle held firmly in this position, place the seal over the knuckle counterbore, with the rubber lip facing up.

C. Using a suitable sleeve and a bronze drift, tap the seal into the knuckle until it bottoms against the bushing or counter bore.

D. Repeat this procedure by reversing the knuckle for the lower seal.

NOTE: In the absence of a suitable driver, do not tap the seal in with a hammer. See the seal in the opening and cover it with a rigid flat metal plate. Tap the plate with a hammer directly over the seal until the seal is flush with the machined surface. Do not drive the seal any further.

EASY STEER BUSHING KNUCKLES

A. Follow instructions for bronze bushed knuckles A, B and C.

B. Using a suitable sleeve and a bronze drift tap the seal into the knuckle bore until it is flush with the machined surface as shown in Figure 23.

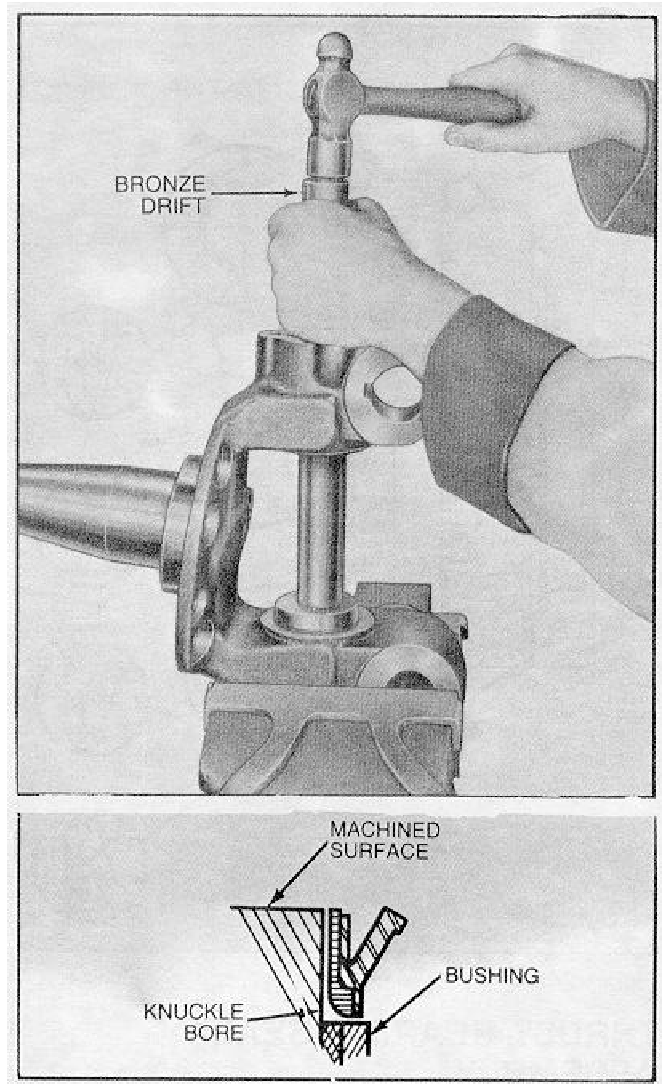


Figure 23

EASY STEER RETROFIT INTO NON-SEALED AXLE DESIGNS ONLY

A. A driver is required to position the seals in the knuckle bore.

B. Position the seals against the bushings as shown.

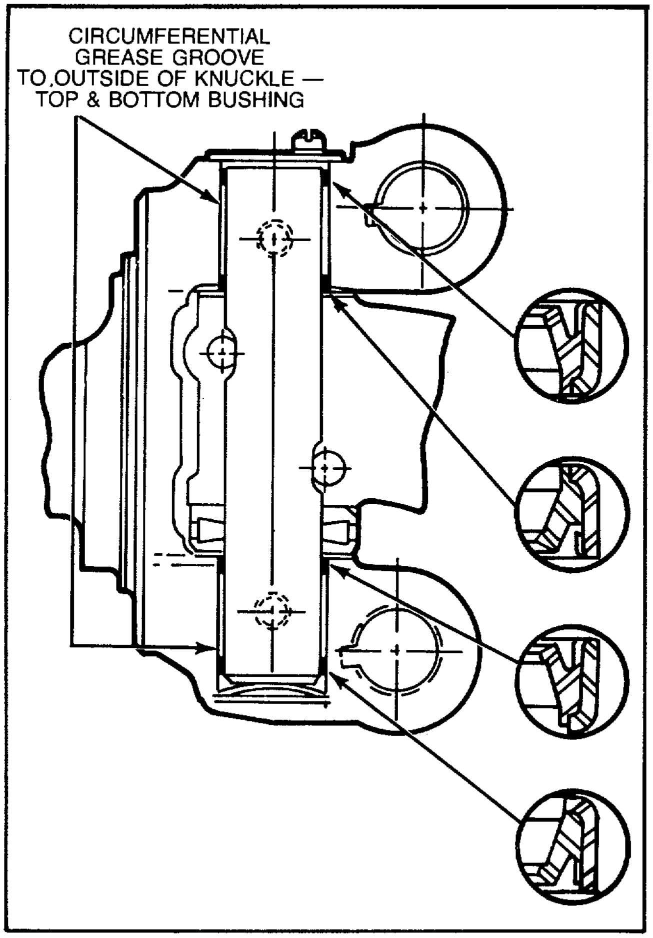


Figure 24

THRUST BEARING SEAL ASSEMBLY

NOTE: Aluminum beam axles employ an integral thrust bearing and seal assembly (Figure 25).

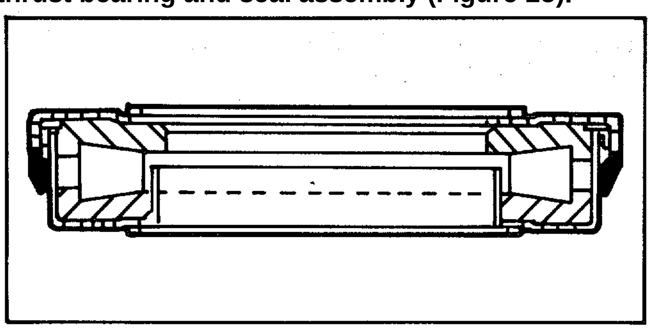


Figure 25

NOTE: Some of the thrust bearings used in front axles have the word "TOP" stamped on the flat face of the bearing retainer. The stamped word "TOP" should NOT be used for bearing installation purposes. Refer to the following instructions for proper bearing positioning.

FRONT AXLES WITH THRUST BEARING SEALS

A. Before installing the thrust bearing and seal assembly on the steering knuckle, make certain the seal is assembled to the thrust bearing correctly.

B. Hold thrust bearing with the opening between the bearing cage and the retainer up. Then snap the seal securely over the opening (Figure 26).

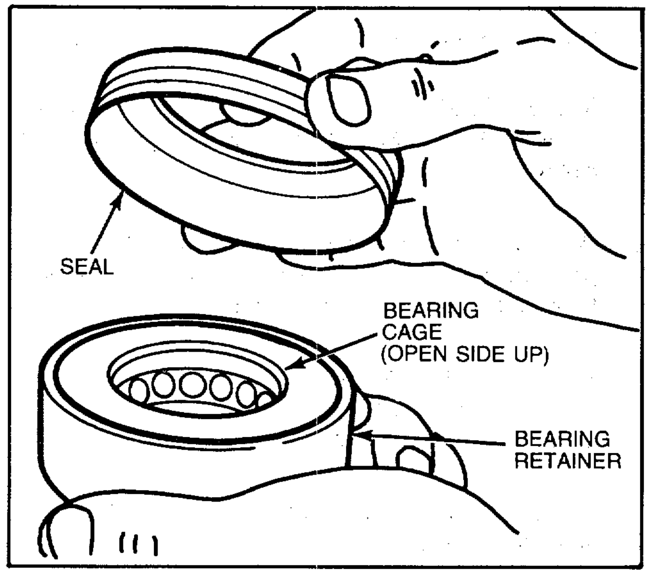


Figure 26

FRONT AXLES WITHOUT THRUST BEARING SEALS

No sub-assembly is required.

KNUCKLE TO AXLE CENTER ASSEMBLY

A. Clean knuckle and axle center bores of any dirt and debris, and dry components.

B. Place the knuckle in position on the axle center.

THRUST BEARINGS WITH SEALS

With the seal positioned on top of the thrust bearing, slide the bearing and seal assembly between the lower face of the axle center and the upper face of the lower knuckle yoke (Figure 27).

IMPORTANT: The thrust bearing must be seated on the upper face of the lower knuckle yoke. On axles WITH thrust bearing seals the seal must always cover the opening between the bearing cage and retainer. Always install the bearing and seal assembly in the axle with the seal on top (Figure 27).

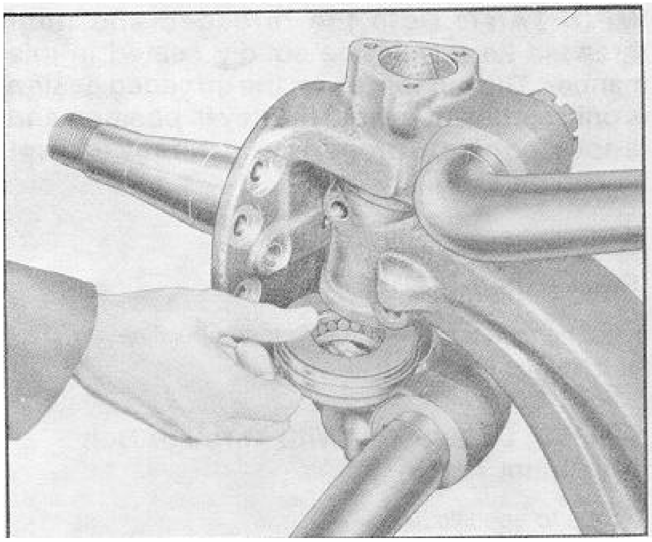


Figure 27

THRUST BEARINGS WITHOUT SEALS

With the open side of the thrust bearing facing down, slide the bearing between the lower face of the axle center and the upper face of the lower knuckle yoke (Figure 28).

IMPORTANT: The thrust bearing must be seated on the face of the lower knuckle yoke. On axles WITHOUT thrust bearing seals the bearing should always be installed in the axle with the closed retainer face up and the cage face (with the opening) down (Figure 28).

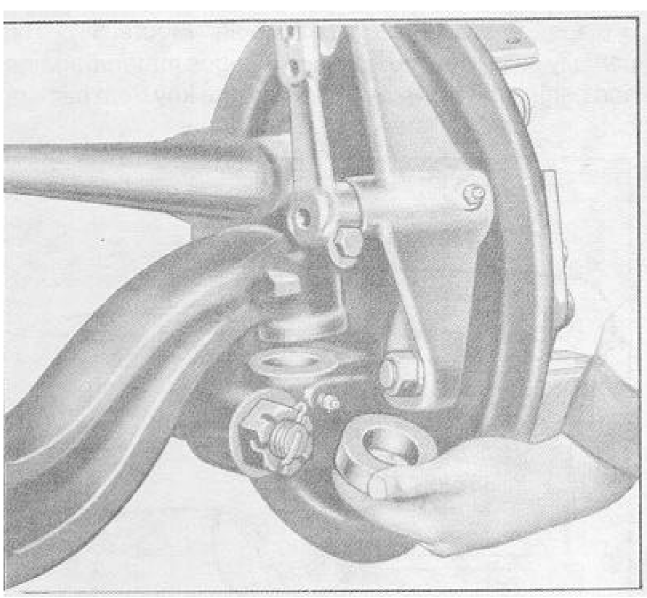


Figure 28

SHIM ASSEMBLY (Figure 29)

Shims must now be positioned between the upper axle center face and the upper knuckle yoke. Shims are used to limit the vertical movement of the knuckle with respect to the axle center and king pin. Some clearance in this area is required however to allow grease to purge from the upper bushing area. Carefully inspect shims, new or used, to be sure none are kinked, bent or torn. Discard any that are damaged. Select a quantity of shims to obtain as little vertical end play as possible. Lift the knuckle in position and slide the shim pack between the axle center boss and the knuckle upper yoke.

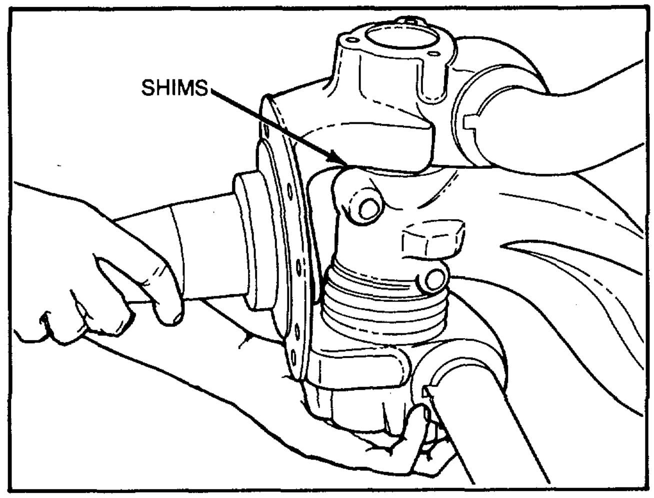


Figure 29

Alignment of the king pin hole in the knuckle and axle center is now required for king pin installation. While looking down through the king pin hole, shift the knuckle to align it with the axle center. Now align the shims to be flush with the axle center around the entire circumference of the king pin hole. The shim alignment can only be done through the upper bushing. Any protrusion of any portion of the shim will prevent the king pin from passing through and result in a damaged shim.

NOTE: Shims are delicate and sharp. Extreme caution should be exercised while aligning shims so as not to cut fingers or bend the Inside diameter of the shims. Damage to the shims during this entire procedure requires disassembly and replacement of the damaged parts.

KING PIN INSTALLATION

Straight King Pins

A. Smear clear chassis grease on the bottom half of the king pin and insert it slowly into the top of the knuckle. King pins are marked with the Rockwell logo, part number and the word “top" on the top end of the pin. Rotate the pin to align the drawkey slots with the drawkey holes in the axle. Slowly push the pin through the bushing, seal and shim pack. The pin should slide through the shim pack freely. Any resistance greater than a hand push indicates misalignment. Remove the pin and realign the components. After the pin is inserted through the shim pack a brass hammer may be used to assist in installation. Care must be taken not to dislodge the lower grease seal as the king pin enters the lower knuckle yoke.

B. Center the king pin in the knuckle to equalize the distance fr6m the top and bottom surfaces. For knuckles with a bottom welsh plug arrangement, increase the bottom gap to allow for assembly of the welsh plug and snap ring.

C. Lightly tap the drawkeys into position, flat side toward king pin; do not firmly seat them until after the end play measurement. Install the lower drawkey from the front side and the upper drawkey from the rear. Aluminum axles use a double drawkey arrangement with a through bolt. Assemble so the wedged ends of the two keys contact the king pin and torque to restrict pin from moving while the end play is measured. Measure end play per procedure on page 21 and adjust if necessary.
NOTE: Never install both drawkeys from the same side.

Seating Keys

After the specified end play is obtained, seat the drawkeys firmly with a hammer and drift all except aluminum axle which does not require seating (Figure 30).

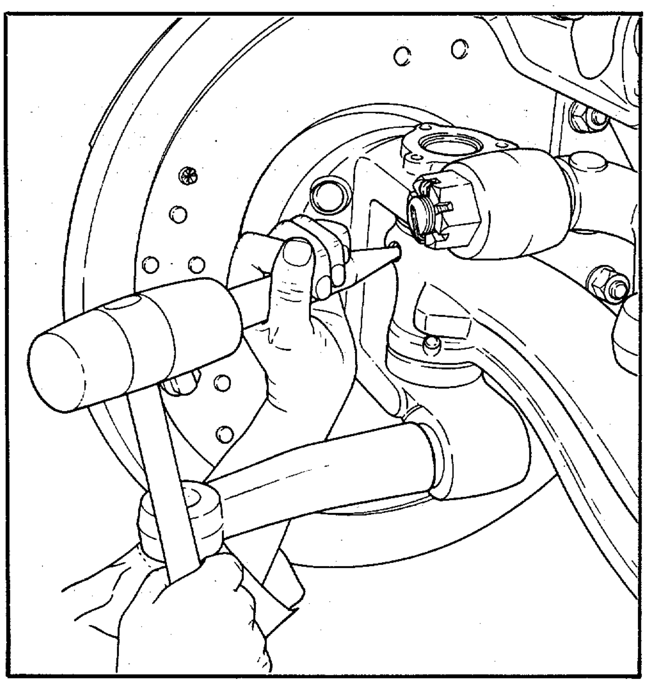


Figure 30

IMPORTANT: Both the threaded and non-threaded keys must be solidly seated in this manner. The nut torque on the threaded design is only sufficient to hold the key in position and is not adequate to properly seat the key (except aluminum axle).

Securing Threaded Drawkeys (Steel Axles)

Install flanged locknut and torque to specification. (Refer to torque chart.)

Securing Double Key With Through Bolt (Aluminum Axles)

Torque to specification.

Securing Plain Drawkeys

Plain drawkeys are secured by staking with a pointed punch and must therefore be only slightly below the forged surface of the axle center. King pin kits are supplied with three different length upper (shorter) and lower (longer) drawkeys.

The seated drawkeys should be 1/32" minimum to 1/8" maximum below the forged surface of the axle center boss. If the key falls out of this range, drive it out and replace it with the appropriate size.

Use a sharp pointed steel punch to indent the forging in 3 places around the drawkey hole (Figure 31). This partially collapses the hole and wedges material against and behind the drawkey to prevent the key from backing out.

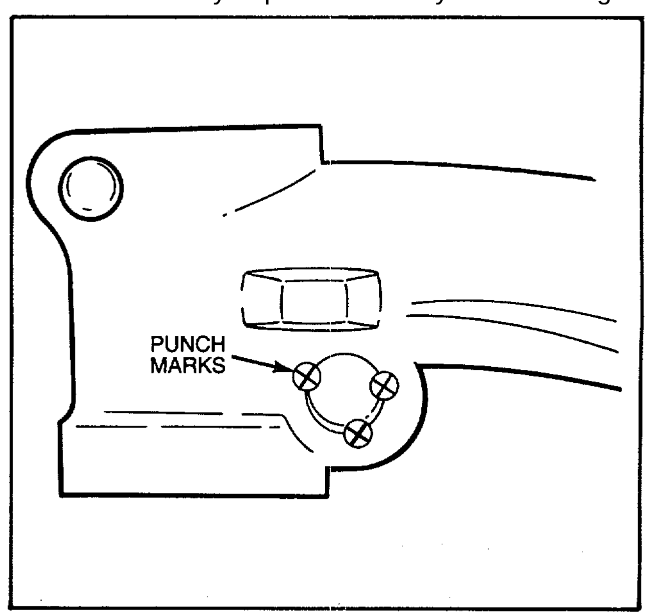


Figure 31

Tapered King Pin

A. Smear chassis grease on the tapered section of the pin and insert the pin from the bottom of the knuckle.

B. Smear chassis grease on the inside and outside of the king pin sleeve and insert it into the upper bushing bore over the king pin.

C. Install king pin nut, and torque only enough to seat the king pin for end play measurement.

D. Measure end play per procedure on page 21 and adjust if necessary.

E. Torque nut to specification and install cotter key. If the cotter hole does not align with the nut castellation, advance the nut. Do not back the nut off.

Rockwell does not recommend measurement of clearance tolerances on steering knuckles with shim gauges (feeler gauge). These will not give an accurate reading of end play. Use only a dial indicator.

Procedure for Measurement of Knuckle End Play

NOTE: End play is the free movement of the steering knuckle up and down along the axis of the king pin. Some end play is required to prevent binding of the knuckle while turning and to provide a passage for grease to purge during bushing lubrication. Excessive end play can cause interference between the king pin and end caps or retainers.

A. With king pin caps off, turn the knuckle to the straight ahead position. Take a rubber mallet and repeatedly strike the top draft of the knuckle as shown. This will shift all of the components down and remove grease layers so an accurate reading may be taken (Figure 32).

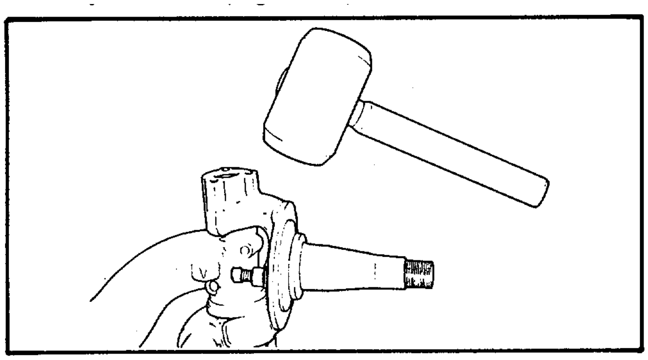


Figure 32

B. Attach the dial indicator with a "C" clamp or magnetic base to the knuckle spindle such that the knuckle can be turned freely as shown (Figure 33).

C. Place the dial indicator plunger on the exposed end of the king pin so that its line of action is approximately parallel to the king pin center line (Figure 33).

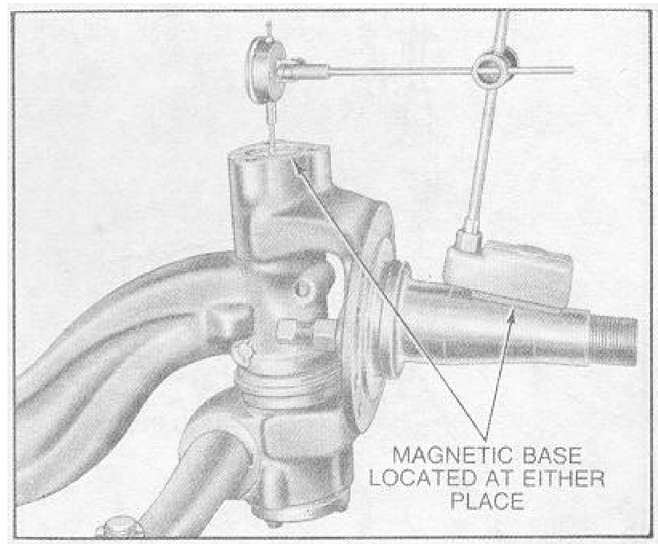


Figure 33

D. Zero the dial indicator.

E. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement (Figure 34).

NOTE: A protective pad, such as a piece of cardboard or heavy tape, should be placed between pry bar and aluminum axle center to prevent grooves.

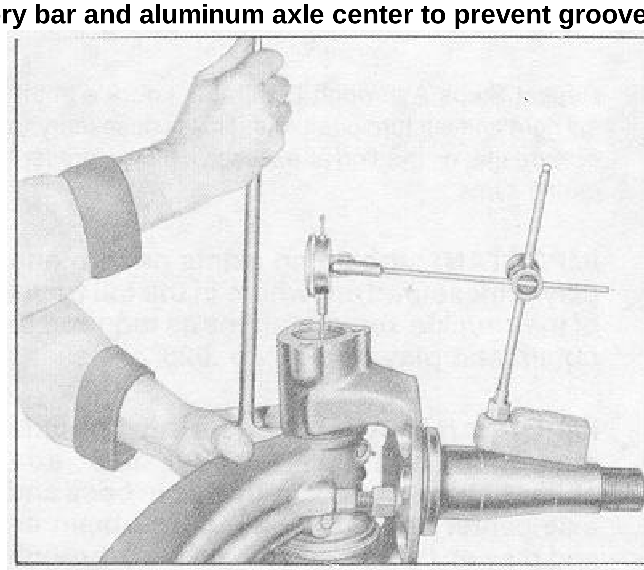


Figure 34

A small hydraulic jack under a block of wood can be used beneath the knuckle to provide the necessary lift. Keep lifting the knuckle until the dial indicator reading levels off (Figure 35).

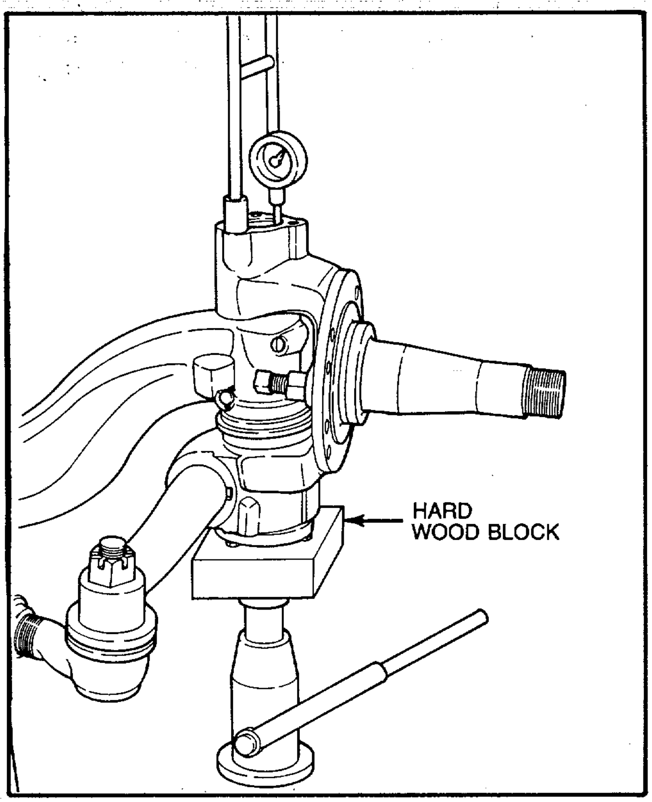


Figure 35

CAUTION: When using a hydraulic jack, be sure that the axle is supported by two jack stands. Raising the end in this manner may cause an axle supported only in the -center to tip and fall causing personal injury.

F. Repeat Steps A through E with the knuckle in the full right and left turn positions. This is necessary to be sure that no binding or excessive play is present during turns.

IMPORTANT: If binding exists or zero end play is measured anywhere in the full travel of the knuckle, remove shims as required to obtain end play of .001" to .025".

IMPORTANT: After measuring knuckle clearance (end play) of over .025" add shims between upper knuckle pin boss and axle center end, as required, to obtain an end play of .001"-.025" (.02-.64 mm) through full range of turn.

NOTE: Normal seating of the thrust bearing, seal and shims will increase the end play reading after a short time in service.

PROCEDURE FOR MEASUREMENT OF KNUCKLE AND END PLAY WITH TIRE AND WHEEL ASSEMBLY MOUNTED:

A. Securely block vehicle to prevent rolling.

B. Place a jack under the axle beam as close as possible to the knuckle end being checked and jack the vehicle up until the tire is clear of the floor.

C. Attach a dial indicator to the axle beam with a "C" clamp or magnetic base (Figure 36).

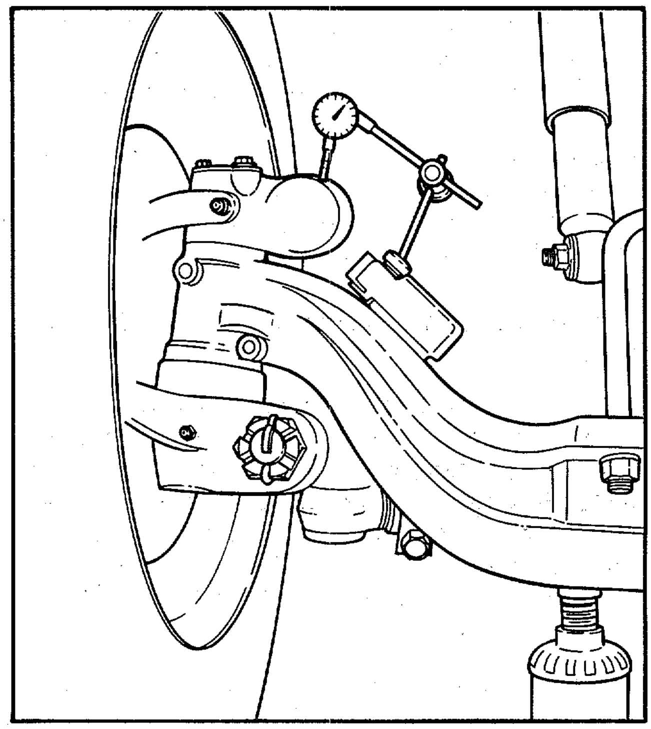


Figure 36

D. Place the dial indicator plunger on top of the king pin cap or knuckle forging so that its line of action is approximately parallel to the king pin center line.

E. Zero the dial indicator.

F. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement. On axles in service, the end play may increase to a maximum of .065" (1.70 mm) at which time it will be necessary to re-shim end play back to .001 "-.025" (.02-.64 mm)

NOTE: Both knuckles should be checked.

If a reading of over .065" is taken, remove the tire and king pin cap and remeasure as per rebuild procedure. If the reading is still over .065" then reshim to specifications.

INSTALLATION OF KING PIN CAPS, WELSH PLUGS AND RETAINERS

IMPORTANT: Before king pin caps and/or welsh plugs are Installed recheck drawkeys and king pin nut to be sure the final staking or torquing procedure has been completed. Omission of the final king pin securing steps may result in damaged or broken king pins and axle centers.

KING PIN CAPS AND COVERS

A. Align king pin caps and gaskets and assemble to knuckles with capscrews and washers.

1. Gaskets do not have a top or bottom orientation and may be installed in either position.

2. Caps do require orienting the flat side toward the gasket and knuckle. The flat, sealing side contains no numbering or lettering.

B. Torque fasteners to specification.

WELSH PLUGS

A. Place welsh plug into the lower knuckle bore with the rounded (convex) side toward the king pin.

B. Install lock ring.

C. On models not grooved for lock rings, secure the plugs in place by staking in four equally spaced places.

KING PIN RETAINERS

A. On units employing grooved knuckle pins that protrude below the knuckle lower yoke, install lock ring in groove.

The upper ends of steering knuckle are protected with covers, caps, or retainers and felts.

B. Install the cover or cap and gasket with capscrews where used.

C. Install the felt, retainer and lock ring on the protruding straight pins that are not provided with covers or caps.

GREASING PROCEDURE

A. Grease upper bushing first then lower. (Grease specification 617 A or B). If grease does not flow through the thrust bearing it will be necessary to raise the knuckle with a jack to close off passage of grease around the thrust bearing. Regrease the lower bushing and thrust bearing then remove jack.

B. Rotate knuckle lock to lock to help distribute the grease. Note the knuckle will now be noticeably harder to rotate than during the end play measurement. This is normal.

C. Repeat step 1.

D. On models using drawkeys fill the voids in the drawkey holes with grease to prevent corrosion and ease future disassembly.

INSTALLATION OF STEERING AND TIE ROD ARMS

A. Press fit key into steering arm and tie rod arm keyway near the small end of the taper.

B. Insert arms into knuckle.

NOTE: It is possible to mistakenly reverse the left hand and right hand tie rod arms. Distinction between left and right arm can be made by visualizing the tie rod assembly position.

On center point models FE970 and FF971 the tie rod ball stud is assembled into the arm from the top side; i. e. , the ball stud is above the arm.

This is also true for FU series axles with tie rod ends that are rebuildable.

All other models have tie rod assemblies that install from the bottom side; i. e. , the ball stud is below the arm.

C. Assemble nuts and torque to specification.

IMPORTANT: The correct torque range must be reached on steering arms and tie

rod arms. Torques below minimum will not seat the tapers properly and reduce service life.

D. Install cotter keys. If the cotter hole does not align with the nut castellation, advance the nut to the next castellation. Do not exceed the maximum specified torque value. Do not back nut off for cotter key hole alignment.

TIE ROD ASSEMBLY AND INSTALLATION

Tie rod assemblies with straight tubes contain left hand threads on one end and right hand threads on the other. These mate with similarly threaded tie rod ends. The ends therefore are not interchangeable. This type of assembly does not require removal from the arm for toe-in adjustment and provides very fine adjustment.

Tie rod assemblies with drop center tube contain coarse pitch threads on one side and fine pitch on the other. Ends for these are also not interchangeable. This type of assembly requires removal from the tie rod arm for adjustment since the drop center tube cannot be rotated. The differences in thread pitch provide a finer adjustment range for setting toe-in.

A. Thread end assembles into tube equally on both sides to the approximate overall length required.

B. Torque clamp lock nuts to specification.

C. Assemble tie rod assembly into the tie rod arms on the axle assembly.

D. Torque the end assembly nuts to specification and install cotter key.

E. If cotter pin hole does not align with the nut castellation, advance to the next castellation and install pin. D6 not exceed the maximum specified torque while doing this. Do not back nut off to align the cotter hole.

NOTE: If tie rod end assemblies, tie rod tubes or tie rod arms have been removed or replaced, toe in must be checked and readjusted.

GENERAL WHEEL BEARING ADJUSTMENT
ASSEMBLY

A. Assemble bearings and hub on the axle spindle.

B. Install thrust washer, if used.

C. Install the wheel bearing adjusting nut. Thread the nut against the bearing or thrust washer. Be sure there is sufficient clearance between the brake shoe and drum so brake shoe drag will not interfere with the bearing adjustment.

SEATING BEARINGS
NOTE: It is recommended that a torque wrench be employed for assembly of the adjusting nut and jam nut.

Tighten the adjusting nut to 100 lb. ft. torque while rotating the wheel in both directions to be sure all bearing surfaces are in contact. Loosen the nut completely and then re-torque to 50 lb. ft. while rotating the wheel.

FINAL BEARING ADJUSTMENT
The final bearing adjustment is designed to result in .001" to .010" end play. Always be sure that this end play has been obtained after the jam nut has been torqued or when the cotter pin has been installed.

IMPORTANT: Failure to obtain end play as specified will cause bearing overload and premature failure.

A. For axles that have single nut construction, back off adjusting nut 1/6 to 1/8 turn. Install cotter pin and measure end play, adjusting if necessary.

B. For axles that have double nut and lock construction, back off adjusting nut 1/4 to 1/3 turn. Assemble wheel bearing lock ring if used, jam nut lock and jam nut. Tighten jam nut to torque specified below. Measure end play and adjust if necessary.

	LB. FT. TORQUE	
NUT SIZE	**MIN.**	**MAX.**
1-1/8" to 2-5/8"	100	150
2-5/8" and over	100	200

C. Bend the jam nut lock over the jam nut and over the adjusting nut if no lock ring is used.

D. For assemblies using a dowelled adjusting nut, pierced lock washer, and no jam nut lock washer torque jam nut as follows, measure end play and adjust if necessary.

NUT SIZE	LB. FT. TORQUE MIN.	MAX.
1-1/8" to 2-5/8"	200	300
2-5/8" and over	250	400

STEERING STOP ADJUSTMENT

All Rockwell axles are delivered with steering stop screws preset. Adjustments are often made by the vehicle manufacturer to accommodate various chassis designs and tire sizes. steering stop adjustments on *new* vehicles are therefore not required.

These adjustments of both axle steering stops and power steering unit should be periodically checked and corrected if necessary.

The stop adjustment should be checked and corrected any time any part of the steering system is disassembled, replaced, added or adjusted.

Adjust the left and right knuckle steering stops to contact when the maximum turning angle of the specific axle is reached, and lock with jam nut (Figure 37). Refer to torque chart on page 24.

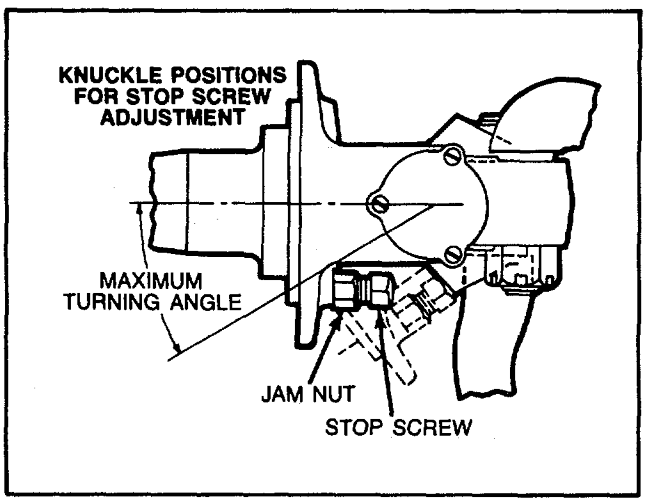


Figure 37

NOTE: Do not adjust the turn angle beyond that specified by the vehicle manufacturer.

POWER STEERING GEAR (OR CYLINDER) ADJUSTMENT

NOTE: Rockwell does not approve any power steering system without provision for pressure relief or positive mechanical stop to be set BEFORE maximum turn angle Is reached. The power must be cut off or reduced substantially ahead of the axle stop to prevent unnecessary stressing of the axle components.

MECHANICAL RELIEF

Vehicles with mechanical Pitman arm stops or assist cylinder stops should be adjusted to end the travel of the Pitman arm or cylinder 1/8" before the steering stop screw would contact the axle boss (Figure 38).

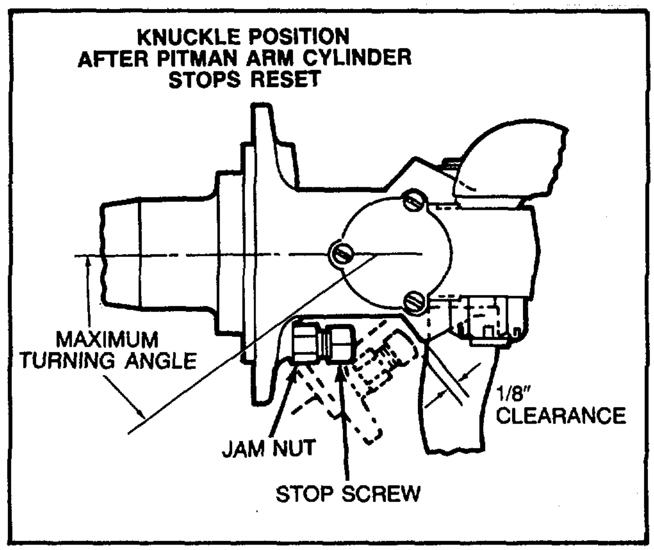


Figure 38

Maximum turn angle will then be determined by the arm or cylinder stop and not the axle stop. This must be done for full left and full right turns.

HYDRAULIC RELIEF

Hydraulic steering gears equipped with poppet valves should be adjusted while a 1/4" to 3/16" spacer is held between the axle stop pad and stop screws. The poppet valves should be adjusted to allow pressure bypass at this position with spacer in place in full left and right turn positions. During this setting the steering gear pressure should be at a minimum, 600 psi or less (Figure 39).

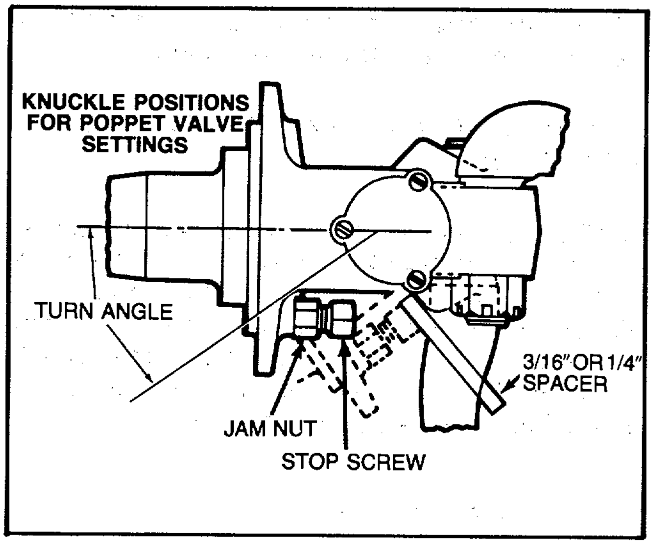


Figure 39

TOE-IN RECOMMENDATIONS

The following recommendations are for all Rockwell front steering axles.

Rockwell concurs with the tire manufacturer's recommendation of 1/16" $\pm$ 1/32" toe-in for bias ply or radial ply tires with the weight of the empty (unloaded) vehicle on the axle. For vehicles measured fully loaded the ,setting is 1/32" ± 1/32".

Do not measure toe-in with the front axle jacked up. The toe-in should be measured with the weight of the vehicle on the axle.

MAKE SURE VEHICLE IS ON A LEVEL FLOOR

A. Jack up the front axle.

B. Use paint or chalk and whiten the center area of both front tires around the entire circumference.

C. Position a scribe or pointed instrument against the whitened part of each tire and rotate the tires. The scribe must be held firmly in place so that a single straight line is scribed all the way around the tire.

D. Lower vehicle on floor and then move the vehicle backward and then forward approximately ten feet.

E. Position trammel bar at rear of tires and adjust pointers to line up with scribe lines and lock in place (scale should be set on zero). Pointers must be raised to spindle height on the tire as shown (Figure 40).

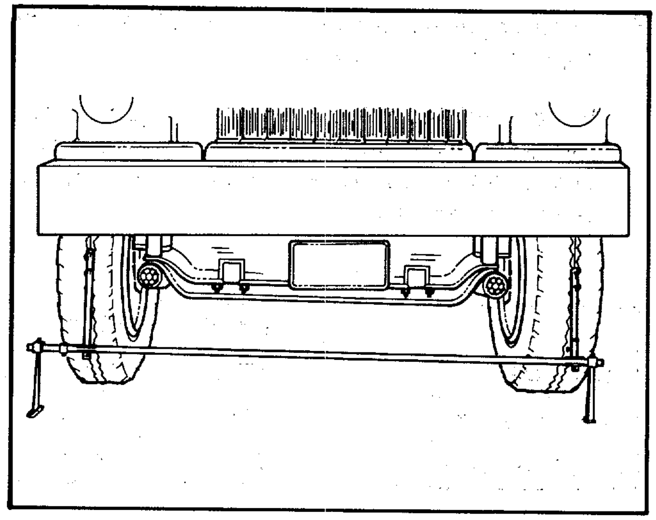


Figure 40

F. Position the trammel bar at the front of the tires. Adjust scale end so that pointers line up with scribe marks.

G. Read toe-in (or toe-out) from scale (Figure 41).

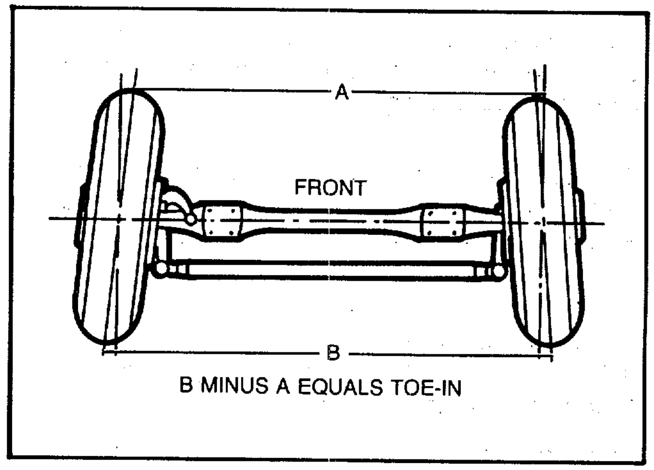


Figure 41

H. The same measurements can be made with a steel tape measure at spindle height.

Toe-in (or. toe-out) is the difference between the measurement taken at the front and rear of the tires (Figure 41).

I If an adjustment is necessary, loosen cross tube clamps and rotate cross tube as required and tighten clamps. Move vehicle backward and then forward about 10 feet. This is particularly important when setting the toe-in on vehicles equipped with radial tires.

J. Recheck toe-in setting to make SURE it is correct.

NON-DRIVING FRONT AXLE CAMBER SPECIFICATIONS
FF FG FL Series

CONDITIONS	**LEFT (DRIVER'S) SIDE**	**RIGHT SIDE**
1. Camber angles machined into axles. • less hubs. • axle not mounted under vehicle. • no load.	+3/4° nominal	+ 1/4° nominal
2. Camber angles of axle equipped with hubs. • axle not mounted under vehicle. • no load.	+ 3/4° (± 7/16°) or +1-3/16° to +5/16° (final reading)	+1/4° (±7/16°) or +11/16° to -3/16° (final reading)
3. Camber angles of FF-931, FF-941, FL-931 and FL-951 axles under rated load. • axle mounted under vehicle.	+11/16° to -3/16° (final reading)	+3/16° to -11/16° (final reading)
4. Camber angles of FF-931A and FF-941A aluminum beam axles under rated load. • axle mounted under vehicle.	+ 13/16° to -1/16° (final reading)	+ 5/16° to - 9/16° (final reading)

IMPORTANT: Camber is not adjustable. ROCKWELL DOES NOT APPROVE OF CHANGING THE CAMBER ANGLE OR BENDING OF STEEL OR ALUMINUM BEAMS. Bending the axle beam to alter camber angles is detrimental to the integrity of the axle beam.

If camber angles, of models mentioned, do not meet specifications shown in the chart, contact your area Rockwell Technical Service Representative for assistance.

Most other models have a + 10 nominal camber on the left and right sides, for condition #1. Conditions #2 and #3 are proportionally higher.

CASTER

Caster settings are determined by the vehicle manufacturer; generally, manually steered vehicles operate best at 1° to 2-1/2° positive caster. Power steered vehicles are generally set between 2° and 4-1/2° positive caster.

Center point models FE970 and FF971 are the only exceptions. These operate best at 1/2° to 2° caster.

16900 and 17100 series axles have + 30 caster machined into the axle center. All other models must be adjusted for the caster at assembly.

For maximum steering effort reduction, easy steer axles should be set at 10 positive caster.

TROUBLESHOOTING GUIDE

1a. Rapid or Uneven Tire Wear

- Incorrect toe-in setting
- Improper tire inflation
- Unbalanced tires
- Improper Ackerman steering geometry
- Tandem alignment

b. Toe-in Control

- When setting toe-in, it is important to neutralize the component and tire deflections by backing up and then going forward and rechecking the toe-in. This is especially important with radial tires. The check and possible re-set should be followed even if bearing plates are used.

2. Hard Steering

- Low power steering system pressure
- Improper assembly of steering gear box
- Inadequate or improper lubrication of knuckle pins
- Inadequate mechanical advantage of steering system in steering box ratio, lengths of pitman arm and steering arm
- Improper caster
- Tight draglink or tie rod ends
- Worn thrust bearing

3. Rapid Wear of Cross Tube Ends

- Inadequate or improper lubrication
- Improper installation of add-on type power steering cylinders
- Severely contaminative environment
- Failure of protective rubber boot

4. Bent or Broken Cross Tube, Broken Ball Stud, Bent or Broken Steering Arm or Cross Tube Arm

- Excessive power steering system pressure
- Misadjusted power steering cut-off
- Operational (curbing)
- Improper installation of add-on power steering

5. Heavily Worn or Broken Steering Arm Ballstud

- Over tightened draglink
- Inadequate or improper lubrication
- Misadjusted power steering stops

6. Excessive Wear of Knuckle Pins and Bushings

- Worn or missing seals and gaskets
- Improper type of grease
- Inadequate lubrication frequency
- Improper lubrication technique
- Inadequate lubrication frequency due to extreme operating conditions such as abrasive dust and sandy environments

7. Front Axle Shimmy or Vibration

- Incorrect caster setting
- Wheels and/or tires not properly balanced
- Worn shock absorbers

TAPERED KING PIN MODELS

KNUCKLE CAP SLOTTED SCREWS

5/16"-18	30-35 LB. IN.

KNUCKLE CAP HEX SCREWS

5/16"-18	15-20 LB. FT.

***KNUCKLE PIN NUT**

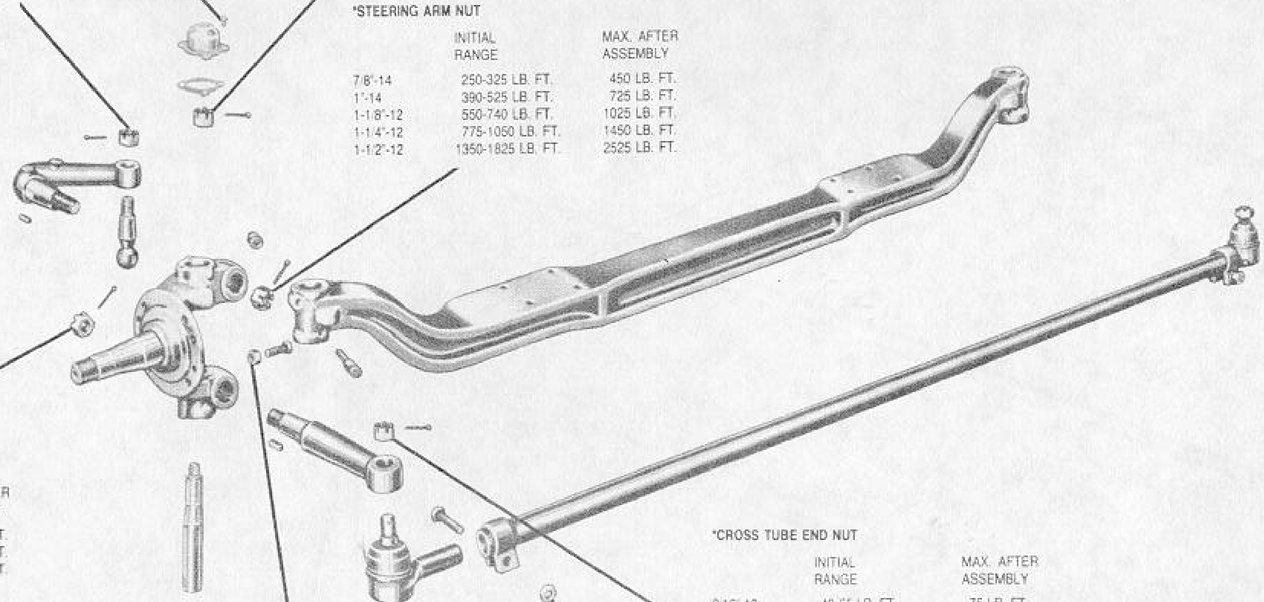
	INITIAL RANGE	MAX. AFTER ASSEMBLY
7/8"-14	160-215 LB. FT.	300 LB. FT.
1"-14	250-325 LB. FT.	450 LB. FT.
1-1/8"-12	350-475 LB. FT.	650 LB. FT.

***STEERING ARM BALL NUT**

	INITIAL RANGE	MAX. AFTER ASSEMBLY
5/8"-16	60-80 LB. FT.	115 LB. FT.
5/8"-18	60-80 LB. FT.	115 LB. FT.
3/4"-16	90-120 LB. FT.	170 LB. FT.
7/8"-14	160-215 LB. FT.	300 LB. FT.

***STEERING ARM NUT**

	INITIAL RANGE	MAX. AFTER ASSEMBLY
7/8"-14	250-325 LB. FT.	450 LB. FT.
1"-14	390-525 LB. FT.	725 LB. FT.
1-1/8"-12	550-740 LB. FT.	1025 LB. FT.
1-1/4"-12	775-1050 LB. FT.	1450 LB. FT.
1-1/2"-12	1350-1825 LB. FT.	2525 LB. FT.



***CROSS TUBE ARM NUT**

	INITIAL RANGE	MAX. AFTER ASSEMBLY
1"-14	390-525 LB. FT.	725 LB. FT.
1-1/8"-12	550-740 LB. FT.	1025 LB. FT.
1-1/4"-12	775-1050 LB. FT.	1450 LB. FT.

***CROSS TUBE END NUT**

	INITIAL RANGE	MAX. AFTER ASSEMBLY
9/16"-18	40-55 LB. FT.	75 LB. FT.
5/8"-16	60-80 LB. FT.	115 LB. FT.
5/8"-18	60-80 LB. FT.	115 LB. FT.
3/4"-16	90-120 LB. FT.	170 LB. FT.
7/8"-14	160-215 LB. FT.	300 LB. FT.
1"-14	250-325 LB. FT.	450 LB. FT.
1-1/8"-12	350-475 LB. FT.	650 LB. FT.

STOP SCREW LOCKNUT

1/2"-13	50-65 LB. FT.

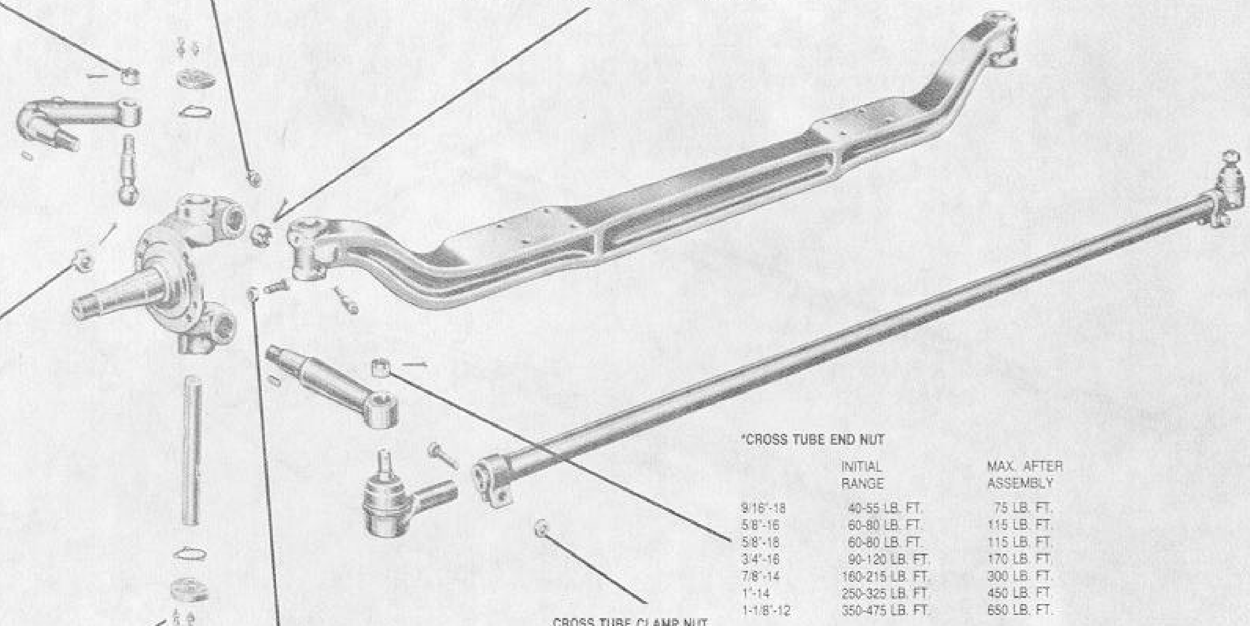
CROSS TUBE CLAMP NUT

	PLAIN NUT	LOCKNUT
5/16"-24	85-115 LB. IN.	75-100 LB. IN.
3/8"-24	18-24 LB. FT.	15-20 LB. FT.
7/16"-20	35-50 LB. FT.	30-40 LB. FT.
1/2"-20	40-55 LB. FT.	35-50 LB. FT.
5/8"-18	50-65 LB. FT.	40-55 LB. FT.

***NUT TIGHTENING PROCEDURES**

1. Torque to the initial range specified.
2. Advance the nut (do not back off) to align the cotter pin hole.
3. The final installed torque must not exceed the "Maximum After Assembly" torque specified.
4. If the final torque exceeds the maximum specified, remove the nut and reinstall to the correct specification.

STRAIGHT KING PIN MODELS



DRAW KEY WEDGE (ALUMINUM CENTER)

M10 x 1.5	30-40 LB. FT.

DRAW KEY NUT (STEEL CENTER)

3/8"-24	20-30 LB. FT.
7/16"-20	30-40 LB. FT.

*STEERING ARM BALL NUT

	INITIAL RANGE	MAX. AFTER ASSEMBLY
5/8"-16	60-80 LB. FT.	115 LB. FT.
5/8"-18	60-80 LB. FT.	115 LB. FT.
3/4"-16	90-120 LB. FT.	170 LB. FT.
7/8"-14	160-215 LB. FT.	300 LB. FT.

*STEERING ARM NUT

	INITIAL RANGE	MAX. AFTER ASSEMBLY
7/8"-14	250-325 LB. FT.	450 LB. FT.
1"-14	390-525 LB. FT.	725 LB. FT.
1-1/8"-12	550-740 LB. FT.	1025 LB. FT.
1-1/4"-12	775-1050 LB. FT.	1450 LB. FT.
1-1/2"-12	1350-1825 LB. FT.	2525 LB. FT.

*CROSS TUBE ARM NUT

	INITIAL RANGE	MAX. AFTER ASSEMBLY
1"-14	390-525 LB. FT.	725 LB. FT.
1-1/8"-12	550-740 LB. FT.	1025 LB. FT.
1-1/4"-12	775-1050 LB. FT.	1450 LB. FT.

*CROSS TUBE END NUT

	INITIAL RANGE	MAX. AFTER ASSEMBLY
9/16"-18	40-55 LB. FT.	75 LB. FT.
5/8"-16	60-80 LB. FT.	115 LB. FT.
5/8"-18	60-80 LB. FT.	115 LB. FT.
3/4"-16	90-120 LB. FT.	170 LB. FT.
7/8"-14	160-215 LB. FT.	300 LB. FT.
1"-14	250-325 LB. FT.	450 LB. FT.
1-1/8"-12	350-475 LB. FT.	650 LB. FT.

CROSS TUBE CLAMP NUT

5/16"-24
3/8"-24
7/16"-20
1/2"-20
5/8"-18

KNUCKLE CAP CAPSCREWS

5/16"-18	20-30 LB. FT.

STOP SCREW LOCKNUT

1/2"-13	50-65 LB. FT.

FOR ALL FASTENERS:

- All torques given apply to parts lightly coated with rust preventative type oil.
- For dry parts — increase torques 10%.
- For parts heavily coated with oil — decrease torques 10%.

Rockwell International

Automotive Businesses
Rockwell International Corporation
2135 West Maple Road
Troy, Michigan 48084 U.S.A.

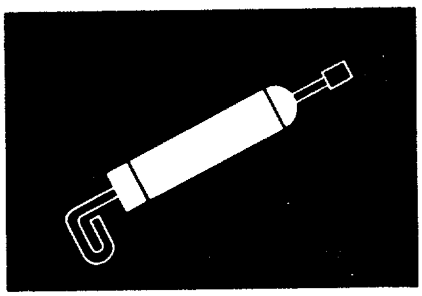
FMM #2 (10-84)
16579

Litho in USA

Section II
FRONT AXLE

Field Maintenance Manual No. 1

Lubrication



Rockwell Recommended

- Practices
- Specifications
- Lubricants
- Capacities
- Change Intervals

Rockwell International

...where science gets down to business

INDEX

INTRODUCTION

The efficiency and life of mechanical equipment is as dependent upon proper lubrication as it is upon proper engineering design. All mechanical components rely on lubrication to:

1. provide a lubricating film between the moving parts to reduce friction.

2. help cool the contacting sliding parts.

3. keep dirt and wear particles away from the mating parts.

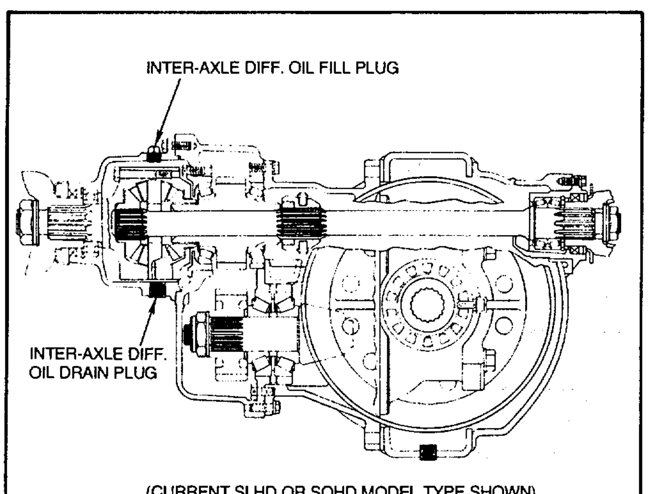
Proper lubrication depends upon using the right type of lubricant, at the proper intervals and filling to the specified capacities. Past experience has shown that many service problems can be traced to an improper lubricant or to incorrect lubrication procedures.

All of the Rockwell recommended lubrication practices, specifications and most of the product capacities are covered in this manual. It is essential to follow these procedures for adequate and proper lubrication of Rockwell components.

RECOMMENDED LUBRICATION PRACTICES

NEW AND RECONDITIONED AXLE SERVICE

Drain and flush the factory-fill axle lubricant of a new or reconditioned axle after the first 1,000 miles (1,600 km) but never later than 3,000 miles (4,800 km). Drain the lubricant (while the unit is still warm) from the carrier/housing, and, if a drain plug is employed, from the inter-axle differential assembly of the forward carrier of tandem axles. Flush axle with clean GL-5 axle lubricant of the same viscosity as used in service. Do not flush axles with solvent such as kerosene.

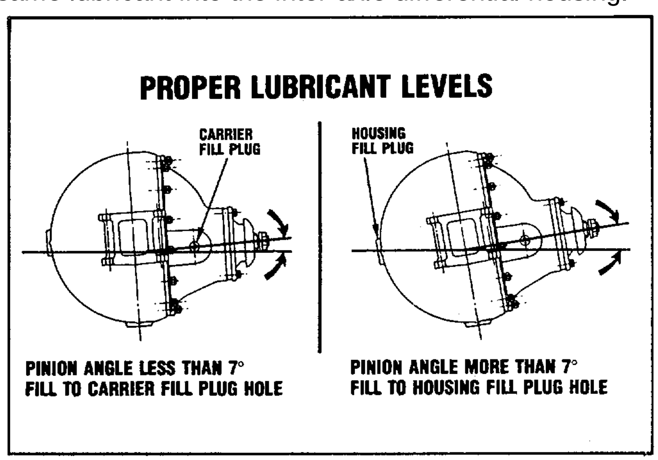


(CURRENT SLHD OR SQHD MODEL TYPE SHOWN)

IMPORTANT: The design of certain Rockwell forward/rear tandem axle carriers such as the LHD, OHD, TDD, UDD AND FDD models include separate cast housings to enclose their respective inter-axle differential assemblies. Baffles and dams are incorporated in these cast housings to maintain a reservoir of lubricant but may also trap wear particles and debris. Therefore, it is important to always purge the lubricant that is retained in these inter-axle differential assemblies whenever the axle lubricant is changed, initially, at scheduled intervals, or at overhauls. For this purpose these types of carriers employ separate oil drain and fill holes located in either the inter-axle differential cover or the inter-axle differential housing.

Also, change the oil filter of drive units employing a pump forced lubrication system. Initially the filter should be changed at the same time as the oil, or 1,000-3,000 miles, (1,600-4,800 km.).

Fill axles to bottom of level hole (in carrier or housing) with specified lubricant with the vehicle on level ground. If the axle employs an inter-axle differential of the type that can be directly filled through a top filler plug hole, pour an additional 2 U. S. pints (0. 946 liters) of the same lubricant into the inter-axle differential housing.



IMPORTANT: The angle of the drive pinion, as mounted under the vehicle, will determine which oil fill/level plug hole should be used.

Except for "Top Mounted" or pinion inverted type carriers, use the following information to locate the fill/level hole. -

Measure the drive pinion angle-if angle is less than 70 (above horizontal) use the hole located in the side of carrier. If the angle is more than 70 (above horizontal) use the hole located in the axle housing bowl. Note: Some axle models may have only one lube fill hole which is located in the housing bowl. With these models use this lube filler hole for all pinion angles. On axles employing "Top Mounted" or pinion inverted type carriers, the fill/level hole is always located in the axle housing bowl. Some axle models have a small tapped and plugged hole located near, but below the housing lubricant level hole. This smaller hole has been provided for the use of a lubricant temperature indicator only and must not be used as a fill or level hole.

After filling the axle with lubricant drive the vehicle, unloaded, for one (1) or two (2) miles (1. 6 to 3. 2 km) at speeds not to exceed 25 miles per hour (40 kph) to thoroughly circulate the lubricant throughout the axle and carrier assemblies.

REGULAR AXLE SERVICE

Follow "New and Reconditioned Axle" procedures except for initial 1000-3000 mile (1600-4800 km) drain and flush instructions. Change lubricant at recommended intervals.

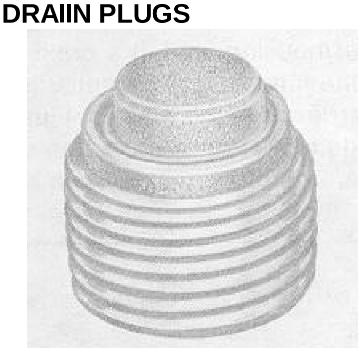
LUBRICANT CHANGE SCHEDULE

There are very practical reasons for recommending lubricant changes. Fluid lubricants serve more than one purpose. They not only lubricate but they transport chemically reactive additives, they wash away minute wear particles, serve as a corrosion inhibitor and also act as a heat transfer medium. Draining and refilling with a fresh supply assists in eliminating both magnetic and non magnetic wear particles which may not have been trapped by a magnetic plug. Exposure to heat and use may also alter the desirable performance properties which are reassured through a lubricant change.

A regular schedule for changing the axle lubricant in a particular vehicle and operation can be accurately determined by analysis of samples taken from the assembly at specified intervals or mileages. The lubricant supplier frequently makes available his laboratory facilities for determining the useful life of his product under actual service conditions. The finally recommended schedule may be correlated, for economic reasons, with lubricant changes governed by climatic conditions and magnetic drain plug maintenance. Lubricant changes should be made as climatic temperatures demand regardless of vehicle mileage or established change schedule. Refer to pages 8 through 24 for recommended lubricants and change intervals of specific equipment being serviced.

IMPORTANT: The normal operating temperature of compounded lubricants during the summer season is approximately 160°F to 220°F.(71°C. 104°C.) The chemicals and additives that give these lubricants increased load carrying capacity oxidize faster at temperatures above 200°F. (104°C.) contributing to more rapid lubricant deterioration. For this reason lubricants of this type that operate continuously at high temperatures must be changed more frequently to realize the inherent advantages they offer. Refer to pages 6 and 7 for detailed information on recommended lubricants and temperature ranges.

MAGNETIC DRAIIN PLUGS



Any drive axle, while it is working, generates small metal wear particles at a fairly steady rate. These wear particles are very fine but hard. If these hard wear particles are allowed to circulate in the lubricant, the internal components will wear at a much faster rate than normal.

Magnetic drain plugs perform the vital function of trapping these small metallic particles that circulate in the lubricant. The magnet must be strong enough to firmly hold the particles under service conditions. We recommend plugs having a minimum pickup capacity of 1. 5 pounds (0. 7 kg.) of low carbon steel in plate or bar form.

Magnets will rapidly lose effectiveness if excessive material is allowed to collect on the element. It is recommended that the plugs be changed or cleaned between lubrication intervals. The plugs can be reused if they maintain the minimum pickup capacity. Spare clean plugs should be kept on hand for replacement if required.

NOTE: For maximum protection against wear particles it is desirable that magnetic plugs be employed at all oil drain hole locations. Further, magnetic plugs can be used at fill or level hole locations if clearance allows. However, the use of a magnetic drain plug in the axle housing is specifically recommended.

TEMPERATURE INDICATORS

Many Rockwell axles have a tapped hole in the housing for the installation of a lubricant temperature indicator. The installation and use of an indicator will aid in reducing the failure of critical axle parts as a result of overheated lubricant. The indicator is particularly useful in through-drive tandem units where severe operating conditions and mismatched or unequally inflated tires may cause a sudden and dangerously high change in lubricant temperature.

Rockwell axles may operate above 190°F. (88°C.) without damage. However, when the lubrication temperature reaches 250°F. (121°C.) the vehicle should be immediately stopped and checked for the cause of overheating.

SEALS

The purpose of seals and gaskets is to keep lubricant in and dirt out of the component. Worn or damaged seals, usually caused by improper installation or extreme hot or cold temperature, will leak and result in low lubricant levels. It is recommended that periodic inspections for seal leakage be made, especially during cold weather. Keep in mind that many lubricants are colorless or semi-transparent, and are difficult to see on the exterior of the axle. Always replace faulty seals with proper tools and installation techniques.

TRACTION EQUALIZERID ADDITIVES

Traction equalizers are employed by many drive units to maintain an appreciable amount of wheel end traction in all operating conditions while still allowing the vehicle to negotiate turns smoothly. This is accomplished with the ability of the traction equalizer to slip above a certain torque value, and remain rigid below this torque value.

Rockwell Traction Equalizers will normally operate with oils not having special additives. Occasionally it is found, however, that the traction equalizer will tend to slip and produce irregular intervals of sharp noises. This generally occurs when the vehicle is operating at low speeds on fairly sharp turns. This slip-stick condition can often be corrected by the addition of certain "friction modifiers" which reduce the static coefficient of friction to a value equal to or lower than the sliding coefficient.

These friction modifiers generally deteriorate faster than the conventional E. P. additives, and the lubricant change schedule should be shortened when these are used.

For axles equipped with Rockwell Traction Equalizers, the following are approved additives, quantities and lube change intervals:

- Additives (typically referred to as "Limited Slip Friction Modifiers" by lubricant suppliers):

1. For all GL-5 gear oils (mineral oil or synthetic) other than Mobil, add any one of the following materials:
   Elco #2 - The Elco Corporation
   Lubrizol #6178 - Lubrizol Corporation
   Hi-Tec E-336 - Edwin Cooper, Inc.

   The R-170 series axle requires 43 pints (20.3 litres) of lubricant. With a Rockwell Traction Equalizer, this same axle requires 40 pints (18.9 litres) of lubricant and 3 pints (1.4 litres) of one of the above additives.

2. For Mobilube HD (mineral oil) and Mobilube SHC (synthetic) use:

Mobil #204 - Mobil Oil Corporation

When using Mobilubes in the R-170 series axle with a Rockwell Traction Equalizer, use 41 pints (19.3 litres) of lubricant and 2 pints (.9 litres) of Mobil #204 additive.

- Lubrication change interval:

The original, factory-installed, drive axle lubricant should be replaced with approved lubricants and the above recommended additives. Thereafter, the recommended lubrication change interval (including additive), on axles equipped with Rockwell Traction Equalizers, should be no more than 50,000 miles (80,000 km).

ROCKWELL RECOMMENDED LUBRICANTS

PROPER LUBRICANTS

Improper lubricants or lubricants with the wrong additives are a major cause of gear set failures. Rockwell hypoid or amboid gear sets require lubricants that have an API-GL-5 grade. Transfer case gearing and worm gearing require an API-GL-1 or 2 grade of lubricant. Gear lube not meeting these requirements will not provide adequate service life and premature failures of the gears will occur. It is important that the following lubrication specifications be adhered to.

IMPORTANT: It is advisable to consider the reputation of the refiner or vendor when selecting. a lubricant. He is responsible for the quality and correct **application of his product.** In **all cases the lubricant supplier assumes all responsibility for the performance of his product and for product and patent liability.**

Lubricant suppliers may obtain copies of any referenced Rockwell Material Specifications by writing to Rockwell International, Heavy Vehicles Components Operations, 2135 West Maple Road, Troy, Michigan 48084.

As a quick guide to Rockwell Material Specifications, the following are very brief descriptions of the various recommended lubricants, specific cross references and outside (climatic) temperature ranges. They are not meant to replace the complete specifications, or to serve in their place.

ROCKWELL LUBRICANT SPECIFICATIONS	DESCRIPTION	CROSS REFERENCE	MINIMUM OUTSIDE TEMPERATURE	MAXIMUM OUTSIDE TEMPERATURE
0-62*	Mineral Oil	GL-1, S.A.E. 90	+10°F (−12.2°C)	**
0-63*	Mineral Oil	GL-1, S.A.E. 140	+40°F (+4.4°C)	**
0-72*	Worm Gear Oil	GL-2, S.A.E. 90	+10°F (−12.2°C)	**
0-73*	Worm Gear Oil	GL-2, S.A.E. 140	+40°F (+4.4°C)	**
0-74*	Spring Seat Oil	GL-2, S.A.E. 250	—	**
0-76	Hypoid Gear Oil	GL-5, S.A.E. 140	+40°F (+4.4°C)	**
0-76-A	Hypoid Gear Oil	GL-5, S.A.E. 85W/140	+10°F (−12.2°C)	**
0-76-B	Hypoid Gear Oil	GL-5, S.A.E. 80W/140	−15°F (−26.1°C)	**
0-76-C	Hypoid Gear Oil	GL-5, S.A.E. 85W/90	+10°F (−12.2°C)	**
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	−15°F (−26.1°C)	**
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	−40°F (−40.0°C)	**
0-76-F	Hypoid Gear Oil	GL-5, S.A.E. 80W	−15°F (−26.1°C)	+70°F (+21.1°C)
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	−40°F (−40°C)	+35°F (+1.6°C)
0-76-K	Hypoid Gear Oil	GL-5, S.A.E. 70W	−67°F (−55°C)	+30°F (−1.1°C)
0-616***	Anchor Pin Grease	Non-Melting Grease with Bentone Thickeners NLGI Grade No. 2	—	—
0-616-A	Special Brake Grease	NLGI Grade No. 1	−40°F (−40°C)	**
0-617-A***	Chassis Grease	6% 12-hydroxy lithium stearate grease NLGI Grade No. 1	—	—
0-617-B***	Chassis Grease	8% 12-hydroxy lithium stearate grease NLGI Grade No. 2	—	—
0-622***	Drive Unit Output Bearing Pre-Grease	3.5% hydroxy lithium stearate grease NLGI Grade No. 000 Approved Material Mobil Mobilux EP023	—	—
0-634-B***	Universal Joint Grease	12-hydroxy lithium stearate grease with 7% to 9% polyethelene and molybdenum disulfate additives. NLGI Grade No. 2	—	—
0-637***	Special Rust Preventing Brake Grease	Metallic based, temperature resistant, anti-seizing compound	—	—
0-645***	Special Low Temperature Brake Grease	Approved Material Mobil 28	−40°F (−40°C)	—

*These lubricants are never to be used in axles employing hypoid, amboid, spiral bevel or planetary gearing.

**There is no upper limit on these outside temperatures for oils and greases. Axle sump temperature must never exceed 250°F (+121°C).

***Grease recommendations are based on commercial products that have given satisfactory results in normal operation. However, there are many proprietary grease products on the market which will perform satisfactorily and may be preferable because of supply problems, common usage for other truck components, etc. Where such products are recommended by reputable suppliers for the specific lubrication of our components, Rockwell has no objections, provided that these substitute products are equal or better than the Rockwell recommendations in lubrication properties, water resistance, corrosion protection, high and low temperature characteristics, oxidation stability, shear stability, etc. All substitute products are subject to Rockwell approval.

OIL VISCOSITIES

For service purposes and the convenience of description in this Field Maintenance Manual the term "Standard" indicates a lubricant of proper viscosity for average temperature conditions during the spring, summer, and fall in the continental United States (except for Alaska), and a part of the continental United States during winter.

"Optional" viscosity lubricants should be used whenever vehicles are parked at outside temperature-lower than the minimum given for the "Standard" lubricant.

The proper viscosity of oil for the specific component shall be selected from the "Outside Temperature" columns on the "Recommended Lubricants" chart. Where more than one lubricant can be selected from this table, the higher viscosity oil should be used.

Experience has shown that the use of an S.A.E. 140 viscosity grade lubricant (Rockwell specifications 0-63, 0-73, 0-76, 0-76-A and 0-76-B) will result in longer gear life.

Unusual temperature or operating conditions may require other or more specific lubricant recommendations. Rockwell will review these circumstances, upon request, and make optional gear oil or grease recommendations. It is essential that all details of vehicle operation, loads, area temperature, etc. , are clearly and completely stated when applying to our Engineering Department for an optional lubricant recommendation.

SINGLE GRADE LUBRICANTS

High viscosity single grade oils S.A.E. 140 or S.A.E. 90 should only be used in warm climates where no cold weather is encountered.

Low viscosity single grade oils S.A.E. 70W, S.A.E. 75W, S.A.E. 80W or S.A.E. 85W should only be used in cold climates where no warm weather is encountered.

Refer to the Recommended Lubricants chart for temperature limitations of each grade of oil.

MULTIGRADE LUBRICANTS

Multigrade oil must be used where vehicles operate in both cold and warm weather between oil changes. If multigrade oils are used, the complete specification, including viscosity stability in service, of each viscosity grade listed must be met. Refer to the Recommended Lubricants chart for temperature limitations of each grade of oil.

GEAR LUBRICANTS FOR LOW TEMPERATURE OPERATIONS

IMPORTANT: For drive units utilizing the low temperature lubricants, oil seals and gasket materials must be in excellent condition to insure against the loss of these lower viscosity oils.

Use oils that meet all the requirements of Rockwell Specification 0-76-J or 0-76-K.

Further, the use of thinning agents, i. e. , kerosene, gasoline or any other dilutants that lower the viscosity of the lubricant IS NOT PERMISSIBLE.

Refer to the Recommended Lubricants chart for temperature limitations of each grade of oil.

SYNTHETIC LUBRICANTS

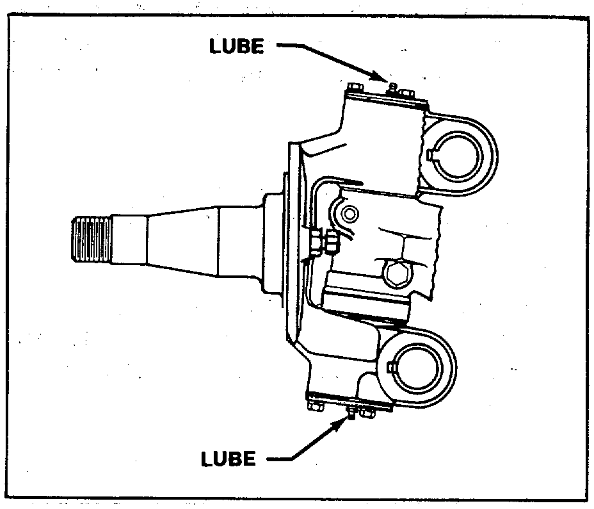
Synthetic lubricants may be used in drive axles, provided they meet all of the requirements of Rockwell specifications 0-76, 0-76-A, 0-76-B, 0-76-C, 0-76-D, 0-76-E, 0-76-F, 0-76-J or 0-76-K.

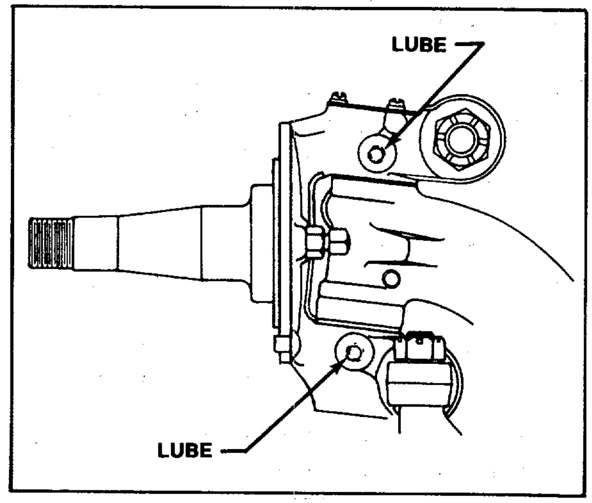
IMPORTANT: Synthetic lubricants must be compatible with standard commercial seals used in the axle assembly (drive unit and wheel ends), otherwise special seals must be installed. Contact your Rockwell representative for information on synthetic lubricants.

LUBRICANT SPECIFICATIONS AND CHANGE INTERVALS

NOTE: The illustrations used in the following sections are typical examples and may not necessarily show all lubrication points for all models discussed.

1. FRONT NON-DRIVING AXLES





SEALED KNUCKLE PIN **CONVENTIONAL. KNUCKLE PIN**

LUBRICANTS:
0-617-A or 0-617-B - All knuckle pins, bushings, cross tube end assemblies, drag link ball sockets and wheel bearings.

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:
The following are minimum recommended intervals. More frequent lubrication will prolong product life.

- Knuckle Pins and Bushings:

  Conventional (standard) straight and tapered pin models (FC, FD, FF, FH, FL and FQ-900,,901, 903 or 970 Series; 16900,16930, 16931, FAE-951 and 952, FU-910, 930 and 935 Series)--3,000 miles (4,800 km.).

  Sealed knuckle pin models (FD, FF, FG and FL-921, 930, 931, 932, 933, 934, 951 and 971 Series; and the 17100 axle)-50,000 miles (80,500 km.) or 12 months, whichever comes first.

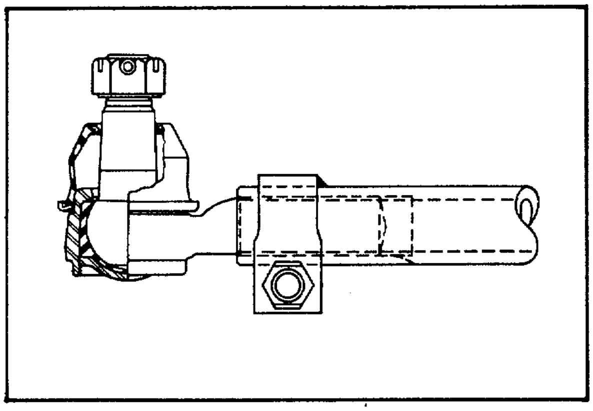
  "Easy-Steer" models (FF and FG-941 and 943-in regular common carrier on-highway service only) - Grease when axle is new, and again after a 4,000 mile (6,500 km.) break-in period only.

  IMPORTANT: The recommended greasing procedures must be followed. Refer to page 9.

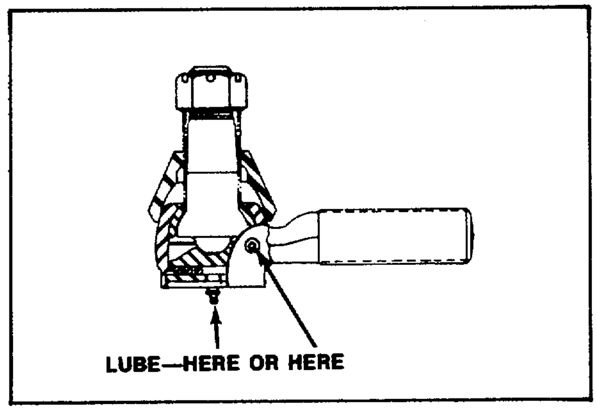
  Also greasable cross tube end assemblies used in "Easy-Steer" axles must still be greased every 50,000 miles (80,500 km.) or 12 months, whichever comes first.

  If periodic knuckle pin greasing is **desired with on-highway "Easy Steer" models,** follow the 50,000 mile sealed knuckle pin interval.

  "Easy-Steer models (FD, FF, FG, and FL-941, 942, 943 and 944 Series in on/off highway service) - grease every 50,000 miles (80,500 km.) or 12 months, whichever comes first.



PERMANENTLY LUBRICATED



GREASABLE CROSS TUBE END

- Cross Tube End Assemblies:

  Greasable type-50,000 miles (80,500 km.) or 12 months, whichever comes first.

  Permanently lubricated non-greasable type do not require lubrication, however, periodic inspection of the sealing boot is recommended at 96,000 mile (154,000 km.) intervals.

- Wheel Bearings:

  Refer to page 12

LUBE PROCEDURES:

- Models with Conventional Straight and Tapered Knuckle Pins:

  To assure proper purging of old grease and contamination from upper and lower bushings, the wheels should be raised off the ground while greasing the knuckle. After this has been done and the tires are lowered to the ground the lower bushing should be re-greased to purge and fill the thrust bearing.

- Models with Sealed Knuckle Pins:

  These assemblies should be greased with the tires on the ground. Apply grease pressure until new grease is seen purging from the thrust bearing seal and from the upper shim pack area.

- Tie Rod Ends:

  Apply grease pressure until new grease is seen purging from the boot area.

- “Easy-Steer" (On-Highway) Models:

  Before the new axle is placed in service, grease knuckles as in sealed king pin procedure above. After a 4,000 mile (6,500 km.) break-in period the knuckles should be carefully re-greased as follows:

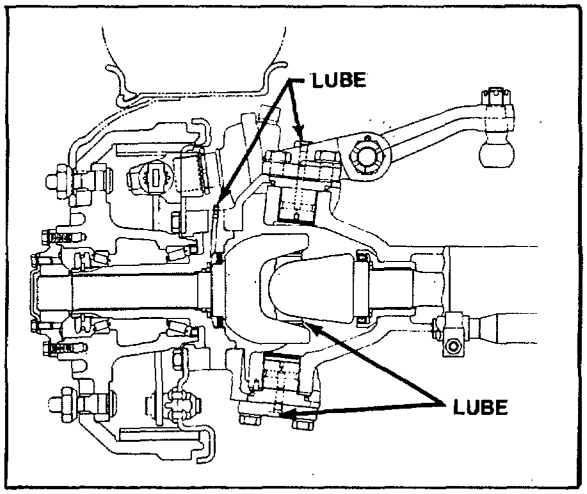
  A. With the tires off the ground, slowly feed grease into each bushing area while turning the wheels from extreme right to left and back again (lock to lock). This will eliminate small air pockets and improve grease distribution.

  B. Lower tires to ground and re-grease both top and bottom bushings, taking care to thoroughly lubricate the thrust bearings.

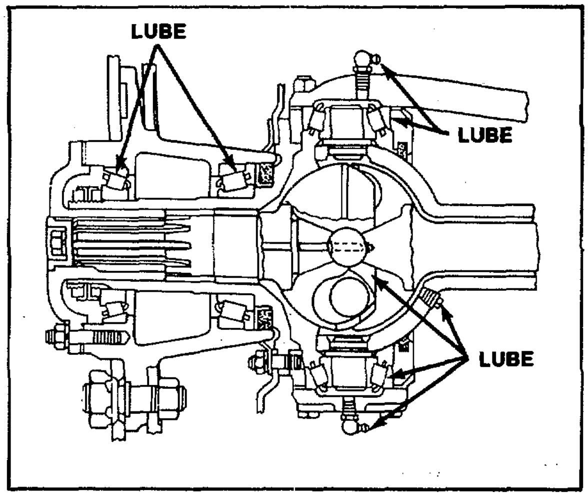
- "Easy-Steer" (On/Off Highway) Models:

  Follow sealed knuckle pin procedures above.

2. FRONT DRIVE STEERING AXLES



CARDAN UNIVERSAL JOINT



CONSTANT VELOCITY UNIVERSAL JOINT

LUBRICANTS:

- 0-617-A or 0-617-B All universal joints (Cardan and Constant Velocity types), knuckle bushings or bearings, cross tube end assemblies, axle shaft thrust washers, and wheel bearings.

- Drive units (differentials)Standard-0-76, 0-76-A or 0-76-B Optional-0-76-C, 0-76-D, 0-76-E, 0-76-F, 0-76-J or 0-76-K Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

- All steering universal joints, knuckle bearings or bushings:

  The frequency of lubricant changes depends upon individual operating conditions, speed and loads. Change whenever seals are replaced, when brakes are relined, at 30,000 mile (48,000 km.) or 2,000 hour intervals. If yearly mileage is less than 30,000 miles or 2,000 hours of operation, change twice a year (spring and fall).

- Crosstube end assemblies:

  Standard greasable type-3,000 miles (4,800 km.) or 200 hours of operation.

- Drive units (differentials):

  25,000 to 30,000 miles (40,000 to 48,000 km.) or 1600 to 2000 hours of operation when yearly use is in excess of 60,000 miles (96,500 km.) or 4000 hours. Otherwise change twice a year (spring and fall).

- Wheel bearings-refer to page 12.

- Universal joints and drive lines-refer to page 24.

LUBE PROCEDURES

- Cardan steering joints.

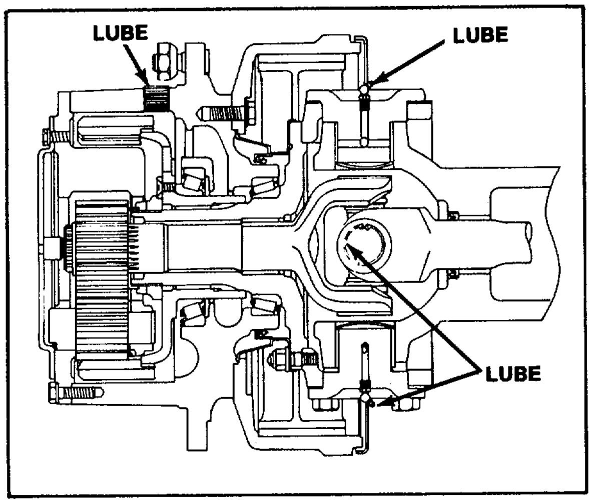
  1. Check for looseness.
  2. Apply grease until new grease purges from all seals.
  3. If grease does not purge at seals, manipulate the U-Joint until purging occurs.

4. If above is not successful, remove cup or joint and check old grease. If grease appears rusty, gritty or burnt, replace the complete universal joint.

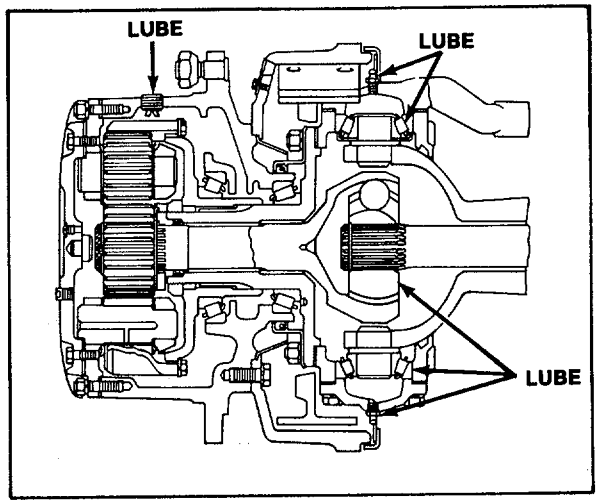
- Constant velocity steering joints:

  To apply new grease, remove axle shaft from housing, then clean old grease from universal joint and repack, by hand, with new grease.

3. PLANETARY AXLES



CARDAN UNIVERSAL JOINT



CONSTANT VELOCITY UNIVERSAL JOINT

LUBRICANTS:

- 0-617-A or 0-617-B All steering universal joints (Cardan and Constant Velocity types), knuckle sleeves, bearings and bushings, crosstube end assemblies, yokes and flanges.

- Wheel end gearing, bearings and drive units (differentials):

  Use lubricants with viscosity grades 90 or below only in planetary axle wheel ends with a common wheel end/axle housing oil level. Lubricants with viscosity grades above 90 must be limited to the housing bowl area of axles without a common wheel end/axle housing oil level. Further, an API-GL-5 lubricant is recommended for all planetary axle wheel end gearing, bearings and drive units.

  Axles with common wheel end/axle housing oil level:
  Standard-0-76-C or 0-76-D
  Optional-0-76-E, 0-76-F, 0-76-J or 0-76-K.

  Axles without common wheel end/axle housing oil level:
  Wheel end only:
  Standard-0-76-C or 0-76-D
  Optional-0-76-E, 0-76-F, 0-76-J or 0-76-K

  Axle housing (drive unit) only:
  Standard-0-76, 0-76-A or 0-76-B
  Optional-0-76-C, 0-76-D, 0-76-E, 0-76-F, 0-76-J, or 0-76-K

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

- Cardan steering Joints-every 200 hours of operation.

- Constant velocity steering joints-every 1000 to 1500 hours of operation or twice a year (spring and fall).

- Knuckle Bearings and Bushings:

  Change whenever seals are replaced, brakes are relined or every 100 to 200 hours of normal operation, but as often as once a day in severe operations.

- Wheel end gearing, bearings and drive units (differentials):

  Change whenever seals are replaced, brakes are relined or every 1000 to 1500 hours of operation or twice a year (spring and fall).

- Universal Joints and Drive Lines: Refer to item 9 on page 24.

LUBE PROCEDURES:

- Cardan steering joints:

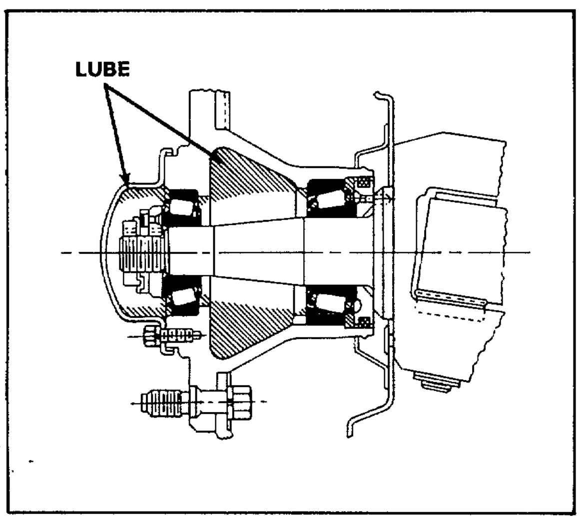
  1. Check for looseness.
  2. Apply grease until new grease purges from all seals.
  3. If grease does not purge at seals, manipulate U-joint until purging occurs.
  4. If above is not successful, remove cup or joint and check old grease. If grease appears rusty, gritty or burnt, replace the complete universal joint.

- Constant velocity steering joints:
  To apply new grease, remove axle shaft from housing, then clean old grease from universal joint and repack, by hand, with new grease.

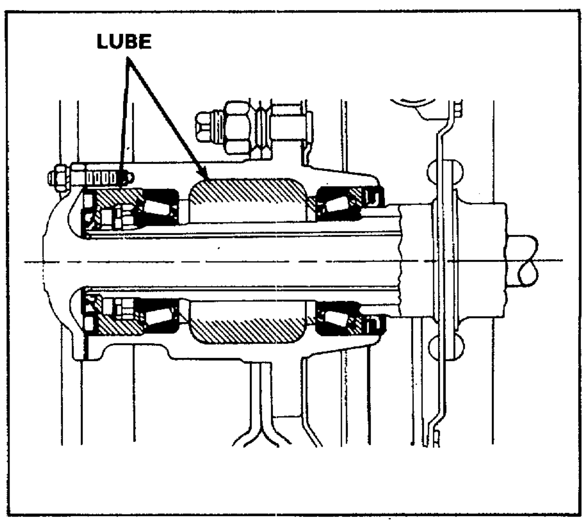
- Planetary wheel ends:
  Fill hubs through "Fill/Drain" oil hole located at top and drain from same hole rotated to the bottom. Fill until lubricant appears at "Oil Level" hole.

4. WHEEL BEARINGS

- **GREASE LUBRICATED**



NON-DRIVE AXLE
HUB ASSEMBLY



DRIVE AXLE
HUB ASSEMBLY

LUBRICANTS:

Standard-0-61 7-A (Preferred)
Optional-0-617-B (Acceptable)

0-617-A has a consistency which is preferred to take advantage of its slumping characteristic and for insurance against the possibility of fretting corrosion in wheel bearings. 0-617-B has a consistency which may be preferred for ease of packing wheel bearings.

Refer to Recommended Lubricants on Pages 6 and 7.

LUBE INTERVALS:

The frequency of lubricant changes depends upon individual operating conditions, speeds and loads. Change whenever seals are replaced, when brakes are relined or at 30,000 miles (48,000 km). If yearly mileage is less than 30,000 miles, change twice a year (spring and fall).

For low mileage trailer operations, i.e., Container and Piggyback, grease may not need changing until every 50,000 miles (80,500 km) or two years. However, check grease twice a year (spring and fall) for contamination and change if required

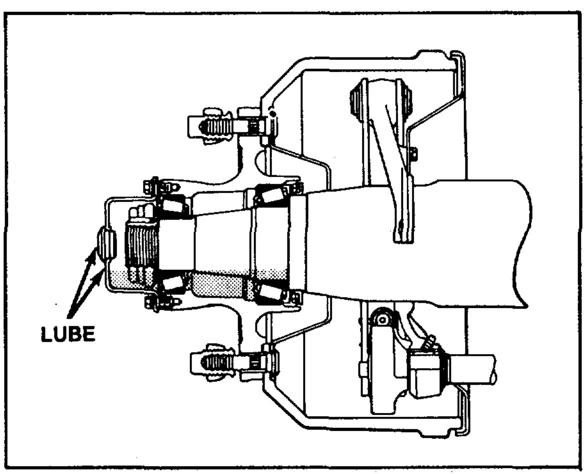
LUBE PROCEDURES:

1. At rebuild time, before installing wheel bearings onto the spindle, coat the bearing journals with a film of grease to deter fretting corrosion.

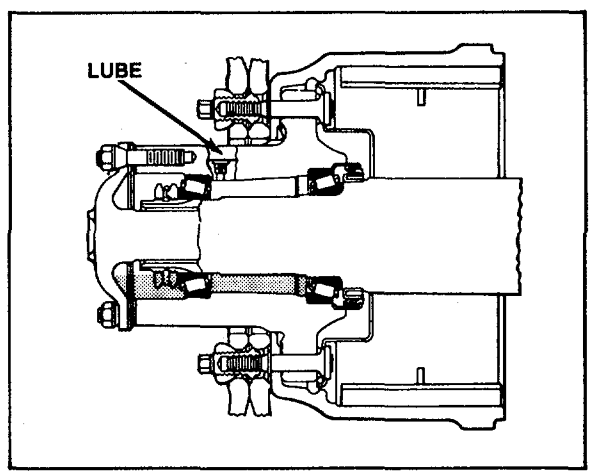
2. Pack bearing with pressure packer, if possible. If a packer is not available, pack the bearing by hand, forcing the grease in the cavities between the rollers and cage from the large end of the cone.

3. Pack the hub between the two bearing cups with grease to the level of the cups' smallest diameter.

- **OIL LUBRICATED**



NON-DRIVE AXLE HUB ASSEMBLY (TRAILER SHOWN)



DRIVE AXLE HUB ASSEMBLY

LUBRICANTS:

Standard-0-76-C or 0-76-D
Optional-0-76-E, 0-76-F, 0-76-J or 0-76-K. (Also 0-76, 0-76-A or 0-76-B if drive axle has a common hub/axle housing oil level and axle requires these lubes for proper operation.)

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:
Check every 1000 miles (1600 km) and change whenever oil becomes contaminated, drive unit lube is changed, seals are replaced, brakes relined or at least once a year.

LUBE PROCEDURES:
The following will assure that oil lubricated wheel bearings are initially lubricated after servicing and before vehicle is put back into operation.

- All Axles:

  Wipe a film of oil on the inner shoulder of the spindle to prevent rust behind the inner bearing cone.

- Drive Axle Hubs With Oil Fill Holes:

  Pour one pint (0.473 liters) of oil (same as used in drive unit) directly into each hub.

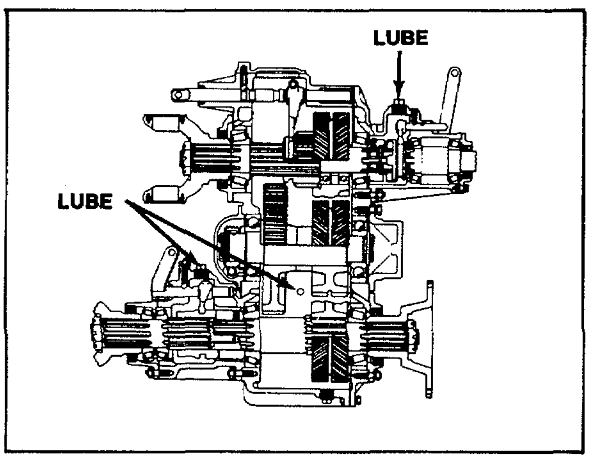
- Drive Axle Hubs Without Oil Fill Holes:

  Pour the specific amount of recommended drive unit lubricant through the carrier or housing bowl oil fill hole. Next tilt the vehicle to the right and to the left enough to allow the oil to flow into the hub cavities. This may be accomplished by jacking up the axle from each end. Keep the axle in each tilted position for one minute to allow all the hub cavities to fill. Approximately one pint (0.473 liters) of oil will be trapped in each hub cavity. With the vehicle back on level surface add the appropriate amount of drive unit lubrication back into the carrier or housing bowl to bring the oil up to the proper level, approximately two pints (0.946 liters).

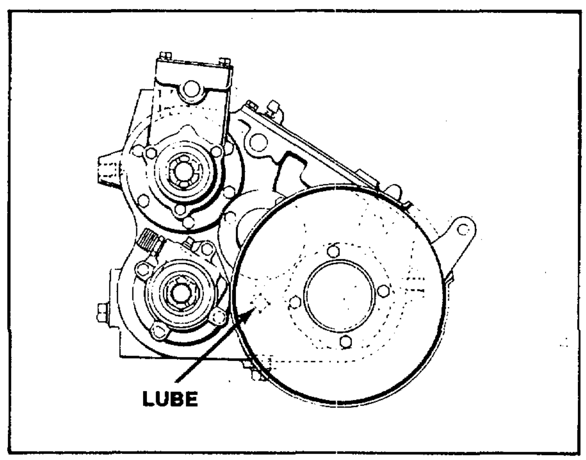
- Trailer Axle Hubs:

  Fill the hub with oil to the bottom edge of the plug hole in cap.

5. TRANSFER CASES



TRANSFER CASE-3 SHAFT DESIGN



TRANSFER CASE-4 SHAFT DESIGN

LUBRICANTS:
Standard-0-62 or 0-63
Optional-0-76 Series

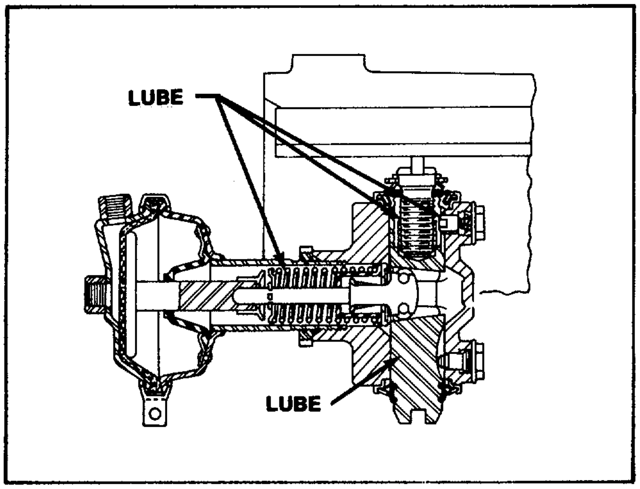
Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:
Check every 1000 miles (1600 km). Drain and fill every 12,000 to 25,000 miles (19,000 to 40,000 km).

LUBE PROCEDURES:
Pour recommended amount of lubricant, less two pints, through filler hole. Add one pint of oil each to the power take off and de-clutch assemblies if used. If transfer case is not mounted under vehicle do not fill unit to specified level until after installation.

6. BRAKES

- **STOPMASTER WEDGE BRAKES AND CHAMBERS (On-Highway and Off-Highway)**



STOPMASTER WEDGE BRAKE AND AIR CHAMBER

LUBRICANTS:
Standard-0-616-A
A high temperature water-proof grease, NLGI Grade No. 1, is recommended for lubricating the brake actuation system. It should be a smooth textured corrosion resistant grease free of fillers and abrasives. It should maintain a satisfactory softness under normal parking and storage temperatures. The following greases meet all of these conditions:

Texaco Thermotex EP #1 or Shell Darina #1

A suitable grease can also be obtained under Rockwell Part No. A-1 779-W-283.

Optional-0-645

Vehicles operating in extremely cold weather (below -40'F) may require a grease conforming to this Rockwell specification (Part No. 2297-X-4574). The following grease meets this specification.

Mobil 28

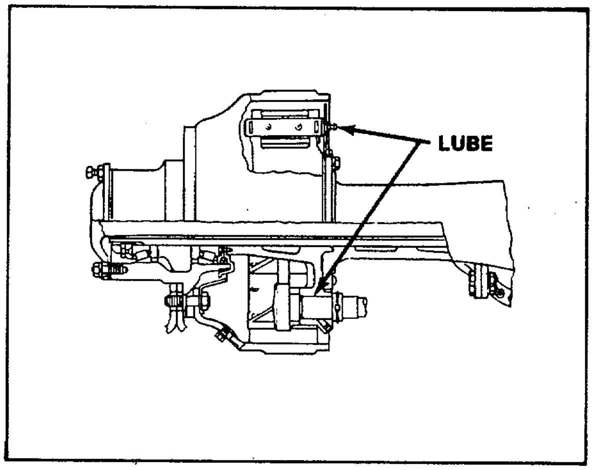
Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

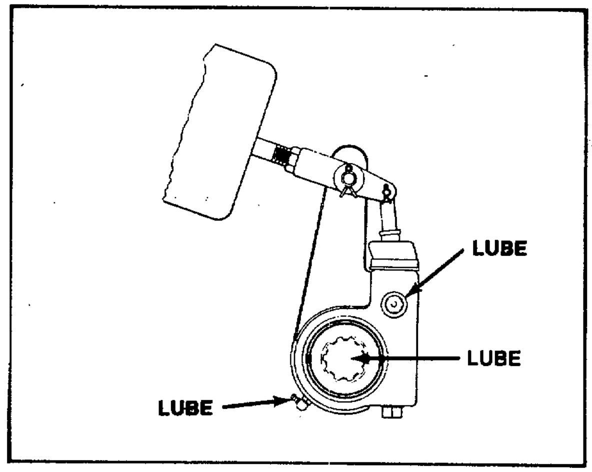
- On-highway-Change whenever seals are replaced, when brakes are relined or at 100,000 miles (160,000 km).

- Off-highway-Change every 12 months (maximum), whenever seals are replaced or when brakes are relined. However, the change interval may be shorter depending on severity of operations. This can be determined by initially scheduling an inspection of internal parts and lubricant every two months until the first 12 month period is up. At each inspection look for contaminated or hardened grease or for lack of grease.

- **CAM-MASTER CAM BRAKES (On-Highway and Off-Highway)**



"P" TYPE S CAM BRAKE



AUTOMATIC SLACK ADJUSTER

LUBRICANTS:

Standard0-617-A or 0-617-B
Manual slack adjusters, camshaft roller journals, metal or nylon camshaft bushings.

Standard 0-616
Anchor pins (where specified).

Standard-0-616-A
Automatic slack adjusters internal parts.

Optional-0-645
Extreme cold weather grease, for automatic slack adjuster internal parts. (See Stopmaster Lubricants)

Standard-0-637
Worm wheel and camshaft splines. A metallic based temperature resistant anti-seizing compound. The following grease meets this specification:

Southwest SA 8249496

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

- On Highway

  Brakes-Every 50,000 miles (80,000 km) or every six months depending on severity of service. For brakes with extended lube features on regular common carrier type vehicles and the "Q" Series brakes change every 100,000 miles (160,000 km).

  Automatic slack adjusters-Every chassis lube interval, every brake assembly lube interval, at reline or at least every 25,000 miles (40,000 km) or three months, whichever comes first.

- Off Highway

  Brakes and automatic slack adjusters-For all components, change grease every four months (maximum), whenever seals are replaced or when brakes are relined. However, the change interval may be shorter than four months depending on the severity of operation. This can be determined by initially scheduling an inspection of internal parts and lubricant every two weeks until the first four month period is up. At each inspection look for contaminated or hardened grease or for lack of grease.

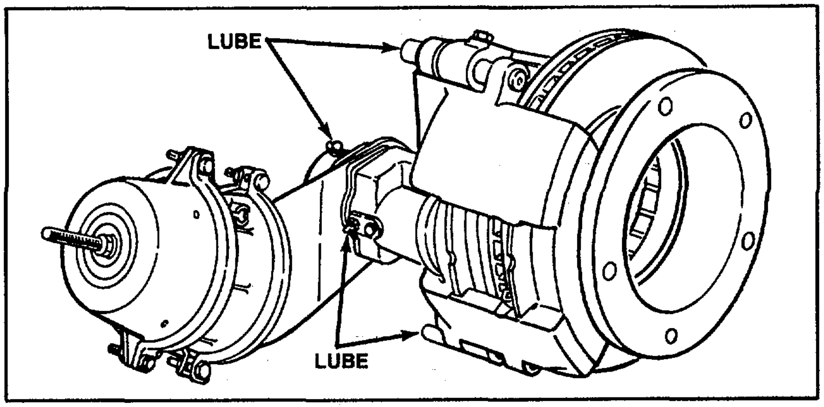
LUBE PROCEDURES:

- Care must be exercised when lubricating camshaft bushings and anchor pins. Over lubrication could cause lubrication saturation of brake linings and possible safety problems.

- For off-highway brakes (20¼/4", 22" or 26" in diameter) the use of meter type fittings which have a maximum of 40 lb. (18.14kg) pressure relief at shut off is recommended.

- Lubricate current model automatic slack adjusters through grease fitting until old grease is purged and new grease emerges through the pressure relief fitting. On models without pressure relief fitting the pawl assembly must be removed to allow old grease to be purged through the pawl slot.

- **DURA-MASTER AIR DISC BRAKES**



LUBRICANTS:

Standard 0-616-A
Internal parts of brake caliper and automatic slack adjuster. (See Stopmaster Lubricants)

Standard 0-637
Slide pins, slide pin retainers, powershaft and slack adjuster worm wheel splines. (See Cam-Master Lubricants)

Optional 0-645
Extreme cold weather use for internal parts of brake caliper and automatic slack adjuster. (See Stopmaster Lubricants)

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

- Automatic slack adjuster:
  25,000 miles (40,000 km) or every three months and/or at regular chassis lube intervals.

- Brake actuating components (caliper):
  50,000 miles (80,000 km) or every six months.

- Caliper slide pins, slide pin retainers, powershaft and slack adjuster worm wheel splines:
  At brake reline and caliper overhaul.

LUBE PROCEDURES:

At regular lube intervals lubricate caliper actuating components and slack adjuster through grease fittings until lube purges through pressure relief fittings.

At brake reline or caliper overhaul with wheel removed, use the following procedures:

Caliper Assembly

1. Insert the appropriate Rockwell slack adjuster template or a .060"-.090" gauge between the brake piston and inboard lining.

2. Apply grease through the slack adjuster fitting until grease purges at the pressure relief fitting.

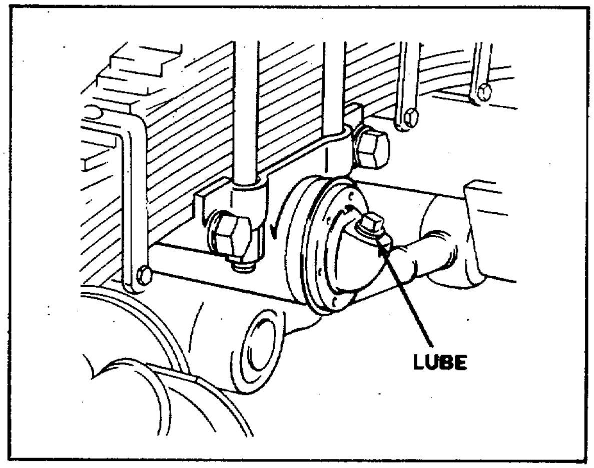
3. Hold down the pressure relief fitting and continue applying grease until it purges through the powershaft cap seal. Discontinue grease gun pressure and wipe off all excessive grease from the caliper assembly.

Automatic Slack Adjuster Assembly

1. Apply grease through the slack adjuster fitting until grease purges from the pressure relief capscrew in the side of the slack housing. Discontinue grease gun pressure.
2. Wipe off all excessive grease from the slack adjuster housing.

7. SPRING SEATS

- **BUSHING TYPE (METAL, NYLON AND DELRIN)**



LUBRICANT:

Standard 0-74
Optional 0-73

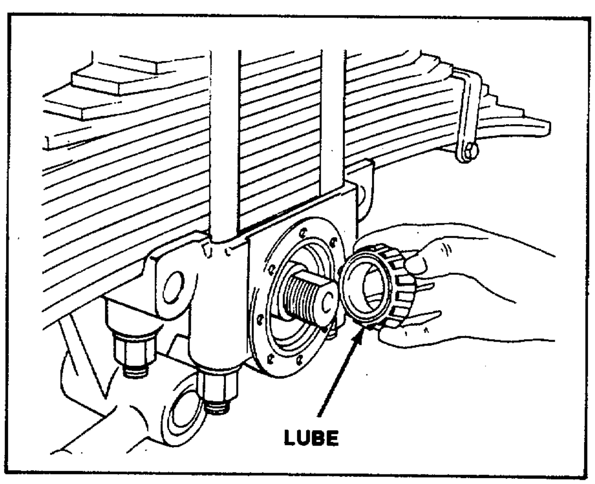
Use 0-73 (S.A.E. Grade 140) if 0-74 (S.AE. Grade 250) is not available. However it will be necessary to check oil levels more frequently when using the lighter grade 140 lubricant.

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

As required. Keep reservoir filled with specified oil.

- **ROLLER BEARING TYPE**

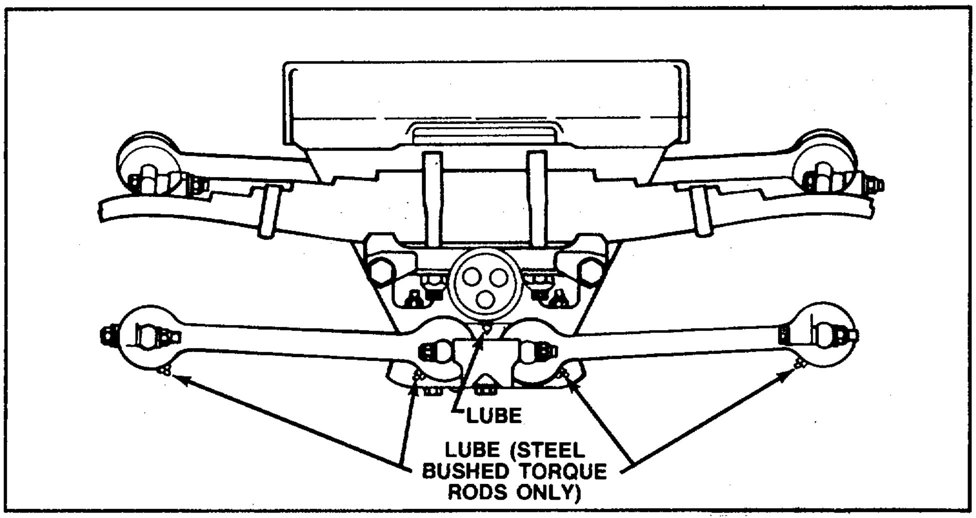


LUBRICANT:
Standard - 0-617-B

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:
Whenever wheel bearings are lubricated or at 30,000 miles (48,000 km). If yearly mileage is less than 30,000 miles (48,000 km) change twice a year (spring and fall).

- **AC-6W 6-ROD BRONZE BUSHING TYPE SPRING SEATS AND STEEL BUSHED TORQUE RODS**



LUBRICANT:
Standard - 0-617-A

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

The spring seat assembly should be lubricated regularly, with frequency depending upon the type of service and conditions under which the vehicle operates. The suggested lubrication interval for units in continuous use is monthly. However, if unit is used in more extreme weather and road conditions shorter intervals may be necessary.

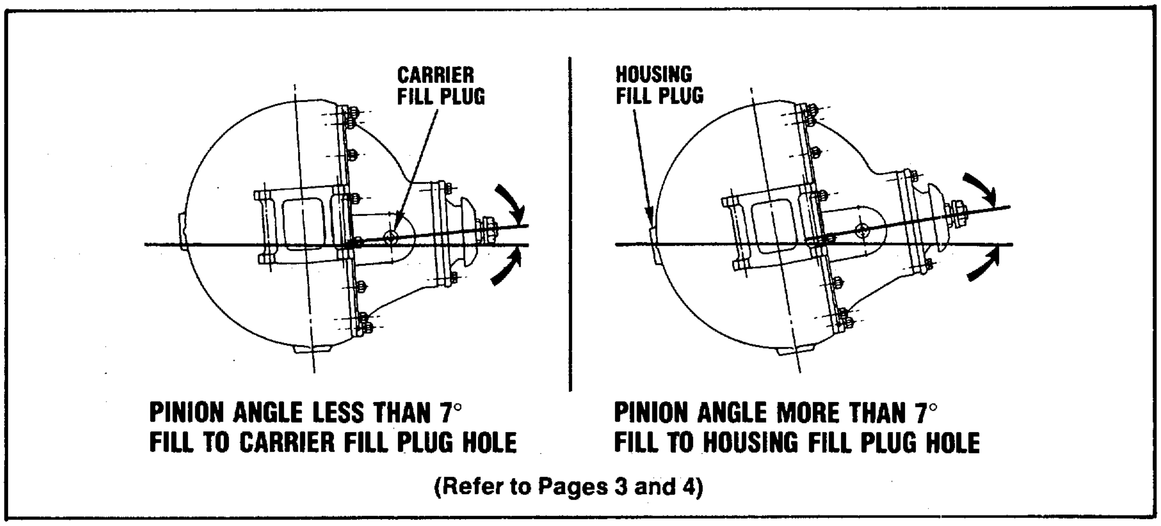
The lubrication interval for steel bushed torque rods, if used, would be the same as for the spring seat assembly (at least once a month).

8. DRIVE UNITS (DIFFERENTIALS)

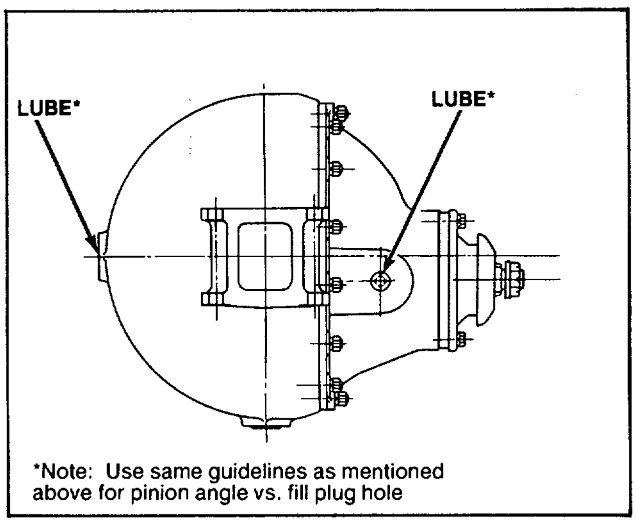
- **HYPOID, AMBOID AND SPIRAL BEVEL GEARS-SINGLE AND DOUBLE REDUCTION**

The design of these gear teeth, which mesh with a sliding action, enables them to withstand higher unit pressures. Therefore, the lubricant used must have extreme pressure properties. Only lubricants with S.A.E. designation API-GL-5 meet these requirements and are recommended for hypoid, amboid and spiral bevel gearing.

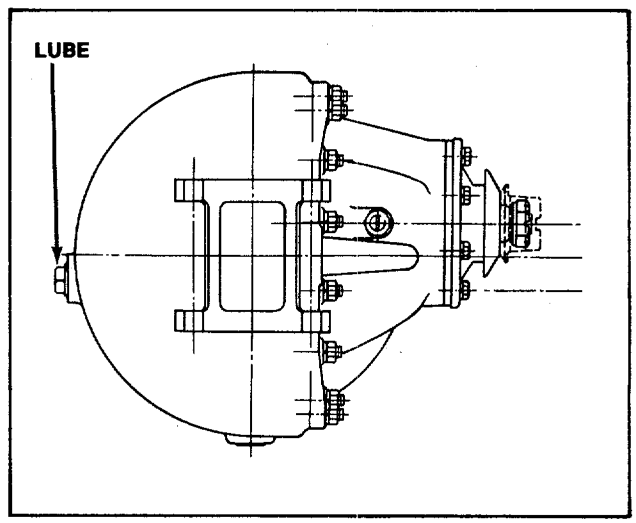
FRONT MOUNTED SINGLE REDUCTION
(Single Axles or Rear/Rear Tandem Axles)



AMBOID AND HYPOID GEARING
FRONT MOUNTED SINGLE REDUCTION-PLANETARY AXLE APPLICATION

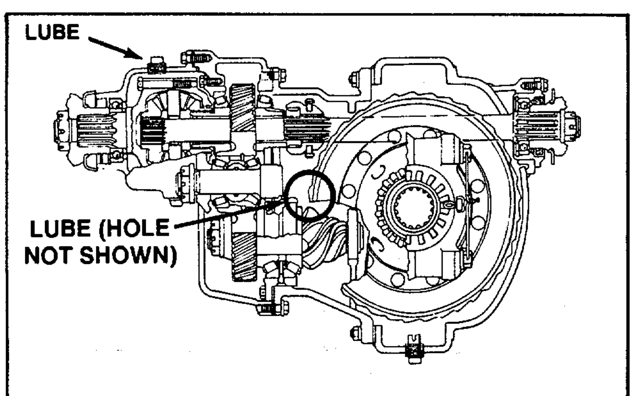


HYPOID GEARING-PINION STANDARD

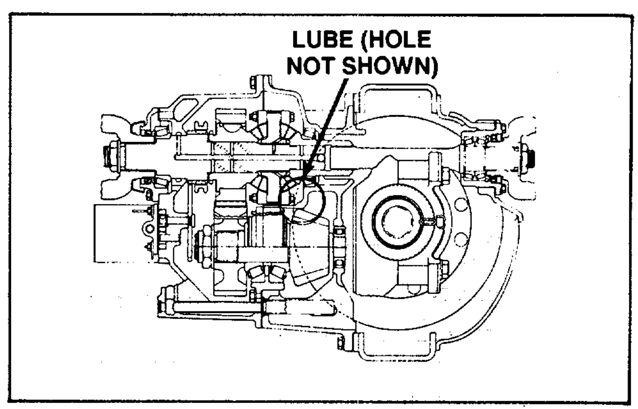


HYPOID GEARING-PINION INVERTED

FRONT MOUNTED SINGLE REDUCTION TANDEM AXLES
(FORWARD/REAR AXLES)

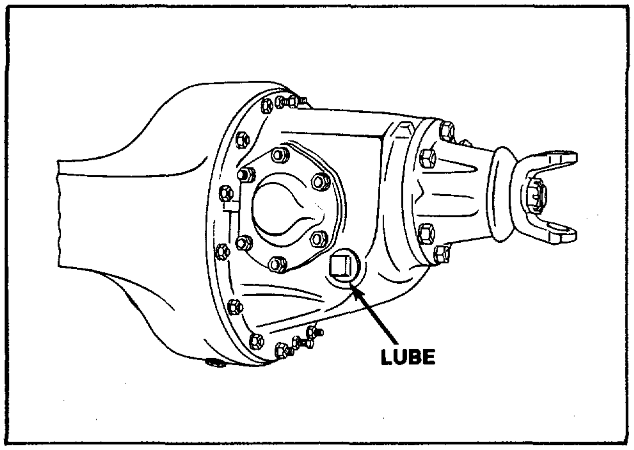


HYPOID GEARING WITH INTER-AXLE DIFF.

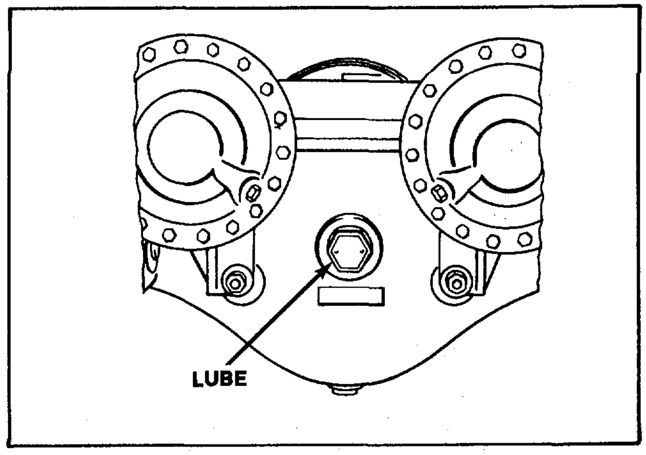


HYPOID GEARING WITH INTER-AXLE DIFF. AND PUMP FORCED LUBRICATION

FRONT MOUNTED DOUBLE REDUCTION AND 2 SPEED AXLES

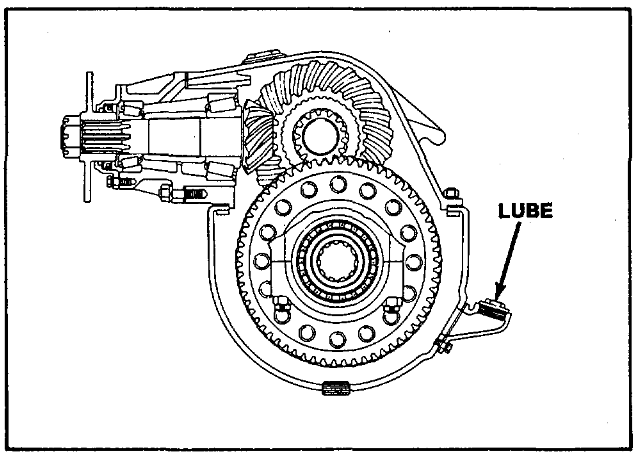


FILL HOLE IN CARRIER

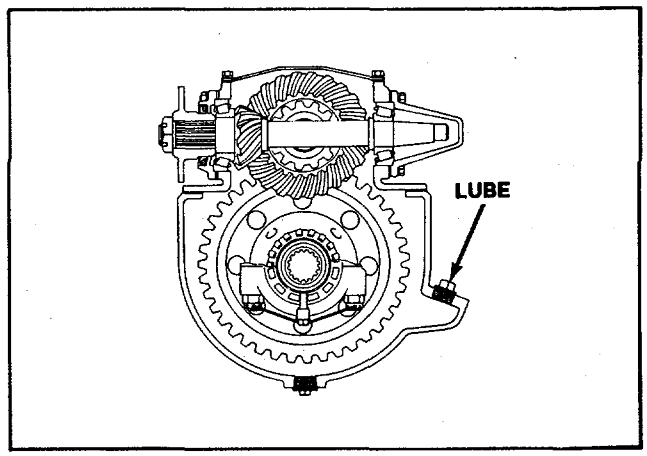


FILL HOLE IN HOUSING

TOP MOUNTED DOUBLE REDUCTION (SINGLE AXLES OR REAR/REAR OFTANDEMS)

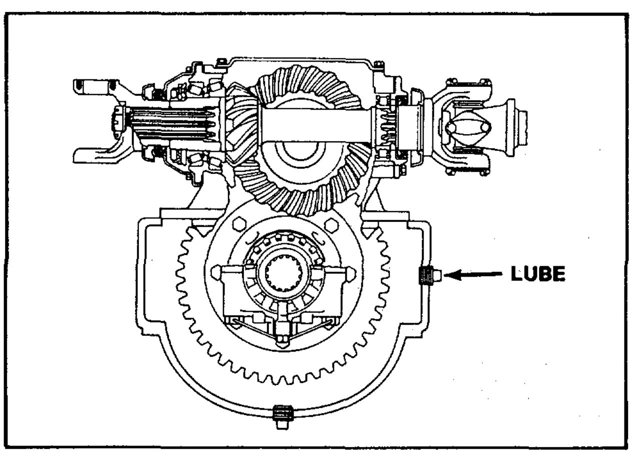


HYPOID AND SPIRAL BEVEL GEARING

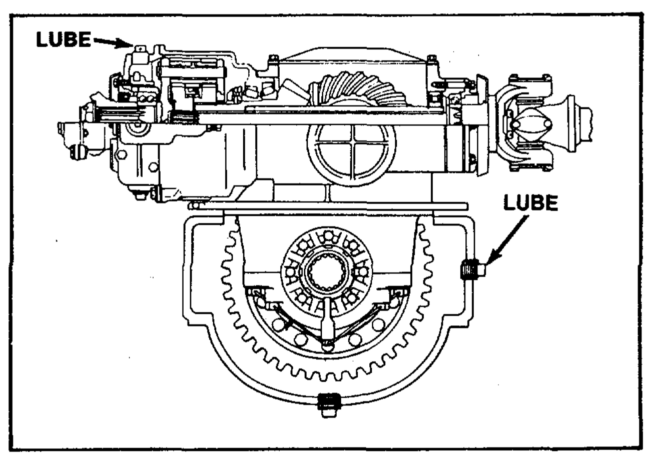


HYPOID AND SPIRAL BEVEL GEARING

TOP MOUNTED DOUBLE REDUCTION TANDEM AXLES (FORWARD/REAR AXLES)



HYPOID GEARING WITHOU T
INTER-AXLE DIFFERENTIAL



HYPOID GEARING WITH
INTER-AXLE DIFFERENTIAL

LUBRICANTS:

- Drive unit gearing
  Standard-0-76, 0-76-A, 0-76-B
  Optional-0-76-C, 0-76-D, 0-76-E, 0-76-F, 0-76-J, 0-76-K

- Output bearings (two tapered bearing design only)

  Standard-Same as above plus 0-622. Refer to the following intervals and procedures.

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

- All new and reconditioned units-Drain and refill initial fill lubricant after the first 1000 miles (1600 km) but never later than 3000 miles (4800 km). Drain the lubricant while the unit is still warm from the carrier, housing and if a drain plug is employed, from the inter-axle differential of the forward carrier of tandem axles.

- Heavy duty on-highway, on/off-highway and off-highway service-Check levels every 1000 miles (1600 km). Drain and refill to bottom of filler hole or top of filler neck every 25,000 to 30,000 miles (40,000 to 48,000 km) when yearly mileage is in excess of 60,000 miles (96,000 km). If yearly mileage is less than 60,000 miles (96,000 km) change twice a year (spring and fall).

- Regular common carrier type duty on-highway service-Change every 100,000 miles (160,000 km) or once a year if yearly mileage is less than 100,000 miles (160,000 km).

- Output bearings (two tapered bearing design only) at overhaul time only, the output bearings must first be coated with oil then packed with 0-622 grease. Refer to following lube procedures.

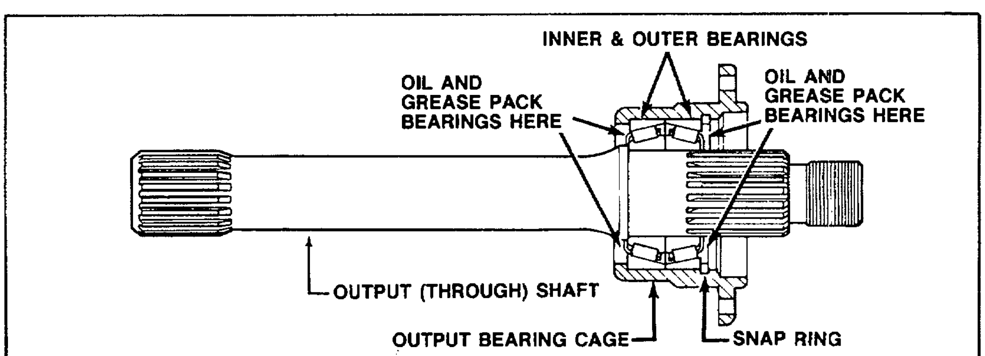
- Oil filter-Replace the oil filter of units employing a pump forced lubrication system every time the oil is changed.

- Oil pump (SQHP only-on and off highway models)New units: Pre-lubricate oil pump gears with 2 oz. (56 gr) of recommended axle lubricant through the oil pump to filter passage. Reconditioned units: Pack the pump cavity with grease (0-622) before installing pump cover.

LUBE PROCEDURES:

- After filling drive unit and/or housing with lubricant add two extra pints (0.946 liters) of same lubricant to axles employing inter-axle differentials of the type that can be directly filled through a top filler hole. Refer to capacities on page 27. Drive the vehicle, unloaded, for one or two miles (1.6 to 3.2 km) at speeds not to exceed 25 miles per hour (40 kph) to thoroughly circulate the lubricant throughout the axle and carrier assemblies.

- Output bearing (two tapered bearing design only.)



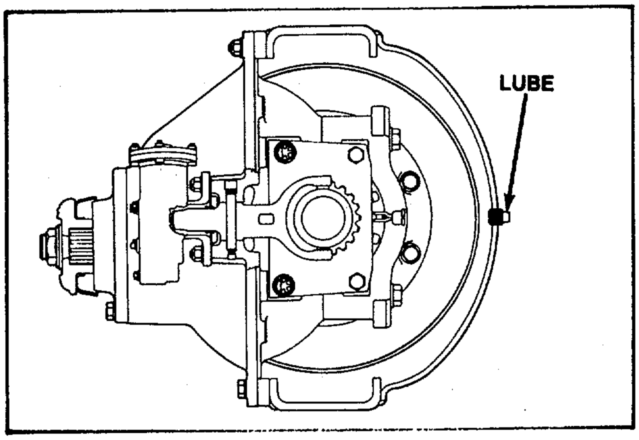
1. Reassemble the output shaft and bearing cage assembly, dry, without coating the parts with lubricant.

2. Adjust output bearings to the correct preload or end play specifications.

3. After bearings are adjusted, squirt oil through the inner and outer openings of the bearing cage to coat bearings. Use the same recommended GL-5 lubricant used in the axle.

4. After oiling, pack both the inner and outer bearings with 0-622 grease. Use a suitable grease gun with a flexible nozzle to pack the bearing cavities through the inner and outer openings of the bearing cage.

- **TWO SPEED HYPOID/PLANETARY GEARING (600 Series)**



LUBRICANTS:

Because of the planetary design of Rockwell 600 Series hypoid/planetary two speed drive units use only SAE 85/90 viscosity API-GL-5 grade hypoid gear oil.

Standard-0-76-C
Optional-Unusual temperature or operating conditions may require other or more specific lubricant recommendations. Rockwell will review these circumstances upon request, and make optional gear oil or grease recommendations.

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

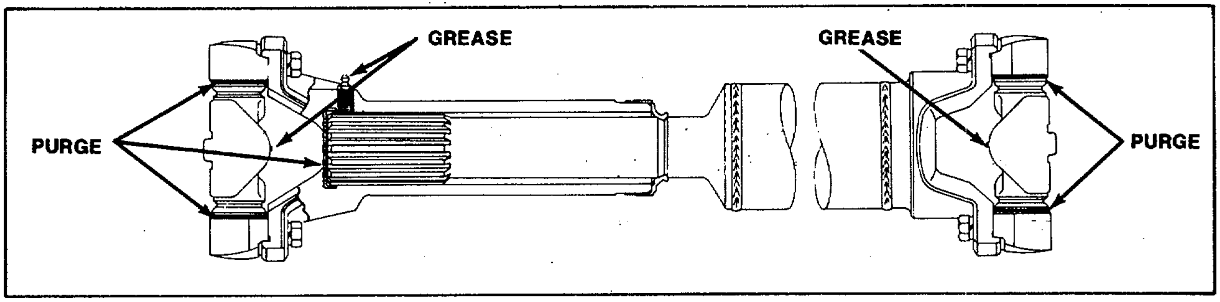
- All new and reconditioned units Drain and refill initial fill lubricant after the first 1000 miles (1600 km) but never later than 3000 miles (4800 km). Drain the lubricant while the unit is still warm from the carrier and housing.

- Check every 1000 miles (1600 km). Drain and refill every 25,000 to 30,000 miles (40,000 to 48,000 km) when yearly mileage is in excess of 60,000 miles (96,000 km). If yearly mileage is less than 60,000 miles (96,000 km) change twice a year (spring and fall).

LUBE PROCEDURES:

Except for Inter-axle Differential information use same procedures as for "Hypoid, Amboid and Spiral Bevel Gears" on page 22.

9. DRIVE LINE UNIVERSAL JOINTS, SLIP YOKES, SPLINES



DRIVE LINE "U" JOINT AND SLIP YOKE

LUBRICANTS:

Standard-0-634-B

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:

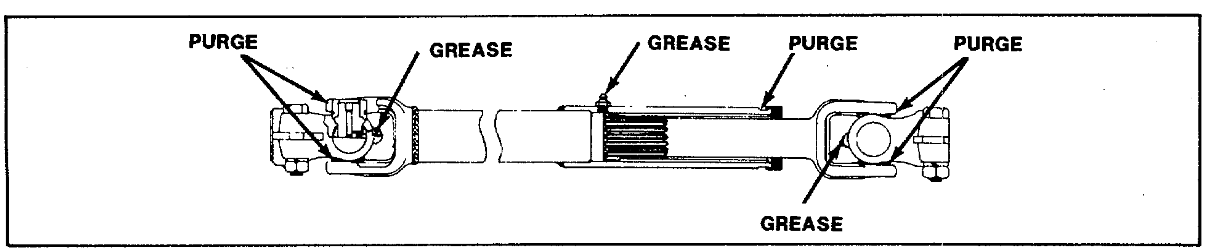
The frequency of lubricant change depends upon individual operating conditions, speeds and loads.

- On highway "X-TRA-LIFE" universal joints and shafts-50,000 miles (80,000 km) maximum. Non "X-TRA-LIFE" universal joints and shafts-1 6,000 miles (25,600 km) maximum.
- Off highway Change intervals will differ greatly and be determined largely upon the type of machinery being used, type of operation and severity of service. The lubricant change interval could be, for example, one day maximum or three months maximum. This can be determined by initially scheduling daily or weekly inspections of the universal joints, shaft and slip yoke parts. Check seals, bearings, splines, etc., and check condition of grease or for lack of grease. Also check to make sure that grease purges from all four bearing and seal positions of the cross.

LUBE PROCEDURES:

- Universal Joints:
  1. Check for looseness
  2. Apply grease until new grease purges from all seals.
  3. If grease does not purge at seals, manipulate the U-joint until purging occurs.
  4. If above is not successful, remove cup or joint and check old grease If grease appears rusty, gritty or burnt, replace the complete universal joint.
- Slip yokes and splines:
  1. Check for looseness or sideplay.
  2. Apply grease until purging takes place at air hole in end of slip yoke.

10. STEERING SHAFT UNIVERSAL JOINTS



STEERING SHAFT UNIVERSAL JOINT

LUBRICANTS:
Standard-0-617-A
Optional-0-617-B

Refer to Recommended Lubricants on pages 6 and 7.

LUBE INTERVALS:
Every 30,000 miles (48,000 km) if yearly mileage is over 30,000 miles, otherwise twice yearly (spring and fall).

LUBRICANT CAPACITIES OF ROCKWELL COMPONENTS

Lubricant capacities are given as a guide only. All measurements are taken still filled, with the pinion shaft on the horizontal centerline (unless otherwise stated *), to top of filler neck on earlier models and bottom of the tapped level hole on later models. If the pinion shaft angle is something other than listed or the specific axle lube capacity is not given, refer to the guide lines mentioned on page 3 and 4 ("Proper Lubricant Levels") for pinion angle versus proper fill plug hole to be used. After determining the proper plug hole, fill the axle with the specified lubricant to bottom of that hole.

The lubricant capacities of two similar axles in the same series may vary considerably due to design changes and the vehicle manufacturer's installation. The actual service capacity may be accurately determined by carefully measuring the amount of specified lubricant necessary to fill the assembly to the correct level and measuring the lubricant again as it is drained from the unit. The vehicle should be on a level floor when this inspection is made.

NOTE:
For the best distribution of lubricant and to assure that axle wheel end components are "wet" before putting the vehicle back into service, tilt the axle from side to side after filling with oil. Keep the axle in each tilted position for one minute to allow all wheel cavities to fill.

SINGLE AXLES†
REFERENCE ONLY

MODEL	CAPACITY U.S. Pints	CAPACITY Litres	MODEL	CAPACITY U.S. Pints	CAPACITY Litres	MODEL	CAPACITY U.S. Pints	CAPACITY Litres
A-150	5½	2.5*	F-58	15	7.0	F-580	15	7.0
B-100	10	4.5	F-75	9	4.0	F-583	15	7.0
B-140	12	5.5	F-77	10	4.5	F-2090	12	5.5
B-150	3½	1.5	F-100	13	6.0	F-3100	16	7.5
C-100	12½	6.0	F-106	13	6.0	F-3110	26	12.5
D-100	12½	6.0	F-120	15	7.0	F-3200	22	10.5
D-140	12½	6.0	F-121	15	7.0	F-4700	40	19.0
E-100	15	7.0	F-140	14	6.5	F-4710	32	15.0
E-105	12½	6.0	F-200	12	5.5	F-7900	40	19.0
E-150	9	4.0	F-223	16	7.5	F-7910	32	15.0
E-300	13*	6.0*	F-233	23	11.0	FS-4711	32	15.0
E-350	22*	10.5*	F-234	23	11.0	FDS-75	14	6.5
E-370	22*	10.5*	F-235	23	11.0	FDS-85	15	7.0
F-30	6	3.0	F-300	16	7.5	FDS-90	14	6.5
F-35	7	3.5	F-337	24	11.5	FDS-750	7	3.0
F-37	7	3.5	F-340	16*	7.5*	FDS-1600	23	11.0
F-38	10	4.5	F-400	16	7.5	FDS-1800	35	16.5
F-46	10	4.5	F-409	28	13.0	FDS-1805	35	16.5
F-50	10	4.5	F-501	10	4.5	FDS-2100	35	16.5
F-53	12	5.5	F-544	10	4.5	G-161	21	10.0
F-54	11	5.0	F-551	11	5.0	G-340	24*	11.0*
F-56	14	6.5	F-552	11	5.0			

**Add one pint (0.47 liters) of lubricant to pinion cage when new or reconditioned drive unit is installed.*
†For correct lubricant specification, see Pages 19-23.

SINGLE AXLES † (CONT.)

MODEL	CAPACITY U.S. Pints	CAPACITY Litres	MODEL	CAPACITY U.S. Pints	CAPACITY Litres	MODEL	CAPACITY U.S. Pints	CAPACITY Litres
G-341	22*	10.5*	RT-240	32*	15.0*	53300	15	7.0
G-361	21*	10.0*	RT-340	32*	15.0*	53500	6	3.0
H-100	20	9.5	R-100	30	14.0	53521	9	4.5
H-140	21	10.0	R-140	28	13.0	53547	9	4.5
H-150	11	5.0	R-155	28	13.0	53600	7	3.25
H-162	20	9.5	R-160	28	13.0	53625	4¾	2.25
H-170	27*	12.5*	R-163	34	16.0	54400	15	7.0
H-172	27	12.5	R-170	43	20.3	55400	20	9.5
H-200	28*	13.0*	R-200	36*	17.0*	55600	20	9.5
H-240	22*	10.5*	R-230	36*	17.0*	56219	22	10.5
H-262	23	11.0	R-230§	45*	21.0*	56400	20	10.5
H-300	26*	12.5*	R-255	28	13.0	56410	20	10.5
H-340	22*	10.5*	R-270	55	26.0	56434	13	6.0
H-350	24*	11.5*	R-300	34*	16.0*	56450	26	12.0
H-360	24*	11.5*	R-330	35*	16.5*	56461	26	12.0
H-370	24*	11.5*	R-330§	44*	20.5*	58200	21	10.0
L-100	23	10.5	R-355	28	13.0	58300	21	10.0
L-140	24	11.5	R-390	60*	28.0*	58415	26	12.0
L-155	24	11.5	R-2090	10	4.5	58822	22	10.5
L-172	27	12.5	R-3100	20	9.5	59722	26	12.0
L-200	31*	14.5*	S-170	43	20.3	65300	14	6.5
L-240	22*	10.5*	S-200	38*	18.0*	65356	23	11.0
L-300	29*	13.5*	S-270	55	26.0	65400	17	8.0
L-340	22*	10.5*	S-300	39*	18.5*	65456	17	8.0
L-350	24*	11.5*	U-140	24	11.5	65700	12	5.5
L-370	32*	15.0*	U-170	43	20.3	66700	20	9.5
L-600	35	16.5	U-200	38*	18.0*	67000	20	9.5
LT-200	31*	14.5*	U-240	38*	18.0*	68700	20	9.5
LT-300	29*	13.5*	U-270	55	26.0	72200	15*	7.0*
M-172	27	12.5	U-300	39*	18.5*	72300	21*	10.0*
QT-140	24	11.5	U-340	39*	18.5*	73300	8*	4.0*
QT-200	31*	14.5*	W-170	43	20.3	74400	9*	4.5*
QT-230§	44*	21.0*	W-270	55	26.0	74878	12*	5.5*
QT-240	34*	16.0*	W-464	28	13.0	75300	20*	9.5*
QT-300	29*	13.5*	46-R	10	4.5	75357	20*	9.5*
QT-330§	44*	21.0*	1300	16	7.5	75400	20*	9.5*
QT-340	32*	15.0*	1700	16	7.5	75700	24*	11.55*
Q-100	31	14.5	59000	26	12.0	76400	18*	8.5*
Q-145	24	11.5	63000	8	4.0	76700	26*	12.0*
Q-200	34*	16.0*	64800	9	4.5	76784	26*	12.0*
Q-245	34*	16.0*	65200	10	4.5	76790	28*	13.0*
Q-300	32*	15.0*	1900	16	7.5	78000	20*	9.5*
Q-345	32*	15.0*	7578	28	13.0	79000	24*	11.5*
Q-350	34*	16.0*	7579	28	13.0	79721	24*	11.5
Q-370	34*	16.0*	7580	28	13.0	93440	20*	9.5*
Q-380	36*	17.0*	7581	28	13.0	94440	20*	9.5*
Q-390	36*	17.0*	7582	28	13.0	96710	25*	12.0*
RL-170	48	22.5	51500	3½	1.5	98415	41*	19.0*

**Add one pint (0.47 liters) of lubricant to pinion cage when new or reconditioned drive unit is installed.*
†For correct lubricant specification, see Pages 19-23. *§Housing over 6½" (165 mm) deep overall.*

TANDEM AXLES†
REFERENCE ONLY

MODEL	CAPACITY U.S. Pints	CAPACITY Litres
SD-353	24	11.5
SD-454	26	12.0
SD-472	28	13.0
SD-473	28	13.0
SD-3000	19	9.0
SD-3010	19	9.0
SD-3020	31	14.5
●SDHD	‡16	‡7.0
SFD-75	16	7.0
SFD-157	9	4.25
SFD-375	23	11.0
SFD-450	36	17.0
SFD-460	29	13.5
SFD-3020	31	14.5
SFD-4600	28	13.0
SFD-4700	28	13.0
SFDD-3020	‡31	‡14.5
SFDD-4600	‡28	‡13.0
SFDD-4640	‡34½	‡16.0
SFDD-4700	‡28	‡13.0
●SFHD		
forward	‡17	‡8.0
rear	16½	7.5
●SHHD	‡26	‡12.0
SL-100		
forward	40	18.9
rear	37	16.1
SLD	28	13.0
SLDD	‡28	‡13.0
●SLHD		
forward	‡32½	‡15.25
rear	32	15.0
SQ-100		
forward	40	18.9
rear	37	16.1
SQD	22	10.5
SQDD	‡22	‡10.5
●SQHD		
forward	‡34	‡16.0
rear	31	14.5
SQHP		
forward	40	19.0
rear	36	17.0
SQTT-335	*44	*21.0
SR-170		
forward	55	26.0
rear	43	23.3
SR-270 & 280		
forward	55	26.0
rear	55	26.0
SRD	22	10.5
SRDD	‡20½	‡10.0
SRHD		
forward	39	18.5
rear	36	17.0
SRT-235	*45	*21.0
SRT-335	*44	*20.5
SSHD		
forward	34	16.0
rear	28	13.0
ST-170		
forward	55	26.0
rear	43	23.3
ST-270 & 280		
forward	55	26.0
rear	55	26.0
STHD		
forward	34	16.0
rear	28	13.0
SU-170		
forward	55	26.0
rear	43	23.3
SU-270 & 280		
forward	55	26.0
rear	55	26.0
SUHD		
forward	34	16.0
rear	28	13.0
SUDD	‡33	‡15.5
SW-170		
forward	55	26.0
rear	43	23.3
SW-270 & 280		
forward	55	26.0
rear	55	26.0

‡Add two pints (1 liter) of lubricant to inter-axle differential housing when new or reconditioned drive unit is installed in addition to specified amount of lubricant in housing. ●Pinion shaft 6° above horizontal centerline. †For correct lubricant specifications, see Pages 19-23.* Add one pint (0.47 liters) of lubricant to pinion cage when new or rereconditioned drive unit is installed.

PLANETARY STEERING AND RIGID AXLES †

REFERENCE ONLY

IMPORTANT: To assure that the wheel ends of planetary axles with a common wheel end/housing bowl oil level are initially lubricated, fill each wheel end directly with the specific amount of lubricant listed in the following chart before vehicle is put back into operation. Use the amount listed under housing bowl for drive units only. DO NOT FILL THE AXLE THROUGH THE DRIVE UNIT OR HOUSING BOWL ONLY.

MODEL SERIES Original/New	OUTER ENDS Capacity Per End U.S. Pints	HOUSING BOWL Capacity U.S. Pints	OUTER ENDS Capacity Per End Litres	HOUSING BOWL Capacity Litres
PR-53	3	33	1.5	15.5
PR-60/PRS-165	3	27	1.5	12.5
PS-100	3½	20	1.75	9.5
PR-100	3½	22	1.75	10.5
PR-108/ PRLC-614	7	29	3.25	13.5
PR-111	4⅝	27	2.00	12.5
PR-112/ PRLC-344	6	44	2.75	20.5
PR-145	5	32	2.5	15.0
PS-150	5	22	2.5	10.5
PR-150/ PRM-672,3	5	29	2.5	13.5
PR-151/ PRM-672,3	8	30	3.75	14.0
PR-153/ PRM-672,3	7½	31	3.5	14.5
PS-200	6	38	2.75	18.0
PR-200	6	40	2.75	19.0
PR-205/ PRM-676,7	7	46	3.25	21.5
PR-207/ PRM-676,7	6	45	2.75	21.0
PR-208/ PRM-676,7	8	43	3.75	20.0
PR-209/ PRLC-675	5	56	2.5	26.5
PR-250/ PRM-1756,7	13	43	6.0	20.0

MODEL SERIES Original/New	OUTER ENDS Capacity Per End U.S. Pints	HOUSING BOWL Capacity U.S. Pints	OUTER ENDS Capacity Per End Litres	HOUSING BOWL Capacity Litres
PS-250/ PSM-826	6	42	2.75	19.5
PR-251/ PRM-1756,7	12	42	5.5	19.5
PR-253/ PRLC-1756,7	13	39	6.0	18.5
PR-256/ PRM-1314,5	18	44	8.5	20.5
PRM-1615	18	44	8.5	20.5
PS-260/ PSM-1044,5	8	44	3.75	20.5
PR-270/ PRLC-823	18	44	8.5	20.5
PS-270/ PSM-1614	8	44	3.75	20.5
PS-310	14	36	6.5	17.0
PR-350/ PRC-3795,6	28	48	13.0	22.5
PR-400/ PRC-1925	16	32	7.5	15.0
PR-500	28	56	13.0	26.5
PS-500/ PSC-4564	29	58	13.5	27.5
PR-501	28	64	13.0	30.0
PR-502/ PRC-4805	31	62	14.5	29.0
PR-700	30	64	14.0	30.0

† *For correct lubricant specification, see Pages 11 and 12.*

TRANSFER CASES†
REFERENCE ONLY

The capacities of Transfer Cases are given in the vertical position. Transfer Cases may be mounted at various approved angles by the vehicle manufacturer and normally should be filled to the top of the filler neck or bottom of the tapped hole. Capacities will vary depending upon the angle of mounting and should be obtained from the vehicle manufacturer.

MODEL	CAPACITY U.S. Pints	CAPACITY Litres	MODEL	CAPACITY U.S.pints	CAPACITY Litres
T-32	4	2.0	T-152	5	2.5
T-50	81/2	4.0	T-154	91/2	4.5
T-59	2	1.0	T-167	10	4.75
T-70	24	11.5	T-179	1 1/2	.75
T-73	24	11.5	T-180	2	1.0
T-76	4	2.0	T-212	2	1.0
T-77	7	3.25	T-221	4	2.0
T-79	6	2.75	T-223	5	2.5
T-96	7	3.25	T-226	6 1/2	3.0
T-98	46	21.5	T-228-D	21	10.0
T-99	2 1/2	1.25	T-228-PD	24	11.5
T-136	14	6.5	T-236	22	10.5
T-138	14	6.5	T-282	19	9.0

† *For correct lubricant specifications, see Page 14.*

LUBE AND INTERVAL CHART

(MAXIMUM LUBRICATION CHANGE INTERVALS †)

	RECOMMENDED‡ STANDARD LUBES	CLASS "A" ON HIGHWAY ONLY	ON/OFF HIGHWAY	OFF ROAD
FRONT AXLES (NON-DRIVE) Knuckle Pins and Bushings "Easy Steer" (941, 942, 943 and 944 Series)	0-617-A, 0-617-B	Lube for Life ***	50,000 miles or 12 months •	3333 hours
Standard (900, 901, 903 and 970 Series)	0-617-A, 0-617-B	3,000 miles	3,000 miles	200 hours
Sealed (921, 930, 931, 932, 933, 934, 951 and 971 Series)	0-617-A, 0-617-B	50,000 miles/12 months •	50,000 miles or 12 months •	3333 hours
Cross Tube End Assemblies Greasable Type	0-617-A, 0-617-B	50,000 miles/12 months •	50,000 miles or 12 months •	3333 hours
DRIVE UNITS (DIFFERENTIALS) *	0-76, 0-76-A, 0-76-B	100,000 miles/12 months •	30,000 miles	2000 hours
With Traction Equilizer Additives	(above with additives)	Spring & Fall	30,000 miles	2000 hours
BRAKES Stopmaster (Wedge) **	0-616-A	100,000 miles/12 months •	12 months	12 months
Cam-Master (Cam) ** "P" Series	(Manual Slacks and Camshaft) 0-617-A, 0-617-B (Ancnor Pins) 0-616 (Automatic Slacks) 0-616-A	50,000 miles/Spring & Fall •	Spring & Fall	4 months
"Q" Series	(Manual Slacks and Camshaft) 0-617-A, 0-617-B (Ancnor Pins) 0-616 (Automatic Slacks) 0-616-A	12 months	12 months	12 months
Dura-Master (Disc)	Automatic Slack 0-616-A	25,000 miles	25,000 miles	1667 hours
	Actuating Components (Caliper) 0-616-A	50,000 miles	50,000 miles	3334 hours
	Slide Pins, Slide Pin Retainers Powershaft and Slack Splines 0-637	At brake reline and caliper overhaul		
WHEEL BEARINGS** Grease Lubricated	0-617-A or 0-617-B	30,000 miles/Spring & Fall •	Spring & Fall	Spring & Fall
Oil Lubricated	0-76-C, 0-76-B	100,000 miles/12 months •	12 months	12 months
SPRING SEATS Bushing Type (Metal, Nylon & Delrin)	0-74	As Required	As Required	As Required
Roller Bearing Type **	0-617-B	30,000 miles/Spring & Fall •	Spring & Fall	Spring & Fall
AC-6W 6 Rod Type	0-617-A	Monthly	Monthly	Monthly
DRIVE LINE UNIVERSAL JOINTS Non "X-TRA LIFE"	0-634-B	16,000 miles	As Required	As Required
"X-TRA LIFE"	0-634-B	50,000 miles	As Required	As Required
STEERING SHAFT UNIVERSAL JOINTS	0-617-A	30,000 miles/Spring & Fall •	Spring & Fall	Spring & Fall
FRONT DRIVE STEERING AXLES Universal Joints, knuckles, bearings and Bushings **	0-617-A, 0-617-B	—	30,000 miles	2000 hours
Cross Tube End Assys.	0-617-A, 0-617-B	—	3,000 miles	200 hours
Drive Units (Differential)	0-76, 0-76-A, 0-76-B	—	30,000 miles •• or Spring & Fall •••	2000 hours •• or Spring & Fall •••
PLANETARY AXLES Steering Universal Joints Cardan	0-617-A, 0-617-B	—	200 hours	200 hours
Constant Velocity	0-617-A, 0-617-B	—	1500 hours or Spring & Fall •	1500 hours or Spring & Fall •
Knuckle Bearings & Bushings**	0-617-A, 0-617-B	—	200 hours	200 hours
Wheel Ends & Drive Units**	(Common Wheel End/Housing Oil Level) 0-76-C or 0-76-D	—		
	(Without Common Wheel End/ Housing Oil Levels) 0-76-C or 0-76-D for Wheel Ends — 0-76, 0-76-A or 0-76-B for housing.		1500 hours or Spring & Fall •	1500 hours or Spring & Fall •
TRANSFER CASES	0-62, 0-63	—	25,000 miles	1666 hours

† The lube intervals listed are considered maximum for ideal operating conditions. Unusual temperatures or operating conditions will require other recommendations. Severe off-road applications may require some components to be lubricated every day. A regular lubrication schedule for particular vehicles and operations can be determined by analysis of lube samples taken from the assembly at specified intervals.

‡ Lubricants listed are recommended for average temperatures and operating conditions. Check the manual for optional lubricants.

* Drain factory fill axle lube from new or reconditioned axles after first 1000 to 3000 miles of operation. Replace oil filter, if employed, every time the oil is changed

** Change lube at indicated intervals, or whenever seals are replaced or brakes relined; whichever occurs first.

*** After 4,000 mile final lube procedure (regular common carrier on-highway service only).

• Whichever comes first.

•• If yearly mileage is over 60,000.

••• If yearly mileage is under 60,000

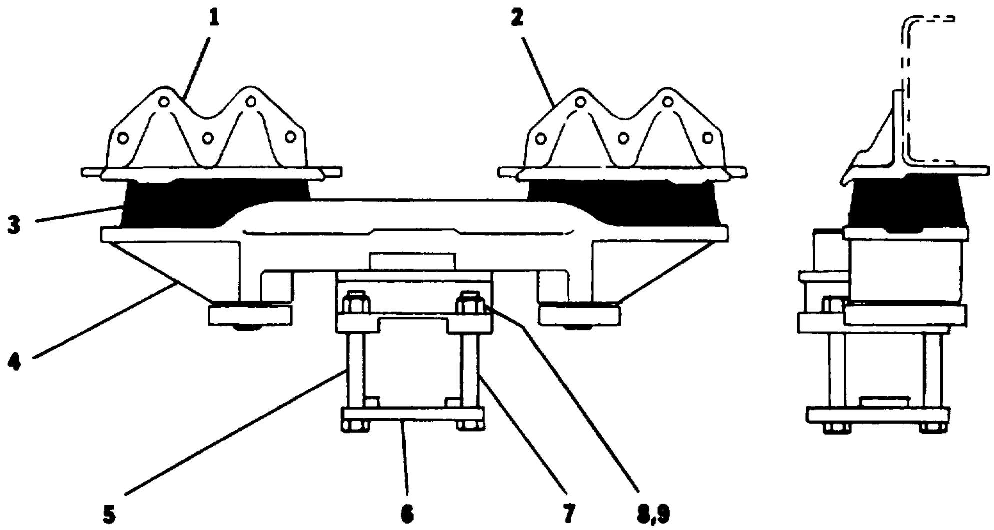
ROCKWELL INTERNATIONAL

Heavy Vehicles Components Operations
Rockwell International Corporation
2135 West Maple Road
Troy, Michigan 48084 U.S.A.

Section III
REAR AXLE
Section III
REAR AXLE

RSA-340 Suspension

All Models



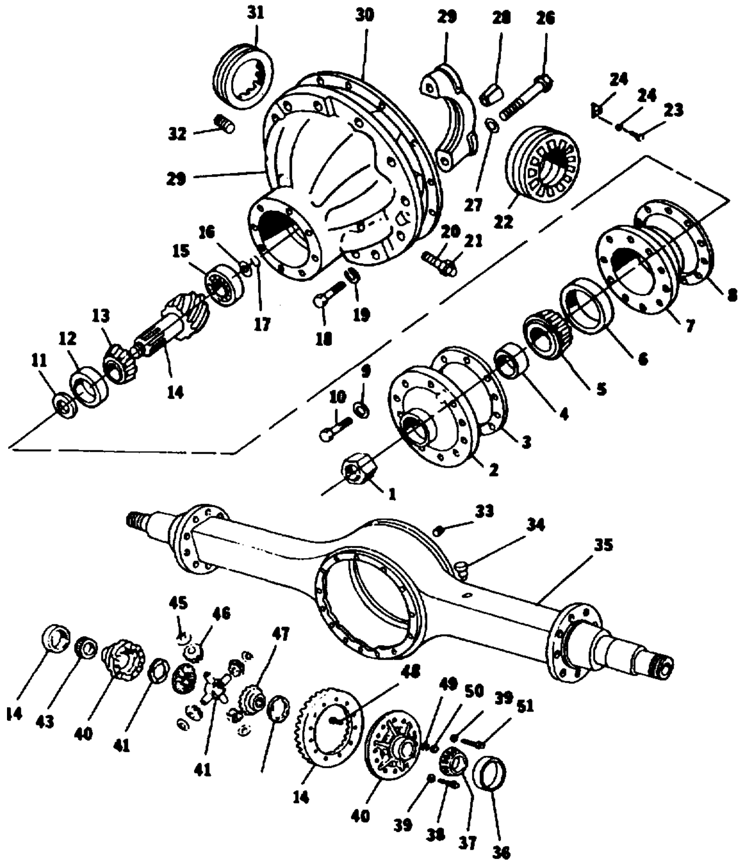
Item	Part No.	Description	Qty.
1	7605-3867	Frame Hanger LHF, RHR	2
2	7605-3868	Frame Hanger RHF, LHR	2
3	7605-3866	Load Cushion	4
4	4605-3857	Saddle Assembly LH (Shown)	1
	7605-3858	Saddle Assembly RH	1
5	7605-3861	Front Bolt (Short)	4
6	7605-3860	Lower Axle Pad LH (Shown)	1
	7605-3859	Lower Axle Pad RH	1
7	7605-3862	Rear Bolt (Long)	4
8	7605-3865	Flat Washer	16
9	7605-3864	Locknut	8
10	7605-3863	Dowel Pin (Not Shown)	2

NOTE: Your chassis Vehicle Identification Number (V.I.N.) or Serial Number on order chassis must be supplied when ordering replacement parts.

Section III

Rear Axle
R-170, S-170, U-170
All Models

DUPLEX



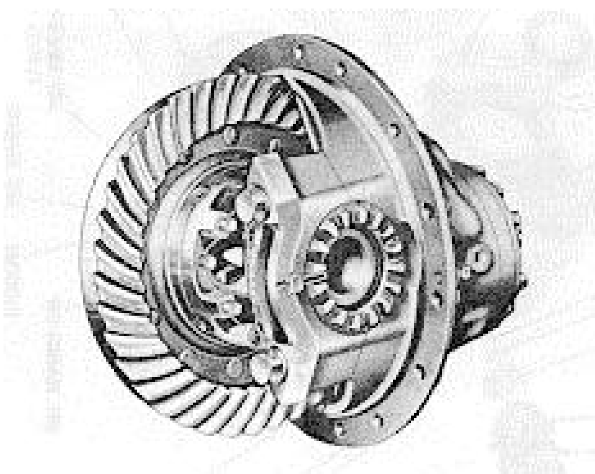
Item	Part No.	Description	Qty	Item	Part No.	Description	Qty.
1		Drive Pinion Nut	1	27		Washer	4
2	7605-2744	Pinion Cage Cover & Seal Assembly (Item 4)	1	28		Dowel	4
3		Gasket	1	29	7605-2756	Carrier & Cap Assembly (Items 26, 27)	1
4		Oil Seal	1	30		Gasket Carrier to Housing (Silastic)	1
5		Bearing Cone, Outer	1	31	7605-2757	Differential Bearing Adjusting Nut, R.H.	1
6		Bearing Cup, Outer	1	32	7605-2700	Plug Carrier Filler	1
7	7605-2745	Cage & Cup Assembly (Items 6, 12)	1	33	7605-2702	Magnetic Drain Plug	1
8		Bearing Cage Shim	A/R	34	7605-2703	Breather Assembly	1
9		Washer	8	35		Axle Housing	1
10		Capscrew	8	36		Differential Bearing Cup, L.H.	1
11		Shim	A/R	37		Differential Bearing Cone, L.H.	1
12		Bearing Cup, Inner	1	38		Differential Case Bolt, Long	8
13		Bearing Cone, Inner	1	39		Washer	12
14		Drive Gear & Pinion Assembly (Specify Ratio)	1	40		Differential Case Assembly (Items 3, 39, 51)	1
15		Rear Drive Pinion Bearing	1			(Specify Ratio)	
16		Washer	1	41		Side Gear thrust Washer	2
17		Snap Ring	1	42		Spider	1
18	7605-2746	Capscrew, Carrier to Housing, Short	6	43		Differential Bearing Cone, R.H.	1
	7605-2747	Capscrew, Carrier to Housing	2	44		Differential Bearing Cup, R.H.	1
	7605-2748	Capscrew, Carrier to Housing	2	45		Pinion Thrust Washer	4
	7605-2749	Stud, Carrier to Housing (Not Shown)	4	46		Pinion Gear	4
	7605-2729	Nut, Carrier to Housing (Not Shown)	4	47		Side Gear	2
19	7605-2696	Washer, Carrier to Housing	14	48		Capscrew, Gear to Case	16
20	7605-2750	Thrust Block Adjusting Screw	2	49		Washer, Gear to Case	16
21	7605-2751	Nut	2	50		Nut, Gear to Case	16
22	7605-2752	Differential Bearing Adjusting Nut, L.H.	1	51		Differential Case Bolt, Short	4
23	7605-2753	Capscrew	4	52	7605-2704	No-Spin Unit (Replaces Items 41, 42, 45, 46, 47)	1
24	7605-2754	Washer	4		7605-2758	Carrier Overhaul Kite (Items 1, 3, 4, 5, 6, 8, 11, 12,	1
25	7605-2755	Differential Bearing Adjusting Nut Lock	2			13, 15, 30, 36, 37, 41, 42, 43, 44, 45, 46, 47)	
26		Capscrew	4		7605-2759	Gasket & Shim Kit (Items 3, 8, 11, 30)	1

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Section III
REAE AXLE
Field Maintenance Manual No. 5

Single-Reduction Drive Unit

Hypoid Gearing



Rockwell International

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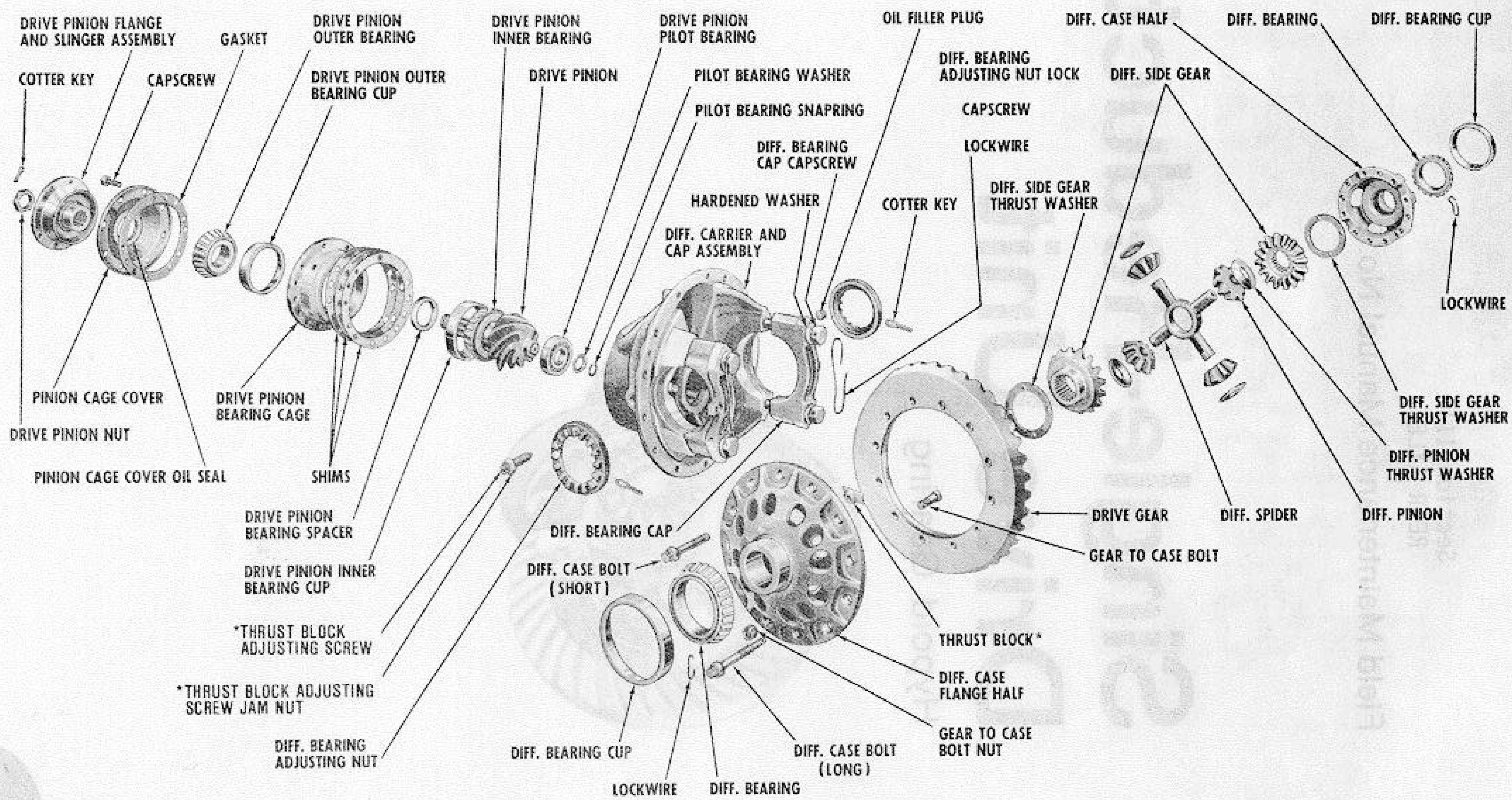
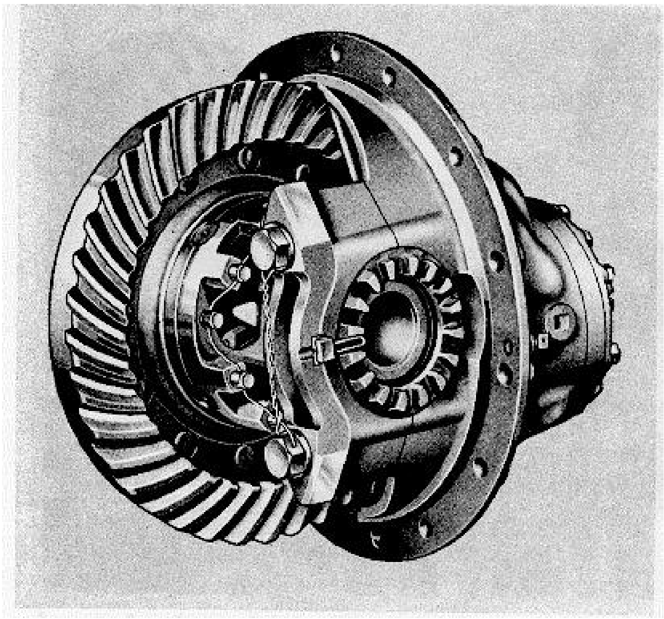
EXPLODED VIEW



* Some models may employ only the thrust screw, which may replace the thrust screw and block assembly.

CARE AND MAINTENANCE



SINGLE-REDUCTION CARRIER

The Rockwell Single-Reduction Final Drive employs a heavy duty hypoid drive pinion and ring gear. The differential and gear assembly is mounted on tapered roller bearings. The straddle mounted pinion has two tapered roller bearings in front of the pinion teeth which take the forward and reverse thrust and a third bearing behind the pinion teeth to carry the radial load.

REMOVAL DIFFERENTIAL CARRIER FROM HOUSING

A. Remove plug from bottom of axle housing and drain lubricant.

B. Remove the axle shaft stud nuts, lockwashers and tapered dowels.

IMPORTANT: To loosen the dowels, hold a 1 1/2 inch diameter brass drift against the center of the axle shaft head, INSIDE THE CIRCULAR DRIVING LUGS. Strike the drift a sharp blow with a 5 to 6 pound hammer or sledge. A 1½ inch diameter brass hammer is an excellent and safe drift.

CAUTION: Do not hit the circular driving lugs on the shaft head this may cause the lugs to shatter and splinter. Do not use chisels or wedges to loosen the shaft or dowels this will damage the hub, shaft and oil seal.

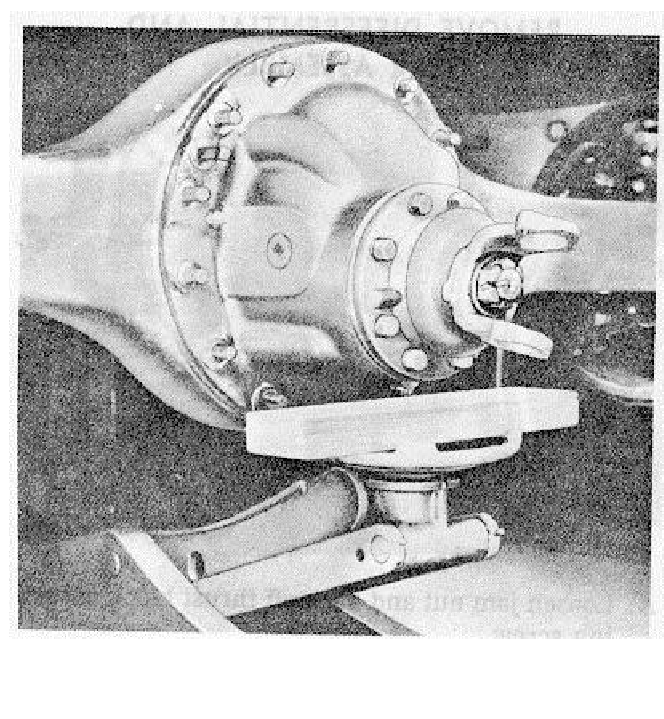
C. Remove the axle shaft from the drive unit and housing.

D. Disconnect universal at pinion shaft.

E. Remove carrier to housing stud nuts and washers. Loosen two top nuts and leave on studs to prevent carrier from falling.

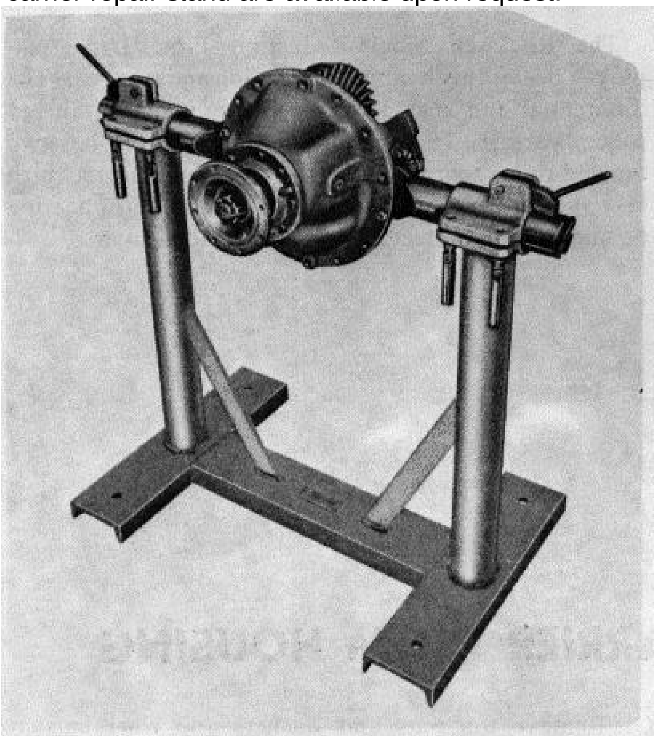
F. Break carrier loose from axle housing with rawhide mallet.

G. Remove top nuts and washers and work carrier free A small pinch bar may be used to straighten the carrier in the housing bore. However, the end must be rounded to prevent indenting the carrier flange. Use a roller jack to safely remove carrier from using



DISASSEMBLE CARRIER

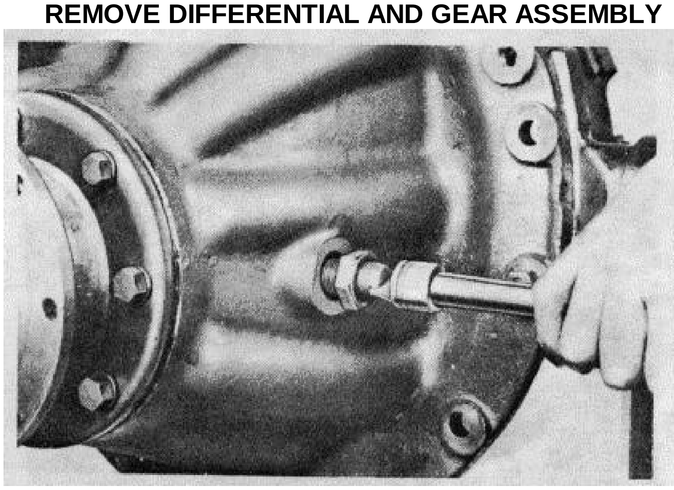
Place carrier in suitable holding fixture as illustrated. Prints of carrier repair stand are available upon request.



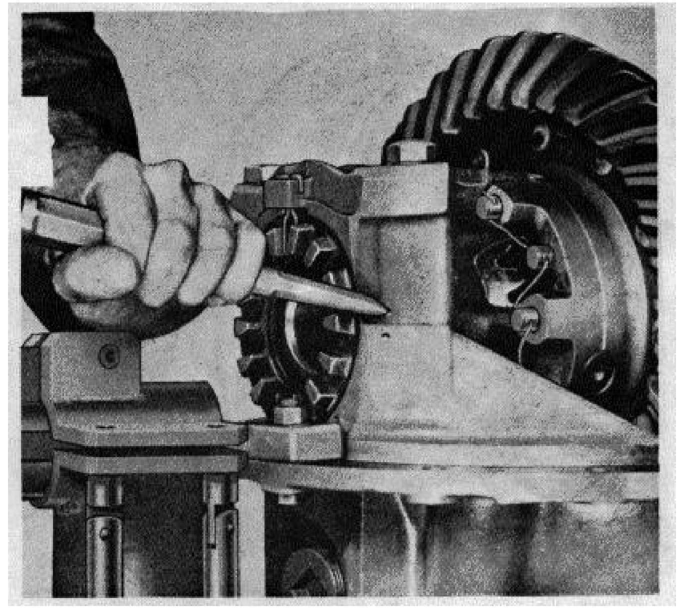
CARRIER IN REPAIR STAND

NOTE: If the initial inspection indicates that the drive gear is not going to be replaced, we suggest the established backlash be measured and noted for reference and used at reassembly.

REMOVE DIFFERENTIAL AND GEAR ASSEMBLY



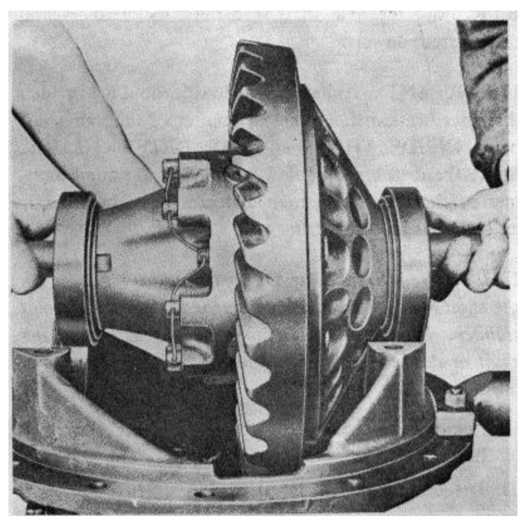
A. Loosen jam nut and back off thrust block adjusting screw.



B. Center punch one differential carrier leg and bearing cap to identify for properly reassembling.

C. Cut lock wire if employed. Remove capscrews and adjusting nut locks.

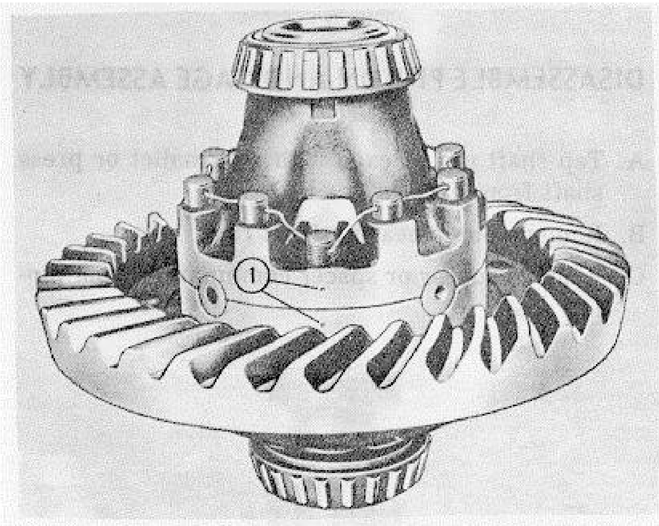
D. Remove bearing cap stud nuts or capscrews, bearing caps and adjusting nuts.



E. Lift out differential and gear assembly.

F. Remove thrust block, if used, from inside of carrier housing

DISASSEMBLE DIFFERENTIAL CASE AND GEAR ASSEMBLY



A. If original identification marks are not clear, mark differential case halves with a punch or chisel for correct alignment when reassembling.

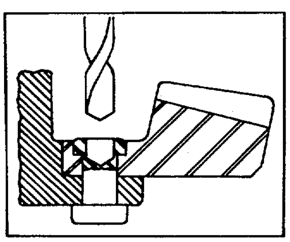
B. Cut lock wire, if used, remove bolts and separate case halves.

C. Remove spider, pinions, side gears and thrust washers.

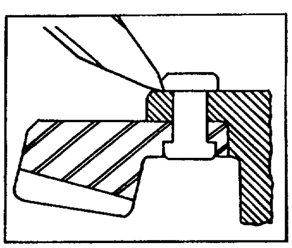
D. If necessary, remove rivets and separate gear and case.

REMOVE GEAR RIVETS

RIGHT



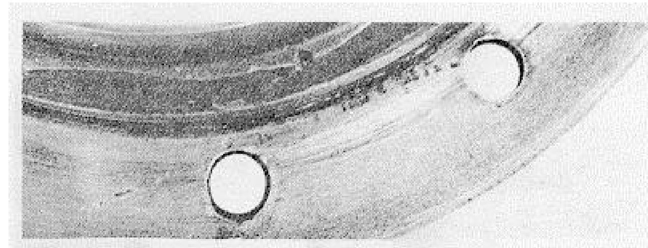
WRONG



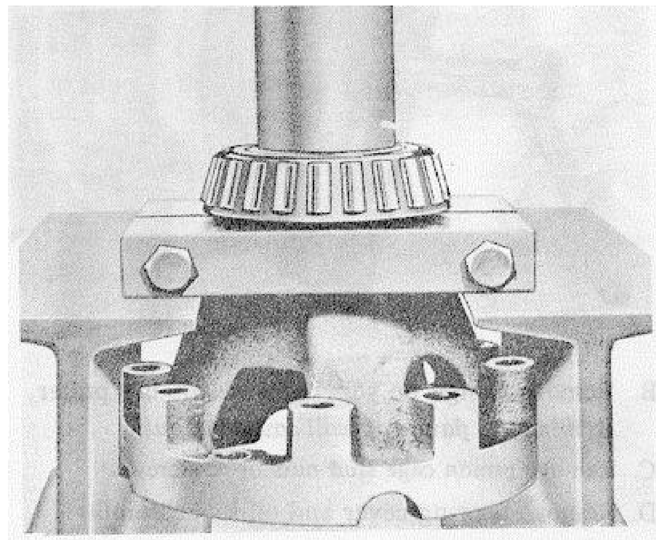
1. Carefully center punch rivets in center of head.

2. Use drill 1/32" smaller than body of rivet to drill through head.

3. Press out rivets.

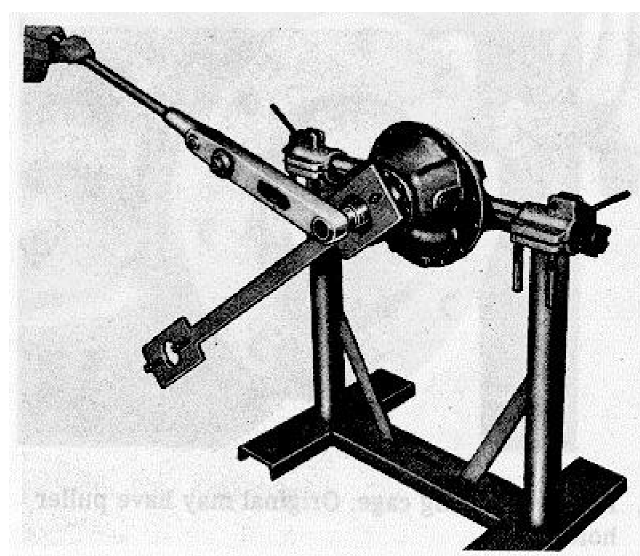


EXAMPLE OF HOW HOLES IN FLANGE WERE ELONGATED WHEN RIVETS WERE CHISELED OUT

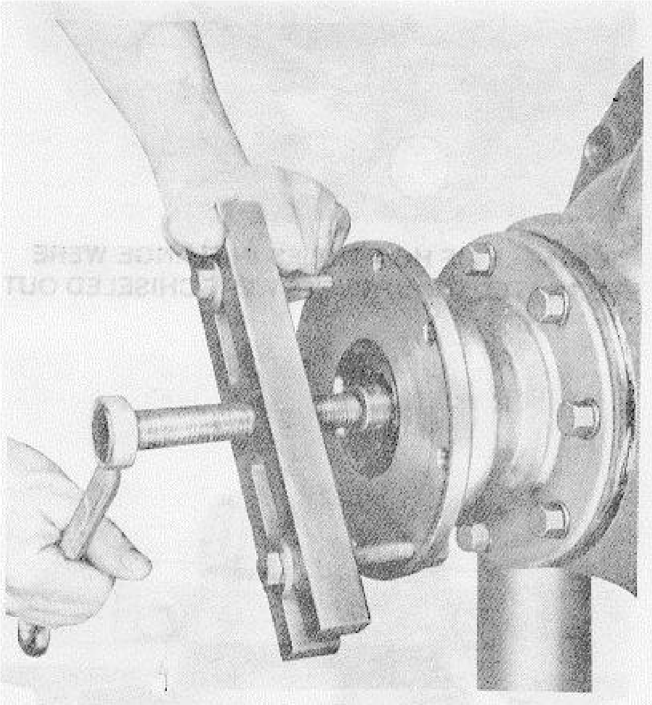


E. If necessary to replace differential bearings, remove with a suitable puller and / or press.

REMOVE PINION AND CAGE ASSEMBLY



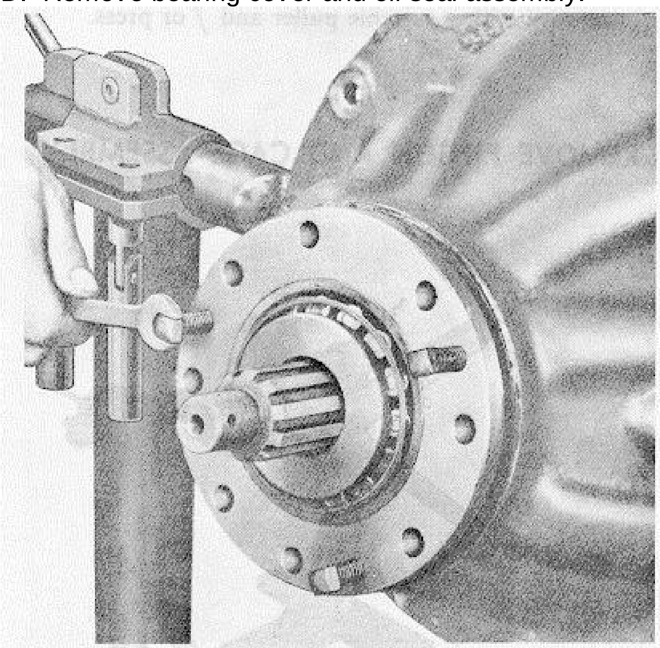
A. Hold flange or yoke with suitable tool and remove pinion shaft nut and washer.



B. Remove flange or yoke with a suitable puller.
Driving the flange off will cause runout.

C. Remove pinion cage stud nuts or capscrews.

D. Remove bearing cover and oil seal assembly.



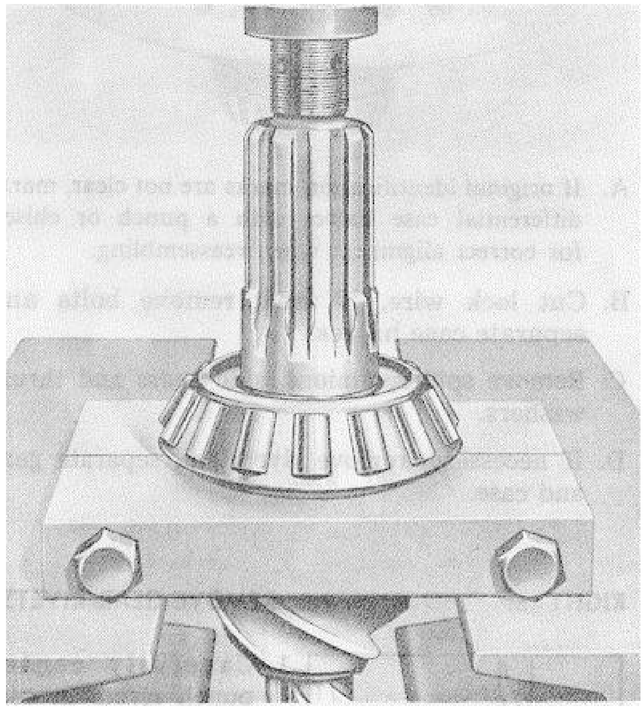
E. Remove bearing cage. Original may have puller holes.

The use of a pinch bar will damage the shims. Driving pinion from inner end with a drift will damage the bearing lock ring groove.

F. Wire shim pack together to facilitate adjustment on reassembling.

DISASSEMBLE PINION AND CAGE ASSEMBLY

A. Tap shaft out of cage with soft mallet or press shaft from cage.
B. Remove outer bearing from cage.
C. Remove spacer or spacer combination from pinion shaft.



D. If necessary to replace rear thrust bearing or radial bearing, remove with suitable puller.

E. Remove oil seal assembly from bearing cover.

PREPARE FOR REASSEMBLY
CLEAN, INSPECT AND REPAIR

Parts having ground and polished surfaces such as gears, bearings, shafts and collars, should be cleaned in a suitable solvent such as kerosene or diesel fuel oil.

GASOLINE SHOULD BE AVOIDED.

Do NOT clean these parts in a hot solution tank *or with water and* alkaline solutions such as sodium hydroxide, orthosilicates or *phosphates.*

We do NOT recommend steam cleaning assembled drive units after they have been removed from the housing. When this method of cleaning is used, water is trapped in the cored passage of the castings and in the close clearances between parts as well as on the parts. This can lead to corrosion (rust) of critical parts of the assembly and the possibility of circulating rust particles in the lubricant. Premature failure of bearings, gears and other parts can be caused by this practice. Assembled drive units cannot be properly cleaned by steam cleaning, dipping or slushing. Complete drive unit disassembly is a necessary requisite to thorough cleaning.

ROUGH PARTS

Rough parts such as differential carrier castings, cast brackets and some brake parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts are not ground or polished. The parts should remain in the tank long enough to be thoroughly cleaned and heated through. This will aid the evaporation of the rinse water. The parts should be thoroughly rinsed after cleaning to remove all traces of alkali. CAUTION: *Exercise* care *to* avoid skin rashes and inhalation *of vapors* when using alkali cleaners.

COMPLETE ASSEMBLIES

Completely assembled axles, torque dividers and transfer cases may be steam cleaned on the outside only, to facilitate initial removal and disassembly, providing all openings are closed. Breathers, vented shift units, and all other openings should be tightly covered or closed to prevent the possibility of water entering the assembly.

DRYING

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless absorbent paper towels or wiping rags free of abrasive material, such as lapping compound, metal filings or contaminated oil. Bearings should never be dried by spinning with compressed air.

CORROSION PREVENTION

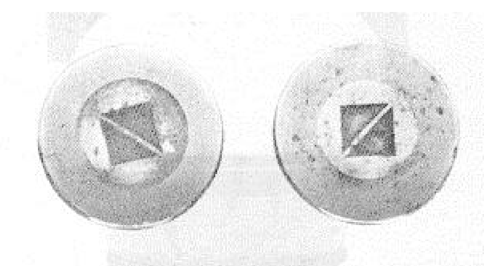
Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with light oil to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good RUST PREVENTIVE and wrapped in special paper or other material designed to prevent corrosion.

INSPECT

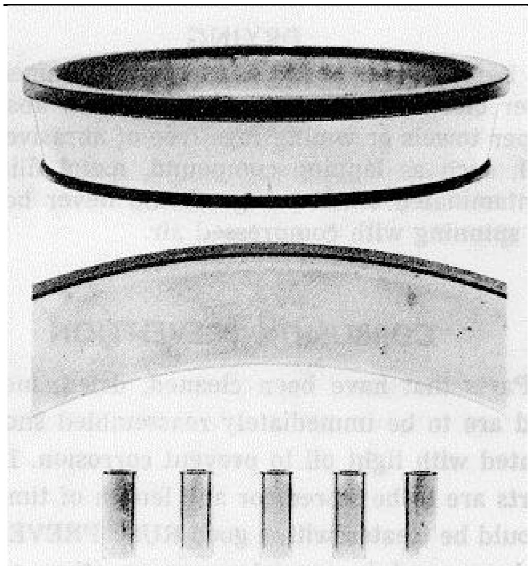
It is impossible to overstress the importance of careful and thorough inspection of drive unit parts prior to reassembly. Thorough visual inspection for indications of wear or stress, and the replacement of such parts as are necessary will eliminate costly and avoidable drive unit failure.

A. Inspect all bearings, cups and cones, including those not removed from parts of the drive unit, and replace if rollers or cups are worn, pitted or damaged in any way. Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid the use of drifts and hammers. They may easily mutilate or distort component parts.

   If any of the following bearing conditions exist, bearings must be replaced:

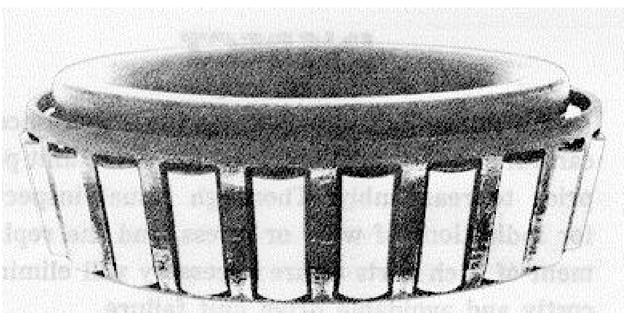


1. Large ends of rollers worn flush to recess or radii at large ends of rollers worn sharp.



2 (a)Visible step wear, particularly at the small end of the roller track.

(b)Deep indentations, cracks or brakes in bearing cup and/or cone surfaces.



3. Bright rubbing marks on the dark phosphate surfaces of the bearing cage.

4. Etching or pitting on functioning surfaces.

5. Spalling or flaking on bearing cup and/or cone surfaces.

B. Inspect hypoid gears for wear or damage. Gears which are worn, ridged, pitted or scored, should be replaced. When necessary to replace either the pinion or gear of hypoid set, the entire gear set should be replaced.

C. Inspect the differential assembly for the following:

1. Pitted, scored or worn thrust surfaces of differential case halves, thrust washers, spider trunnions and differential gears. Thrust washers must be replaced in sets. The use of a combination of old and new washers will result in premature failure.

2. Wear or damage to the differential pinion and side gear teeth. Always replace differential pinions and side gears in sets.

D. Inspect axle shafts for signs of torsional fractures or other indication of impending failure.

REPAIR

A. In the interest of safety and preserving the service life of drive axle assemblies, Rockwell recommends that axle assemblies not be repair welded. Repair welding can detract from the structural integrity of a component, particularly as to heat treated parts where the benefit of heat treatment may be nullified by the welding.
Since it can be extremely hazardous and detrimental to repair weld components of any kind, repair welding can be approved only where stringent controls are imposed and equipment, customarily located only at manufacturing facilities, is employed, so as to minimize the potentially detrimental effects of repair welding.

In deciding whether to repair or scrap any damaged part, always keep in mind *that we, as manufacturers, never hesitate to scrap any part which is in any way doubtful.*

B. Hex nuts with rounded corners, all lock washers, oil seals and gaskets should be replaced at the time of overhaul.

Use only genuine Rockwell replacement parts for satisfactory service. For example, using gaskets of foreign material generally leads to mechanical trouble due to variations in thickness and the inability of certain materials to withstand compression oil, etc.

C. Remove nicks, mars and buffs from machined or ground surfaces. Threads must be clean and free to obtain accurate adjustment and correct torque. A fine mill file or India stone is suitable for this purpose. Studs must be tight prior to reassembling the parts.

D. When assembling component parts use a press where possible.

E. Tighten all the nuts to the specified torque. Where lockwire is employed, use soft iron locking wire to prevent possibility of wire breakage.

F. The burrs, caused by lock washers, at the spot face of stud holes of cages and covers should be removed to assure easy reassembly of these parts.

SILICONE (RTV)
GASKET APPLICATION

NOTE: Where silicone RTV gasket material is used, Dow Silastic No. RTV-732 Black and General Electric No. RTV-1473 Black meet our requirements. However, silicone RTV is also available in bulk under Rockwell part number 1199-Q-2981; in 10 oz. tubes, part number 1250-X388, or in 3 oz. tubes, part number 1199-T-3842.

SERVICE

Removal of all gaskets including silicone RTV is accomplished by peeling or scraping the used gasket off both mating surfaces.

Application of silicone RTV gasket material is as follows:

1. Remove dirt, grease or moisture from both mating surfaces.
2. Dry both surfaces.
3. Apply thin bead, approximately 1/8" diameter completely around one mating surface and all fastener holes to assure complete sealing and prevent leakage. *CAUTION. Minor concentrations of acetic* acid vapor may be produced during application. Adequate ventilation should be provid*ed* when *silicone* R TV *is* applied *in* confined *areas.*

   Further, eye contact with these silicone RTV gasket materials may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

4. Assemble the components immediately to permit silicone RTV gasket material to spread evenly.

When rebuilding any assembly, always use torque values on fasteners as specified by either Rockwell or the vehicle manufacturer.

C*A*UTION: *Failure to* use appropriate gasket *material will* cause *axle to* leak.

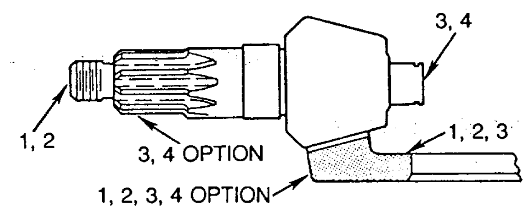
REASSEMBLE CARRIER

IMPORTANT: If a new gear set (drive pinion and ring gear) is being installed into the carrier, refer to the following gear set information before starting reassembly. However, if the original gear set is to be installed start with "Reassemble Pinion and Cage Assembly" on page 11.

GEAR SET IDENTIFICATION

The following information is marked on current drive pinion and gear sets, and will be used for identifying, matching and adjusting procedures.

The items listed are keyed to the following illustration.



STRADDLE MOUNTED PINION
(Shown with parallel sided splines)

1. Part Number

2. Tooth Combination Number The Part Number and Tooth Combination Number are found on the shank or threaded end of all pinions. On the ring gears the numbers are normally found on the front face of the gear. However, as an option, they may be located at the gear O. D.
   For any given pinion and gear set the ring gear always has an even part number (i. e. 36786) and the matched pinion has the odd number (i. e. 36787). The tooth combination. number (i. e. 5-37) indicates the gear set has a 5 tooth pinion and a 37-tooth ring gear, the equivalent of a 7. 4 to 1 gear ratio.

   Always refer to the Part Number and' Tooth Combination Number before starting the reassembly. Check to be certain the pinion and gear match.

3. Gear Set Matching Numbers All Rockwell drive pinion and gear sets are manufactured and sold only in matched sets. Both pieces of the set have a matching number such as 'M29" or any combination of a letter and number.

On most pinions the number is usually marked on the head end. However, on pinions with parallel-sided splines the number may be marked on the top flat of one of the splines.

On the ring gear the number is usually found on the front face of the gear, although sometimes it may be on the gear O. D. A gear and pinion which do not have the same matching numbers must *not* be run together.

Therefore if either a pinion or a ring gear should require replacement *both* must be replaced in a matched set.

4. Pinion Cone Variation Number

   Each pinion has a Pinion Cone (P. C.) Variation Number which indicates variations (in thousandths of an inch) from the nominal mounting distance. This Pinion Cone Variation Number is necessary because pinion and gear sets for a specific series of axles cannot be manufactured exactly alike, and there may be slight differences in the Mounting Distance of the individual gear sets. This P. C.

Variation Number must be used to modify the Nominal Pinion Gauging Dimension when using a pinion setting gauge or when calculating pinion cage shim pack thicknesses.

The Pinion Cone Variation Number (i. e. P. C. +3 or P. C. -5) is normally found on the pinion head end; however, it may sometimes be located on a spline of a pinion with the larger parallel sided-type splines or on the ring gear O. D.

NOTE: The nominal pinion mounting distance and backlash setting is not marked on current gear sets. Refer to the following charts for this information.

NOMINAL PINION MOUNTING DISTANCE

AXLE MODELS		**NOMINAL PINION MOUNTING DISTANCE**
B-I00, B-101		5.250" (133.35 mm)
C-100		6.125" (155.58 mm)
D-100		6.500" (165.10 mm)
D-140 F-106 F-130 F-140, F-142, F-145, F-146, F-147, F-149		6.812” (173.03 mm)
H-140, H-141, H-145		7.500" (190.50 mm)
H-150		7.156" (181.77 mm)
H-162		7.625” (193.68 mm)
H-170, H-172		
L-100	with 3.545 thru 5.833 ratios except 4.875 ratios	7.562" (192.08 mm)
	with 6.166 thru 8.600 ratios including 4.875 ratio	7.688" (195.28 mm)
L-140, L-145, L-148		7.625" (193.68 mm)
L-155	with 3.545 thru 5.833 ratios except 4.875 ratios	7.562" (192.08 mm)
	with 6.166 thru 8.600 ratios including 4.875 ratio	7.688” (195.28 mm)
L-172		7.625" (193.68 mm)
Q-145, Q-146, Q-148		8.250" (209.55 mm)
R-I00, R-110 R-114, R-115 R-120 R-140, R-141, R-143 R-155, R-158 R-160, R-162, R-164		8.750" (222.25 mm)
R-170, R-171, R-173 R-180		10.000" (254.00 mm)
U-140		8.750" (222.25 mm)
U-170		10.000" (254.00 mm)
U-180		

BACKLASH SETTING

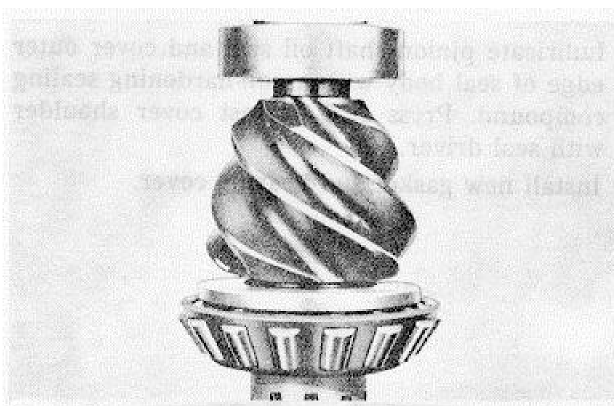
CARRIER TYPE & PITCH DIAMETER	BACKLASH SETTING
Single Reduction Carriers*(Less than 17" Pitch Dia.)	.005" - .015' (.13-.39 mm)
Single Reduction Carriers *(17” Pitch Dia. & over)	.008" - .020" (.21-.51 mm)

***NOTE: To determine approximate pitch diameter, measure the ring gear outer diameter.**

REASSEMBLE PINION AND CAGE ASSEMBLY

A. If new cups are to be installed, press firmly against pinion bearing cage shoulders.

B. Lubricate bearings and cups with the recommended axle lubricant.



C. Press rear thrust and radial bearings firmly against the pinion shoulders with a suitable sleeve that will bear only on bearing inner race.

D. Install radial bearing lock ring and squeeze ring into pinion shaft groove with pliers.

E. Insert pinion and bearing assembly in pinion cage and position spacer or spacer combination over pinion shaft.

F. Press front bearing firmly against spacer.

G. Rotate cage several revolutions to assure normal bearing contact.

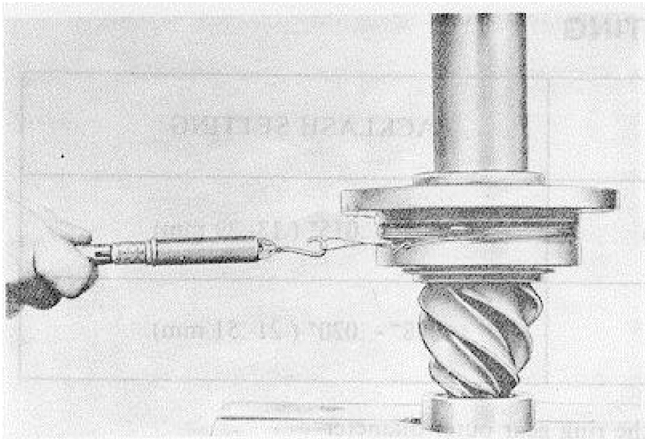
H. While in press under pressure, check bearing preload torque. Wrap soft wire around cage and pull on horizontal line with pound scale.

Use *rotating torque,* not starting torque.

If a press is not available, the pinion nut may be tightened to the correct torque and preload checked.

The correct pressures and torque for checking pinion bearing preload are as follows:

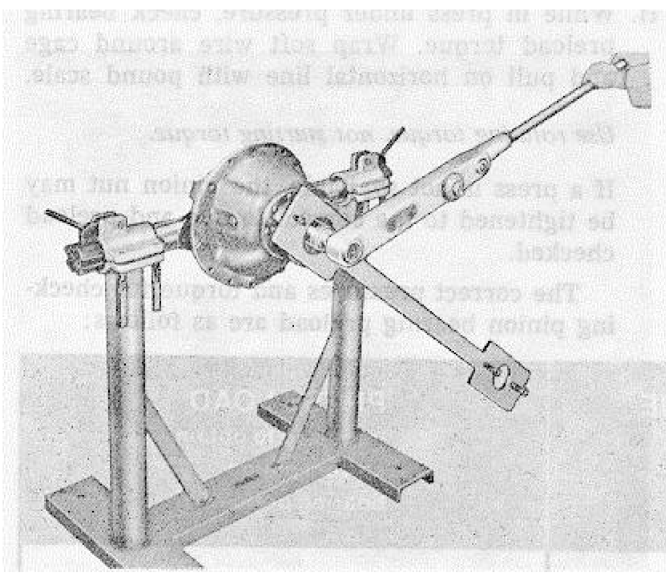
PINION SHAFT THREAD SIZE	PINION NUT TORQUE (required to obtain correct pinion bearing preload)	PRESS LOAD (required to obtain correct pinion bearing preload)
⅞″ — 20	200 — 275 lb. ft.	22,000 lbs. (11 tons)
1″ — 20	300 — 400 lb. ft.	30,000 lbs. (15 tons)
1¼″ — 12	700 — 900 lb. ft.	54,000 lbs. (27 tons)
1¼″ — 18	700 — 900 lb. ft.	54,000 lbs. (27 tons)
1½″ — 12	800 — 1100 lb. ft.	54,000 lbs. (27 tons)
1½″ — 18	800 — 1100 lb. ft.	54,000 lbs. (27 tons)
1¾″ — 12	900 — 1200 lb. ft.	50,000 lbs. (25 tons)
2″ — 12	1200 — 1500 lb. ft.	50,000 lbs. (25 tons)



If rotating torque is not within 5 to 15 pound inches, use thinner spacer to increase or thicker spacer to decrease preload.

Example: Assuming pinion cage diameter to be 6 inches, the radius would be 3 inches and with 5 pounds pull would equal 15 pound inches preload torque.

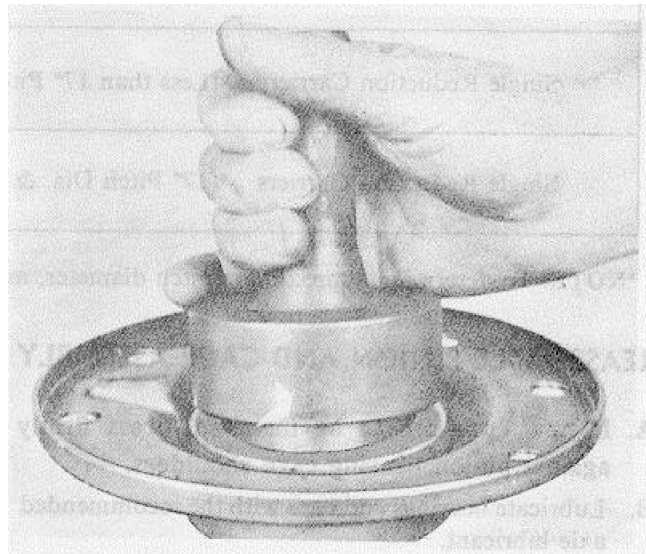
I. Press flange or yoke against forward bearing and install washer and pinion shaft nut.



J. Place pinion and cage assembly over carrier studs, hold flange and tighten pinion shaft nut to the correct torque. The flange must be held with a suitable tool or fixture to tighten nut.

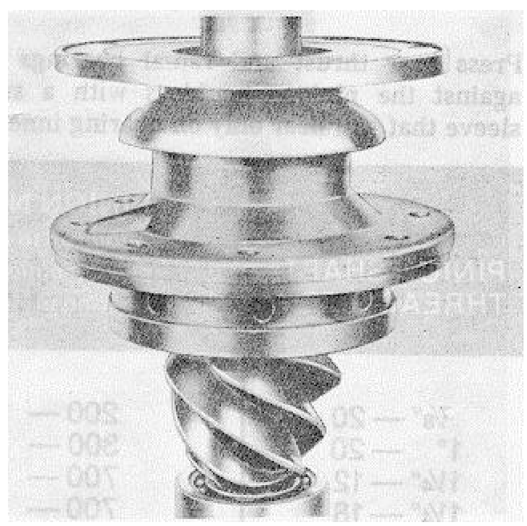
K. Recheck pinion bearing preload torque. If rotating torque is not within 5 to 15 pound inches, repeat the foregoing procedure.

L. Hold flange and remove pinion shaft nut and flange.



M. Lubricate pinion shaft oil seal and cover outer edge of seal body with a non-hardening sealing compound. Press seal against cover shoulder with seal driver.

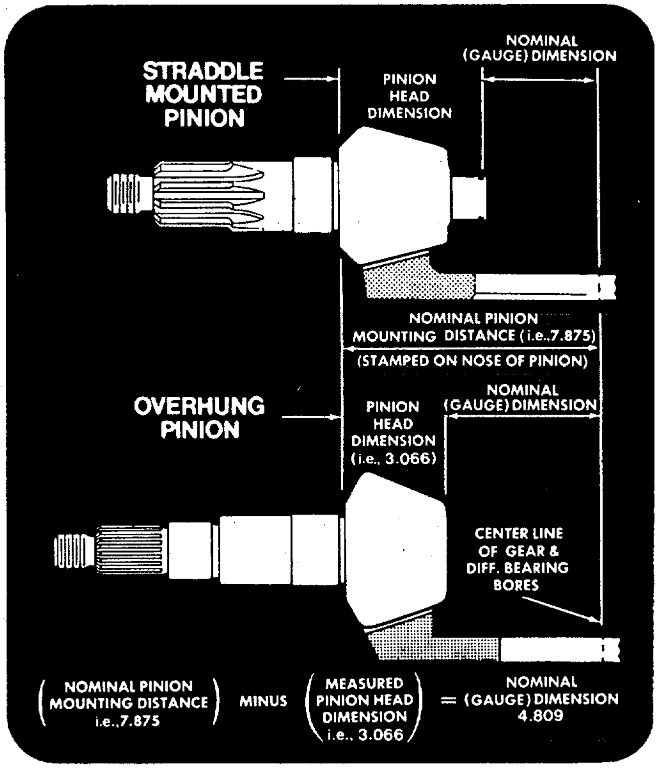
N. Install new gasket and bearing cover.



O. Press flange against forward bearing and install washer and pinion shaft nut..

P. Tighten nut to the correct torque value.

ADJUSTING THE PINION CAGE SHIM PACK THICKNESS WITH A PINION SETTING GAUGE.



The correct use of a pinion setting gauge will simplify the accurate installation of the pinion and cage assembly into the carrier. When using the pinion setting gauge, never use the nominal pinion mounting dimension without first modifying it to a workable value. The Nominal Pinion Mounting Dimension (i. E. 7. 875*)* indicates the proper distance from the center of the ring gear to the bearing shoulder on the pinion.

However, because the opinion setting gauge measures the distance from the ring gear center to the nose of the pinion rather than the bearing shoulder, it becomes necessary to subtract the length of the pinion head from the Nominal Pinion Mounting Dimension in order to establish the correct nominal or gauge dimensions to work with.

To accurately install and adjust the pinion and cage assembly in a typical single reduction carrier using a pinion setting gauge, follow these procedures:

1. Record the Nominal Pinion Mounting Dimension and the original shim pack thickness for future reference.

2. With a micrometer or vernier scale, measure the length of the pinion head from its nose to its bearing shoulder. Mark the spot on the pinion nose from which this measurement was taken. Later, when using the pinion setting gauge, measure to or clamp step plate to this same spot for consistency in the calculations.

3. Substract the measured pinion head length from the Nominal Pinion Mounting Dimension to establish the pinion nominal gauge dimension. Repeating the example in the illustration this would be 7. 875 3. 066 = 4. 809. The remainder 4. 809 is the basic value or Nominal Gauge Dimension used for calculations when using the pinion setting gauge.

4. Modify the nominal gauge dimension (4. 809) by the Pinion Cone Variation Number etched on the pinion (i. e. P. C. +3 or P. C. -5). This P. C. number indicates the variation in thousandths of an inch from the nominal mounting distance of that specific gear set. Add or subtract this value as indicated by its sign from the nominal gauge dimension established in Step 3. This will give the corrected pinion gauge dimension.

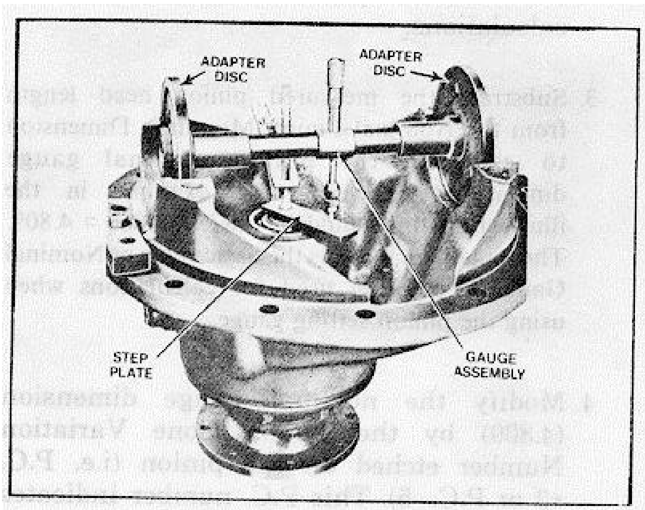
Example: P. C. = +3
4. 809 + . 003 = 4. 812"

Example: P. C. = -5
4. 809 . 005 = 4. 804"

5. Install the pinion and cage assembly into carrier, using the original shim pack that was removed when the unit was disassembled. Tighten all pinion cage cap screws or stud nuts to the specified torque.

was removed when the unit was disassembled. Tighten all pinion cage cap screws or stud nuts to the specified torque.

6. Assemble the pinion setting gauge and step plate (if required) into the differential bearing bores using proper adapter discs. Refer to Technic Aid Section 8, Aid #19 for specifics on adapter discs. Adjust the micrometer arbor so it is directly over and. at a 90° angle to the pinion nose or step plate.



7. Run the micrometer down to measure the distance to the pinion or step plate. Make note of this measurement and use the following procedures to calculate for correct shim pack thickness.

   If a step plate is required, subtract its thickness (. 400") from the corrected pinion gauge dimension calculated in Step 4.

Example:
Corrected Nominal Gauge Distance (4.809"-.005") 4.804"

Example:	
Corrected Nominal Gauge Distance (4.809"-.005")	4.804"
Step Plate Thickness	-.400"
Corrected Micrometer Distance (Final measurement to be obtained)	4.404"
Initial Micrometer Reading (Using original shim pack)	-4.384"
Shim Pack Correction (To be added)	.020"

8. After making the necessary corrections to the shim pack and tightening the cap screws or nuts to the specified torque, recheck the micrometer measurement again to be certain of the correct pinion adjustment.

C. ADJUSTING THE PINION CAGE SHIM PACK THICKNESS WITHOUT A- PINION SETTING GAUGE.

A second means of accurately installing a new pinion and cage assembly into the carrier is to mathematically calculate the proper pinion cage shim pack thickness.

The following are the procedures to use:

1. Measure the thickness of the original shim pack used with the gear set being replaced. Use a micrometer or vernier gauge. Record this measurement for future use.

2. Observe the "PC" or variation number on the original pinion being replaced. If this number is a plus (+) value subtract it from the original shim pack measurement . taken in item "1". If the variation number is a minus (-) value add it to the measurement from item "1". Make a note of this value
   NOTE: *The value calculated in item "2" will establish* a *"standard shim pack thickness", without a variation. This value will be used in calculating the shim pack thickness used with a new* pinion *and gear set.*

3. Observe the "PC" or variation number on the new pinion, (locations of the "PC" number are shown above). Add or subtract this Number as indicated by the variation sign (+ add or subtract) from the calculated "standard shim pack thickness" determined in item "2".

   The resulting answer indicates the thickness (in thousandths) of the new shim pack to be used. Refer to the following examples which cover all the possible combinations of + or original and new "PC" variations.

EXAMPLES OF CALCULATION:

EXAMPLE NO. 1

Original Pack Thickness	.030"
Original Variation (PC +2)	-.002
Standard- Pack Thickness	.0280
New Variation (PC +5)	+.005
New Pack Thickness	.033"

EXAMPLE NO. 2

Original Pack Thickness		.030"
Original Variation (PC -2)	+	.002
Standard Pack Thickness		.032"
New Variation (PC +5)	+	.005
New Pack Thickness		.037"

EXAMPLE: NO. 3

Original Pack Thickness		.030"
Original Variation (PC +2)	-	.002
Standard Pack Thickness		.028"
New Variation (PC -5)	-	.005
New Pack Thickness		.023"

EXAMPLE NO. 4

Original Pack Thickness	+	.030"
Original Variation (PC -2)		.002
Standard Pack Thickness		.032"
New Variation (PC -5)	-	.005
New Pack Thickness		.027"

After calculating the shim pack thickness, assemble the new pinion and cage assembly with the correct shim pack into the carrier as follows:

IMPORTANT: *Remember, that all Rockwell drive pinion and gear sets are manufactured and sold only in matching sets. Therefore, if either a pinion or a ring gear should require replacement both must be replaced in a matching set.*

INSTALL PINION & CAGE ASSEMBLY

A. Position the correct shim pack between the pinion cage and carrier.

IMPORTANT: *Use* a *minimum of three (3) shims per pack. If the pack is* made *up from various thicknesses of shims locate thinnest shims on both sides of the pack for maximum sealing ability.*

B. Install the pinion and cage assembly with shims into carrier and tap into position with soft mallet.

C. Install pinion cage capscrews. Tighten capscrews to the correct torque.

D. After the differential and gear assembly is installed into carrier make a gear tooth contact check.

ASSEMBLE DIFFERENTIAL AND GEAR

IMPORTANT: The ring gear must be heated before assembling onto the case half, otherwise damage to the case half will result.

Proper service replacement of the differential ring gear onto the differential case half is necessary for correct gear adjustment and longer drive unit service life. For correct installation, Rockwell recommends heating the ring gear in water to approximately 160° 180°F for about ten minutes before assembly. This will allow an easier fit of the gear over the differential case pilot, without the use of a press, and without damaging the case and ring gear mating surfaces.

The gear should not be pressed or driven on the case, as this would cause excessive metal particles to lodge between the gear and case, thus resulting in gear runout. Proper installation should, therefore, incorporate preheating the gear as described above to assure correct interference fit and to eliminate metal pick-up.

A. Rivet the hypoid gear to the case half with new Rockwell rivets. Rivets should not be heated, but always upset cold. When the correct rivet is used, the head being formed will be at least 1/8'" larger in diameter than the rivet hole. The head will then be approximately the same height as the preformed head. Excessive pressure will cause distortion of the case holes and result in gear eccentricity.

Tonnage required for squeezing cold rivets. These pressures are approximate for annealed steel rivets and pressure can be adjusted to suit individual working conditions.

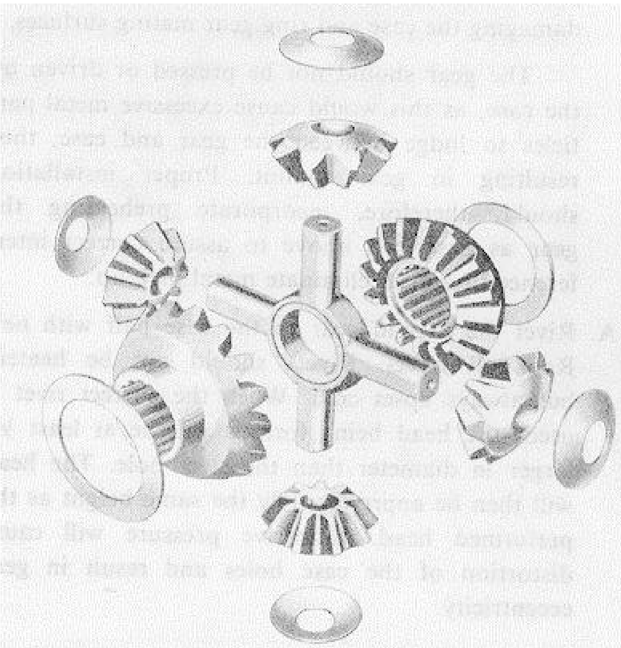
DIAMETER OF RIVET	TONNAGE REQUIRED
7/16 ""	22
1/2"	30
9/16	36
5/8"	45

Final pressure should be held for approximately one minute to make sure the rivet has filled the hole.

After installing rivets, check for proper fit between gear and case half. Using a feeler gauge . 003" maximum thickness check for gap between back face of gear and case flange. Check at four equally spaced locations around the assembly. If gauge can be inserted more than one half the distance between the flange O. D. and gear pilot diameter, the gear must be removed. Check for cause, correct and reassemble gear onto case half.

Differential case and gear bolts are available for service replacement of rivets. The use of bolts greatly facilitates servicing these units in the field and eliminates the need for special equipment necessary to correctly cold upset rivets. Consult chart for service bolt instruction shown with the torque chart on last page of manual.

B. Lubricate differential case inner walls and all component parts with axle lubricant.

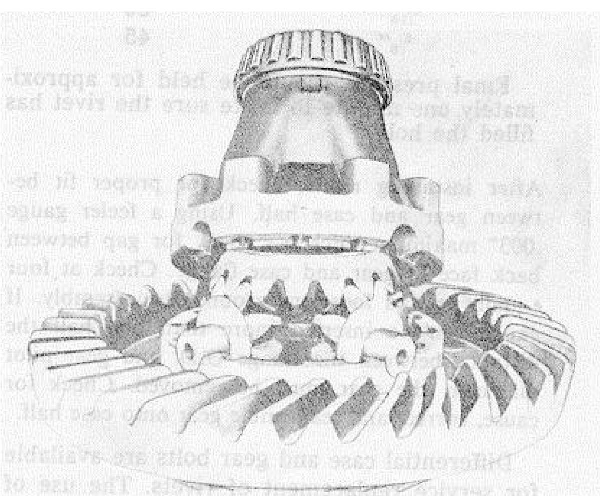


DIFFERENTIAL PINION AND SIDE GEAR-ASSEMBLY

C. Position thrust washer and side gear in ring gear and case half assembly.

D. Place spider with pinions and thrust washers in position.

E. Install component side gear and thrust washer.



F. Align mating marks, position component case half and draw assembly together with four bolts or capscrews equally spaced.

NOTE: If "DRI-LOC" bolts are used, refer to procedures on pages 21 and 22.

G. Check assembly for free rotation of differential gears and correct if necessary.

H. Install remaining bolts and capscrews, tighten to the correct torque and lock wire.

I. If bearings are to be replaced, press squarely and firmly on differential case halves.

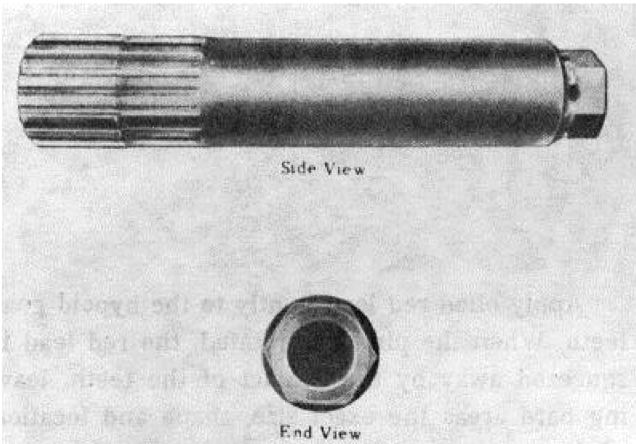
ROLLING RESISTANCE CHECK OF DIFFERENTIAL NEST

A. Place differential and ring gear assembly in a vise IMPORTANT: Use soft metal covers over vise jaw to protect ring gear.

B. Insert checking tool (made from splined axle shaft end) into differential nest. Allow splines of tool to engage with spline of one side gear only.

C. Using a suitable socket and torque wrench, rotate differential nest while observing scale on torque wrench.

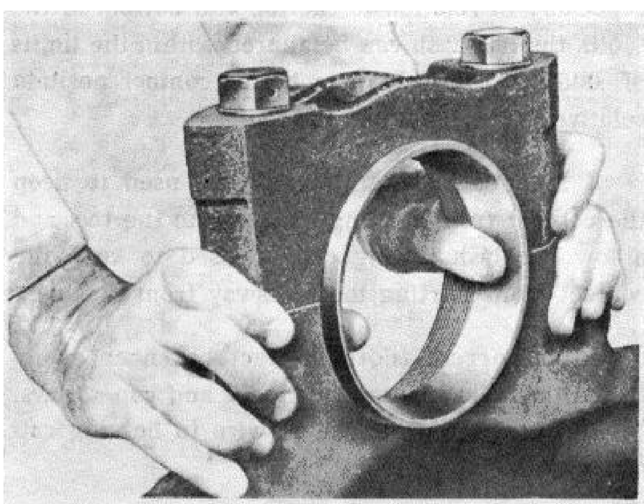
Correct rolling resistance of differential assembly is 50 lb. ft. torque maximum applied to one side gear. This applies to all differential assemblies.



D. A suitable checking tool can be made by cutting an axle shaft to an appropriate length and welding a nut on the end to accept a wrench socket.

INSTALL BEARING CUPS IN CARRIER LEG BORES

A. Temporarily install the bearing cups, threaded adjusting rings where employed and bearing caps. Tighten the capscrews to the proper torque.



B. The bearing cups must be of a hand push fit in the bores, otherwise the bores must be re- worked with a scraper or some emery cloth until a hand push fit is obtained. Use a blued bearing cup as a gauge and check the fits as work progresses. Once the cups fit properly, remove the bearing caps.

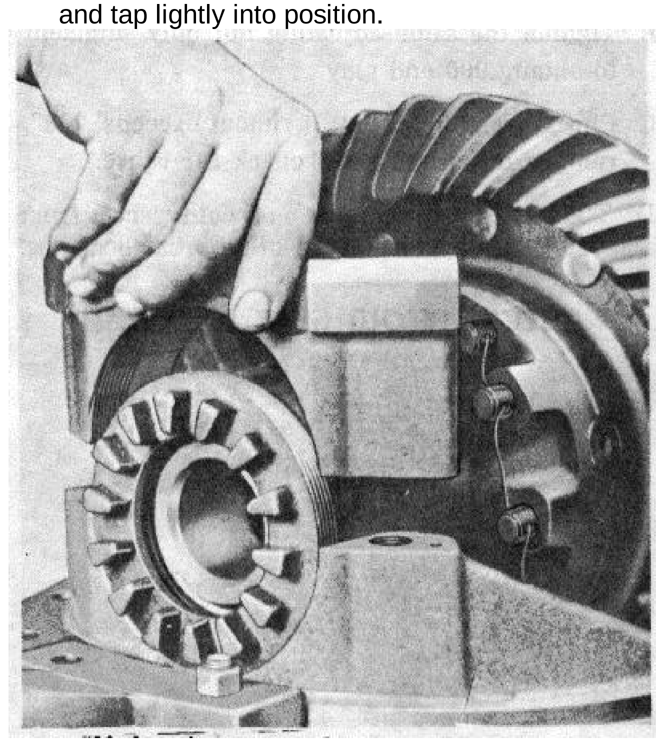
INSTALL DIFFERENTIAL AND GEAR ASSEMBLY

A. After checking related parts, coat the differential bearing cones and cups with specified rear axle lubricant.

B. Place the bearing cups over the assembled differential bearing cones, then position the differential assembly in the carrier.

C. Insert bearing adjusting nuts and turn hand-tight against bearing cups.

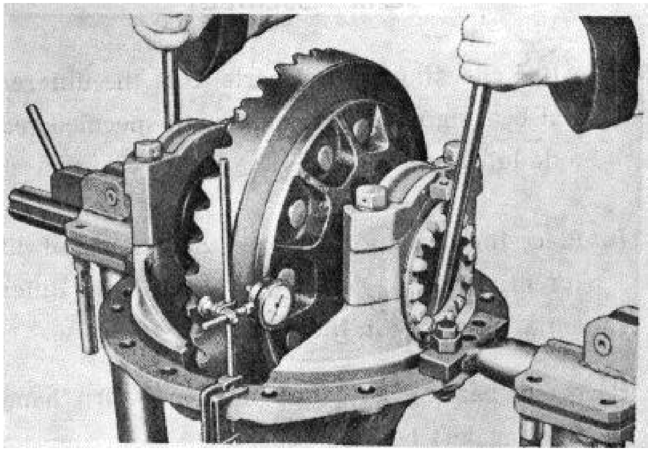
D. Install bearing caps in the correct location as marked and tap lightly into position.



If bearing caps do not position property, adjusting nuts may be cross threaded. Remove caps and reposition the adjusting nuts. Forcing caps into position will result in irreparable damage to the carrier housing or bearing caps.

E. Install flat washers where used and stud nuts or capscrews. Tighten stud nuts or capscrews to correct torque.

ADJUST DIFFERENTIAL BEARING PRELOAD



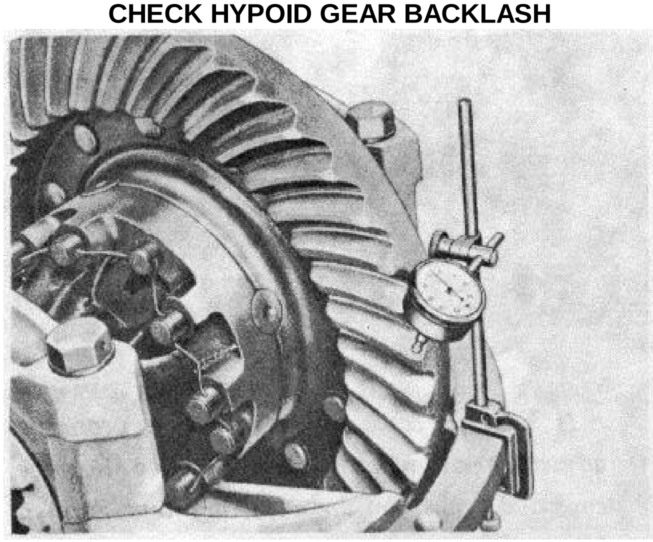
A. Using dial indicator at backface of gear, looser the bearing adjusting nut on the side opposite gear only sufficient to notice end play on the indicator.

B. Tighten the same adjusting nut only sufficient to obtain .000 end play.

C. Check gear for runout. If runout exceeds .008", remove differential and check for cause.

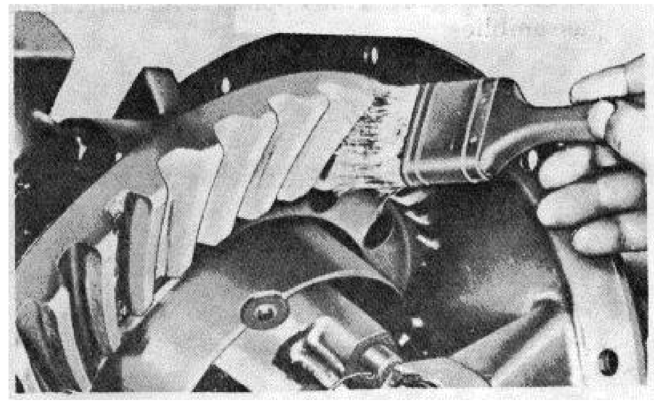
D. Tighten adjusting nuts one notch each from .000 end play to preload differential bearings.

CHECK HYPOID GEAR BACKLASH



If the drive gear is not going to be replaced, we suggest the established backlash recorded be- fore disassembly be used. For new gears the new backlash should be initially set at .010". Adjust backlash by moving the gear only. This is done by backing off one adjusting ring and advancing the opposite ring the same amount.

CHECK TOOTH CONTACT



Apply oiled red lead lightly to the hypoid gear teeth. When the pinion is rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts.

Sharper impressions may be obtained by applying a small amount of resistance to the gear with a flat steel bar and using a wrench to rotate the pinion. When making adjustments, check the drive side of the gear teeth. Coast side should be automatically correct when drive side is correct. As a rule, coating about twelve teeth is sufficient for checking purposes.

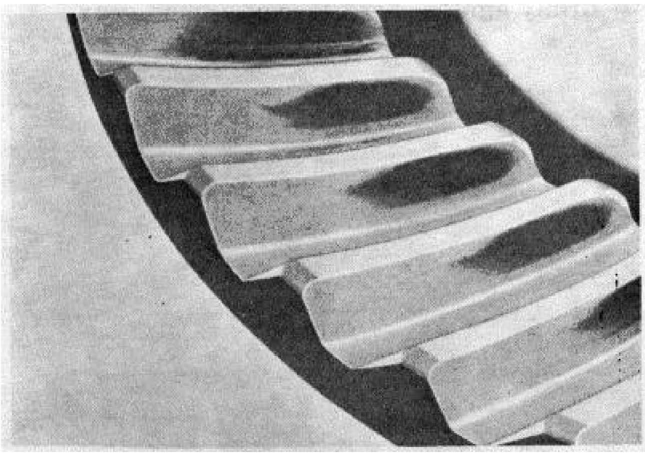
After obtaining a satisfactory tooth contact, especially in relation to the top and bottom of the tooth, the backlash can be altered within the limits of .005"-.015" to obtain a better contact position relative to the length of the tooth.

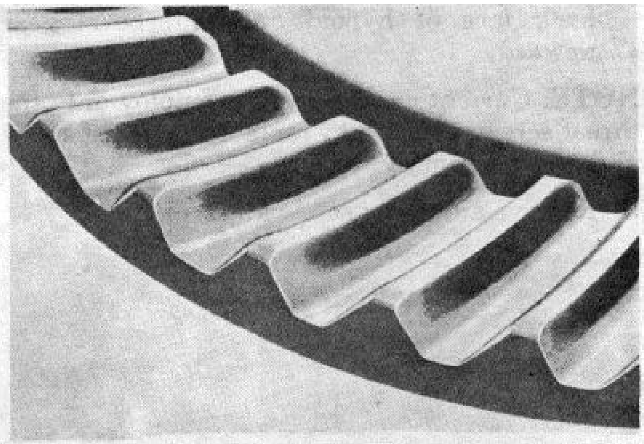
A high backlash setting can be used to keep the contact from starting too close to the toe, and a low backlash setting can be used to keep the contact from starting too far away from the toe.*

After correct tooth contact has been established, install adjusting nut locks and cap screws. Tighten cap screws and lock wire to bearing cap cap screws.

**For further detailed information refer to SAE Paper SP-228, Section 2, by W. A. Johnson and R. F. Cornish.*

CORRECT TOOTH CONTACT ASSURES LONGER GEAR LIFE





SATISFACTORY TOOTH CONTACT (GEARS UNLOADED)

With adjustments properly made (pinion at correct depth and backlash set at .010") the above contacts will be procured. The area of contact favors the toe and is centered between the top and bottom of the tooth.

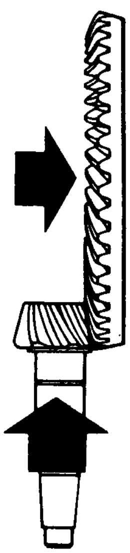
The hand rolled pattern shown above (gears unloaded), will result in a pattern centered in the length of the tooth when the gears are under load shown at right. The loaded pattern will be almost full length and the top of pattern will approach the top of the gear tooth.

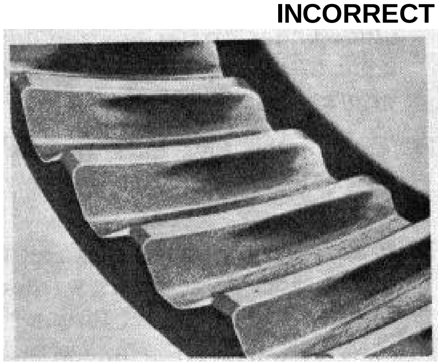
SATISFACTORY TOOTH CONTACT (GEARS LOADED)

The pattern on the coast side of teeth will appear the same width as the drive side shown above; however, the over-all length will be centered between the toe and heel of gear tooth.

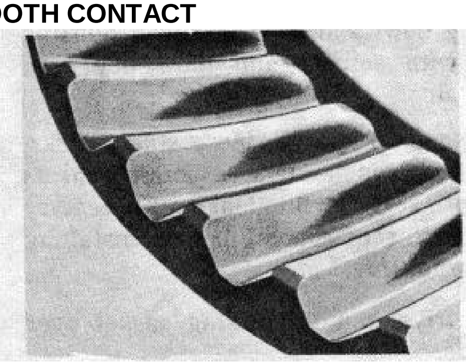
Set used hypoid gear to have the tooth contacts to match wear patterns. Hand rolled patterns of used gears will be smaller in area and should be at the toe end of wear patterns.

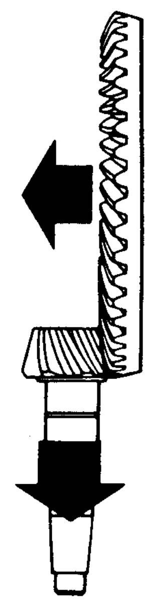
INCORRECT TOOTH CONTACT





A high contact indicates pinion is too far out. Set the pinion to the correct depth by removing shims under the pinion cage. Slight outward movement of hypoid gear may be necessary to maintain correct backlash.





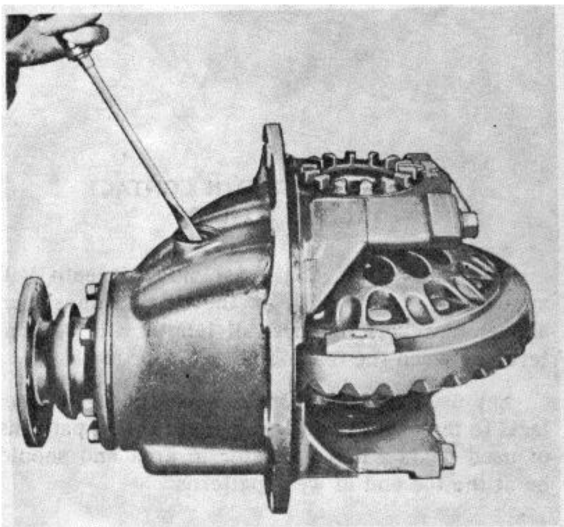
A how contact indicates pinion is too deep. Set the pinion to the correct depth by adding shims under the pinion cage. Slight inward movement of the hypoid gear may be necessary to maintain correct backlash.

INSTALL THRUST SCREW QR BLOCK

A. Remove carrier from stand and position with back face of hypoid or spiral bevel gear upward.

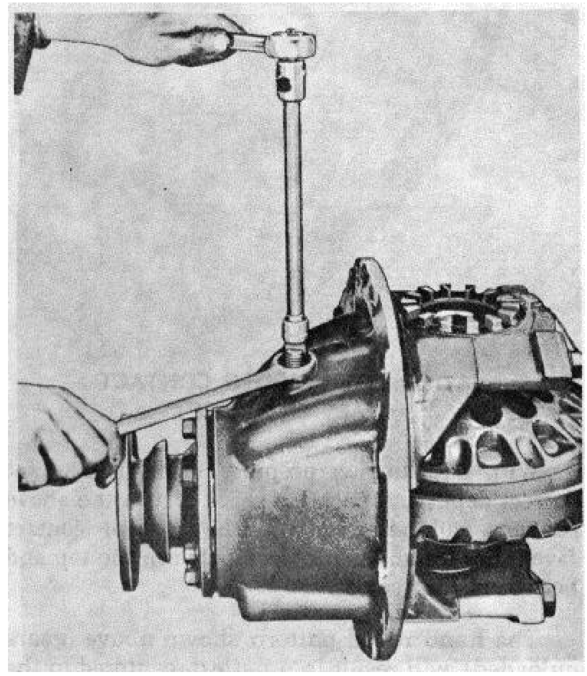
NOTE: Current carrier designs employ only the thrust screw, which may replace the thrust screw and block assembly.

B. Remove adjusting screw and lock nut.



C. If a thrust block is employed, place thrust block on rear face of hypoid gear and rotate gear until the hole in the thrust block is aligned with the adjusting screw hole.

D. Install thrust screw and lock nut and tighten thrust screw sufficient to locate thrust block firmly against back face of hypoid gear.



E. To secure the correct adjustment of .010"-.015" clearance, loosen adjusting screw (or thrust screw) 1/4 turn and lock securely with nut.

F. Recheck to assure minimum clearance of .010" during full rotation of bevel gear.

CLEAN AND INSPECT .HOUSING, INSTALL DRIVE UNIT

A. Remove any accumulation of dirt, grit or gum from housing bowl and sleeves. Clean housing thoroughly with solvent and blow dry with compressed air.

B. Inspect housing for cracks, loose studs, nicks, and burrs at machined surfaces. Remove nicks and burrs with stone or file. Make all necessary repairs or parts replacement before installing drive unit in housing.

C. Install new drive unit to housing gasket over housing studs.

Roll carrier into position on roller jack. Start carrier into housing with four flat washers and nuts equally spaced.

Do not drive carrier into housing with a hammer at the carrier stud flange. The flange may easily be distorted and cause severe oil leakage.

Install lock washers and stud nuts on any studs under carrier housing offsets. It is impossible to start these nuts after carrier is drawn into housing.

D. Tighten the four nuts over flat washers alternately to draw carrier squarely into axle housing.

E. If necessary, remove nuts and flat washers and install taper dowels, lock washers and stud nuts. Tighten to the correct torque.

F. Connect universal at pinion shaft.

G. Install axle shafts.

PREPARATION FOR STORAGE

In the event the carrier is a spare and may not be immediately installed, all gears and bearings should be thoroughly oiled and the carrier placed in a dustproof container.

LUBRICATION

Proper lubrication of the drive units is extremely important. Our "Standard" recommended lubricant is Rockwell-Standard Specification 0- 76, 0-76-A, 0-76-B or 0-76-D SAE 140 viscosity, multipurpose gear lubricant. Unusual operating conditions such as extremes in climatic temperatures may require lubricants of "Optional" viscosities. However, experience has shown that the use of an SAE 140 viscosity grade lubricant will result in longer gear life. Refer to Field Maintenance Manual No. 1, "Lubrication," for detailed information.

Since Rockwell lubricant specifications are periodically revised, always refer to Field Maintenance Manual No. 1 for current complete lubricant specifications and applications.

A. Fill axle housing to the correct level with specified lubricant.

B. Lubricate universal joint.

C. Drive the vehicle, unloaded, for one to two miles at speeds not to exceed 25 miles per hour to thoroughly circulate the lubricant throughout the assembly.

NEW AND RECONDITIONED AXLE SERVICE

The original rear axle lubricant should be drained at the end of the drive-away or before the maximum of 3,000 miles prior to placing the vehicle in regular service. Drain the lubricant initially used in the assembly following reconditioning at the same interval. Completely drain the lubricant while the unit is warm.

Fill axle housings to bottom of level hole with specified lubricant with the vehicle level.

REGULAR AXLE SERVICE

Refer to Field Maintenance Manual No. 1, "Lubrication," for recommended service interval.

Completely drain the lubricant while the unit is warm.

Some newer model axles have a smaller tapped and plugged hole located near and below the housing lubricant level hole. This smaller hole has been provided for the use of a lubricant temperature indicator only and should not be used as a fill or level hole.

MAGNETIC DRAIN PLUGS

Magnetic drain plugs perform the vital function of trapping small metallic particles that circulate in the lubricant, through the gears and bearings, causing rapid wear and premature failure. The magnet must be strong enough to firmly hold the particles under service conditions. We recommend plugs with elements having a minimum pick-up capacity of 2 pounds of low carbon steel in plate or flat bar form. See Plug section in Field Maintenance Manual No. 1.

Spare clean plugs should be kept on hand for replacement at regular intervals. The change schedule can easily be established by periodic plug examination.

FASTENER TORQUES

Rockwell employs two methods of fastener retention: Original design single reduction carriers employ a lock wire. Current design models employ Dri-Loc bolts or Loctite 277/Rockwell Part No. 2297-C-3747 Liquid Adhesive.

When service is required, rebuild these assemblies with new Dri-Loc bolts or reuse the old bolts by applying liquid adhesive to the threaded holes in the cases. *(NOTE: Dri-Loc bolts or liquid adhesive is not used in nut and bolt constructed cases.)*

When new Dri-Loc bolts are used, identified by a visible patch of adhesive on threads, the locking feature is usable only once. When the same bolt is reused, liquid adhesive must be applied to the threaded hole in the case to achieve the locking feature. Use the following procedures:

New Dri-Loc Bolts

1. Wipe excess oil and any residue from the threaded holes in the case. The holes should be relatively oil free, however, no special cleaning is required.

2. Assemble the differential case components using the new Dri-Loc bolts. DO NOT APPLY LIQUID ADHESIVE OR ANY OTHER TYPE OF FASTENER RETAINER MATERIAL, SEAL- ANT OR ADHESIVE ON NEW DRI-LOC BOLTS OR IN THE THREADED HOLES.

3. Tighten the Dri-Loc case bolts to the specified torque value recommended for the same regular bolt. Dri-Loc will not alter the torque requirement. Refer to Fastener Torque Chart at the end of this manual.

NOTE: No cure time is required for Dri-Loc bolts prior to rebuilding the axle and returning it to service.

Reuse of Dri-Loc Bolts or Use of Regular Bolts and Liquid Adhesive

1. Wipe excess oil residue from the bolts and threaded holes in the case. The bolts and holes should be relatively oil free, however, no special cleaning is required. When reusing Dri-Loc bolts, it is not necessary to remove the Dri-Loc residue from the threads.

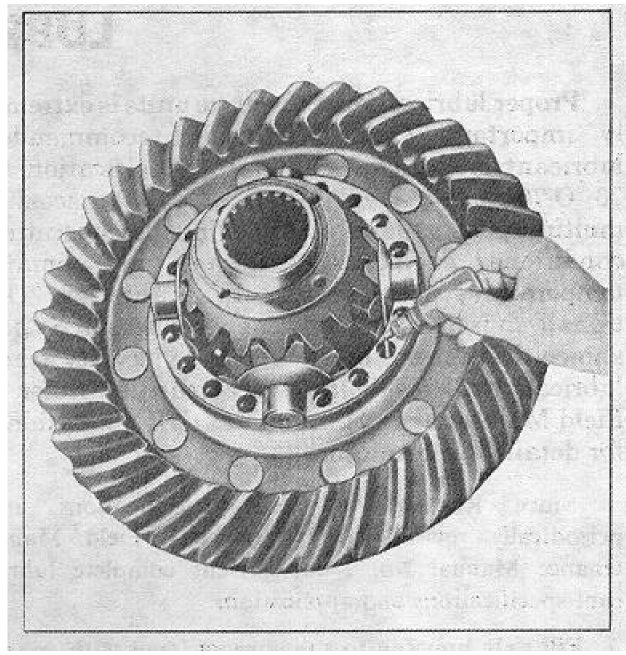
2. Apply liquid adhesive to the threaded holes only, by letting four or five drops run down the side of each hole. Before threading in the bolts, visually check to make sure that the liquid adhesive has contacted the threads.

IMPORTANT: Do not apply liquid adhesive to the bolt, since trapped air in the hole will create back pressure and "blow out" the liquid adhesive as the bolt advances.

3. Tighten the bolts to the specific torque value recommended for that size bolt. Liquid adhesive will not alter the torque requirement. Refer to the Fastener Torque Chart at the end of this manual.

NOTE: No cure time is required for liquid adhesive prior to rebuilding the axle and returning it to service.

Rockwell 2297-C-3747 liquid adhesive is available in ten (10) bottle cartons (10 cc per bottle) from Rockwell International, Florence Distribution



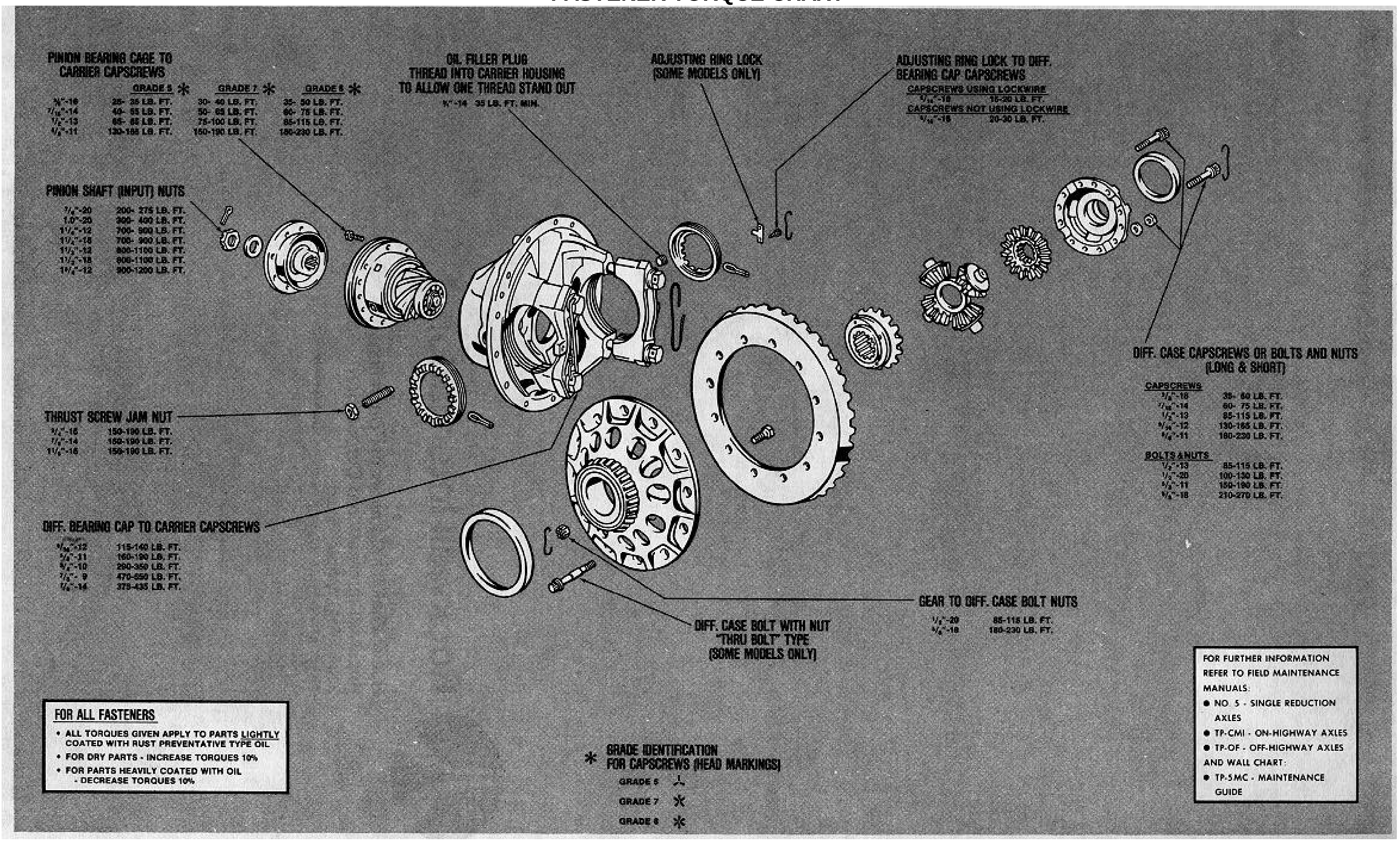
Center, Florence, Kentucky 41042. Liquid adhesive is presently available at your local dealer.

IMPORTANT: When servicing drive units assembled with Dri-Loc bolts or liquid adhesive in threaded case holes where the bolts do not require removal -Check each bolt for tightness by applying the minimum amount of torque specified for that size fastener. If the bolt does not rotate, it is satisfactory. If the bolt rotates to any degree, it must be removed from the case halves and liquid adhesive must be applied to the threaded hole. Use the procedures under "Reuse of Dri-Loc Bolts or Use of Regular Bolts and Liquid Adhesive".

Further, if bolt removal becomes difficult due to worn bolt heads or unusually high breakaway torques, the locking strength of either liquid adhesive or Dri-Loc bolts can be reduced by heating. Heat the bolt for only a few seconds at a time while trying to loosen it. DO NOT EXCEED 350°F MAXIMUM. Heating should be done slowly to avoid thermal stresses in the differential case and gears. Application of heat reduces the strength of liquid adhesive and Dri-Loc below recommended installation torque.

Rockwell does not recommend removing bolts with an impact wrench or by striking with a hammer.

SINGLE REDUCTION DRIVE UNITS
(SINGLE AXLES AND REAR / REAR TANDEM UNITS)
FASTENER TORQUE CHART

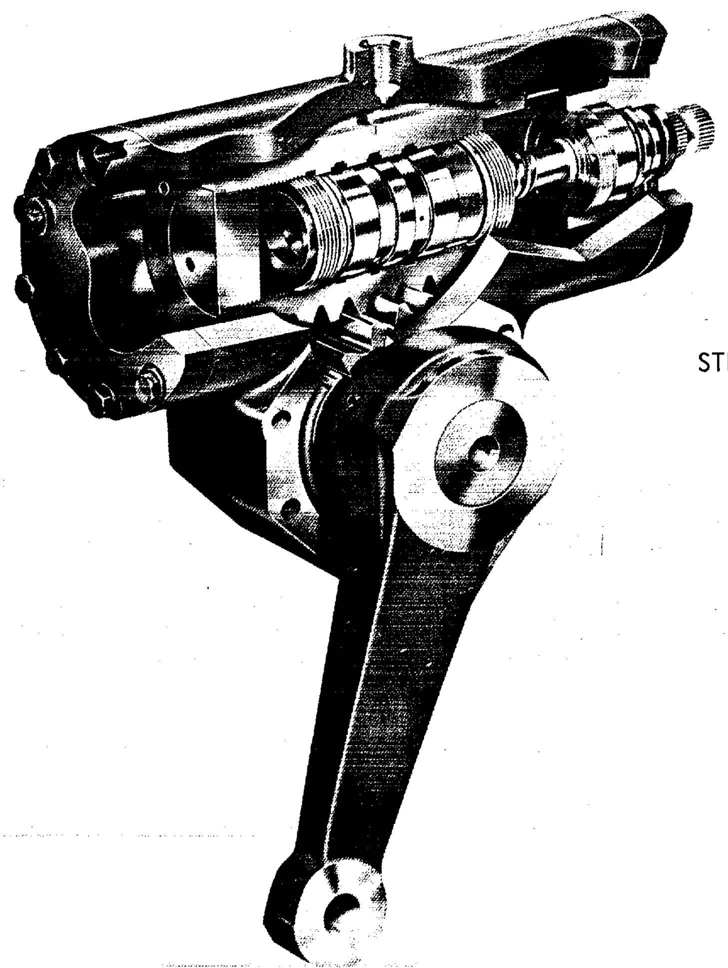


Rockwell International

Heavy Vehicles Components Operations
Rockwell International Corporation
2135 West Maple Road
Troy, Michigan 48084 U.S.A.

Sheppard

POWER STEERING



Section IV
STEERING SYSTEM

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101 PHILADELPHIA ST.
HANOVER, PA 17331
PHONE 717-637-3751

SER. CAT. 0832

INTRODUCTION

This Sheppard Power Steering Service Manual covers repair procedures for the steering gear assembly only. The vehicle manufacturers' service manuals should be used for removal and reinstallation instruction, and hydraulic supply pump specifications.

All information, illustrations and specifications referenced in this publication are the latest available at the time of printing. The right is reserved to make changes at any time without notice.

Any reference made in this publication as to brand name, special tools or item part numbers are made only as a guide. An equivalent product may be used at the discretion of the repairer.

SAFETY NOTICE

The repair procedures outlined in this manual are intended to be used as a guide for repairing the Sheppard Integral Power Steering Gear. To ensure safe and reliable operation, service and repair procedures should be carefully considered. For each repair, a limited number of special tools are required and should be used as recommended.

This manual contains a number of cautions and notes that should be read carefully in order to avoid personal injury or faulty repairs which could cause a vehicle accident at a later date. It is not possible to know, evaluate, and advise the repairer of all possible ways in which repairs might be completed, or of the possible hazardous consequences of each way.

The repairer must ensure himself that the repair procedure he selects to use will not endanger his personal safety nor safe operation of the vehicle.

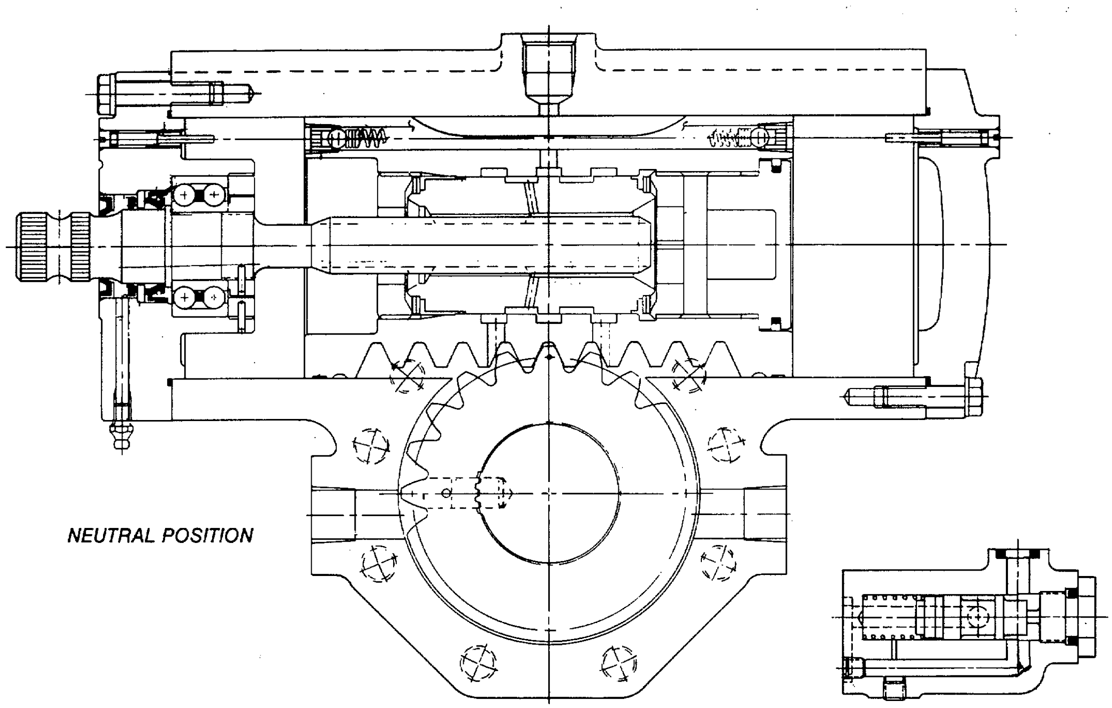
How to use this manual.

This service manual will contain information covering all current and past model Sheppard Power Steering Gears. The Sheppard Short Series Steering Gear is used as the base line and earlier and later production models will be covered in this manual as variations.

Use the identification guide to determine which particular Sheppard Steering Gear you are working with. Follow the disassembly, cleaning and inspection, and repair procedures in this manual using the variation(s) procedures as they apply to your steering gear.

INDEX

**DESIGN ADVANTAGES YOU GET WITH -, -
SHEPPARD INTEGRAL POWER STEERING**



NEUTRAL POSITION

1 Dependable and trouble-free service. ADJUSTABLE STOPS prevent damage and unnecessary wear. When wheels are turned to a desirable extreme in either direction, adjustable stops automatically unload the complete hydraulic system. Thus all parts of the steering mechanism are protected from undue stress and damage. Oil in the hydraulic system is prevented from overheating. Service life of both pump and by-pass valve are prolonged.

2 Fast responsive steering control. With Sheppard integral design there is only ONE HIGH-PRESSURE LINE from pump to gear. This eliminates drift and mushy steering caused by the swelling and breathing of a complex of external pressure lines between separate valve, pump, cylinder and gear.

3 The Sheppard unit is mounted similar to the mechanical steering gear. Accidental snagging and damage over rough terrain is avoided because GEAR DOES NOT PROTRUDE below frame.

4 Parts wear is negligible because there are ONLY 4 MOVING PARTS.

5 With Sheppard integral design, steering response is immediate and precise because the CONTROL VALVE IS LOCATED WITHIN THE PISTON. This eliminates springy hydraulic pressure lines that can cause lag and hesitation.

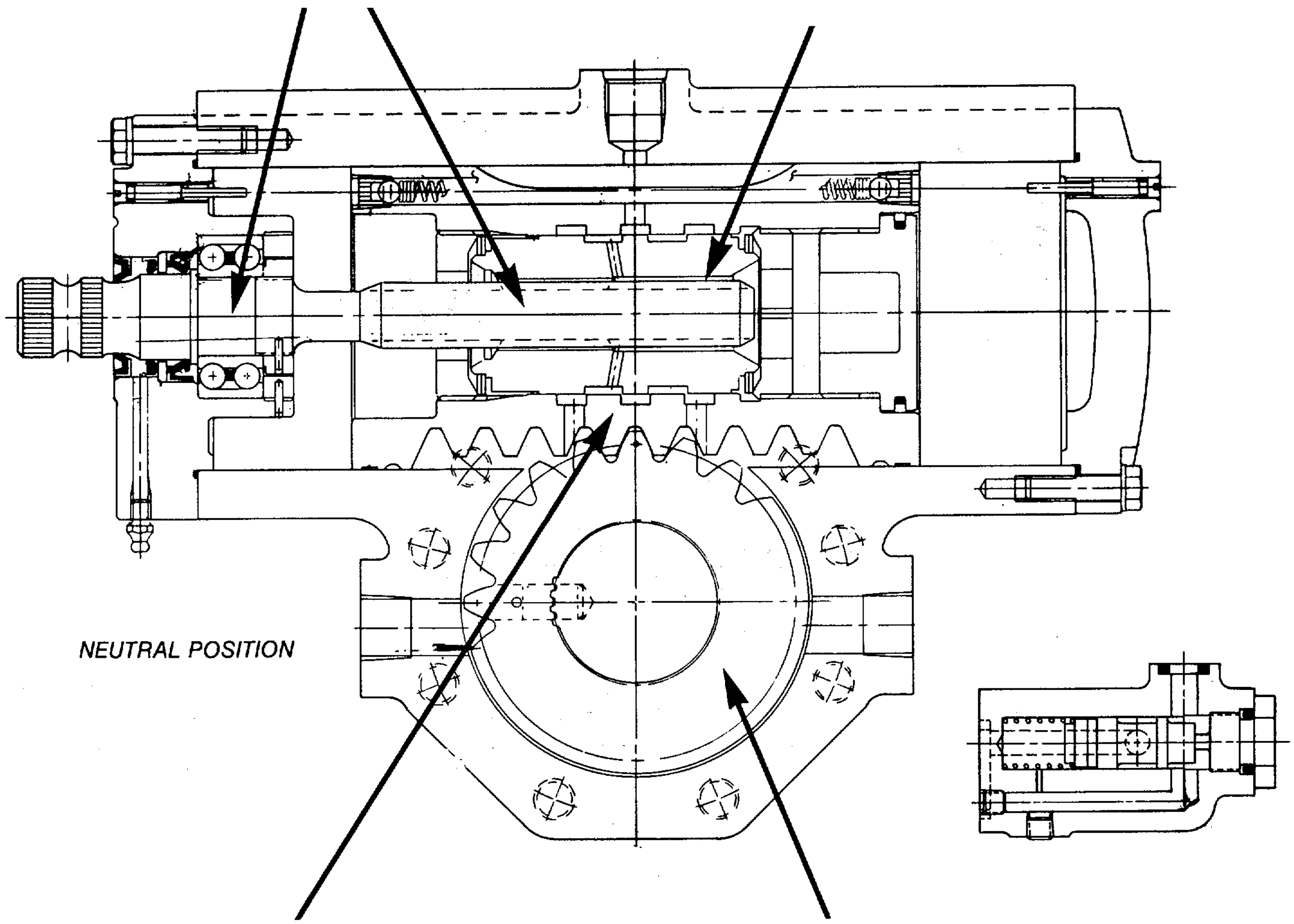
6 In event of hydraulic malfunction, BUILT-IN MECHANICAL STEERING allows for safe control of the vehicle.

7 Integral Pressure Relief Valve. An optional pressure relief valve is available which limits the maximum pressure in the steering system. This feature will avoid rapid temperature build-up caused by normal pressure relief and oil recirculation within the pumping chamber or pump body.

4 BASIC OPERATING PARTS:

1. ACTUATING SHAFT is connected to the steering column assembly with a heavy Acme thread having mulitiple starts.

2. ACTUATING VALVE is contained within the piston and threaded to accommodate the input shaft. When the input shaft is turned, the valve travels over shaft threaded area. Two ports on valve outside diameter control oil flow through the pistion. The valve has a linear motion, permitting edges of the ports to seat against mating edges on the inside of the piston.



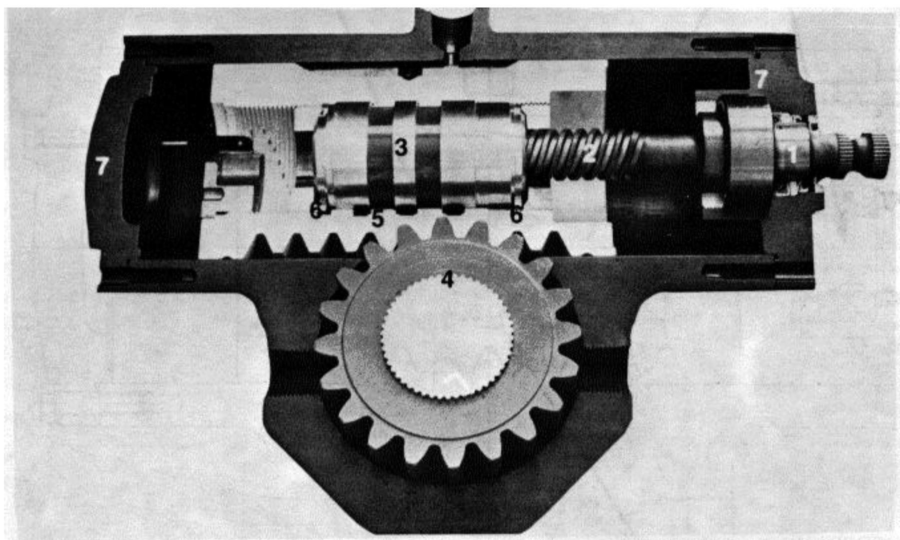
3. PISTON is located within the housing. A rack on the piston engages the pinion gear on the output shaft. Ports in the piston function for either pressure or exhaust depending upon direction of valve travel. The piston centers itself over the valve to provide steering action.

4. PINION AND OUTPUT SHAFT assembly located in the housing is turned by the piston rack. This provides rotating action at the pitman arm connected to the steering linkage.

OPERATING PRINCIPLES

The Sheppard Integral Power Steering Gear provides full-time hydraulic steering which is light and responsive. Only sufficient manual input effort to overcome the reversing springs and close the control valve to cause a pressure build-up is required. Full rated axle loads can be steered with ease.

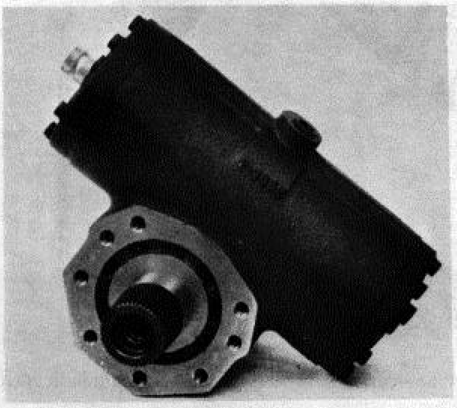
The actuating shaft (1) is connected to the steering column and is threaded with an Acme type thread. (2) The actuating valve (3) is threaded to accommodate the actuating shaft and is centered within the piston by reversing springs.-The valve moves in a linear motion within the piston permitting the edges of the valve to overlap mating edges on the inside of the piston. This causes high-pressure oil to build up at one end of the piston. This higher pressure on one end of the piston causes the piston to move in the bore of the gear housing. The output shaft and pinion gear (4) are engaged to a rack gear (5) machined into one side of the piston. As the piston moves, the output shaft and pitman arm are rotated by the rack and pinion gear and steering operation is performed. When rotation or input from the actuating shaft ceases, pressure on, or movement of the actuating valve stops and the reversing springs (6) at the ends of the valve center the valve in the piston relieving the high pressure and power to the steering ceases. Movement of the actuating valve, to control oil pressure is controlled by the deflection of the reversing spring at either end of the valve. Total movement of the valve is approximately .040 of an inch. Relief valve plungers (7) or adjustable stops are provided at the bearing cap and cylinder head. When the plungers are adjusted properly, they will automatically unload the hydraulic system if the wheels are turned to either extreme direction.



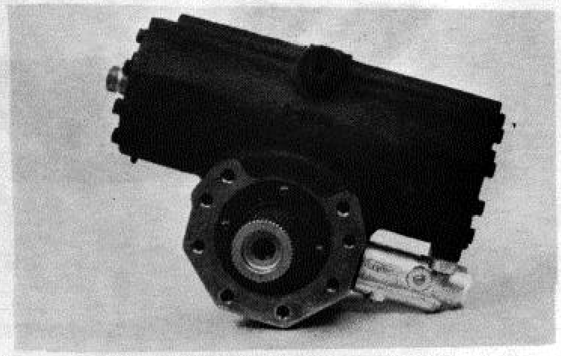
When the engine is running there is constant oil flow through the steering gear at low pressure. This constant oil flow provides for instant response and absorbs road shock to help eliminate steering wheel kick and protect the steering gear. Pressure is equal throughout the steering gear and oil cooling and lubrication are assured. Care should be used in towing or moving a vehicle where the engine or hydraulic supply pump are inoperative. In this instance the ability of the steering gear to protect itself is reduced and mechanical damages can be encountered.

An optional pressure relief valve integral with the steering gear is available on the Series 5 Steering Gears. This valve limits maximum steering system relief pressure at the steering gear, a point in the steering system which is farthest from the supply pump, pumping chamber. This effectively reduces system temperature by avoiding high-pressure by-pass and recirculation within the pump.

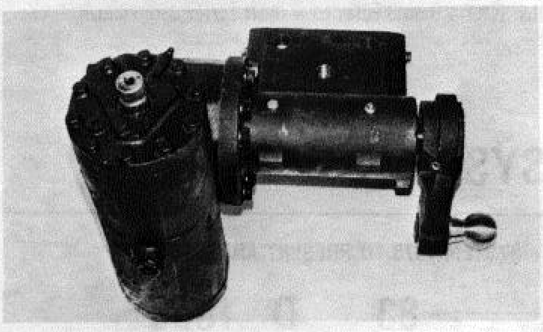
The Sheppard Integral Power Steering Gears have been designed to provide long service life and simple service and repair. The rack and pinion gear set does not require adjustment. There is no center point adjustment. The high-pressure seal at the input/actuating shaft is the only seal which is exposed to high pressure and motion. This seal is protected by a dirt seal and a salt seal which are separated by a grease pack that is flushed during lubrication. The clearance between the cylinder bore and the piston is closely controlled to eliminate the need for seals on the piston. With reasonable care and limited maintenance the Sheppard Steering Gear will provide many miles of trouble free and effortless performance.



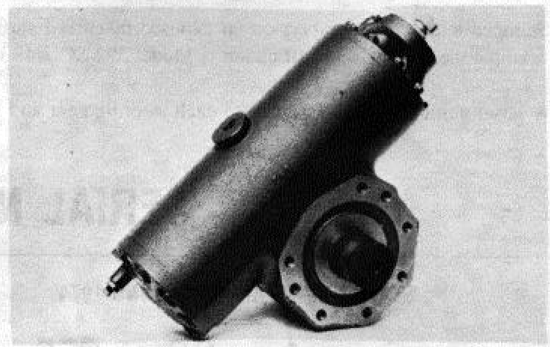
(S-1) SHORT SERIES STEERING GEAR



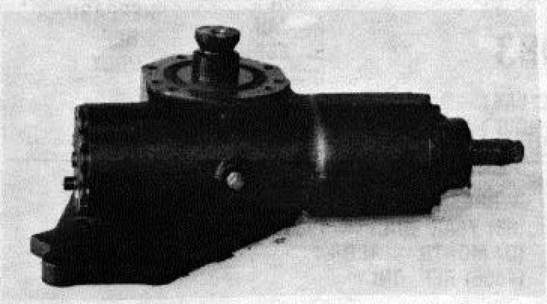
(S-5) SHORT SERIES-5 STEERING GEAR
WITH OPTIONAL INTEGRATED RELIEF VALVE



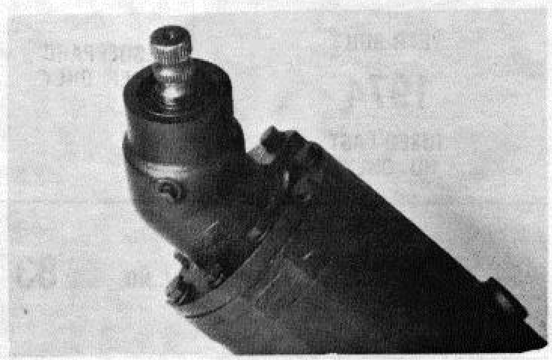
(S-2) AXLE MOUNT WITH
SHORT SERIES STEERING GEAR



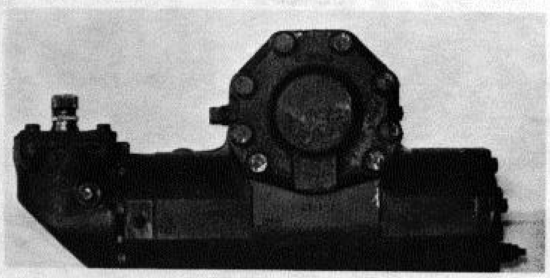
(S-6) EARLY PRODUCTION STEERING GEAR



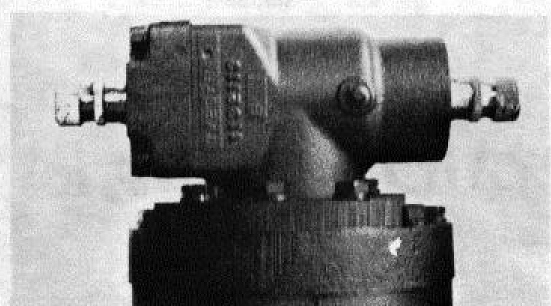
(S-3) STEP-BORE STEERING GEAR (372-382)



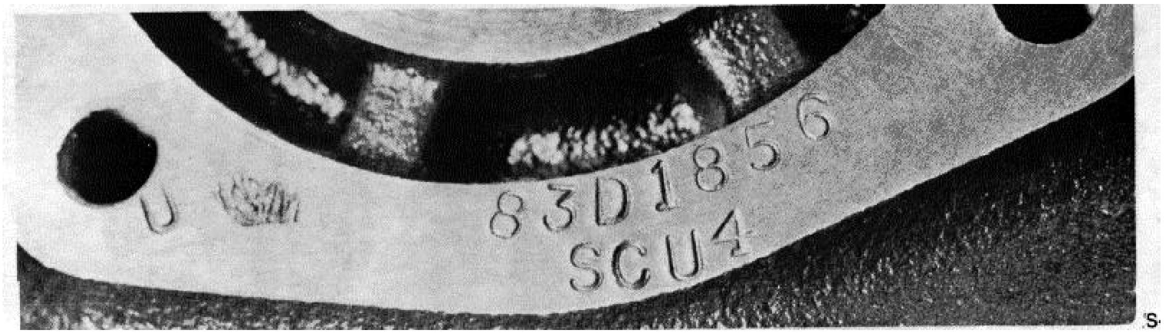
(S-7) SWIVEL MITER INPUT



(S-4) ANGLE DRIVE OR FIXED MITER GEAR INPUT



(S-8) "T" BOX MITER INPUT FOR
DUAL STEERING CONTROLS

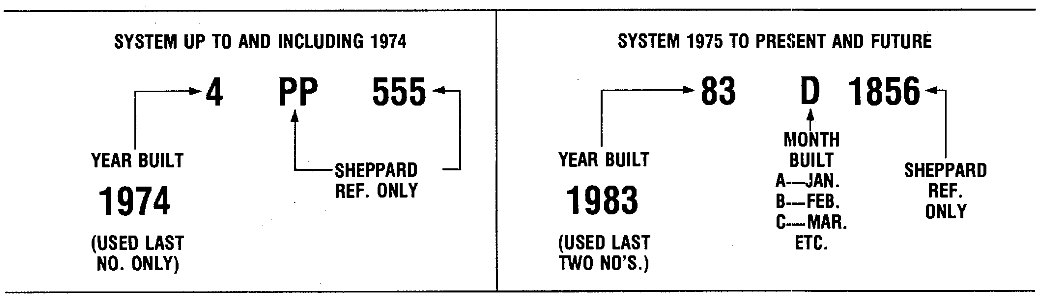


A number is cast into the steering gear housing and identifies the basic family to which the steering gear belongs. 392-S would indicate a :392 short series steering gear. See series 4 and series 5 example below.

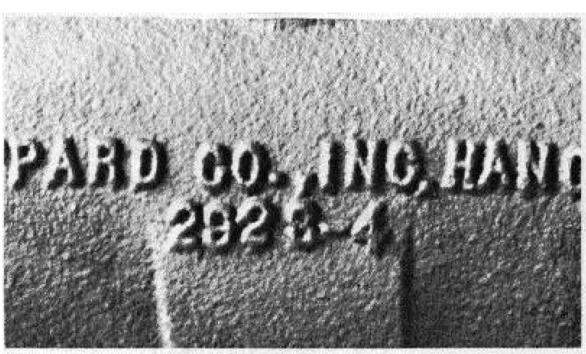
Stamped letters and numbers on an exposed machined surface of the housing identifies the particular member of a family. In the above example the complete identification is Model 392 SCU-4. 392-S cast number plus SCU-4 would refer to a short series 392 steering gear.

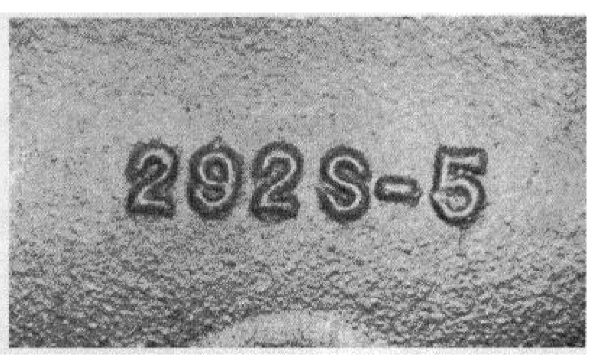
A serial number is also assigned to each steering gear and is interpreted below:

SERIAL NUMBER SYSTEM



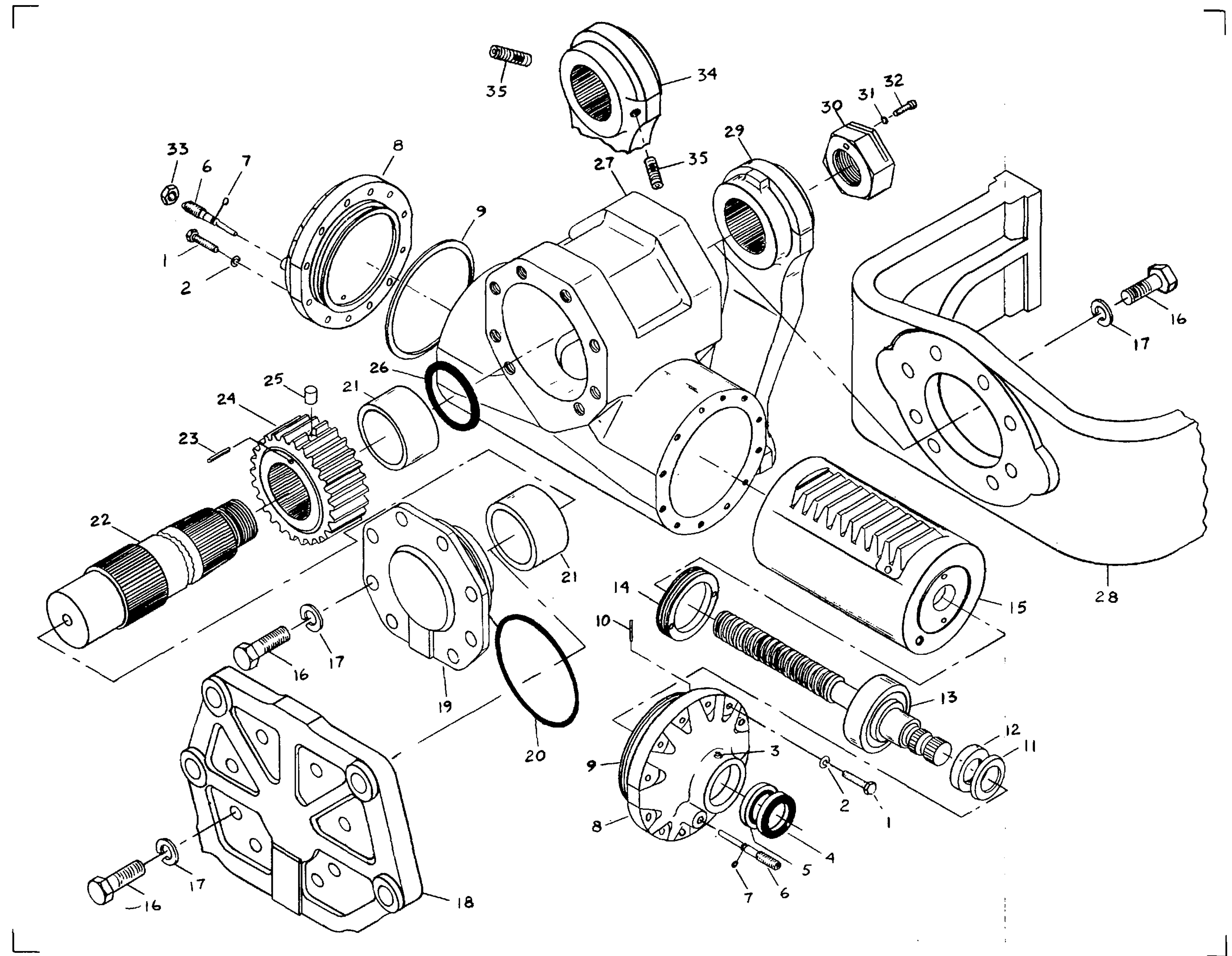
THIS SERIAL NO.	**83 D 1856**	**REPRESENTS:** **(83) YEAR BUILT - 19B3** **(0) MONTH - APRIL** **(1856) REF. ONLY**





DESCRIPTION

1. BOLT
2. LOCKWASHER
3. GREASE FITTING
4. SALT SEAL
5. OIL SEAL
6. PLUNGER
7. O-RING
8. BEARING CAP
9. SEAL RING
10. LOCKING NUT PIN
11. SEAL WASHER
12. OIL SEAL
13. ACTUATING SHAFT & BRG. ASS'Y
14. BEARING NUT
15. PISTON & VALVE ASS'Y
16. BOLT
17. LOCKWASHER
18. HOUSING COVER (OPTIONAL)
19. HOUSING COVER
20. O-RING
21. BEARING
22. OUTPUT SHAFT
23. ROLL PIN
24. OUTPUT SHAFT GEAR
25. RETAINING PIN
26. QUAD RING
27. HOUSING
28. BRACKET
29. PITMAN ARM
30. LOCKING NUT
31. LOCKWASHER
32. SOCKET HD. CAPSCREW
33. HEX NUT
34. PITMAN ARM
35. SETSCREW, SOC. HD.



No.	CHANGE	C.N.	DATE	BY
F				
E				
D				
C				
B				
A				

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON DIMENSIONS ARE:

ONE PLACE DEC.	(.X)	±.060
TWO PLACE DEC.	(.XX)	±.030
THREE PLACE DEC.	(.XXX)	±.010
ANGLES		±1°
FRACTIONS		±1/64

√ R.M.S. IN MICRO INCHES MAX.

LAYOUT	ASSEMBLY
REFERENCE	

R. H. SHEPPARD CO. INC.
HANOVER, PA. U.S.A.

NAME		
MATERIAL	DATE	MODEL NO.
REQ'D. PER UNIT	DRAWN BY	DRAWING NO.
SCALE	CHECKED BY	

OIL SPECIFICATIONS	**10W-40 API SD SE, (FORMERLY MS)**	**MIL SPEC L-2104C**

LUBRICATION - STEERING GEARS

The lubricant used in the power steering system is the medium by which hydraulic pressures are applied and relieved, under control, to effect steering assist.

In addition the lubricant also lubricates moving parts and dissipates heat which reduces efficiency and accelerates wear. It is of the utmost importance to use a lubricant specified and approved by R. H. Sheppard Co., Inc. in the Sheppard Steering Gear.

The Sheppard Gear requires the use of 10W-40 (API SD-SE) Motor Oil. Highway vehicles should have the oil changed twice a year or every 50,000 miles. Off-highway vehicles will require more frequent change intervals.

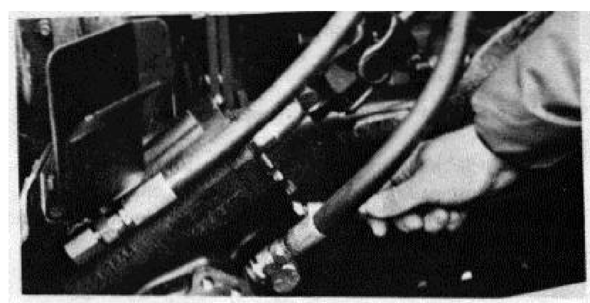
The Series-5 steering gears may be operated with hydraulic fluid or Dexron. Motor oil is preferred. See Vehicle Manufacturer's Recommendations.

The power steering pump reservoir must be kept filled to the proper indicator level and free of air. When filling the reservoir, start the engine and turn the steering wheel from left to right and continue filling until proper level is maintained. (See final adjustments section for system bleeding procedures).

A replaceable type filter element is located in the pump reservoir. Carefully clean any build-up of dirt and grease from the reservoir cover. Remove the reservoir cover and filter element. Clean inside of reservoir with a lint free cloth. Install a new filter element, refill with oil and replace cover.

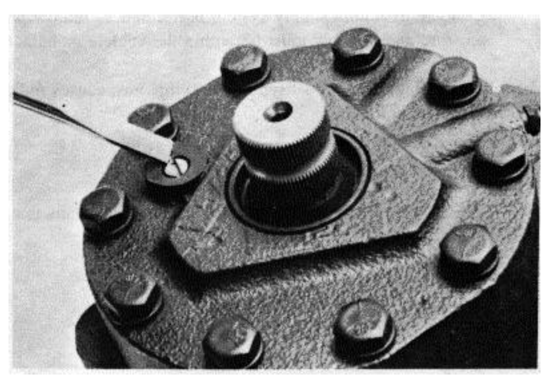
The filter element should be changed when the oil in the steering system is changed.

LUBRICATION - BEARING CAP



To lubricate the dirt and salt seals in the bearing cap, and flush out any contaminants that have passed these seals, chassis grease should be added with low pressure when the vehicle is serviced.

'The grease between the dirt and salt seals protects the actuating shaft from rust and corrosion and in addition keeps foreign materials from getting into the high-pressure seal area. The bearing cap should be serviced at least four times a year, more frequently where the truck is operating in an atmosphere where dust and abrasive or corrosive materials are present.



ADJUSTMENTS

The Sheppard Power steering gear requires no adjustment. The relief plunger adjustment is provided for differences in tire sizes. If the original equipment tire size is changed, the relief plungers should be readjusted to ensure that the steering pressure is relieved in the steering gear before the road wheels reach their maximum steering angles. Follow the procedures detailed under Relief Valve Plunger Adjustment in the final adjustments section.

GENERAL DIAGNOSIS

Whenever steering complaints are encountered it is important that the complete steering system be inspected. Special body or equipment installations should also be considered for their affect on steering performance.

The steering system consists of the Sheppard Integral Power Steering Gear, a hydraulic supply pump with pressure and flow controls and an oil reservoir, the front axle and mechanical components and the steering column or input shaft and connecting linkages. The front tires and wheels must also be considered as part of the total steering system.

Steering performance can be affected by out of line conditions anywhere in the total steering system. Other factors outside the steering system can also contribute to poor steering performance.

Many times a steering gear is removed and disassembled needlessly, because an organized diagnosis procedure has not been followed. Start your diagnosis by:

I. Defining the complaint

(a). Talk to and question the driver
(b). Drive the vehicle

II. Visual Inspection

(a). Look for poor loading practices
(b). Check tires for mismatch and proper air pressure
(c). Check for dry fifth wheel or improper location
(d). Check suspension for sagging or shifting (out of line rear axles will tend to steer the front end of the vehicle).

III. Mechanical Components Inspection

(a). Check all front axle components for wear looseness or seizure.
(b). Inspect front and rear suspension components
(c). Check steering gear mounting to be sure it is tight and not shifting on the chassis or axle
(d). Inspect steering column components

IV. Hydraulic Supply System Inspection

Evaluate hydraulic supply system performance. Follow procedures in "Hydraulic Supply-Diagnosis" section of this manual. Oil pressure and oil flow must be within the vehicle manufacturer's specifications.

The following diagnosis charts list possible symptoms, causes and corrective action. Careful and complete diagnosis will enable you to solve steering problems quickly.

Note: Keep in mind that the same problems that upset manual steering will also affect power steering.

Symptom	Possible cause	Remedy
Oil leaking at output shaft of steering gear	Clogged oil filter in reservoir (high back pressure)	Replace filter Increase change frequency
	Pinched or restricted oil return line	Locate and correct Check back pressure
	Damaged quad ring seal	Replace quad ring seal
	Damaged bronze bearings	Replace Bronze bearings Polish output shaft or replace to remove bronze deposits
Oil leaking at actuating shaft of steering gear	Worn or damaged oil seal	Replace seals
Damaged actuating shaft seal surface	Replace damaged parts	Lube bearing cap more often
Oil leaking at supply pump drive shaft	Damaged oil seal Oil seal-heat damaged Loose or damaged bushing on pump drive shaft	Replace oil seal Check operating temperature Repair pump per pump service instructions
Oil leaking between reservoir and pump body	Seal or gasket damaged	Replace damaged parts
Lubricant milky or white in appearance	Water entry through reservoir venting system	Clean vent system or replace cap assembly
Oil forced out of reservoir	Clogged oil filter	Change oil and oil filter Increase change intervals
	Loose pump drive belts	Adjust belts or replace
Air in system	Bleed air from system	Check for air leak on suction side of supply pump
	Faulty supply pump (Cavitation)	Check supply pump following "Hydraulic Supply-Diagnosis"
	Repair pump per pump service instruction	
	Relief plungers of steering gear not adjusted properly	Adjust relief plungers (see final adjustments)
	Operating temperatures too high	Follow "Hydraulic Supply-Diagnosis" procedures
Engine Oil in power steering reservoir (Gear driven pump)	Faulty seal at pump drive shaft	Repair pump
	Faulty seal at accessory shaft driving supply pump	Repair accessory drive

Symptom	Possible cause	Remedy
Lubricating Oil discolored or smells bad	Operating temperatures too high	Check and correct cause of overheating
	Change intervals too long	Increase oil change frequency
	Incorrect lubricant used	Drain, flush and refill with 10W-40 motor oil
High Operating Temperatures	Oil flow restriction	Check back pressure (see Hydraulic Supply Diagnosis section of this manual)
	Oil flow too high	Check maximum oil flow (see Hydraulic Supply - Diagnosis section)
Oil in Reservoir - Foaming	Air leak in suction side of supply pump	Refer to pump servicing instructions
	Pump cavitating	Check for restriction in pump supply
	Oil overheating	See high operating temperatures
	Incorrect lubricant	Change to 10W-40 motor oil
No power steering on cold start	Hydraulic supply pump vanes not extending (Vane type pump only)	Increase engine speed momentarily to extend vanes and start pump action. Usually a temporary and infrequent occurrence and not cause for pump repair or replacement.
Excessive pump pressure with steering gear in neutral position.	Pinched oil return line High back pressure	Relocate line
	Binding steering column	Repair steering column
	Damaged actuating shaft bearing	Replace damaged parts as required.
Wheel cuts restricted	Relief plungers misadjusted	Adjust relief plungers (see final adjustments)
Erratic steering or no steering at all	Insufficient volume of oil being metered by flow divider to steering gear induced by foreign particles on flow divider valve, causing.	Polish flow divider valve to remove foreign particles and burrs Refer to pump servicing instructions valve to hang up in the bore
(Check supply system as detailed in "Hydraulic Supply - Diagnosis" section)	Flow divider spring takes permanent set because of fatigue, thereby, allowing flow divider valve to move easily and reduce oil volume	Replace flow divider spring Refer to pump servicing instructions.
	Broken by-pass spring in flow divider	Replace with flow divider valve assembly, which includes by-pass spring Refer to pump servicing instructions
	Sticking pressure relief valve	Repair or replace relief valve as required Refer to pump servicing instructions.

Symptom	Possible cause	Remedy
Hard Steering	Loose belts	Tighten or replace belts
	Worn pulley(s) due to belt slipping	Replace pulley(s) and belts (keep belt tight)
	Faulty supply pump	Follow "Hydraulic Supply - Diagnosis" procedures Refer to pump servicing procedures
	Front axle overloaded	Correct loading practices
	Faulty steering geometry	Align front end
	High operating temperature	Locate and correct cause of overheating
Wheel steering hard in one or both directions	Bent or damaged king pins and tie rods	Repair or replace king pins and tie rods Refer to servicing instructions
	Front end load too great for rated axle capacity	Lighten load or install larger steering gear
	Fatigued by-pass valve spring in pump	Replace with flow control valve assembly Refer to pump servicing instructions
	Low oil level in steering system	Fill oil reservoir as required See "Lubrication"
	Air in system	Bleed system and check for cause of air (See final adjustments)
	Caster and camber degree incorrect	Correct to "Specifications"
	Metal or foreign material caught in actuating valve Actuating valve worn or chipped by dirt	Remove actuating valve Clean and check parts for damage If damage is excessive replace damaged parts as required
Wheel steering hard in one direction	Broken reversing springs in steering gear.	Replace reversing springs and damaged parts Refer to repair procedures to check for additional damage
Metal or foreign material in relief ball seat	Remove piston and clean relief valve seats or in piston of steering gear	replace damaged parts
	Foreign material in relief valve	Clean relief valve
Steering extremely light in one or both direction	Bent or damaged reversing springs	Check for impact or accident damage Replace damaged parts (see "Inspection" Paragraph)

Symptom	Possible cause	Remedy
Steering input not smooth (seizing, binding)	Worn universal joint	Check and replace as required
	Universal joint not phased properly	See paragraph last page this section
	Low oil flow	Idle speed too slow Drive belts slipping Supply pump not to specifications (see "Hydraulic Supply - Diagnosis")
	Pump cavitating	Correct pump supply
	Overheating	Correct cause of overheating
Darting, wandering (oversteering)	Oil flow too high	Supply pump not to specifications (see "Hydraulic Supply - Diagnosis")
	Air trapped in steering gear	Bleed system (see final adjustments)
	Looseness, worn front end parts Front end alignment not correct	Check and repair as required Align front end - Caster
	Radial tire sidewall flex Check for out of line tread	Check tire pressure Contact tire manufacturer representative
	Excessive wear or damage in steering gear	Check and repair as required.
	Overloading	Reduce loads
	Steering column u-joint phasing incorrect	See note end of this paragraph
	Mechanical bind in steering gear	Check steering gear mounting for distortion Check for damaged or distorted steering gear components.

Note: Universal Joints

Universal joints are designed to operate best when the angle between the drive and driven shafts is a maximum of 20 to 25 degrees. Angles greater than this will cause undesirable velocity changes between the two shafts. This velocity change may upset steering performance. When two universal joints are used, it is in most instances possible to phase the two joints to match a high and low velocity in a manner that will provide equal velocity between the drive and driven shafts. A third universal joint in the shaft arrangement can upset the phasing of the first two joints and it is important that this third joints operating angle is limited to a maximum of 20-25 degrees.

Phasing of the universal joints in the steering column can be checked quite easily. Using an inch-pound graduated dial reading type torque wrench, read the variation in the torque reading while steering from lock-to-lock, with a socket on the steering shaft nut under the horn button. Variation of more than 15 in.-lb. indicates improper phasing. This reading is taken with the vehicle stationary and the engine running.

Phasing can usually be accomplished by rotating the two piece intermediate shaft one spline at a time until the torque reading remains the same all the way around the 360 degree rotation of the steering wheel.

Symptom	Possible cause	Remedy
Excessive backlash	Worn universal joint	Replace universal joint
	Worn pins and keys universal joint to actuating shaft and universal joint to steering shaft	Replace pins and keys.
	Low oil volume	Check flow divider and pump drive belts
	Pitman arm ball worn "egg-shaped"	Replace pitman arm assembly where riveted ball is used or only where bolted ball is used (vertical socket)
	Improperly adjusted drag link, pitman arm to drag link and steering arm to drag link	Adjust drag link, drag link to pitman arm and drag link to steering arm
	Loose bracket frame to bracket or bracket to gear	Remove bracket, clean frame and bracket check radius of frame making sure bracket is not bearing on radius surface Check bracket for wear from working Replace bracket and tighten to recommended torque rating according to size and grade of bolts If necessary, replace bracket with new one
	Rack on piston damaged	Replace parts as required
	Damaged pinion gear on output shaft	Replace pinion gear
	Damaged output shaft splines	Replace output shaft
	Worn output shaft bushings	Replace bushings and polish shaft to remove bronze deposits
	Worn actuating shaft and valve threads	Replace worn parts as required Follow "Hydraulic Supply Diagnosis" procedures to locate cause of wear
	Free play in miter gears of angle drive	Remove miter gear housing shims to mesh gears
	Damaged reversing springs	Check and repair as required
	Universal joint yoke loose on	Repair or replace damaged parts actuating shaft
No attempt to return straight ahead from turns	No positive caster	Set to 4° to 6° positive caster
	Steering column bind	Check and repair U-joints and support bearings
	Steering gear mounting distorted bore interference	Shim mounting pads to correct piston to
	Linkage ball sockets seized or binding	Check and repair or replace

Symptom	Possible cause	Remedy
No attempt to return straight ahead from turns (cont'd)	King pins seized or binding	Repair or replace
	Knuckle clearance misadjust	Adjust clearance to specifications
	Oil flow rate incorrect	Check and correct supply pump or controls

Note:

Acme thread wear generally comes from inadequate lubrication or excessive manual steering of the vehicle. Manual steering results from inadequate pump pressure or flow, or an overloaded front axle where you need steering forces in excess of the hydraulic design of the steering gear.

Note: Freeplay

The movement of the shuttle type actuating valve within the piston, along with the normal clearances required between operating parts in the steering gear will produce a certain amount of unresponsive motion at the rim of the steering wheel. This unresponsive motion is inherent to the design and must be considered normal. With recent advances in technology and manufacturing methods it has been possible to considerably reduce the amount of this unresponsive motion. Steering gears in service prior to July 1978 could be expected to have 31/2 to 4 inches unresponsive motion. Current production Sheppard steering gears in service will have 1 1/2 to 21/2 inches of unresponsive motion. Various combinations of steering gear ratios and steering wheel diameters could effectively reduce these maximum allowances.

Unresponsive motion is measured at the rim of the steering wheel. It must, therefore, be noted that any freeplay in the steering column and related components will affect your measurement. The steering gear mounting must be tight and steering linkage wear adjusted out or worn parts replaced.

The vehicle should be standing on a smooth shop floor with the engine idling when unresponsive motion is checked. Measurement is made at the rim of the steering wheel from initial tire and wheel movement left steer to initial tire and wheel movement right steer.

HYDRAULIC SUPPLY - DIAGNOSIS

The Sheppard Integral Power Steering Gear is dependent upon adequate supplies of oil pressure and volume of oil flow to enable the steering gear to operate as designed. Oil pressure reacting on a piston creates the force to cause the piston to move and assist steering effort.

As the piston moves it is displaced in the cylinder bore by a volume of oil under pressure. How fast the piston can be displaced is dependent upon adequate oil flow and volume.

Oil pressure and oil flow requirements are engineering considerations that are established during the design of a total power steering installation. When diagnosing power steering problems you must be able to determine that oil pressure and oil flow meet design specifications. Pressure and flow specifications vary considerably and the vehicle manufacturer's recommendations must be followed carefully at all times.

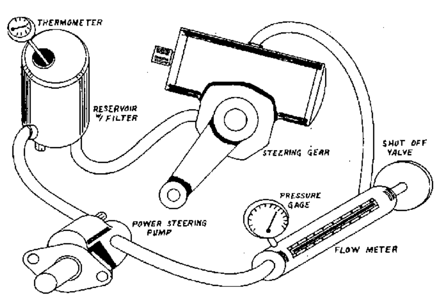
Back pressure and operating temperature are two additional factors that must be considered during the diagnosis of power steering problems. High back pressures will restrict the movement of the piston in the power steering gear and this back pressure must be overcome before steering power is available. Back pressure is caused by restrictions to oil flow. A clogged oil filter, undersized fittings and lines, pinched lines and high flow rates are possible causes of back pressure.

High system oil temperatures reduce the overall efficiency of the steering pump and the steering gear. High temperatures are caused by restriction to flow or inadequate system oil capacity to allow for heat dissipation during normal operation. A supply pump which constantly operates at maximum pressure relief will also generate more heat than can be dissipated.

Various types of pressure gauges and flow meters are available and can be used to diagnose power steering problems. A pressure gauge which reads at least 3000 PSI and a flow meter with a capacity to 10 GPM are used to check pressures and oil flow. A shutoff valve downstream from the pressure gauge makes it possible to isolate the steering pump from the steering gear and by closing the valve, maximum pump relief pressure can be read.

A simple thermometer in the reservoir will indicate system oil temperatures.

The gauge set illustrated will indicate pressure (PSI) and flow (GPM) with a single connection in series with the high-pressure line to the steering gear. A shutoff valve is included.



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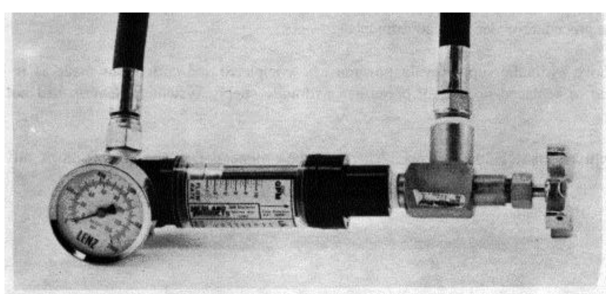

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HYDRAULIC SUPPLY-DIAGNOSIS PAGE 2

Using the equipment available to you, proceed with your evaluation of the hydraulic supply system. Refer to the diagnosis chart for further assistance.

1. Make necessary gauge/meter connections.

2. Start engine and check system oil level assuring that oil flow is in proper direction through the flow meter.

3. Place thermometer in reservoir.

4. Run the engine at correct idle speed and steer from lock-to-lock several times to allow system to warm up. (140 to 160 degrees F.)

5. **Pump maximum pressure relief** With the engine running at specified idle speed, slowly turn the shutoff valve until closed and read the pressure at which the pressure relief valve opens. (Open the shutoff valve as quickly as possible to avoid heat build-up or possible damage to the steering pump.) This pressure reading should equal the maximum pump pressure specified by the manufacturer of your chassis. Check your specifications.

   Caution: A malfunctioning pressure relief valve may not relieve pump pressure and closing the shutoff valve may cause severe pump damages or high-pressure hoses to rupture. Constantly observe the pressure gauge while closing the shutoff valve. If pressure rises rapidly or appears to be uncontrolled do not completely close the valve before inspecting the pump and pressure relief valve.

6. **Flow Test Minimum Recommended Flow** With the engine running at a specified idle speed, vehicle stationary on the shop floor and with a normal load on the front axle, steer the wheels from full right to full left turn and observe the flow meter. The flow must not fall below the minimum GPM flow specification. Note: It is important that flow be checked at normal operating temperature and with a load on the front axle, or steering response complaints may not be found. Inadequate flow will cause binding, uneven or intermittently hard steering.

7. **Flow Test Recommended Maximum** Increase the engine speed to approximately 1500 RPM and note the flow rate with the steering wheel stationary. Check this reading against the maximum flow rate specifications. Excessive oil flow can cause high operating temperature, and sluggish heavy steering response.

8. **Back Pressure** Normal system back pressure will be 50 to 75 PSI with the engine idling and the steering wheel stationary. Back pressure is checked with the system at normal operating temperature.

9. **Operating Temperatures** Steering system oil temperature is best checked after two hours of normal operation. Ideal operating temperature should range between 140 to 160 degrees Fahrenheit. Normal operation in this range will allow for intermittently higher temperatures which will be encountered during periods of heavy steering usage.

10. **Aerated Oil** Visually check for the presence of air mixed with the oil in the steering system. The oil should be clear. Any signs of frothing indicate air entry and steering performance will be affected. Carefully check for leakage on the suction side of the steering pump. Drain and refill the system and bleed for air following the procedure under final adjustments.

Before any steering gear repairs are attempted the above hydraulic supply evaluation must be completed and corrections made as required. Many times steering gears have been repaired or replaced needlessly because a hydraulic supply system evaluation had not been made.
Additional references to pressure and flow testing will be made in the diagnosis charts in the "General Diagnosis" section of this manual.

OPERATING PRESSURE & OIL FLOW SPECIFICATIONS

The R. H. Sheppard Co. Inc., manufactures two series of steering gears. A low pressure series designed to operate in the range of 0-1300 PSI and a high-pressure series with design capabilities to 2000 PSI. Each vehicle manufacturer specifies the maximum operating pressure at which their various steering installations are to be operated. Refer to your vehicle manufacturer's specifications for correct relief settings for each of your vehicles. Do not increase the maximum operating pressure without consulting the vehicle manufacturer or serious damages can be encountered.

Oil flow for the Sheppard steering gears are outlined below by Model number. The indicated Model numbers correspond with the Model number cast into the steering gear housing. Oil flow requirements remain the same for all similar Models and do not change from installation to installation. Follow the O.E.M. Truck Manufacturer's recommendations.

Low Pressure Series

Model	**188**	**191**	**39**	**491**	**51**	**59**
Oil Flow (GPM) U.S.						
Minimum*	1.9	2.2	3.6	4.3	4.8	5.7
Maximum	2.4	2.7	4.4	5.3	6.0	7.0

High Pressure Series

Model	**192**	**252,292 ALL**	**372,382,352**	**392 ALL**	**492 ALL**	**592 ALL**
Oil Flow (GPM) U.S.						
Minimum*	2.2	3.2	3.6	3.6	4.3	5.7
Maximum	2.7	4.0	4.4	4.4	5.3	7.0

Dual Systems

Model	**292W/292**	**Slave**	**372-382W/292 Slave**		**392W/392**	**Slave**
Ratio	**Low**	**High**	**Low**	**High**	**Low**	**High**
Oil Flow (GPM) U.S.						
Minimum*	4.5	4.0	5.0	4.0	5.0	4.0
Maximum	5.5	5.0	6.0	4.5	6.0	5.0

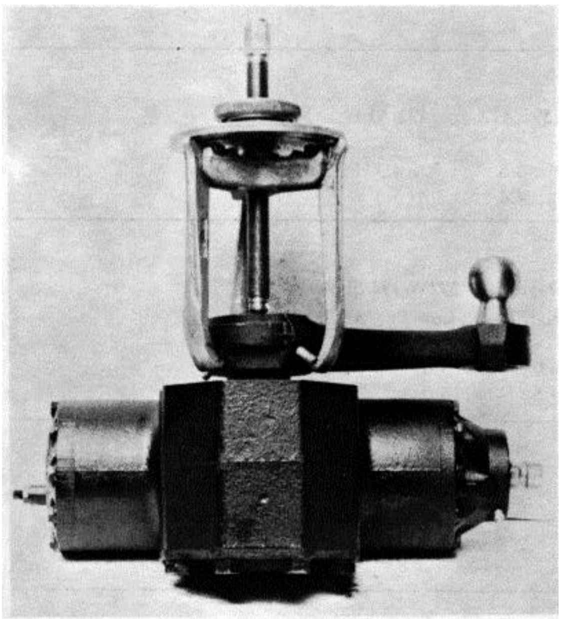
Model	**392W/292**	**Slave**	**492W/492**	**Slave**	**592W/592**	**Slave**
Ratio	**Low**	**High**	**Low**	**High**	**Low**	**High**
Oil Flow (GPM) U.S.						
Minimum*	5.0	4.0	6.0	5.0	8.0	7.0
Maximum	6.0	5.0	7.0	6.0	9.0	8.0

*Minimum flow is checked at operating temperature while steering from full left to full right with the engine at idle.

To determine low or high ratio, disconnect the master gear drag link, turn the steering wheel from full left to full right and count the number of turns. If total turns is 5 or less the ratio is low. Over 5 turns is high ratio.

Review your diagnosis

The diagnosis section of this manual has been placed in the front of the Sheppard Power Steering Service Manual to emphasize the importance of proper diagnosis. Repair time and down time as well as total repair costs can be reduced if needless disassembly and steering gear parts replacements can be avoided. Before removing the steering gear from the chassis you must be certain that the hydraulic supply system is operating correctly and that all mechanical components are in good repair.



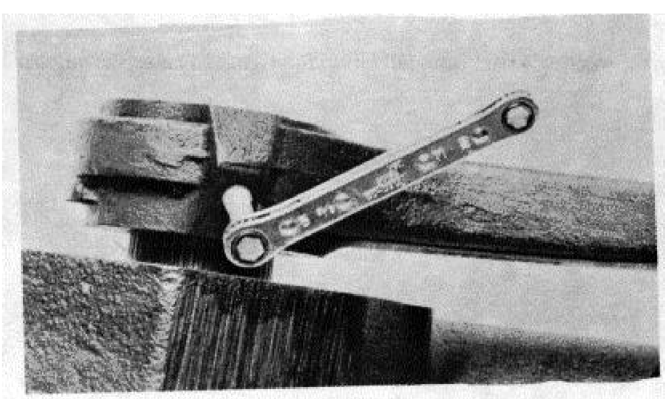
S-15

Caution: The Sheppard Integral Power Steering Gear is a precision machined assembly and care must be taken during repair to keep it free of dirt and foreign material. All internal parts must be handled carefully to avoid damages to machined surfaces. Nicks or burrs can cause damages to mating parts and must be removed with a fine hand stone before reassembly. Working on a soft cardboard or plywood surfaced workbench is advisable. Follow disassembly procedures as required.

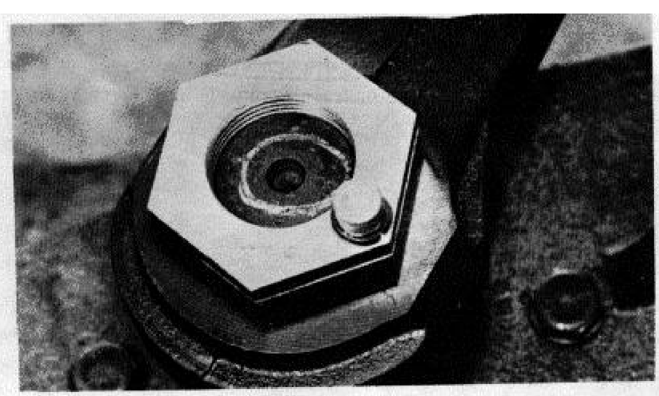
It may be necessary on some installations to remove the pitman arm before the steering gear is removed from the chassis. In all cases, it is important that a suitable puller is used when the pitman arm is removed. (Snap-on puller P/N CG 283)

The pitman arm may be located on the output shaft by two socket head retaining set screws, a self locking nut, or by a split nut and cap screw arrangement.

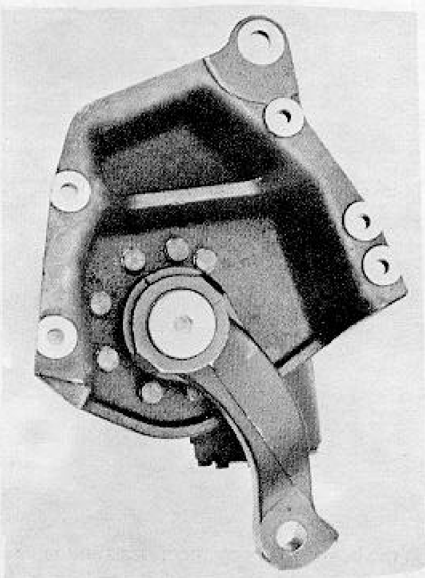
Caution: Do not pound on the pitman arm or apply excessive heat as damages to the pitman arm or output shaft could cause a serious accident at a later date. Welding of the pitman arm and shaft must be avoided at all times.



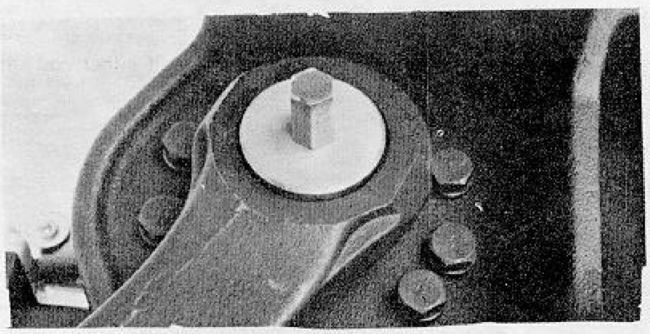
S-16



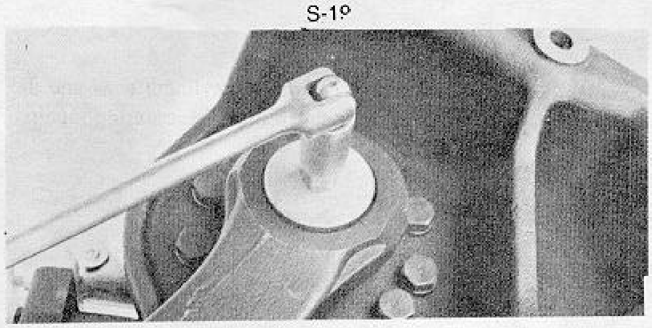
S-17



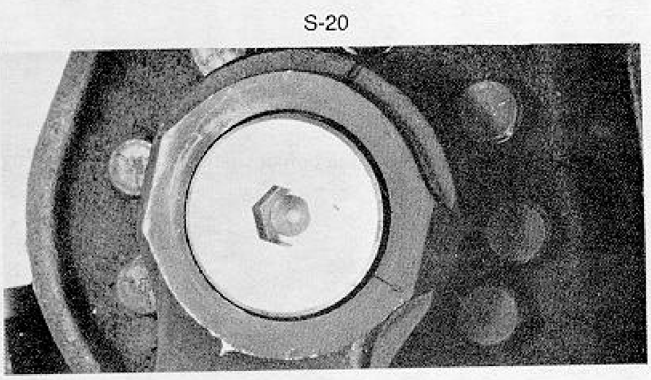
S-18



S-19



S-20

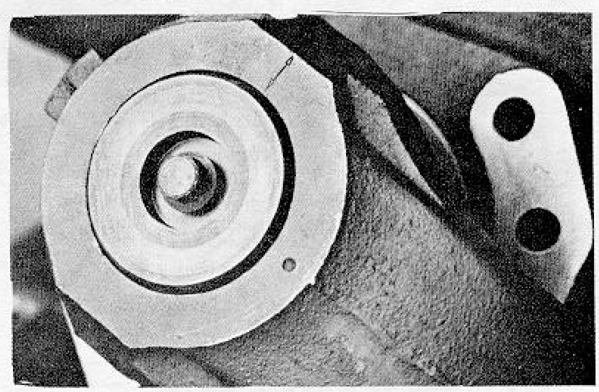


The pitman arm may also be drawn onto the tapered spline of the output shaft with a one-piece installation and safety retainer. The 592 steering gear may also use a similar installation and safety retainer. However, it may be of a two-piece design. See below. S-23 S-24

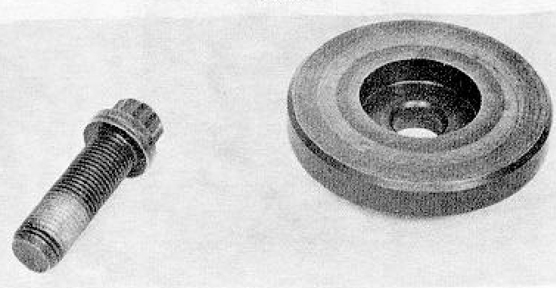
To remove the retainer, a short piece of 5/8 or 3/4 inch hard steel hexagon stock is inserted into the retainer.

The retainer is now screwed out of the output shaft. The two piece retainer used on the 592 steering gear is removed with a standard socket arrangement. S-23 - S-24

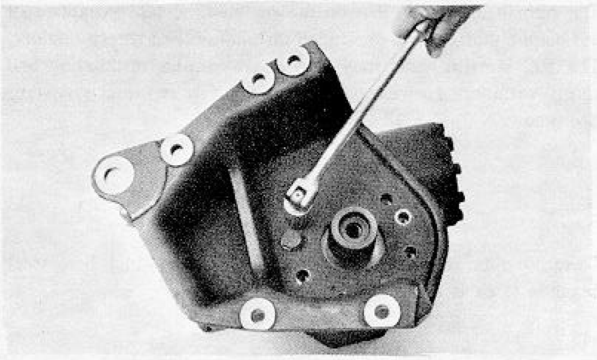
S-22



S-23

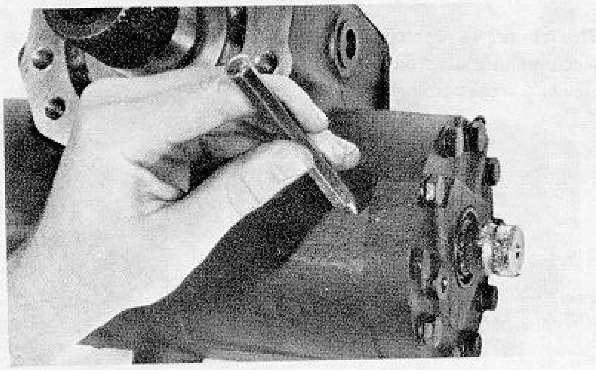


S-24



S-25

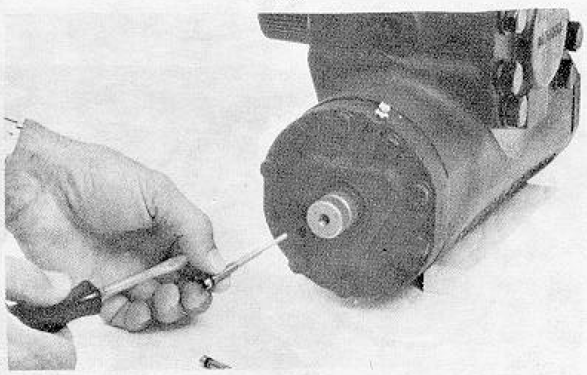
Separate the mounting bracket from the steering gear, if used.



S-26

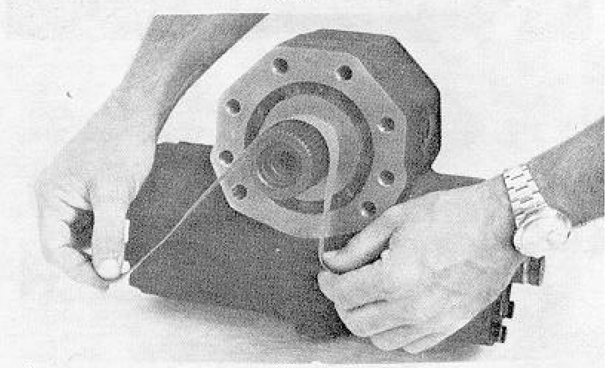
Make reference marks on the bearing cap; cylinder head and housing so that the steering gear can be reassembled in the same configuration.

Note: The cylinder head and bearing cap will fit either end of the housing.



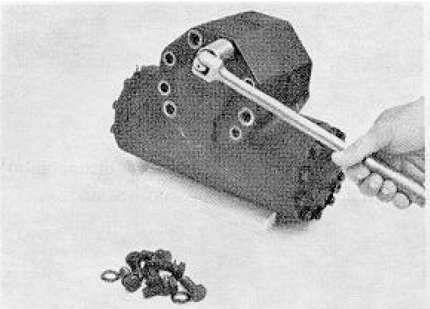
S-27

Remove the relief valve plungers from the cylinder head and the bearing cap. This will protect them from damage during repairs.



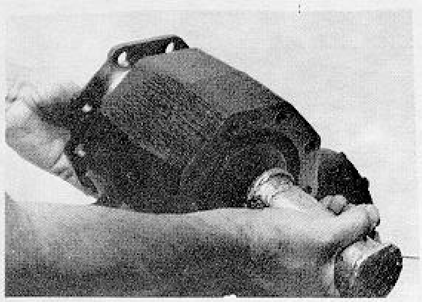
S-28

Clean the exposed portion of the output shaft to prevent damaging the bearing.



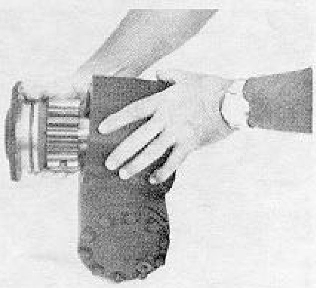
S-29

Remove the eight bolts attaching the pinion gear cover to the housing.



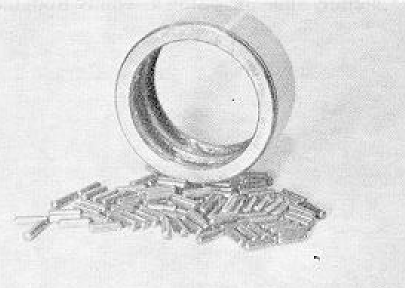
S-30

Using a soft hammer, tap on the end of the output shaft to. Loosen the cover.

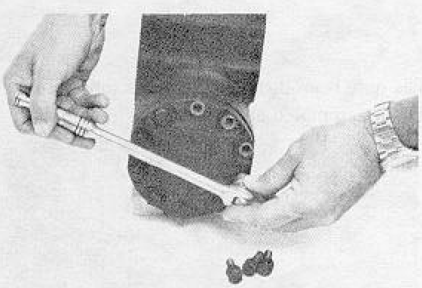


S-31

Carefully slide the output shaft, pinion gear, and cover through the housing. Pull the output shaft out of the cover. Remove and discard the cover "O"-ring seal.

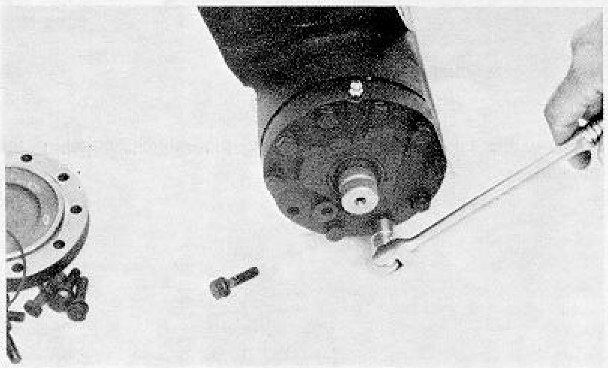


Note: The Series 5 steering gear may use loose needle roller bearings in the cover and housing to support the output shaft. On disassembly the needle rollers for the two bearings must be kept separate. See Series 5 variation.



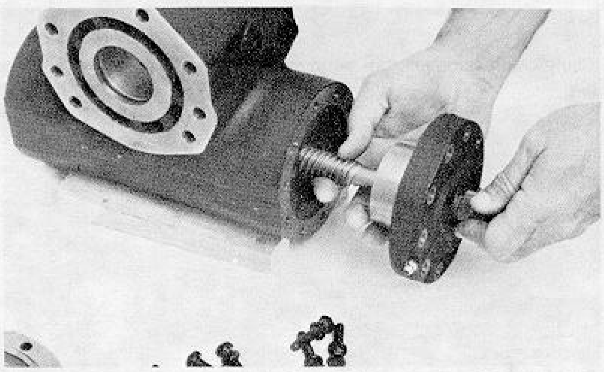
S-32

Remove the cylinder head and discard the seal ring.



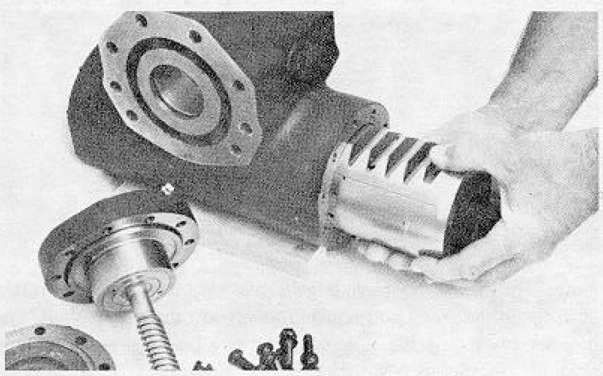
S-33

Remove the bolts from the bearing cap, and turn the actuating shaft to free the bearing cap from the piston and housing.



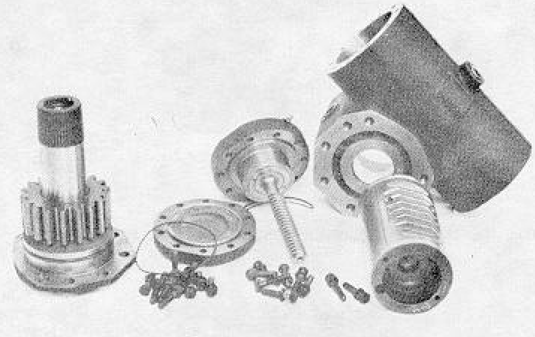
S-34

Support the bearing cap and turn the actuating shaft until it is free of the piston. Remove and discard the seal ring.



S-35

Carefully slide the piston assembly from the bore of the housing.



S-36

The steering gear has now been disassembled into subassemblies which can be further disassembled and repaired as required.

CLEANING & INSPECTION

Cleaning

Cleanliness is of utmost importance. Dirt and foreign material introduced into the steering system during repair operations can cause damages and steering malfunctions at a later date. Due to the close tolerances between mating parts it is advisable to have all parts at the same temperature for reassembly.

Clean machined parts individually to avoid damage due to "bumping" together. Use clean solvent to wash parts. Dry parts with compressed air. Nicks or burrs must be removed with a fine hand stone before assembly. Use only clean motor oil to coat parts to ease assembly.

All "O"-rings, seals and gaskets should be replaced as a part of any repair.

All hoses, lines and the reservoir and filter should be cleaned before reinstalling repaired steering gear or after pump replacement.

Inspection

A careful visual inspection of all steering gear parts must be made. Worn parts as well as any parts that show signs of stress or fatigue must be replaced.

Caution: Steering gears that have been accident damaged should be considered suspect. Impact loads transmitted through the front axle and steering linkage into the steering gear can stress parts to a point just short of failure. Further use is unsafe and replacement of the steering gear assembly and pitman arm is strongly recommended. Distorted pitman arms, broken or bent reversing springs, twisted output shafts, broken or cracked rack and pinion gear teeth are some signs of impact damages. Broken or damaged mounting brackets should not be replaced without further investigation.

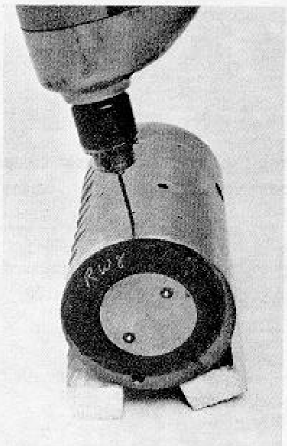
Steering Gear parts inspection may reveal problems in other areas of the steering system. To avoid repeat problems each clue gained from parts inspection should be followed to conclusion. Listed below are the more common observations you may make during steering gear inspection and their possible cause. This information should be considered carefully when repairing low mileage vehicles. Remember it is more important to repair the cause than to repair the results.

Parts discolored (blue)	1. Operating temperatures too high 2. Flow rate excessive 3. System back pressure too high 4. Steering column binding 5. Actuating valve blocked 6. Hydraulic supply pump malfunctioning
Bronze bushing wear	1. Incorrect lubricant used 2. Excessive temperature 3. Overloading 4. Contaminated oil
Actuating shaft and actuating valve acme thread wear	1. Overloading 2. Insufficient operating pressure 3. Insufficient oil flow 4. Continued operation at high temperature
Broken or bent reversing spring	1. Accident damaged 2. Air in system
Broken housing	1. Accident damaged 2. Uncontrolled operating pressure
Actuating shaft bearing retaining nut stripped	1. Impact or accident damaged 2. Air in system
Housing or piston scoring (Also see following NOTE)	1. Foreign material entry 2. Severe overloading 3. Incorrect lubricant used 4. Excessive temperature (over 200°F.) 5. Pump damaged 6. Air in system
Roller Bearings (Pitted rough) (Bearing cage broken)	1. Operating pressure too high 2. Foreign material in system 3. Excessive overloading
Roller Bearings Needles flattened Output shaft brinelled or dented	1. Impact damages

Note on scoring

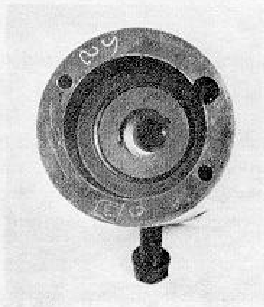
Minor scoring and scuffing of the piston and housing of the steering gear should not be cause for alarm. During operation at relatively high pressures and flow rates this minor damage will not affect the safety or operation of the steering gear. If scoring is severe leakage will affect steering reaction time and slow, binding, or uneven steering input will be noticeable. In this case the damaged parts should be replaced. Minor scoring should be polished with a fine hand stone or crocus cloth to allow free movement of mating parts. The cylinder bore should not be honed or bored out as this will increase leakage. Slow, binding, or uneven steering input can also be caused by problems with the hydraulic supply pump and it is important that the pump is operating properly. See "Hydraulic Supply Diagnosis" section of this manual.

REPAIR - SHORT SERIES PISTONS



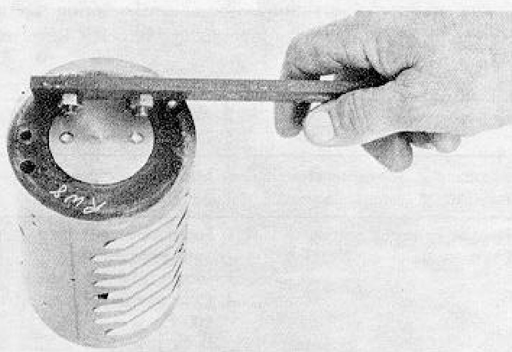
S-37

To remove the control valve from the piston, the piston plug must first be removed. The plug is locked to the piston with a 1/8 inch soft pin. Use a 5/64 inch drill to drill out the pin. See variation on early production gears and 372 and 382 step-bore steering gears.



S-38

Caution: The bottom adjusting nut which is exposed should never be removed or the reference to the valve center is lost.



S-39

Use a spanner wrench to remove the piston plug from the piston.

Note: The spanner wrench shown here can be fabricated using a piece of flat stock with two cap screws bolted in place with the proper spacing to fit the piston plug.

S-40

The seals on the piston plug can be removed and discarded if replacement is required.

S-41

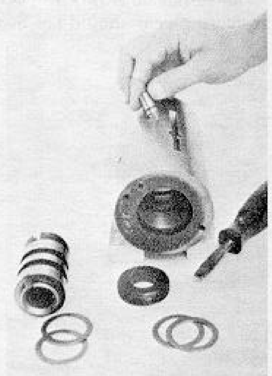
Mark the top adjustment nut and piston so that the nut can be reinstalled in its original position.
Caution: Misadjustment of the top adjustment nut could cause erratic steering.

S-42

Use a 5/64 inch drill to drill out the adjusting nut lock pin. A piece of stock material is used to turn the adjusting nut out of the piston.

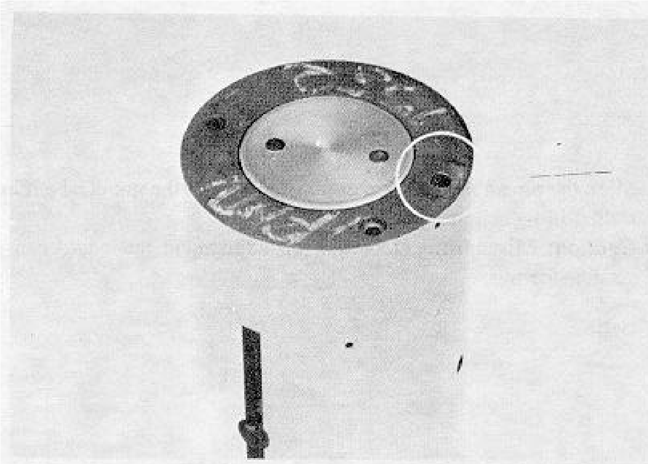
S-43

Carefully slide the control valve and reversing springs out of the piston.



S-44

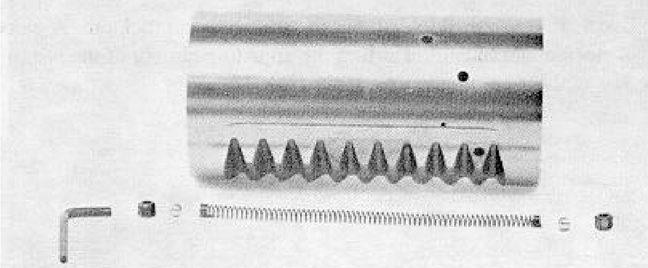
The valve positioning pin can now be removed from the piston. Remove and discard the seal on the valve positioning pin. Remove the remaining two reversing springs.



S-45

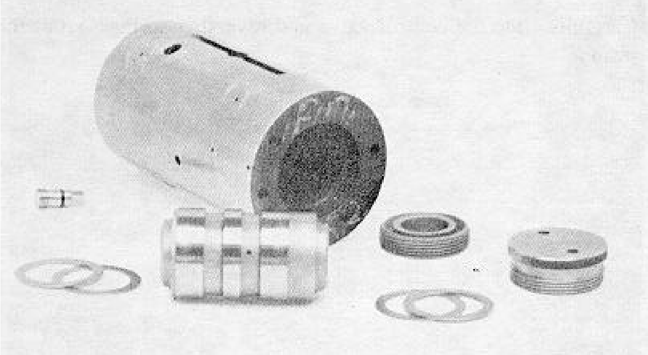
A 3/16 inch allen wrench is used to remove the relief valve seats. There is a slight spring tension on the relief ball valves.

Caution: Handle carefully to avoid loss or personal injury.



S-46

The relief passage is drilled through the piston from end-to-end. There is a ball valve and a valve seat at each end. The ball valves are held against their seats by a spiral spring.



S-47

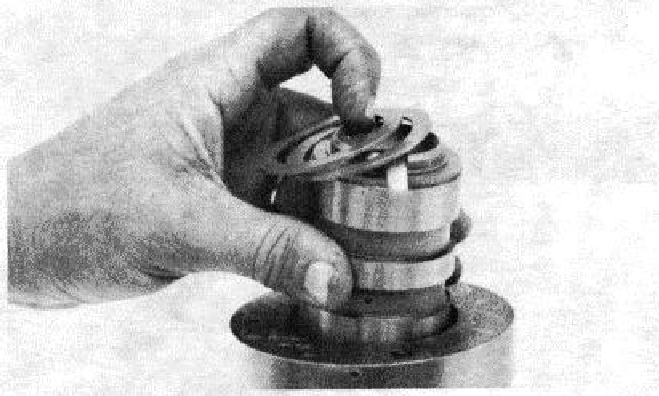
The components of the piston and actuating valve assembly can now be cleaned and inspected. The reversing springs and the relief system parts are the only replaceable parts in the piston. The reversing springs should be flat. Bent or dished springs are an indication of severe impact damages and all components of the steering gear should be inspected for damages.

S-48

Carefully reassemble the piston. Place two reversing springs on the center of the adjusting nut in the piston. Put a new 0-ring seal on the valve positioning pin and screw the pin into the piston until the top of the pin is below the surface of the piston.

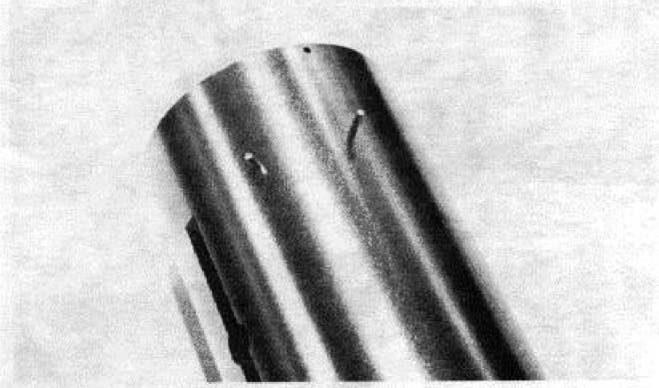
Reinstall the actuating valve in the piston with the long locating slot in line with the valve positioning pin. Turn the valve positioning pin until it lines up with the slot of the valve and the valve slides into the reversing springs.

Note: Some Short Series 3 and 4 pistons also use a tapered valve positioning pin, which is adjustable. These pistons can be identified by the piston plug which uses seal rings. These pistons will also have a control valve with a maximum inch and three quarters diameter.



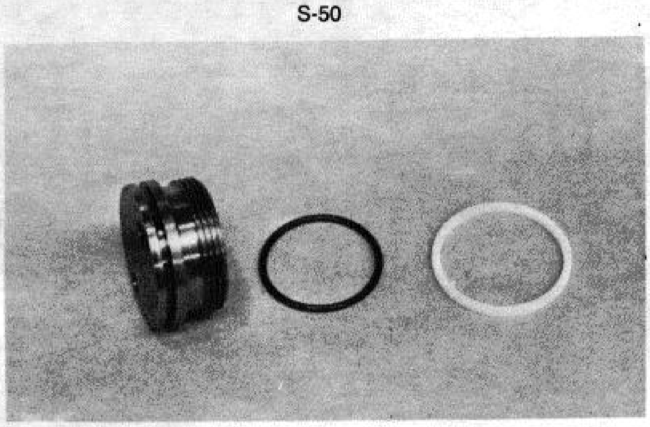
S-49

Place the two reversing springs on the nose of the valve. Screw the adjusting nut into the piston until the nut contacts the reversing springs and the valve has no end play. Now turn the adjusting nut to line up your reference marks and the locking pin will enter the original pin holes.



S-50

If the lock pin will not enter the original holes a second hole is provided and the adjusting nut can be drilled and the pin installed in this position. The tip of the pin must be below the surface of the piston.

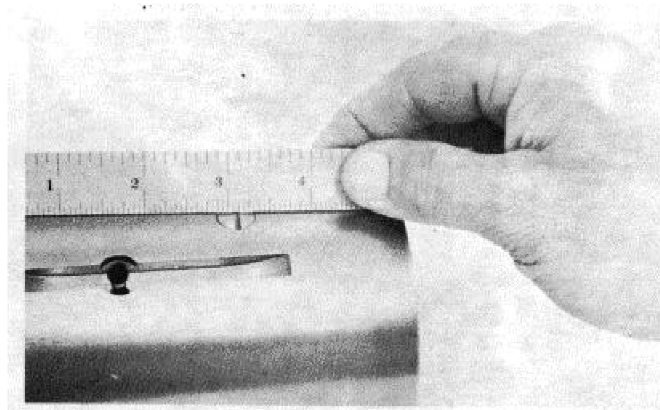


Install a new O-Ring expander and a new square ring seal on the piston plug and install the plug in the piston. Tighten plug securely. Drill and pin the plug to the piston. The tip of the pin must be below the surface of the piston.

Reinstall the relief valve seats, balls and springs.

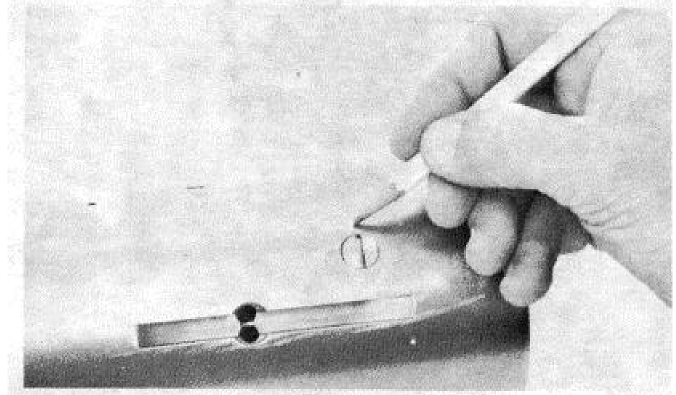
VARIATION - SERIES 5 PISTONS

The valve positioning pin which locates and guides the actuating valve in the piston of the Series 5 gear is tapered. This tapered valve positioning pin must be adjusted when the piston is reassembled. Install a new O-Ring Seal on the valve positioning pin and screw it into the piston until it is flush with the surface of the piston.



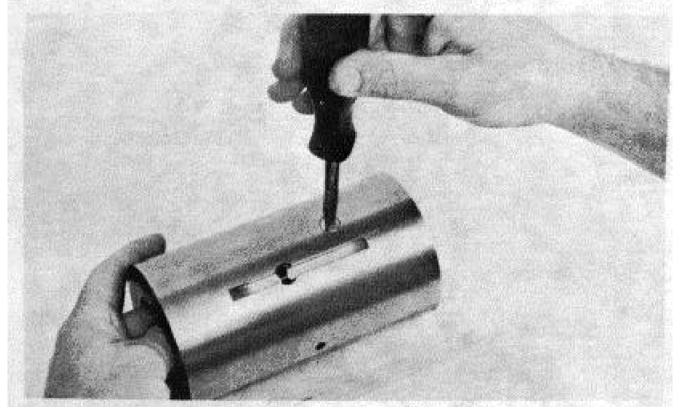
S-52

Make reference marks with a pencil on the piston and the pin and then install the actuating valve in the piston, lining up the long guide slot in the valve with the guide pin. When the valve positioning pin has entered the valve and the valve has bottomed, check the valve for radial movement and freedom of movement over the valve positioning pin.

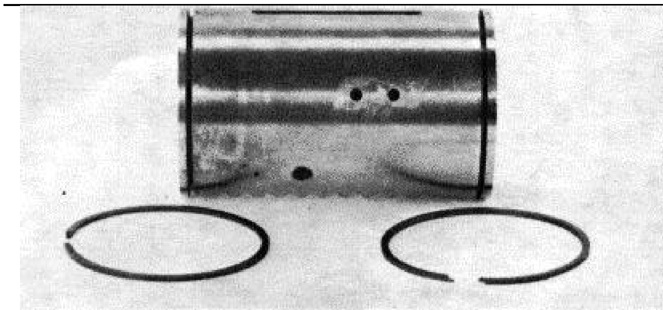


S-53

The valve positioning pin is adjusted 1/4 turn at a time until the valve has no radial movement and slides smoothly over the valve positioning pin. Each time the valve positioning pin is adjusted the actuating valve will have to be pulled out of the piston far enough to disengage the valve positioning pin. When the valve positioning pin is properly adjusted complete assembly of the piston as previously detailed for Series 5 Steering Gears.



S-54

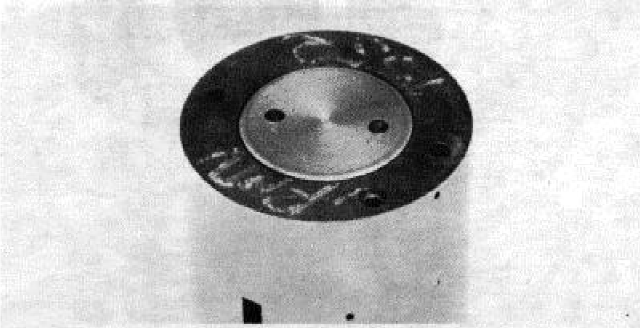


S-55

VARIATIONS - EARLY PRODUCTION PISTONS

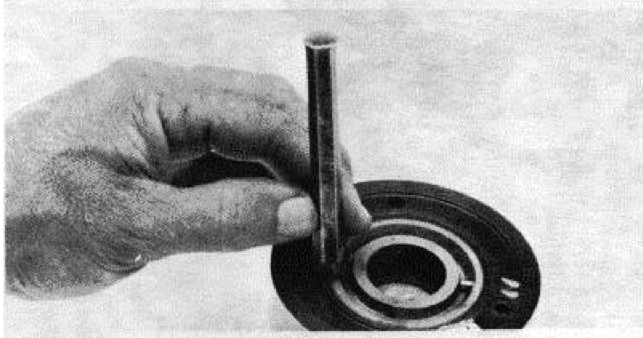
Note: Variations

Very early production steering gears may be fitted with piston rings. They can be removed and discarded as they are no longer required. The 372/382 series steering gears with the step-bore housing and piston flange will continue to use the piston ring.



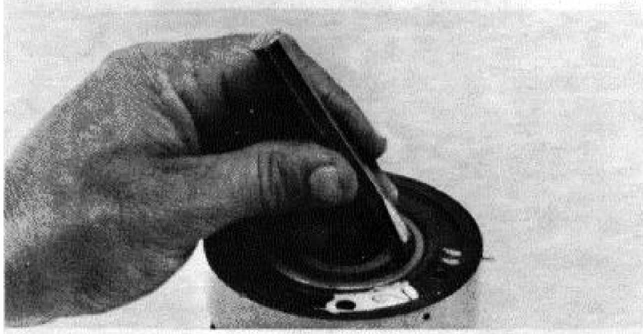
S-56

The piston bottom plug should not be removed except in cases of severe oil contamination, and for cleaning. On reinstallation the plug must be pinned. Pipe sealer should be used sparingly on the threads of the plug.



S-57

Mark the top adjustment nut and piston so that the nut can be reinstalled in its original position.
Caution: Misadjustment of the top adjustment nut could cause erratic steering.

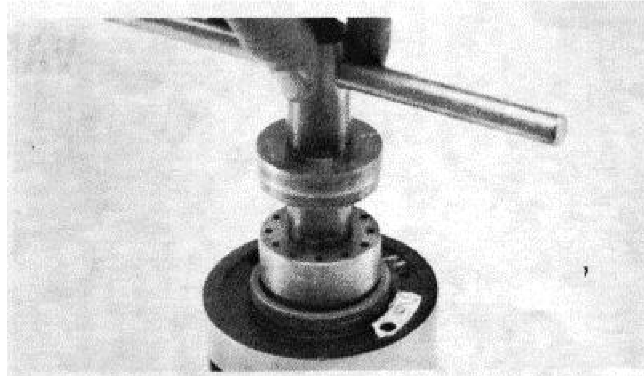


S-58

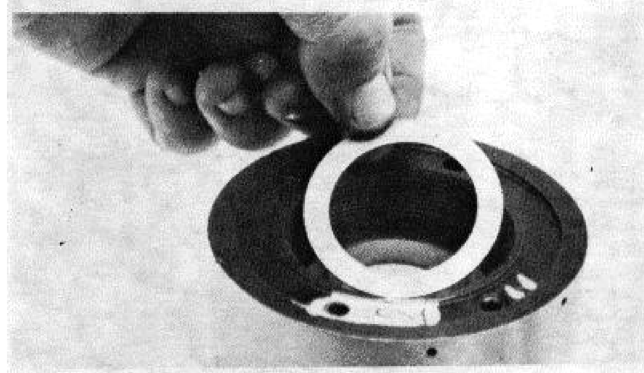
Carefully remove the pin locking the adjustment nut to the piston assembly.

Using a spanner wrench remove the top -adjusting nut from the piston.

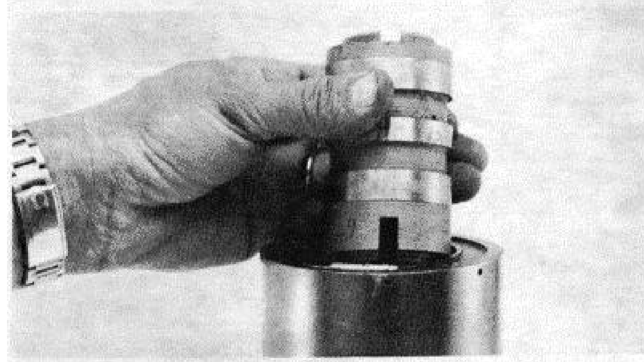
Note: The bottom adjustment nut inside piston should never be removed.


S-59

Remove the top reversing spring from the nose of the actuating valve.

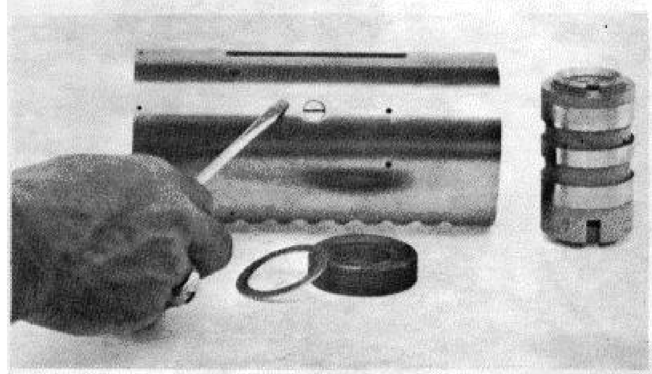

S-60

Pull the actuating valve from the piston. Do not force the valve from the piston bore. The actuating valve and piston are serviced only as an assembly due to the critical tolerances in this area.

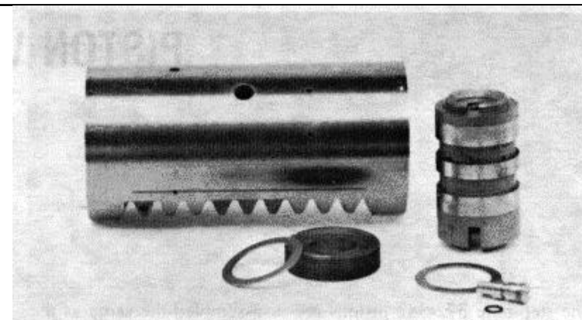

S-61

Remove the actuating valve positioning pin from the piston.

Note: The positioning pin on later production steering gears will have-an "O"-ring oil seal.

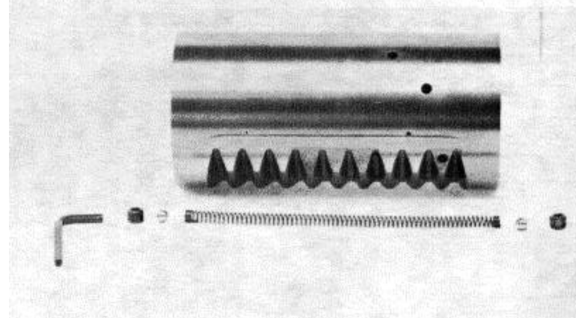

S-62

The reversing springs are the only serviceable parts in the piston assembly.



S-63

Use an allen wrench to remove the relief ball seats, relief balls and spring.
Caution: The balls are under slight spring pressure. Handle carefully to avoid loss or personal injury.

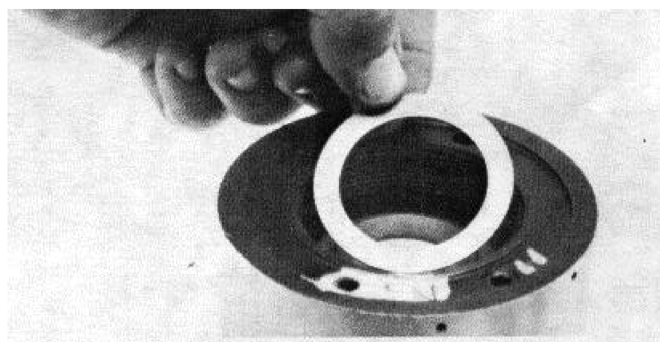


S-64

REASSEMBLY- EARLY PRODUCTION PISTONS

Position the relief valve spring and one relief valve ball into the valve bore. Then, using a 3116" allen wrench, install one of the valve seats. The valve seats must be tight and flush with or slightly below the end surface of the piston.

Install the second relief valve ball seat in the same manner.



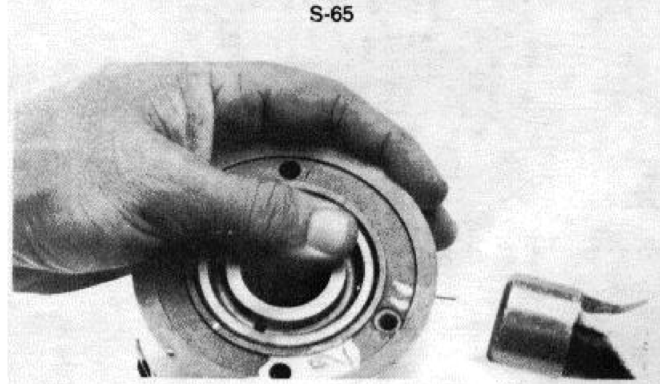
S-65

Position one of the reversing springs in bottom of valve bore. Be sure spring is centered. The end of the valve must enter the inside diameter of the spring.

Install the valve positioning pin in the piston. Turn pin inward with a screwdriver until it is below the outside surface of the piston.

The flats must enter into the piston 1/4" to engage the mating slot in the valve.

Carefully slide the actuating valve into the piston so that the slot on the end of the valve is positioned over the pin.



S-66

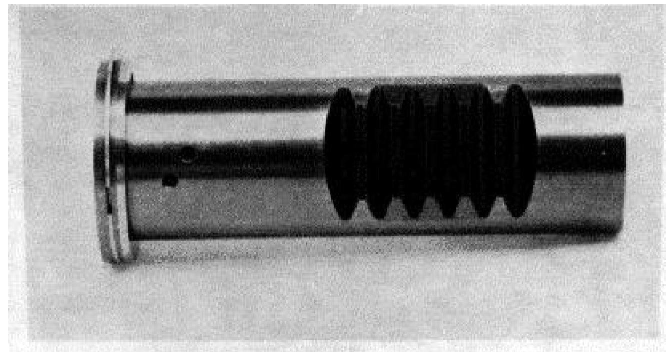
Position the remaining reversing spring on shoulder of the valve end.

Reinstall valve adjustment nut, turning it clockwise into the piston until it is against the spring. Align the reference marks on the nut and piston. Then, lock nut in place by installing the locking pin.

Be sure pin is below the outside edge of piston.

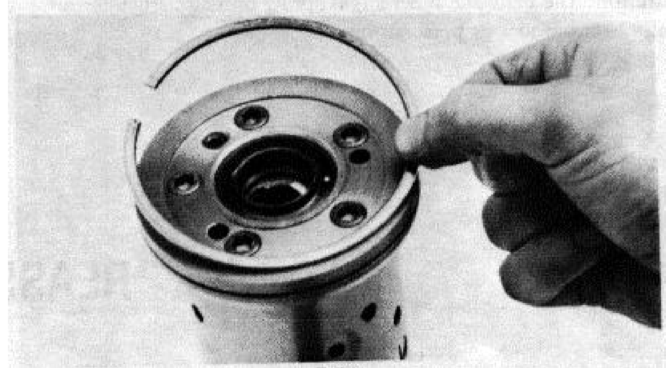
PISTON VARIATION - 372-382 SERIES - STEP-BORE

The step-bore 372-382 pistons are disassembled the same as the standard piston, except the piston ring flange is factory located and installed and must not be removed.

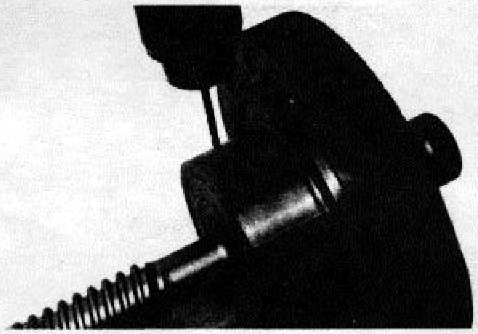


S-67

The piston ring is replaceable in the case of wear or breakage.



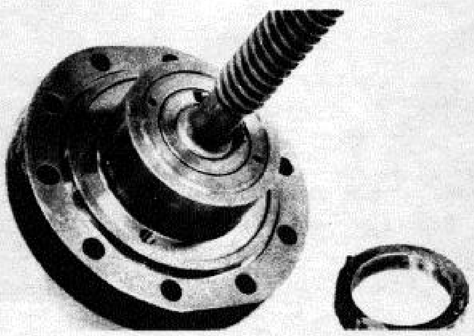
S-68



S-69

REPAIR SHORT SERIES- BEARING CAP ASSEMBLY

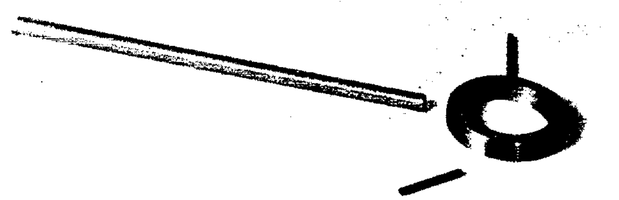
Separate the actuating shaft from the bearing cap. The actuating shaft retainer is pinned to the bearing cap. Use a 5/64 inch drill and drill through the pin.



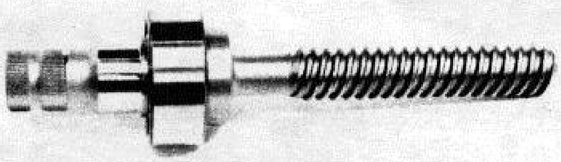
S-70

Use a spanner wrench to remove the retainer.

You can fabricate your own spanner wrenches as required using discarded retainers and a piece of stock as a handle and two roll pins. Drill through the retainer and drive the roll pins through the retainer. Weld the stock material as a handle to the retainer.



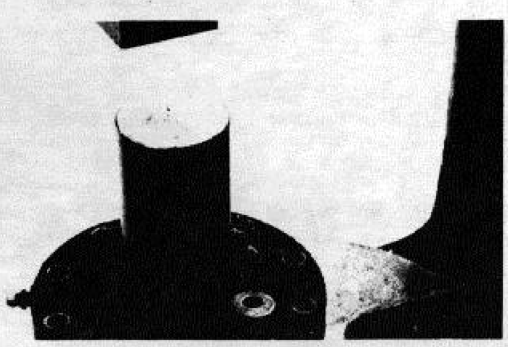
S-70A



S-71

Carefully tap or press the actuating shaft and bearing out of the bearing cap.

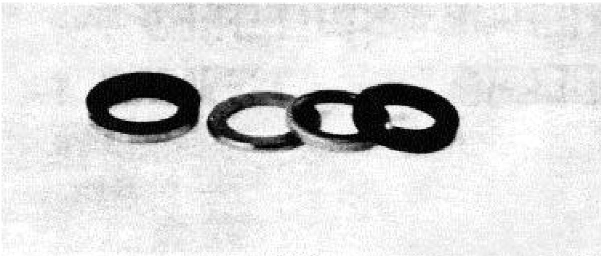
The actuating shaft and bearing are not supplied separately. No attempt should be made to remove the bearing.



S-72

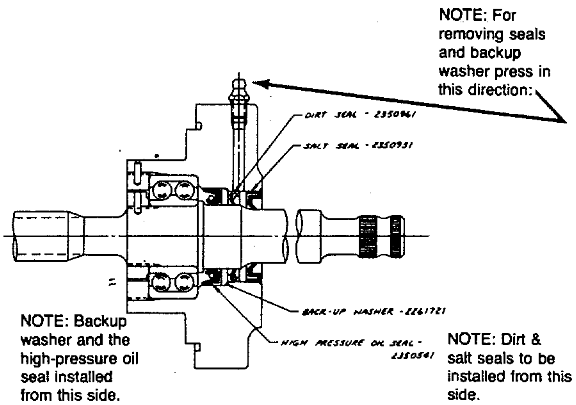
The bearing cap seals are removed by pressing them toward the inside.

Note: The high-pressure seal back up washer will also be displaced with the seals. and should be recovered for reinstallation with new
seals.

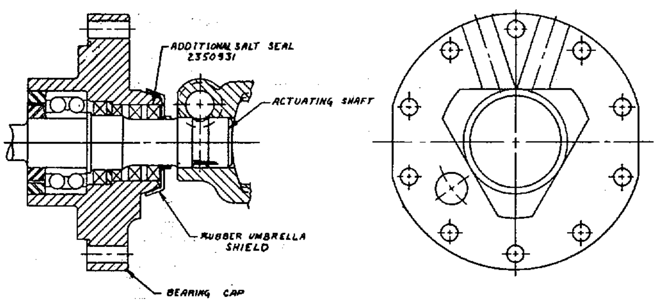


S-73

Reassembly of actuating shaft and bearing cap with integral salt seal.



A second salt seal and an umbrella style seal are used on some model steering gears. The illustration to the left details this seal arrangement. Seal replacement is the same as detailed below except the second salt seal is installed in the bearing cap.



Take backup washer and reinstall with under cut down as shown.

Take a piece of round stock 2" long and turn to 1.615 and smooth one end.

Put the piece of round stock in the bearing end against the backup washer. Set the bearing cap on a press and evenly install the dirt seal, lip out from the other end until it rests against the backup washer.

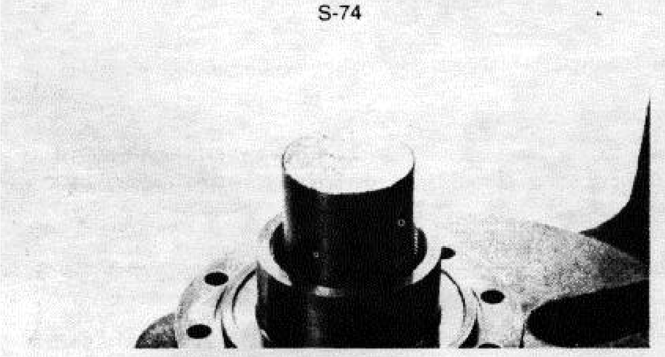
Evenly install the salt seal, lip out, into the bearing cap until flush with top.

Turn bearing cap over and evenly install the high-pressure oil seal until it rests against the backup washer.

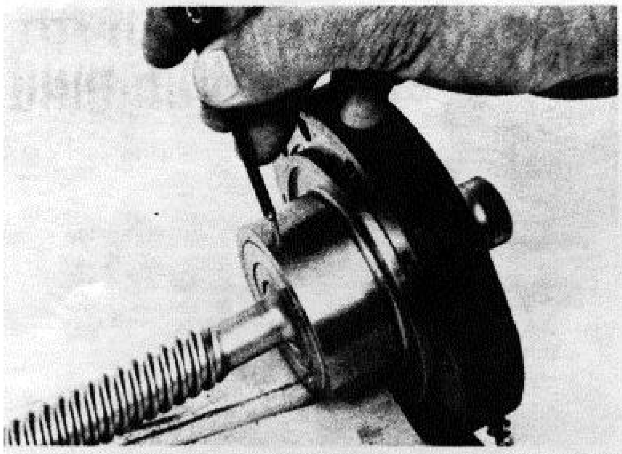
Lubricate all three seals with grease before installing actuating shaft assembly.

Caution: If the backup washer is not installed properly, the oil leak will return on the first application of pressure.

S-74



S-75



S-76

Press the actuating shaft into the bearing cap. Reinstall the bearing
retainer. Tighten retainer securely to keep the bearing from having
end play. Install a new lock pin.

VARIATION - VERY EARLY PRODUCTION - BEARING CAPS

S-77

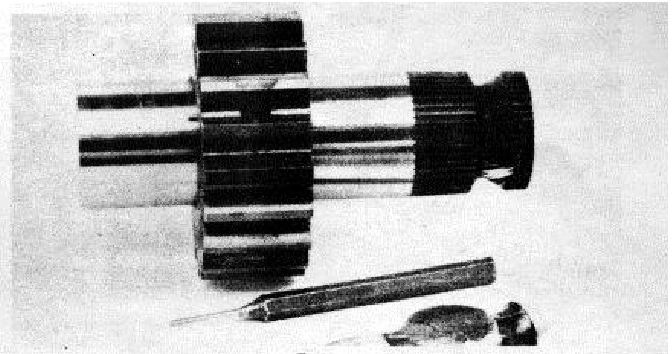
Some early production steering gears used two seals in the bearing cap and the back up washer was machined in the bearing cap housing. Use a screwdriver to pry out the dirt seal.

S-78

With the dirt seal removed, two access holes to the high-pressure seal are uncovered. Use a punch to tap the high-pressure seal out of the housing. Care must be taken to avoid damage to the housing or oil leakage will reoccur.

REPAIR - SHORT SERIES - OUTPUT SHAFT AND PINION

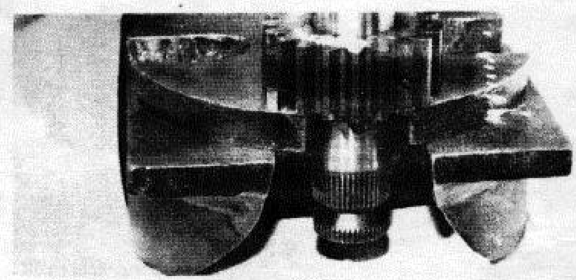
The pinion gear is located and held in place on the output shaft with a retaining pin. A roll pin through the pinion gear will keep the retaining pin from backing out of place. To remove the pinion gear, punch out the roll pin and drill out the retaining pin. Press the pinion gear off the output shaft.



S-79

Note: If the retaining pin cannot be drilled out, it can be sheared off with approximately 10 tons of pressure on a press. Drive half the pin out of the, pinion gear and now drill the remaining half out of the shaft.

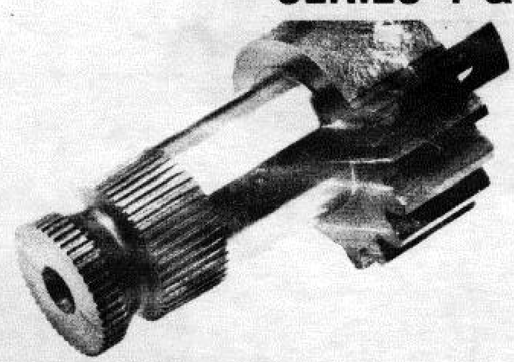
Caution: Use safety precautions when shearing the pin under pressure.



S-80

To reassemble the pinion gear to the output shaft, align the timing arrows on the output shaft to the arrow on the pinion gear. Press the gear on to the shaft splines until the locating pin can be driven through the gear and into the locating hole in the shaft. Install the roll pin through the gear.

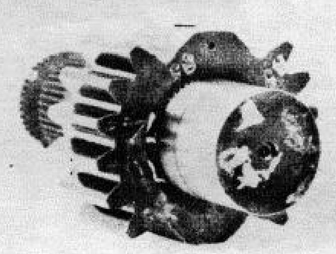
VARIATION – OUTPUT SHAFT SERIES 4 & 5



S-81

To provide 100 degrees of pitman arm travel some series 5 steering gears use a one piece forged output shaft and pinion gear assembly. Service of this assembly is by replacement only.

VARIATION: 372/382 SERIES

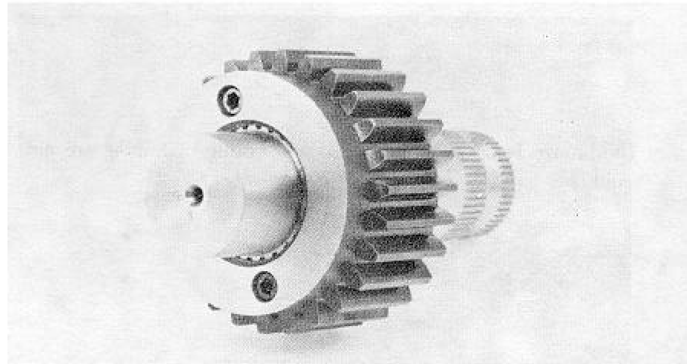


S-82

The 372/382 series output shaft and pinion gear are different in appearance but are serviced in the same manner as the high-pressure or short series gears.

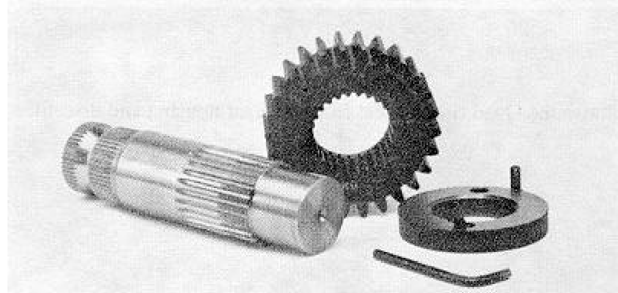
VARIATION: LOW PRESSURE SERIES
OUTPUT SHAFT & PINION

Use an allen wrench to remove the cap screws. The retaining nut is now removed by turning it counter-clockwise off the output shaft. Press the gear off the shaft.



S-83

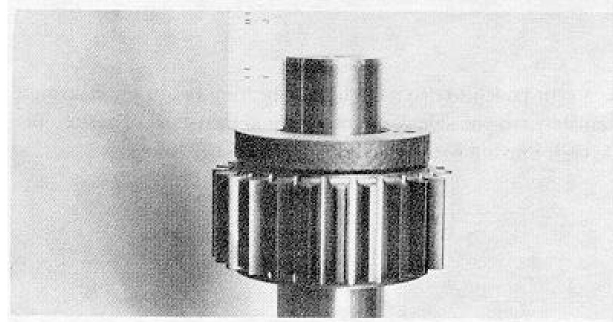
The pinion gear on low pressure steering gears is held to the output shaft with a retaining nut threaded to the output shaft and locked to the pinion gear with two cap screws.



S-84

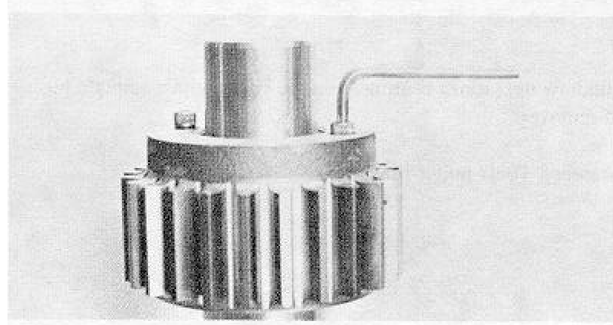
When the pinion gear is reinstalled on the output shaft the distance between the end of the shaft to the face of the retainer must be adjusted. Place the gear on the shaft splines, aligning the timing marks and thread the retainer onto the shaft against the pinion gear. The distance between the end of the shaft and the face of the retainer should be adjusted by moving the gear on the shaft until the following dimension is obtained:

Model 39 - 1 10/32 "
Model 59 - 1 25/32"
Model 491 - 1 13/32"



S-85A

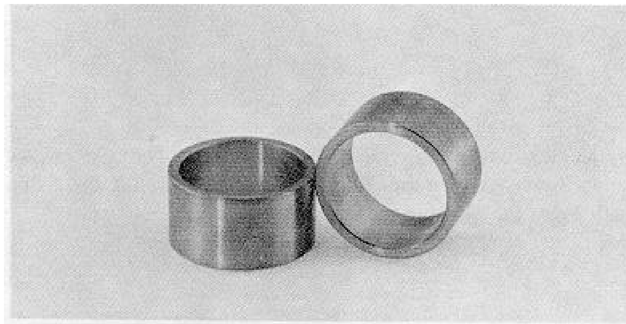
Now the retainer is backed off until the drilled holes in the retainer align with the tapped holes in the pinion gear. Install and tighten retaining screws drawing the gear tightly against the retainer. It may be necessary to press the gear onto the shaft or back against the retainer.



S-85B

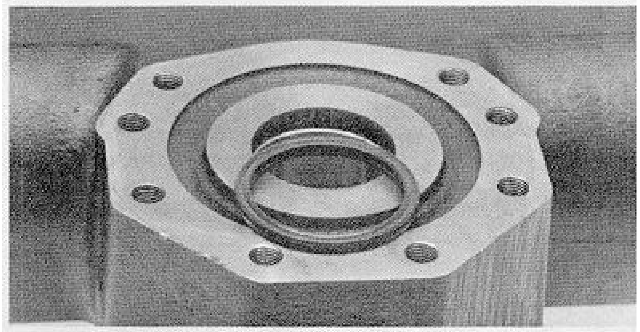
REPAIR - SHORT SERIES - HOUSING ASSEMBLY

The bronze bearings are presized and boring or honing are not required.



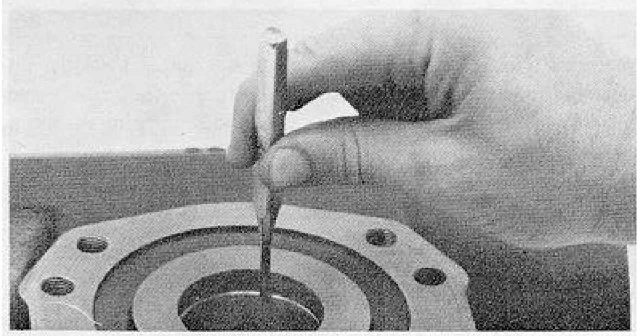
S-86

Remove the Quad ring oil seal from the gear housing and discard.



S-87

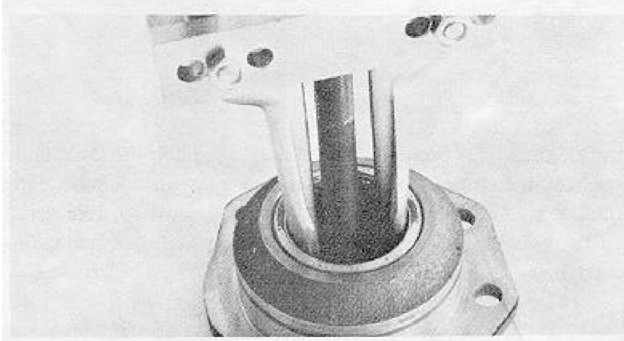
Use a drift punch to drive the bronze bearing out of the housing. Alternately tap one side of the bearing and then at an opposite side to keep it moving evenly.



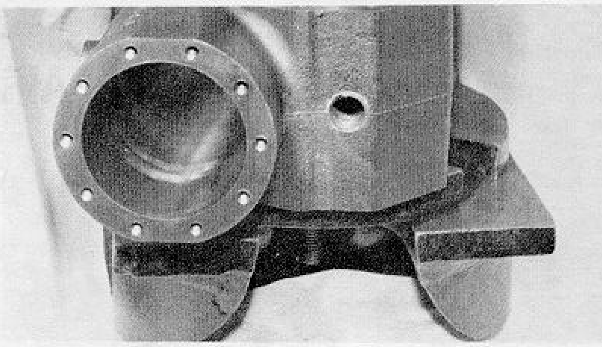
S-88

Withdraw the bronze bearing from the cover with a suitable bushing remover.

Owatonna Tools puller illustrated

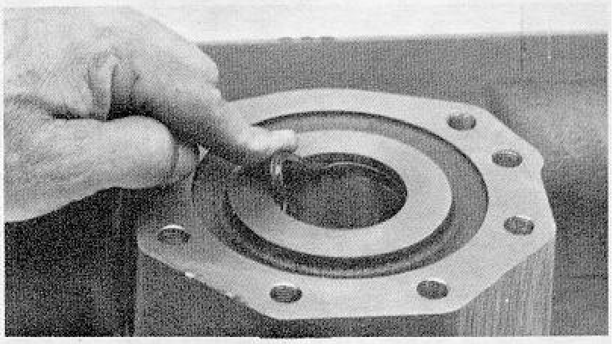


S-89



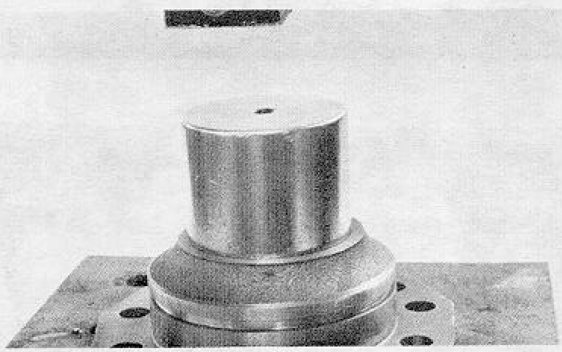
S-90

Install new bearings (if removed) in the gear housing and cover, using a press and a straight line pushing action. The bushing is. pushed into the gear housing, so that the inside face of bushing is flush with inside face of gear housing.



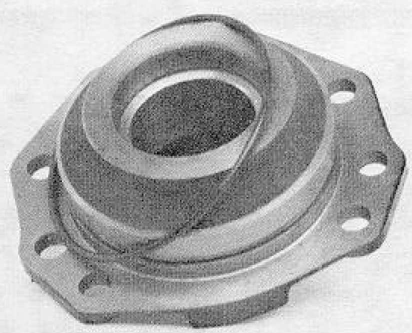
S-91

Install a new Quad ring in the groove in the gear housing. The quad ring is a "stuff-fit" and at first glance may appear to be too large.



S-92

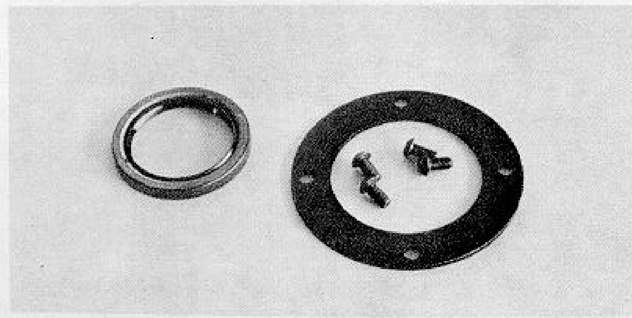
Press a new bronze bearing into the pinion cover.



S-93

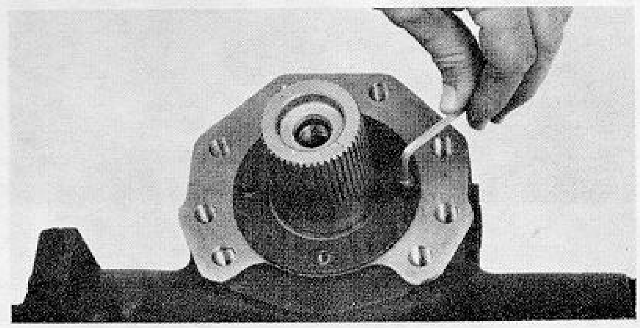
The bronze bearing should be recessed 1/2 inch below the face of the cover, on all 292, 392 and 492 steering gears. The 592 bearing is recessed 5/16". All other bearings are installed flush with the face of the cover.

The output shaft oil seal used in the Series 5 Gear is of the metal clad type and is held in the housing with a retainer and four allen head screws.



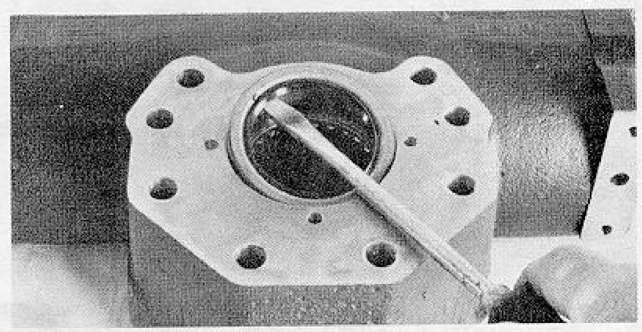
S-94

To replace the seal, remove the four screws and the retainer and pull the output shaft out of the housing.



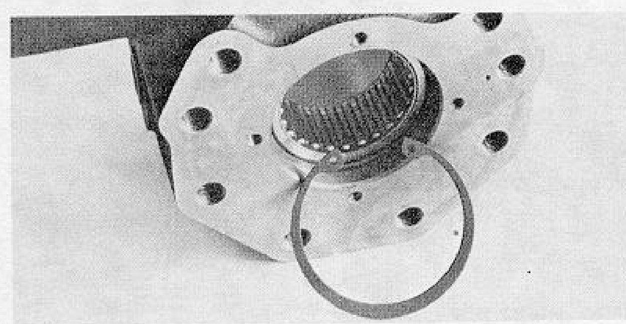
S-95

Use a long straight tip screwdriver to lever the seal out of the housing bore.

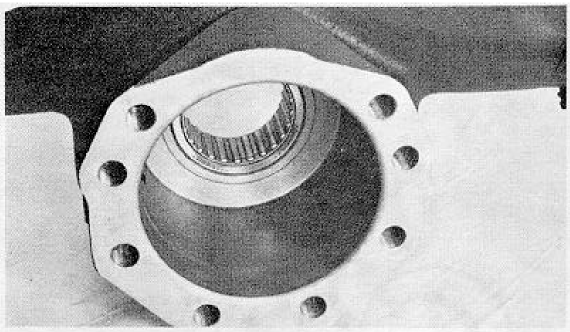


S-96

If the needle bearing in the housing is to be replaced the output shaft seal must be removed to gain access to the bearing locating snap ring in the housing. Remove the snap ring from the housing and press the bearing out of the housing.

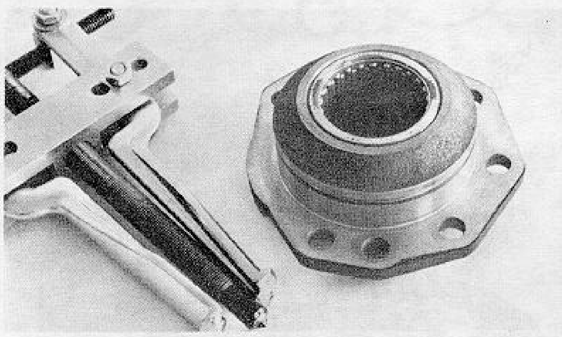


S-97


S-98

On reassembly the snap ring is installed first and the bearing is pressed into the housing until it contacts the snap ring.

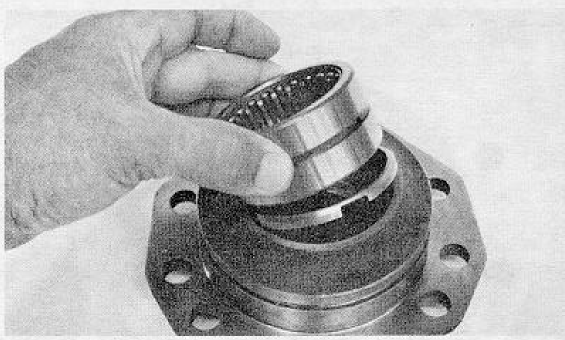
Note: The 59255 bearing has the snap ring on the bearing. In this case the bearing is pressed into the housing until the snap ring contacts the housing.


S-99

The needle bearing in the pinion cover is removed using a bushing removal tool.

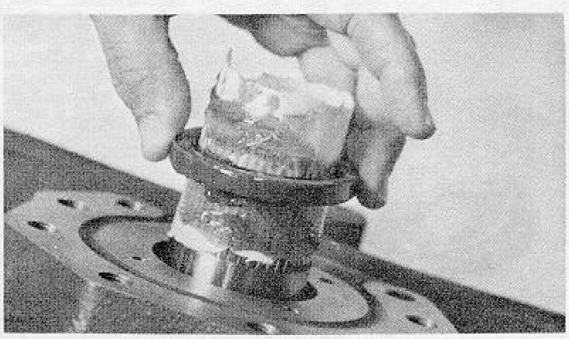
An Owatonna puller is illustrated.

Note: The bearing should not be removed unless it is going to be replaced.


S-100

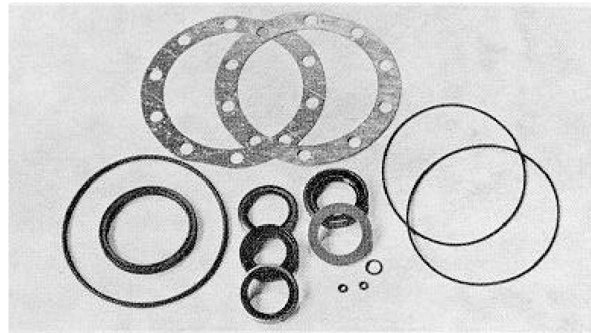
A new bearing is pressed into place flush with the face of the bearing bore and against the spacer in the bore of the pinion housing.

Note: Some Series 5 steering gears use a double row needle bearing where the needle rollers are loose. During service, care must be taken to ensure that the needle rollers are installed in the bearing housing which they came out of. Use chassis lube to hold the needle rollers in the bearing races during reassembly.
Note: The 59255 bearing has the snap ring on the bearing. In this case the bearing is pressed into the cover until the snap ring contacts the cover.


S-101

The output shaft seal is installed with the shaft in place. To protect the seal, wrap the splined end of the shaft with greased paper and slide the seal into place over the shaft. The seal can be drawn into place using the retainer and the allen screws. Alternately tighten the allen screws until the seal is in place and the retainer is secured to the housing.

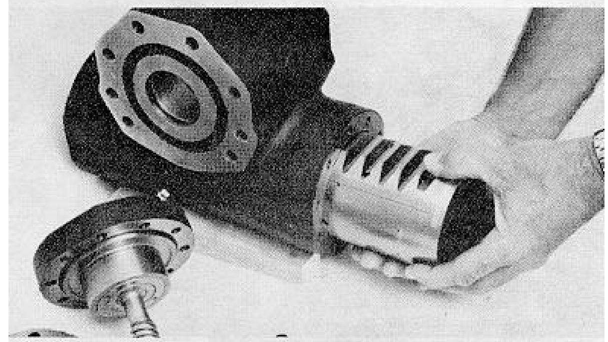
Typical overhaul seal kit



S-102

Put a light coat of motor oil in the cylinder bore.

Carefully install piston in cylinder bore with opening for actuating shaft towards bearing cap end of housing.

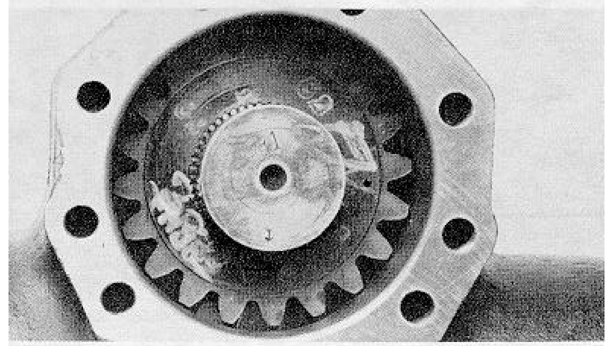


S-103

Align timing mark on piston rack with center of pinion gear housing.

Grease housing bearing and quad ring and carefully slide output shaft through housing. Align timing marks on pinion gear with timing mark on rack.

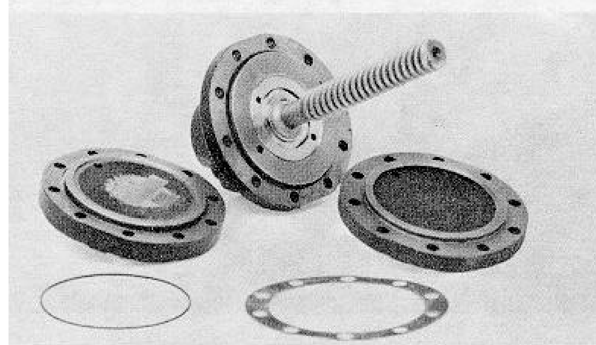
Caution: If the rack is not properly timed to the pinion gear of the forged one-piece shaft and gear assembly it is possible for the gears to disengage in service.



S-104

Install cylinder head with new gasket or seal. Align reference marks and tighten bolts to specified torque.

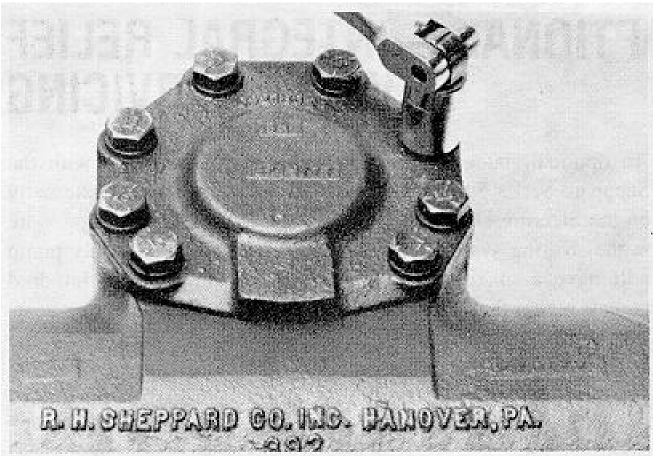
Using a new gasket or seal on the bearing cap, thread actuating shaft into the valve. Line up punch marks on gear housing and bearing cap. Turn shaft until cap comes into place on the end of cylinder. Check plunger hole alignment with valve seat in the piston. Tighten bolts to specified torque.



S-105

Note: Variation

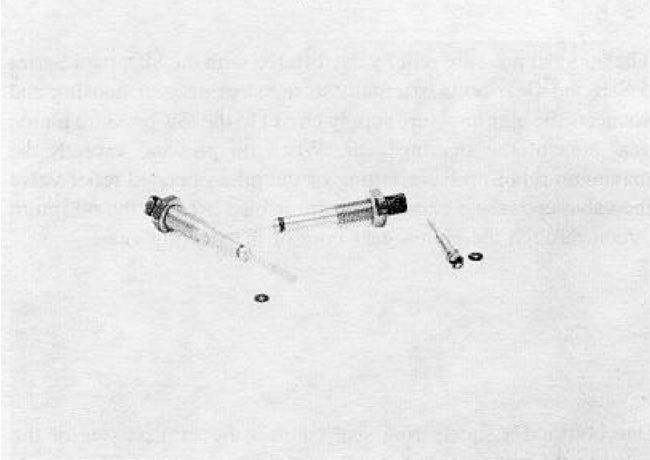
Several steering gear models use square ring seals in place of gaskets on the cylinder head and bearing cap.



S-106

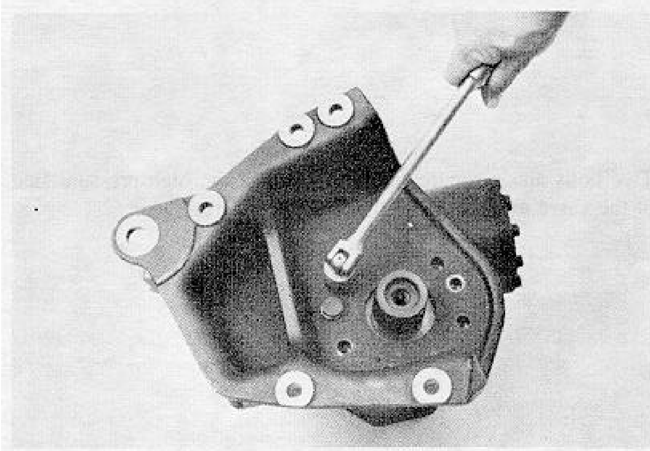
Position a new "O"-ring seal on housing cover. Install cover assembly. It may be necessary to use a soft hammer to tap the cover in place.

Install the bolts and torque to proper specifications.



S-107

The relief valve plungers may now be installed, using new "O"rings. Turn them approximately six turns. Final adjustment of the plungers are made when the steering gear is installed on the vehicle.



S-108

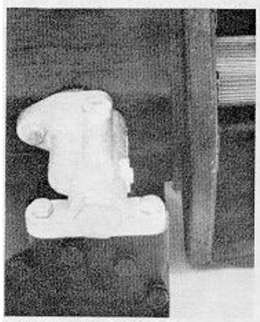
Note: Variation

Later production steering gears may have slotted and recessed relief plunger. The later style plungers are removed or adjusted with a straight bladed screwdriver.

These plungers can be turned out until they are flush with the plunger boss. Turning them out beyond this point could cause an oil leak.

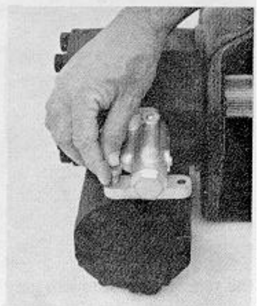
Reinstall the bracket on the steering gear and torque the bolts to specification.

OPTIONAL- INTEGRAL RELIEF VALVE SERVICING



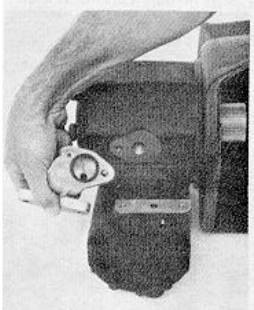
S-109

An optional, integral, pressure relief valve is offered with the Sheppard Series 5 Steering Gear. This valve is mounted externally on the Steering Gear and limits the maximum operating pressure in the steering system. In most cases the hydraulic supply pump will have a maximum relief pressure setting several hundred pounds higher than the relief valve integral with the steering gear. Therefore, when maximum relief pressures are reached in the steering system the excess pressure is relieved at the steering gear and the supply pump is not subjected to high temperatures caused by normal pressure relief and recirculation within the supply pump.



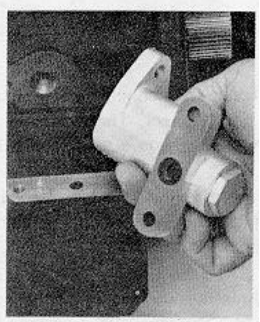
S-110

The optional pressure relief valve offered with the Sheppard Series 5 Steering Gear bolts externally to the steering gear housing and connects the high-pressure supply circuit to the low pressure pinion gear area of the steering gear. When oil pressure exceeds the maximum relief pressure setting of the pilot operated relief valve the valve opens and excess pressure is bled off into the oil return circuit through the pinion gear bore of the steering gear.



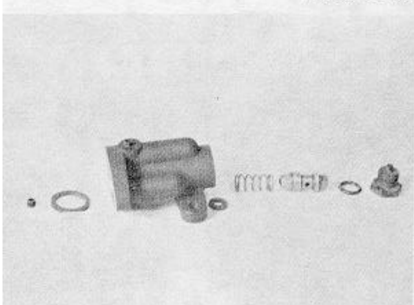
S-111

One bolt and a square ring seal connect the exhaust side of the valve to the pinion gear housing of the steering gear.



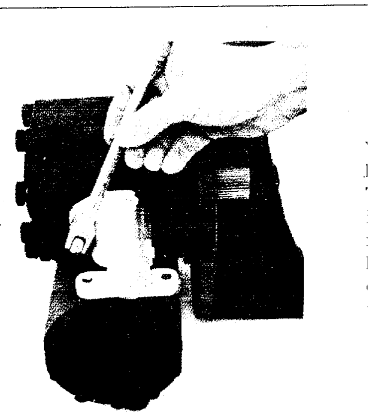
S-112

Two bolts and a square ring seal connect the high-pressure side of the valve to the cylinder head of the steering gear.



S-113

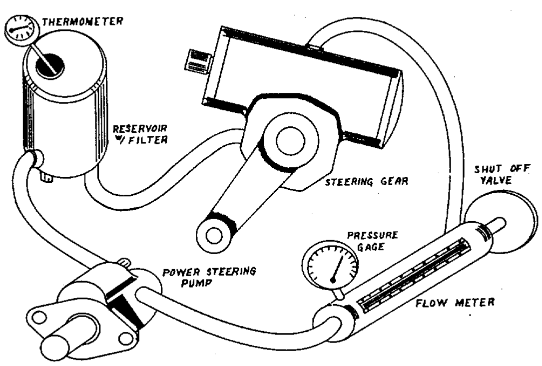
The valve is disassembled for cleaning and inspection by removing the valve end plug and withdrawing the relief valve and compensating spring.



S-114

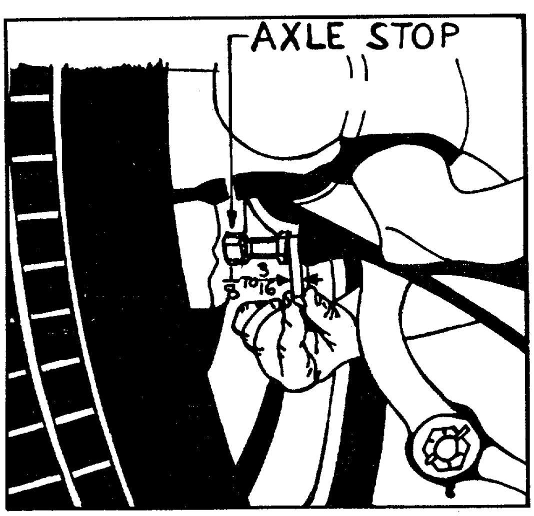
When the pressure relief valve is reassembled to the steering gear housing, it is important that attaching bolts are properly torqued. The single cap screw attaching the relief valve to the pinion housing of the gear must be installed and torqued to specifications first. The two cap screws attaching the relief valve to the cylinder head are then installed and torqued. This procedure will avoid causing distortion which could lead to binding of the relief valve in its bore.

TESTING INTEGRAL RELIEF VALVE



1. Connect pressure gauge and flow meter into the steering circuit as illustrated.

2. Close valve on gauge assembly and read supply pump relief pressure.



Caution: A malfunctioning pressure relief valve may not relieve pump pressure and closing the shutoff valve may cause severe pump damages or high-pressure hoses to rupture. Constantly observe the pressure gauge while closing the shutoff valve. If pressure rises rapidly or appears to be uncontrolled do not completely close the valve before inspecting the pump and pressure relief valve.

3. If supply pump does not meet specifications, repair pump.

4. If the supply pump is okay, place a 1/2-inch spacer between the axle stops on one side and turn the steering wheel hard in the direction necessary to pinch the spacer block. Record the maximum pressure reading.

5. Remove the spacer and repeat test in the opposite direction. Record pressure.

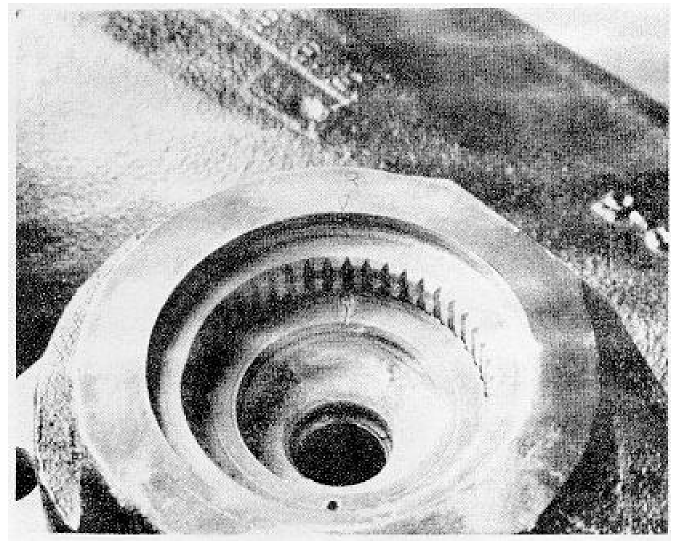
6. If pressure is equal on both sides, but not within specifications, remove and repair or replace the integral pressure relief valve.

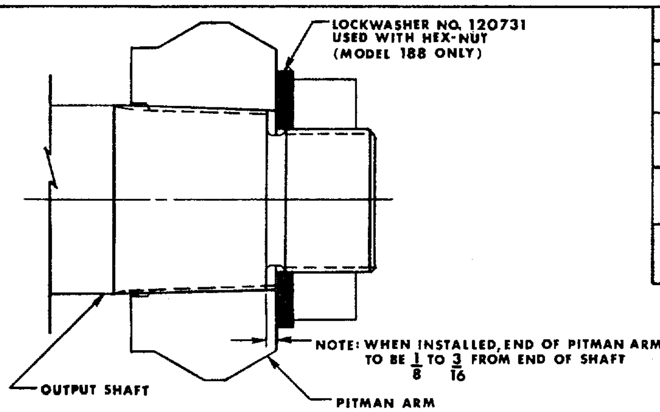
PITMAN ARM INSTALLATION INSTRUCTIONS

When the pitman arm is installed, the timing arrows on the arm and the output shafts must be aligned. If the pitman arm has two timing arrows marked "L" and "R" the same arm is used on both the master and the slave gear. The "L" arrow is used on the left or master gear and the "R" arrow is used on the right or slave gear.

The following charts detail the various pitman arm installation methods offered by The Sheppard Co.

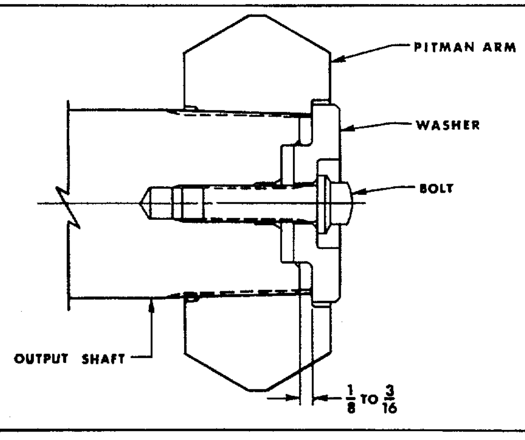
Follow these procedures for the attachment method you are working with. Correct torque values are very important. Use the lubricant where 'indicated.





TORQUE SPECIFICATIONS			
MODEL NO.	LOCKNUT NO.	TORQUE NUT TO:	
188	HEX-NUT 219776	250 FT. LBS.	339 N·M
191 - 192 39	2415991	410 FT. LBS.	556 N·M
292 - 392 491	2410101	450 FT. LBS.	610 N·M
51 - 59	2410801	500 FT. LBS.	678 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN PITMAN ARM AND NUT, IN THE THREADS OF THE NUT AND ON THE THREADS OF THE OUTPUT SHAFT.

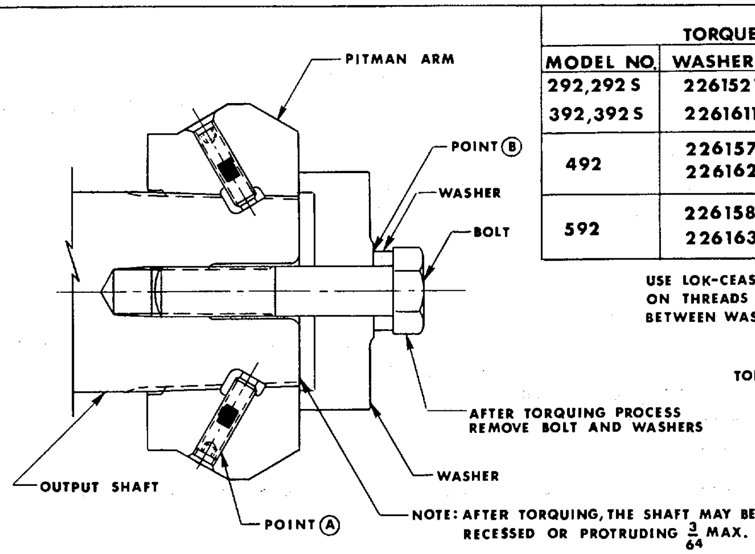


TORQUE SPECIFICATIONS				
MODEL NO.	BOLT NO.	WASHER NO.	TORQUE BOLT TO:	
592 S-5	2420891 1/2-20UNF, 1 1/2 LG. GRADE 8	2261811	150 FT. LBS.	203 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN BOLT AND WASHER, IN THE THREADS OF THE OUTPUT SHAFT AND ON THE THREADS OF THE BOLT.

R. H. SHEPPARD Co. INC.

PITMAN ARM INSTALLATION INSTRUCTIONS - CONT'D.



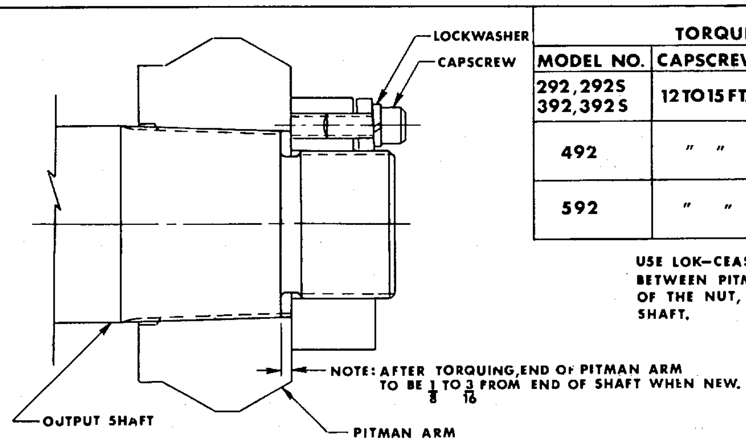
TORQUE SPECIFICATIONS

MODEL NO.	WASHERS	BOLT NO.	TORQUE BOLT TO:	
292, 292 S 392, 392 S	2261521 2261611	181441 $\frac{1}{2}$–20 UNF X 2$\frac{3}{4}$ LG GRADE 5	85 FT. LBS.	115 N·M
492	2261571 2261621	181463 $\frac{9}{16}$–18 UNF X 3" LG GRADE 5	160 FT. LBS.	217 N·M
592	2261581 2261631	271591 $\frac{5}{8}$–18 UNF X 3" LG GRADE 5	170 FT. LBS.	230 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD ON THREADS OF SETSCREWS (POINT (A)) AND BETWEEN WASHERS (POINT (B)).

TORQUE SET SCREWS TO 12 TO 15 FT. LBS. (16 TO 20 N·M)

SET SCREWS – PART NO. 2420791
HEX SOCKET HEAD
HALF DOG WITH ALLEN
NYLOK SPOT LOK.
2 REQUIRED AND SUPPLIED
WITH PITMAN ARM

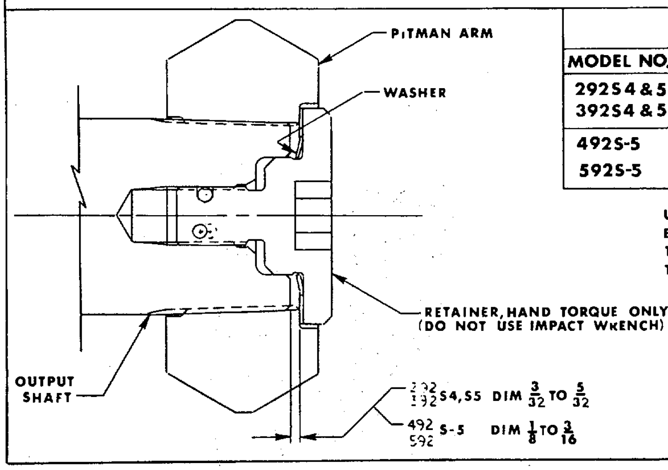


TORQUE SPECIFICATIONS

MODEL NO.	CAPSCREW TORQUE TO:		TORQUE NUT TO:	
292, 292S 392, 392S	12 TO 15 FT. LBS.	16 TO 20 N·M	285 FT. LBS.	386 N·M
492	" "	" "	675 FT. LBS.	915 N·M
592	" "	" "	775 FT. LBS.	1050 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN PITMAN ARM AND NUT; IN THE THR'DS. OF THE NUT, AND ON THR'DS. OF THE OUTPUT SHAFT.

CAPSCREW – HEX. SOCKET HEAD $\frac{5}{16}$-24 UNF X $\frac{3}{4}$ LONG



TORQUE SPECIFICATIONS

MODEL NO.	RETAINER NO.	WASHER NO.	TORQUE RETAINER TO:	
292S4 & 5 392S4 & 5	1790322	2261861	225 FT. LBS.	305 N·M
492S-5 592S-5	1790312	2261851	450 FT. LBS.	610 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN PITMAN ARM AND RETAINER, IN THE THR'DS. OF THE OUTPUT SHAFT, AND ON THE THR'DS. OF THE RETAINER.

R.H. SHEPPARD Co. INC.

Bleeding air from system

The steering gear by design is self bleeding; however, in some installations where the gear is positioned at an odd angle or where the piston does not make a full stroke in the cylinder bore air can be trapped in the steering gear. To avoid this possibility the air should be bled from the system anytime the oil has been changed or the steering system is repaired.

After reinstalling the steering gear on the vehicle but prior to connecting the drag link to the pitman arm, bleed the air from the steering system in the following manner:

1. Fill pump reservoir with recommended oil. It will be necessary to continue filling after starting the engine and during the bleeding operation until correct oil level is maintained.
2. Set parking brake or block wheels. Start engine and allow it to operate at fast idle speed.
3. With engine running, turn steering wheel from left to right and return making three complete cycles to remove all air from the steering system.
4. Stop engine. Reconnect the drag link.

Following these procedures will ensure that the piston bottoms in both directions of steer, opens the relief valve in the piston, and allows the air to escape to the reservoir and into the atmosphere. (A)

Check and adjust the relief valve plungers as required

Adjusting relief valve plungers

The relief valve plunger adjustment is provided to automatically reduce the steering pressure when the road wheels have reached their limits of turn. This keeps the supply pump from operating at maximum relief pressure when the road wheels are at their steering limits. System temperatures are therefore reduced and high stress loads on the mechanical components of the steering system are relieved.

High-pressure oil at either end of the piston will push the relief ball valve off its seat and fill the relief passage with oil at high pressure. At the opposite end of this passage the relief ball valve is held against its seat and holds the high pressure in the relief passage. As the piston moves close to its limits of stroke, the adjustable relief plungers push the relief ball valve off its seat and the pressure is relieved. The distance the piston can move is dependent upon the total front axle/steering system geometry and tire size. The relief valve plungers are adjustable to allow for variations or changes in these areas.

Adjust the relief valve plungers as follows:

1. Start the engine and allow it to operate at idle speed.
2. With full weight of the vehicle on all wheels, turn the steering wheel in one direction until a high-pressure hiss is heard or the axle stops contact.
3. Turn the relief valve plunger in or out until the high-pressure hiss is heard when there is 1/8 to 3/16 inch clearance between the axle stops. (B)
4. Repeat this procedure for the opposite direction of steer, and adjust the relief valve plunger on the opposite end of the steering gear.

Turning the plungers in will increase the space between the axle stops. Turning the plungers out will decrease the clearance between the stops. Do not turn the slotted plungers out beyond flush with the plunger boss or a leak will occur. Axle stops should only be adjusted in accordance with the vehicle manufacturer's specifications.

After relief valve plunger adjustment always check to ensure that the road wheels and tires have adequate clearance between suspension, brake and frame components.

FINAL ADJUSTMENTS - STEERING GEARS WITH MITER INPUT

Fixed Miter Gears - Relief Valve Plunger Adjustment

Steering gears using the fixed location miter gear arrangement have a nonadjustable relief plunger in the miter end of the steering gear. Proper relief adjustment can be made by lengthening or shortening the drag link. Relief plunger adjustment for the opposite end of the steering gear are made by adjusting the relief plunger as detailed in the foregoing paragraphs.

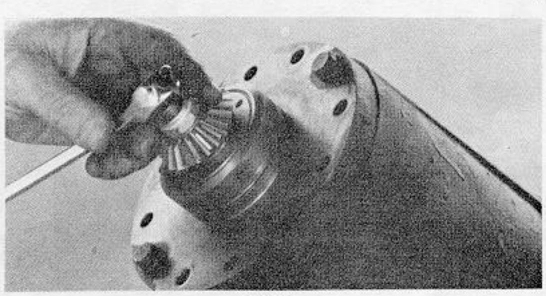
Swivel Miter and "T" Box Meter Relief Valve Plunger Adjustment

The relief valve plunger used with the swivel and "T" box miters uses an adjustable relief valve plunger. Access to this adjustment is gained by removing the two housing retaining clamps and lifting the housing off the steering gear bearing cap. To make the adjustment, the retaining clamp bars are reinstalled and the bolts are torqued to specifications. Start the engine and turn the actuating shaft using a socket and ratchet on the actuating shaft nut. Use a screwdriver to, turn the plunger in or out of the bearing cap until the proper clearance is obtained at the steering knuckle axle stop.

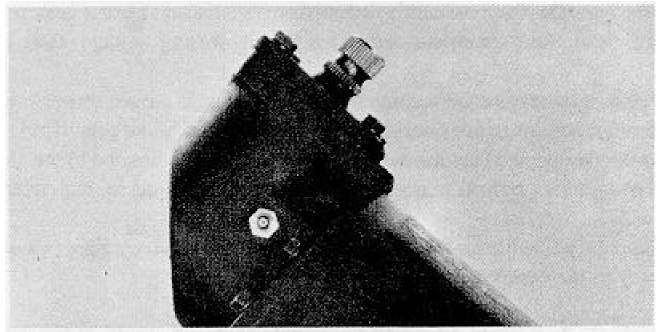
When the adjustment has been completed stop the engine and reinstall the miter housing at its original location.*

Note: The miter housing in most cases will be indexed to the bearing cap with a roll pin which passes through the clamping bar and enters a drilled hole in the miter housing. This ensures that the miter housing is placed in its optimum position. The locating pin will also keep the housing from turning in service. During reassembly make sure that the locating pin is properly installed.

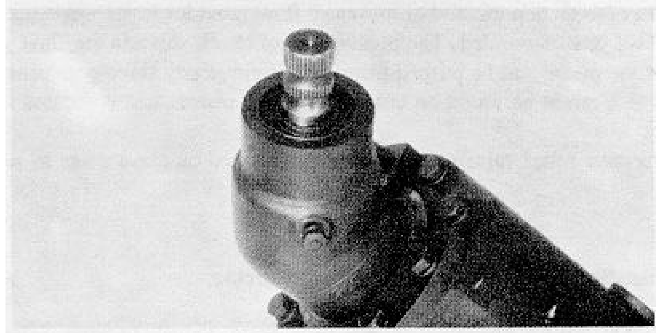
Caution: Retorque the actuating shaft nut to proper specifications as it may have loosened during the adjustment procedures. Torque the nut to 50 lb. ft.



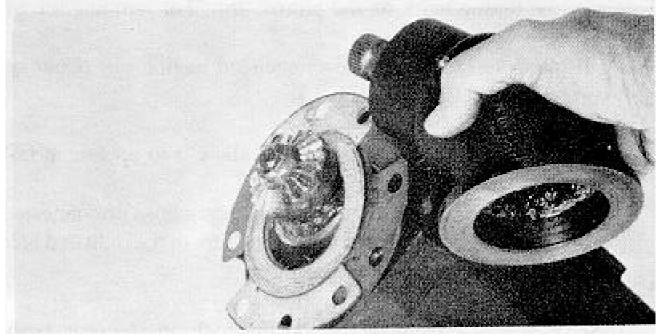
S-123



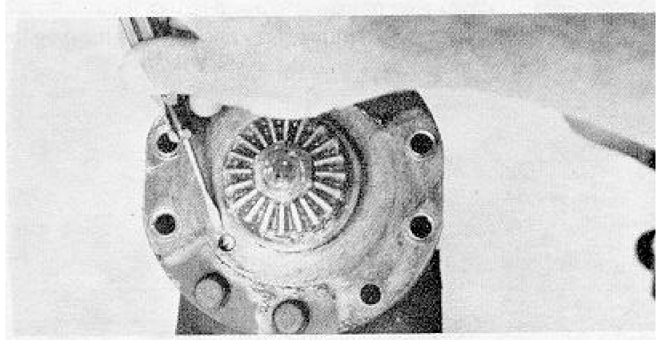
S-119



S-120



S-121



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DUAL STEERING SYSTEMS

Two integral steering gear units are sometimes used where high front axle loads or installation space limitations are encountered.

The secondary gear assembly differs from the master steering gear in that it does not have an actuating shaft, nor does the piston have an actuating valve. Both gears are connected to the steering linkage, drag links, pitman arms and rack and pinion gears.

Pressure to operate the secondary,. or slave gear, is passed through ports in the cylinder head and bearing cap of the master gear and is routed through high-pressure lines to the proper end of the slave gear. Thus, as the actuating valve of the master gear is moved to cause pressure build up on the piston of the master gear, pressure is also directed to the slave gear piston. Fig. I illustrates a typical dual steering gear layout. Fig. 2 illustrates a typical master gear and slave gear used in dual steering gear installations.

Fluid exhausted from the low pressure end of the master gear is routed through the low pressure pinion gear area of the slave gear and ther back to the reservoir.

Early production dual gear systems routed the exhaust fluid from the master gear pinion gear area directly to the reservoir. Later systems route the exhaust fluid from the pinion gear area of the master gear through the pinion gear area of the slave gear and then to the reservoir. The later production method of oil return flow provides faster warm up of the slave gear and offers further assurance that air entrapment in the slave gear is avoided. The pressure relief check valve in the slave gear piston also allows entrapped air to escape to the low pressure side of the piston and be purged from the system. Early slave gear pistons have two check valves. Present versions have only one check valve which might be found on either end of the piston, and is located in the piston end plug.

Pressure relief valve plungers are not required on slave gears as pressure relief is provided by the master gear.

Bleeding Air From System Dual Steering

To bleed the air from the steering system on the vehicle after installing the steering gears, the pitman alms may be installed if there is no clearance problem with the pitman arm striking any object using the full travel of the gear. Install them by aligning the timing mark on output shaft with the timing mark on the pitman arm. For torquing see pitman arm torquing assembly. Then proceed in the following manner.

1. Fill pump reservoir with recommended engine oil. (Continue filling after starting engine and during the bleeding operation until correct oil level is maintained.)

2. Set parking brake. Start engine and allow it to operate at fast idle speed.

3. (See Figs. I &, 2) With engine running, drag links disconnected, turn steering wheel to the left and hold until the secondary (slave) gear pitman arm moves the full travel. Then turn to the right and hold until the secondary (slave) gear pitman arm again moves the full travel, repeat this process three or more times.

4. (See Figs. I & 2) Connect the drag link to the master gear. Do not connect the secondary (slave) gear drag link at this time. Turn steering wheel to the left and hold until the secondary (slave) gear pitman arm moves the full travel. Then turn to the right and hold until the secondary (slave) gear pitman arm again moves the full travel. Repeat this process three or more times. Turn the steering wheel until the secondary (slave) gear pitman arm lines up with the drag link. Then install the pitman arm. (DO NOT move the pitman arm by hand or air will be pulled back into the system.)

DUAL SYSTEMS

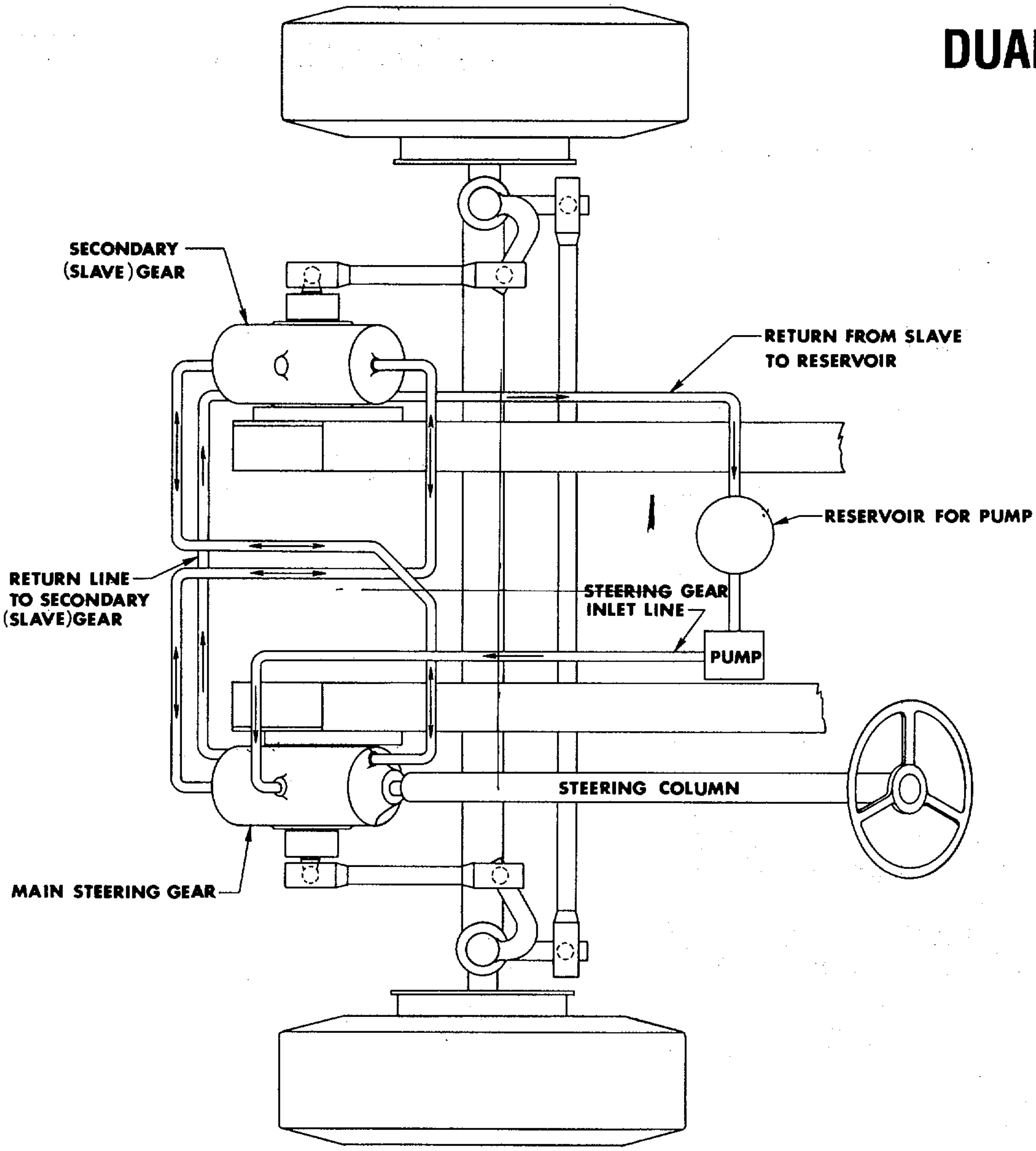


FIG. 1

MAIN GEAR

SECONDARY GEAR

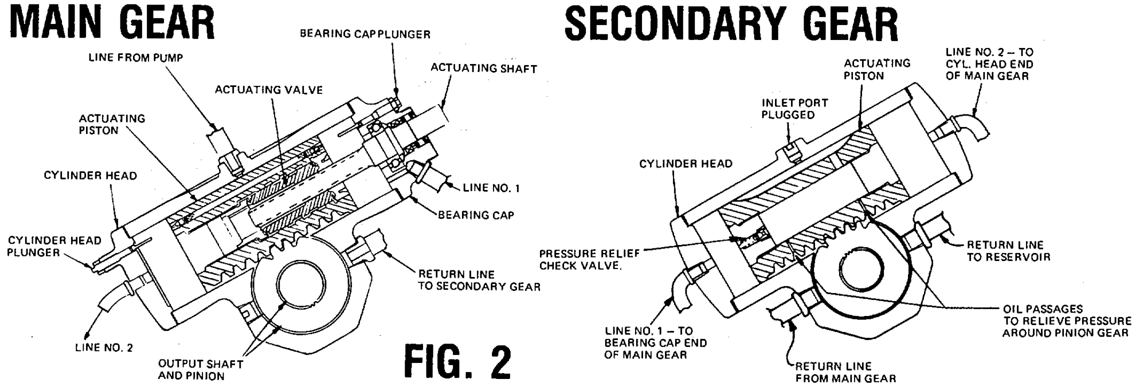


FIG. 2

INTEGRAL SLAVE GEARS

The Sheppard Integral Slave Gears are quite simple in operation and require few repairs.

The major components in the slave gear are the power piston and the pinion gear/output shaft assembly.

Disassembly of the slave gear requires the removal of the cylinder heads and the pinion cover or mounting bracket.

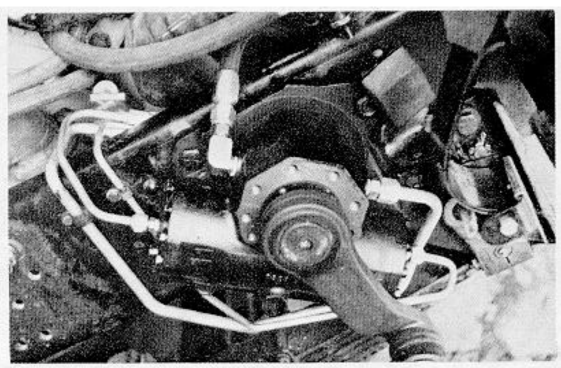
The pinion gear/output shaft assembly is removed and the piston is pulled out of the housing bore.

The output shaft bearings are serviced using the same procedures used for the master gear.

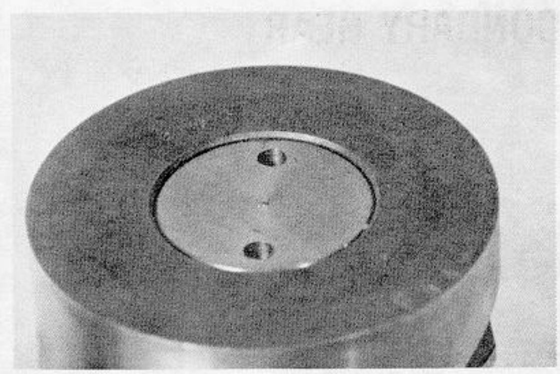
On reassembly the timing marks on the piston rack and the pinion gear must be carefully timed.

Some slave gear models use seal rings on the ends of the power piston.

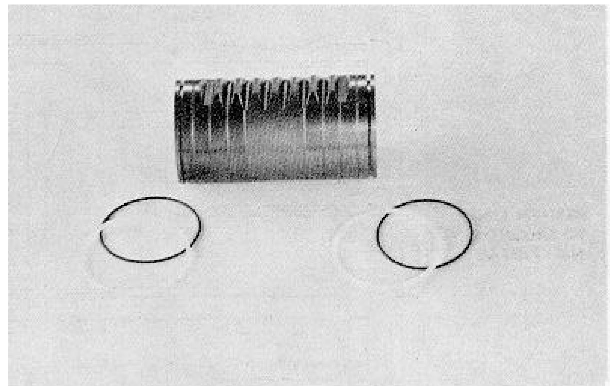
New seals are installed by placing the 0-ring expander in the piston groove and installing the square cut seal ring over it.



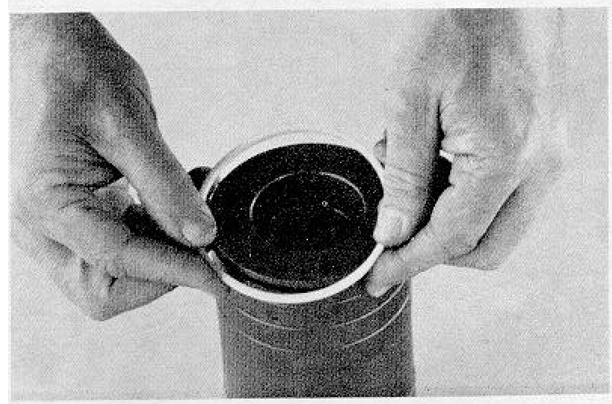
S-124



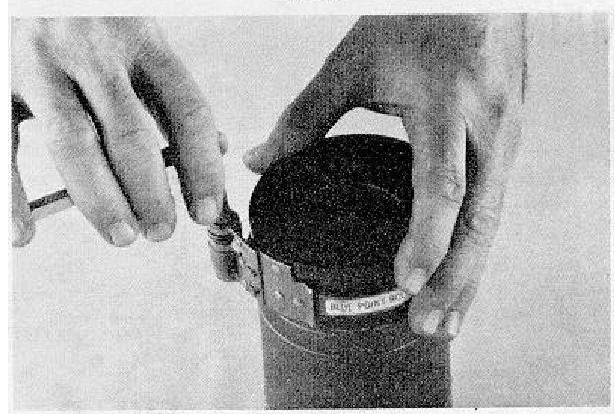
S-125



S-126



S-127



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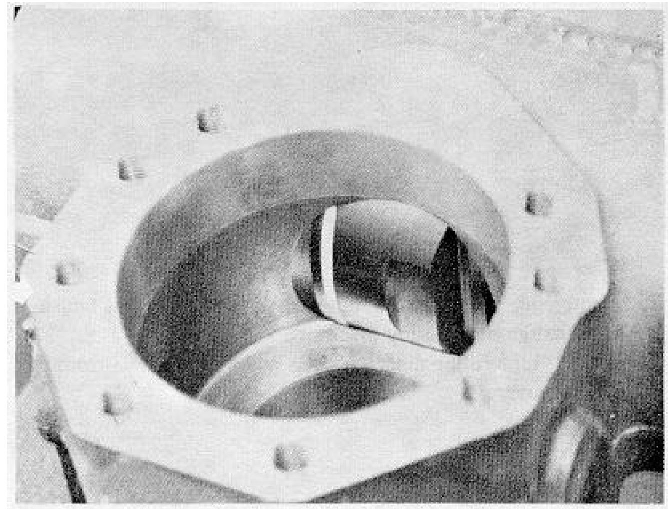
You will have to carefully work the piston ring past the pinion gear opening in the cylinder bore. While maintaining pressure on the end of the piston, use the blunt end of a wooden stick to press the piston seal into the ring groove. As the piston ring is compressed into the ring groove the piston will slide further into the bore until the piston ring has passed the pinion gear opening.



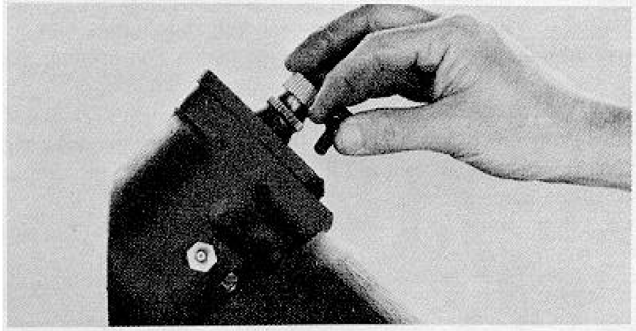
Note: Due to the nature of the seal material it will stretch as it is fitted to the ring groove. If you let the piston set with the seal rings in place they will contract and it will become easier to install it in the piston bore.

TORQUE SPECIFICATIONS

APPLICATION	SIZE	FT. LBS.
CYLINDER HEAD AND BEARING CAP	5/16-24NF	20
CYLINDER HEAD AND BEARING CAP	3/8-24NF	33
STEERING GEAR COVER (MOUNTED)	7/16-20NF	53
STEERING GEAR COVER (MOUNTED)	1/2-20NF	83
STEERING GEAR COVER (MOUNTED)	9/16-18NF	122
STEERING GEAR COVER (MOUNTED)	5/8-18NF	167
STEERING GEAR COVER (MOUNTED)	5/8- IINC	152
STEERING GEAR COVER (STANDARD)	7/16-20NF	36
STEERING GEAR COVER (STANDARD)	1/2-20NF	56
STEERING GEAR COVER (STANDARD)	9/16-18NF	81
STEERING GEAR COVER (STANDARD)	5/8-18NF	112
STEERING GEAR COVER (STANDARD)	5/8-1 INC	100
MITER ACT. SHAFT LOCK NUT		50

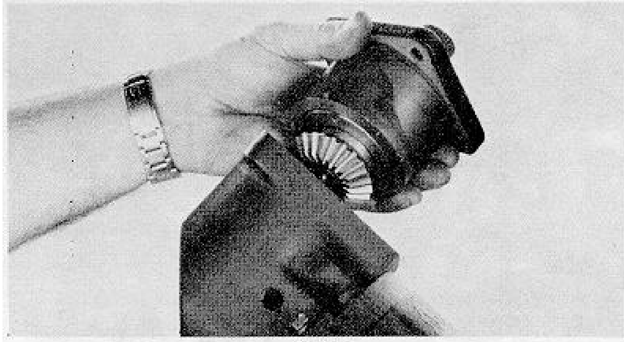
FIXED MITER- DISASSEMBLY & REPAIR

Make reference marks on the miter cover and the miter housing to aid in realignment during assembly. Remove the lube fitting and four bolts and lock washers from the miter shaft cover.



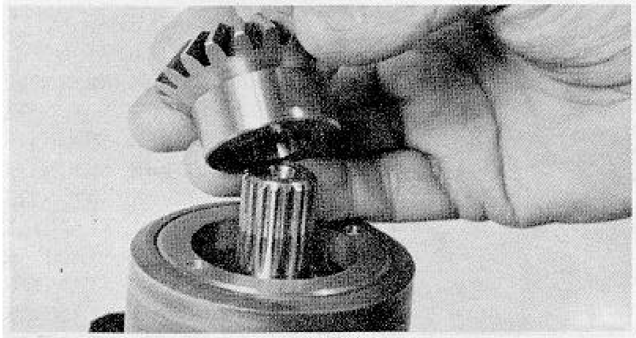
S-129

Carefully turn and pull miter shaft and cover from the miter housing.



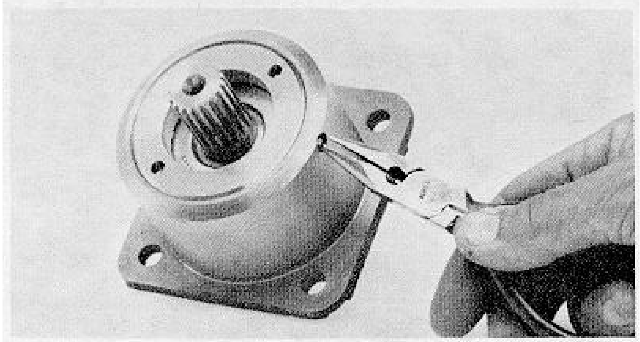
S-130

Drive roll pin from miter gear and pull gear off miter shaft. Remove shims/gaskets and lay aside.

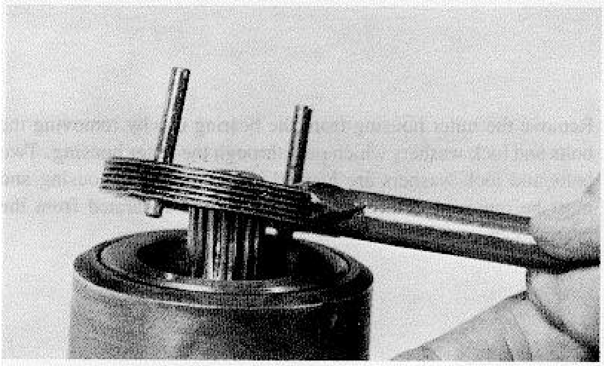


S-131

Pry locating pin out of the bearing retainer ring and pull from the cover.

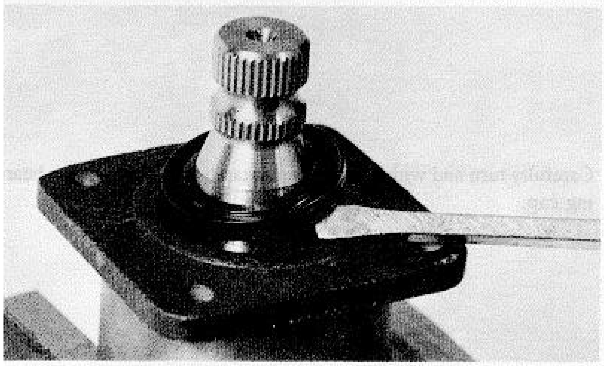


S-132



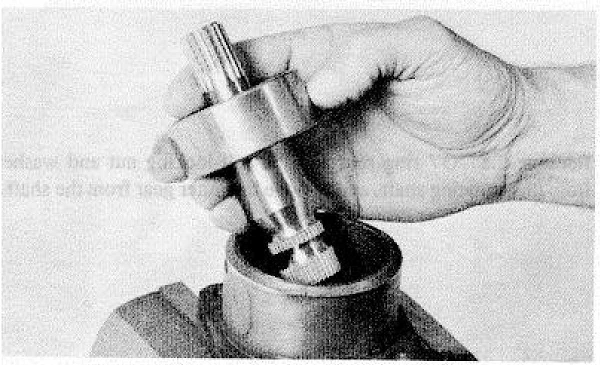
S-133

Turn bearing retainer counter clockwise to remove from the cover tap the miter shaft and bearing out of the miter cover.



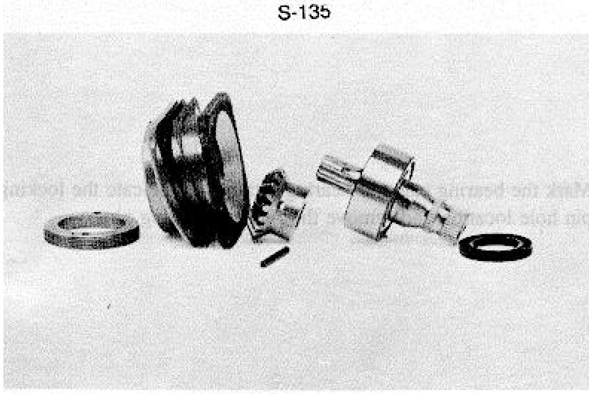
S-134

Remove seal from miter cover.



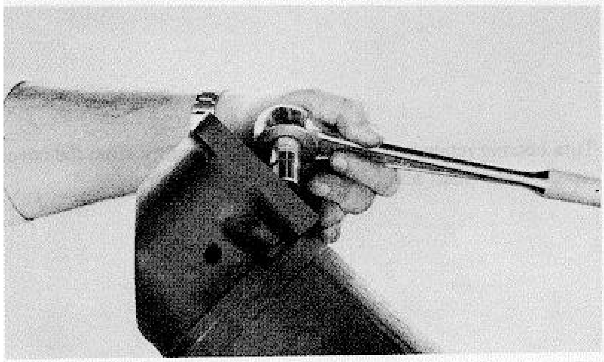
S-135

Carefully tap or press miter shaft out of the bearing.



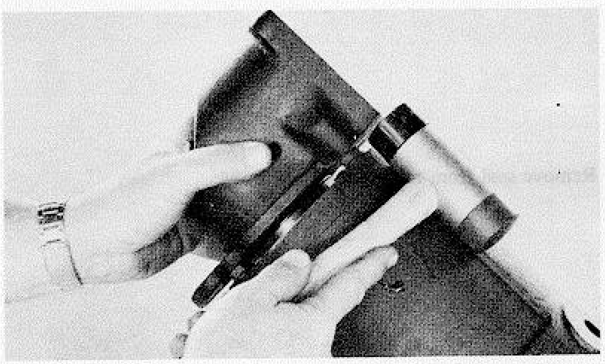
S-136

For reassembly, reverse the order of disassembly, installing new parts as required. The bearing retainer is tightened to remove any possibility of end play or movement. Reinstall the locating pin to lock the retainer to the miter cap. It may be necessary to drill a new hole through the cover into the retainer.



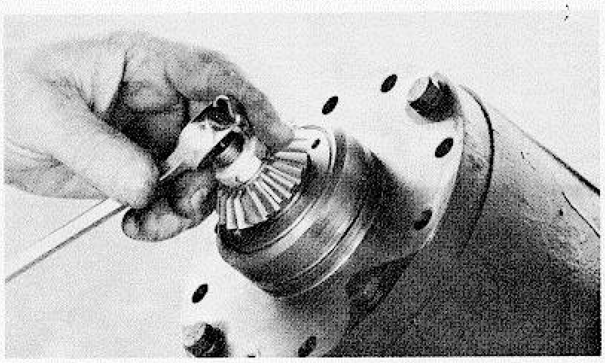
S-137

Remove the miter housing from the bearing cap by removing the bolts and lock washers which pass through the miter housing. Two bolts and lock washers are located inside the miter housing and must be removed before the housing can be separated from the bearing cap.



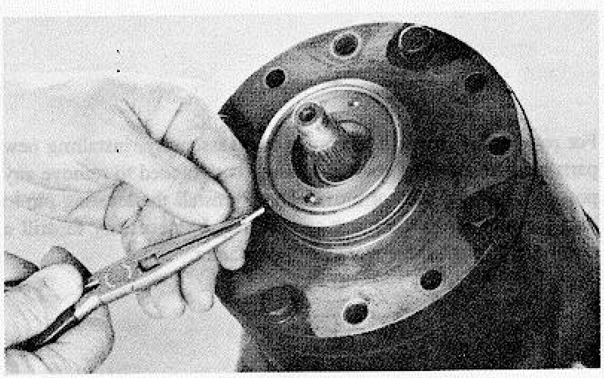
S-138

Carefully turn and with a soft hammer tap the housing off the bearing cap.



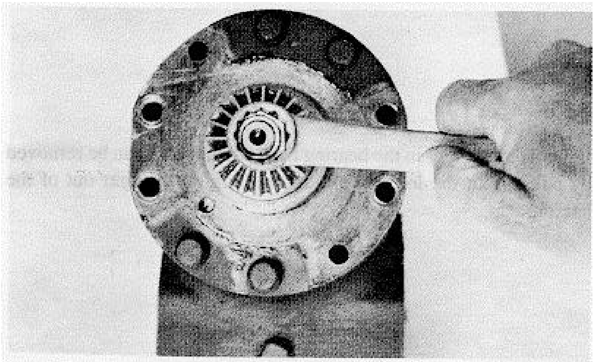
S-139

Remove the "O" -ring seal and the self-locking nut and washer from the actuating shaft, and remove the miter gear from the shaft.



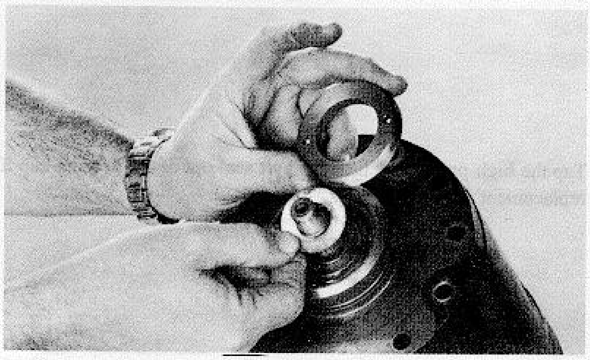
S-140

Mark the bearing cap and bearing retainer to indicate the locking pin hole location and remove the retainer locking pin.



S-141

Remove bearing retaining nut from the bearing cap.

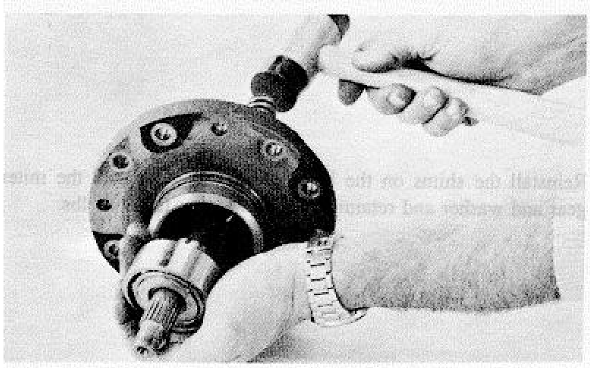


S-142

Remove the shims laying on top of the bearing and lay aside for reuse.

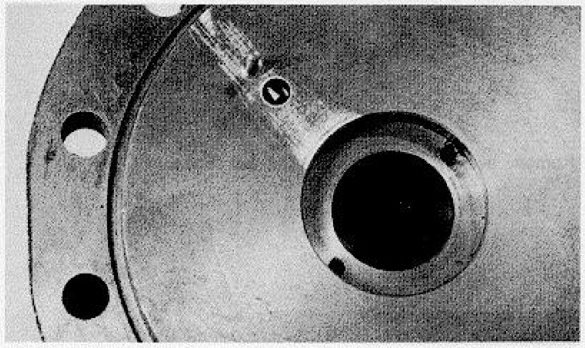
S-143

Remove remaining bolts and lockwasher attaching the bearing cap to the steering gear housing. Turn the actuating shaft and bearing cap out of the steering gear.



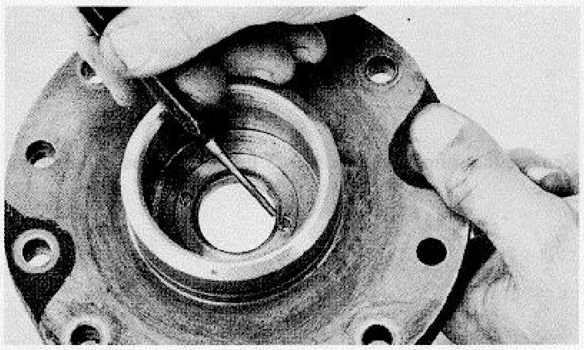
S-144

Carefully tap or press the actuating shaft and bearing out of the bearing cap. If necessary for replacement press the bearing off the actuating shaft.



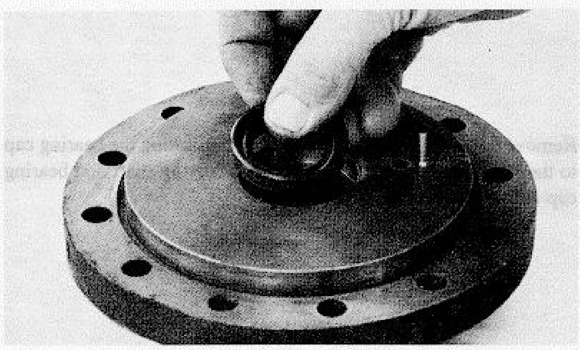
S-145

If the fixed plunger in the bearing cap is damaged it can be removed by pulling out the locking pin and pulling the plunger out of the bearing cap.



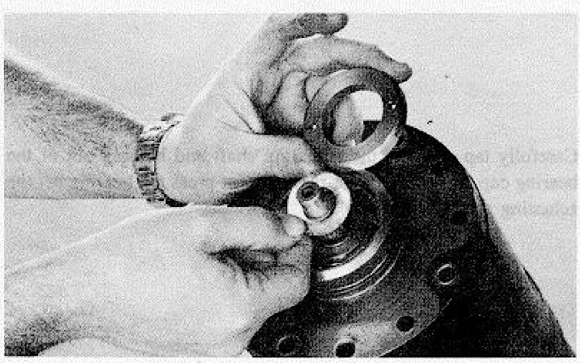
S-146

Tap the high-pressure actuating shaft seal out of the bearing cap if replacement is required.



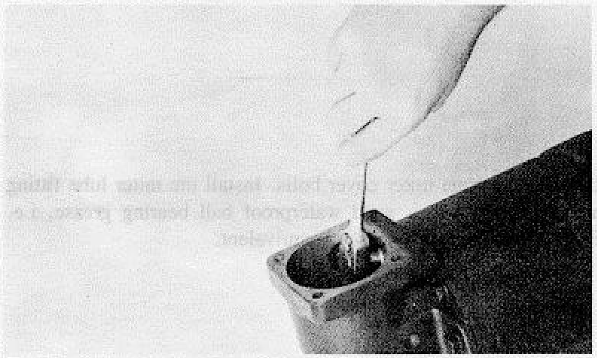
S-147

Press a new seal in the bearing cap with the lip of the seal facing inside. Carefully install the actuating shaft and bearing through the seal and into the bearing cap. Replace bearing retainer and install locking pin.



S-148

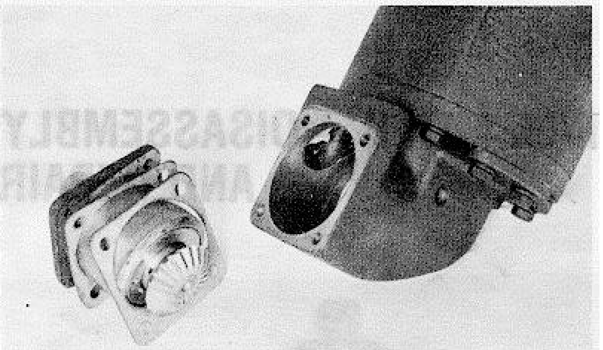
Reinstall the shimns on the bearing surface and install the miter gear and washer and retaining nut and torque to 60 ft. lbs.



S-149

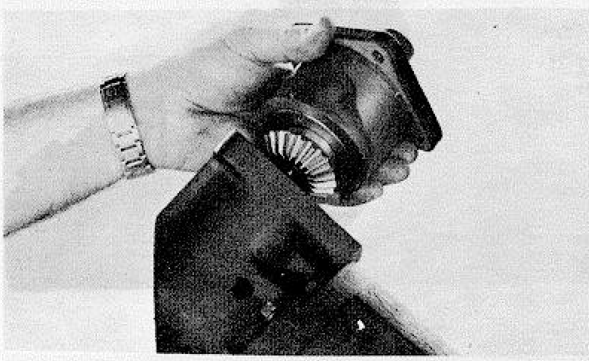
Reinstall the miter housing to the bearing cap.

Caution: Do not neglect to reinstall the bolts and lockwashers inside the miter housing. Torque all bolts to specifications.



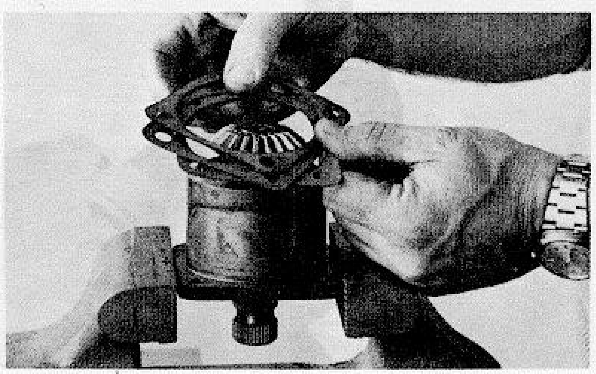
S-150

Reassemble miter housing cover using new gaskets and seals as required. Realign all reference marks made during disassembly and install all locking pins.



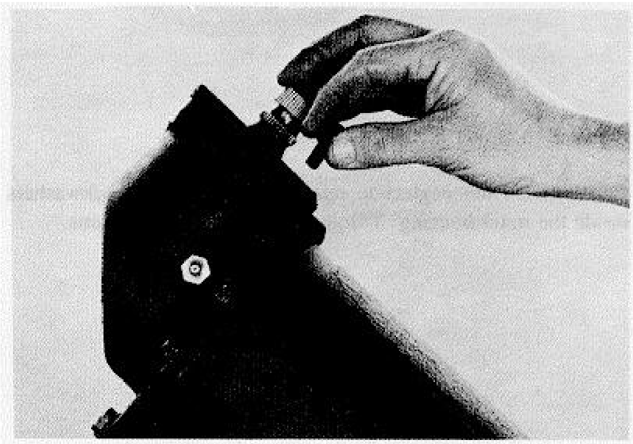
S-151

Install the reassembled miter cover into miter housing with shim pack/gaskets removed during disassembly and secure with two bolts and lockwashers.



S-152

Check back lash between miter gears by turning the miter shaft with your fingers. Add or remove miter cover shims until zero backlash is obtained. The miter gears should be dry and free of grease for this adjustment.

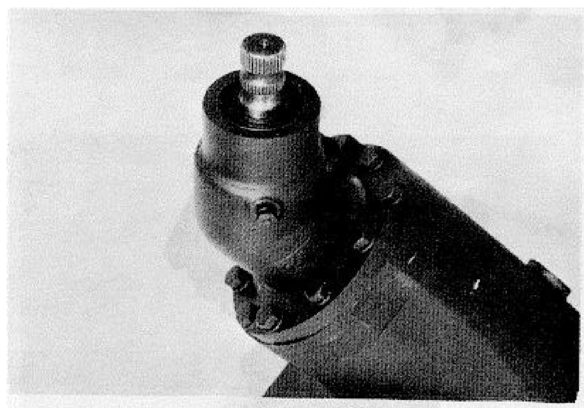


S-153

Install and torque miter cover bolts. Install the miter lube fitting and fill miter with a good waterproof ball bearing grease, i.e. Fiske Multi Purpose Grease or equivalent.

SWIVEL MITER- DISASSEMBLY AND REPAIR

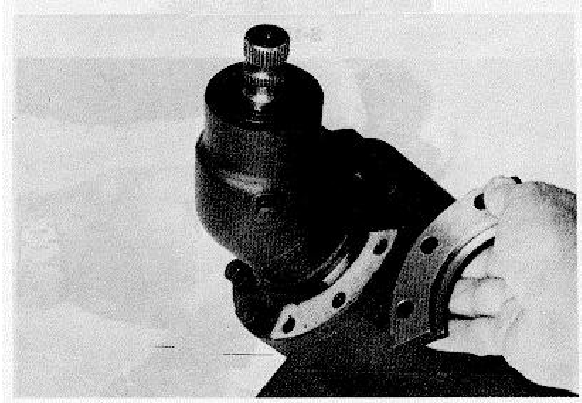
The miter housing on the swivel miter input arrangement of the Sheppard Integral Power Steering Gear can be turned a full 360 degrees and clamped in the most desirable design location to compliment the steering column and U-joint angles.



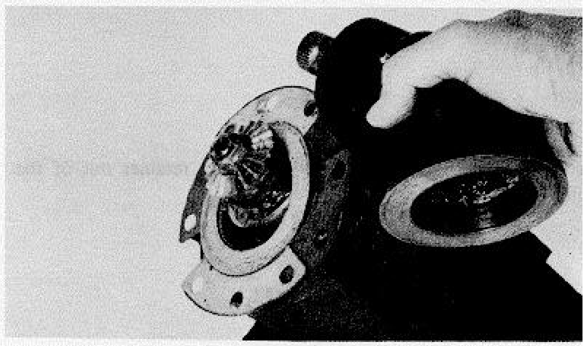
S-154

A clamping bar on each side of the miter housing clamps the housing to the bearing cap. Three bolts pass through each bar and the bearing cap and thread into the steering gear housing.

Caution: The steering should not be operated with these bolts removed or loosened. High operating pressures may damage the bearing cap or bearing cap seals.



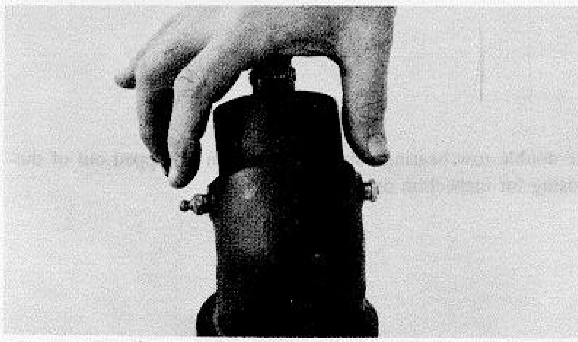
S-155



S-156

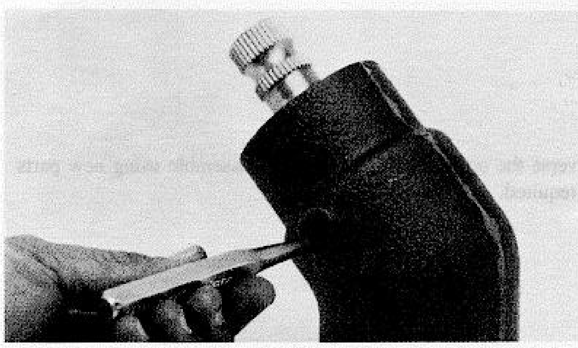
To remove the miter housing from the steering gear, the clamping bars are both removed and the miter housing and gasket/shim pack can be lifted off the bearing cap.

Note: The miter housing to bearing cap position should be marked so that it can be reinstalled in its original location. Some steering gear models will have a roll pin through the clamping bar and into the miter housing to index it to its design position. In this case it is important that the clamping bar is reinstalled in the same position so that the roll pin can be reinstalled.



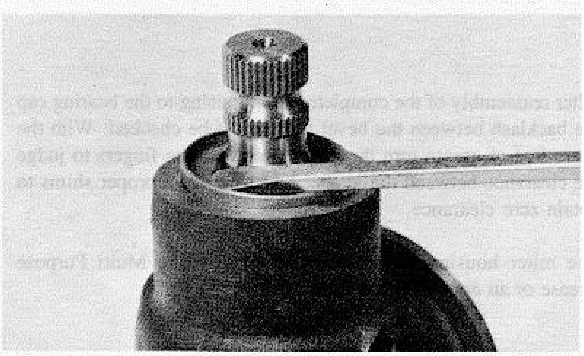
S-157

The miter housing can now be serviced. Remove the lube fitting and the relief fitting on the opposite side of the housing.



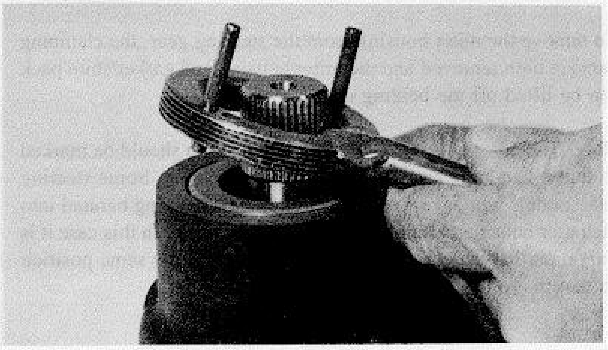
S-158

Turn the input shaft and line up the roll pin with the openings in the miter housing. Use a drift punch and hammer to drive the roll pin out of the miter gear and input shaft. The roll pin must be pushed through the hole in the opposite side of the housing. The miter gear can now be pried off the input shaft and the shaft can be tapped out of the housing and bearing assembly.



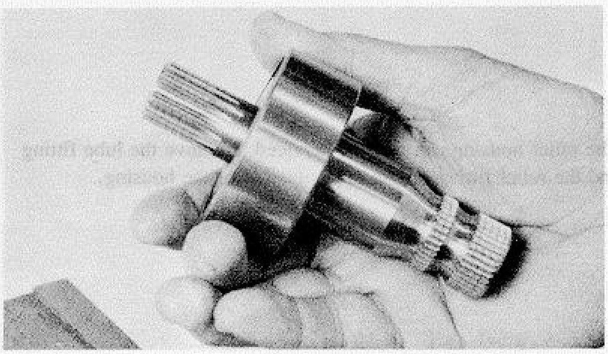
S-159

Lever the oil seal out of the input shaft end of the miter housing.



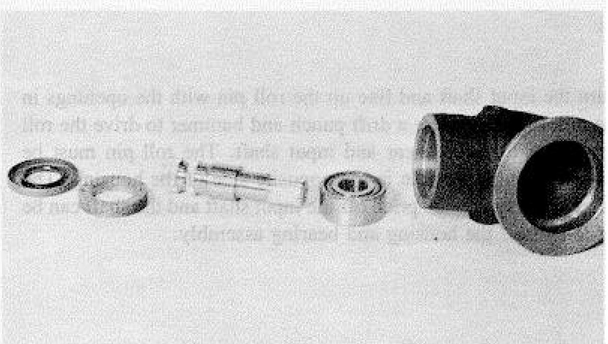
S-160

Use a spanner wrench to turn the bearing retainer out of the miter housing.



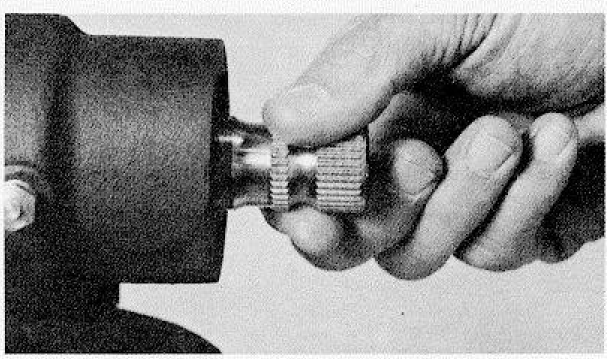
S-161

The double row bearing can now be drawn or tapped out of the housing for inspection or replacement.



S-162

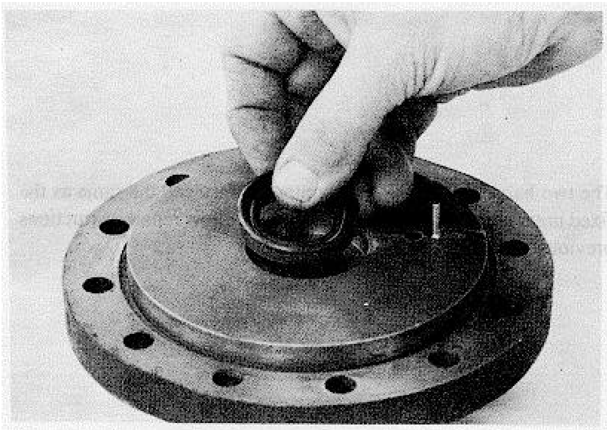
Reverse the order of disassembly to reassemble using new parts as required.



S-163

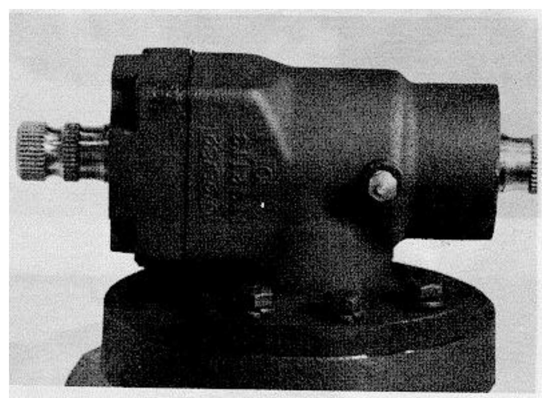
After reassembly of the complete miter housing to the bearing cap the backlash between the bevel gears must be checked. With the gears free of grease turn the input shaft with the fingers to judge the clearance between the gears. Add or remove proper shims to obtain zero clearance.

The miter housing should be filled with Fiske Multi Purpose Grease or an equivalent waterproof lubricant.


S-164

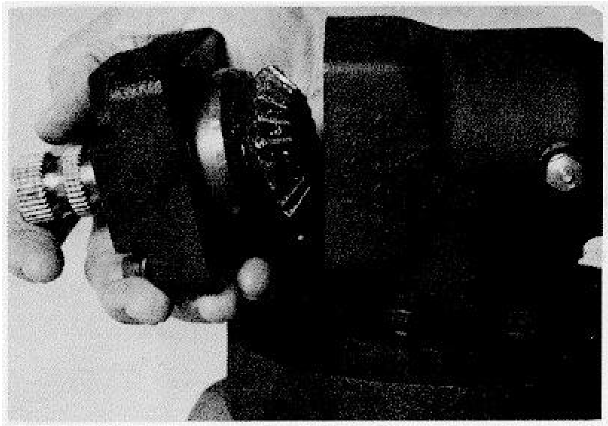
The steering gear bearing cap and high-pressure oil seal are serviced in the same manner as the fixed miter gear assembly. Refer to the fixed miter section of this manual for complete details..

T-BOX INPUT MITER- DISASSEMBLY & REPAIR


S-165

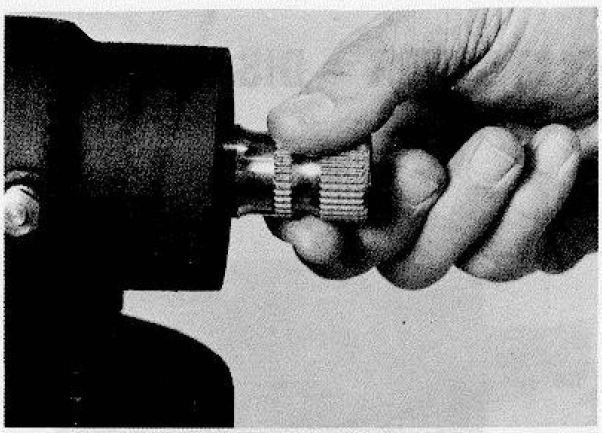
The Sheppard "T" box miter has two input shafts and is used where dual steering controls are desirable. The "T" box housing can be swiveled a full 360 degrees to place it in its optimum design position.

Note: The miter housing in most cases will be indexed to the bearing cap with a roll pin which passes through the clamping bar and enters a drilled hole in the miter housing. This ensures that the miter housing is placed in its optimum position. The locating pin will also keep the housing from turning in service. During reassembly make sure that the locating pin is properly installed.



S-166

The two halves of the "T" box miter are serviced the same as the fixed miter cap and the swivel miter cap. Follow repair instructions previously outlined.



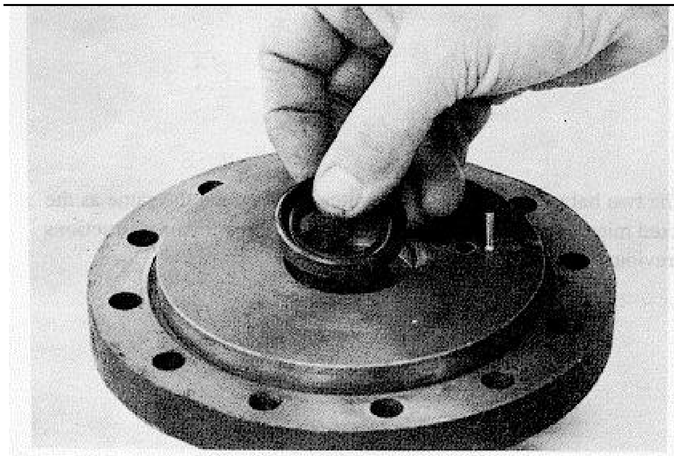
S-167

When the miter housing is reassembled to the steering gear the backlash must be adjusted to zero. Remove or install housing to bearing cap gaskets/shims to obtain zero backlash.

S-168

Once the miter housing is in place and the gear clearance has been checked and adjusted, the second input shaft and miter cap is installed. Again the gear clearance must be adjusted by removal or addition of gaskets/shims to obtain zero backlash.

Fill the miter housing with Fiske Multi Purpose Grease or an equivalent waterproof lubricant until a small quantity comes out the relief valve opposite the lube fitting.



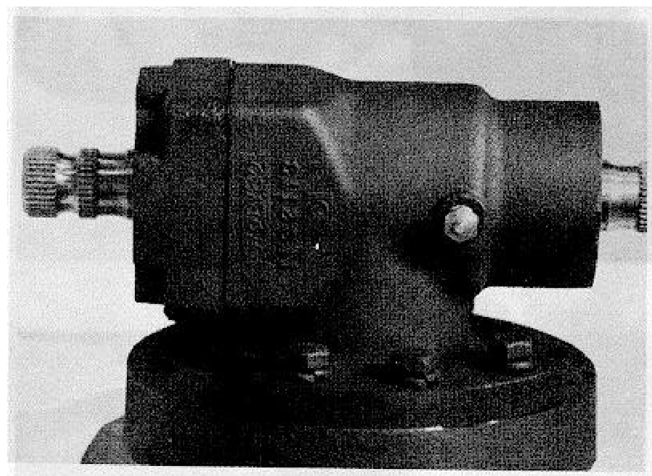
S-164

The steering gear bearing cap and high-pressure oil seal are serviced in the same manner as the fixed miter gear assembly. Refer to the fixed miter section of this manual for complete details..

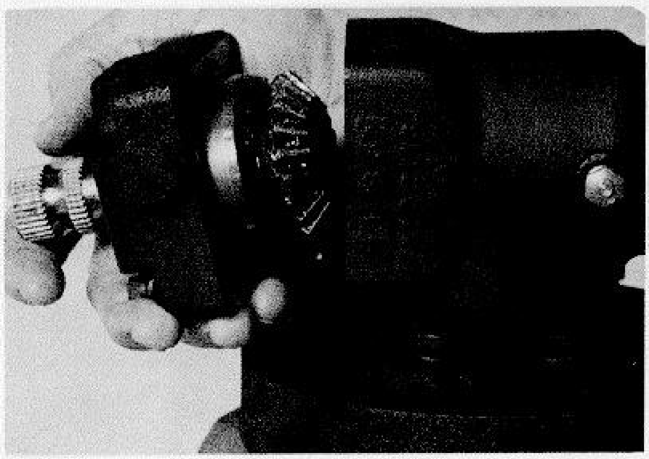
T-BOX INPUT MITER- DISASSEMBLY & REPAIR

The Sheppard "T" box miter has two input shafts and is used where dual steering controls are desirable. The "T" box housing can be swiveled a full 360 degrees to place it in its optimum design position.

Note: The miter housing in most cases will be indexed to the bearing cap with a roll pin which passes through the clamping bar and enters a drilled hole in the miter housing. This ensures that the miter housing is placed in its optimum position. The locating pin will also keep the housing from turning in service. During re-assembly make sure that the locating pin is properly installed.

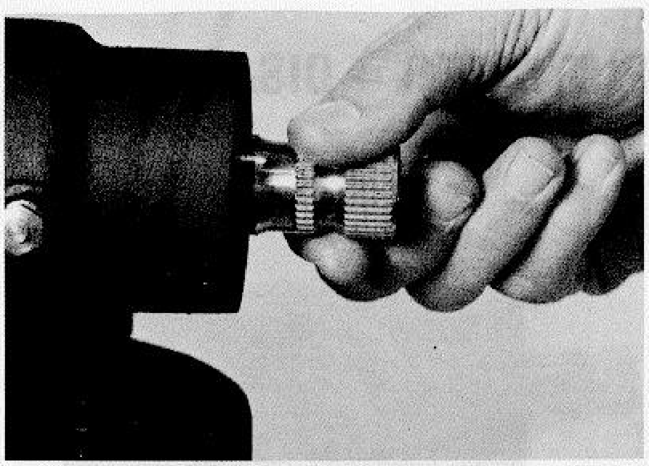


S-165



S-166

The two halves of -the "T" box miter are serviced the same as the fixed miter cap and the swivel miter cap. Follow repair instructions previously outlined.



S-167

When the miter housing is reassembled to the steering gear the backlash must be adjusted to zero. Remove or install housing to bearing cap gaskets/shims to obtain zero backlash.

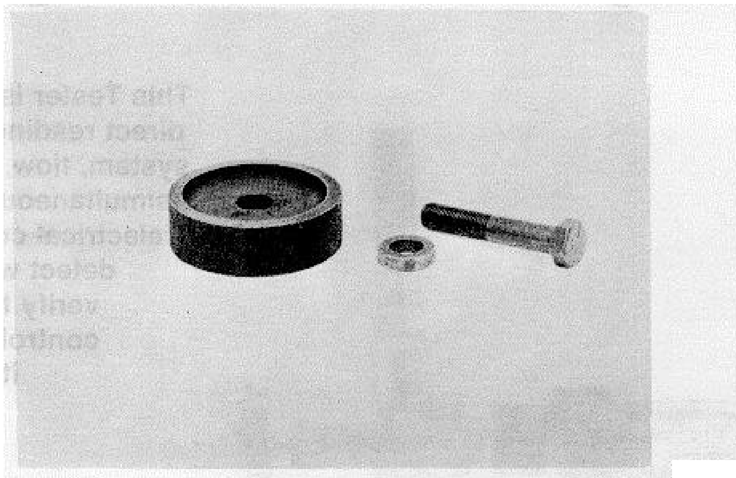
S-168

Once the miter housing is in place and the gear clearance has been checked and adjusted, the second input shaft and miter cap is installed. Again the gear clearance must be adjusted by removal or addition of gaskets/shims to obtain zero backlash.

Fill the miter housing with Fiske Multi Purpose Grease or an equivalent waterproof lubricant until a small quantity comes out the relief valve opposite the lube fitting.

Available from the R. H. Sheppard Co. Inc.

Pitman Arm Installation Tool Set



S-169

- **Easy to use - Assures accurate torque settings**
- **Fill your requirements now!**
- **A must for the busy shop!**

Model No.	Washer (Fig. 2)	Washer (Fig. 3)	Bolt (Fig. 1)	Part No.
191-192-292-39 252-292S-352-392S 372-382-392-491	2261611	2261521	181441 – ½ – 20NF x 2¾" Lg. Grade 5	Set No. 1
492 51-59	2261621	2261571	181463 – 9/16 – 18NF x 3" Lg. Grade 5	Set No. 2
592	2261631	2261581	271591 – 5/8 – 18NF x 3" Lg. Grade 5	Set No. 3

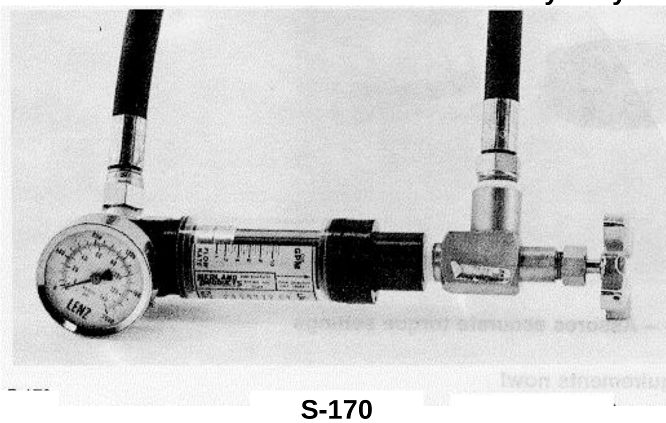
PHOTO COPY AND USE FOR ORDER FORM.

CUSTOMER'S ORDER NO.	DATE	OUR ORDER NO.

SOLD TO:	SHIPPED TO:

ITEM NO.	QTY. ORDERED	PART NUMBER	PART DESCRIPTION	UNIT PRICE	TOTAL
		Sets (S) 1, 2, 3	Pitman Arm Installation Tool Set		

Heavy-Duty Power Steering TEST KIT



S-170

This Tester is a self contained, direct reading device to check system, flow, pressure or both simultaneously. Requiring no electrical connections, it can detect worn components, verify flow and pressure control settings or monitor overall system performance.

LOW COST -

EASY TO USE -

Only one hose connection is broken, either at the pump output or at the pressure input to the power steering gear housing.

★ SHIPMENT FROM STOCK
★ INCLUDES SHEPPARD SERVICE MANUAL

* Installs between pump and steering gear
* Shutoff valve isolates pump from gear
* Pressure and flow can be read simultaneously
* 0-2000 P.S.I. pressure gauge
* 1-10 G.P.M. flow meter
* Complete with hoses & standard swivel fitting

PHOTO COPY AND USE FOR ORDER FORM.

CUSTOMER'S ORDER NO.	DATE	OUR ORDER NO.

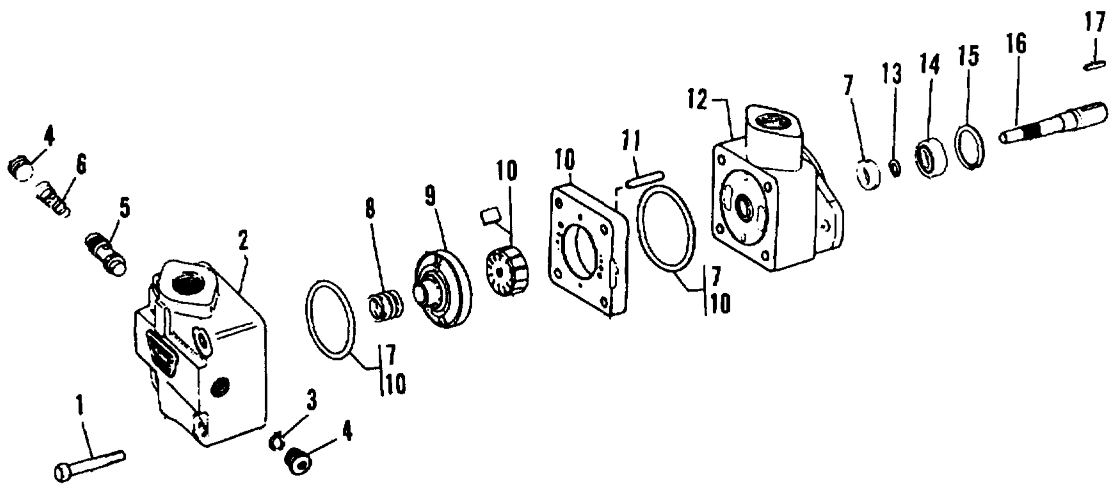
SOLD TO:	SHIPPED TO:

ITEM NO.	QTY. ORDERED	PART NUMBER	PART DESCRIPTION	UNIT PRICE	TOTAL
		5517641	Pressure and Flow Test Kit		

Includes Sheppard service manual with operating instructions

7605-5256 Power Steering Pump

Section IV
STERING SYSTEM

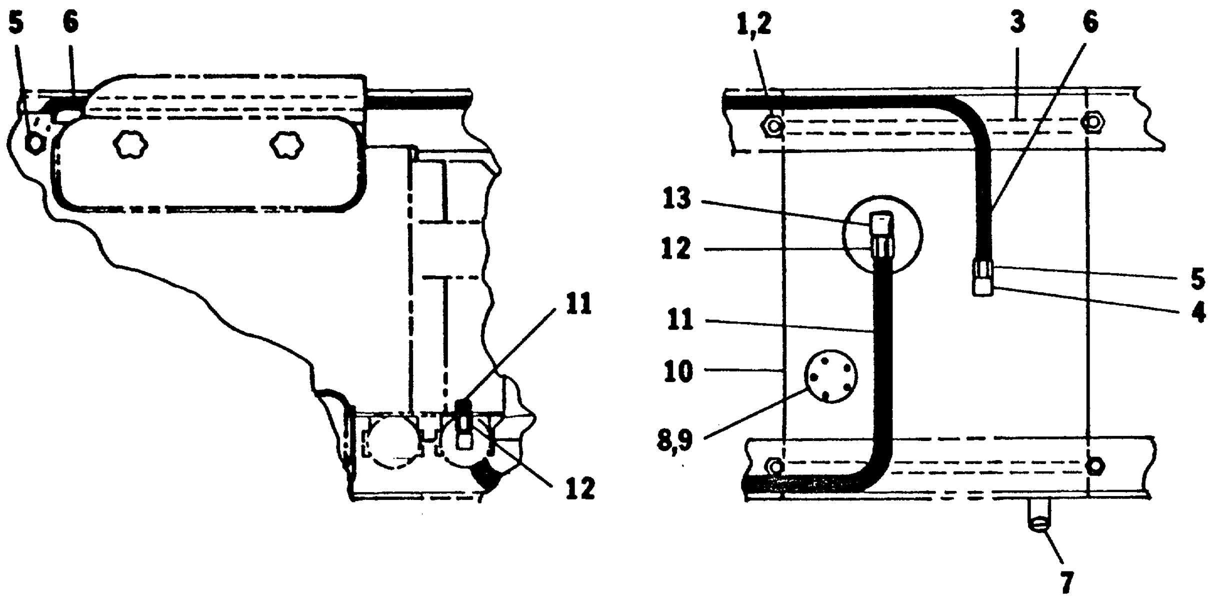


Item	Part No.	Description	Qty.
1	7605-7918	Hex Head Capscrew	4
2	7305-7919	Cover	1
3	7605-7920	Snap Ring	1
4	7605-7921	Plug	2
5	7605-7922	Control Valve	1
6	7605-7923	Spring	1
7	7605-7924	Seal Kit (Includes (2) O Ring and (1) Seal)	1
8	7605-7925	Spring	1
9	7605-7926	Pressure Plate (Includes Ring Brushing)	1
10	7605-7927	Cartridge Kit (Includes Ring, Rotor, Vane Kit (Consists of 12 Vanes) and (2) O Ring)	1
11	7605-7928	Pin	2
12	7605-7929	Body	1
13	7605-7930	Retaining Ring	1
14	7605-7931	Bearing	1
15	7605-7932	Retaining Ring	1
16	7605-7933	Shaft	1
17	7605-7934	Key	1

Note: Your chassis Vechicle Identification Number (V.I.N.), or Serial Number
on older chassis must be supplied when ordering replacement parts.

SECTION V

Section V



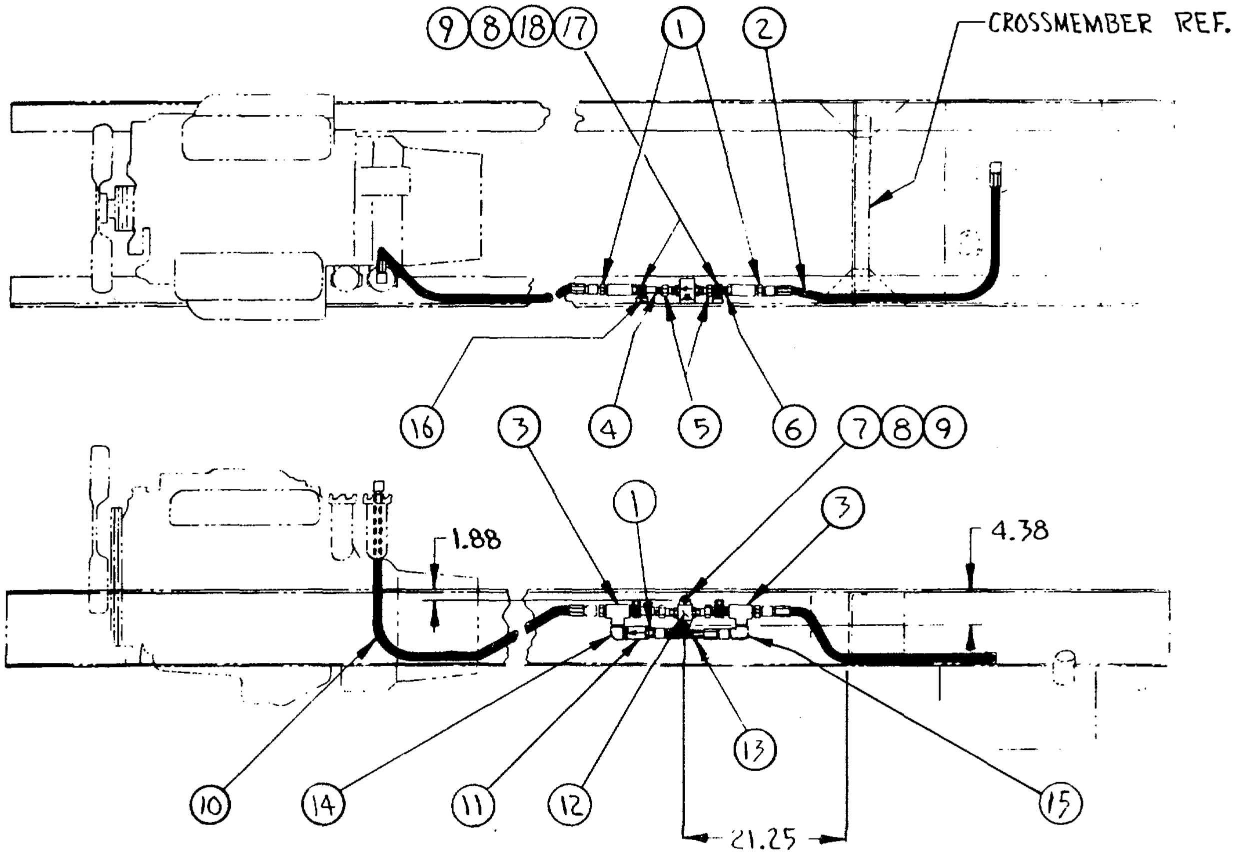
Item	Part No.	Description	Qty.
1	7603-1470	Lock Nut 1/2-20	4
2	7602-7938	Washer 1/2	4
3	7605-2422	Fuel Tank Strap, 50 Gal.	4
4	8874-3044	3/8 NPT to 1/2 Tube 90° Elbow	1
5	7602-6948	Hose Fitting, 1/2 Tube	2
6	7610-1781	1/2 I.D. Hose	A/R
7	7605-1921	Fuel Tank Cap	1
8	7810-3698	Fuel Level Sender	1
9	8203-5010	Gasket	1
10	7808-0916	Fuel Tank, 50 Gal.	1
11	7610-1782	5/8 I.D. Hose	A/R
12	7605-0497	Hose Fitting, 5/8 Tube	2
13	8874-3074	3/8 NPT to 5/8 Tube 90° Elbow	1
14	7605-1064	Fuel Tank, 100 Gal. (Not Shown)	1
15	7605-1185	Fuel Tank Strap, 100 Gal. (Not Shown)	4

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Section V
FUEL SYSTEM

Auxiliary Electric Fuel Pump

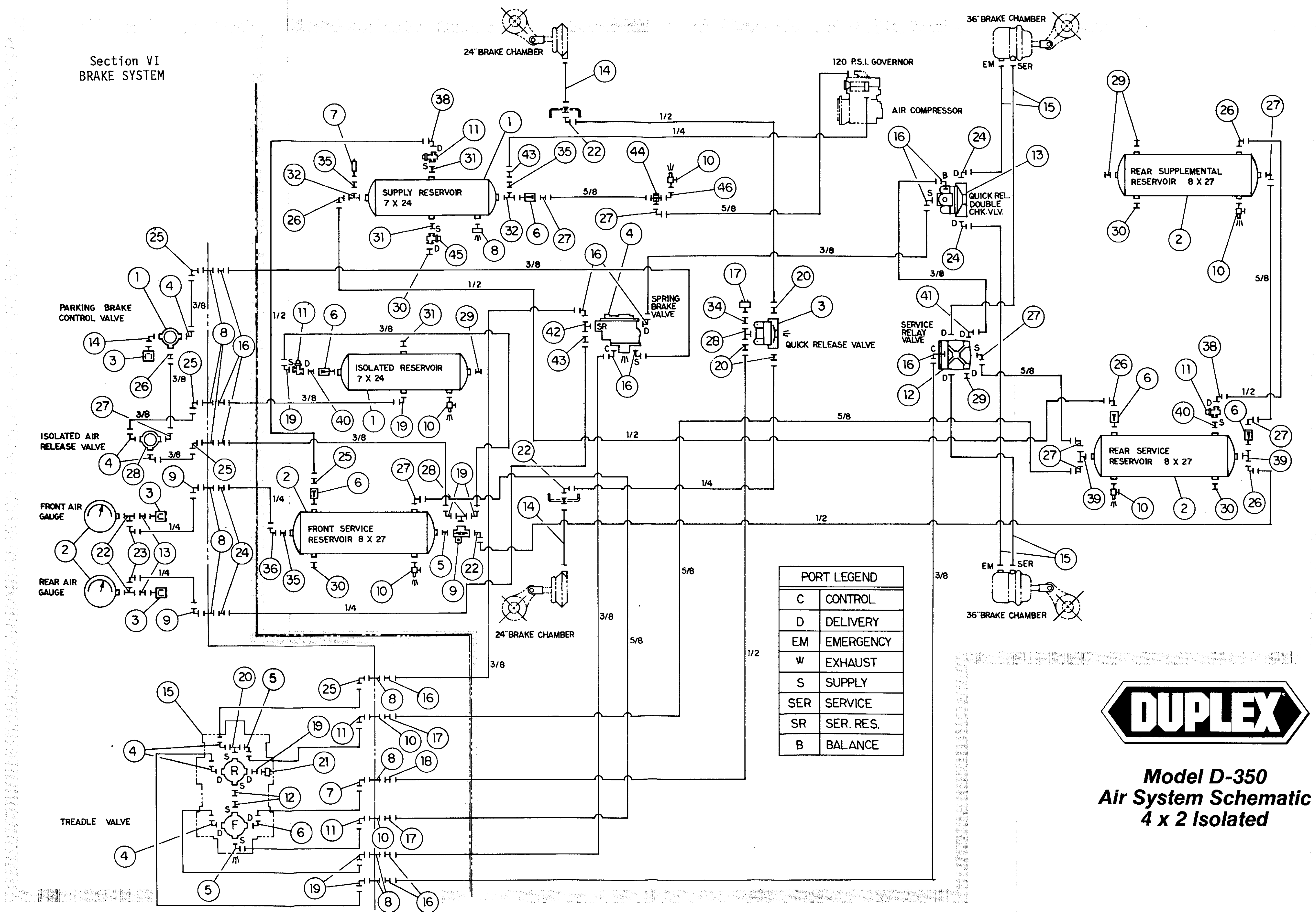
All Models



Item	Part No.	Description	Qty.
1	8874-3018	Adaptor	3
2	7604-6803	Hose Assembly	1
3	7604-6286	Tee	2
4	8870-1063	Nipple	1
5	7604-4513	Swivel	2
6	8870-1053	Nipple	1
7	8820-1005	Hex Head Capscrew	2
8	8855-1009	Lockwasher	4
9	8850-1004	Hex Nut	4
10	7604-6807	Hose Assembly	1
11	7604-3252	Check Valve	1
12	7604-5712	Fuel Pump	1
13	7604-6809	Hose Assembly	1
14	8871-1102	Elbow	1
15	8874-3074	Elbow	1
16	7604-6811	Spacer	2
17	7603-5121	Clamp	2
18	8820-1007	Hex Head Capscrew	2

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Section VI
BRAKE SYSTEM



PORT LEGEND	
C	CONTROL
D	DELIVERY
EM	EMERGENCY
|||	EXHAUST
S	SUPPLY
SER	SERVICE
SR	SER. RES.
B	BALANCE

DUPLEX

Model D-350
Air System Schematic
4 x 2 Isolated

Model D-350
Air System Schematic
4 X 2 Isolated

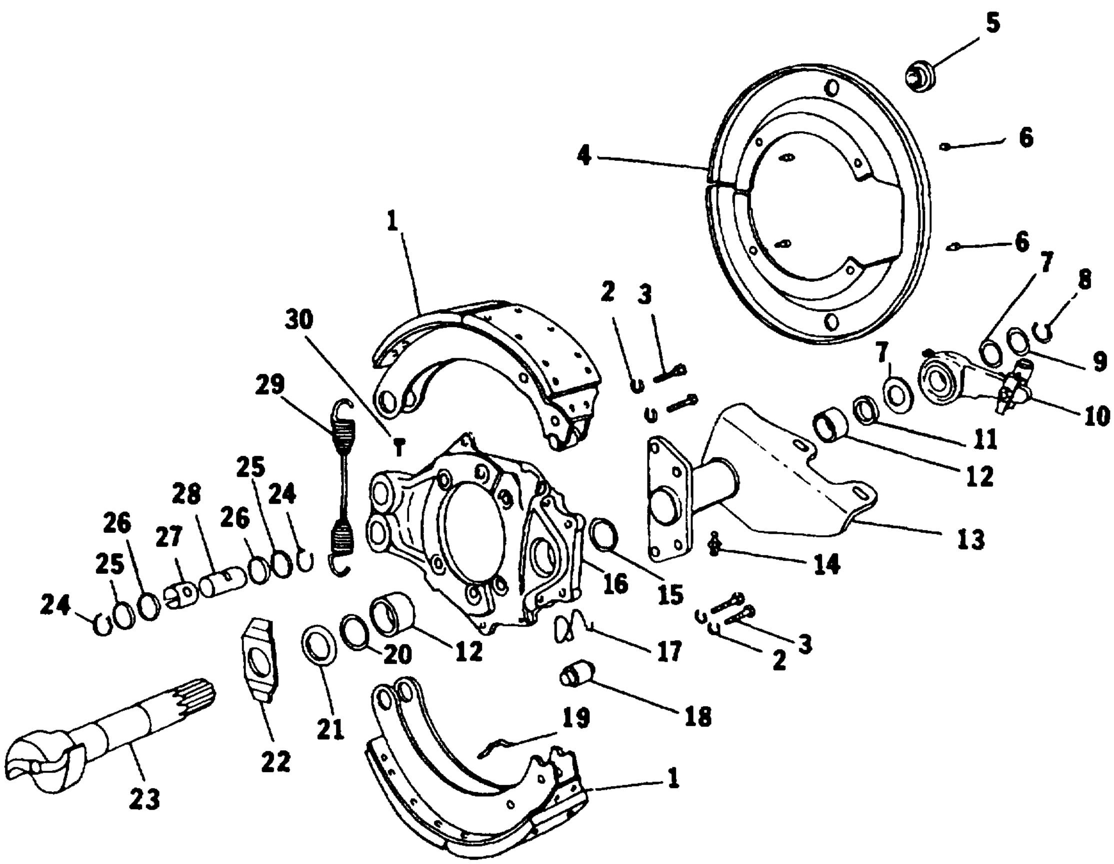
Section VI
BRAKE SYSTEM

Item	Part No.	Description	Qty
		CAB SECTION	
1	7811-3418	Parking Brake Valve	1
2	7604-7269	Air Pressure Gauge	2
3	7604-7305	Low Pressure Switch	3
4	7810-3453	3/8 Tube – 3/8 NPT 90° Elbow	6
5	7604-4297	5/8 Tube – 3/8 NPT 90° Elbow	2
6	7604-2398	1/2 Tube – 3/8 NPT 90° Elbow	1
7	7811-3648	1/2 Tube – 1/4 NPT 90° Elbow	1
8	7604-7257	1/4 NPT Bulkhead Union	9
9	7604-2413	1/4 Tube-1/4 NPT 90° Elbow	2
10	7605-3637	3/8 NPT Bulkhead Union	2
11	7604-4297	5/8 Tube – 3/8 NPT 90° Elbow	2
12	8871-1252	3/8 NPT Pug, Square Head	2
13	8871-1325	1/4 NPT-1/8 NPT Reducer	2
14	7605-3891	1/4 Tube – 1/8 NPT 90° Street Elbow	1
15	7605-3372	Treadle Valve	1
16	8127-7407	3/8 Tube – 1/4 NPT Straight	6
17	7811-3671	5/8 Tube – 3/8 NPT Straight	2
18	7605-0481	1/2 Tube – 1/2 NPT Straight	1
19	8871-2302	3/8 NPT- 1/4 NPT Reducer	3
20	7605-0506	3/8 NPT – Branch Tee	1
21	7811-3415	Stop Light Switch	1
22	7605-1104	1/8 NPT Street Tee	2
23	7604-2399	1/4 Tube – 1/8 NPT 90° Elbow	2
24	7605-2404	1/4 Tube – 1/4 NPT Straight	2
25	7604-2396	3/8 Tube – 1/4 NPT 90° Elbow	4
26	7604-2403	3/8 Tube – 1/8 NPT Straight	1
27	7604-2396	3/8 Tube – 1/4 NPT 90° Elbow	1
28	8126-0137	Isolated Air Release Valve	1
		MAIN SECTION	
1	7605-2811	Air Reservoir	2
2	7605-2812	Air Reservoir	3
3	7605-1663	Quick Release Valve	1
4	8688-3030	Spring Brake Valve	1
5	7605-3804	1/2 NPT – 3/8 NPT Reducer	1
6	7810-3575	Check Valve	5
7	8452-1057	Safety Valve	1
8	7810-3577	Automatic Drain Valve	1
9	8668-3293	Double Check Valve	1
10	7605-0492	Manual Drain Valve	5
11	7605-2815	Pressure Regulator	3
12	7605-2818	Service Relay Valve	1
13	7605-2816	Quick Release Double Check Valve	1
14	7811-3650	Brake Hose, 24"	2
15	7811-3670	Brake Hose, 36"	4
16	7604-2396	3/8 Tube – 1/4 NPT 90° Elbow	7
17	7811-3415	Stop Light Switch	1
19	7810-3453	3/8 Tube – 3/8 NPT 90° Elbow	4
20	7604-2394	1/2 Tube –3/8 NPT Straight	3
22	7604-2398	1/2 Tube – 3/8 NPT 90° Elbow	3
24	7605-3389	3/8 NPT – 1/2 NPT 90° Elbow	2
25	7605-0481	1/2 Tube – 1/2 NPT Straight	1
26	7811-3648	1/2 Tube – 1/2 NPT 90° Elbow	4
27	7810-3443	5/8 Tube – 1/2 NPT 90° Elbow	8
28	7605-0506	3/8 NPT Branch Tee	2
29	8871-1253	1/2 NPT Plug, Square Head	4
30	8871-1251	1/4 NPT Plug, Square Head	4
31	7605-1138	3/8 NPT – 1/4 NPT Reducer	3
32	7605-1183	1/2 NPT Street Tee	2
34	8871-2302	3/8 NPT – 1/4 NPT Reducer	1
35	8871-1384	1/2 NPT – 1/4 NPT Reducer	3
36	7604-2413	1/4 NPT – 1/4 NPT 90° Elbow	1
383	7810-3452	1/2 NPT – 1/4 NPT 90° Elbow	2
9	7605-0505	1/2 NPT Branch Tee	2
40	7605-1099	1/2 NPT –1/4 NPT Reducer	2
41	7605-3596	3/8 Tube – 1/2 NPT 90° Elbow	1
42	7605-3595	1/4 NPT Branch Tee	1
43	7605-2404	1/4 Tube – 1/4 NPT Straight	2
44	7605-2808	1/2 NPT Bracket Weldment	1
45	7810-3106	Pressure Regulator	1
46	8871-1103	1/2 NPT 90° Street Elbow	1

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis Must be supplied when ordering replacement parts.

Rear Breaks
16 ½ x 7 " P" Series
All Models

Section VI
BREAK SYSTEM



Item	Part No.	Description	Qty.	Item	Part No.	Description	Qty.
1		Break Shoe & Living Assembly	2	17		Retainer, Shoe Roller	2
2		Washer	4	18		Roller, Break Shoe	2
3		Capscrew	4	19		Pin, Break Shoe Return Spring	2
4		Dust Shield	1	20		"O" Ring	1
5		Inspection Plug	1	21		Seal, Camshaft	1
6		Capscrew	4	22		Washer, Camshaft	1
7		Washer, Spacing	AR	23	7605-5667	Camshaft, R.H.	1
8		Locking, Camshaft	1		7605-5668	Camshaft, L.H.	1
9		Washer, Spacing	AR	24		Lock Ring, Anchor Pin	4
10	7605-5665	Slack Adjusting	1	25		Retainer, Anchor Pin Felt	4
11		Seal, Camshaft	1	26		Felt, Anchor Pin	4
21		Brushing, Camshaft	1	27		Brushing, Anchor Pin	2
13	7605-2688	Break Chamber Bracket, L.H.	1	28		Anchor Pin, Break Shoe	2
	7605-2689	Break Chamber Bracket, R.H.	1	29		Return Spring, Break Shoe	1
14		Grease Fitting	1	30		Set Screw, Anchor Pin	2
15		Gasket, Chamber Bracket	1	31	7605-5669	Major Show Overhaul Kit (Incl. Items 1,18,24-30)	1
16	7605-5666	Break Spider	1				

NOTE: Your chassis Vehicle Identification Number (V.I.N.) or Serial Number on order chassis must be supplied when ordering replacement parts.

Bendix

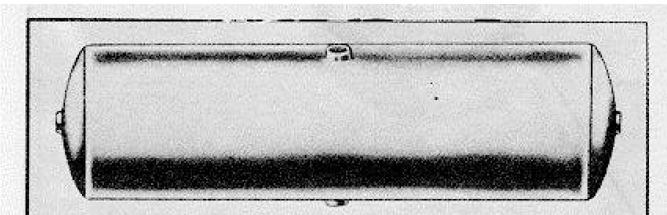
Heavy Vehicle Systems Group

Service Data

SD-04-1

(Formerly SD-5)

RESERVOIRS



TYPICAL SINGLE COMPARTMENT RESERVOIR

DESCRIPTION

The reservoir is a storage tank; its function is to provide a volume of compressed air for braking which will be adequate in relation to the volume used by the brake chambers and auxiliary devices and to provide a location in the system where the air, heated by compression, may be cooled and the water vapor condensed.

Bendix reservoirs are built in accordance with SAE Standard Air Brake Reservoir Test Code and Inspection Procedure SAE J-10-a. They are made from steel sheet, with stamped heads and rolled shells. The seams are electrically welded, and each reservoir is internally coated for corrosion resistance. Each reservoir is tested at 300 PSI hydrostatic pressure.

Reservoirs are supplied in various pipe ferrule arrange- ments and lengths and in diameters from 3-1/2" to 14" having various volumes from approximately 100 cubic inches to 7600 cubic inches for tractors and trailers. All ferrules are tapped to SAE dryseal pipe thread standards.

Reservoirs are also supplied in double and triple compartment configuration and in some cases include an integral check valve between compartments in a double compartment reservoir. Figure 1 illustrates a two compartment reservoir. Two styles of check valves are shown in Figures 2 and 3. Figure 3 is the current design.

OPERATION

The reservoirs in an air brake system primarily serve to store energy in the form of compressed air. They also per- form the less obvious function of providing a means of cooling the air as delivered from the compressor and thereby condensing water vapor into a liquid as well as collecting oil passed by the compressor. This water and oil collects as an emulsion; the greatest amount in the reservoir nearest the compressor. It should be drained off either manually or by means of an automatic drain device.

OPERATION OF INTEGRAL CHECK VALVE The integral check valve provides a one-way passage of air from the upstream compartment to the downstream. This check valve may serve to meet the legal requirement for a check valve to protect the service brake system. in case of failure in the compressor, discharge lines or first reservoir compartment.

PREVENTIVE MAINTENANCE

All reservoirs should be drained daily. If an automatic drain device is used, it should be checked periodically for proper functioning. If an air dryer or aftercooler is used, the reservoirs should be manually drained periodically to verify the proper function of the drying device. Reservoirs, which have collected a considerable oily emulsion, should be drained by opening a drain cock and allow to drain until all drainage stops.

MAINTENANCE OF THE INTEGRAL CHECK VALVE

Every six months, 1800 operating hours or 50,000 miles the check valve on the two compartment reservoir should be tested for leakage, as outlined below, and parts inspected for damage or deterioration and replaced if considered unserviceable.

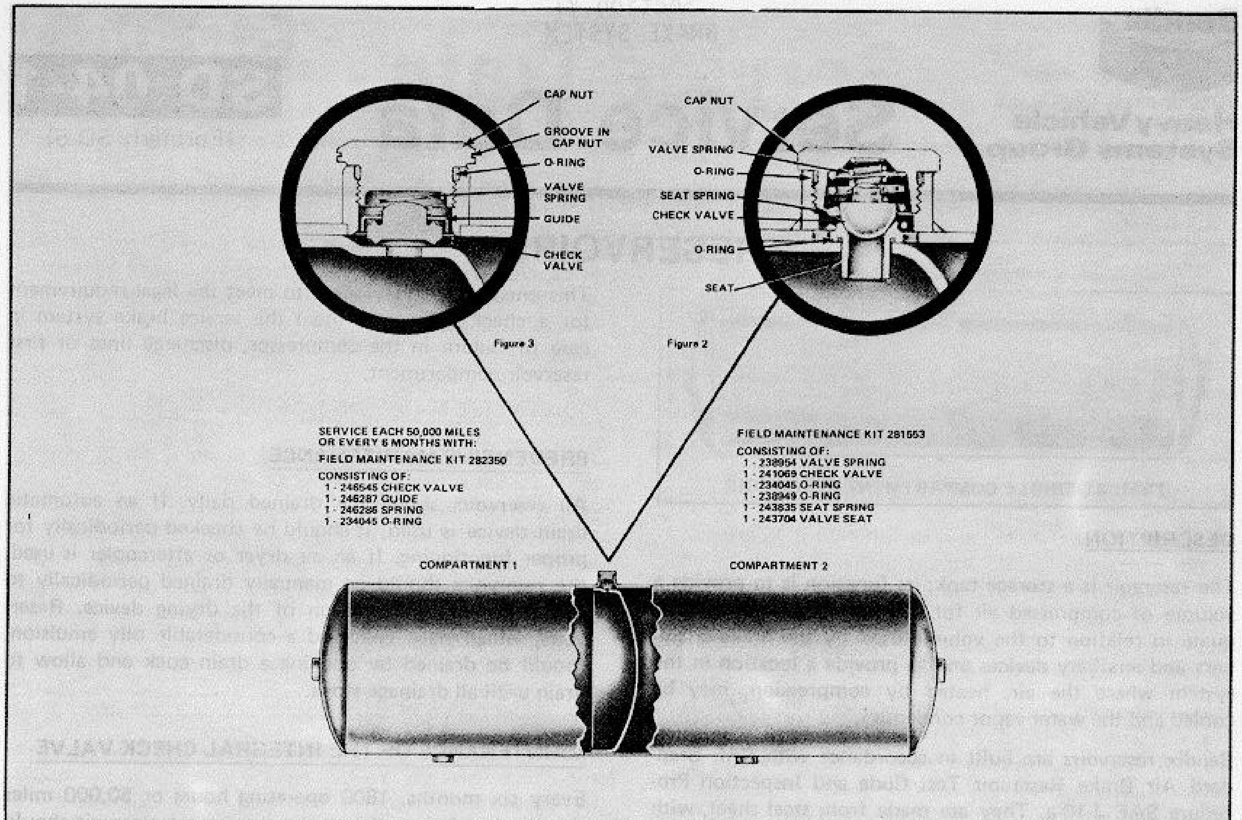
OPERATING AND LEAKAGE TEST FOR TWO-COMPARTMENT RESERVOIR CHECK VALVE

1. Determine the direction of the air flow.
2. Build up system air pressure to governor cut-out and turn off engine.
3. Completely drain compartment # 1 (see Figure 1). NOTE: It may be necessary to remove automatic drain device if so equipped.
4. To determine pressure retention in # 2 compartment, perform one of the following tests:
   a. Check dash gauge (if connected to # 2 compartment).
   b. Apply service brake (if supplied from # 2 compartment).
   c. Momentarily open drain device on # 2 compartment.

DO NOT COMPLETELY DRAIN # 2 COMPARTMENT.

5. Apply a soap solution to the drain ferrule #1 compartment. A slight bubble leakage is permitted.

If # 2 compartment fails to hold air pressure or if excessive leakage is evident at the drain ferrule of # 1 compartment, the check valve should be inspected for serviceability and its parts replaced if necessary.



TWO COMPARTMENT RESERVOIR WITH CHECK VALVE

Figure 1

DISASSEMBLY

GENERAL

There are two types of two-compartment reservoir check valves and they are:

1. The old ball style check with a removable seat and a seat spring (see Figure 2).
2. The new flat style that has a non-removable stainless steel seat (see Figure 3).

Both types of check valves are located in a housing (large ferrule) with a cap nut cover. They are generally located on top of the reservoir shell.

DISASSEMBLY OF THE BALL STYLE CHECK VALVE (Figure 2)

Block and hold vehicle by means other than air brakes.

Completely drain compartments # 1 and # 2.

Remove cap nut and cap nut 0-ring.

Remove check valve and check valve spring.

Remove seat spring.

With a hook or similar device, carefully remove the check valve seat and its 0-ring so as not to mar or scratch it.

DISASSEMBLY OF THE FLAT STYLE CHECK VALVE (Figure 3)

Block and hold vehicle by means other than air brakes.

Completely drain compartments # 1 and # 2.

Remove cap nut and cap nut 0-ring.

Remove valve spring.

Remove valve and valve guide.

CLEANING AND INSPECTION

Wash all metal parts in a good cleaning solvent and dry them thoroughly. All rubber parts should be wiped clean. Inspect springs for distortion, corrosion, and cracks. Inspect valves and valve seats for nicks, cuts and burrs. Inspect all rubber parts for swelling and deterioration. Replace all parts, particularly rubber parts, not considered serviceable during these inspections.

ASSEMBLY

GENERAL

Before assembly, the 0-rings should be coated with silicone lubricant BW-650-M Bendix pc. number 291126.

ASSEMBLY OF THE BALL STYLE CHECK VALVE

Replace seat 0-ring and press seat into shelf.

Replace seat spring.

Install check valve and valve spring.

Replace 0-ring on cap nut and install and tighten cap nut.

ASSEMBLY OF THE FLAT STYLE CHECK VALVE

Replace valve guide on valve and install valve.

Install valve spring.

Replace 0-ring on cap nut and install and tighten cap nut.

TEST

Perform tests as outlined in "Operation and Leakage Test" section.

INSTALLATION

Reservoirs should be securely mounted where they will be protected against outside damage and so they will not vibrate or move during normal operation of the vehicle. A vibrating reservoir usually causes broken tubing lines.

They should be the low point in the air brake system and all lines connected to them should drain toward the reservoir.

The pipe tapped openings in the reservoir should not under any circumstances be reduced in size from original installation.

A drain cock or draining device must be installed in the bottom connection of every reservoir and, in the case of the two-compartment reservoir, in each compartment. The first reservoir or first compartment must be protected by installing a safety valve.

MINOR REPAIRS

Minor repairs to the reservoir consist of examining the reservoir mounting and the inspection of the outside for corrosion or damage. The outside should be kept painted to prevent the possibility of corrosion causing a failure.

MAJOR REPAIRS

Repairs involving welding should never be performed on reservoirs. If a reservoir has been damaged so as to be unfit for use, it should be replaced with a new one.

In exceptional cases where the inside of a reservoir has become excessively coated with sludge which cannot be drained off, it is sometimes advisable to remove it and clean with a solvent, steam, or water. If a solvent is used to clean the reservoir, the reservoir should be thoroughly aerated before reinstalling.

IMPORTANT! PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.

3. Never exceed recommended pressure and always wear safety glasses when working.

4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only pro- per tools and observe all precautions pertaining to use of those tools.

5. Use only genuine Bendix replacement parts and components.

   A. Only components, devices and mounting and attaching hardware specifically designed for use in hydraulic brake systems should be used.

   B. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type and strength as the original equipment.

6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

Bendix Heavy Vehicle Systems Group

S-04-1 5/81

Bendix
Heavy Vehicle Systems Group

Service Data

SD-03-69
Formerly SD-29

QR AND QR-1 QUICK RELEASE VALVES

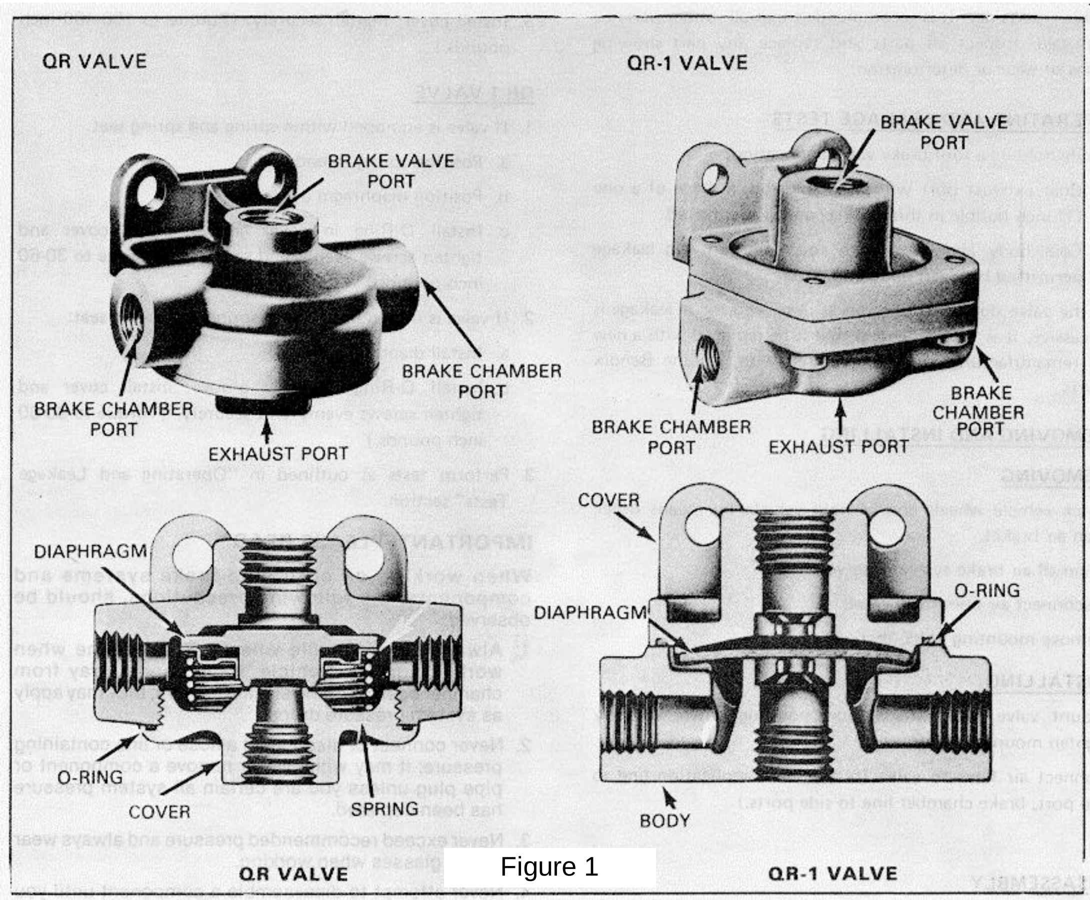


Figure 1

DESCRIPTION

The function of the Quick Release Valve is to speed up the exhaust of air from the air chambers. It is mounted close to the chambers it serves. In its standard configuration the valve is designed to deliver within one (1) psi of control pressure to the controlled device; however, for special applications the valve is available with greater differential pressure designed into the valve.

Reference Figure 1, two styles of Quick Release Valves are available and are functionally the same; the QR valve, which is of older design and utilizes a spring and spring seat, and the QR-1 valve, which in its standard configuration does not employ a spring or spring seat. (Note: AH-1 Valves with a pressure differential employ a spring and spring seat.) Porting consists of one (1) brake valve port, two (2) delivery ports and one (1) exhaust port.

OPERATION

When a brake application is made, air pressure enters the brake valve port; the diaphragm moves down, sealing the exhaust. At the same time, air pressure forces the edges of the diaphragm down and air flows out the delivery port.

When air pressure being delivered (beneath the diaphragm) equals the pressure being delivered by the brake valve (above the diaphragm), the outer edge of the-diaphragm will seal against the body seat. The exhaust port is still sealed by the center portion of the diaphragm when the brake valve application is released; the air pressure above the diaphragm is released back through the brake valve exhaust; air pressure beneath the diaphragm forces the diaphragm to rise, opening the exhaust, allowing air in the chambers to exhaust.

PREVENTIVE MAINTENANCE

Every 12 months, 100,000 miles or 3600 operating hours; disassemble valve, wash metal parts in mineral spirits, wipe rubber parts dry. It is recommended that all rubber parts be replaced. Inspect all parts and replace any part showing signs of wear or deterioration.

OPERATING AND LEAKAGE TESTS

While holding a foot brake valve application,
1. Coat exhaust port with soap solution; leakage of a one (1) inch bubble in three (3) seconds is permitted.
2. Coat body and cover with soap solution. No leakage permitted between body and cover. If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts

REMOVING AND INSTALLING

REMOVING

Block vehicle wheels and/or hold vehicle by means other than air brakes.

Drain all ail brake system reservoirs.

Disconnect air lines from valve.

Remove mounting bolts, then valve.

INSTALLING

Mount valve with exhaust port pointing down; securely tighten mounting bolts.

Connect air lines to valve (brake valve application line to top port; brake chamber line to side ports.)

DISASSEMBLY

QR VALVE
1. Using wrench on square portion of exhaust port, remove cover:
2. Remove spring, spring seat and diaphragm. Remove cover 0-Ring.

QR-1 VALVE

1. Remove four screws.

2. Remove spring and spring seat (if so equipped).

3. Remove diaphragm.

4. Remove cover O-Ring.

CLEANING AND INSPECTION

Clean all metal parts in mineral spirits. Wipe all rubber parts clean.

It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

ASSEMBLY
OR VALVE-,.
1. Position spring seat over the diaphragm and then install into body.
2. Install spring and cover O-Ring.
3. Install cover; tighten securely. (Torque to 150-400 inch pounds.)

QR-1 VALVE
1. If valve is equipped within spring and spring seat:
   a. Position spring in body.
   b. Position diaphragm over spring seat.
   c. Install O-Ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30-60 inch pounds.)
2. If valve is not equipped with spring and spring seat:
   a. Install diaphragm.
   b. Install O-Ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30-60 inch pounds.)
3. Perform tests as outlined in "Operating and Leakage Tests" section.

IMPORTANT PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.

3. Never exceed recommended pressure and always wear safety glasses when working.

4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

5. Use only genuine Bendix replacement parts and components.

   A. Only components, devices and mounting and attaching hardware specifically designed **for use in hydraulic brake systems** should be used.

   B. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type and strength as the original equipment.

6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

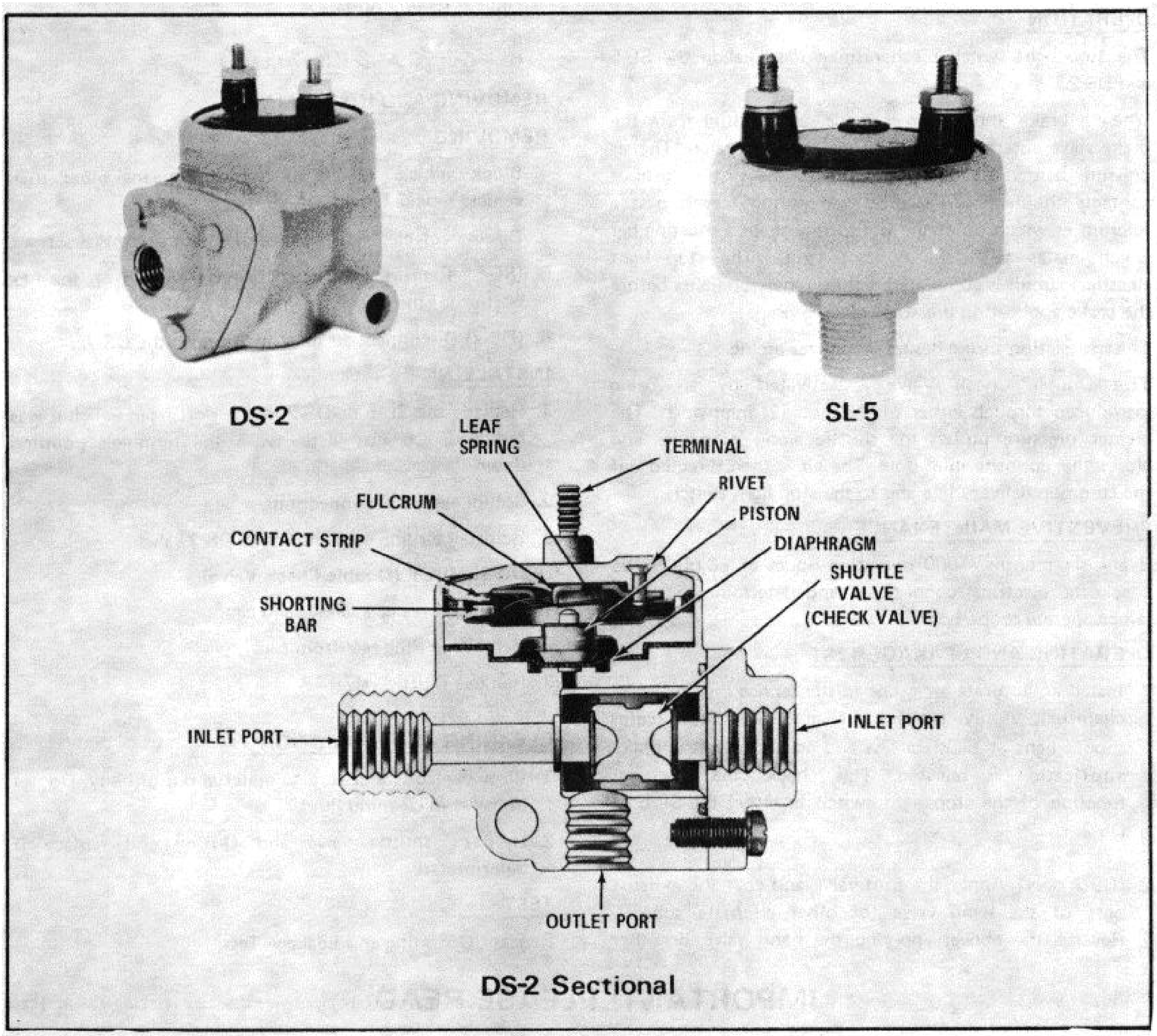
Bendix
Heavy Vehicle Systems Group

Section VI
BRAKE SYSTEM

Service Data

SD-03-69
Formerly SD-29

SL-5 STOP LIGHT SWITCH & DS-2 COMBINED STOP LIGHT SWITCH &-DOUBLE CHECK VALVE



DS-2 Sectional

DESCRIPTION
The stop light switch (SL-5) is an electro-pneumatic 5 psi non-grounded switch that operates in conjunction with the brake valve and stop lights by completing the electrical circuit and lighting the stop lights when a brake application is made.

The combined stop light switch and double check valve (DS-2), as the name implies, combines a stop light switch (SL-5) with a double check valve to perform the function of both. It operates in conjunction with the brake valve and hand control valve by directing the flow of air from whichever delivers the higher pressure into a common delivery line and to the stop light switch, closing the electrical circuit to the stop lamps.

The stop light switch can be used with either 12 or 24 volt systems.

The stop light switch is not a serviceable item; and if found defective in either device, the complete unit must be replaced.

The shuttle valve in the DS-2 is serviceable and may be replaced.

Both the SL-5 and DS-2 have been tested and meet the requirements of FMVSS-121.

OPERATION

The stop light switch mechanism is identical in the SL-5 and DS2.

When a brake application is made, air pressure from the brake valve enters the cavity below the diaphragm. The air pressure below the diaphragm moves the piston until it contacts the leaf spring. The leaf spring travels past a fulcrum at which point the leaf springs snaps a shorting bar which mates with the contact strips. The stop light electrical circuit is completed, lighting the stop lights before the brake application pressures reach 6 psi.

The snap action spring design minimizes arcing.

The Double Check Valve is activated by air being introduced through either of the two (2) inlet ports. The greater pressure pushes the shuttle along its guides and closes the opposite inlet port. The air is then directed out the common delivery line and to the stop light switch.

PREVENTIVE MAINTENANCE

Every six months, 1800 operating hours or 50,000 miles check the electrical connections and determine that stop lamps operate properly.

OPERATING AND LEAKAGE TEST

1. Install an accurate air gauge in the service line (or brake chamber). Apply brake valve gradually. Stop lamps should light at 6 psi or less and go out after the brake application is released. This checks the electrical function of the stop light switch in either the SL-5 or DS-2.

2. (DS-2 only) Apply the foot valve and coat the exhaust port of the hand valve (or other alternate source). Reverse the above, applying the hand valve or other alternate source and coat the exhaust port of the foot valve. In either mode a leakage of not more than a 1" bubble in 5 seconds is permissible.

3. (SL-5 or DS-2) When pressurized, no leakage is permitted from the body of the valve or switch.

If the SL-5 or DS-2 does not function as described above or if leakage is excessive, the valve or switch should be replaced with a new unit or in the case of the double check portion of the DS-2 repaired with genuine Bendix parts available at Bendix outlets.

REMOVING AND INSTALLING

REMOVING

1. Block vehicle wheels or hold by means other than vehicle service brakes.

2. Disconnect electrical connections from terminal screws.
3. (SL-5) Remove the switch using a wrench on the hex portion of the body.
4. (DS-2) Disconnect air lines and remove the DS-2.

INSTALLING

1. Replace the SL-5 or DS-2 in the port from which it was removed. Do not install with the terminals pointing down.

2. Secure electrical connections.

3. Reinstall air line connections to DS-2 valve.

DISASSEMBLY (Double Check Valve)

1. Remove three cap screws and cap.

2. Remove O-Ring seal from cap.

3. Remove shuttle valve.

CLEANING AND INSPECTION

1. Blow dust or other foreign material out of body. Do not immerse in cleaning fluid.

2. Inspect shuttle valve and O-Ring and replace if deteriorated.

TEST

Repeat "Operating and Leakage Test."

IMPORTANT! PLEASE READ

When working on or around air brake systems and components, the following precautions should be observed:

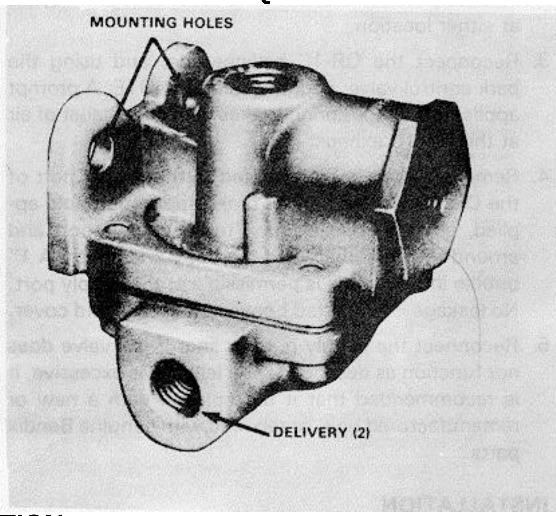
1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

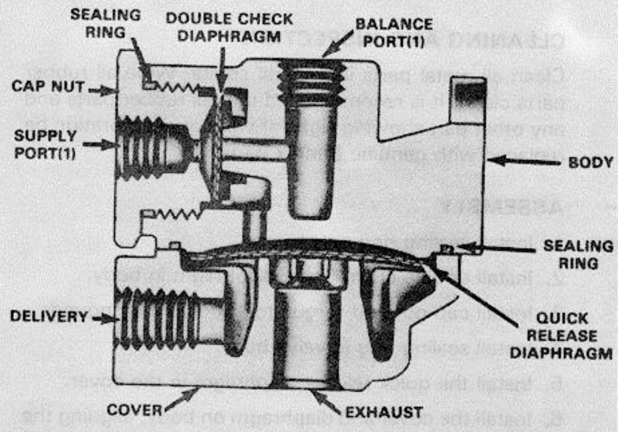
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.

3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.

4. Never attempt to disassemble a component until you have read and understand recommended procedures. Use only proper tools and observe all precautions pertaining to use of those tools. Some components contain powerful springs and injury can result if not properly disassembled.

QR-1C DOUBLE CHECK AND QUICK RELEASE VALVE





DESCRIPTION

The QR-1C is a dual function valve. The valve's primary function is to serve the emergency side of a spring brake actuator as a quick release valve. In addition, it functions as an anti-compound device. The double check valve prevents a service and emergency brake application from occurring simultaneously.

The QR-1C Valve is generally mounted on the axle and serves two spring brake actuators. The air connections to the QR-1C are as follows:

1. QR-1 C delivery port (2) connected to emergency port of spring brake.
2. QR-1C balance port (1) connected to delivery of brake valve or relay valve. NOTE: If relay valve is in- stalled on vehicle, it should be connected to the delivery side (not service or signal side).
3. QR-1C supply port (1) connected to delivery of park control valve.

OPERATION

Spring Brakes Released

When the spring brakes are released, air from the park control valve flows through the QR-1C Valve, causing the double check valve and quick release diaphragms to flex and seal the balance and exhaust ports. Air flows into the emergency port of the spring brakes from the QR-1C Valve delivery ports.

Spring Brakes Applied

When the spring brakes are applied, supply line air pressure to the valve is exhausted through the park control valve. As air Pressure is removed from one side of the double check valve and quick release diaphragms, they flex in the opposite direction opening the balance and exhaust ports. Spring brake emergency pressure is released at the exhaust port of the valve while the small amount of air trapped between the two diaphragms is released through the relay valve or brake valve exhaust.

Anti-compounding

When a service brake application is made with the spring brakes applied, service air enters the balance port and flows through the valve into the emergency ports of the spring brakes. This prevents the compounding of a service and spring brake application. Service air passing through the valve flexes the double check and quick release diaphragms, sealing the supply and exhaust ports. When the service application is released, air is exhausted from the spring brakes.

PREVENTIVE MAINTENANCE

Every 12 months, 100,000 miles or 3600 operating hours; disassemble valve, wash metal parts in mineral spirits, wipe parts dry. It is recommended that all rubber parts be replaced. Inspect all parts and replace any part showing signs of wear or deterioration.

REMOVAL

1. Block vehicle wheels and/or hold vehicle by means other than air brakes.
2. Drain all air brake system reservoirs.
3. Identify and disconnect air lines from valve.
4. Remove mounting bolts, then valve.

DISASSEMBLY

Mark the relationship of the body and cover before disassembly.

1. Remove cap nut.
2. Remove sealing ring from cap nut.
3. Remove double check valve diaphragm.
4. Remove four Phillips head screws.
5. Separate the body and cover and remove the sealing ring and quick release diaphragm.

CLEANING AND INSPECTION

Clean all metal parts in mineral spirits. Wipe all rubber parts clean. It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

ASSEMBLY

1. Install sealing ring on cap nut.
2. Install double check valve diaphragm in body.
3. Install cap nut and torque to 150-400 inch pounds.
4. Install sealing ring in valve body.
5. Install the quick release diaphragm in the cover.
6. Install the cover and diaphragm on body, aligning the marks made during disassembly. Secure together using the four Phillips head screws and torque to 30-60 inch pounds.
7. Re-install the QR-1C; and before putting the vehicle in service, perform the "Operation and Leakage Tests."

OPERATING AND LEAKAGE TESTS

Before performing these tests, park the vehicle on a level surface and hold the vehicle by means other than the brakes.

1. With the park control valve in the released position, note that the spring brakes are released.
2. Remove the air line connected to the QR-1C balance port and apply a soap solution to the exhaust and balance port. A 1" bubble. in 5 seconds is permissible at either location.
3. Reconnect the QR-1C balance line; and using the park control valve, park the vehicle. NOTE: A prompt application of the spring brakes with an exhaust of air at the QR-1C exhaust port.
4. Remove the air line connected to the supply port of the QR-1C. With a service brake application hold applied, apply a soap solution to the supply port and around the seam between the body and cover. A 1" bubble in 5 seconds is permissible at the supply port. No leakage is permitted between the body and cover.
5. Reconnect the supply port air line. If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts.

INSTALLATION

Mount valve with exhaust port pointing down; securely tighten mounting bolts. Reconnect air lines as identified during removal.

IMPORTANT! PLEASE READ

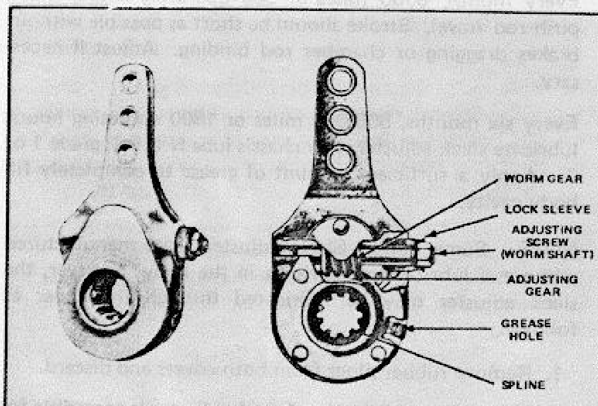
When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Use only proper tools and observe all precautions pertaining to use of those tools. Some components contain powerful springs and injury can result if not properly disassembled.

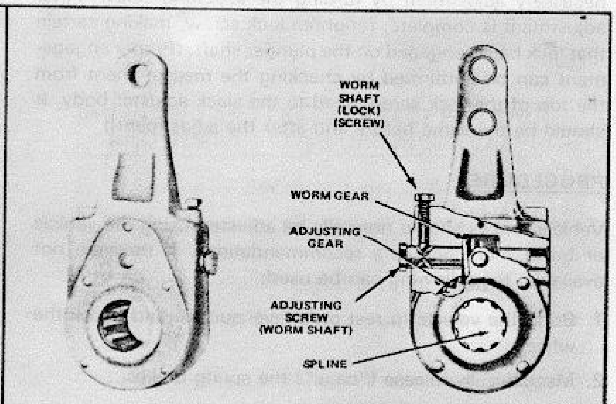
Bendix
Heavy Vehicle Systems Group

Service Data SD-03-72

MANUAL SLACK ADJUSTERS



POSITIVE LOCK TYPE SLACK ADJUSTER
Figure 1



BALL INDENT TYPE SLACK ADJUSTER
Figure 2

DESCRIPTION

In an S-cam type foundation brake, the final link between the pneumatic system and the foundation brake is the slack adjuster. The arm of the slack adjuster is fastened to the push rod of the chamber with a yoke, and the slack adjuster spline is installed on the brake cam shaft.

Primarily, the slack adjuster is a lever, converting the linear force of the air chamber push rod into a torque which turns the brake cam shaft and applies the brakes.

Standard slack adjusters contain four basic components; the body, worm, gear and adjusting screw. The adjusting screw is provided to adjust the slack caused by the wear of the brake lining.

All Slack Adjusters utilize the worm and gear principle and, fundamentally, differ only in torque limit specifications; A type 20 slack adjuster has a limit of 20,000 inch pounds torque, a type 30 slack adjuster has a limit of 20,000 inch pounds torque, etc.

Slack Adjusters are manufactured with various arm lengths and in various configurations; straight, offset, etc. to satisfy various installation requirements. Splines are available in several different types and sizes.

OPERATION

When the brakes are applied, air pressure forces the air chamber diaphragm and push rod to move; this rotates the slack adjuster, which in turn rotates the cam shaft. This causes the "S" cam to spread the brake shoes which contact the brake drum.

When the brakes are released, air pressure is exhausted from the air chamber. The chamber return spring and the brake shoe return springs return the brake cam, cam shaft, slack adjuster and chamber push rod to the released position.

ADJUSTING MECHANISM

The adjusting mechanism of a Slack Adjuster consists of an adjusting screw (worm shaft), worm and slack adjuster worm gear. Turning the adjusting screw nut on the end of the worm shaft rotates the worm shaft and worm. The worm meshes with and rotates the slack adjuster worm gear which is connected to the brake cam by a splined cam shaft. The turning of the slack adjuster worm gear rotates the cam shaft and brake cam, spreading the brake shoes, compensating for brake lining wear.

There are two types of adjusting mechanisms used on Bendix Slack Adjusters currently manufactured. The light to medium torque rated slack adjuster (Fig. 1) use a positive lock mechanism consisting of a spring loaded lock sleeve, which when positioned properly, engages the adjusting screw nut, preventing the adjusting screw (worm shaft) from rotating.

The heavier torque rated slack adjusters (Fig. 2) utilize the lock ball or plunger and worm shaft indent principle adjust- ment lock. The lock ball or plunger must engage the indent on the worm shaft after the adjustment is completed. An audible metallic click can be heard when engagement is made.

BRAKE ADJUSTMENT

Using the Positive Lock Slack Adjuster Mechanism:

Wipe the adjusting screw nut and locking sleeve area clean. Position wrench or socket over the adjusting screw and disengage the locking sleeve by depressing the lock sleeve. Make the necessary adjustment by turning the adjusting screw with the locking sleeve depressed.

When adjustment is completed, the adjusting screw nut should be positioned so the locking sleeve engages the adjusting screw nut, thus locking the adjusting screw in place. DO NOT ATTEMPT TO TURN THE ADJUSTING SCREW WITHOUT FULLY DEPRESSING THE LOCK SLEEVE.

Using the Ball Indent Slack Adjuster Mechanism: (Figure 2)

Before proceeding with adjustment, measure distance from top of lock screw head to slack adjuster body.

To adjust, back off lock screw (counter clockwise) and make necessary adjustment by turning the adjusting screw. After adjustment is complete, retighten lock screw, making certain that lock ball is engaged on the plunger shaft. (Proper engage- ment can be confirmed by checking the measurement from the top of the lock screw head to the slack adjuster body. It should be the same before and after the adjustment.)

PROCEDURE

Vehicle brakes should normally be adjusted using the vehicle or brake manufacturer's recommendations. If they are not available, the following can be used:

1. Bring the vehicle to rest on a level surface and chock the wheels.

2. Mechanically release ("cage") the spring brakes.

Preferred Adjustment Method

Raise the vehicle wheel that is to be adjusted off the ground so that it turns freely. Turn the slack adjuster adjusting mechanism until the brakes begin to drag. Adjustment is then locked off until the wheel turns freely.

This adjustment method will result in the shortest possible actuator stroke without the brakes dragging.

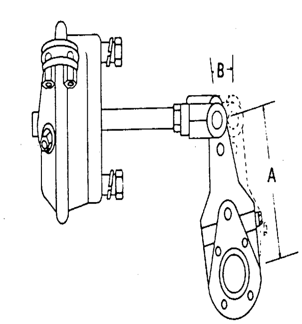
Alternate Adjustment Method

1. Determine the slack adjuster arm length (Dim. A).

2. Measure push rod movement (stroke) by manually extending push rod until brake shoes contact drum.

3. Refer to chart below. If Dim. "B" is greater than allowable stroke indicated in chart below, adjust push rod movement (stroke) to 3/8".

Slack Adj. Arm Length "A" Dim. (in.)	Push Rod Movement (stroke) "B" Dim. (in.)
5	1-1/2
5-1/2	1-1/4
6	1
6-1/2	3/4



After adjustment, check for brake drag by gently striking the brake drum with a hammer. When the brake shoes are away from the drum, a ringing sound will be heard. A dull sound indicates brake drag and requires readjustment until the drag is eliminated.

NOTE: If the brakes cannot be adjusted per the above chart, inspect the foundation brake and drum for worn or damaged components.

PREVENTIVE MAINTENANCE

Every month, 8000 miles or 300 operating hours; check push rod travel. Stroke should be short as possible without brakes dragging or chamber rod binding. Adjust if necessary.

Every six months, 500,000 miles or 1800 operating hours; lubricate slack adjuster with chassis lube N.L.G.I. grade 1 or 2. Apply a sufficient amount of grease to completely fill body cavity.

NOTE: Some Bendix Slack Adjusters were manufactured without a lubrication provision in the body; however, the slack adjuster may be lubricated through the cover as follows:

1. Remove rubber plugs from both covers and discard.

2. Determine which side of slack adjuster is accessible for lubrication and install Washer (Pc.No. 230156) and Grease Fitting (BW Pc.No. 244017) Alemite #1625 using Alemite tool #5254 to press grease fitting firmly in place in cover.

3. Install steel plug (Pc.No. 244400) in other cover, making certain it is firmly in place.

4. Lubricate Slack Adjuster. Apply a sufficient amount of grease to completely fill body cavity.

SERVICE TESTS

1. Apply brakes and check that Slack Adjusters rotate freely and without binding.

2. Release brakes and check that Slack Adjusters return to the released position without binding.

3. With brakes released, check that the angle formed by the Slack Adjuster arm and actuator push rod is greater than 90 degrees. All Slack Adjusters should be set at this same angle.

4. With brakes applied, check that the angle formed by the Slack Adjuster arm and actuator push rod is still slightly greater than 90 degrees. All Slack Adjusters should be set at this same angle.

REMOVAL AND INSTALLATION

CAUTION: Before attempting to remove Slack Adjusters, proper precautions should be taken so that an automatic application of the actuators does not occur while removing or installing Slack Adjusters, thus causing possible injury. Decreasing air pressure can cause a sudden full brake application without warning. Depending on type of system on vehicle, it may be necessary to drain all air reservoirs or mechanically back off spring brake chambers.

A. REMOVAL

1. Remove the chamber push rod yoke pin.

2. Remove the retaining mechanism from end of brake cam shaft.
3. Rotate the slack adjuster by turning the adjusting nut.
4. Slide the slack adjuster off of the spline end of the brake cam shaft.

B. INSTALLATION

1. Install Slack Adjuster on brake cam shaft so the adjustment screw and grease fitting (if so equipped) are accessible for servicing.
2. Install retaining mechanism on end of brake cam shaft to hold Slack Adjuster in place.
3. Turn adjusting nut to line up yoke pin hole with arm hole. Install yoke pin and cotter pin.
4. Refer to steps 3 and 4 under "Service Tests" and make sure the proper adjustments are made after installing a Slack Adjuster.

SLACK ADJUSTER REPLACEMENT

When replacing one type of Slack Adjuster with another type, it is necessary to match or exceed the torque rating and match the arm length, yoke pin diameter, offset spline diameter and width. It is also necessary to make certain that there is adequate clearance at released and full stroke.

DISASSEMBLY AND ASSEMBLY

NOTE: Disassembly and assembly instructions apply only to assemblies with riveted covers. Assemblies with welded covers are considered non-serviceable and are replaced as an assembly.

TYPE 20 TO 30 WITH POSITIVE LOCK MECHANISM AND RIVETED COVER DISASSEMBLY

1. Remove rivets holding covers.
2. Remove welch plug.
3. Before removing worm shaft, measure height from top of adjusting screw to the slack adjuster body. This measurement is important, as it serves as a reference when the worm shaft is reassembled.
4. Press out worm shaft from worm by pressing in on the end of the worm shaft opposite the adjusting screw nut.
5. Remove worm shaft, worm shaft lock and worm lock spring.
6. Remove worm and slack adjuster worm gear from slack adjuster body.

TYPE 35 WITH POSITIVE LOCK MECHANISM DISASSEMBLY

1. Remove retaining ring holding the cover, cover nut and gear in place.
2. Remove set screw in worm nut.
3. Depress worm lock and remove lock nut pin.
4. Remove worm lock and worm lock spring.
5. Unscrew worm nut.
6. Remove worm shaft, worm and gear from slack adjuster body.

7. Before removing worm shaft, measure height from top of adjusting screw to the slack adjusted body. This measurement is important, as it serves as a reference when the worm shaft is reassembled.
8. Press out the worm shaft from worm by pressing on the end of the worm shaft opposite the adjusting screw nut.

TYPE 35 AND TYPE 55 (WITHOUT RIVETED COVER) AND BALL INDENT LOCK MECHANISM DISASSEMBLY

1. Remove cam lock pin, cam lock, thrust washer, plunger spring and plunger.
2. Bend up tab of lock washer and remove worm nut.
3. Remove retaining ring and cover.
4. Before removing worm shaft, measure height from the top of adjusting screw to the slack adjuster body. This measurement is important, as it serves as a reference when the worm shaft is reassembled.
5. Remove worm and shaft and slack adjuster gear.
6. Remove plunger and plunger spring from body.
7. If worm gear is to be pressed from-shaft, note dimension from end of shaft to gear before proceeding.

TYPE 35, 40, 55 (WITH RIVITED COVER AND BALL INDENT LOCK MECHANISM) DISASSEMBLY

1. Remove rivets holding the covers.
2. Remove welch plug.
3. Before removing ball indent lock mechanism, measure and note distance from top of lock screw head to slack adjuster body.
4. Remove ball indent lock mechanism screw.
5. Remove spring and ball.
6. Before removing worm shaft, measure height from top of adjusting screw to the slack adjuster body. This measurement is important, as it serves as a reference when the worm shaft is reassembled.
7. Press out worm shaft from worm by pressing on end of worm shaft opposite the adjusting nut.
8. Remove worm and slack adjuster worm gear.

CLEANING AND INSPECTION

Wash all parts in mineral spirits and dry. Inspect parts and replace any part showing signs of wear or deterioration.

TYPE 20 TO 30 WITH POSITIVE LOCK MECHANISM AND RIVETED COVER ASSEMBLY

1. Place worm and worm gear in Slack Adjuster body.
2. Position and press the worm shaft, worm shaft lock and spring into the worm and Slack Adjuster body. The recess in the worm shaft lock must be lined up with the pin in the Slack Adjuster body before pressing into position. Make certain that when pressing the worm shaft into the body that the height measurement between the top of the adjusting screw and slack adjuster body is the same before and after removal.
3. Install covers and rivet securely.

4. Install new welch plug in body.
5. Lubricate as outlined in "Preventive Maintenance" section.

TYPE 35 WITH POSITIVE LOCK MECHANISM ASSEMBLY

1. Press worm shaft into worm. Care should be exercised to be sure the worm shaft is pressed into the proper dimension.
2. Install the worm shaft, worm and gear in the Slack Adjuster body.
3. Make certain that when pressing the worm shaft into the body that the height measurement between the top of the adjusting screw and slack adjuster body is the same before and after removal.
4. Install worm lock guide pin in worm nut.
5. Screw the worm nut into Slack Adjuster body.
6. Install worm lock and worm lock spring over worm shaft and adjusting screw nut.
7. Depress worm lock and install lock nut pin in adjusting screw nut.
8. Install set screw in worm nut.
9. Assemble cover and cover nut to the body by installing the retaining ring.
10. Lubricate Slack Adjuster as outlined in "Preventive Maintenance" section.

TYPE 35 AND TYPE 55 (WITHOUT RIVETED COVER) AND BALL INDENT LOCK MECHANISM ASSEMBLY

1. Install plunger spring and plunger in body.
2. Install Slack Adjuster gear in body.
3. If worm was removed from shaft, new worm should be pressed on shaft noting dimension as instructed in No. 4 of disassembly procedure.
4. Install worm and shaft. Worm and shaft must be run in so that the worm fully engages slack adjuster worm gear. Make certain that when pressing the worm shaft into the body that the height measurement between the top of the adjusting screw and slack adjuster body is the same before and after removal.
5. Install cover and retaining ring in groove of body.
6. Install new lockwasher on worm nut in body and tighten. Bend up at least 2 tabs of lockwasher, one of which should fit in groove of body.
7. Install plunger spring, thrust washer and plunger in lock hole.
8. Install cam lock in body. Install pin.
9. Lubricate Slack Adjuster, as outlined in "Preventive Maintenance" section.

TYPE 35,,40,55 (WITH RIVETED COVER AND BALL INDENT LOCK MECHANISM).
ASSEMBLY

1. Place worm and worm gear in slack adjuster body.
2. Press the worm shaft into the worm. The indents in the worm shaft must be lined up with the ball lock hole. Make certain that when pressing the worm shaft into the body that the height measurement between the top of the adjusting screw and slack adjuster body is the same before and after removal.
3. Install covers and rivet securely.
4. Install ball, spring and ball indent lock mechanism. Turn adjusting screw, allowing ball to fully engage indent in shaft. Check for full engagement by tightening lock mechanism screw to same dimension as noted in step #3 of "Disassembly" instructions.
5. Before installing welch plug, grease bottom of shaft. Install new welch plug.
6. Lubricate Slack Adjuster as outlined in "Preventive Maintenance" section.

TEST OF REBUILT SLACK ADJUSTERS

After lubricating rebuilt Slack Adjuster (see "Preventive Maintenance" section), all moving parts of the Slack Adjusters should rotate freely and not bind. With Slack Adjuster installed In vehicle, refer to "Service Test" section. Check that rebuilt Slack Adjuster functions properly.

IMPORTANT! PLEASE READ

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

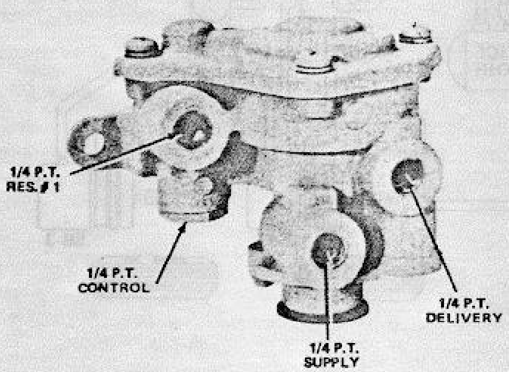
Bendix
Heavy Vehicle Systems Group

Section VI
BRAKE SYSTEM

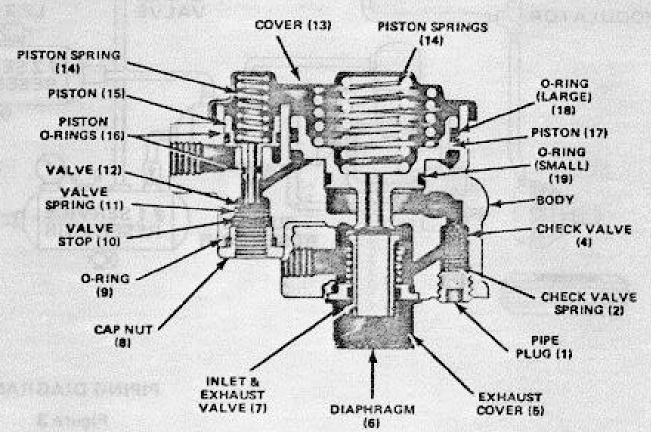
Service Data

SD-03-87
(Formerly SD-66)

SR-1 SPRING BRAKE VALVE . .



EXTERIOR VIEW
Figure 1



SECTIONAL VIEW
Figure 2

DESCRIPTION:

The SR-1 Spring Brake Valve is used in dual or "split" air brake systems equipped with spring brake actuators. The function of the SR-1 is to supply a specific, limited hold-off pressure to the spring brakes, and in the event of loss of No. 1 service air pressure, to modulate the spring brakes through the use of the service brake valve. The valve has four identified 1/4" N.P.T.F. ports and a diaphragm protected exhaust port. Two 5/16" diameter holes are provided in the integral mounting bracket of the valve body. The SR-1 must be mounted with the exhaust port down toward the road surface.

OPERATION - INITIAL AIR SYSTEM CHARGE

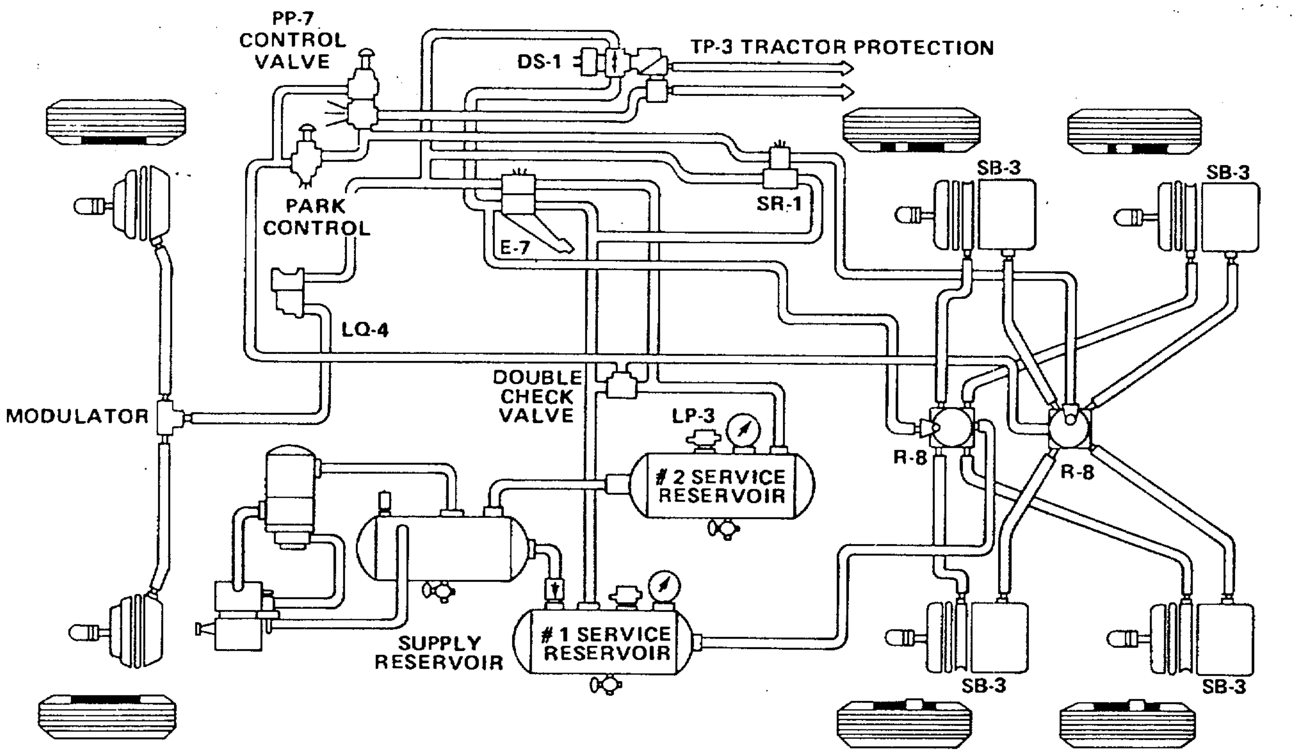
Upon initial charge, air from #1 & #2 service reservoirs flows through the park control valve and enters the SR-1 supply port. Air entering the supply port flows past inlet and exhaust valve B to the underside of piston B and out the delivery port of the SR-1 to the emergency air connection at the spring brake actuator. Note that the springs above piston B force it into contact with inlet and exhaust valve B. In the position shown the exhaust is closed and toe inlet is open.

Air flowing from the No. 1 reservoir only enters the reservoir port of the SR-1- This air remains under piston A as system pressure builds. With No. 1 reservoir pressure below approximately 55 P.S.I. the spring above piston A forces it into contact with inlet and exhaust valve A causing the exhaust to seal and the inlet to open. With air system pressure above approximately 55 P.S.I. in No. 1 & 2 service reservoirs, piston A has moved against the force of the spring above it, allowing the inlet of valve A to close and opening the hollow exhaust passage through piston A.

OPERATION - AIR BRAKE SYSTEM FULLY CHARGED

When air pressure beneath piston B is approximately 95* P.S.I., piston B rises slightly, against the force of the springs above it, allowing the inlet of valve B to close. The exhaust through valve B remains closed. The closing of the inlet portion of valve B retains approximately 95* P.S.I. in the hold-off cavity of the spring brake actuators while allowing full air system pressure to build elsewhere.

- Note**:** Other spring brake hold-off pressures are supplied according to the vehicle manufacturer's specifications. 95 P.S.I. was chosen only for; the purpose of explanation.



PIPING DIAGRAM

Figure 4

Charging — Below 55 p.s.i.

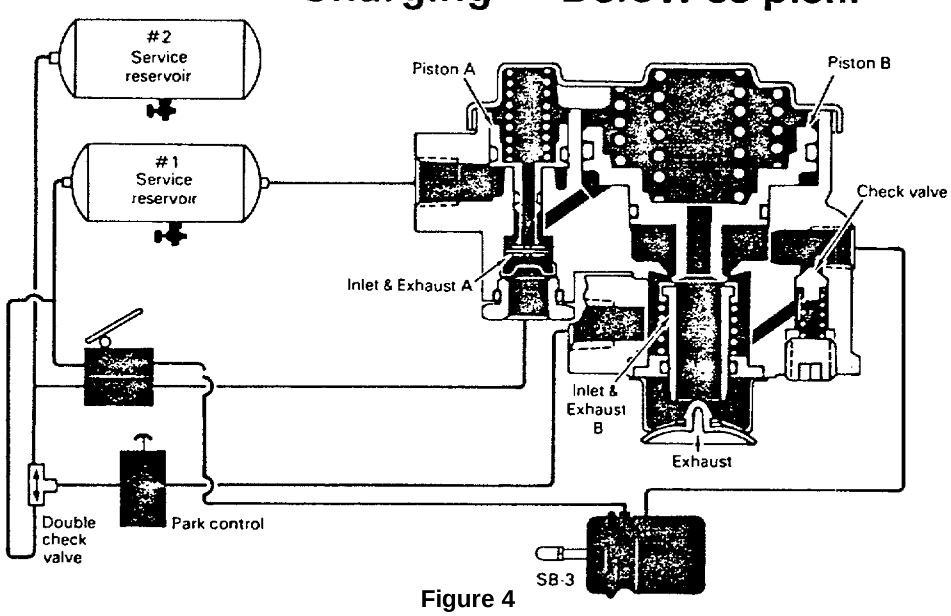


Figure 4

System fully charged

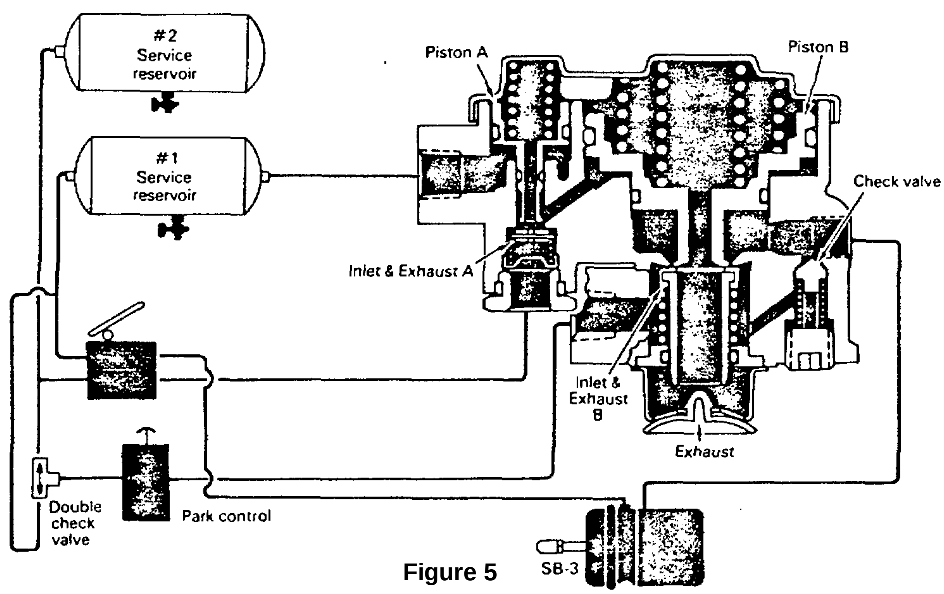


Figure 5

Normal service application

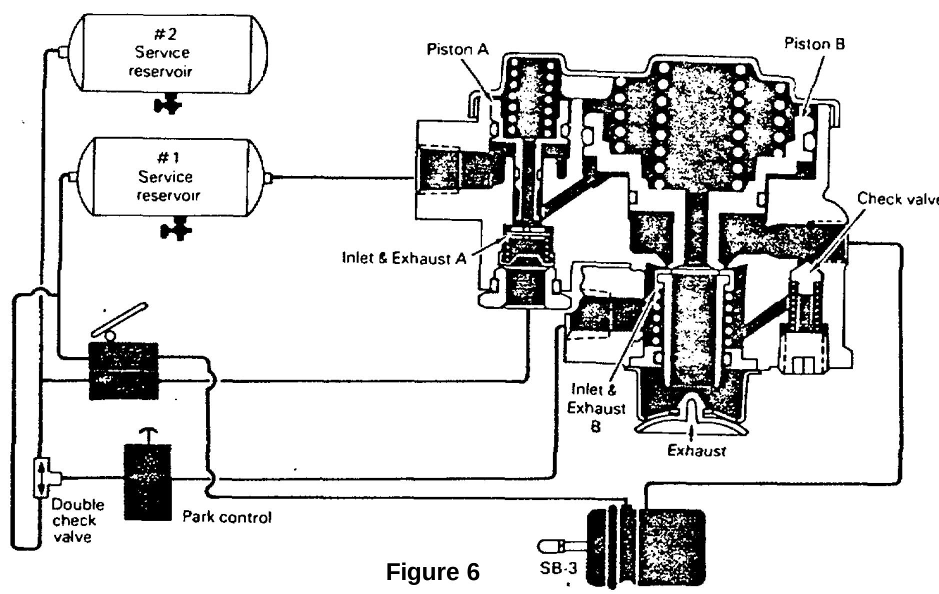


Figure 6

<u>OPERATION - NORMAL SERVICE RESERVOIRS 1&2 CHARGED</u>

When a service application is made by actuating the dual brake valve; air, from the No. 2 delivery circuit is delivered from the brake valve to the control port, and is stopped at the closed inlet of valve A. No movement of the internal components of the SR-1 takes place. Air from the No. 1 delivery circuit of the dual brake valve actuates the service section of the spring brake actuators.

<u>OPERATION - SERVICE APPLICATION WITH LOSS OF NO. 2 RESERVOIR PRESSURE</u>

In the event air pressure is lost in No. 2 reservoir, the No. 1 reservoir as well as the parking control valve will be protected through the action of the double and single check valves in the air system. A service application of the dual air brake valve in this situation results in little or no air being delivered from the No. 2 delivery circuit to the control port of the SR-1. No movement of the SR-1 internal components takes place.

Service application — loss of #2 reservoir

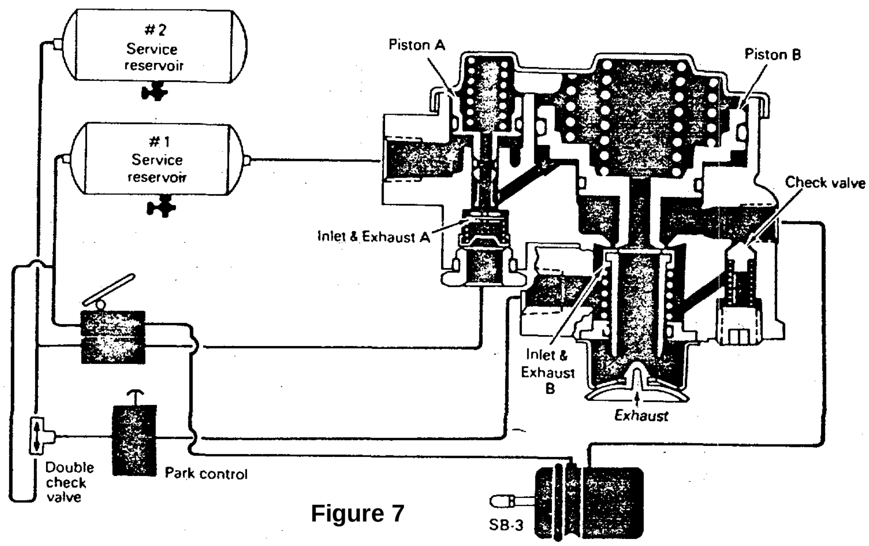


Figure 7

Service application — loss of #1 reservoir

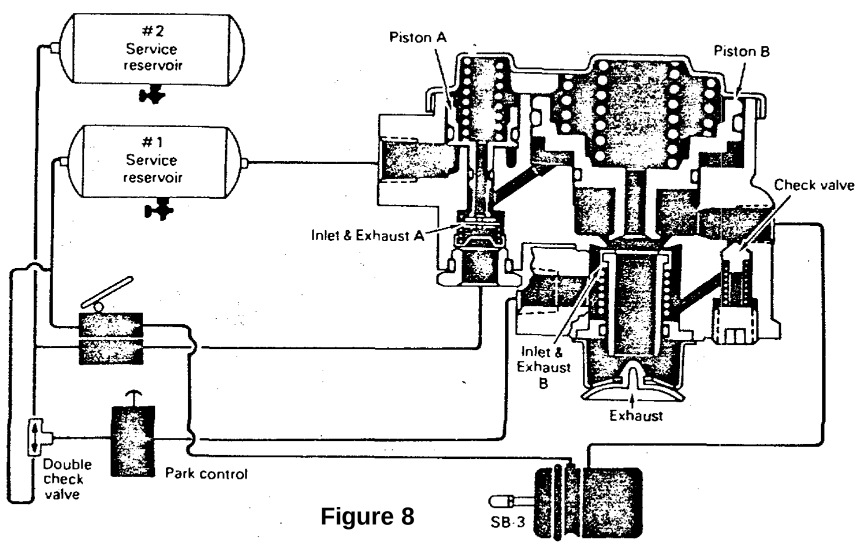


Figure 8

Braking is assured because the No. 1 service reservoir is protected by a check valve and the No. 1 delivery circuit of the dual brake valve will apply the ser- vice section of the spring brake actuators.

<u>OPERATION - SERVICE APPLICATION WITH LOSS OF NO. 1 RESERVOIR PRESSURE</u>

If air pressure in the No. 1 service reservoir falls below approximately 55 P.S.I., the pressure beneath piston A is insufficient to resist the spring force above and piston A moves into contact with valve A. Initial contact between piston A and valve A closes the hollow exhaust passage of piston A. Continued movement of the piston opens the inlet of valve A.

The No. 2 service reservoir and the park control valve are protected from pressure loss by the action of the. Double Check Valve.

When a service application of the dual brake valve is made, air delivered from the No. 2 delivery circuit of the dual brake valve enters the SR-1 control port. Air entering the control port, now moves past the inlet of valve A and is conducted through a passage in the body to the underside of piston B. The added force of air pressure beneath piston B, moves up, opening the exhaust of valve B. When the exhaust of valve B opens, air pressure trapped in the emergency section of the spring brake actuator is allowed to escape resulting in a brake application by the emergency section. The amount of air pressure released from the spring brake is

Park application

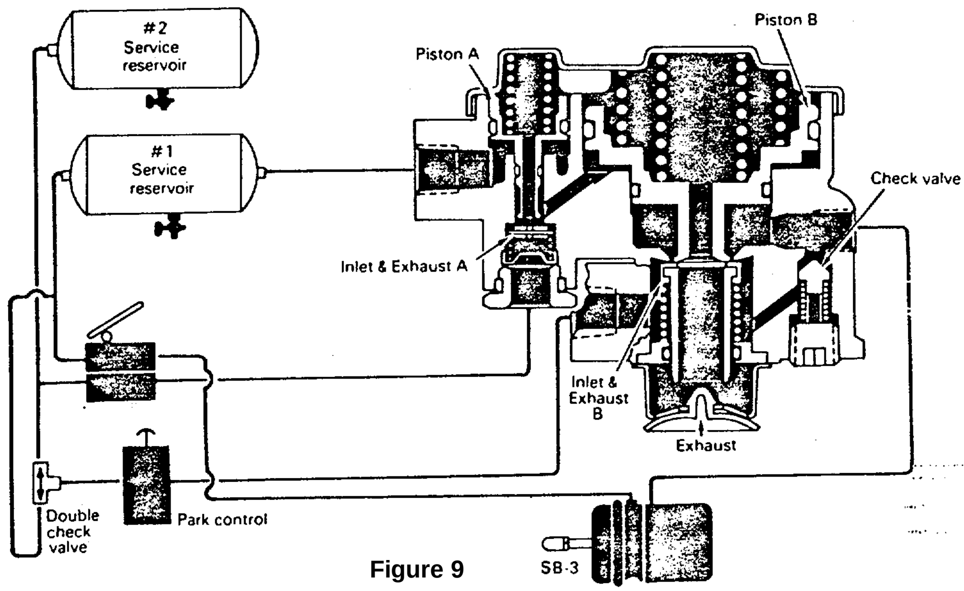


Figure 9

in proportion to the amount of air pressure delivered to the control port of the SR-1 by the No. 2 delivery of the dual brake valve.

<u>OPERATION PARKING</u>

If both systems #1 and #2 are intact and the park control valve is placed in the "park" or exhaust position, the SR-1 supply of air pressure and the air pressure in the spring brake actuator cavities is exhausted. The single check valve in the SR-1 assists this exhaust of air pressure from the spring brake by allowing the air below piston B to flow back out the open exhaust of the park control valve. When air pressure below piston B has dropped sufficiently, piston B moves down opening the inlet of valve B thus providing an additional exhaust passage for air exhausting through the SR-1 from the spring brakes.

<u>PREVENTIVE MAINTENANCE</u>

Every 3600 operating hours, 100,000 miles or yearly, disassemble valve, clean all parts in mineral spirits. Replace all rubber parts, and any part worn or damaged with genuine Bendix parts.

<u>SERVICE CHECKS</u>

<u>OPERATING CHECKS</u>

Block vehicle and hold by means other than vehicle brakes. Charge air brake system to governor cut-out pressure.

1. Place parking control valve in the "park" position. Observe that the spring brake actuators apply promptly. In the delivery port of the valve install a test gauge known to be accurate. Place the parking control valve in the "release" position. Observe that the spring brake actuators release fully.

2. With the parking control valve in the "release" position, note the gauge pressure reading. (Check the vehicle manual for the correct spring brake actuator hold-off pressure.) If the pressure reading is incorrect, the valve must be repaired or replaced.

3. Place the parking control valve in the "park" position, the gauge reading should drop to zero promptly. A slow release of pressure may indicate faulty operation of the single check valve (within the Modulating Valve.)

4. Place the parking control valve in the "release" position. Locate the number one service reservoir and drain it completely.

Apply the foot brake valve several times and note that the pressure reading on the gauge decreases each time the foot brake valve is applied. After several applications, pressure on the gauge will drop to the point where release of the spring brake actuators will no longer occur.

<u>LEAKAGE CHECK</u>

With the air system fully charged and the parking control valve in the "release" position, coat the exhaust port and around the valve corner with a soap solution. Slight leakage is permitted.

If the SR-1 Spring Brake Valve does not function as described above, or leakage is excessive, it is recommended that it be returned to the nearest Bendix authorized distributor for a new remanufactured valve. If this is not possible, the valve can be repaired with genuine Bendix parts in which case the following should prove helpful.

Note: A maintenance kit for the SR-1 Spring Brake Valve is available from any authorized Bendix outlet. All parts necessary for minor repair are included.

<u>REMOVAL</u>

1. Prior to removing the SR-1 apply the parking brakes and drain all the vehicle reservoirs.

2. Identify all air lines before disconnecting.

3. Remove the two mounting bolts from the SR-1 and remove the valve.

DISASSEMBLY (Refer to Figure 2)

1. Remove the socket head pipe plug (1).
2. Remove the check valve spring (2) and the check valve (4).
3. Remove the two phillips head screws and remove the exhaust cover (5).
4. Separate the exhaust diaphragm (6) from the cover.
5. Remove the inlet and exhaust valve assembly (7).
6. Remove the inlet and exhaust valve cap nut (8) and separate the cap nut o-ring (9).
7. Remove the valve stop (10) valve spring (11) and inlet and exhaust valve (12).
8. Remove the four phillips head screws and lockwashers that secure the cover to the body. Caution: the cover is under a spring load, and should be held while removing the screws.
9. Remove the cover (13) and the three piston springs (14). Note: Some SR-1 piece numbers have one large piston spring.
10. Remove the small piston (15) and the small and large 0-rings (16).
11. Remove the large piston (17). Remove piston 0-rings (18) & (19).

CLEANING & INSPECTION

Wash all metal parts in mineral spirits and dry. Inspect all parts for excessive wear or deterioration. Inspect the valve seats for nicks or burrs. Check the springs for cracks or corrosion. Replace all rubber parts and any part not found to be serviceable during inspection. Use only genuine Bendix replacement parts.

ASSEMBLY (Refer to Figure 2)

Prior to assembly of the SR-1 Spring Brake Valve, lubricate all o-rings, o-ring grooves, and piston bores with Dow Corning 55-M Pneumatic Grease (Bendix No. 291126).

Note: All torques specified in this manual are assembly torques and can be expected to fall off, after assembly is accomplished. Do not retorque after initial assembly torques fall.

1. Assemble the check valve (4), and valve spring (2) and install in body.
2. Apply pipe sealant to the socket head pipe plug (1) and install in the body. Tighten to 130-170 inch pounds torque.
3. Install inlet and exhaust valve assembly (7) in valve body.
4. Secure the exhaust cover (5) with two 10-24 phillips screws and lockwashers. Tighten to 20-30 inch pounds torque.
5. Install exhaust diaphragm (6) into the exhaust cover.
6. Place inlet exhaust valve (12) in the body. Install the valve spring (11) and valve stop (10).
7. Install o-ring (9) on cap nut and install cap nut (8) in body. Tighten to 100-125 inch pounds torque.
8. Install the small and large o-rings (16) on the small diameter piston (15) and install piston in the body.
9. Install large o-ring (18) and small o-ring (19) on the large diameter piston and install piston in the body.
10. Install the piston springs (14) in their respective pistons.
11. Secure the cover to body using four 1/4"-20 phillips head screws and lockwashers. Tighten to 50-80 inch pounds torque.

TESTING THE REBUILT SR-1 SPRING BRAKE VALVE

Test the rebuilt SR-1 Spring Brake Valve by performing the operation and leakage test outlined in the "Service Checks" section of this manual.

IMPORTANT! PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended pressure and always wear safety glasses when working.

Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices and mounting and attaching hardware specifically designed for use in hydraulic brake systems should be used.
   B. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type and strength as the original equipment.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

Bendix

Heavy Vehicle Systems Group

Section VI

BRAKE SYSTEM

Service Data

SD-03-5

Formerly SD-65

E-6, E-10 DUAL BRAKE VALVE

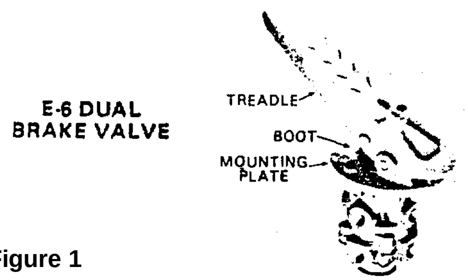


Figure 1

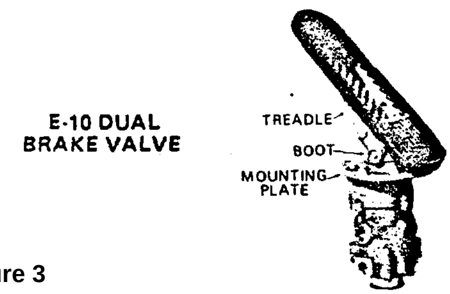


Figure 3

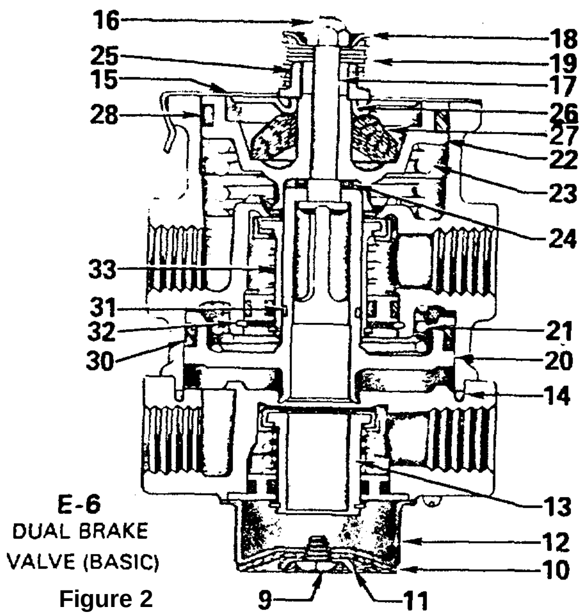


Figure 2

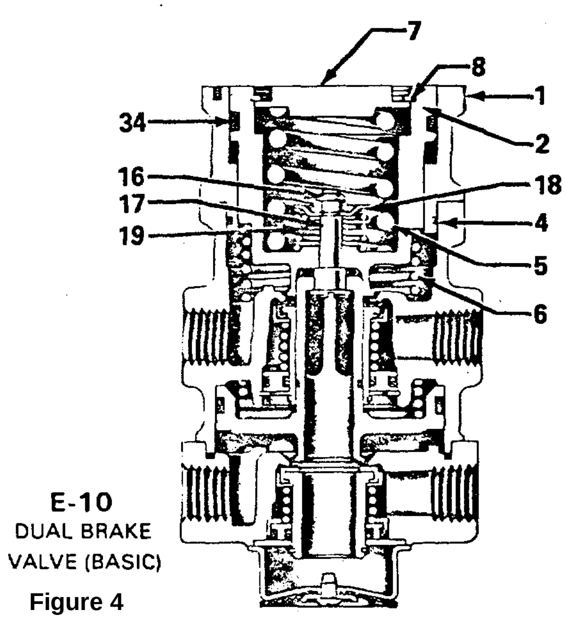


Figure 4

DESCRIPTION

The E-6 (Fig. 1) and E-10 (Fig. 3) Dual Brake Valves are floor mounted, treadle-operated type brake valve with two separate supply and delivery circuits for service and secondary braking, which provides the driver with a graduated control for applying and releasing the vehicle brakes.

The E-10 Dual Brake Valve (Fig. 3) is similar to the E-6 Dual Brake Valve except that a metal coil spring housed in an upper body assembly replaces the rubber spring used in the E-6 valve. The use of a metal coil spring (and the upper body assembly) provides greater travel and, therefore, provides the driver with a less sensitive "feel" when making a brake application. The E-10 Dual Brake Valve is generally used on busses, where smooth brake applications contribute to passenger comfort.

The circuits in the E-6/E-10 Dual Brake Valves are identified as follows: The No. 1 circuit portion is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 circuit portion is that portion between the relay piston and the exhaust cavity.

The No. 1 circuit portion of the valve is similar in operation to a standard single-circuit air brake valve, and under normal operating conditions the No. 2 circuit portion is similar in operation to a relay valve.

Both No. 1 and No. 2 circuit portions of the Brake Valve use a common exhaust protected by an exhaust diaphragm.

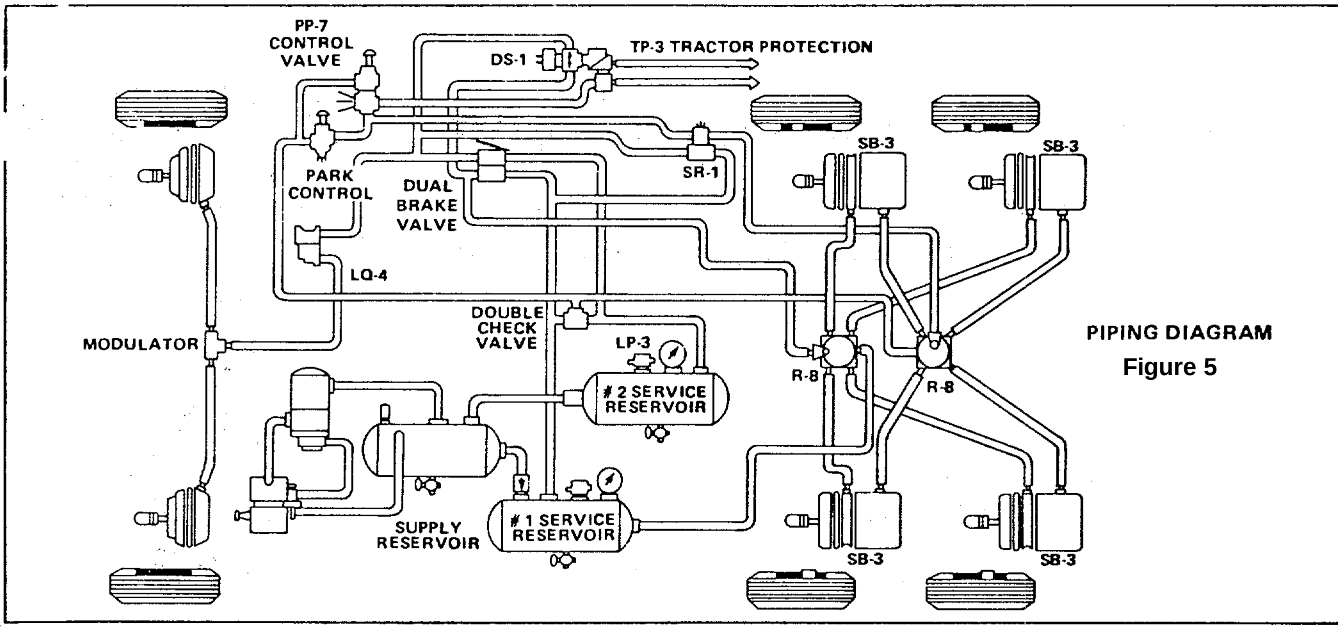


Figure 5

OPERATION

APPLYING: NORMAL OPERATION - NO. 1 CIRCUIT PORTION

When the brake treadle is depressed, the plunger exerts force on the spring seat, graduating spring, and No. 1 piston. The No. 1 piston which contains the exhaust valve seat, closes the No. 1 exhaust valve. As the exhaust valve closes, the No. 1 inlet valve is moved off its seat allowing No. 1 air to flow out the No. 1 delivery port.

APPLYING: NORMAL OPERATION - NO. 2 CIRCUIT PORTION

When the No. 1 inlet valve is moved off its seat, air is permitted to pass through the bleed passage and enters the relay piston cavity. The air pressure moves the relay piston, which contains the exhaust seat and closes the No. 2 exhaust valve. As the No. 2 exhaust valve closes, the No. 2 inlet valve is moved off its seat allowing the No. 2 air to flow out the No. 2 delivery port. Because of the small volume of air required to move the relay piston, action of the No. 2 circuit portion of the valve is almost simultaneous with the No. 1 circuit portion.

APPLYING: LOSS OF AIR IN THE NO. 2 CIRCUIT

Should air be lost in the No. 2 circuit, the No. 1 circuit portion will continue to function as described above under "Normal Operation: No. 1 Circuit Portion".

APPLYING: LOSS OF AIR IN THE NO. 1 CIRCUIT

Should air be lost in the No. 1 circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the No. 1 circuit supply and delivery poris, the No. 1 piston will mechanically move the relay piston allowing the piston to close the No. 2 exhaust valve and open the No. 2 inlet valve and allow air to flow out the No. 2 delivery port.

BALANCED: NO. 1 CIRCUIT PORTION

When the No. 1 delivery pressure acting on the piston equals the mechanical force of the brake pedal application, the No. 1 piston will move and the No. 1 inlet-valve will close, stopping the further flow of air from the No. 1 supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

BALANCED: NO. 2 CIRCUIT PORTION

When the air pressure on the No. 2 side of the relay piston approaches that being delivered on the No. 1 side of the relay piston, the relay piston moves closing the No. 2 inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the No. 2 delivery pressure balances the No. 1 delivery pressure.

When applications in the graduating range are made, a balanced position in the No. 1 portion is reached as the air pressure on the delivery side of the No. 1 piston equals the effort exerted by the driver's foot on the treadle. A balanced position in the No. 2 portion is reached when air pressure on the No. 2 side of the relay piston closely approaches the air pressure on the No. 1 side of the relay piston.

When the brake treadle is fully depressed, both the No. 1 and No. 2 inlet valves remain open and full reservoir pressure is delivered to the actuators.

RELEASING: NO. 1 CIRCUIT PORTION

With the brake treadle released, mechanical force is removed from the spring seat, graduating spring, and No. 1 piston. Air pressure and spring load moves the No. 1 piston, opening the No. 1 exhaust valve, allowing air pressure in the No. 1 delivery line to exhaust out the exhaust port.

RELEASING: NO. 2 CIRCUIT PORTION

With the brake treadle released, air is exhausted from the No. 1 circuit side of the relay piston. Air pressure and spring load move the relay piston, opening the No. 2 exhaust valve allowing air pressure in the No. 2 delivery line to exhaust out the exhaust port.

PREVENTIVE MAINTENANCE

EVERY 3 MONTHS, 25,000 MILES OR 900 OPERATING HOURS

Clean any accumulated dirt, gravel, or foreign material away from the heel of the treadle, plunger boot, and mounting plate.

Using light oil, lubricate the treadle roller, roller pin, and hinge pin.

Check the rubber plunger boot for cracks, holes or deterioration and replace if necessary. Also, check mounting plate and treadle for integrity.

Apply 2 to 4 drops of oil between plunger and mounting plate - do not over oil!

EVERY YEAR, 100,000 MILES, OR 3,600 OPERATING HOURS

Disassemble, clean parts with mineral spirits, replace all rubber parts or any part worn or damaged. Check for proper operation before placing vehicle in service.

SERVICE CHECKS

OPERATING CHECK

Check the delivery pressure of both No, 1 and No. 2 circuits using test gauges known to be accurate. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.

After a full application is released, the reading on the test gauges should fall off to zero promptly. It should be noted that the No. 1 circuit delivery pressure will be about 2 PSI greater than the No. 2 circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

IMPORTANT -A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits, including the pneumatic and mechanical devices are operating normally. Always check the vehicle brake system for proper operation after per- forming brake work and before returning the vehicle to service.

LEAKAGE CHECK

1. Make and hold a high pressure (80 psi) application.
2. Coat the exhaust port and body of the brake valve with a soap solution.
3. Leakage permitted is a one inch bubble in 3 seconds.

If the brake valve does not function as described above or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at Bendix outlets.

REMOVAL

1. Check the vehicle wheels or park the vehicle by mechanical means. Drain all air system reservoirs.
2. Identify and disconnect all supply and delivery lines at the brake valve.
3. Remove the brake valve and treadle assembly from the vehicle by removing the three cap screws on the outer bolt circle of the mounting plate. The basic brake valve alone can be removed by removing the three cap screws on the inner bolt circle.

DISASSEMBLY (Fig. 2)

1. If the entire brake valve and treadle assembly was removed from the vehicle, remove the three cap screws securing the treadle assembly to the basic brake valve.
2. Remove the Phillips head screw (9) securing the exhaust diaphragm (10) and washer (11) to the exhaust cover (12).
3. Remove the four screws that secure the exhaust cover (12) to the lower body.
4. Remove the No. 2 inlet and exhaust valve assembly (13) from the lower body.
5. Remove the four hex head cap screws securing the lower body to the upper body and separate the body halves.
6 Remove the rubber seal ring (14) from the lower body.
7. E-6 VALVE ONLY - While applying thumb pressure to the No. 1 piston, lift out and up on the three lock tabs of the No. 1 piston retainer (15).

E-10 VALVE ONLY (Fig. 4)

8. A. While depressing spring seat (7), remove retaining ring (8).
   B. Remove spring seat and coil spring (5).
9. Using a 3/8" wrench, hold the lock nut (16) on the threaded end of the stem (17) in the primary piston (2). Insert a screwdriver in the exhaust passage through the center of the valve and engage the slotted head of the stem.
10. Remove lock nut (16), spring seat (18), stem spring (19), primary piston (2), and primary piston return spring (6). Remove 0-ring (34).
11. Remove adapter (1). Remove 0-ring (4) from adapter.

CAUTION: Before proceeding with the disassembly, refer to Figure 4 and note that the lock nut and stem are used to contain the No. 1 piston return spring, stem spring and the relay piston spring. The combined force of these springs is approximately 50 pounds and care must be taken when removing the lock nut as the spring forces will be released. It is recommended that the primary piston and relay piston be manually or mechanically contained while the nut and stem are being removed.

E-6 VALVE ONLY -

12. Using a screwdriver to restrain the stem, as in step nine, remove the lock nut (16), spring seat (18) and stem spring (19).
13. Remove the relay piston (20), relay piston spring (21), primary piston and primary piston return spring (23) from the upper body. Use care so as not to nick seats. **NOTE:** Certain E-6 valves do not have a relay piston spring (21). If none is found, none should be replaced.
14. On valves manufactured after October 7, 1976, a small washer (24) will be found in the cavity in the lower side of the primary piston (22).
15. Disassemble the primary piston by rotating the spring seat nut (25) counterclockwise. Separate the spring seat nut, spring seat (26), rubber spring (27) and remove the piston 0-ring (28).
16. Remove the large (30) and small (31) 0-rings from the relay piston (20).
17. Remove the retaining ring (32) securing the No. 1 inlet and exhaust valve assembly (33) in the upper body and remove the valve assembly.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry.
2. Inspect all parts for excessive wear or deterioration.
3. Inspect the valve seats for nicks or burrs.
4. Check the springs for cracks or corrosion.
5. Replace all rubber parts and any part not found to be serviceable during inspection, using only genuine Bendix replacement parts.

ASSEMBLY

Prior to reassembling, lubricate all 0-rings, 0-ring grooves, piston bores and metal to metal moving surfaces with Dow Corning 55-M pneumatic grease (Bendix piece number 291 126).

NOTE: All torques specified in this manual are assembly torques and can be expected to fall off, after assembly is accomplished. Do not retorque after initial assembly torques fall.

1. Install the No. 1 inlet and exhaust assembly (33) in the upper body and replace the' retaining ring (32) to secure it. Be sure the retaining ring is seated completely in its groove.
2. Install the large (30) and small (31) 0-rings on the relay piston.
3. Install the primary piston 0-ring (28) in the piston 0-ring groove.

E-6 VALVE ONLY

4. Install the rubber spring (27), concave side down in the primary piston (22) and place the spring seat (26), flat side up, over the rubber spring.
5. Install the primary piston spring seat nut (25), with its hex closest to the spring seat, and rotate clockwise until the top surface of the spring seat is even with the top surface of the piston. Set aside.
6. Install large (30) and small (31) 0-rings on relay piston (20).
7. Place relay piston, spring (21) (if used) in concave portion of relay piston and install relay piston through No. 1 inlet/exhaust assembly (33) and into under side of upper body.
8. Place screwdriver, blade up, in vise. Place stem (17) in relay piston upper body sub-assembly over the blade of the screwdriver with blade engaged in the slot in the head of the stem.
9. Place the washer (24) over the stem. This washer should be installed in all valves.
10. Install primary return spring (23) in upper body piston bore.
11. Install the primary piston rubber spring sub-assembly (steps 4 & 5) over the stem, into the upper body piston bore.
12. Compress the primary and relay pistons into the upper body from either side and hold them compressed, either manually or mechanically. **SEE THE CAUTIONARY NOTE UNDER STEP 11 IN THE "DISASSEMBLY" SECTION OF THIS MANUAL.**
13. Place the stem spring (19) over the spring seat nut (25) and the spring seat (18) over the stem.
14. Install the lock nut (16) on the stem and torque to 20-30 inch pounds.
15. Install the primary piston retainer (15) over the piston, making certain all three lock tabs have engaged the outer lip of the body.

IMPORTANT! PLEASE READ

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Use only proper tools and observe all precautions pertaining to use of those tools. Some components contain powerful springs and injury can result if not properly disassembled.

Bendix

Heavy Vehicle Systems Group

Section VI

BRAKE SYSTEM

Service Data

SD-03-55

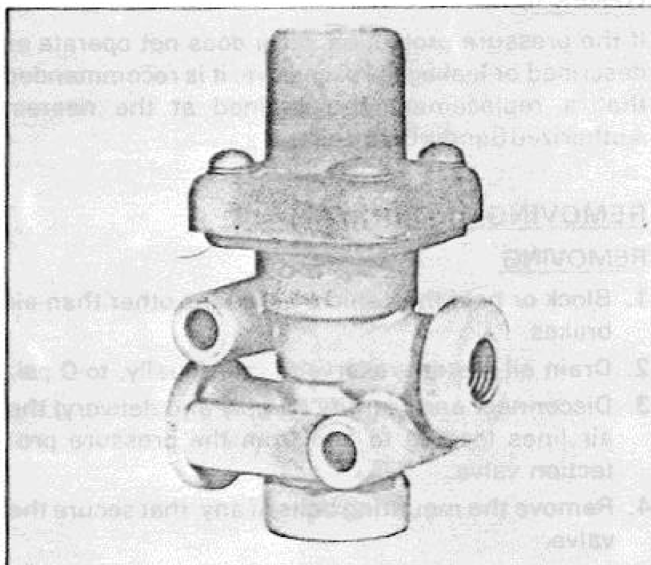
Formerly SD-46

PRESSURE PROTECTION VALVES

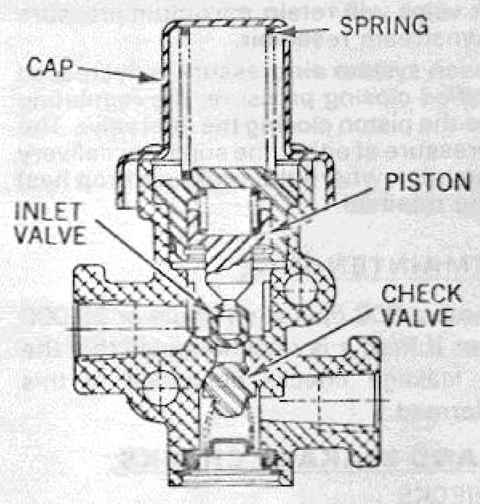
DESCRIPTION

The pressure protection valve is a normally closed, pressure control valve which can be referred to as a non-exhausting sequence valve. These valves are used in many different applications. An example would be in an air brake system to protect one reservoir, or reservoir system from another, by closing automatically at a preset pressure should a reservoir system failure occur. The valves can also be used to delay filling of auxiliary reservoirs to insure a quick build-up of brake system pressure.

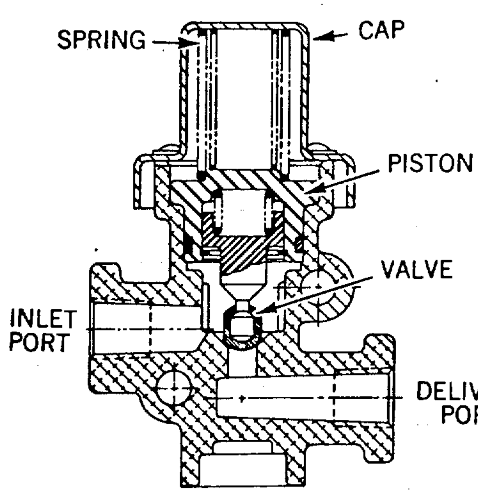
The PR-2,and PR-4 pressure protection valves have one 1/4" N.P.T.F. supply port and one 1/4" N.P.T.F. delivery port which are identified. Both valves are provided with two 9/32" mounting holes through the body. The closing pressure of the PR-2 is externally adjustable while the PR-4 has a fixed setting.



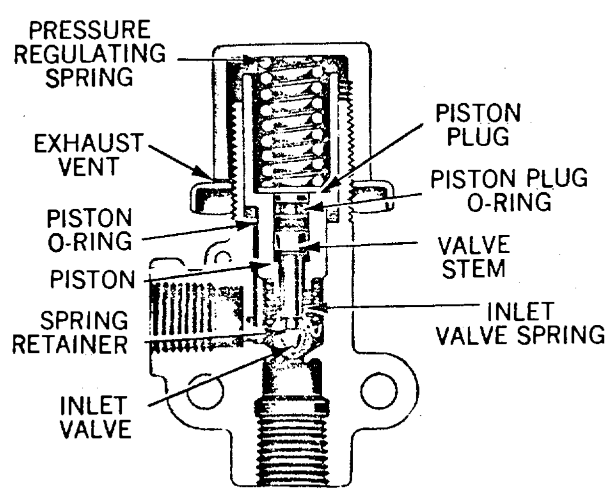
PR-3 or PR-4



PR-3



PR-4



PR-2

OPERATION

Air entering the supply port is initially prevented from flowing out the delivery port by the inlet valve which is held closed by the pressure regulating spring above the piston. When sufficient air pressure builds beneath the piston to overcome the setting of the regulating spring, the piston will move, causing the inlet valve to unseat (open), and allow air to flow out the delivery port. As long as air pressure at the supply port and beneath the piston remains above the specified closing pressure, the inlet valve will remain open.

NOTE: The PR-2 and PR-4 closing pressure is noted on the label affixed to the valve. Opening pressures of the valves are higher than closing pressures. The pressure ranges are noted below:

PR-2-Opening pressure 15-20 psi higher than closing pressure.

PR-3 & PR-4-Opening pressure approx. 10 psi higher than closing pressure.

PR-3-Check valve will retain maximum pressure in downstream reservoir.

If for any reason system air pressure is decreased below the specified closing pressure, the regulating spring will move the piston closing the inlet valve. The remaining air pressure at either the supply or delivery side, (depending upon where the pressure drop has) occurred) will be retained.

PREVENTIVE MAINTENANCE

Every three months, 900 operating hours or 25,000 miles, whichever if first, it is recommended that the operation and leakage checks described in this manual be performed.

OPERATING AND LEAKAGE CHECKS

OPERATING CHECKS

1. Provide a pressure gauge and drain valve at the supply side and delivery side of the pressure protection valve being checked.
2. Build up the air system to full pressure and shut off the engine.
3. While watching the gauges on the supply and delivery sides of the valve, slowly begin to exhaust pressure from the delivery side. Note that both gauges will show pressure loss until the closing pressure of the pressure protection valve is reached.

   The pressure protection valve should close at approximately (± 5 psi) the pressure indicated on the valve's label or in the vehicle handbook. The gauge on the delivery side of the valve should continue to show loss of pressure while the gauge on the supply side should stop at the same pressure as the setting of the valve.

   PR-3 only) Build pressure up again and shut off engine. Slowly exhaust air from the supply side of the PR-3.

   The gauge on the delivery side of the valve should remain at the highest pressure previously attained.

LEAKAGE CHECKS

1. Build up the air system to full pressure and shut off the engine.

2. Apply a soap solution around the cap of the pressure protection valve. A one-inch bubble in three seconds or longer is acceptable. PR-3 No leakage permissable at bottom of valve.

3. Drain the air pressure from the delivery side of the pressure protection valve and disconnect the air line to it.

4. Apply a soap solution to the delivery port. A one inch bubble in five seconds or more is acceptable.

GENERAL

If the pressure protection valve does not operate as described or leakage is excessive, it is recommended that a replacement be obtained at the nearest Authorized Bendix Distributor.

REMOVING AND INSTALLING

REMOVING

1. Block or hold the vehicle by means other than air brakes.
2. Drain all system reservoirs individually, to 0 psi.
3. Disconnect and identify (supply and delivery) the air lines leading to and from the pressure protection valve.
4. Remove the mounting bolts, if any, that secure the valve.

INSTALLING

1. Re-install the mounting bolts and secure the replacement valve to the vehicle.
2. Reconnect the supply delivery air lines to the proper ports of the replacement valve.

GENERAL

After installing a replacement valve, it is recommended that the operating and leakage checks be performed as outlined in this manual. If the closing pressure does not conform to that shown on the valve label or in the vehicle or a different setting is desired, the PR-2 may be adjusted by loosening the locknut and tightening or loosening the adjusting cap as required; however, if the proper setting cannot be attained by moderate adjustment of the cap, the valve may have the wrong spring and will have to be exchanged for the correct valve. The PR-3 and PR-4 are not adjustable.

IMPORTANT! PLEASE READ

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Use only proper tools and observe all precautions pertaining to use of those tools. Some components contain powerful springs and injury can result if not properly disassembled.

DV-2 AUTOMATIC RESERVOIR DRAIN VALVE

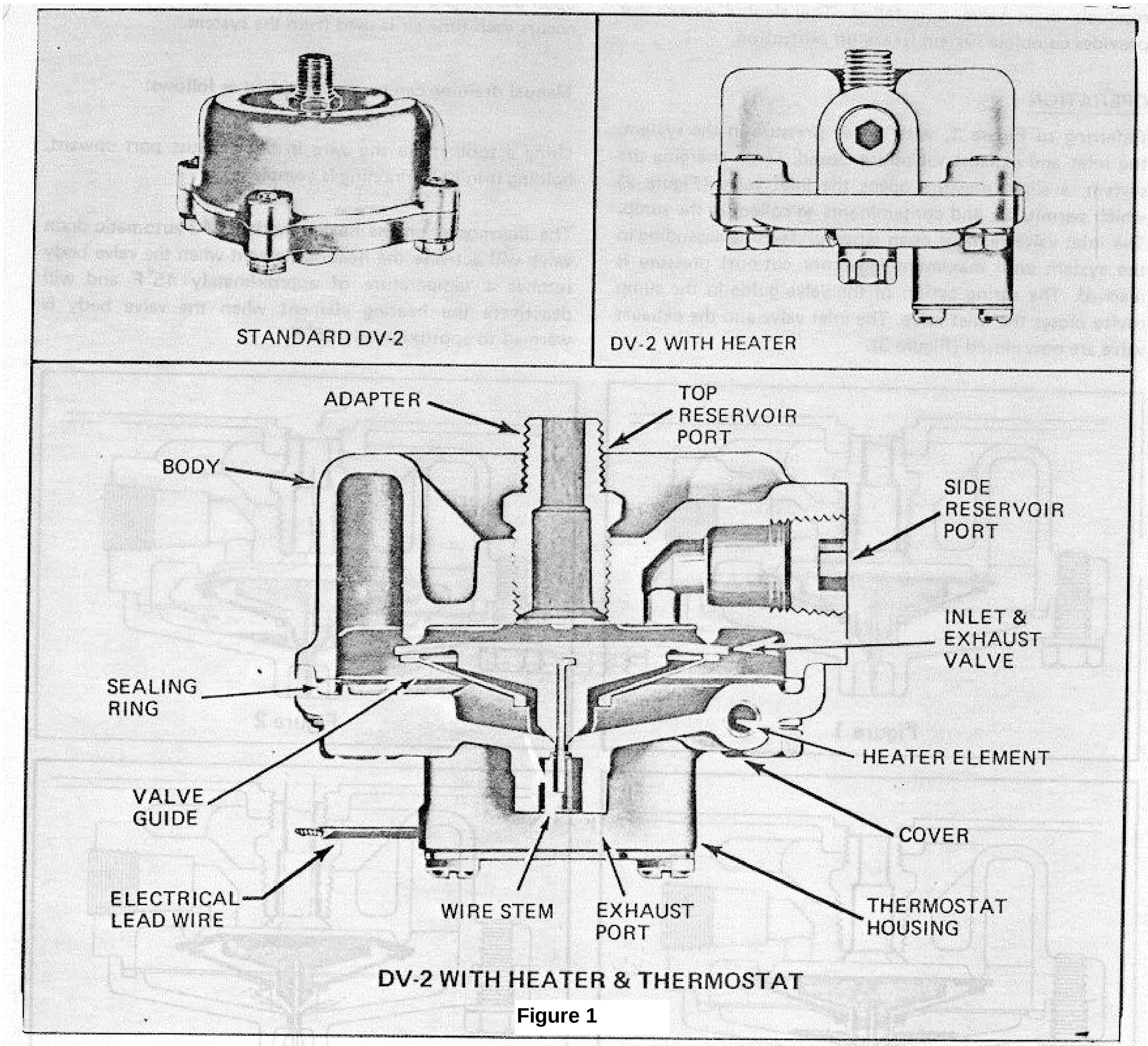


Figure 1

DESCRIPTION

The DV-2 Automatic Reservoir Drain Valve ejects moisture and contaminants from the reservoir in which it is connected. It operates automatically and requires no manual assistance or control lines from other sources. The automatic reservoir drain valve has a die cast aluminum body and cover and is normally mounted either in the bottom of the reservoir using the top port of the drain valve or in the end of an end drain reservoir using the side port of the valve. The DV-2 is also available with a heater and thermostat cast into the cover for vehicles operated in subfreezing temperatures

The heated DV-2 is supplied in either a 12 or 24 volt model and in bottom or end drain configuration. A 1/4" male pipe adapter is supplied with all DV-2 drain valves, end drain and bottom drain, both standard and heated. This adapter should be installed directly into the reservoir. Early versions included a filter screen in the adapter. The filter should be discarded. Later versions may have a standard pipe nipple instead of the adapter.

NOTE: If a vehicle equipped with a DV-2 Automatic Drain Valve(s) is operated in subfreezing temperatures, it is recommended that an alcohol evaporator be installed and properly maintained regardless of the fact that a heated reservoir drain valve is installed. The alcohol evaporator provides complete system freeze-up protection.

OPERATION

Referring to Figure 1, with no air pressure in the system, the inlet and exhaust valves are closed. Upon charging the system, a slight pressure opens the inlet valve (Figure 2) which permits air and contaminants to collect in the sump. The inlet valve remains open when pressure is ascending in the system until maximum (governor cut-out) pressure is reached. The spring action of the valve guide in the sump cavity closes the inlet valve. The inlet valve and the exhaust valve are now closed (Figure 3).

When reservoir pressure drops slightly (approximately . 2 psi), air pressure in the sump cavity opens the exhaust valve (Figure 4) and allows moisture and contaminants to be ejected from the sump cavity until pressure in the sump cavity drops sufficiently to close the exhaust valve.

The length of time the exhaust valve remains open and the amount of moisture and contaminants ejected depends upon the sump pressure and the reservoir pressure drop that occurs each time air is used from the system.

Manual draining can be accomplished as follows:

Using a tool, move the wire in the exhaust port upward, holding it in until draining is completed.

The thermostat on the heated model DV-2 automatic drain valve will activate the heating element when the valve body reaches a temperature of approximately 450F and will deactivate the heating element when the valve body is warmed to approximately 85° F.

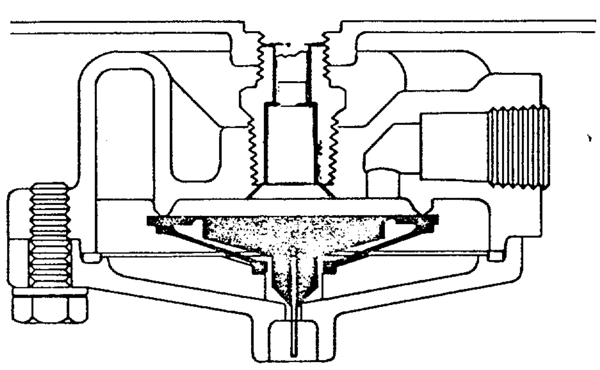


Figure 1

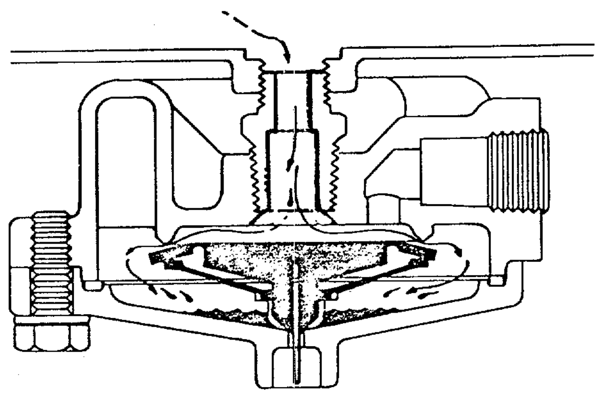


Figure 2

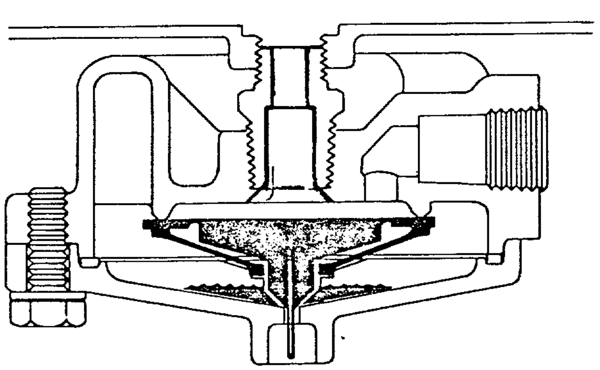


Figure 3

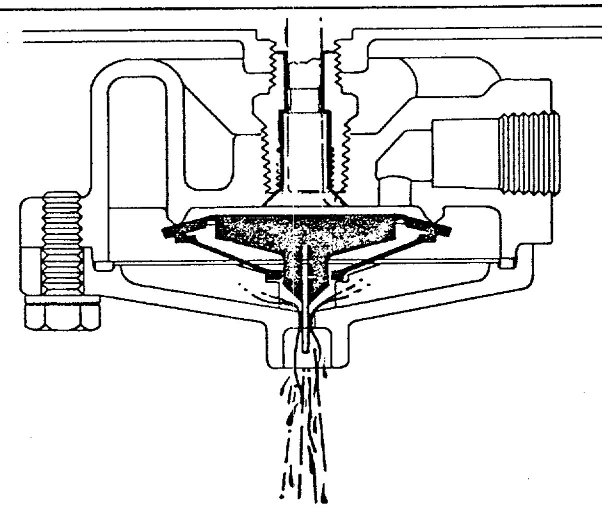


Figure 4

PREVENTIVE MAINTENANCE

Every 1800 operating hours or 50,000 miles or every 6 months the automatic drain valve should be removed, disassembled, cleaned, and lubricated.

Parts showing signs of wear or deterioration should be replaced.

If there is a filter screen in the adapter sitting it should be removed and discarded.

SERVICE CHECKS

OPERATING TEST

With system charged, make several foot valve applications and note each time an application is made, an exhaust of air occurs at the exhaust port of the drain valve. If no air comes out, push the wire stem. If no air comes out, there may be a plugged filter in the adapter which should be removed and discarded.

LEAKAGE TEST

With system charged and pressure stabilized in system, there should be no leaks at the drain valve exhaust A constant slight exhaust of air at the drain valve exhaust could be caused by excessive leakage in the air brake system.

If the DV-2 Automatic Drain Valve does not function as described or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit or repaired with genuine Bendix parts available at Bendix outlets.

INSTALLING AND REMOVING

REMOVING

Block and hold vehicle by means other than air brakes.

Drain air system.

Disconnect heater wire if valve is so equipped.

Remove automatic reservoir drain valve.

DISASSEMBLY Remove 4 cap screws and lock washers.

Remove cover and sealing ring.

NOTE: The heater and thermostat of the DV-2's so equipped are not serviceable. If the heater or thermostat has failed, the entire cover must be replaced. Do not remove the thermostat cover plate. It is moisture sealed and removal could result in early thermostat failure.

Remove valve guide.

Remove inlet and exhaust valve.

Remove adapter and filter assembly (if filter present).

Remove filter retainer (if any).

Remove filter (if any).

INSTALLING

Block and hold vehicle by means other than air brakes.

Drain air system.

To avoid early fouling at the DV-2, thoroughly finish and clean the reservoir before installing the drain valve.

Aerate any tank thoroughly if any solvents have been used in the cleaning process.

IMPORTANT

When installing a DV-2 drain valve equipped with a heater and thermostat, first determine if the vehicle electrical system is 12 or 24 volt, and that the Heater/Thermostat Unit is of the same voltage. The #14 gauge lead wire on the valve should be connected to the "on" position of the engine control or ignition switch. Use an 8 amp fuse for one valve, a 15 amp fuse for two valves, and a 20 amp fuse for three valves. All electrical connections must be waterproof.

CLEANING AND INSPECTION

Cleaning solvent may be used on metal parts.

Rubber parts should be wiped clean.

Inspect all parts for wear or deterioration.

Discard filter screen if present.

Replace all parts not considered serviceable during these inspections.

Bendix Field Maintenance Kit 282134 contains all parts necessary for servicing all models of tire DV-2.

ASSEMBLY

Before assembling the valve, apply a light film of grease on inlet valve seat

DO NOT APPLY OIL TO THE INLET AND EXHAUST VALVE.

Place sealing ring in groove of cover.

Place valve guide over inlet and exhaust valve.

Place valve guide and inlet and exhaust assembly into cover (wire will project through exhaust port).

Place body on cover and install cap screws and lockwashers.

Install adapter or pipe nipple in appropriate port.

Install drain valve in reservoir and reconnect heater wire if drain valve is so equipped.

NOTE: Covers on the standard and heated drain valve scan be interchanged.

TESTING REBUILT AUTOMATIC RESERVOIR DRAIN VALVE

Perform "Operating and Leakage Checks" as outlined in this section.

IMPORTANT! PLEASE READ

When working on or around air brake systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

2. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.

3. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.

4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

Bendix Heavy Vehicle Systems Group

Heavy Vehicle Systems Group

Section VI
BRAKE SYSTEM

Service Data

SD-03-66
Formerly SD-55

IN-LINE SINGLE CHECK VALVES

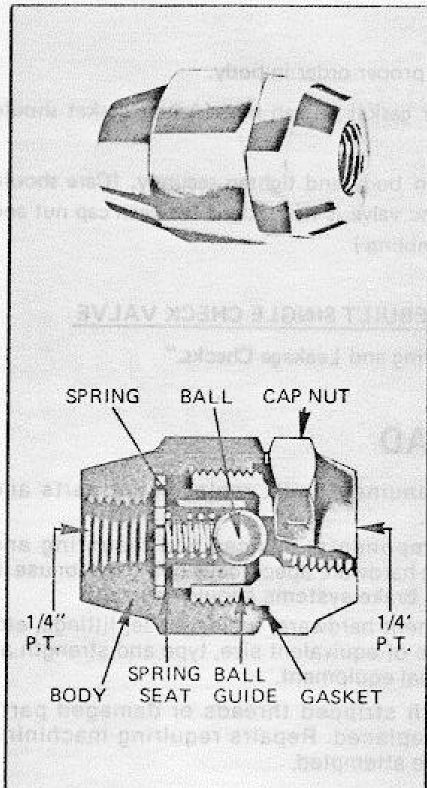


Figure 1

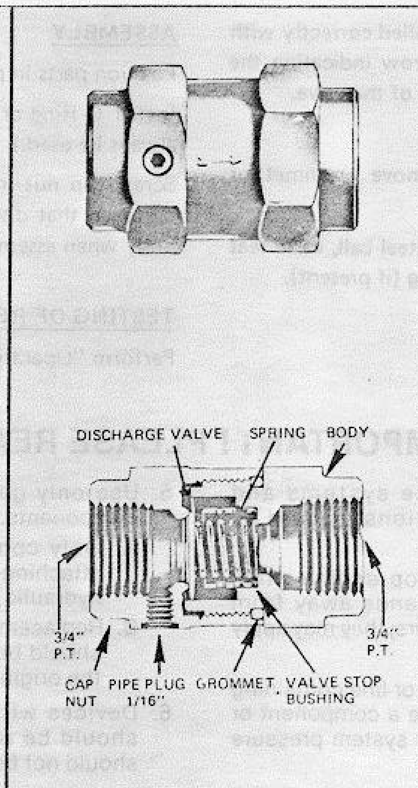


Figure 2

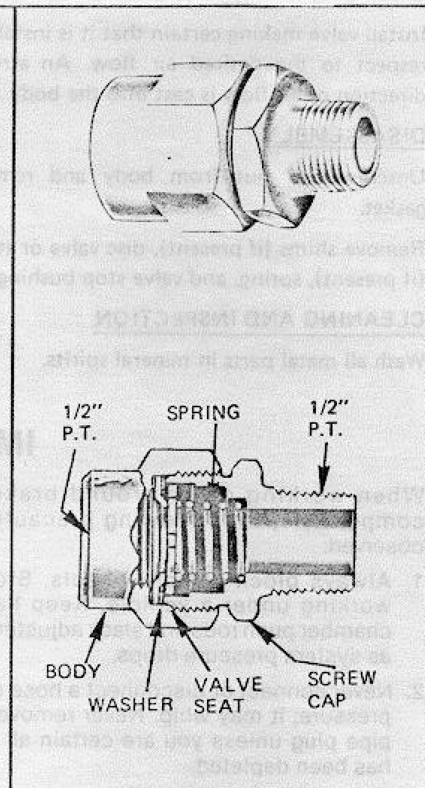


Figure 3

DESCRIPTION

The In-Line Single Check Valve is a device placed in an air line to allow air flow in one direction only and to prevent flow of air in the reverse direction.

The three types of In-Line Single Check Valves used in service are:

1. The ball type (Figure 1).
2. The disc type with integral seat (Figure 2).
3. The disc type with a replaceable seat (Figure 3); the replaceable seat being made of either metal or rubber.

An arrow indicating the direction of air flow is cast into the body of the valve.

OPERATION

Air flow in the normal direction moves the check valve ball or disc from its seat, and the flow is unobstructed. Flow in the reverse direction is prevented by the seating of the ball or disc, which is caused by a drop in up-stream air pressure and assisted by the spring.

PREVENTIVE MAINTENANCE

Every six months, 1800 operating hours or every 50,000 miles, disassemble, clean and inspect all parts.

Replace any parts showing signs of wear or deterioration.

Reassemble and check for proper operation.

OPERATING AND LEAKAGE CHECK

NOTE: Depending upon installation, it may be easier or necessary to completely remove check valves so that the following checks may be made.

With air pressure present at outlet side of check valve and the inlet side open to atmosphere, coat the open end of the check valve with soap suds; a 1" bubble in 5 seconds is permissible.

If the check valve does not function as described, or leakage is excessive, it is recommended that it be replaced with a new unit or repaired with genuine Bendix parts available at Bendix H. V. S. G. outlets.

REMOVING AND INSTALLING

REMOVING

Block and hold vehicle by means other than air brakes.

Completely drain all reservoirs.

Disconnect air lines at single check valve and remove.

INSTALLING

Check and, if necessary, clean or replace air lines to valve.

Install valve making certain that it is installed correctly with respect to the desired air flow. An arrow indicating the direction of air flow is cast into the body of the valve.

DISASSEMBLY

Unscrew cap nut from body and remove grommet or gasket Remove shims (if present), disc valve or steel ball, valve seat (if present), spring, and valve stop bushing (if present).

CLEANING AND INSPECTION

Wash all metal parts in mineral spirits.

Rubber parts should be wiped clean.

Inspect ball or disc valve and seat for signs of wear or deterioration.

Check spring for cracks, corrosion or distortion.

Inspect body and cap nut for cracks or damage.

Replace all parts not considered serviceable during these inspections.

ASSEMBLY

Position parts in proper order in body.

Install O-Ring or gasket on cap nut (A new gasket should always be used.) Screw cap nut in body and tighten securely. (Care should be taken that disc valve is not lodged between cap nut and body when assembling.)

TESTING OF REBUILT SINGLE CHECK VALVE

Perform "Operating and Leakage Checks. "

IMPORTANT! PLEASE READ

When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.

3. Never exceed recommended pressure and always wear safety glasses when working.

4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

5. Use only genuine Bendix replacement parts and components.

   A. Only components, devices and mounting and attaching hardware specifically designed for use in hydraulic brake systems should be used.

   B. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type and strength as the original equipment.

6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

Bendix

Heavy Vehicle Systems Group

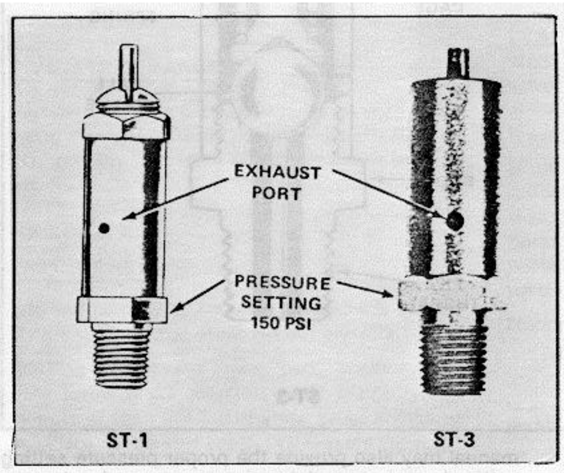
BRAKE SYSTEM

Service Data

SD-03-68

Formerly SD-6

SAFETY VALVE



DESCRIPTION

The Safety Valve protects the air brake system against excessive air pressure build-up. The valve consists of a spring loaded, ball valve subjected to reservoir pressure which will permit air to exhaust reservoir pressure to atmosphere if reservoir pressure rises above the valves' pressure setting, which is determined by the force of the spring.

OPERATION

To illustrate the operation of the Safety Valve, we shall assume that the Governor cut-out pressure is set at 125 psi. A Safety valve with a setting of 150 psi could then be used. Should system pressure rise to approximately 150 psi air pressure would force the ball valve off its seat, and allow reservoir pressure to vent to atmosphere through the exhaust port in the spring cage.

When reservoir pressure decreases sufficiently, the spring force will seat the ball check valve, sealing off reservoir pressure. This would occur at approximately 135 psi for the 150 psi valve. It is important to note that the desired pressure setting of the Safety Valve is determined by the governor cut-out pressure. The opening and closing pressures of the Safety Valve should always be in excess of Governor cut-out pressure setting. The pressure setting is stamped on the lower wrench flat of the valve.

Normally, the Safety Valve remains inoperative and only functions if for any reason reservoir pressure rises above the setting of the valve. Constant "popping off" or exhausting of the Safety Valve can be caused by a faulty Safety Valve, faulty governor, faulty compressor unloading mechanism, or a combination of any of the preceding.

PREVENTIVE MAINTENANCE

Every 100,000 miles, 3600 operating hours, or yearly, the Safety Valve should be removed, disassembled, cleaned and checked for proper operation (See Operating and Leakage Checks).

OPERATING AND LEAKAGE CHECKS

OPERATING TEST: With air pressure in the system, pull the exposed end of the valve stem removing the spring load from the ball check valve. Air should exhaust from the valve's exhaust port. Release the stem, the air flow should stop. Failure of valve to pass operating test would indicate the valve should be disassembled cleaned and rebuilt. (See "Disassembly and Assembly" section). If adjustment is necessary, see "Adjustment" section.

LEAKAGE CHECK: Coat the exhaust port with soap solution. A leakage of a one (1) inch bubble in 5 seconds is permitted. Excessive leakage indicates dirt in valve, faulty ball valve or seat. Valve should be disassembled, cleaned and rebuilt. (See "Disassembly and Assembly" section).

REMOVING AND INSTALLING

REMOVING

1. Block wheels or otherwise secure vehicle and drain reservoirs.
2. Using wrench flat closest to reservoir, unscrew valve from reservoir.

INSTALLING

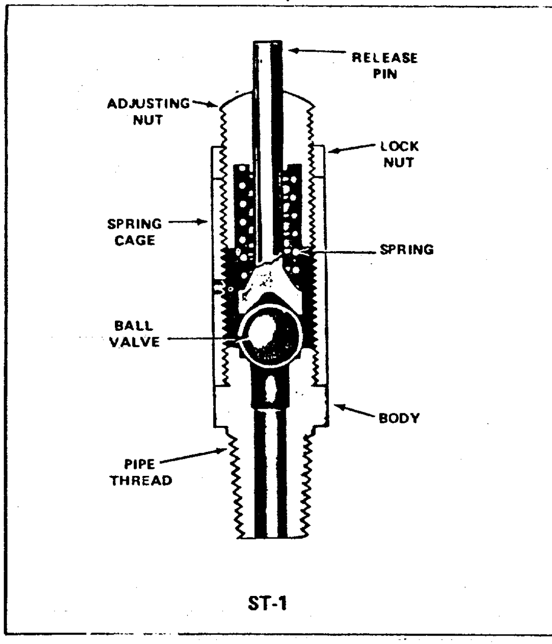
Safety valve should be installed in same reservoir that Compressor discharge line is connected to Install in a convenient location in a top port of the reservoir. If Safety Valve is installed horizontally, exhaust port should point down, stem of the valve should face rear of vehicle.

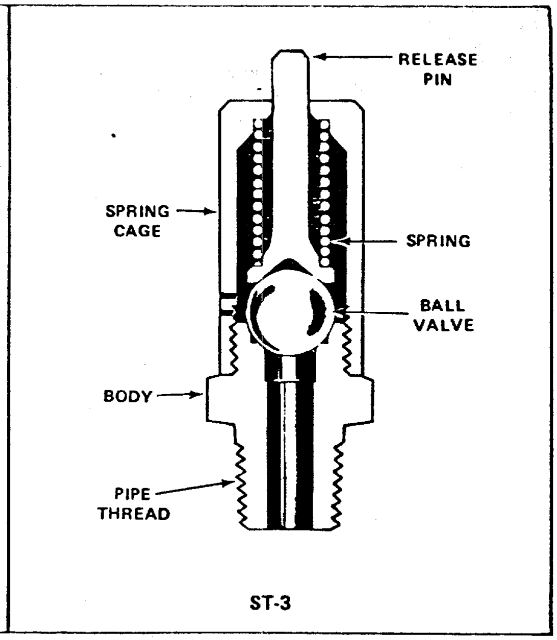
DISASSEMBLY: ST-1 ADJUSTABLE VALVE

1. Clamp lower wrench flat in vise-.(flat nearest pipe thread).
2. Using upper wrench flat, unscrew lock nut Unscrew and remove spring cage from body of valve.
3. Remove ball valve, spring and release pin from spring cage.

DISASSEMBLY: ST-3 NON-ADJUSTABLE VALVE

1. Clamp spring cage in soft jawed vise.
2. Using wrench flat, unscrew body from spring cage.
3. Remove ball valve, spring and release pin from spring cage.





CLEANING AND INSPECTION

Clean all parts in mineral spirits. Inspect all parts. All parts not considered serviceable should be replaced with genuine Bendix replacement parts.

ASSEMBLY: ST-1-ADJUSTABLE VALVE

1. Place the ball valve in body.
2. Install spring and release pin in spring cage with adjusting screw.
3. Position the release pin over ball valve. Screw body with ball into the spring cage. Tighten securely.
4. Adjust for proper setting (see "Adjustment" section).

ASSEMBLY: ST-3 NON-ADJUSTABLE VALVE

1. Install spring, release pin in spring cage.
2. Position ball valve in body and screw spring cage onto body.
3. Hold spring cage in soft jawed vise and tighten body securely.

TO RAISE PRESSURE SETTING

1. Loosen lock nut.
2. Turn adjusting nut clockwise to obtain correct pressure setting.
3. Tighten lock nut.

TO LOWER PRESSURE SETTING

1. Loosen lock nut.
2. Turn adjusting nut counter clockwise to obtain correct pressure setting.
3. Tighten lock nut.

TESTING OF REBUILT SAFETY VALVES:

Perform operating and leakage checks.

ADJUSTMENT OF SAFETY VALVE

NOTE: The ST-3 Safety Valve is not adjustable.

The pressure setting of the Safety Valve is stamped on the cover wrench flat (closest to the pipe thread). The vehicle manual may also provide the proper pressure setting. If setting is not known, determine governor cut-out pressure setting and adjust Safety Valve so that the Safety Valve closes at a pressure setting somewhat above governor cut-out pressure setting (See "Operation" section).

To adjust, the Safety Valve must be connected to an a system with air pressure in excess of desired setting. It is important that 'an accurate gauge be used to check pressure settings while making adjustments.

PRECAUTIONARY NOTE:

IMPORTANT! PLEASE READ

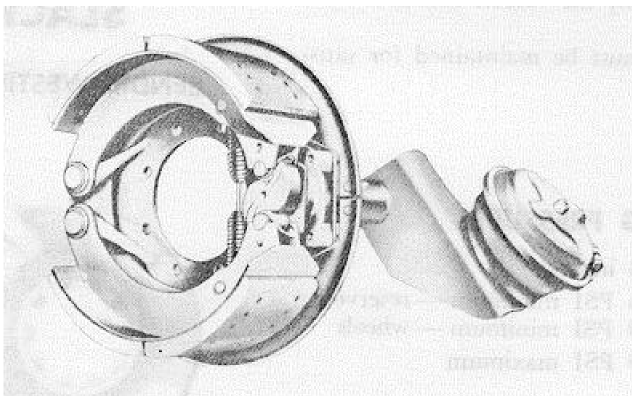
When working on or around brake systems and components, the following precautions, should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.
2. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or pipe plug unless you are certain all system pressure has been depleted.
3. Never exceed recommended pressure and always wear safety glasses when working.
4. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.
5. Use only genuine Bendix replacement parts and components.
   A. Only components, devices and mounting and attaching hardware specifically designed for use in hydraulic brake systems should be used.
   B. Replacement hardware, tubing, hose, fittings, etc. A should be of equivalent size, type and strength as the original equipment.
6. Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.

Section VI
BRAKE SYSTEM

Field Maintenance Manual No. 4

Brakes



Use Only Genuine Rockwell Parts

Rockwell International

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BRAKES
CARE AND MAINTENANCE

IMPORTANT - Brake lining contains asbestos fibers. Caution should be exercised in handling and maintenance as described in OSHA Regulation (29 CFR PART 1910.1001).

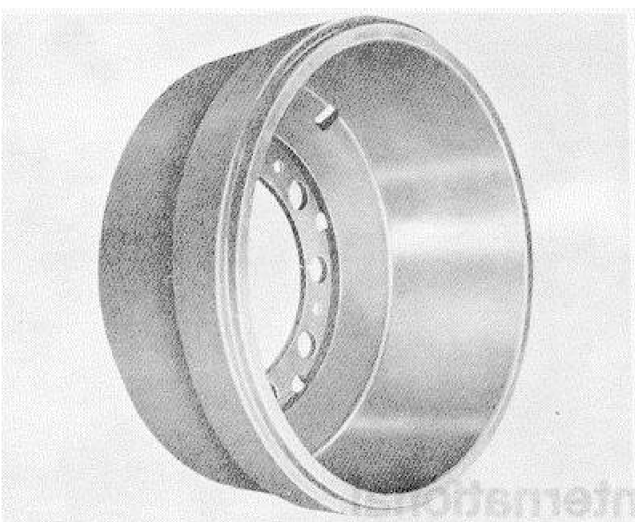
Different types of brake actuating systems are used. This equipment is applied by the vehicle manufacturer.

The following outputs must be maintained for satisfactory brake operation.

OPERATING PRESSURES

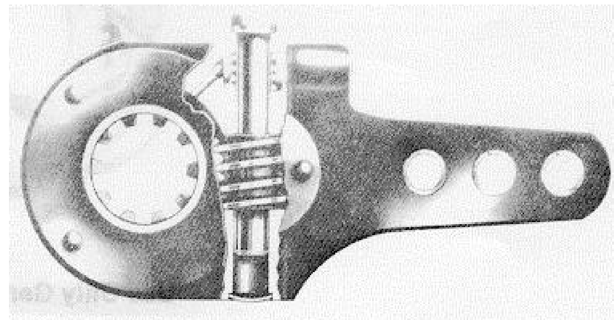
Vacuum	18	inches
Air	85	PSI minimum-reservoir
....	60	PSI minimum-wheels
Hydraulic	1500	PSI maximum

DRUMS

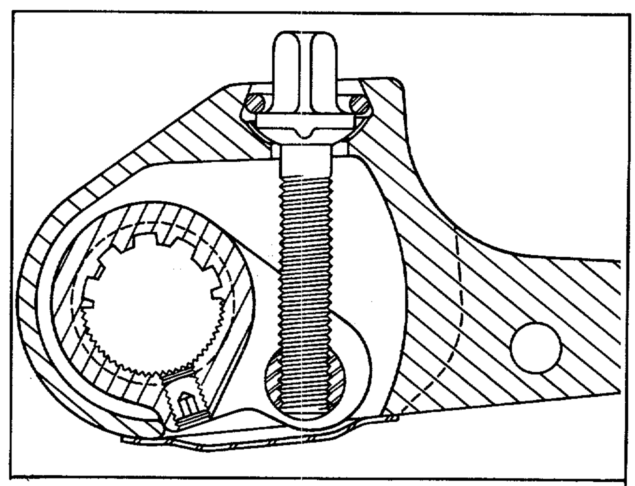


Rockwell does not encourage the reboring of brake drums due to the reduced strength of refaced drums. As an economy measure, in order to salvage drums, some operators do follow this practice. On the Cam-Master® "P" Automotive and CamMaster® "P" Trailer series brakes, under circumstances where refaced drums and oversize linings are used, precautions regarding cam travel should be observed to prevent sticking cams or cam "roll over." This condition prevails when the linings become worn. The service instructions relative to the use of oversize roller cam followers should be carefully followed. Drums which have been refaced should be installed on vehicles operating under the least severe conditions.

SLACK ADJUSTERS
BENDIX-WESTINGHOUSE AND MIDLAND

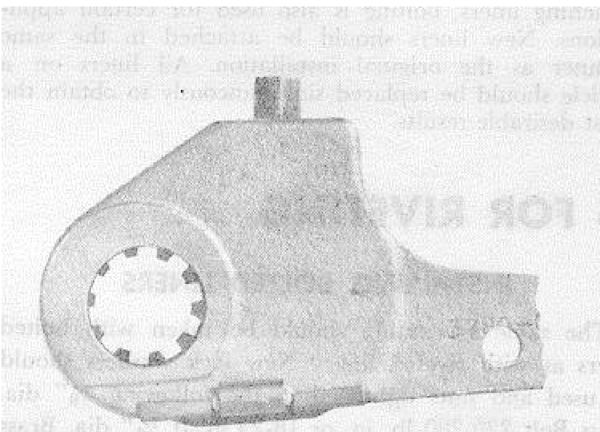


Bendix-Westinghouse and Midland levers permit 360° rotation. Later models of the B/W lever incorporate a self-locking device operated by the adjusting screw wrench.



Service on these units should be obtained through the vehicle manufacturers, Bendix-Westinghouse or Midland. Rockwell does not supply service or parts for these assemblies.

The Rockwell enclosed adjustable lever allows 69 degree rotation of the cam shaft from the initial position. This permits sufficient adjustment to compensate for approximately 5/16" lining wear. To obtain additional adjustment, the lever is moved 4 serrations or 1 spline and readjusted as required.

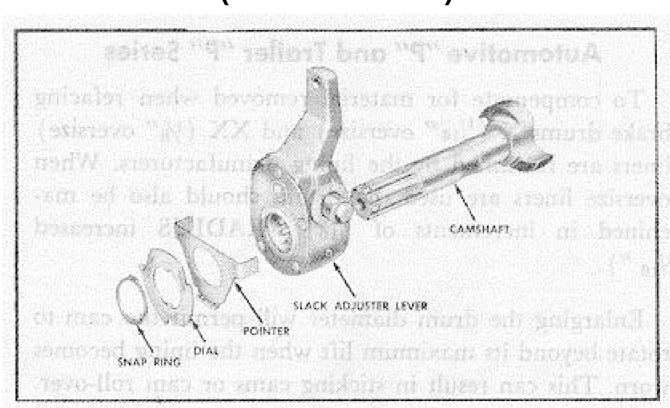


ADJUSTMENT

Adjust bolt locks at 1/4 turn intervals. One notch, or 1/4 turn, provides .0025" movement at the shoe center. When the adjustment limit is reached, loosen clamp bolt and remove lever. Adjust lever to original position, and move back four serrations on shaft, or one full spline. Tighten clamp bolt and adjust as required.

LINING WEAR INDICATOR

(DIAL-& POINTER)



The use of a lining wear indicator (dial and pointer) on slack adjusters of cam actuated brakes will show the progressive degree of brake lining wear. The dial and pointer, when properly installed, will only give an approximation of lining wear. However, this is accurate enough to tell when lining replacement is necessary.

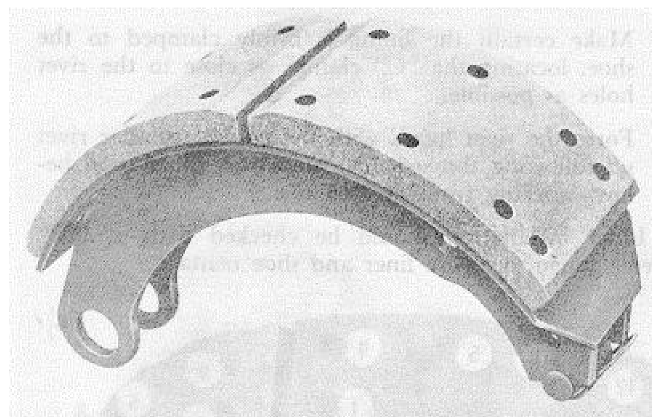
For further information on installing lining wear indicators refer to Rockwell Technic Aid - Section 6, Aid #42.

ROCKWELL AUTOMATIC

For information on Rockwell automatic slack adjusters refer to advance manual "Automatic Slack Adjusters".

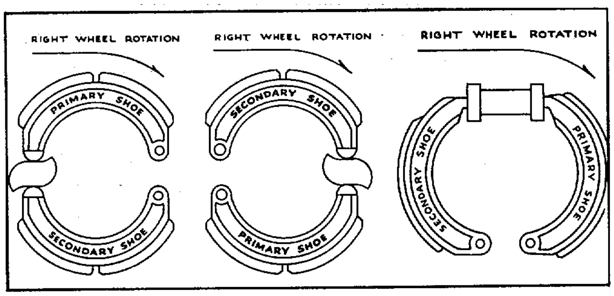
BRAKE LINERS

IMPORTANT-Brake lining contains asbestos fiber,. Caution should be exercised in handling and maintenance as described in OSHA Regulation (29 CFR PART 1910, 1001).



Brake liners vary considerably in both size and content. This is determined by the joint engineering departments of Rockwell and the vehicle manufacturer, depending on the vehicle and its prospective application. Consequently, liners should be replaced in accordance with the manufacturer's recommendations.

Combination liners with a different coefficient of friction for the forward (primary) and reverse (secondary) shoes arc frequently used. On this type installation



the forward blocks must be installed on the forward shoe. It should be remembered, that following the rotation of the drum, the first shoe after passing the cam or wheel cylinder is the forward shoe. Primary lining will be painted blue on the edge and the secondary, yellow.

If the cam is behind the axle the top shoe is the primary and the lower shoe the secondary acting shoe.

If the cam is ahead of the axle the lower shoe is the primary acting shoe.

On hydraulic brakes of the conventional type the front shoe is the primary or forward and the rear, secondary or reverse shoe.

While riveting or bonding is the general method of attaching liners, bolting is also used for certain applications. New liners should be attached in the same manner as the original installation. All liners on a vehicle should be replaced simultaneously to obtain the most desirable results.

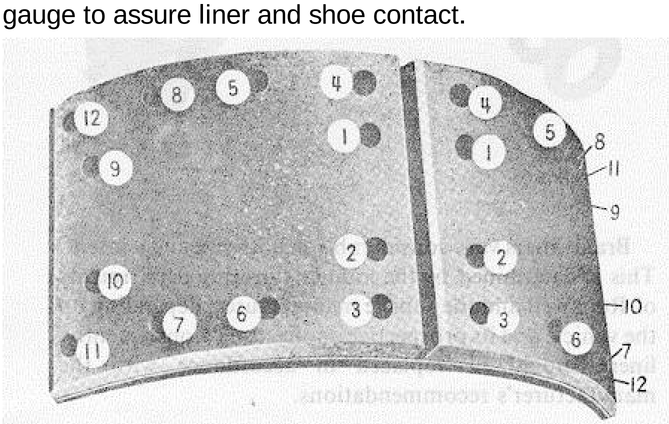
SERVICE INSTRUCTONS FOR RIVETING

Liner and shoe contact faces should be clean before clamping liner in position. Rivets of the correct body diameter. head size and shape, length, and material should be used.

On the earlier pressed steel shoes rivet holes are slightly smaller than the present punched holes. It may be necessary to line drill the linings and shoes with a No. 5 drill (.2055" diameter). If replacing bonded liners with riveted liners use the No. 5 drill for new holes.

1. Clamp the lining to the brake shoe with "C" clamps so the rivet holes in both pieces arc in alignment.
2. Drive the rivets squarely into the holes with a 7/16" flat head drift.
3. Make certain the lining is firmly clamped to the shoe, locating the "C" clamps as close to the rivet holes as possible.
4. Form the rivet heads with the correct tubular rivet set following the sequence shown in illustration below, working from heel to toe.

Liner installation should be checked with a .002" feeler gauge to assure liner and shoe contact.



INSTALLING BOLTED LINERS

The same precaution should be taken with bolted liners as with riveted liners. New lock washers should be used and nuts tightened to the following 3/8" dia. Brass Bolt 220-280 lb. in. or 18-23 lb. ft ¼" dia. Brass Bolt 80-100 lb. in. or 7-8 lb. ft.

CIRCLE GRINDING

When liners are installed on brake assemblies not provided with adjustable anchor pins, the liners should be circle ground to provide the correct liner and drum contact. With the cam in the full release position, the liner should be ground .070" less than the drum diameter. If 80% of the liner has not cleaned up, the cam should be adjusted and the liners ground until 80% contact of the drum diameter is obtained. The 80% contact must be continuous and in the middle of the lining.

USE OF OVERSIZE LINERS
Automotive "P" and Trailer "P" Series

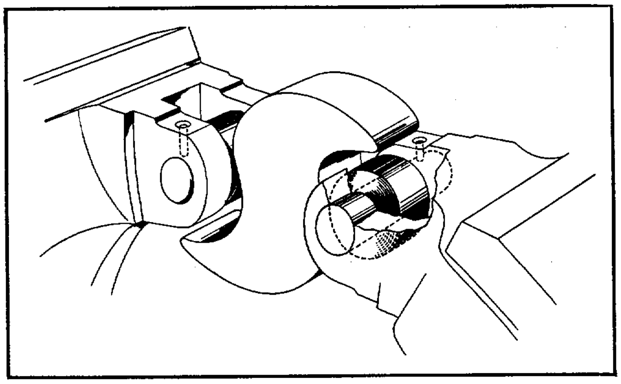
To compensate for material removed when refacing brake drums X (1/16" oversize) and XX (1/8" oversize) liners are furnished by the lining manufacturers. When oversize liners are used the drums should also be machined in increments of 1/16" (RADIUS increased 1/16").

Enlarging the drum diameter will permit the cam to rotate beyond its maximum lift when the lining becomes worn. This can result in sticking cams or cam roll-over.

Cam Roll-over

To avoid this condition and obtain maximum lining wear, oversize roller cam followers, thicker wear plates or wear plate shims (depending on brake design) should be installed when the liners become approximately 50% worn.

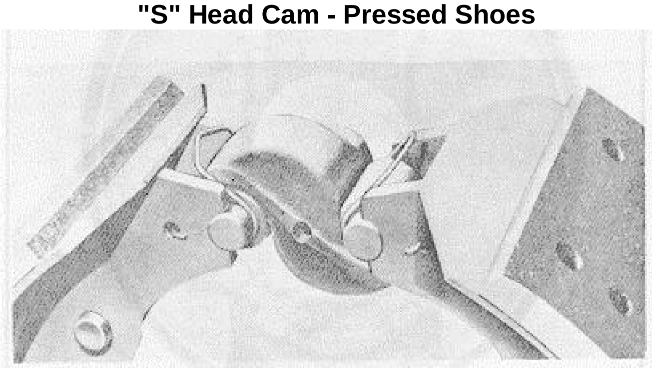
ROLLER CAM FOLLOWERS
"S" Head Cam - Cast Shoes



Part No.	*Size*	*O.D.*
1199-A-625	Standard	1.250"
1199-M-937	Plus 1/8" (.125")	1.375"
1199-Z-910*	Plus 1/4" (.250")	1.500"
1199-A-911*	Plus 1/2" (.500")	1.750"

*Install when liners are approximately 50% worn.

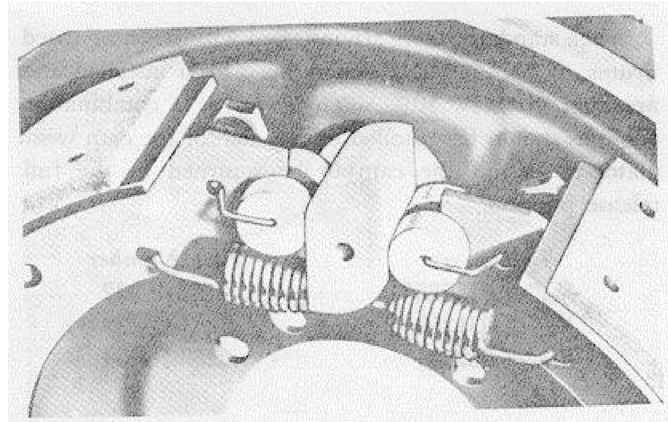
"S" Head Cam - Pressed Shoes



Part No.	*Size*	*O.D.*
1779-R-18	Standard	1.250"
1779-C-81	1/8" Oversize	1.375"
1779-D-82	**1/4" Oversize	1.500"
1779-E-83	**1/2" Oversize	1.750"

**Install when liners are approximately 50% worn.

Flat Head Cam



Part No.	*Size*	*O.D.*
1779-K-63	Standard	1.245"
1779-X-102	1/16” Oversize	1.307"
1199-A-3563	1/8" Oversize	1.370"

Roller cam followers are available in four sizes, each having been designed for a specific purpose.

Standard (1.250”)
Standard rollers are used when installing standard lining with standard drums, "X" lining with 1/16" oversize drums and "XX" lining with 1/8" oversize drums.

If the drums were previously refaced and oversize rollers later installed, the oversize rollers must be removed and standard rollers installed.

-1/16" Oversize (1.307") - Flat Head Cam Only
1/16” oversize rollers are to be used when original standard liners are not worn enough for change but are used with worn or trued drums 1/16" oversize.

1/8" Oversize (1.375")
1/8" oversize rollers are to be used with the installation of standard liners with worn or trued drums which are 1/32" oversize. 1/8" oversize rollers should be installed and the liners circle ground a few thousandths less than drum diameter.

1/4" Oversize (1.500")
Where "X" liners have been installed with 1/16” oversize drums and standard rollers, these rollers should be removed and ¼" oversize installed before the lining becomes worn to a point where the brake cam is no longer effective with the standard rollers.

1/2" Oversize (1.750”)
Where "XX" liners and 1/8" oversize drums have been used, the standard rollers should be removed when the liners become approximately 50% worn and 1/2" oversize rollers installed.

CAM PLATE SHIMS

When standard liners are installed with worn or trued drums, or "X" or "XX" liners have been installed and are approximately 50% worn, shims or a combination of shims should be installed under each of the cam wear plates to permit the cam to be returned to the full release position.

Thickness	*Part Number*
1/64" (.015625")	2203-P-432
1/32" (.03125")	2203-Q-433
1/16" (.0625")	2203-R-434

PREVENTIVE MAINTENANCE

A schedule for the periodic adjustment, cleaning, inspection and lubrication of brake equipment should be established by the operator on the basis of past experience and severity of operation. Linings and drums are parts particularly subject to wear depreciation. To compensate for this wear, brakes should be adjusted as frequently as required to maintain satisfactory operation and maximum safety. Adjustments should provide uniform lining clearance, correct travel of levers and proper equalization.

Brakes should be cleaner, inspected, lubricated and adjusted each time the hubs are removed.

During a major overhaul, the following parts should be carefully checked and replaced with Genuine Replacement Parts as required:

1. Backing plates for distortion, and backing plates or spiders for looseness or sheared rivets.
2. Anchor pins for wear or misalignment.
3. Brake shoes for wear at anchor pin holes, wear pads or lever contact areas.
4. Cam shafts and cam shaft bearings or bushings for wear.
5. Shoe return springs should be replaced at the time of overhaul.
6. Brake linings for grease saturation, wear and loose rivets or bolts.
7. Drums for cracks, scoring or other damage.

Prior to reassembling, the following parts should be LIGHTLY COATED with brake lubricant, Specification 0-615 or the equivalent:

1. Adjustable anchor pin bearing surface.
2. Cam or shoe abutments.
3. Cam shaft needle bearings and nylon bushings.
4. Cam roller follower shafts and journals and hardened wear pads.

Excessive lubricant should be avoided as grease soaked lining cannot be salvaged or cleaned.

The use of meter type fittings which have a maximum 40 lb. pressure relief or shut off is recommended for all fittings on camshafts.

Wheel cylinders should be checked for leaks and damaged boots replaced.

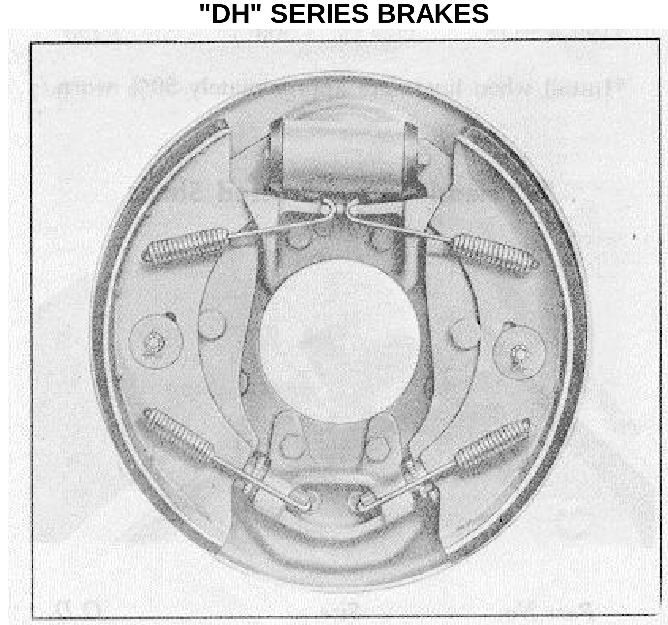
It is recommended that ill new lock rings be installed where used.

Wheel bearings should be properly adjusted before making brake adjustments.

Linings should not be allowed to wear to the point where rivets or bolts may contact brake drums.

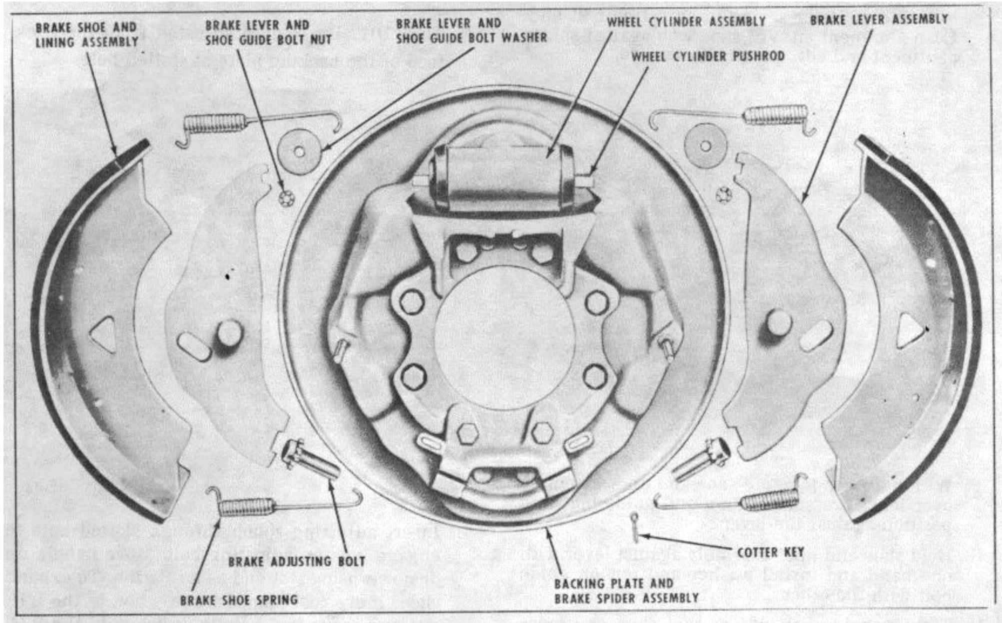
SERVICE INSTRUCTIONS

"DH" SERIES BRAKES



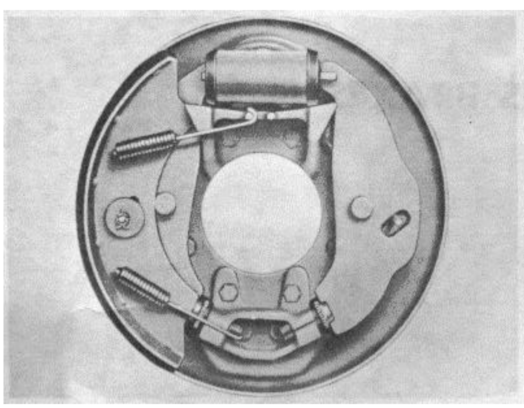
The "DH" Brake is a dual primary brake, hydraulically actuated. This brake, commonly referred to as the Duplex Brake, features identical shoe and liner assemblies and four identical return springs which simplify assembly and disassembly.

"DH" BRAKE LAYOUT



DISASSEMBLY

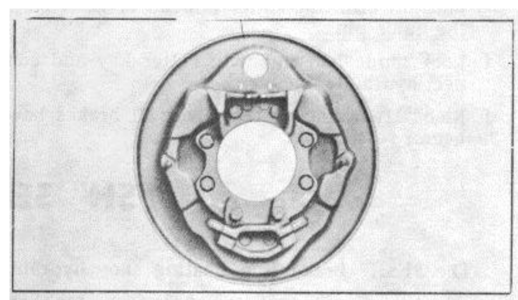
A. Remove wheels and brake drums.
B. Remove cotter key from guide bolts.
C. Install wheel cylinder clamp to prevent forcing pistons out of wheel cylinders.



D. Holding the shoe against the brake backing plate with one hand (after guide bolt cotter keys have been removed), remove the guide bolt nut and washer with the other hand.

E. Allow the springs to rotate the shoe abutment end until the spring tension is released.

F. Unhook the return springs from the spider, adjustment bolt and shoes. Remove shoes.



G. Fir complete disassembly, disconnect the hydraulic lines, remove wheel cylinder cap screws and wheel cylinder.

H. Remove brake adjusting bolts.

ASSEMBLY

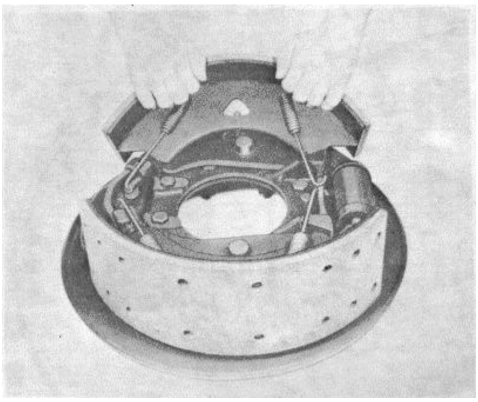
A. Install wheel cylinder and push rods. Tighten wheel cylinder cap screws securely.

B. Install adjusting bolts and turn in fully. .

C. Position lever so that ends mate with pushrod at top and adjusting bolt at the bottom. (There are right and left hand levers.)

D. Hook short ends of both springs into brake shoe we b holes.

E. Hook long end of upper spring on spider and long end of lower spring in adjusting bolt end. Lean abutment ends of shoe web against spider abutment are bolts



F. With both hands rotate shoe and liner assembly over lever pressure bottom and guide bolt into position against the lever.

G. Hold shoe and liner assembly against lever with one hand and install washer and nut on guide bolt with the other.

H. Tighten guide bolt nut so that shoe and lever will have clearance of .015". When the spring type guide bolt washer is used, tighten the guide bolt nut until the cotter pin can be inserted in the guide pin.

I. Lock guide bolt nut with cotter key and connect hydraulic lines.

J. Bleed Hydraulic System after all brakes have been re-assembled.

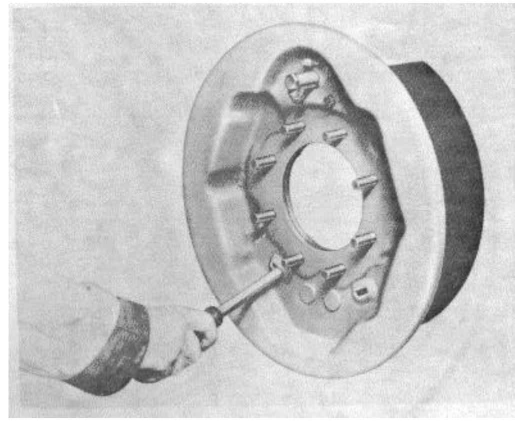
"FSH" SERIES BRAKES

The "FSH" brake is a floating shoe hydraulic brake. Actuation permits the shoes to center themselves in drum with equal effectiveness in either direction. This brake is supplied either with or without a built-in mechanical parking brake.

The "FSH" brake is also built with automatic adjustment for use on special applications. On the "FSH" automatic type, one actuation of the foot pedal sets the automatic adjustment. No further adjustment of the brake is required during the full life of the brake lining.

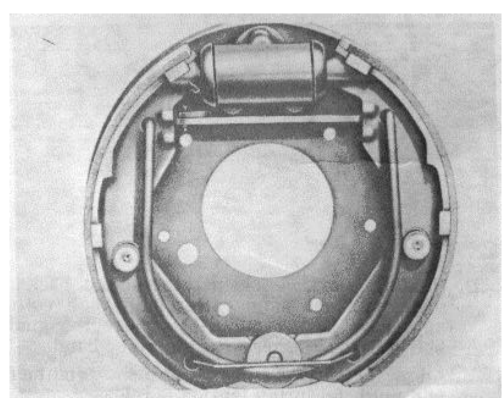
ADJUSTMENT

A. The "DH" Brakes are adjusted from the backface of the backing plate at slotted holes.

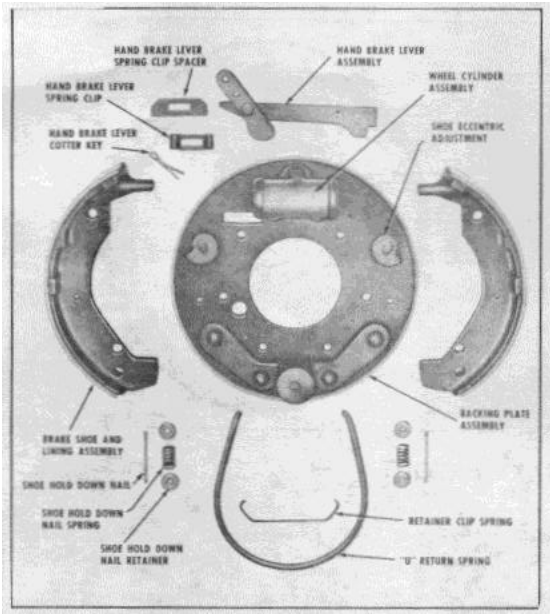


B. Insert adjusting spoon through slotted hole to engage lugs on adjusting bolt. Move handle up or down using slot end as a fulcrum. To expand shoes move tool handle down when in the L.H. slot and move tool handle up when in the R.H. slot.

C. Shoe liners should be brought out tight against the brake drum. Adjusting bolt should then be backed off until the drum can rotate freely. Brake shoes should be adjusted individually.



"FSH" BRAKE LAYOUT



DISASSEMBLY

A. Remove wheels and brake drums.

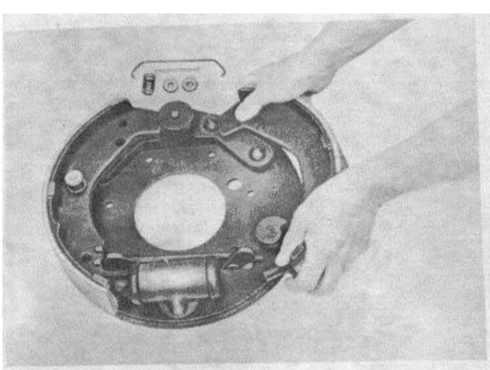
B. Remove "clip spring" over "U spring" with suit able tool.

C. Unhook and remove "U spring."

D. Hold from turning, the "hold down nail outer spring cup" with one hand, depress spring until pliers can grip the nail. Turn nail 1/4 turn and remove cup, spring and hold down nail.

E. Remove brake shoes.

F. On "FSH" brakes incorporating the mechanical hand brake, remove the cotter key on lever and remove spacer, clip and hand brake assembly.



G. For complete disassembly, disconnect hydraulic line, remove wheel cylinder attaching screw, cap screw and wheel cylinder.

ASSEMBLY

A. Install wheel cylinder and tighten screw and cap screw securely. Connect hydraulic line.

B. Install on units employing the mechanical hand brake, the hand brake lever assembly and insert clip, spacer and cotter key.

C. Insert push rod end of shoe in wheel cylinder and position brake shoe.

D. Assemble "hold down nails," cups and springs.

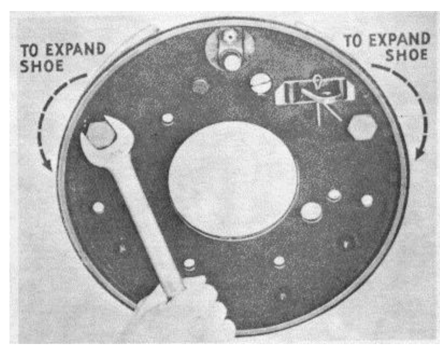
E. Assemble "U spring." Place hook in one shoe and stretch spring opposite hook into the other shoe.

F. Assemble bottom "clip spring" into shoes over "U spring."

G. To position adjusting pawl on brakes with automat ic adjustment, tap shoe in with lead hammer until brake assembly will go into drum.

ADJUSTMENT

A. The "FSH" adjustable type brake has two eccentric cams that may be adjusted by use of a 15/ G open end wrench on adjusting bolts.



B. Upon reassembly, first actuate brake to center shoes in drum.

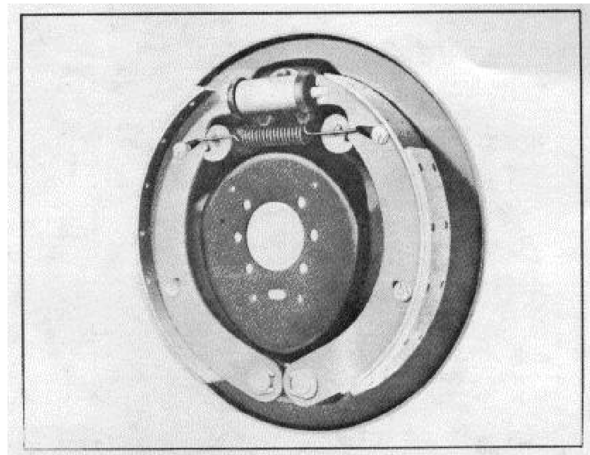
C. Adjust liners out until a slight drag can be felt while drum is in rotation. Back off adjusting bolt until drum can rotate freely.

Subsequent adjustments to compensate for lining wear may be made by moving shoe in or out by turning the eccentric cam in direction desired.

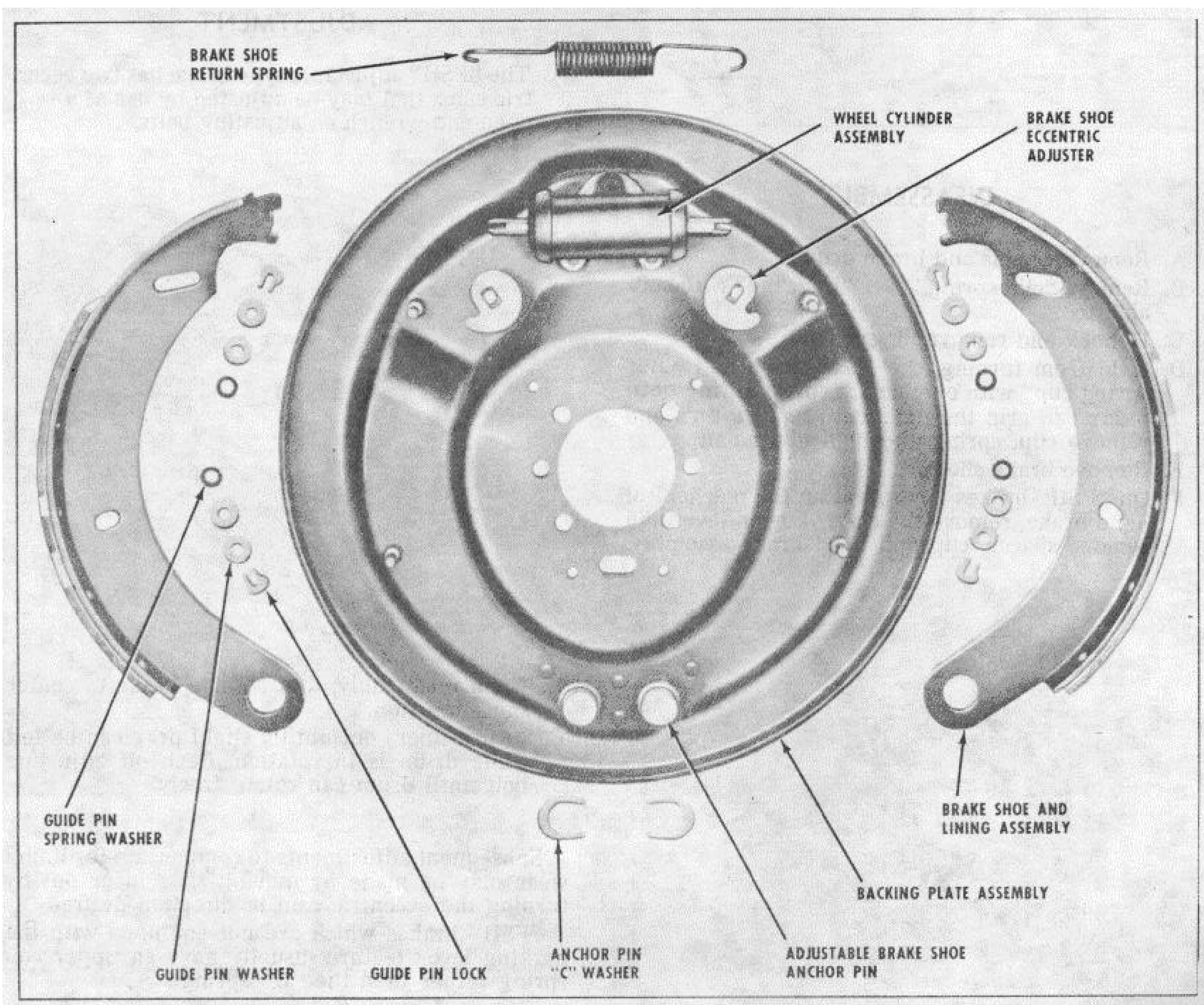
"FSH" brakes which are not equipped with the parking lever feature, usually have an upper coil spring rather than the "U" spring.

"H" SERIES BRAKES

The Hydraulic Brake commonly referred to as the plain "H" is a light duty, two shoe type brake, mounted on a backing plate which also serves as a dust shield. Adjustable anchor pins provide a means of centering the brake shoe arc in relation to the drum, and secondary or minor adjustments are made by rotating the eccentric cam which bears on the brake shoe web or pin in the shoe web.



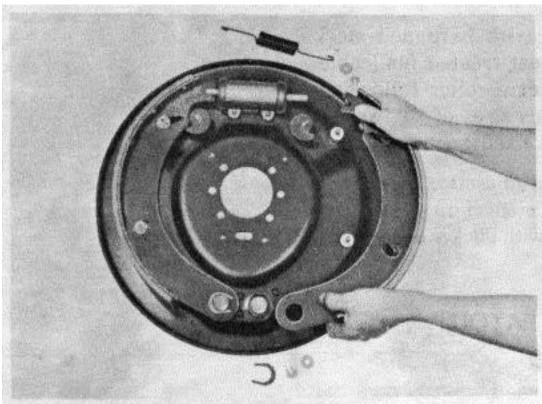
HYDRAULIC BRAKE LAYOUT



DISASSEMBLY

A. Disconnect brake shoe return spring.

B. Remove anchor pin "C" washers and guide pin locks and washers.



C. Remove brake shoe and lining assemblies.

D. Remove anchor pin lock nuts, lock washers and anchor pins.

E. For complete disassembly remove cap screws, washers and wheel cylinder assembly and disconnect hydraulic lines.

REASSEMBLY

A. Position wheel cylinder, install cap screws and lock washers and tighten securely. Re-connect hydraulic lines.

B. Insert anchor pins and install washers and lock nuts. (Punch marks must be together and wrench flats in line.)

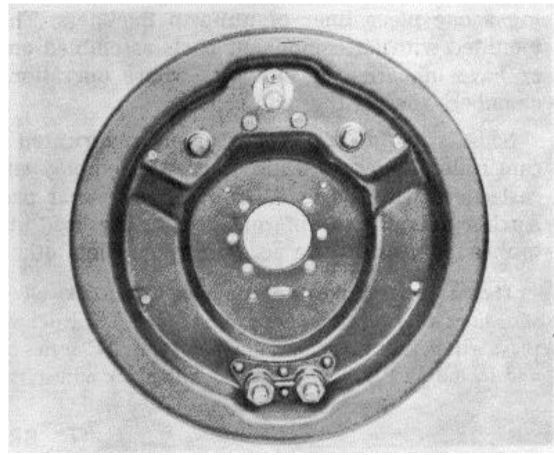
C. Position shoe and lining assemblies and install washers and lock rings.

D. Back off adjusting cams and position shoes on push rods in wheel cylinder.

E. Hook shoe return spring in brake shoe web holes.

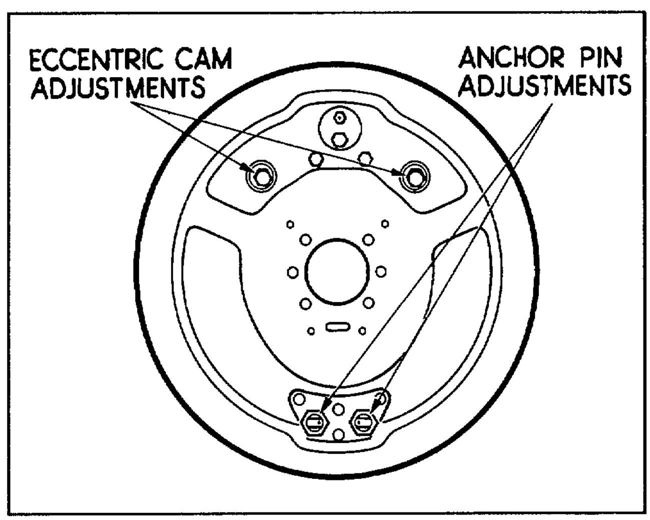
ADJUSTMENT

Following overhaul or when new linings are installed, the initial adjustment should be carefully made to both properly locate the curvature of the lining to the drum and obtain the proper clearance.

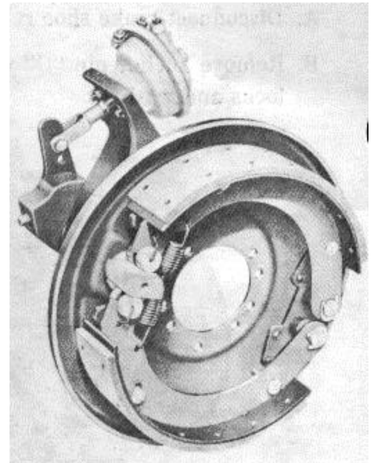


Each shoe must be adjusted to center the brake shoe arc in relation to the drum. Adjust cam to bring lining into contact with the drum and rotate anchor pin sufficiently to relieve drag. Repeat until additional rotation of anchor pin will no longer relieve drag. Lock anchor pin lock nut and back off cam sufficiently to permit wheel to turn freely.

Subsequent adjustments to compensate for lining wear are made with the eccentric cam only. Turn cam to bring lining into contact with the drum. Back off sufficiently to permit free rolling drum. Repeat on opposite shoe.



THE CAM-MASTER "T" SERIES BRAKES

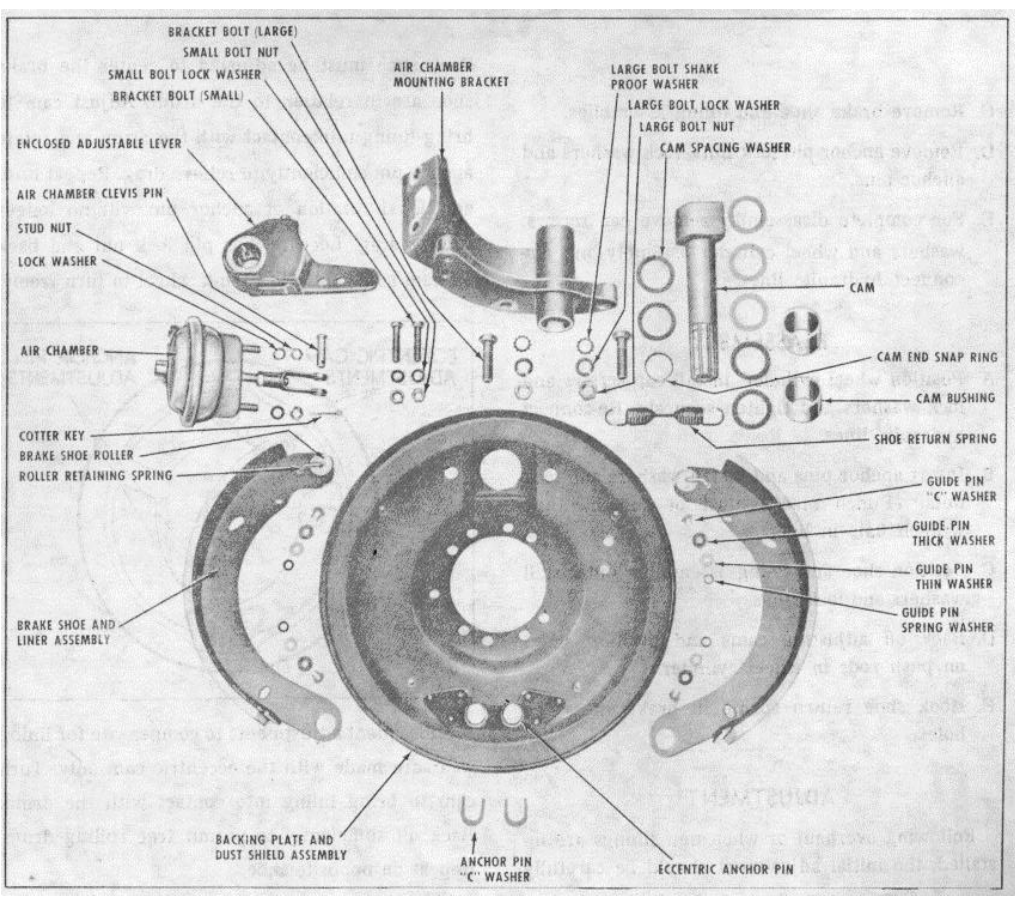


The "T" series brake is an air actuated two shoe brake, each shoe employing a one, piece liner of uniform thickness. These brakes are either unit mounted with all component parts assembled on a backing plate or spider, or have inboard cam supports where operation warrants locating the air chambers toward the axle centers.

Some sizes of "T" brakes employ fabricated shoes with hardened steel cam roller followers while other sizes employ either heat treated malleable cast shoes with hardened cam follower wear pads or cam roller followers. Anchor pins of two different designs are used in various sizes of "T" series brakes. Some sizes use eccentric pins while others use fixed anchor pins.

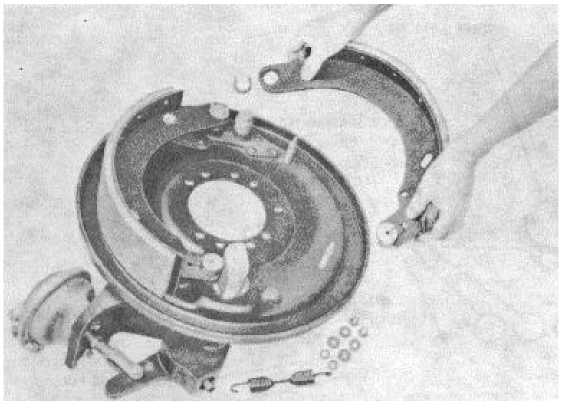
The "T" series brakes are re-equipped with Rockwell enclosed adjustable levers when shoe liner thickness does not exceed 7/ 16". The Rockwell enclosed adjustable lever on these will permit the maximum liner wear. "T' series brakes with thicker liners, up to .and 2 1/2". are with slack adjusters.

“T” BRAKE LAYOUT



DISASSEMBLY

A. Remove shoe return spring.
B. Remove "C" washers from guide pins and anchor pins.



C. Remove brake shoe and liner assemblies.
D. Remove flat washers from guide pins.
E. Remove brake shoe rollers and springs if necessary to replace.
F. Disconnect cam lever assembly by removing first the spring lock, washer and the clevis pin.
G. Remove the cam lever, cam and cam washer.
H. Remove cam bushing only if replacement is necessary.

ASSEMBLY

A. Install camshaft bushing if removal was made.
B. Install cam and spacer washers.
C. Assemble guide pin washers and position shoes over anchor pins and guide pins.
D. Assemble guide pin and anchor pin washers and "C" washers.
E. Hook brake shoe return spring between shoes.
F. Install cam lever assembly and washer and secure with spring groove lock.

ADJUSTMENT

On the "T" Fabricated Steel Brake each shoe must be adjusted to center the brake shoe arc with the drum.

A. Loosen cam bracket bolts Apply full air. Hold air and tighten bolts. Be sure bolts are tight.
B. Rotate both anchor pins to the full release position. (Punch marks together-wrench flats in line.)
C. Adjust cam to bring liners in contact with drum and rotate anchor pins sufficiently to relieve drag. Repeat until additional rotation of anchor pins will no longer free drag.
D. Tighten anchor pin lock nuts and back off cam to minimum running clearance.

To compensate for liner wear on both the "T" Fabricated Steel and the "T" Cast assemblies, adjust cam at cam lever adjusting bolt to bring liners in contact with drum and back off to minimum running clearance.

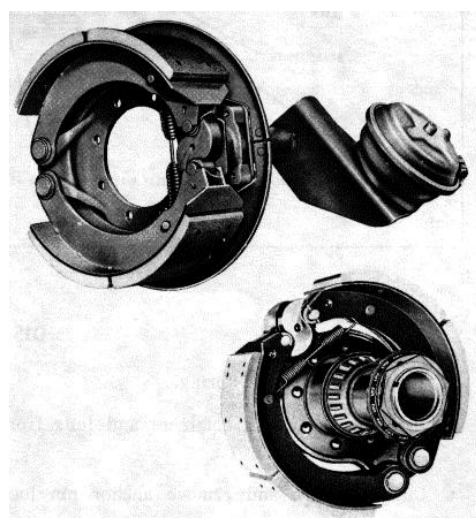
THE CAM-MASTER "P" SERIES BRAKES

The Automotive "P" series brake is an air actuated two shoe brake, each shoe employing two 3/4" tapered block liners. These shoes are of fabricated steel, mounted on individual anchor pins and supported by open type spiders. The air chamber mounts on a bracket that bolts directly to the spider thus making the brake completely unit mounted.

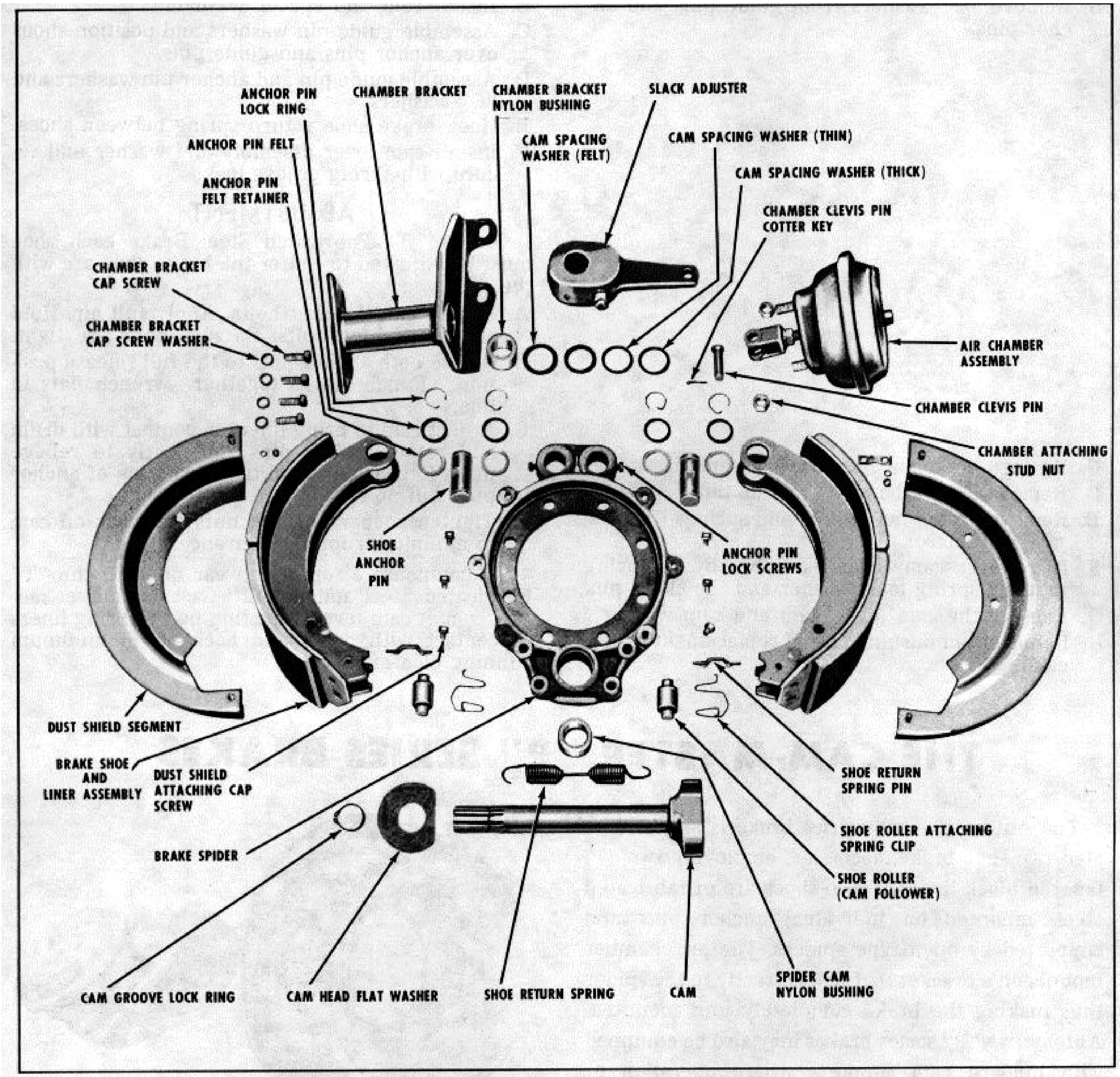
Automotive "P" series brakes may also be equipped with inboard cam supports where operation or axle design requires mounting the air chambers toward the axle centers.

Dust shields are available for use when protection becomes desirable.

The "P" series brakes are actuated by the "S" type constant lift cams which are forged integrally with shaft and supported in nylon bushings. Cam pressure is applied through roller cam followers.



"P" BRAKE LAYOUT



DISASSEMBLY

A. Remove shoe return spring.

B. Remove lock rings, retainers and felts from anchor pins.

C. Cut lock wire and remove anchor pin lock screws.

D. Remove anchor pins and shoe assemblies.

E. Unhook cam follower retainer spring and remove roller cam follower.

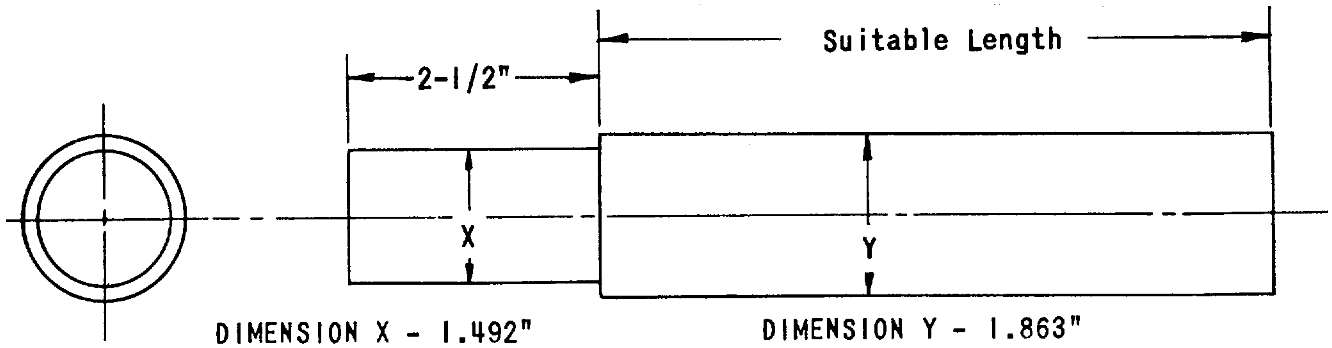
F. Remove cam end lock ring, washer and slack adjuster.

G. Remove cam shaft with felt, washer for felt and large washer, from spider.

H. Remove washers and felts from cam shaft and spider.

I. Remove nylon bushing from spider only if replacement is necessary. See suitable tool for both the removal and installing of nylon bushings.

BUSHING REMOVAL AND INSTALLATION TOOL



ASSEMBLY

A. Install new nylon bushing in brake spider if required, using suitable tool.

B. Install roller cam followers and retainer springs. See instruction relative to roller cam followers where drums have been refaced and oversize liners installed.

C. Install large washers, felt and washer on cam end of cam shaft. Install assembly through spider and bracket.

D. Position brake shoe assembly over spider and tap anchor pin into position with brass punch, "flat" in line with lock screw hole. See special instructions if combination lining has been used.

E. Install lock screws, tighten securely and thread with lock wire.

F. Position felts, retainers and install lock rings.

G. Install shoe return spring.

H. Install slack adjuster on splined end of cam shaft and adjust as required.

ADJUSTMENT

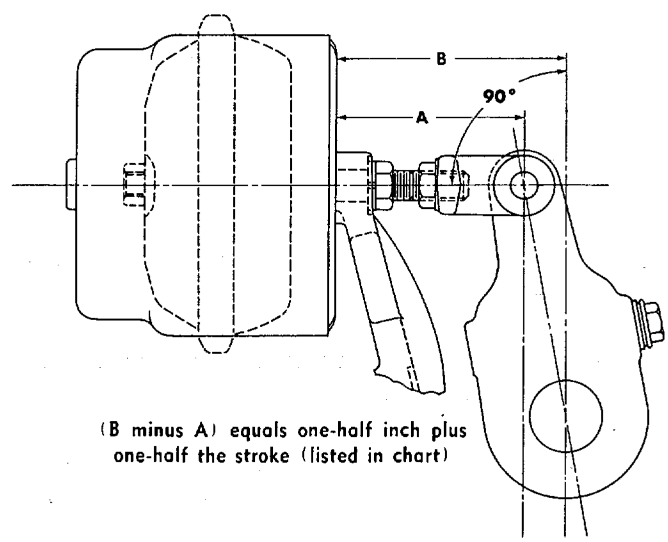
A. New liners should be circle ground to . U'(U" less than drum diameter. Adjust cam as required to obtain 80% contact.

B. Adjust slack adjusters or levers to obtain free running clearance. When travel increases from liner wear to the maximums listed in the table below, readjust.

CHAMBER STROKE AT WHICH BRAKE SHOULD BE READJUSTED

Chamber Size Effective Area	"Diaphragm"	"Brake Chamber"	"Roto-chamber"
9"	1 3/8"	1 1/2	1 1/2"
12"	1 3/8"	1 1/2"	1 1/2"
16"	1 3/4	1 3/4"	1 7/8"
20"	-	1 3/4"	1 7/8"
24"	1 3/4"	1 3/4"	1 7/8
30"	2"	2 1	2 1/4
36"	2 1/4"	2 1/2	2 5/8
50	-	-	3"

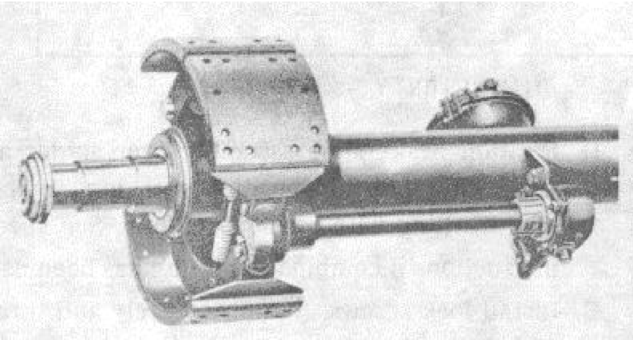
CORRECT POSITION OF CHAMBER PUSH-ROD AND SLACK ADJUSTER IN "OFF" POSITION

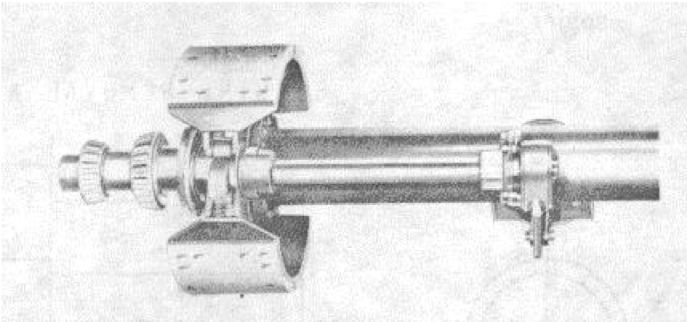


THE CAM-MASTER TRAILER AXLE POWER BRAKES

The Trailer "P" series brake is a two shoe brake designed for use with power. The shoes are fabricated steel and are mounted on individual anchor pins on either replaceable open spiders or fixed open spiders.

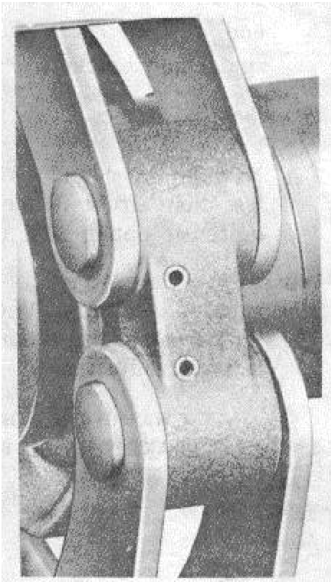
The air chambers are mounted on brackets that are welded to the beam and inner cam supports are adjustable for cam shaft alignment.

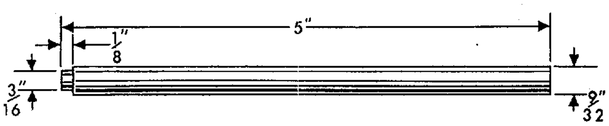




Trailer brake shoe anchor pins (depending on model) may be either the stationary type secured by use of spider set screws or the free rolling type held in place by a locking pin. The brakes are actuated by the "S" type constant lift cams which are forged integrally with the shaft and supported in nylon bushings at both inner and outer ends. Cam pressure is applied through roller cam followers.

A suitable punch for the removal of these locking pins may be made from a 5" rod 9132" in diameter by turning or grinding one end to 3/16c, diameter 1/8" long. This smaller end will pilot in the pin and prevent punch from slipping. See illustration of suitable punch below.





DISASSEMBLY

A. Remove shoe return spring.

B. Remove lock ring, retainer and felt from anchor pin if employed.

C. Cut lock wire and remove anchor pin lock screw or drive out locking pin.

D. Tap out anchor pin and remove shoe assembly.

E. Unhook shoe web retainer spring and remove roller cam follower.

F. Remove inner cam end lock ring, washer and slack adjuster.

G. Remove washers and felts from cam shaft and spider.

H. Remove nylon bushing from spider only if replacement is necessary.

I. If inner cam end nylon bushing is to be replaced remove bolts and separate adjustable support bracket and remove the bushing.

ASSEMBLY

A. Install the spider (outer) nylon bushing, felts and retainers first if (outer) nylon bushing has been replaced.

B. Loosely assemble the camshaft inner nylon bushing retainers to the nylon bushing and then loosely attach the retainers and nylon bushing assembly to the housing bracket.

C. Lubricate the inner surfaces of both the (outer) nylon and (inner) nylon bushing.

D Install camshaft with large flat washer into spider and nylon bushing assembly. When end of camshaft clears bushing assembly install lock ring on camshaft and proceed with shaft into and through the inner nylon bushing.

E. Slide lock ring over shaft and secure into groove next to spider.

F. Align the parts and carefully tighten the retainers around the nylon bushing, then tighten the retainer and bushing.

G. Position "S" cam at zero and install slack adjuster, washer and lock ring.

H. Attach roller cam follower to brake shoe web with retainer spring.

I. Assemble brake shoe assembly to spider and tap anchor pin in place.

J. Secure anchor pin with lock screw and lock wire or locking pin depending on type employed.

K. Install felts, retainers and lock rings if employed.

L. Install shoe return spring.

ADJUSTMENT

Follow adjustment procedure as outlined under "P" Brake section, located on bottom of page 14.

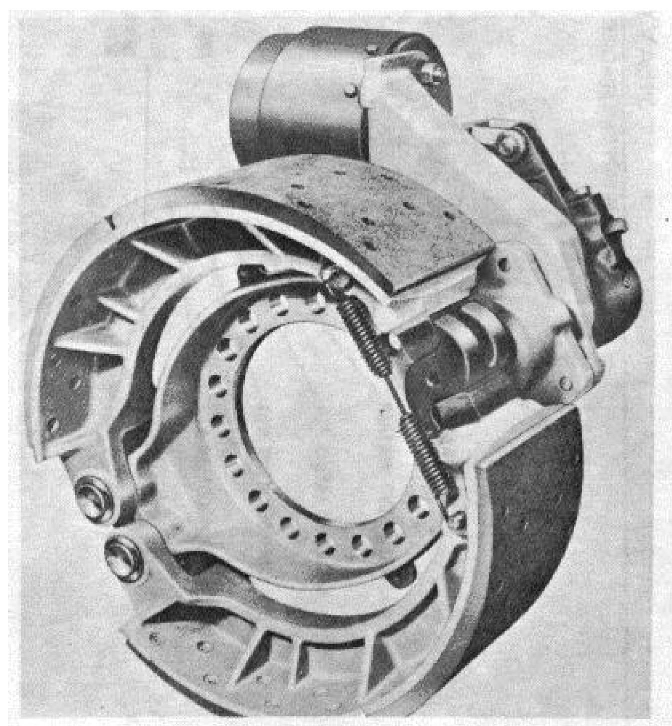
THE CAM-MASTER HEAVY DUTY "P" SERIES BRAKES

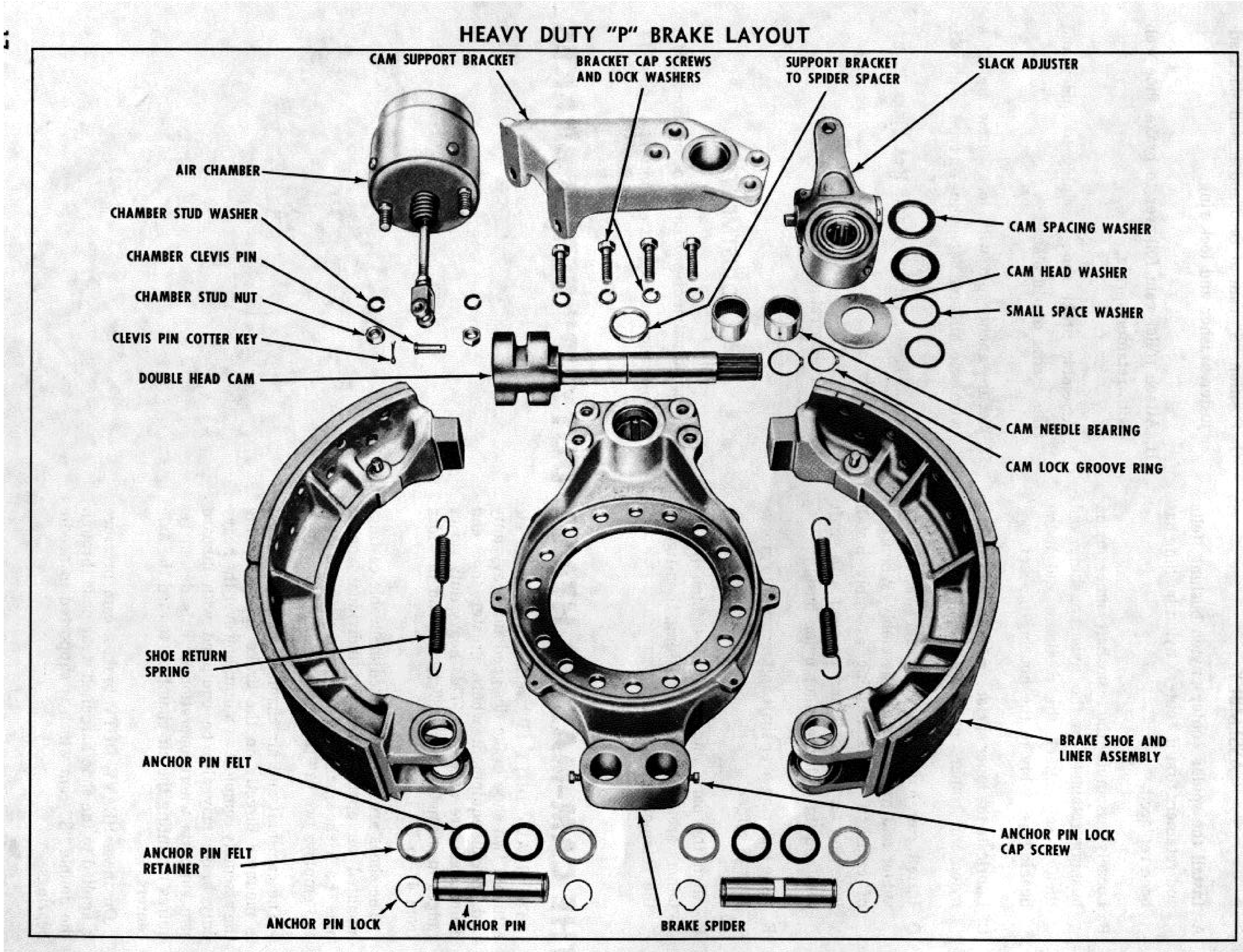
The HEAVY DUTY "P" series brake is an air actuated two shoe brake designed for heavy duty and special equipment where greater shoe and drum areas are necessary. This heavy duty series ranges in diameter from 18" to 22" and in width from 4" to 7".

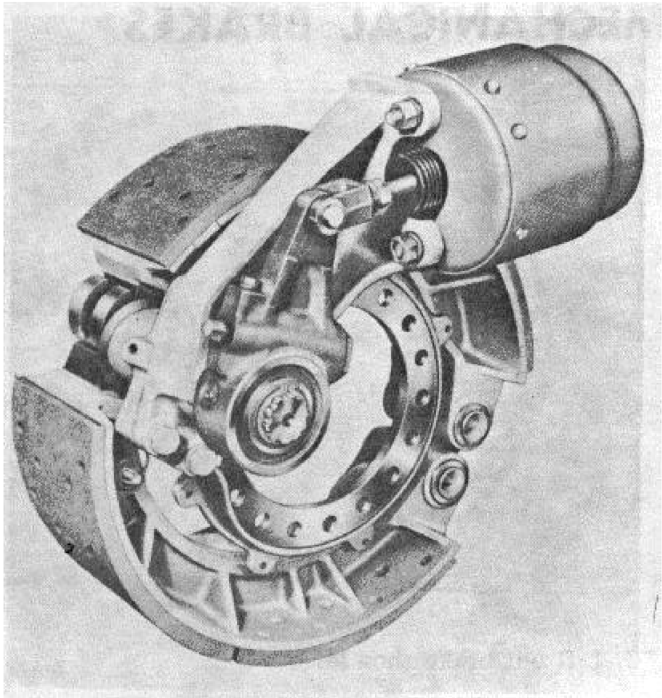
The shoes are of heat treated malleable castings mounted on open spiders by individual anchor pins. Each shoe has hardened cam pressure pads and employs two 3!4" tapered block liners.

The camshaft and air chamber support bracket is mounted directly on the brake spider making the assembly complete as a unit, however the heavy duty brake may also be equipped with inboard cam supports where operation or axle design requires mounting the air chambers toward the axle centers.

On these HEAVY DUTY brakes, cam pressure is applied to the shoe hardened wear pads through the double "S" cam which is supported in needle bearings.



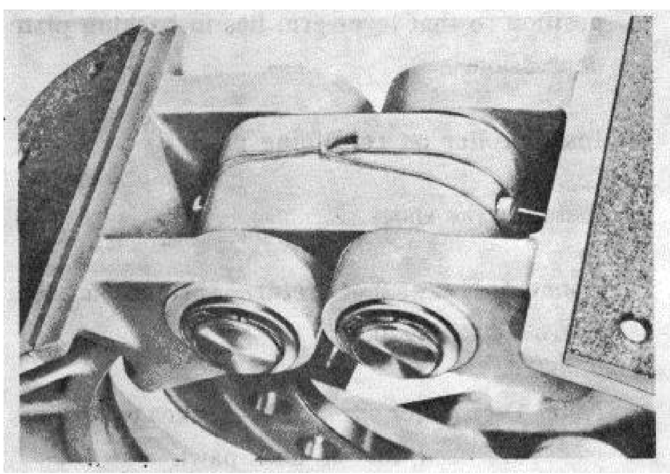

HEAVY DUTY "P" BRAKE LAYOUT
CAM SUPPORT BRACKET
BRACKET CAP SCREWS AND LOCK WASHERS
SUPPORT BRACKET TO SPIDER SPACER
SLACK ADJUSTER
AIR CHAMBER
CHAMBER STUD WASHER
CHAMBER CLEVIS PIN
CHAMBER STUD NUT
CLEVIS PIN COTTER KEY
DOUBLE HEAD CAM
CAM SPACING WASHER
CAM HEAD WASHER
SMALL SPACE WASHER
CAM NEEDLE BEARING
CAM LOCK GROOVE RING
SHOE RETURN SPRING
BRAKE SHOE AND LINER ASSEMBLY
ANCHOR PIN FELT
ANCHOR PIN LOCK CAP SCREW
ANCHOR PIN FELT RETAINER
ANCHOR PIN LOCK
ANCHOR PIN
BRAKE SPIDER



DISASSEMBLY

A. Remove shoe return springs.

B. Remove lock rings, retainers and felts from anchor pins.



C. Cut lock wire anchor remove anchor pin lock screws.

D. Remove anchor pins and shoe assemblies.

E. Remove air chamber mounting stud nuts and lock washers.

F. Remove air chamber clevis pin cotter key, clevis pin and air chamber.

G. Remove cam end lock ring and flat washer.

H. Remove slack adjuster lever.

I. Remove cam by tapping out from rear.

J. Remove chamber bracket mounting cap screws and lock washers. Remove bracket.

K. Remove needle bearings, only if replacement is to be made, by pressing out with a suitable sleeve.

ASSEMBLY

A.. Install new cage and needle bearing assemblies if replacement is necessary.

B. Locate and secure with cap screw and lock washers the air chamber mounting bracket and tighten cap screws securely.

C. Lubricate needle bearings with lubricant (specification of 0-615 or the equivalent).

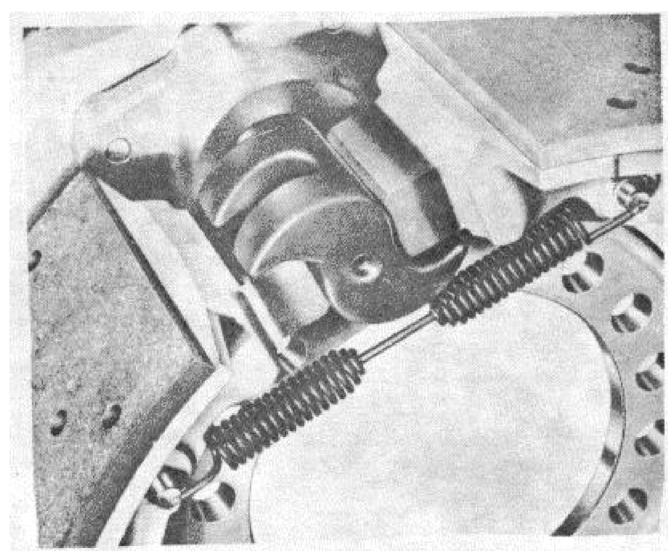
D. Install slack adjuster on cam so that shoes are in a fully released position and install cam washer and cam groove lock ring.

E. Mount air chamber on bracket and secure with chamber mounting stud nuts and washers.

F. Connect slack adjusting lever to air chamber pushrod clevis with clevis pin and cotter key.

G. Install brake shoes with anchor pins and secure pins with felts, felt retainers and pin groove locking rings.

H. Install anchor pin locking screws and lock wire,



I. Connect brake shoe return springs.

ADJUSTMENT

Follow adjustment procedure as outlined under "P" Brake section, located on bottom of page 14.

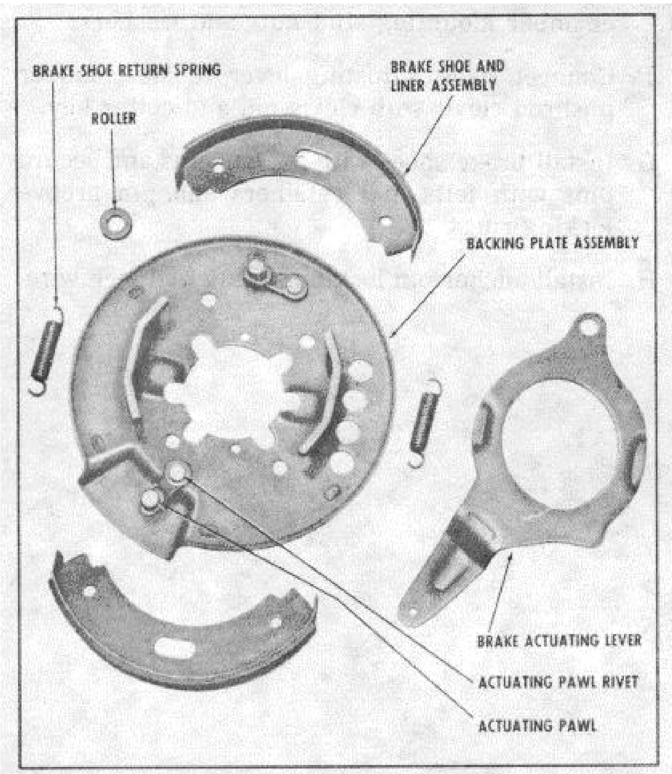
"DLM" DUPLEX LEVER MECHANICAL BRAKES

The "DLM" brake is a two shoe mechanical brake designed for use as either a control or parking brake.

Equal pressure is applied to both shoes through lever actuation in either forward or reverse rotation.

"DLM" brake shoes and springs are interchangeable. Brake is fully enclosed to exclude dirt or foreign matter.

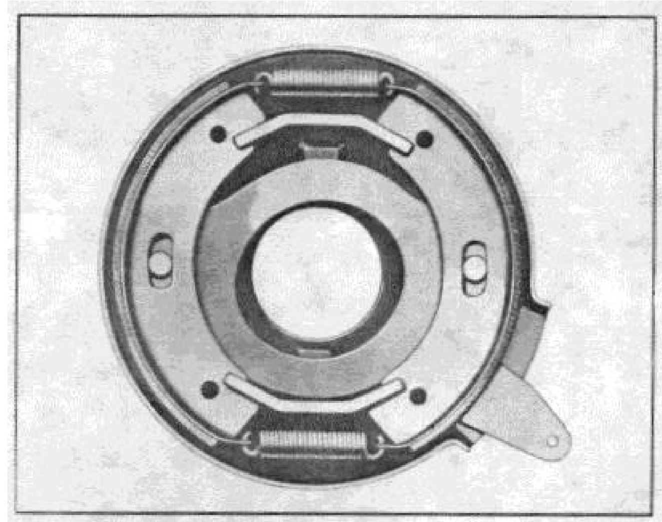
"DLM" BRAKE LAYOUT



DISASSEMBLY

A. Disconnect and remove brake shoe return springs.

B. Remove brake shoes and liner assemblies.



C. Lift out brake shoe lever.

ASSEMBLY

A. Install brake lever over opposite pawl pin and position so that lever arm lies in backing plate depression.

B. Install roller on remaining pawl.

C. Install brake shoes.

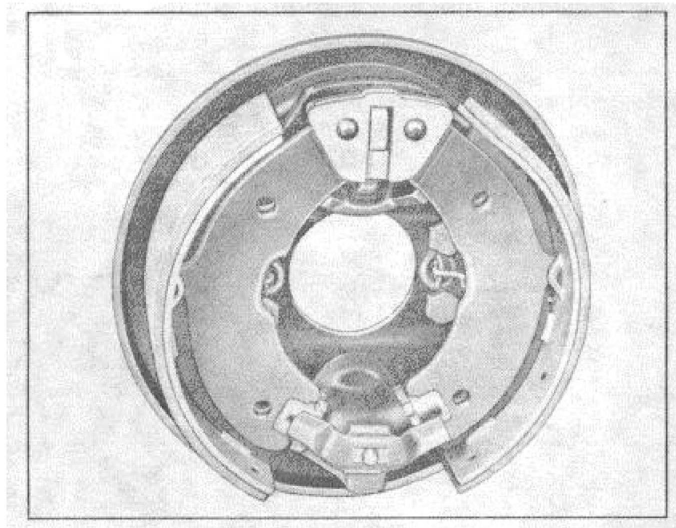
D. Connect brake shoe return springs in slots nearest backing plate.

Note: On smaller size "DLM" brakes two rollers are used, one on each pawl.

ADJUSTMENT

Equal alignment is completely controlled by the design of the actuating lever and the only adjustment necessary is through connecting linkage to lever arm

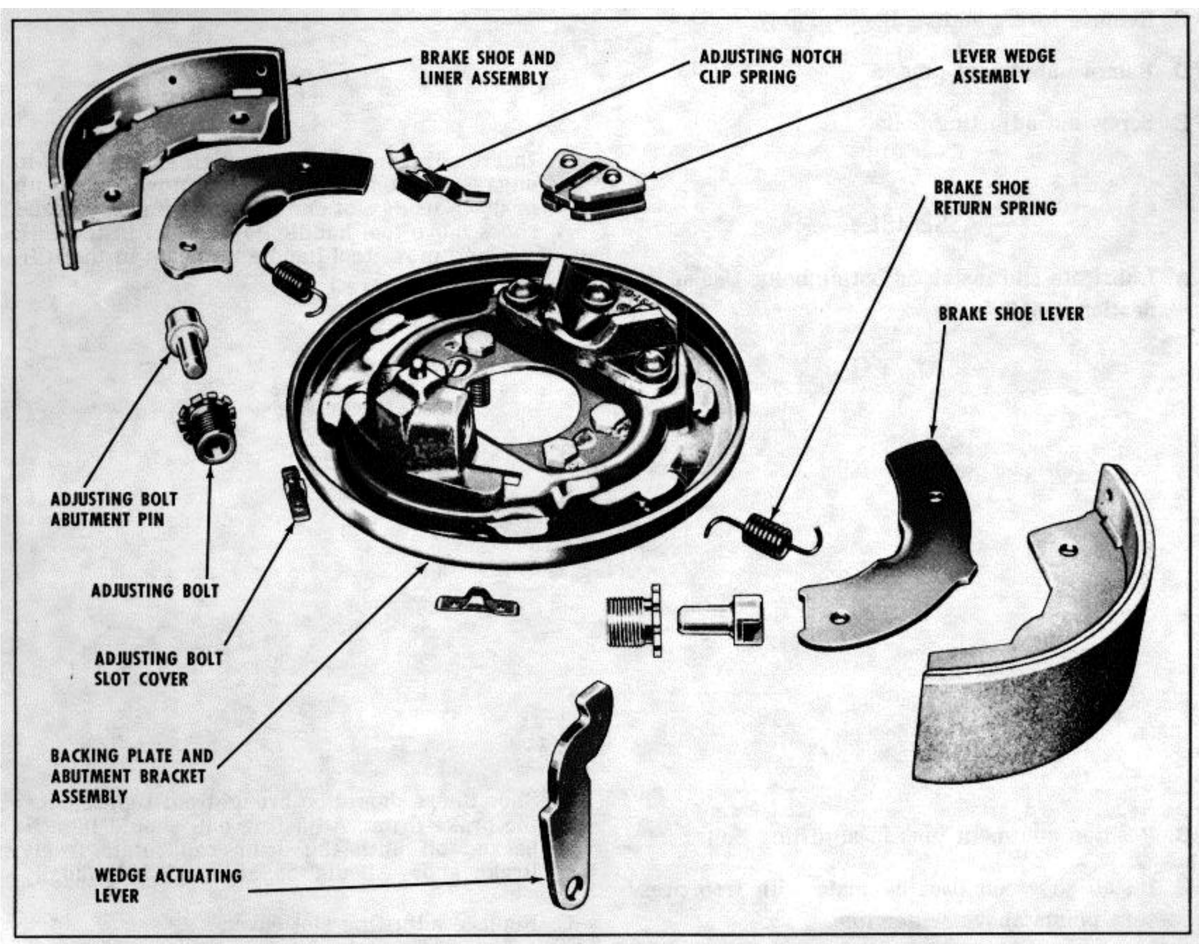
"DM" DUPLEX MECHANICAL BRAKES



The "DM" brake is a two shoe mechanical brake designed for either service or parking use. The shoes are actuated by a lever and wedge and are self-aligning. The two shoes are interchangeable and do an equal amount of work in either forward or reverse direction.

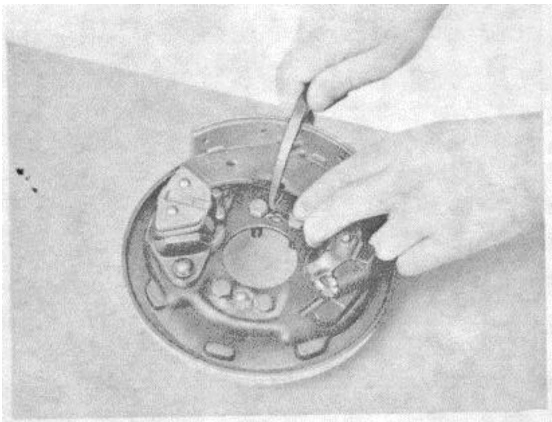
The adjusting bolts in the abutment bracket provide a means for adjusting the brake shoe clearance with the drum.

"DM" BRAKE LAYOUT



DISASSEMBLY

A. Disconnect brake shoe return springs.



B. Remove shoe and liner assemblies.

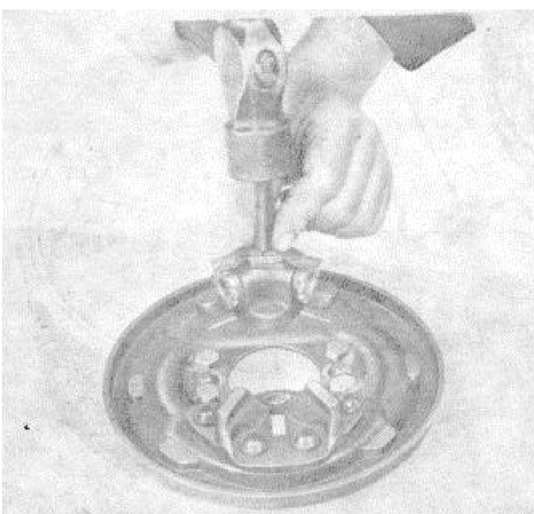
C. Remove levers and wedge assembly.

D. Remove abutment pins.

E. Screw out adjusting bolts.

ASSEMBLY

A. Lubricate and install adjusting bolts. Use specification 0-615.



B. Position abutment pins in adjusting bolts.

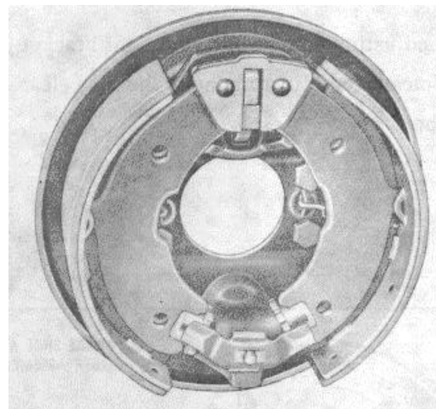
C. Install shoes on backing plate with web pressure points above center line.

D. Insert straight end of return spring in shoe web and hook rounded end into backing plate catch.

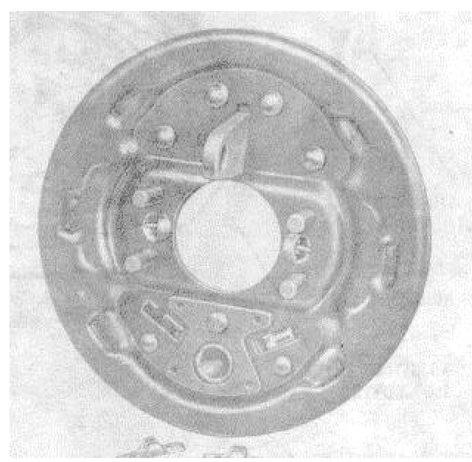
E. Install brake shoe levers (formed pressure points contacting web pressure points).

F. Insert operating lever through top abutment slot.

G. Lubricate with specification 0-615 the wedge assembly side slots and install by spreading the shoe and lever assemblies.



A. Insert adjusting spoon through slotted hole to engage lugs on adjusting bolt. Move handle up or down using slot end as a fulcrum. To expand shoes move tool handle down when in the L.H. slot and move tool handle up when in the R.H. slot.



B. Shoe liners should be brought out tight against the brake drum. Adjusting bolt should then be backed off until the drum can rotate freely. Brake shoes should be adjusted individually.

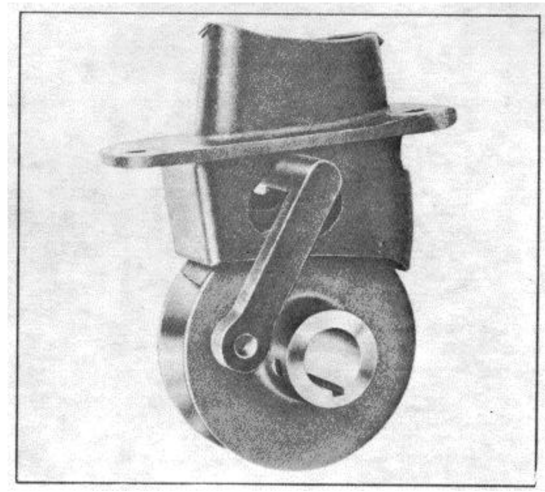
C. Replace adjusting slot cover.

"VEE" BRAKES

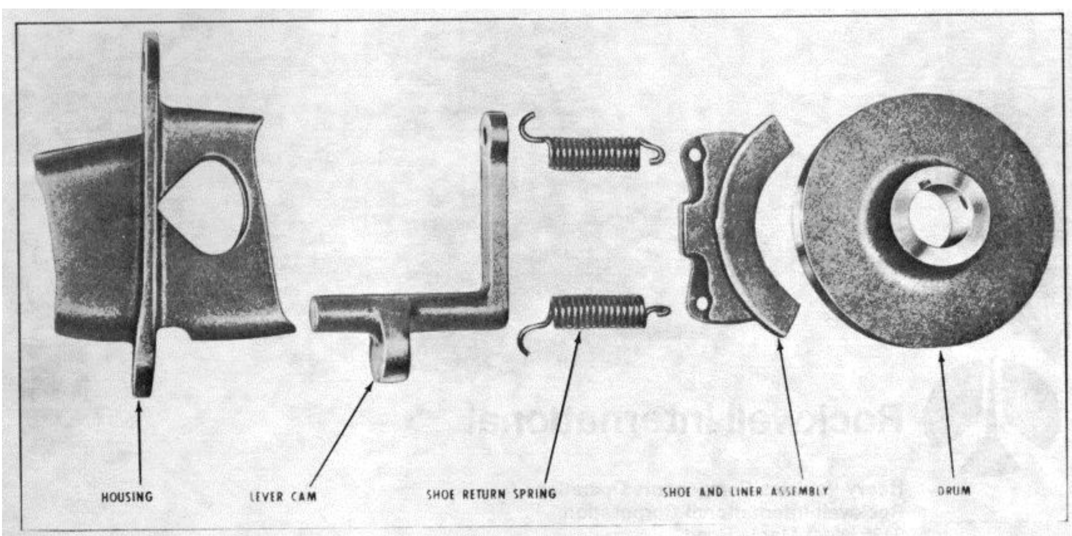
The "VEE" brake is a mechanical wedge shoe type brake. The wedge shoe and liner assembly when actuated into the "V" of drum is equally effective in forward and reverse.

The drum mounts on the shaft to be controlled and pressure is applied through the lever. The "VEE" brake is used both as a service brake and a parking brake.

The "VEE" brake can be completely assembled before mounting into its enclosure.



"VEE" BRAKE LAYOUT



DISASSEMBLY

A. Unhook return spring ends. (Use a buttonhook type of spring stretcher.)

B. Remove lever by dropping shoe assembly and rotating lever cam to pass through opening.

C. Remove shoe and spring assembly and unhook springs from shoe.

ASSEMBLY

A. Lubricate housing abutment, shoe cam pad and lever cam bearing area.

B. Insert small hook of springs into shoe with opposite hook ends out.

C. Install lever and rotate cam so that shoe may be raised into actuating position.

D. Hook spring end hooks into housing.

ADJUSTMENT

A. Pull lever forward to maximum cam travel and back off 3/8".

B. Insert linkage connection pin.

Rockwell International

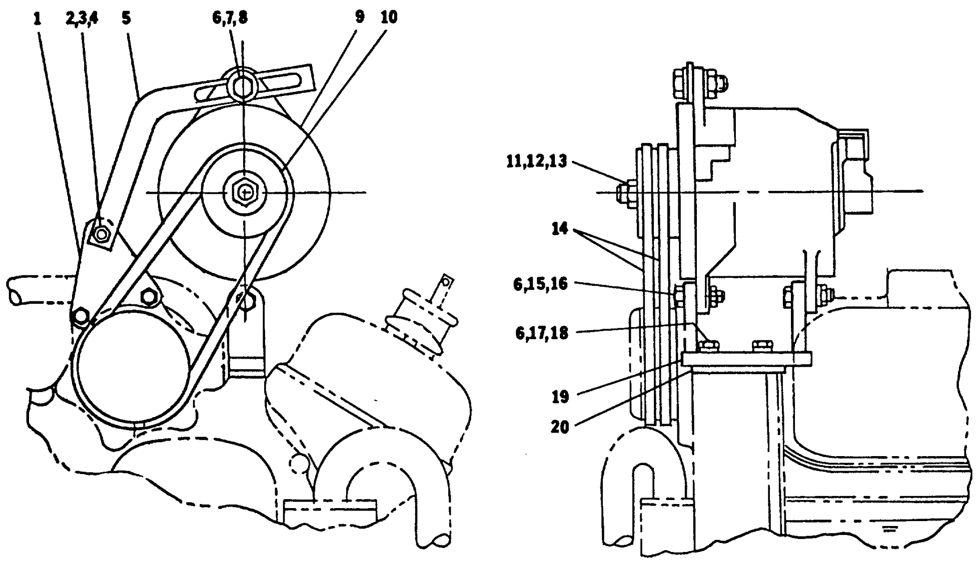
Heavy Vehicles Components Operations
Rockwell International Corporation
2135 West Maple Road
Troy, Michigan 48084 U.S.A.

  PRINTED IN U.S.A.

Electrical Circuit Schematic
All Models

Wire No.	Circuit
1	Start Button #1 to Starter Solenoid
1A	Start Button #2 to Starter Solenoid
2A	Start Button #1 to Start Button #2
2B	Ignition Relay #2 to Neutral Start Switch
2C	Ignition Relay #2 to Start Button
3	Circuit Breaker to Front Spotlights
5A	Tail Light Relay to License Plate Light
6	Circuit Breaker to Right and Left Turn Signals
7	Headlight Switch to Gauge and Indicator Lights
9	Headlight Switch to Clearance & Parking and Tail Light Relays
9A	Headlight Switch to Circuit Breaker
10	Fuel Gauge to Fuel Level Sender
11	Circuit Breaker to Positive Terminals of Gauges and Warning Lights
12	Circuit Breaker to Dash Engine Stop Button
13	Fuel Switch to Fuel Relay Coil
18	Dimmer Switch to Left Hi-Beam
18A	Dimmer Switch to Right Hi-Beam
18B	Dimmer Switch to Hi-Beam Indicator Light
19	Dimmer Switch to Left Low-Beam
19A	Dimmer Switch to Right Low-Beam
22	Horn Button to Horn Relay
24	Circuit Breaker to Horn Relay
25A	Circuit Breaker to Stop Light Switch
26	Stop Light Switch to Steering Column Turn Signal Switch
29	Horn Relay to Electric Horn
31	Circuit Breaker to Ignition Relay #1 & Fuel Pressure stat
31A	Ignition Relay #1 to Nartron Warning Alarm & Fuel Pressure stat
33	Ground System in All Harnesses
39	Speedometer to Front Axle Wheel Sensor
40	Speedometer to Front Axle Wheel Sensor
41	Tachometer to Alternator A.C. Phase Post
43	Front Air Gauge to Front Air Tank Pressure Sender
44	Rear Air Gauge to Rear Air Tank Pressure Sender
45	Warning Alarm to Front Low Air Warning Light
45A	Front Low Air Warning Light to Front Air Tank Low Pressure Switch
46	Warning Alarm to Rear Low Air Warning Light
46A	Rear Low Air Warning Light to Rear Air Tank Low Pressure Switch
50	Circuit Breaker to Windshield Wiper Switches
51	Circuit Breaker to Windshield Washer Switch
53	Windshield Washer Switch to Washer Fluid Bottle
54	Circuit Breaker to Left & Right Door Jamb Switches
54A	Left Door Jamb Switch to Interior Courtesy Light
54B	Right Door Jamb Switch to Interior Courtesy Light
55	Circuit Breaker to Engine Enclosure Light Switch
56	Circuit Breaker to Heater Blower Motor Switch
58	Oil Pressure Gauge to Engine Oil Pressure Sender
59	Water Temperature Gauge to Engine Water Temperature Sender
62	Circuit Breaker to Turn Signal Flasher
62A	Turn Signal Flasher to Steering Column
62B	Turn Signal Flasher to Steering Column
63	Steering Column to Right Front Turn Signal & Side Turn Signal
63A	Steering Column to Right Turn Dash Indicator
64	Steering Column to Left Front Turn Signal & Side Turn Signal
64A	Steering Column to Left Turn Dash Indicator
65	Steering Column to Right Rear Turn Signal
66	Steering Column to Left Rear Turn Signal
70	Warning Alarm to Oil Pressure Warning Light
70A	Warning Alarm to Water Temperature Warning Light
71	Transmission Temperature Warning Light to Transmission Temperature Switch
71A	Warning Alarm to Transmission Temperature Warning Light
72	Transmission Temperature Gauge to Transmission Temperature Sender
80	Circuit Breaker to Back-Up Light Switch
81	Back-Up Light Switch to Back-Up Lights & Back-Up Alarm
86	Water Temperature Warning Light to Water Temperature Switch
87	Oil Pressure Warning Light to Oil Pressure Switch
88	Circuit Breaker to Parking Brake Switch
90	Parking Brake Switch to Dash Indicator Light
92	Circuit Breaker to Auxiliary Power/Optional Accessory
96	Headlight Relay to Dimmer Switch
97	Clearance & Parking Light Relay to Cab Clearance Lights and Right & Left Turn Signals
98	Circuit Breaker to Clearance & Parking Light Relay & Tail Light Relay
99	Circuit Breaker to Neutral Start Switch
100	Circuit Breaker to Jake Brake (Option)
101	Jake Brake Switch to Jake Brake (Option)
102	Jake Brake Switch to Jake Brake (Option)
102	Jake Brake Switch to Jake Brake (Option)
103	Jake Brake Switch to Jake Brake (Option)
104	Fast Idle Switch to Fast Idle Solenoid (Option)
104A	Circuit Breaker to Fast Idle Switch (Option)
105	Auxilliary Gauge to Optional Accessory
.106	Fuel Pump Switch to Fuel Pump (Option)
106A	Fuel Pump Switch to Circuit Breaker
107	Circuit Breaker to Air Dryer
108	Circuit Breaker to Fuel Water Separator
109	Ignition Switch to Circuit Breaker
110	Ignition Switch to Tachometer, Ignition Relay #1 & Ignition Relay #2
126	Ammeter Positive to Ammeter Shunt
127	Ammeter Negative to Ammeter Shunt

Note: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.



Item	Part No.	Description	Qty.
1	7808-0202	Adjusting Mounting Bracket	1
2	8820-1035	H.H.C.S. 3/8-16 x 1	1
3	8855-1011	Lockwasher 3/8	1
4	8850-1006	Hex Nut 3/8-16	1
5	7810-1828	Adjusting Strap	1
6	8820-1068	H.H.C.S. 1/2-13 x 1-3/4	3
7	7602-7938	Hardened Washer 1/2	3
8	8852-1008	Crown Lock Nut 1/2-13	1
9	7604-5799	Alternator, 130 Amp	1
	7811-3243	Alternator, 145 Amps	1
	7605-0198	Alternator, 160 Amp	1
10	7804-7736	Pulley, 130 & 160 Amp	1
	7808-0471	Pulley, 145 Amp	1
11	w/alt.	#8 Woodruff Key	1
12	w/alt.	Flat Washer 5/8	1
13	w/alt.	Hex Nut 5/8-18	1
14	7604-2248	Alternator Belt	2
15	8855-1013	Lockwasher 1/2	3
16	8850-1008	Hex Nut 1/2-13	2
17	8820-1052	H.H.C.S. 7/16-14 x 1-1/2	2
18	8855-1012	Lockwasher 7/16	2
19	7604-6506	Alternator Mounting Bracket	1
20	7604-5145	Spacer	1

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Section VII
ELECTRICAL SYSTEM

Pages: 12 Dated 5-1-80
Supersedes Bulletin
Dated 3-1-69, 11-1-73
Reference: 1B-115, 1B-116
1M-186, 1M-187, 1M-188
1S-180, 1S-186, 1S-187, 1M-188

Delco Remy

CRANKING MOTORS
30-MT, 35-MT, 40-MT, 50-MT Series

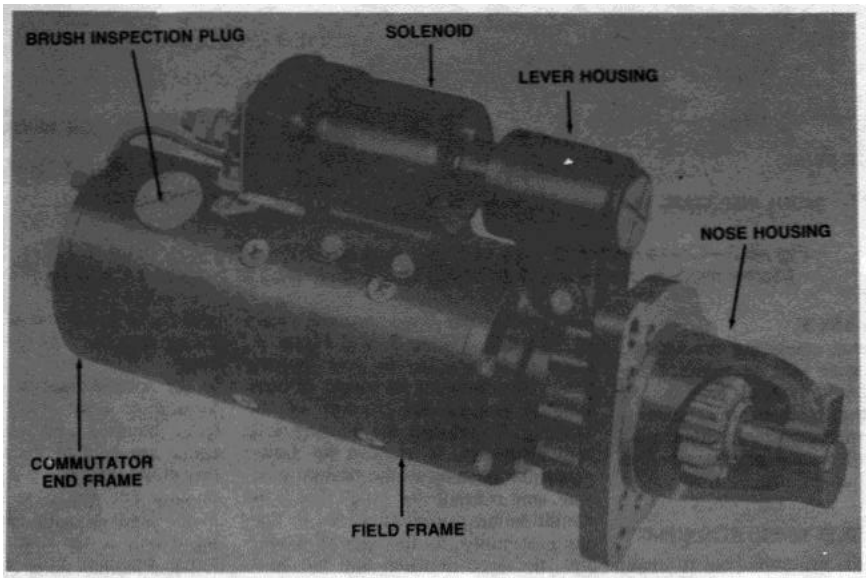


Figure 1- Typical 50-MT Series heavy duty cranking motor

The heavy duty cranking motors covered in this bulletin have a shift lever and solenoid plunger that are totally enclosed to protect them from exposure to dirt, icing conditions and splash. The nose housing can be rotated to obtain a number of different solenoid positions with respect to the mounting flange, which is a feature that makes these motors universally adaptable to a wide variety of different mounting applications.

Positive lubrication is provided to the bronze bushings by an oil saturated wick that projects through the bushings and contacts the armature shaft. Oil can be added to each wick by removing a pipe plug which is accessible on the outside of the motor.

Available as an optional feature are oil reservoirs for the bronze bearings which makes available a larger oil supply thereby extending the time required between lubrication periods. Another optional feature is "O" rings which can be added to resist entry of dirt and moisture into the entire motor assembly. When the oil reservoirs and "O" rings are included, the motor will provide long periods of attention-free operation.

Many models feature a seal between the shaft and lever housing and all models have a rubber boot or linkage seal over the solenoid plunger. The seal and the boot, when used together, prevent entry of oil into the motor main frame and solenoid case, allowing the motor to be used on wet clutch applications.

Four kinds of clutches, a heavy duty sprag, a Positork drive, an intermediate duty type and a splined drive, may be used with enclosed heavy duty type cranking motors. All four types are moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until starting is assured and the solenoid circuit is interrupted. In case of a butt engagement with the heavy duty sprag clutch or Positork drive, the motor will not be energized to prevent damage to the pinion and gear teeth. The spline drive is normally used on gas turbine applications, and can be engaged into the turbine spline gear before the turbine gear has coasted to a stop.

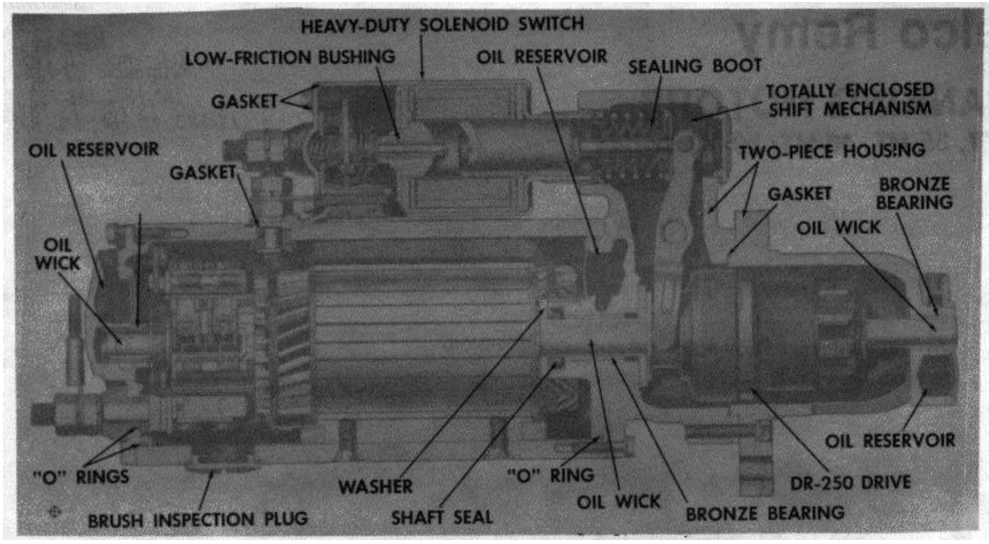


Figure 2 - Cross-sectional view of motor with DR-250 heavy duty drive (50-MT)
(Some model use heavy duty sprag clutch illustrated in Figures 14 and 15.)

MAINTENANCE
Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, motors should be disassembled, inspected, cleaned, and tested as described in succeeding paragraphs.

ADJUSTABLE NOSE HOUSING
Two methods are employed to attach the nose housing to the lever housing.

As shown in the cross-sectional views of Figure 2, Figure 3, and Figure 4, one method attaches the nose housing to the lever housing by means of bolts located around the outside of the housing. To relocate the housing, it is only necessary to remove the bolts, rotate the housing to the desired position, and reinstall the bolts. The bolts should be torqued to 13-17 lb. ft. during reassembly. In this type of assembly, the lever housing and the commutator end frame are attached to the field frame independently by bolts entering threaded holes in the field frame.

In the second method, where the intermediate duty clutch is used, the lever housing and commutator end frame are held to the field frame by thru-bolts extending from the commutator end frame to threaded holes in the lever housing. The nose housing is held to the lever housing by internal attaching bolts extending from the lever housing to threaded hole in.

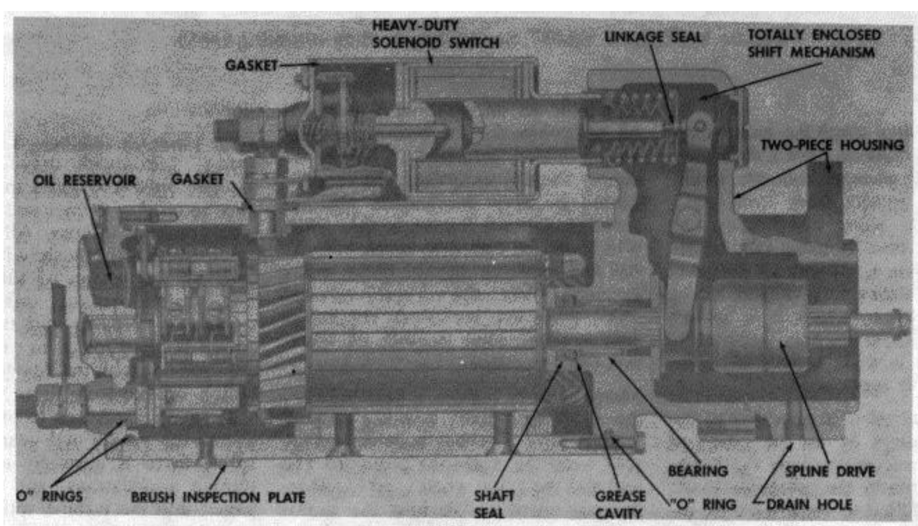
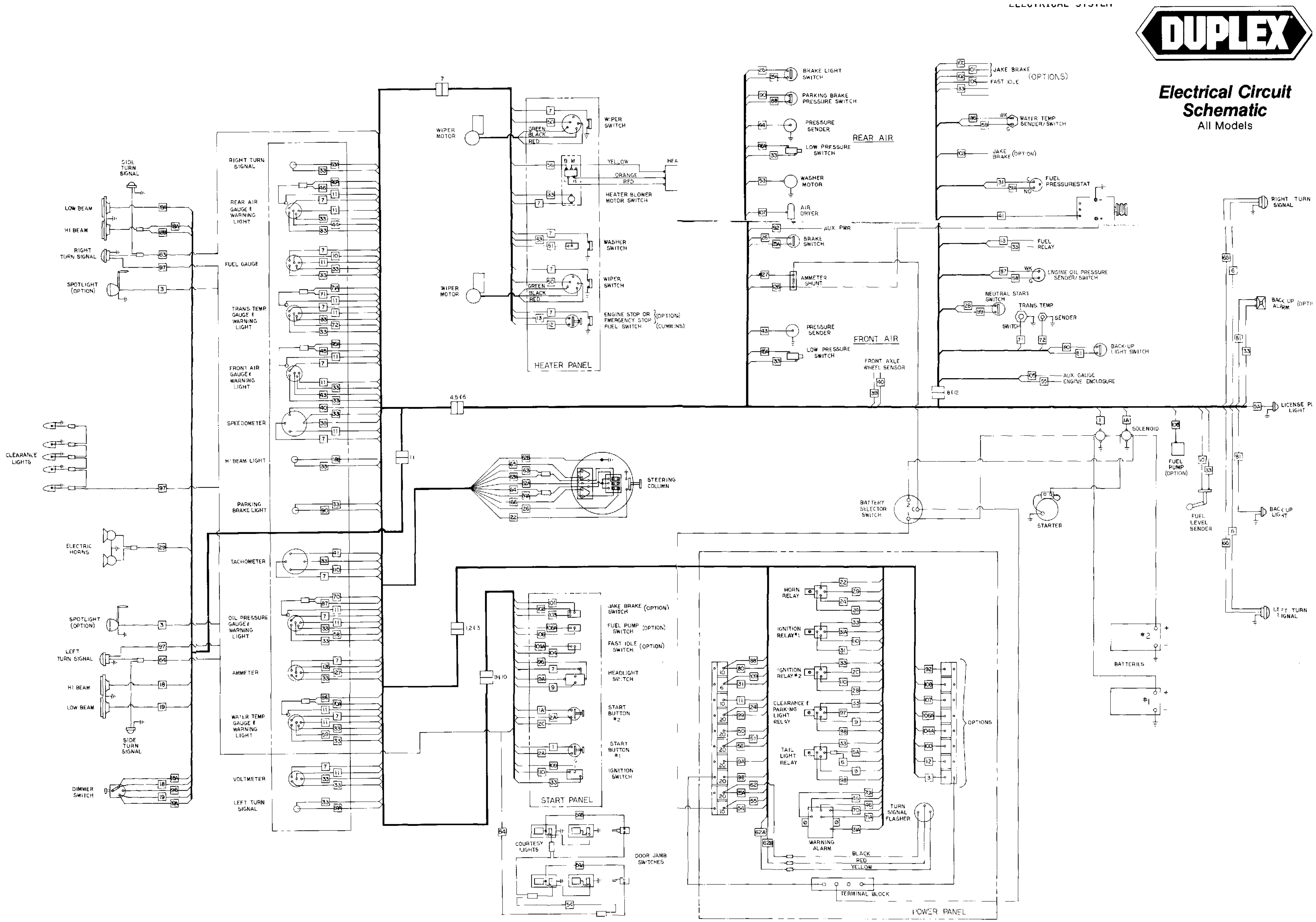


Figure 3-Cross sectional view of motor with spline drive (50-MT)

Electrical Circuit Schematic
All Models



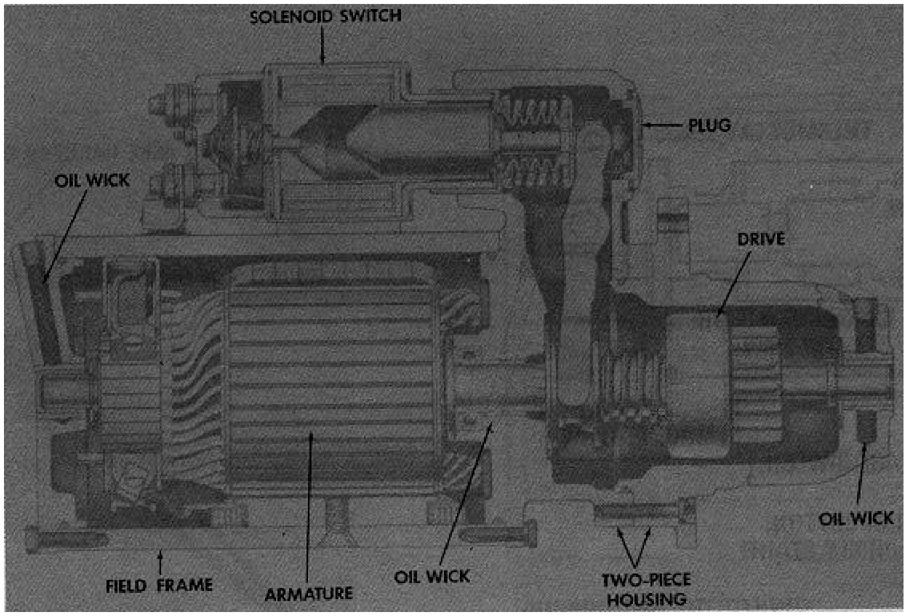


Figure 4-Cross-sectional view of motor with intermediate duty clutch. (35-MT) Note different attaching bolt construction than Figure 5.

the nose housing (Fig. 5). With this arrangement, it is necessary to partially disassemble the motor to provide access to the attaching bolts when relocating the nose housing.

To accomplish this, remove the electrical connector and the screws attaching the solenoid assembly to the field frame and then remove the thru-bolts from the commutator end frame. Separate the field frame from the remaining assembly, and pull the armature away from the lever housing until the pinion stop rests against the clutch pinion. This will clear the nose housing attaching bolts so they can be removed with a box or open end wrench, permitting relocation of the nose housing. During reassembly, torque the nose housing attaching bolts to 11-15 lb. ft.

OPERATION

There are many different cranking motor circuits used on various applications. The cranking circuit may contain a key start switch or push switch, or both, a relay, magnetic switches, solenoids, oil pressure switch, fuel pressure switch and other protective devices, such as an "ALDO" relay.

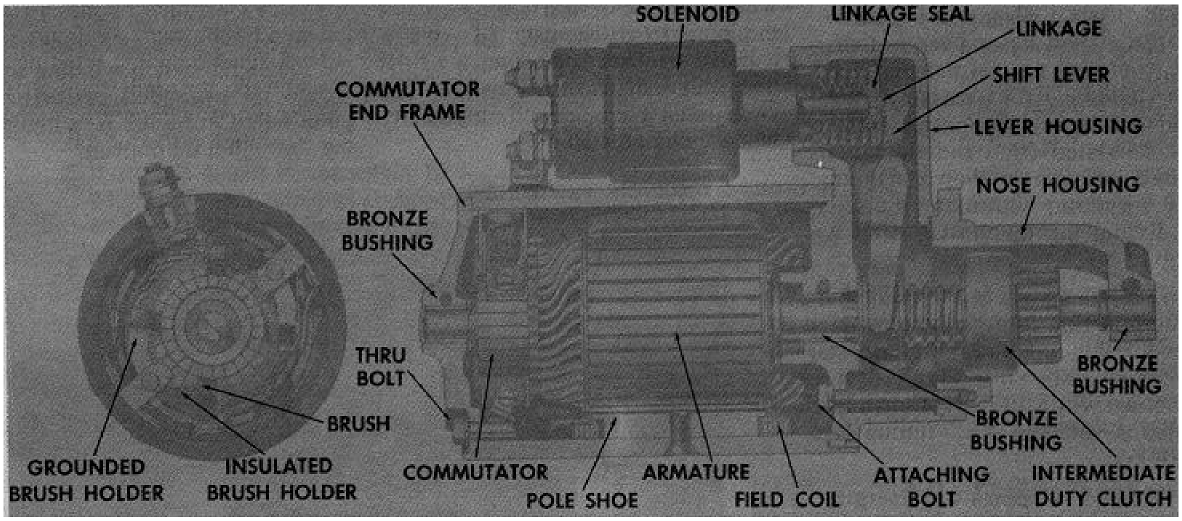


Figure 5-Cross-sectional view of motor with intermediate duty clutch. Note different attaching bolt construction than Figure 4.

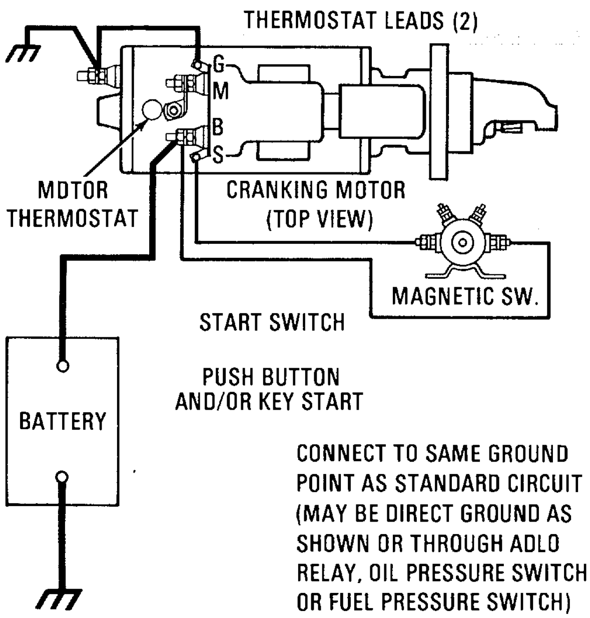


Figure 6-Basic wiring circuit. Reference should be made to the vehicle manufacturer's wiring diagram for the complete cranking circuit.

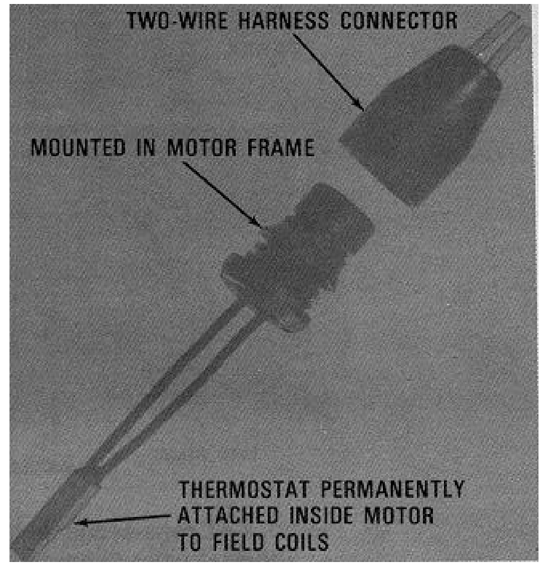


Figure 7-Typical thermostat.

A typical circuit is shown in Figure 6. The motor shown has a built-in thermostat to protect against damage due to over-cranking for excessively long periods of time. Thermostat components separated from the field coils and motor frame are shown in Figure 7. Also a motor with harness disconnected from the thermostat is shown in Figure 8.

When the start switch is closed, battery current flows through the through a thermostat.

magnetic switch winding and the thermostat to ground, as shown in Figure 6. The magnetic switch closes, connecting the motor solenoid "S" terminal to the battery.

The solenoid windings are energized and the resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately when the engine starts.

A cranking period for all types of motors should never exceed 30 seconds without stopping to allow the motor to cool. If over-cranking should occur, the thermostat will open and the cranking cycle will stop to protect the motor. After the cranking motor cools, usually 1-6 minutes, the thermostat will close and then a new starting attempt can be made.

A circuit without the motor thermostat would be the same as Figure 6, except the magnetic switch winding terminal would be grounded directly to the point noted in Figure 6, without passing

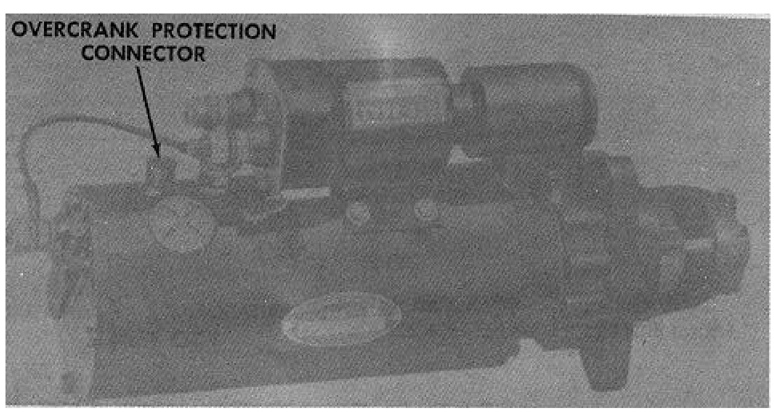


Figure 8 Typical motor snowing thermostat connector.

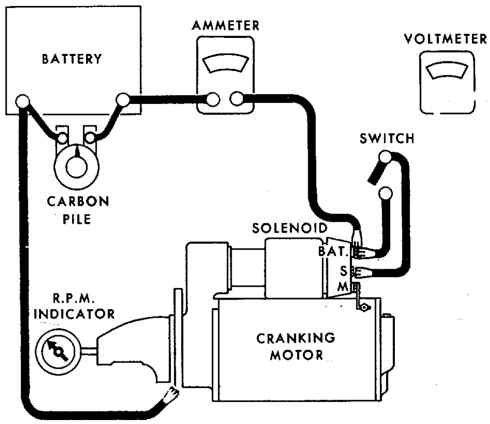


Figure 9-No-load test circuit.

TROUBLESHOOTING THE CRANKING CIRCUIT

Before removing any unit in a cranking circuit for repair, the following checks should be made:

Battery: To determine the condition of the battery, follow the testing procedure outlined in Service Bulletin 1B-115 or 1B-116. Insure that the battery is fully charged.

Wiring: Inspect the wiring for damage. Inspect all connections to the cranking motor, solenoid, magnetic switch, ignition switch or any other control switch, and battery, including all ground connections. Clean and tighten all connections as required.

Magnetic Switch, Solenoid and Control Switches: Inspect all switches to determine their condition. From the vehicle wiring diagram, determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

Thermostat, or Overcrank Protection:

To check the thermostat for continuity, detach wiring harness connector and connect an ohmmeter to the two thermostat terminals on the motor. (Fig. 8). The ohmmeter should read zero. If not, thermostat is open circuit. DO NOT check thermostat when hot, since it is supposed to be open-circuit above certain temperatures.

Motor: If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

CRANKING MOTOR TESTS

Regardless of the construction, never operate the cranking motor more than 30 seconds at a time without pausing to allow it to cool at least two minutes. On some applications, 30 seconds may be excessive. Overheating, caused by excessive cranking will seriously damage the cranking motor (without thermostat).

With the cranking motor removed from the engine, the armature should be checked for freedom of rotation by prying the pinion with a screwdriver.

Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely. If the armature does not turn freely the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

No-Load Test (Fig. 9)

Connect a voltmeter from the motor terminal to the motor frame, and use an r.p.m. indicator to measure armature speed. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal. Close the switch and compare the r.p.m., current, and voltage reading with the specifications in Service Bulletins 1M-186, 1M-187, or 1M-188. It is not necessary to obtain the exact voltage specified in these bulletins, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the r.p.m. will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value. If more than one 12-volt battery is used, connect the carbon pile to only one of the 12-volt batteries. If the specified current draw does not include the solenoid, deduct from the ammeter reading the specified current draw of the solenoid hold-in winding. Make disconnections only with the switch open. Interpret the test results as follows:

Interpreting Results of Tests

1. Rated current draw and no-load speed indicates normal condition of the cranking motor.
2. Low free speed and high current draw indicate:
   a. Too much friction-tight, dirty, or worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

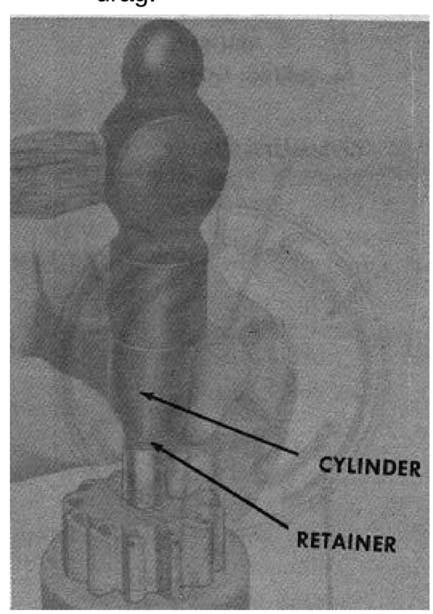


Figure 10-Rerhoving retainer from snap ring.

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 terminal or fields.
   b. "Frozen" bearings (this should have been determined by turning the armature by hand).
4. **Failure to operate with no current draw indicates**:
   a. Open field circuit. This can be checked after disassembly by inspecting internal connections and tracing 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 indicate**:
   a. High internal resistance due to poor connections, defective leads, dirty commutator and causes listed under Number 4.
6. High free speed and high current draw indicate shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

DISASSEMBLY

Normally the cranking motor should be disassembled only so far as is necessary to make repair or replacement of the defective parts. As a precaution, it is suggested that safety glasses be worn when disassembling or assembling the cranking motor.

Intermediate Duty Clutch Motor

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.
2. Disconnect field coil connector from solenoid motor terminal, and remove solenoid mounting screws.
3. Remove thru-bolt or cap screws.
4. Remove commutator end frame from field frame and field frame from lever housing.

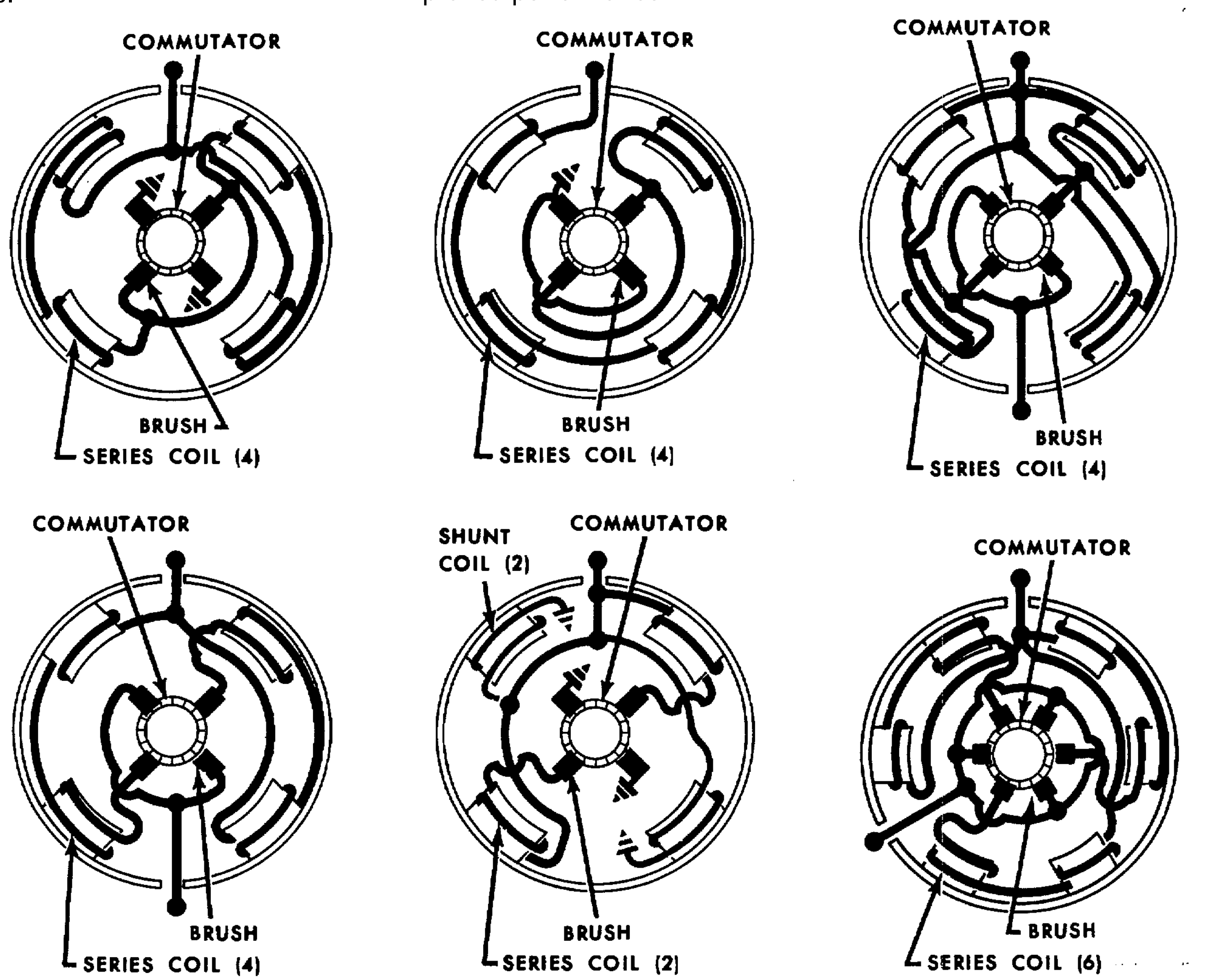


Figure 11-Typical motor circuits.

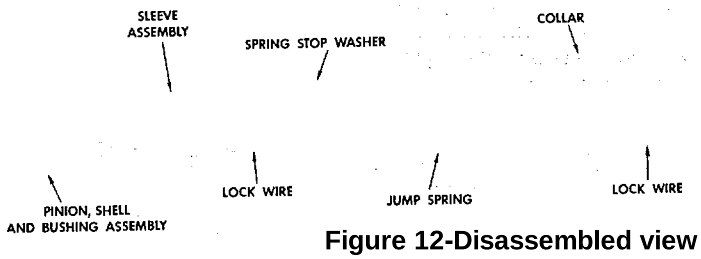


Figure 12-Disassembled view of early type intermediate duty sprag clutch drive assembly

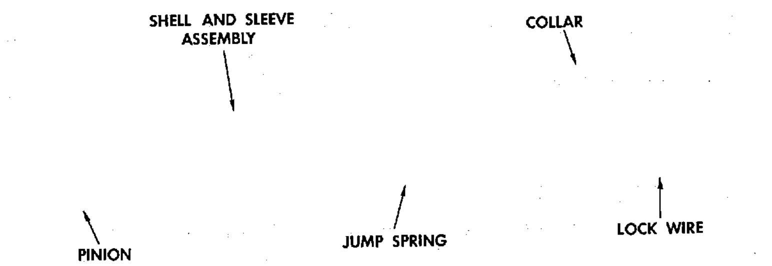


Figure 13-Disassembled view of late type intermediate dutv spray clutch drive assembly.

5. Remove nose housing attaching bolts and separate nose housing from lever housing.

6. Slide a standard half-inch pipe coupling or other metal cylinder of suitable size (an old pinion of suitable size can be used if available) onto shaft so end of coupling or cylinder butts against edge of retainer. Tap end of coupling with hammer, driving retainer towards armature and off snap ring (Fig. 10).

7. Remove snap ring from groove in shaft using pliers or other suitable tool. If snap ring is too badly distorted during removal it may be necessary to use a new one when reassembling clutch.

8. Remove the armature and clutch from the lever housing. 9. Separate the solenoid from the lever housing.

Heavy Duty Clutch, Positork Drive, and Spline Drive Motors

1. Note the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.

2. Disconnect field coil connector from solenoid motor terminal, and lead from solenoid ground terminal.

3. On motors which have brush inspection plates, remove the plates and then remove the brush lead screws. This will disconnect the field leads from the brush holders.

4. Remove the attaching bolts and separate the commutator end frame from the field frame.

5. Separate the nose housing and field frame from lever housing by removing attaching bolts.

6. Remove armature and clutch assembly from lever housing.

7. Separate solenoid from lever housing by pulling apart.

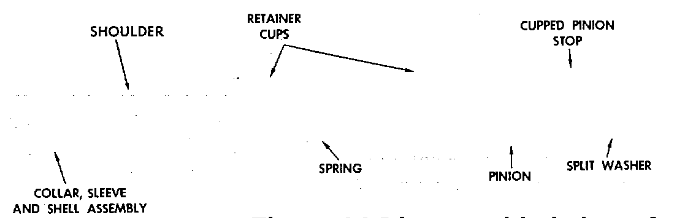


Figure 14-Disassembled view of early type heavy duty sprag clutch drive assembly.

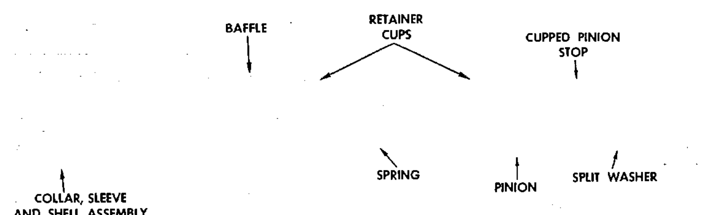


Figure 15-Disassembled view of late type heavy duty sprag clutch drive assembly.

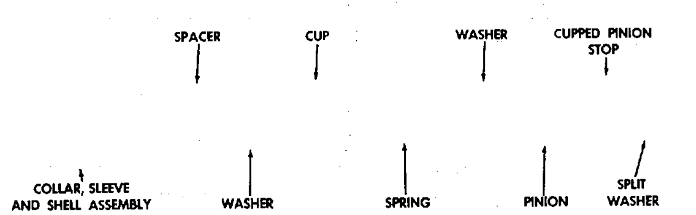


Figure 16-Disassembled view of DR-250 drive.

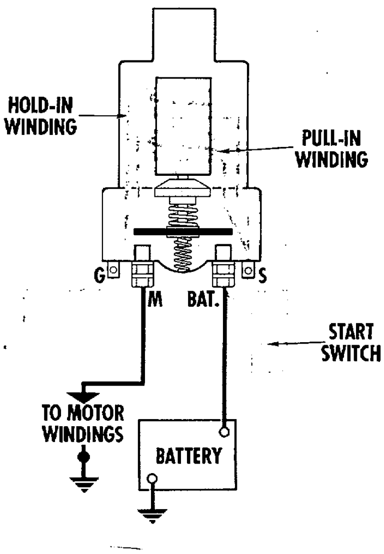


Figure 17-Basic solenoid circuit. (Types shown in Figures 1, 2, and 3.)

CLEANING

The drive, armature and fields should not be cleaned in any degreasing tank, or with grease dissolving solvents, since these would dissolve the lubricant in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

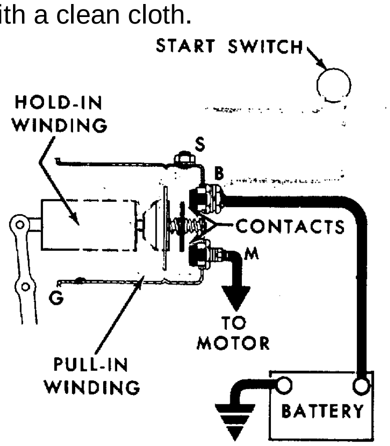


Figure 1-Basic solenoid circuit. (Types shown in Figures 4 and 5.)

If the commutator is dirty it may be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

Brushes and Holders

Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush spring (are giving firm contact between the brushes and commutator. If the springs are distorted or discolored they should be replaced.

ARMATURE SERVICING

If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a lathe so the commutator can be turned down. The insulation should then be undercut 1/32 of an inch wide and 1/32 of an inch deep, and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure. **NOTE:** The undercut operation must be omitted on cranking motors having Test Specifications 2412, 2415, 3501, 3564, 3574 and 3599 as listed in Delco Remy Service Bulletins IM-186, 1M-187, and IM-188. **Do not** undercut commutators on motors having these specifications.

The armature should be checked for opens, short circuits and grounds as follows:

1. Opens-Opens are usually caused by excessively long cranking periods. The most likely place for an open to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by resoldering or welding the leads in the riser bars (using rosin flux), and turning down the commutator in a lathe to remove the burned material. The

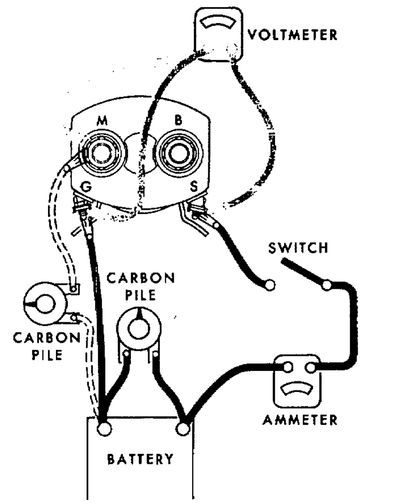


Figure 19-Checking solenoid hold-in and pull-in windings. (Note: Terminal locations may vary.)

insulation should then be undercut except as noted above.

2. Short Circuits-Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.
3. Grounds-Grounds in the armature can be detected by the use of a 110-volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the cranking motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

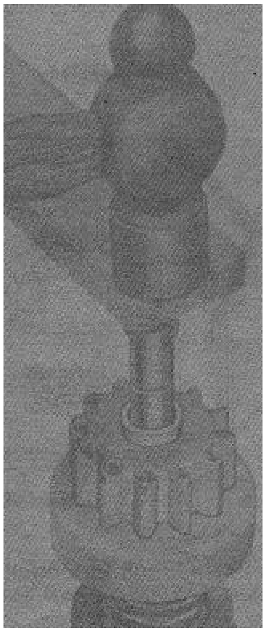


Figure 20 - Forcing snap ring over shaft.

FIELD COIL CHECKS

The various types of circuits used are shown in the wiring diagrams of Figure 11. The field coils can be checked for grounds and opens by using a test lamp.

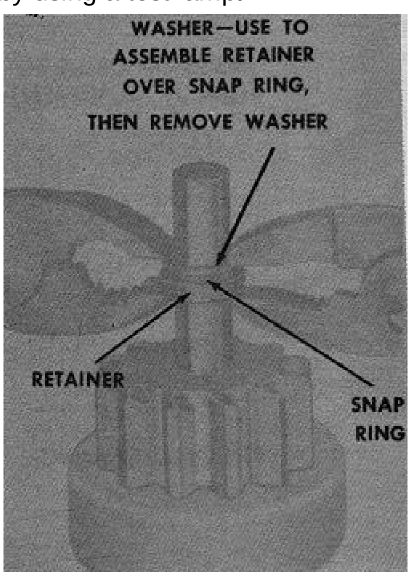


Figure 21-Forcing retainer over snap ring.

Grounds-If the motor has one or more coils normally connected to ground, the ground connections must be disconnected during this check. Connect one lead of the 110-volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

Opens-Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

FIELD COIL REMOVAL

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place. Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

CLUTCH ASSEMBLY

Disassembly procedures for the various types of clutches are outlined below.

A. Intermediate Duty Sprag Clutch.

An early type clutch and late type clutch are shown in Figures 12 and 13.

1. Remove the lock wire, collar, and jump spring from the sleeve assembly.
2. Remove the spring stop washer and second lock wire from the early type clutch (Fig. 12).
3. Remove the retainer ring and large washers. Do not remove the sleeve assembly or sprags from the shell assembly.
4. Lubricate the sprags and saturate the felt washer with No. 5W20 oil. Heavier oil must not be used.
5. Assembly is the reverse of disassembly.

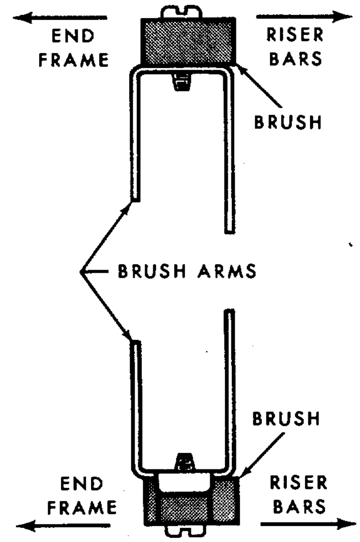


Figure 22-Brush with offset hole assembled to brush arm.

B. Heavy Duty Sprag Clutch and DR-250 Drive.

An early type and a late type heavy duty sprag clutch are shown in Figures 14 and 15 and the DR-250 drive is shown in Figure 16.

1. Remove the cupped pinion stop and split washer. In removing the cupped pinion stop, it will probably be damaged. A new one will be required at time of reassembly.
2. Remove the other parts as illustrated.
3. **Do not** lubricate the sprags on heavy duty clutches, as they are lubricated for life with special oil at the factory.
4. Assembly is the reverse of disassembly.

C. Spline Drive and Positork Drive.

These types of drive assemblies are serviced by complete replacement only.

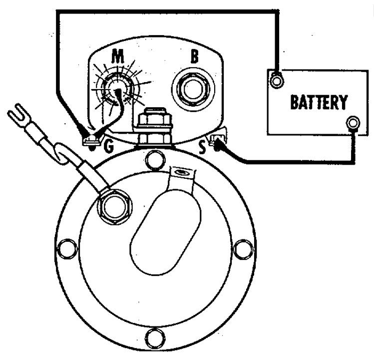


Figure 23Circuit for checking pinion clearance. (Types shown in Figures 1, 2 and 3.)

SOLENOID CHECKS

A basic solenoid circuit is shown in Figures 17 and 18. Solenoids may differ in appearance but can be checked electrically by connecting a battery of the specified voltage, a switch, and an ammeter to the two solenoid windings. With all leads disconnected from the solenoid, make test connections as shown to the solenoid switch (S or SW) terminal and to ground, or to the second switch terminal, (G), if present, to check the hold-in winding (Fig. 19). Use the carbon pile to decrease the battery voltage to the value specified in Service Bulletins IS-180, 1S-186, 1S-187 and IS-188 and com- pare the ammeter reading with specifications. A high reading indicates a shorted hold-in winding, and a low reading excessive resistance. To check the pull-in winding connect from the solenoid switch terminal (S) to the solenoid motor (M or MOT) terminal. To check for grounds, move battery lead from "G" terminal to solenoid case, and from "M" terminal to solenoid case. (Fig 19, not shown) Ammeter should read zero for both windings. If not solenoid is grounded.

NOTE: If needed to reduce the voltage to the specified value, connect the carbon pile between the battery and the "M" terminal as shown in dashed red instead of across the battery as shown in solid red lines. If the carbon pile is not needed, connect a jumper directly from the battery to the "M" terminal as shown by the dashed red line.

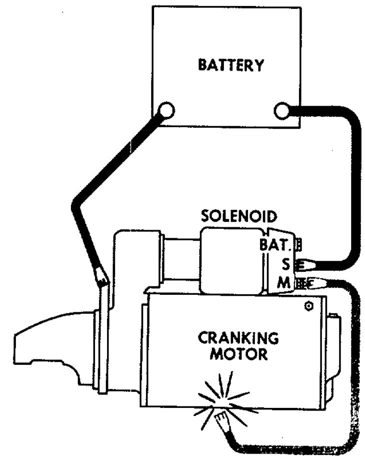


Figure 24-Circuit for checking pinion clearance. (Types shown in Figures 4 and 5.)

CAUTION: To prevent overheating, do not leave the pull-in winding energized more than 15 seconds. The current draw will decrease as the winding temperature increases.

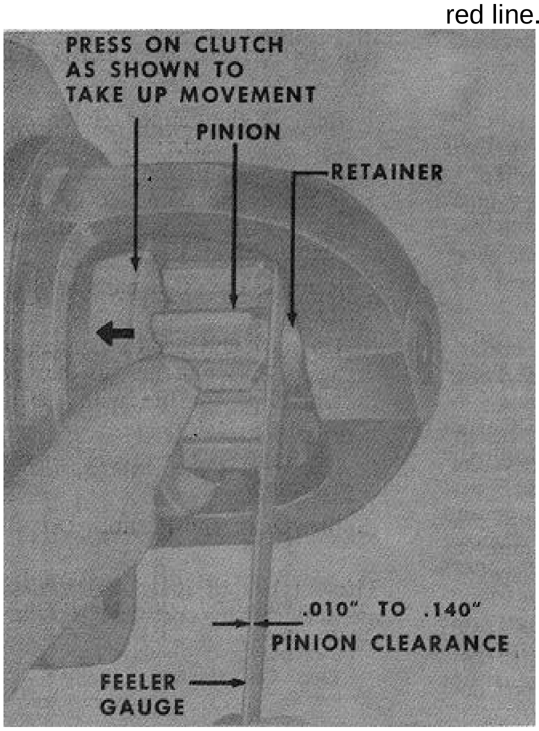


Figure 25-Checking pinion clearance on intermediate duty clutch motor.

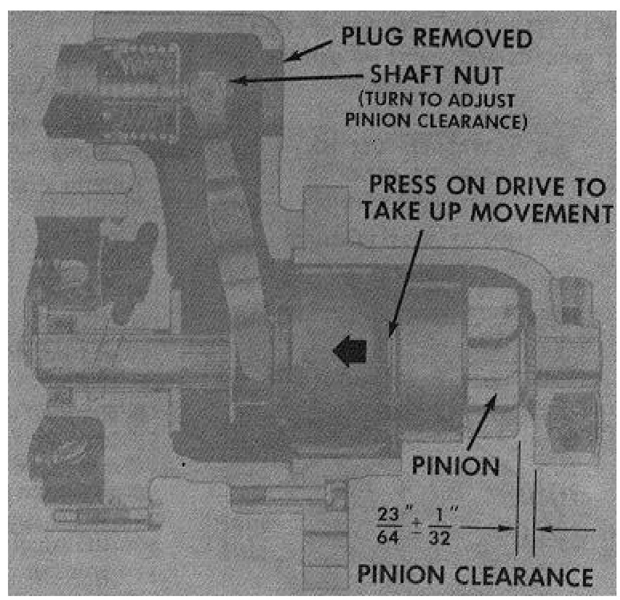


Figure 26-Checking pinion clearance on heavy duty motor.

A magnetic switch can be checked in the same manner by connecting across its winding.

REASSEMBLY

The reassembly procedure for each type of motor is the reverse of disassembly.

On motors using a snap ring and re- tainer on the shaft as a pinion stop, the ring and retainer can be assembled in the manner shown in Figures 20 and 21. With the retainer placed over the shaft with the cupped surface facing the end of the shaft, force the ring over the shaft with a light hammer blow and then slide the ring down into the groove (Fig. 20). To force the re- tainer over the snap ring, place a suit- able washer over the shaft and squeeze with pliers (Fig. 21). REMOVE THE WASHER.

To reassemble the end frame having eight brushes onto the field frame, pull the armature out of the field frame just far enough to permit the brushes to be placed over the commutator. Then push the commutator end frame and the armature back against the field frame.

On intermediate duty clutch motors, be sure to assemble all brushes to the brush arms so the long side of the brush is toward the riser bars. See Figure 22.

LUBRICATION

All bearings, wicks and oil reservoirs should be saturated with SAE No. 20 oil. Place' a light coat of lubricant Delco Remy No. 1960954 on the washer located on the shaft between the armature and shift lever housing. Washer is identified in Figure 2.

Sintered bronze bearings used in these motors have a dull finish, as compared to the early type machined, cast bronze bearings which had a shiny finish.

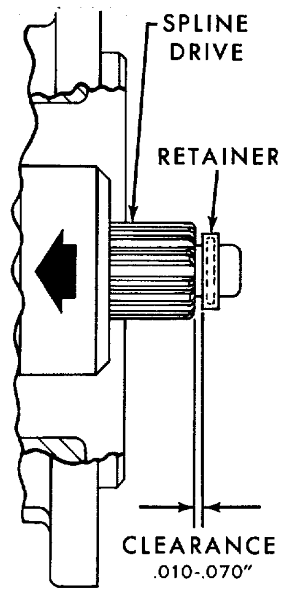


Figure 27-Checking pinion clearance on spline drive motor.

Before pressing the bearing into place, dip it in SAE No. 20 oil. Also, tangent wicks (if present) should be soaked with SAE No. 20 oil. Insert the wick into place first, and then press in the bearing.

DO NOT DRILL, REAM or MACHINE sintered bearings in any way! These bearings are **supplied to size.** If drilled or reamed, the I.D., (inside diameter) will be too large, also the bearing pores will be sealed over.

It is not necessary to cross-drill a sintered bearing when used with a tan- gent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

Middle bearings are **support** bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between middle bearing and shaft is large and the clearance provides a loose fit when assembled.

PINION CLEARANCE

There are no provisions for adjusting pinion clearance on motors using the intermediate duty clutch (Fig. 5). However, all types should be checked after reassembly to make sure the clearance is within specifications. In- correct clearance where not adjustable indicates excessive wear, and worn parts should be replaced.

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown in Figure 23 or Figure 24.
2. **Momentarily** flash a jumper lead shown in blue color in Figure 23 or Figure 24. The drive will now shift into cranking position and remain so until the battery is disconnected.
3. Push the pinion or drive back towards the commutator end to eliminate slack movement.
4. Measure the distance between drive and drive stop (Figs. 25, 26, and 27).
5. Adjust clearance by removing plug and turning shaft nut (Figs. 26 and 27). **Although typical specifications are shown, always refer to 1M-188, 1M-187, or 1M-186 for specifications applying to specific models.**

NOTES

CO: 1.2, 1 WDS & PS, 1.2X. 131,132 16, 1.2-52 1FD

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Section VII
ELECTRICAL SYSTEM

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Delco-Remy
Tests of
DELCOTRON® INTEGRAL CHARGING SYSTEM
(40-SI Series, 150 Type)

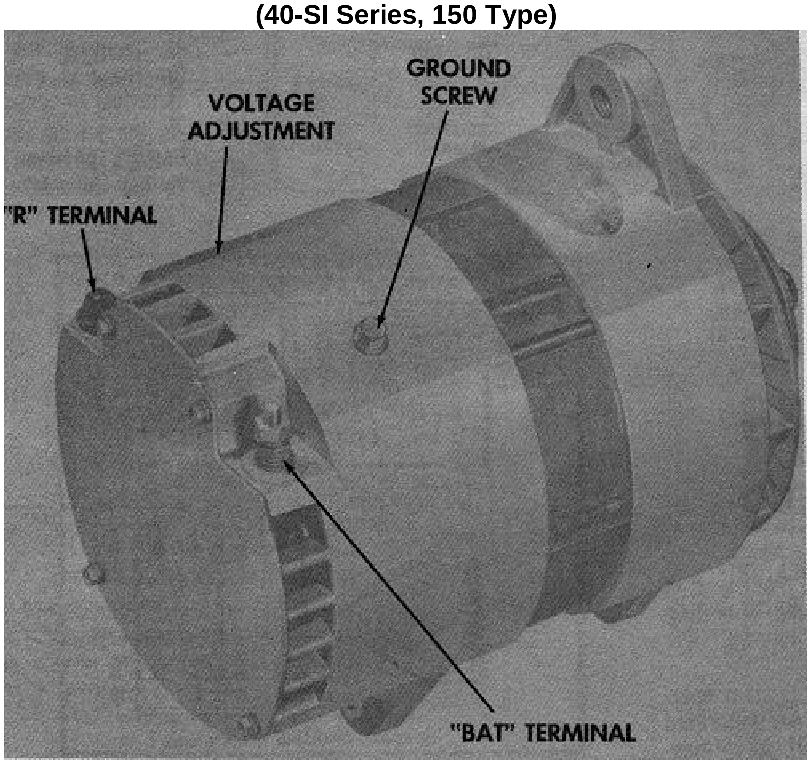

Figure 1-Typical integral charging system.

INTRODUCTION

The Integral Charging System or generator, illustrated in Figures 1 and 2 features a solid state regulator that is mounted inside the slip ring end frame. The regulator voltage setting can be adjusted externally by repositioning a voltage adjustment cap in the slip ring end frame. This feature is covered in detail in Figure 8. Only one wire is needed to connect the Integral Charging System to the battery, along with an adequate ground return. An "R" terminal is provided to operate auxiliary equipment in some circuits. Also, some models have three a.c. terminals to which a transformer-rectifier combination may be connected for conversion to 110 volts d.c.

The rotor bearing in the slip ring end frame contains a supply of lubricant sufficiently adequate to eliminate the need for periodic lubrication. The drive end frame bearing is sealed on both sides and is serviced by complete replacement. Two brushes carry current through the two slip rings to the field coil mounted on the rotor, and under normal conditions will provide long periods of attention-free service.

IMPORTANT: This bulletin covers generators with a two-terminal regulator having two male blade terminals and also generators with a three-terminal regulator having two male blade terminals plus a threaded stud terminal. The procedures in this bulletin cover both types of generators; namely, the two-terminal type and the three-terminal type.

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DELCOTRON INTEGRAL CHARGING SYSTEM

1G-285 Service Bulletin

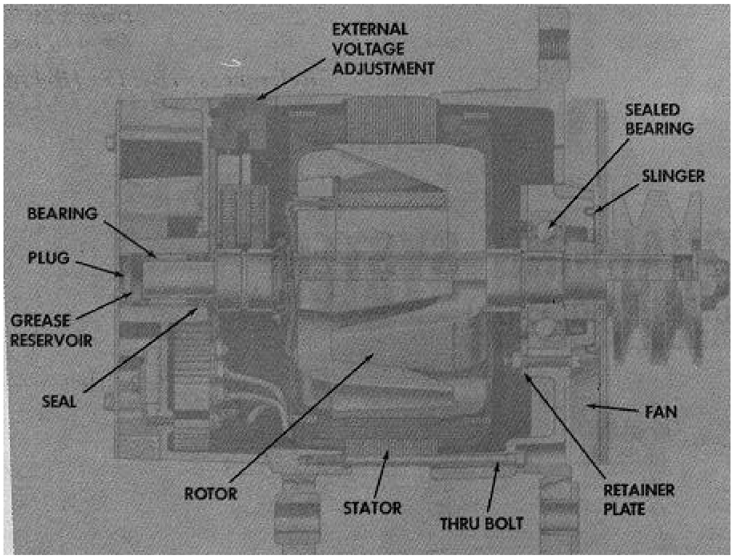


Figure 2—Cross-sectional view typical integral charging system.

OPERATING PRINCIPLES

(TWO-TERMINAL REGULATOR)

Typical wiring diagrams are illustrated in Figures 3 and 4. The basic operating principles are explained as follows.

With the Integral Charging System operating, a.c. voltages initially are generated in the stator windings by residual magnetism in the rotor. Current then flows through the diode trio, resistor R1, and resistor R4 to turn transistor TR1 on. The stator then supplies d.c. field current through the diode trio, the field, TR1, and then through the grounded diodes in the rectifier bridges back to the stator. Also, the diodes in the rectifier bridges change the stator a.c. voltages to a d.c. voltage which appears between ground and the "BAT" terminal. As speed increases, current is provided for charging the battery and operating electrical accessories.

As the speed and voltage increase, the voltage between R2 and R3 increases to the value where zener diode D1 conducts. Transistor TR2 then turns on and TR1 turns off. With TR1 off, the field current and system voltage decrease, and D1 then blocks current flow causing TR1 to turn back on. The field current and system voltage increase, and this cycle then repeats many times per second to limit the voltage to the adjusted value.

Capacitor C1 smooths out the voltage across R3, resistor R4 prevents excessive current through TR1 at high temperatures, and diode D2 prevents high-induced-voltages in the field windings when TR1 turns off.

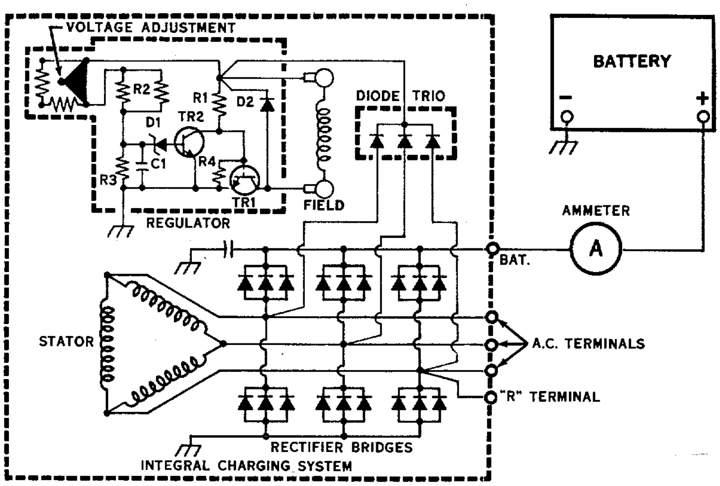


Figure 4—Typical wiring diagram showing internal circuits.
(Three-rectifier bridge type)

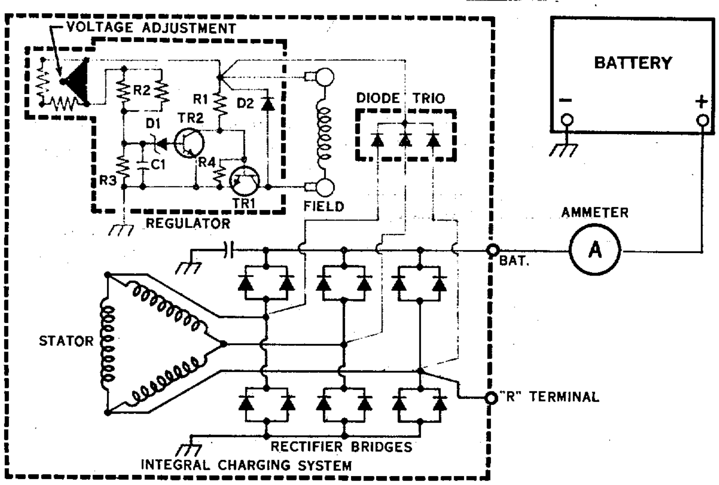


Figure 3—Typical wiring diagram showing internal circuits.
(Two-rectifier bridge type)

OPERATING PRINCIPLES (THREE-TERMINAL REGULATOR)

Typical wiring diagrams are shown in Figures 5 and 6. The basic operating principles are explained 'as follows.

With the Integral Charging System operating, a.c. voltages initially are generated in the stator .windings by residual magnetism in the rotor. The diodes in the rectifier bridge change the stator a.c. voltages to a d.c. voltage which appears between ground and the "BAT" terminal. As speed increases, current is provided for charging the battery and operating electrical accessories.

Current also flows from the stator and rectifier bridge through resistor R1 and resistor R4 to turn transistor TR1 on.

The stator then supplies d.c. field current through the diode trio, the field, TR1, and then through the diodes in the rectifier bridge back to the stator.

As the speed and voltage increase the voltage between R2 and R3 increases to the value where zener diode D1 conducts. Transistor TR2 then turns on and TR1 turns off. With TR1 off, the field current and system voltage decrease and D1 then blocks current flow causing TR1 to turn back on. The field current and system voltage increase and this cycle then repeats many times per second to limit the voltage to the adjusted value.

Capacitor C1 smoothes out the voltage across R3, resistor R4 prevents excessive current through TR1 at high temperatures, and diode D2 prevents high- induced-voltages in the field windings when TR1 turns off.

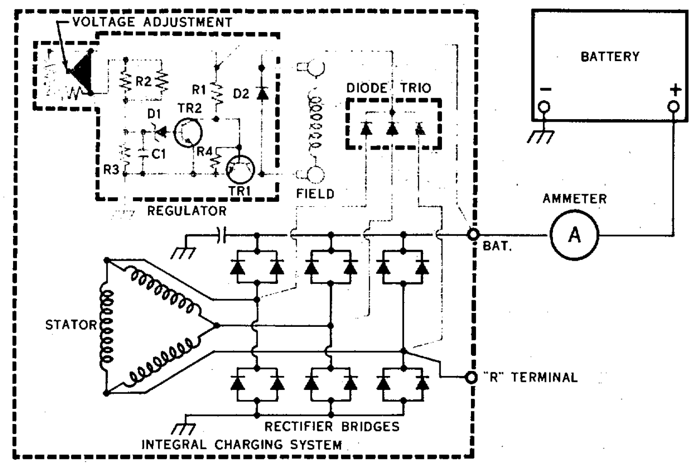


Figure 5-Typical wiring diagram showing internal circuits. (Two-rectifier bridge type)

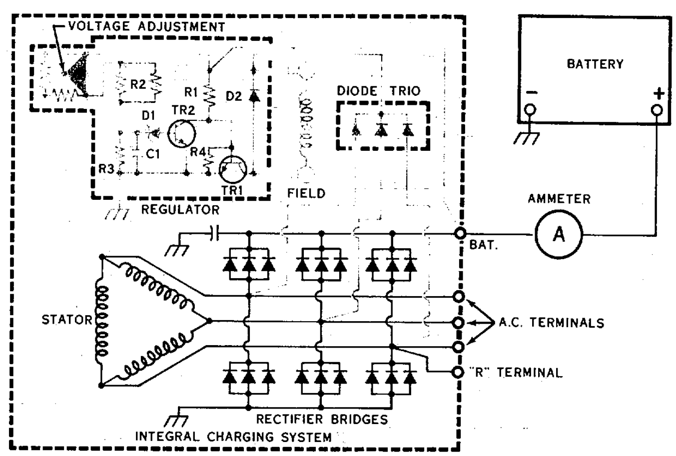


Figure 6-Typical wiring diagram showing internal circuits. (Three-rectifier bridge type)

TROUBLESHOOTING PROCEDURES

(Close adherence to the following procedures in the order presented will lead to the location and correction of charging system defects in the shortest possible time. Only a portion of these procedures need be performed. It will never be necessary to perform all the procedures in order to locate the trouble.)

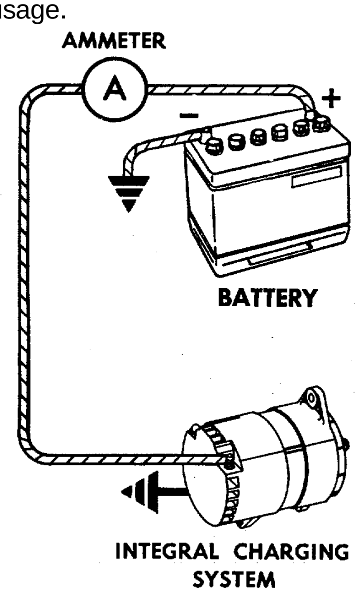
A basic wiring diagram showing lead connections is shown in Figure 7. To avoid damage to the electrical equipment, always observe the following pre-cautions:

- Do not polarize the Integral Charging System.
- Do not short across or ground any of the terminals in the charging circuit except as specifically instructed herein.
- Make sure the Integral Charging System and battery have the same ground polarity.
- When connecting a charger or a booster battery to the vehicle battery, connect negative to negative and positive to positive.

Trouble in the charging system will show up as one or more of the following conditions:

A. An undercharged battery, as evidenced by slow cranking and low specific gravity readings.

B. An overcharged battery, as evidenced by excessive water usage.



INTEGRAL CHARGING SYSTEM

Figure 7-Typical wiring diagram showing basic lead connections.

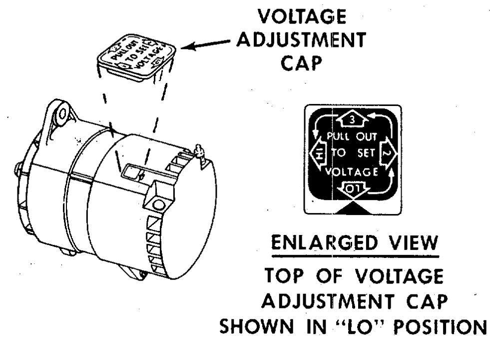


Figure 8-Voltage adjustment cap.

A. UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions:

1. Insure that the undercharged condition has not been caused by accessories having been left on for ex- tended periods.
2. Check the drive belt for proper tension.
3. If a battery defect is suspected, check per Delco-Remy Service Bulletin 1B-115 or IB-116.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the cable clamps and battery posts.
5. Connect a voltmeter from "BAT" terminal on Integral Charging System to ground. A zero reading indicates an open between voltmeter connection and battery.
6. If previous Steps 1 through 5 check satisfactorily, check Integral Charging System as follows:
   a. Disconnect battery ground cable.
   b. Connect an ammeter in the circuit at the "BAT" terminal of the Integral Charging System.
   c. Reconnect battery ground cable.
   d. Turn on accessories. Connect a carbon pile across the battery.
   e. Operate engine at moderate speed as required, usually 4000 generator r.p.m. or more, and adjust carbon pile as required, to obtain maximum current output.

IMPORTANT: Initial voltage build-up is by residual magnetism in the rotor. Increase the speed as re- quired to obtain maximum current output.

f. If ampere output is within 10 per- cent of rated output as stamped on generator frame, Integral Charging System is not defective. In this case, an adjustment of the voltage setting may correct the undercharged condition. Raise the setting by removing the voltage adjusting cap, rotating in increments of 90°, and then reinserting the cap in the connector body. As illustrated in Figure 8, the cap is set for low voltage. With position 2 aligned with the arrow, the setting is increased to medium low, position 3 is medium high, and position "HI" is the highest regulator setting. After adjusting the setting, check for an improved battery condition after a service period of reasonable length, such as one week. **IMPORTANT:** The voltage adjustment in Figure 8 is for purposes of illustration only. The actual adjustment as shipped from the factory may be in some other position such as position 3, depending on the application requirement. If readjusting the setting does not correct the undercharged condition, proceed to "Integral Charging System Repair."

g. If ampere output is not within 10 percent of rated output as stamped on Integral Charging System frame, remove the Integral Charging System for repair as covered in section entitled" INTEGRAL CHARGING SYSTEM REPAIR."

B. OVERCHARGED BATTERY

1. Check the battery per Delco-Remy Service Bulletin 1B-115 or 1B-116. **IMPORTANT-** Remember that an over-heated battery will be overcharged even though no charging circuit defects are present.
2. If battery is not defective or overheated, connect a voltmeter between Integral Charging System "BAT" terminal and ground.
3. With all accessories turned off, increase engine speed as required to obtain maximum voltage reading.
4. If voltage exceeds 15 volts on a 12- volt system, or 30 volts on a 24-volt system, remove Integral Charging System for repair as covered under heading of "INTEGRAL CHARGING SYSTEM REPAIR."
5. If voltage does not exceed the values listed in Step 4 preceding, adjust voltage to a lower value by removing voltage adjusting cap and reinserting into connector body. Then check battery condition after a service period of reasonable length, such as one week. Figure 8 is for purposes of illustration only, and shows the cap adjusted for the lowest setting. The actual adjustment as shipped from the factory may be in some other position, such as position 3, depending on the application requirement. The lowest setting is with "LO" aligned with the arrow, position 2 is medium low, position 3 is medium high, and "HI" is the highest setting.

INTEGRAL CHARGING SYSTEM REPAIR

To repair the Integral Charging System, observe the following procedure.

DISASSEMBLY

1. Remove end plate from slip ring end frame.
2. Hold shaft with hex wrench inserted into hex hole in end of shaft while removing shaft nut. Remove washer, pulley, fan and slinger.
3. Remove four thru-bolts from drive end frame.
4. Separate slip ring end frame and stator assembly from drive end frame and rotor assembly.
5. Separate stator from end frame by removing three stator lead attaching nuts. Figures 9 and 10, and 11 and12 show

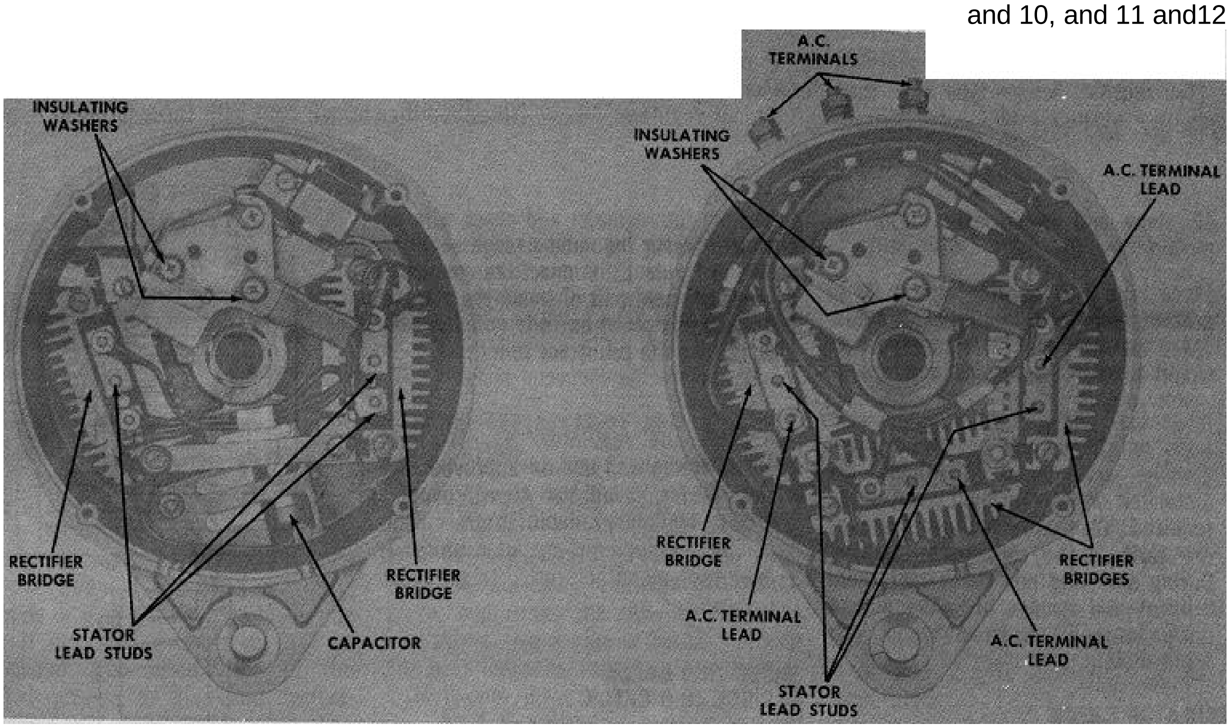


Figure 9-End frame view with stator removed. (Two-rectifier bridge type with two-terminal regulator)

Figure 10-End frame view with stator removed. (Three-rectifier bridge type with two-terminal regulator)

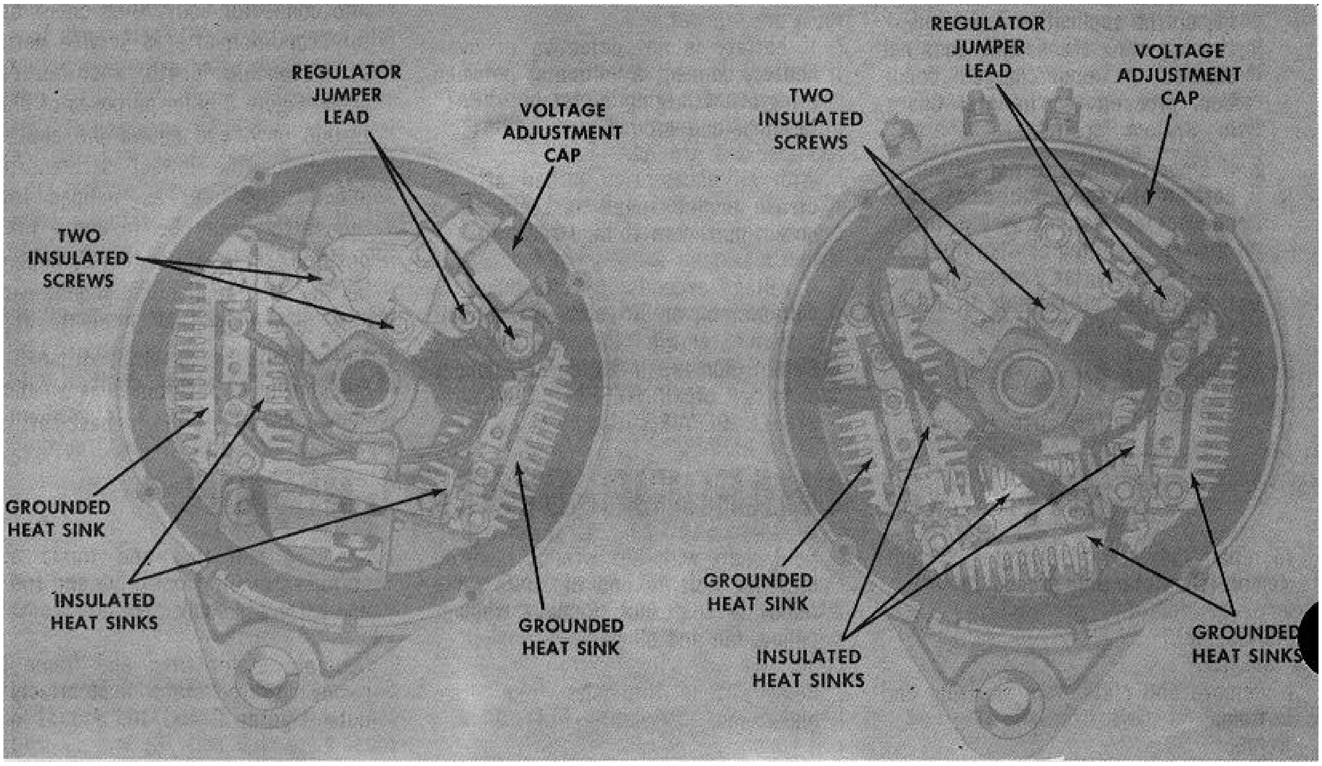


Figure 11-End frame view with stator removed. (Two-rectifier bridge type with three-terminal regulator)

Figure 12-End frame view with stator removed. (Three-rectifier bridge type with three-terminal regulator)

end frame with stator removed.

6. Place tape over bearing and shaft to protect from dirt. Use pressure sensitive tape and not friction tape that would leave a gummy deposit.
7. Inspect all leads for burned connec- tions or opens, and brushes for excessive wear. Inspect springs for distortion or discoloration. Replace as required. C1ean brushes with a soft dry cloth if they are to be reused. During servicing and reassembly hold brushes and springs in holder with a pin or toothpick inserted through end frame hole.

REGULATOR CHECK

Check first the voltage adjustment connector body for opens. Remove the connector body from the regulator and check with an ohmmeter using the middle range scale as shown in Figure 13. Connect the ohmmeter to each adjacent pair of terminals, making four checks in all. If any one check is infinite, replace the connector body.

To check the regulator, remove from the end frame and use an approved regulator tester, available from commercial test equipment manufacturers. Follow the manufacturer's recommended test procedure.

DIODE TRIO CHECK

The diode trio is identified in Figures 14 and 15. To check the diode trio, remove it from the end frame assembly

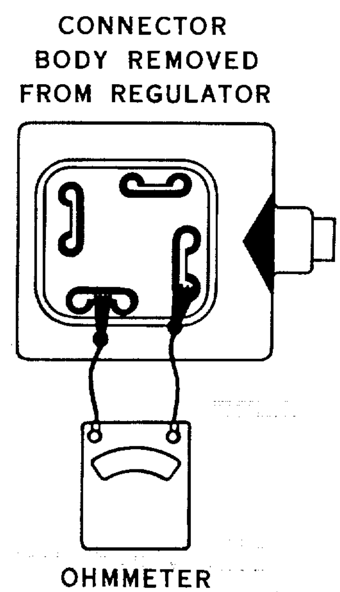


Figure 13-Checking connector body.

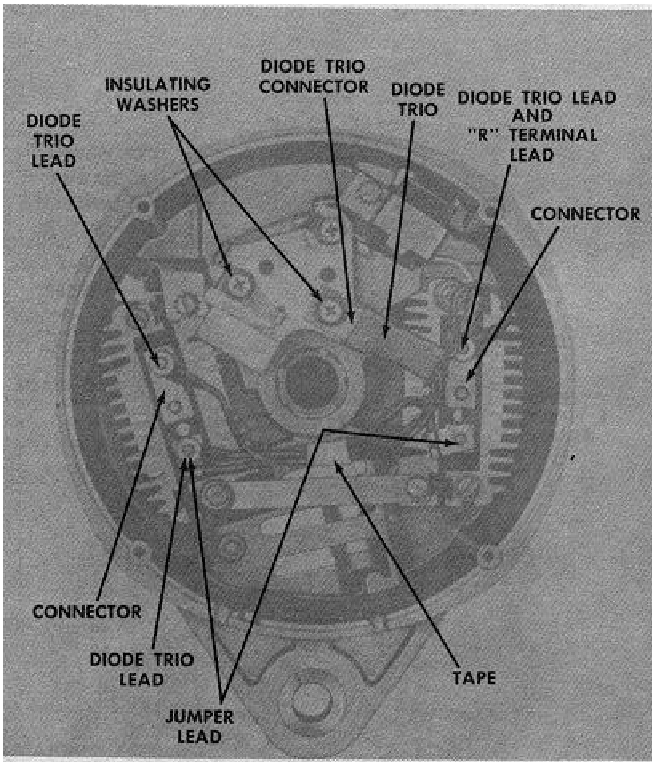


Figure 14-End frame view with stator removed. (Two-rectifier bridge type)

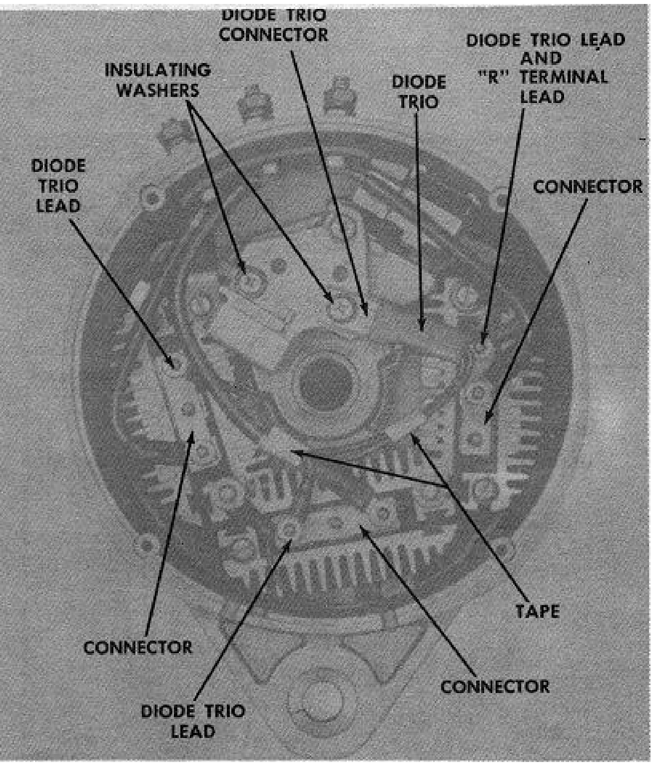


Figure 15-End Frame view with stator removed. (Three-rectifier bridge type)

by detaching the nuts and attaching screw. **Note that the insulating washer on the screw is assembled over the top of the diode trio connector.** Connect an ohmmeter having a 11/2 volt cell, and using the lowest range scale, to the single connector and to one of the three connectors (Fig. 16). Observe the reading. Then reverse the ohmmeter leads to the **same two** connectors. If both readings are the same, replace the diode trio. A good diode trio will give one high and one low reading. Repeat this same test between the single connector and each of the other two connectors. NOTE: Diode trios differing in appearance may be specified for use in the same Integral Charging System, and the two are completely interchangeable.

RECTIFIER BRIDGE CHECK

(Omit for overcharged battery)

Note that each rectifier bridge has a grounded heat sink and an insulated heat sink. The insulated heat sinks are connected together, and electrically are -connected to the output or "BAT" terminal. Figure 16- Checking diode trio.

To check the rectifier bridge, disconnect the regulator jumper lead on three-terminal regulator end frame, then connect the ohmmeter to a heat sink and one of the three terminals (Figs. 17 and 18). Then reverse the lead connections to the same heat sink and same terminal.

If both readings are the same, replace the rectifier bridge by detaching the necessary screws and nuts. A good rectifier bridge will give one high and one low reading. Repeat this same test between the same heat sink and the other two terminals, and between the other heat sink and each of the three terminals. This makes a total of six checks, with two readings taken for each check on each rectifier bridge. Check the other two rectifier bridges in the same manner. IMPORTANT: If rectifier bridge is constructed with flat metal clips at the three studs, press down very firmly onto flat metal clips, and not onto threaded stud (Fig, 18). Rectifier bridges differing in appearance and with or without metal clips at the three studs may be specified for use in the same Integral Charging System, and the different types are interchangeable.

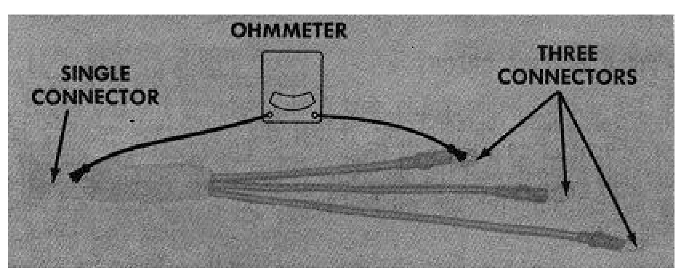


Figure 16-Checking diode trio.

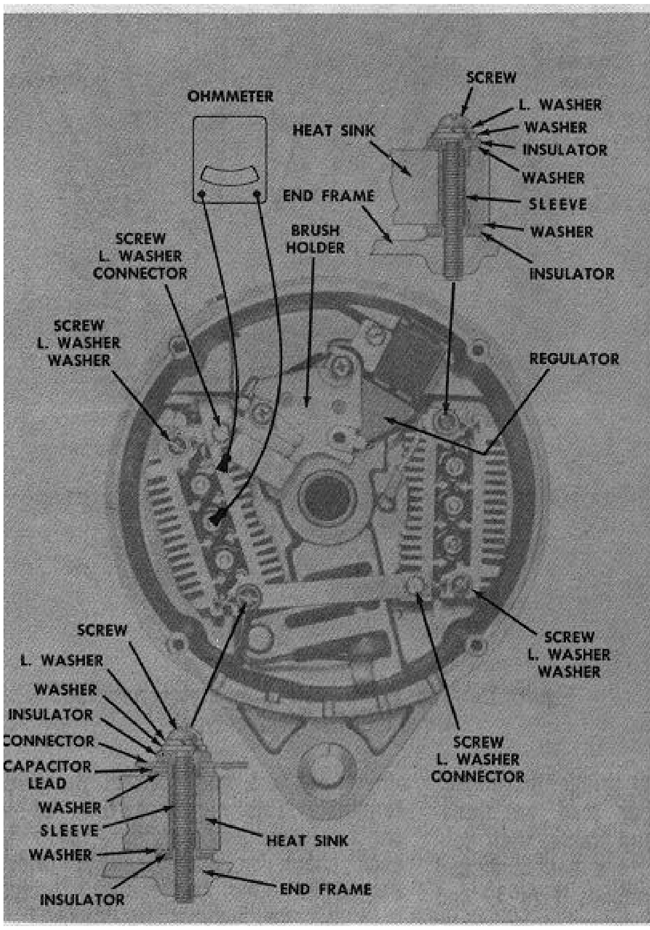


Figure 17-Parts stack-up and ohmmeter check.
(Stator and diode trio removed)

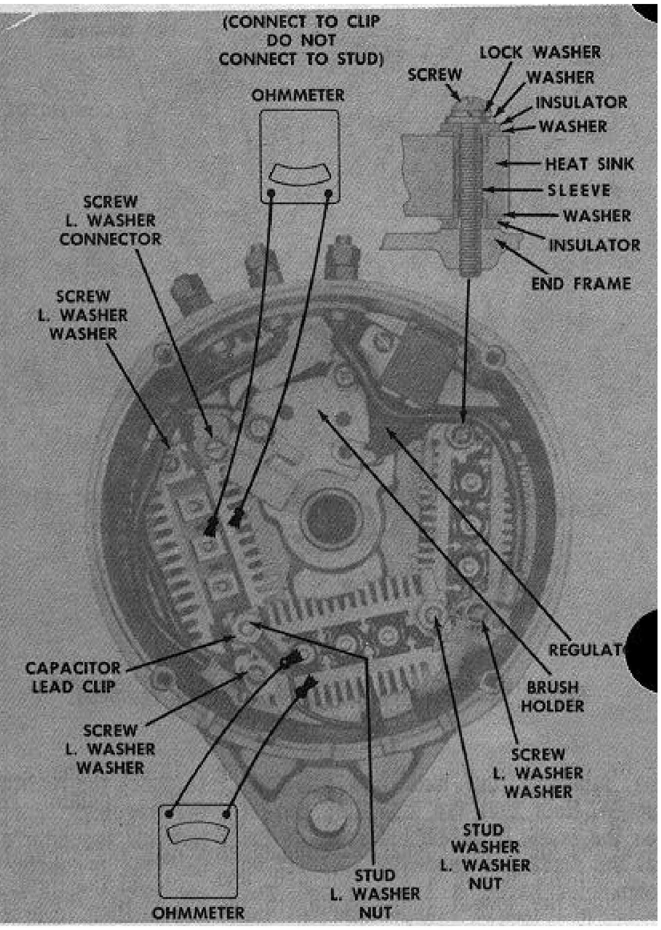


Figure 18-Parts stack-up and ohmmeter checks.
(Stator and diode trio removed)

The ohmmeter check of the rectifier bridge, and of the diode trio as previously covered, is a valid and accurate check. **Do not** replace either unit unless at least one pair of readings is the same. **CAUTION:** Do not use high voltage to check these units such as a 110-volt test lamp.

ROTOR FIELD WINDING CHECKS

To check for opens, connect the test lamp or ohmmeter to each slip ring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open (Fig. 19).

The winding is checked for short circuits or excessive resistance by connecting a battery and ammeter in series with the edges of the two slip rings. Note the ammeter reading and refer to Delco-Remy Service Bulletin 1G-187 for specifications. An ammeter reading above the specified value indicates shorted windings; a reading below the specified value indicates excessive resistance. If the winding is shorted, **replace the rotor.**

An alternate method is to check the resistance of the field by connecting an ohmmeter to the two slip rings (Fig. 19). If the resistance reading is below the specified value, the winding is shorted; if above the specified value the winding has excessive resistance. The specified resistance value can be determined by dividing the voltage by the current given in Bulletin 1G-187. Remember that the winding resistance and ammeter reading will vary slightly with winding temperature changes.

STATOR CHECKS

(Omit for overcharged battery)

The stator windings may be checked for grounds with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter reading is low when connected from any stator lead to a clean me part of the frame, the windings . grounded (Fig. 20). The delta windings cannot be checked for opens or for short circuits without laboratory test equipment. However, if all other electrical checks are normal and the generator fails to supply rated output, butt will supply at least 10 amperes output, shorted stator windings are indicated.

BRUSH HOLDER AND REGULATOR REPLACEMENT
After removing the stator and diode trio, the brush holder and regulator may be replaced by removing the two remaining screws. Note the two insulators located over the top of the brush clips and that these two screws have special insulating sleeves over the screw body above the threads. The third mounting screw may or may not have an insulating sleeve. If not, this screw must not be interchanged with either one of the other two screws, as a ground may result, causing no output or uncontrolled output.

SLIP RING SERVICING
If the slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor, and hold the polishing cloth against the slip rings until they are clean. CAUTION: The rotor must be rotated in order that the slip rings will be cleaned evenly. C1eaning the slip rings by hand without spinning the rotor may result in flat spots on the slip rings, causing brush noise.

Slip rings which are rough or out of round should be trued in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

BEARING REPLACEMENT AND LUBRICATION
The drive end frame bearing is sealed on both sides, and cannot be lubricated. To replace the bearing, press the rotor from the end frame, remove the retainer plate, and press the bearing from the end frame. Use a tube or collar that just fits over the outer race to press the new bearing into the end frame.

Figure 21 Only
The bearing in the slip ring end frame should be replaced if its grease supply is exhausted. No attempt should be made to relubricate and reuse the bear- ing. To remove the bearing from the slip ring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the out- side of the housing towards the inside.

To install a new bearing, use the tube or collar to press the bearing in from the outside of the housing towards the inside to the dimension shown in Figure 21. Fill the plug with Delco-Remy No. 1948791 lubricant so that when pressed in flush with the end frame the grease reservoir will be half filled. Insure that some of the lubricant will be contacting the bearing when the plug is assembled. Use a new seal, and press in to the dimension shown in Figure 21. Coat the seal lip with the lubricant to facilitate assembly of the rotor shaft into the bear- ing. Note that the lip of the seal is toward the bearing.

Figure 22 Only
The type bearing shown in Figure 22 is a complete assembly, and the bearing, seal and grease reservoir cannot be separated.
To replace the bearing assembly, push out from either end. Push the new bearing in as directed in Figure 22. The bearing need not be relubricated.

REASSEMBLY
Reassembly is the reverse of disassembly.

To install the slip ring frame assem- bly to the rotor and drive end frame assembly, remove the tape over the bearing and shaft, and make sure the shaft is perfectly clean after removing the tape. Insert a pin through the holes to hold up the brushes. Carefully install the shaft into the slip ring end frame assembly to avoid damage to the seal. After tightening the thru-bolts remove

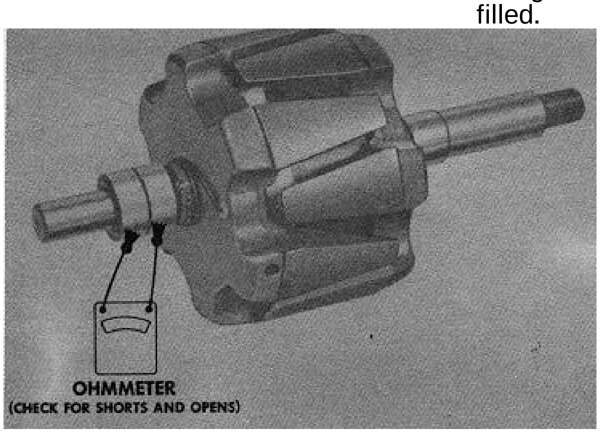


Figure 19-Checking rotor.

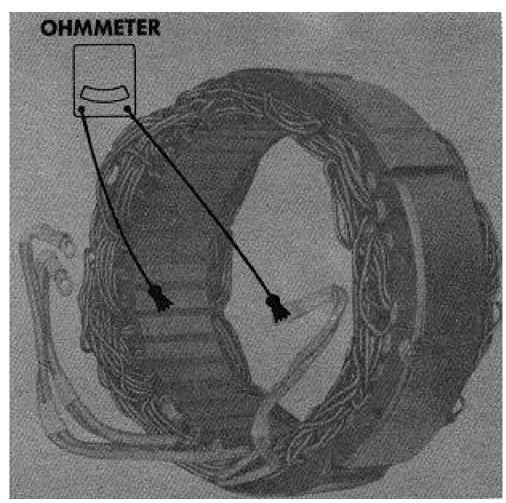


Figure 20 Checking stator.

the brush retaining pin to allow the brushes to fall down onto the slip rings.

Assemble the slinger, fan, pulley, washer and nut. Hold the shaft with a hex wrench inserted into the hex hole in the shaft end, then tighten the nut to 70- 80 lb. ft.

MAGNETIZING THE ROTOR

IMPORTANT: The rotor normally retains magnetism to provide voltage build-up when the engine is started. After disassembly or servicing, however, it may be necessary to reestablish the magnetism. To magnetize the rotor connect the Integral Charging System to the battery in a normal manner, then momentarily connect a jumper lead from the battery positive post to the Integral Charging System relay terminal, identified in Figure 1. This procedure will restore the normal residual magnetism in the rotor.

INTEGRAL CHARGING SYSTEM BENCH CHECK

The Integral Charging System may be checked on the bench for output by connecting an ammeter in the circuit (Fig. 7) and a voltmeter from the "BAT" terminal to ground, then following the procedure in the "TROUBLESHOOTING PROCEDURES" section.

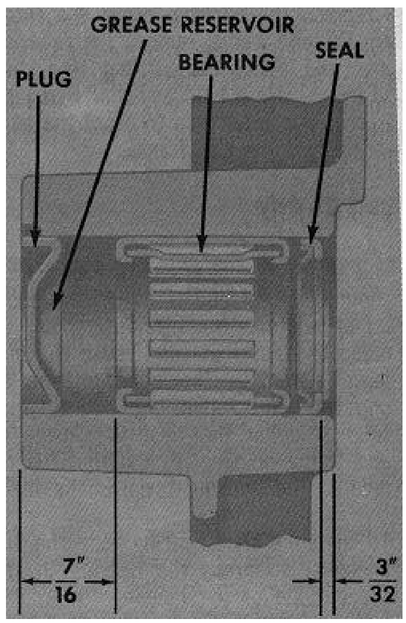


Figure 21-Slip ring end bearings and seal locations.

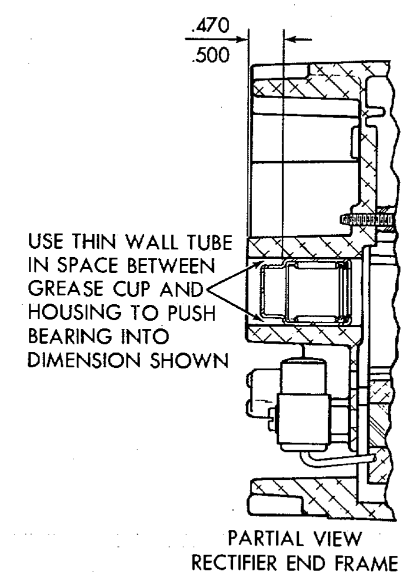


Figure 22-Slip ring end bearing location..

IMPORTANT: Read the introductory paragraphs on page 4 before proceeding with either one of these sections.

UNDERCHARGED BATTERY

This condition, as evidenced by slow cranking and low specific gravity readings, can be caused by one or more of the following conditions:

1. Insure that the undercharged condition has not been caused by accessories having been left on for extended periods.
2. Check the drive belt for proper tension.
3. If a battery defect is suspected, check per Delco-Remy Service Bulletin 1B-115 or 1B-116, respectively.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the cable clamps and battery posts.
5. Connect a voltmeter from "BAT" terminal to ground. A zero reading indicates an open between voltmeter connection and battery.
6. If previous Steps 1 through 5 check satisfactorily, check Integral Charging System as follows:
   a. Disconnect battery ground cable.
   b. Connect an ammeter in the circuit at the "BAT" terminal of the Integral Charging System.
   c. Reconnect battery ground cable.
   d. Turn on accessories. Connect a carbon pile across the battery.
   e. Operate engine at moderate speed as required, usually 4000 generator r.p.m. or more, and adjust carbon pile as required, to obtain maximum current output.

      IMPORTANT: Initial voltage build-up is by residual magnetism in the rotor. Increase the speed as required to obtain maximum current output.

If ampere output is within 10 percent of rated output as stamped on frame, Integral Charging System is not defective. In this case, an adjustment of the voltage setting may correct the undercharged condition. Raise the setting by removing the voltage adjusting cap, rotating in increments of 90°, and then re-inserting the cap in the connector body as illustrated in Figure 8.

If ampere output is not within 10 percent of rated output as stamped on Integral Charging System frame, remove the Integral Charging System for repair as covered in section entitled "INTEGRAL CHARGING SYSTEM REPAIR."

OVERCHARGED BATTERY

1. Check the battery per Delco-Remy Service Bulletin 1B-115 or IB-116. IMPORTANT—Remember that an overheated battery will be overcharged even though no charging circuit defects are present.
2. If an obvious overcharge condition exists as evidenced by excessive water usage, and if the battery is not overheated and not defective, remove the Integral Charging System for repair as covered under heading of "INTEGRAL CHARGING SYSTEM REPAIR."

NOTES

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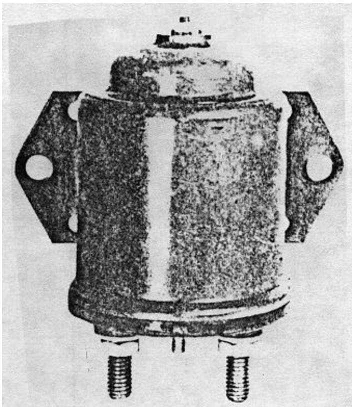
maintenance instructions

DC MAGNETIC SWITCHES —
S001 4906SC, S001 4912SC
S001 4924SC, S001 4932SC

FORM 2826
File: Maintenance
Instr. Section
Old - DC Manual
New - Service Manual
Dated: March, 1966



Section VII
ELECTRICAL SYSTEM

DESCRIPTION

This group of totally enclosed switches is designed for use in cranking motor circuits. They are controlled by a hand snitch usually located in a position readily accessible to the operator. The major parts of these switches are an operating coil, a contactor shaft assembly and a pair of heavy duty contacts.

When the operating coil is energized the. contactor is forced against the main contacts and completes the circuit between the two contact terminal studs. When the operating coil is de-energized a spring returns the contactor to the open position.

INSTALLATION

Mount the magnetic switch in a vertical position with the terminals at the bottom. The leads from the battery and cranking motor should be kept as short as the installation permits. Refer to the Wire Size Table for proper size of the connecting leads.

OPERATIONAL CHECK

Should the switch fail to operate properly it should be removed from the vehicle and the following tests made.

1. With a test lamp check each of the four terminals for grounds to the switch base. Check to be certain there is no circuit between the two main contac4 terminals.

2. Apply the rated battery voltage to the operating coil terminals to determine if contactor plunger is operating properly.

If the above tests indicate that the switch is operating properly and no grounds or shorts are present the other parts of the cranking motor wiring circuit should be checked before disassembling the magnetic switch.

DISASSEMBLY

1. Remove the two Keps nuts from the coil terminals and the one from the center stud. Lift the base and contact stud assembly from the switch housing.

Remove the remaining Keps nut from the top of the switch housing and pull the center stud out.

The contactor plate and shaft can now be removed without disturb)ing coil leads and terminal studs.

REPAIR

1. Check the contact surfaces. Pitted or burned contacts should be resurfaced with a smooth file. Should the contact or disc be burned or rough the disc should be reversed on the shaft, to provide a new contact surface. This is done by compressing the spring back of the disc and removing the snap ring. Make sure the snap ring is seated in the shaft groove when reassembling.

2. With an ohmmeter, check resistance of the operating coil. The values should agree as shown in the switch characteristic table.

Coils not checking out to the values as shown in the switch characteristic table indicate replacement of the coil and shell assembly.

REASSEMBLY AND TEST

Reassemble the switch in the reverse order of disassembly with special care on the following:

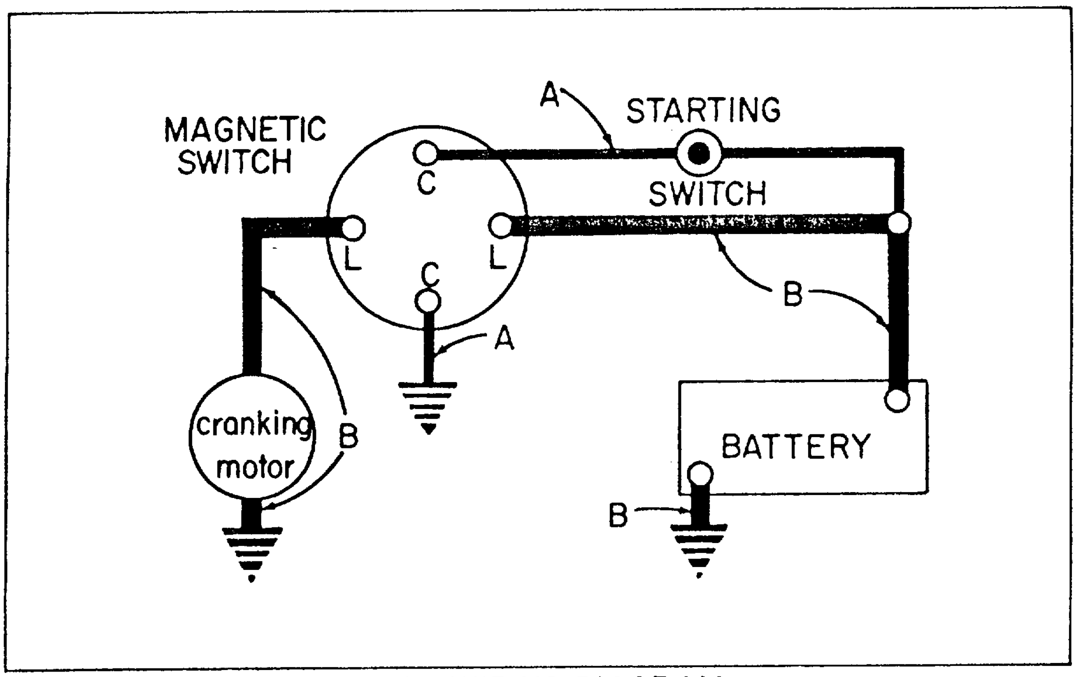
1. Make sure the fiber spacer is in place with the coil leads between the spacer and shell.

2. The contactor plunger must move freely on the center stud. <u>DO NOT USE OIL OR OTHER LUBRICANT.</u>

3. With the cupped washer and return spring in place and the "O" ring on the contact basepush the base over the center stud. Make certain the "O" ring is properly seated and the coil terminals in place. Secure assembly by tightening the Kep nuts on the terminal screws, then tightening the two nuts on the center stud.

SWITCH CHARACTERISTICS

SWITCH NO.	VOLTS	CONTACT RATING (AMPS)	COIL RES. (OHMS)	CLOSING VOLTAGE	DROPOUT VOLTS (MAX.)	COIL CURRENT AMPS (MAX)
S001 4906SC	6	600	.05	3.0	1.0	12.0
S001 4912SC	12	600	1.8	5.0	1.6	6.5
S001 4924SC	24	600	8.0	9.5	3.0	3.0
S001 4932SC	32	500	13.8	12.5	3.9	2.3



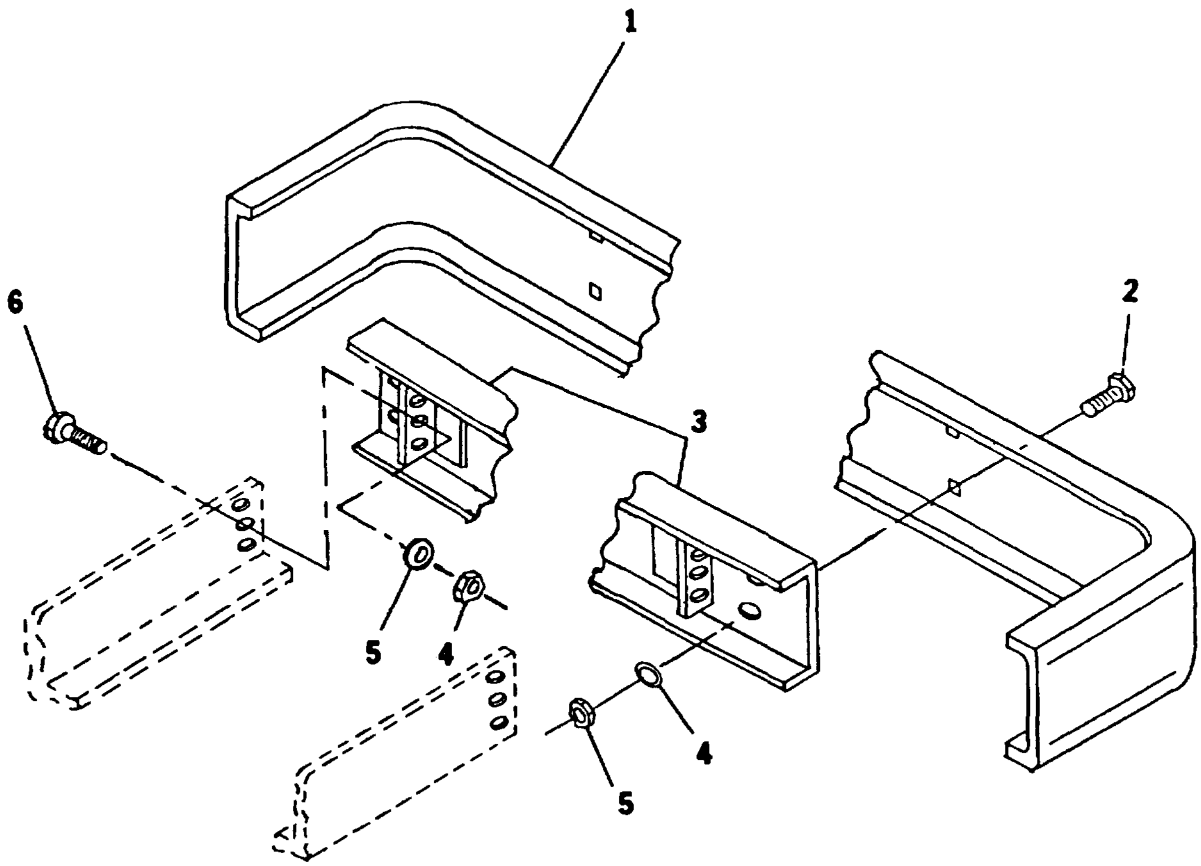
BASIC WIRING DIAGRAM

RECOMMENDED WIRE SIZES

Lead A - No. 12 Wire Total Length of B Wires	MOTOR VOLTAGE 6	12	24	32
[illegible] feet	No. 00(2)	No. 0	No. 1	No. 4
15 feet	No. 0000(2)	No. 00	No. 0	No. 2
20 feet	No. 000(3)	No. 000	No. 00	No. 1
25 feet		No. 0000	No. 000	No. 00

Bumper

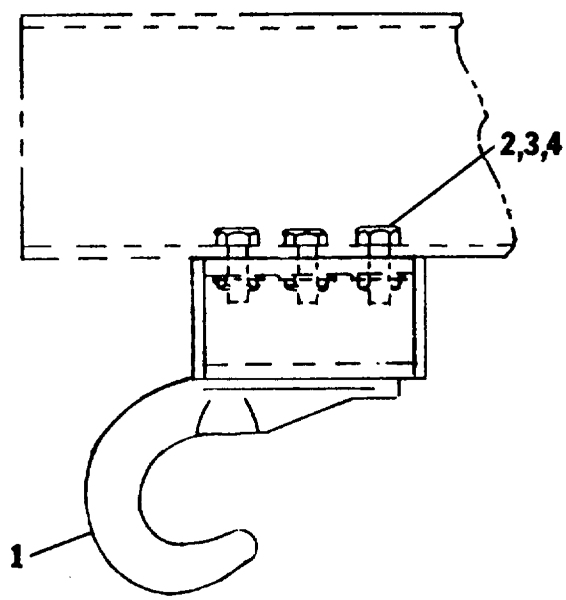
All Models



Item	Part No.	Description	Qty.
1	7605-1489	Stainless Steel Bumper	1
2	7605-1668	½" x 1-1/2" LG Chrome Plated Chrriage Bolt	4
3	7905-1666	Bumper Bracket	1
4	7602-7938	½" Hard Washer	10
5	8852-1208	½" – 13 Cas. Pl. Locknut	10
6	8820-1067	½" – 13 x ½ LG. Cas Pl. Hex Head Capscrew	6

NOTE: Your chassis Vehicle Identification Number (V.I.N.) or Serial Number on older chassis, must be supplied when ordering replacement parts.

Tow Hook
All Models

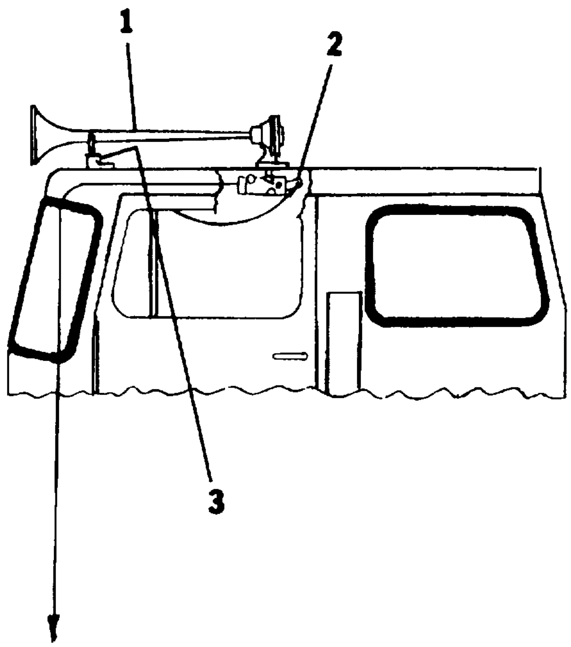


Item	Part No.	Description	Qty.
1	7604-5673	Tow Hook – L.H. (Shown)	1
	7604-5674	Tow Hook - R.H. (Not Shown)	1
2		¾" -10x1-3/4 Hex Head Capscrew	6
3		¾" Hardened Flat Washer	6
4		¾" -10 Hex Nut	6

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Air Horns

All Models

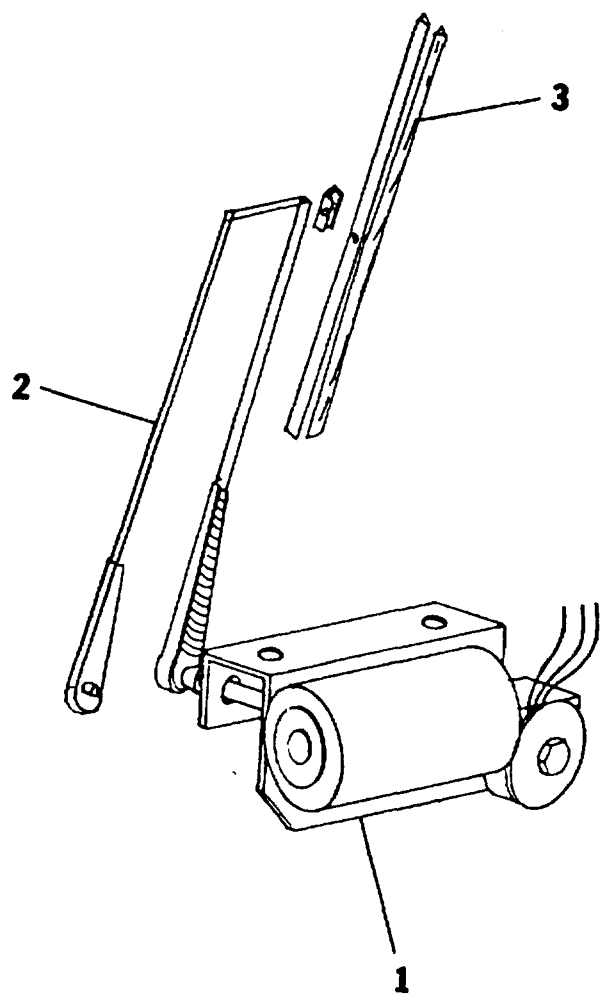


Item.	Part No.	Description	Qty.
1	7605-0109	Air Horn (Grover)	2
	7605-1142	Air Horn (Hadley)	2
2	7605-2586	Air Valve	1
3	7605-0110	Bracket Kit for Grover Air Horns	1

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Electric Wipers

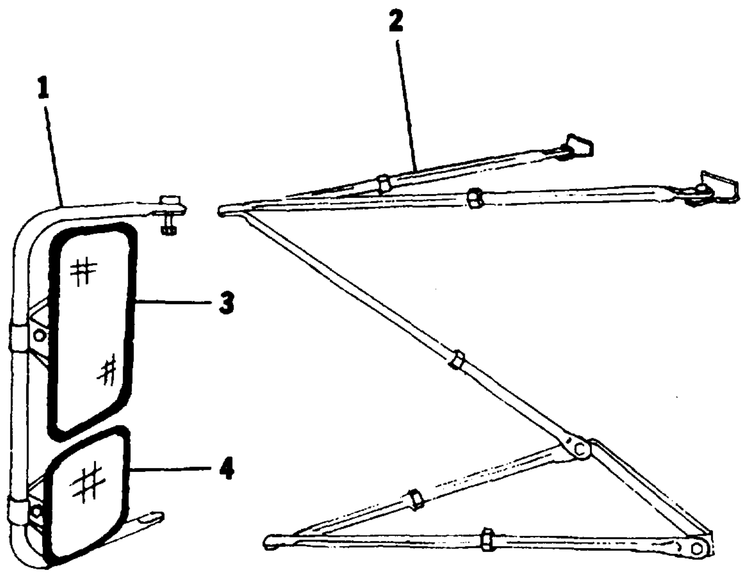
All Models



Item	Part No.	Description	Qty.
1	7605-0281	Wiper Motor L.H.	1
	7605-0282	Wiper Motor R.H.	1
2	7605-3781	Wiper Arm	2
3	7605-3616	Wiper Blade	2
4	7605-0279	Pantograph Adapter Kit (Not Shown)	2
5	7605-5126	Washer Jet (Not Shown)	2

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Mirror Assembly
Three Arm Unit
All Models

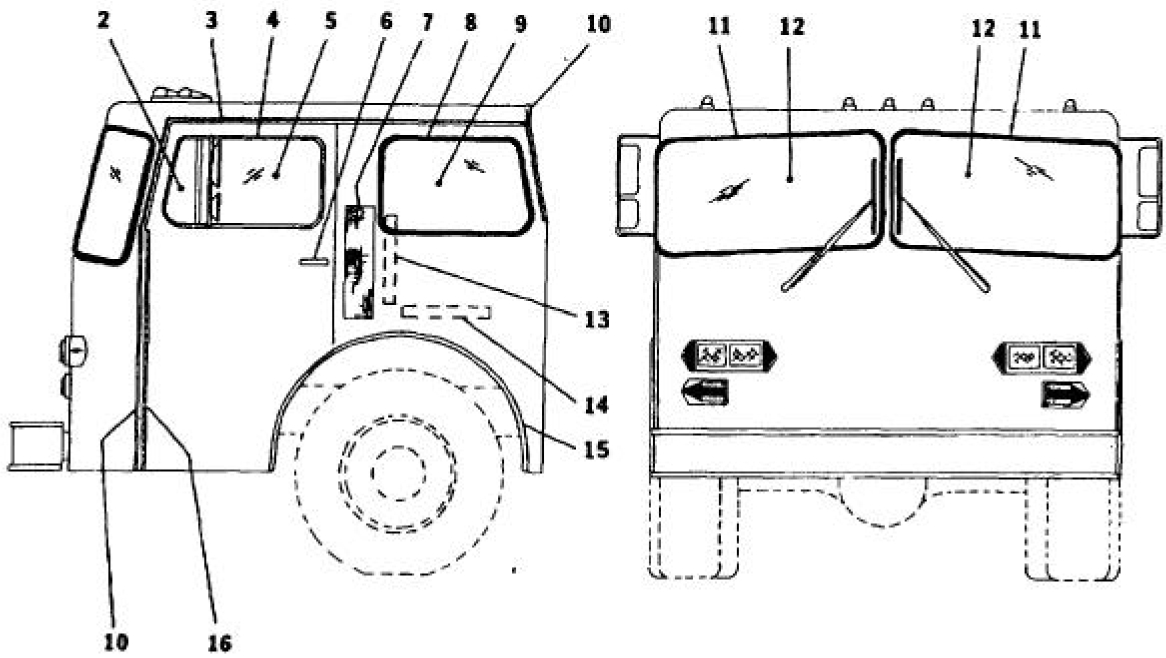


Item	Part No.	Description	Qty.
1	7808-1477	Head & Loop Assembly (Includes Items 3,4)	2
2	7810-3424	Mounting Bracket Kit	2
3	7611-7325	Flat Mirror Head	2
4	7611-7324	Convex Mirror Head	2

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Cab Exterior

Model D-350



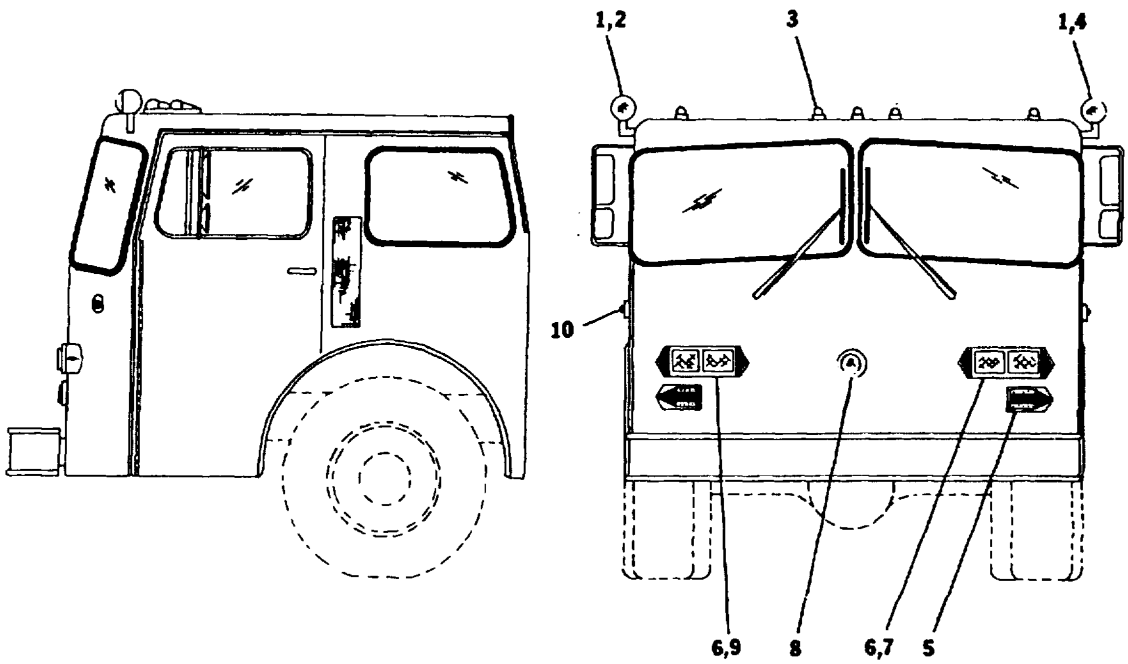
Item	Part No.	Description	Qty.
1	7605-3333	Cab	1
2	7611-6833	Cozy Wing Ventilator LH	1
	7611-6834	Cozy Wing Ventilator RH	1
3	7605-4103	Rain Gutter Moulding	2
4	7605-4110	Aluminum WindowMoulding	2
5	7605-4109	Door Glass	2
6	7605-4106	Outside Door Handle	2
7	7605-3376	Air Intake Cover	2
8	7605-1893	Window Moulding & Key Rubber	2
9	7605-4101	Rear Side Glass	2
10	7611-6881	Drip Moulding	3
11	7605-1893	Window Moulding & Key Rubber	2
12	7605-4100	Windshield	2
13	7605-1754	Rear Rider' s Back – Black	2
	7605-1755	Rear Rider' s Back – Red	2
14	7605-1752	Rear Rider' s Cushion – Black	2
	7605-1753	Rear Rider' s Cushion – Red	2
15	7605-4104	Fenderette	2
16	7605-4107	Door Hinge	2
		OPTIONAL EQUIPMENT (Not Shown)	
17	7605-4113	Fender Liner	2

NOTE: Your chassis Vehicle Identification Number (N.I.N.0, or Serial Number on older chassis must be supplied when Ordering replacement parts.

DUPLEX

Exterior Cab Lights

Model D-350

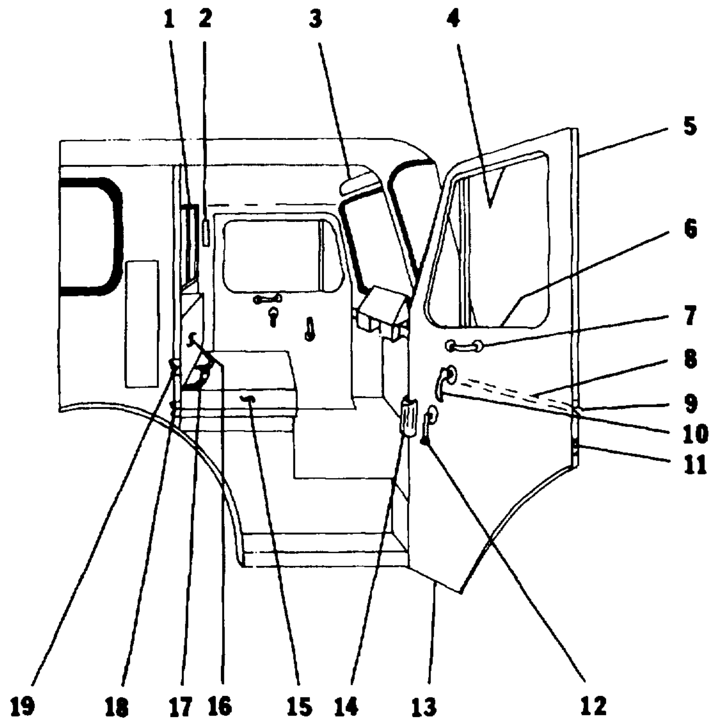


Item	Part No.	Description	Qty.
1	7605-1143	Spotlights (Optional)	2
2	7605-1145	RH Spotlight Bracket (Optional)	1
3	7604-7035	Clearance Lights	5
4	7605-1144	LH Spotlight Bracket (Optional)	1
5	7605-0132	Arrow Turn Signal	2
6	7605-3726	Headlight Bezel	2
7	7605-4005	LG Headlight Assembly	1
8	7605-4047	Mars 888 Light with Clear Lens (Optional)	1
	7605-4048	Mars 888 Light with Blue Lens (Optional)	1
	7605-4049	Mars 888 Light with Red Lens (Optional)	1
9	7605-4006	RH Headlight Assembly	1
10	7605-1911	Side Turn Signal	2

NOTE: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Cab lnterior

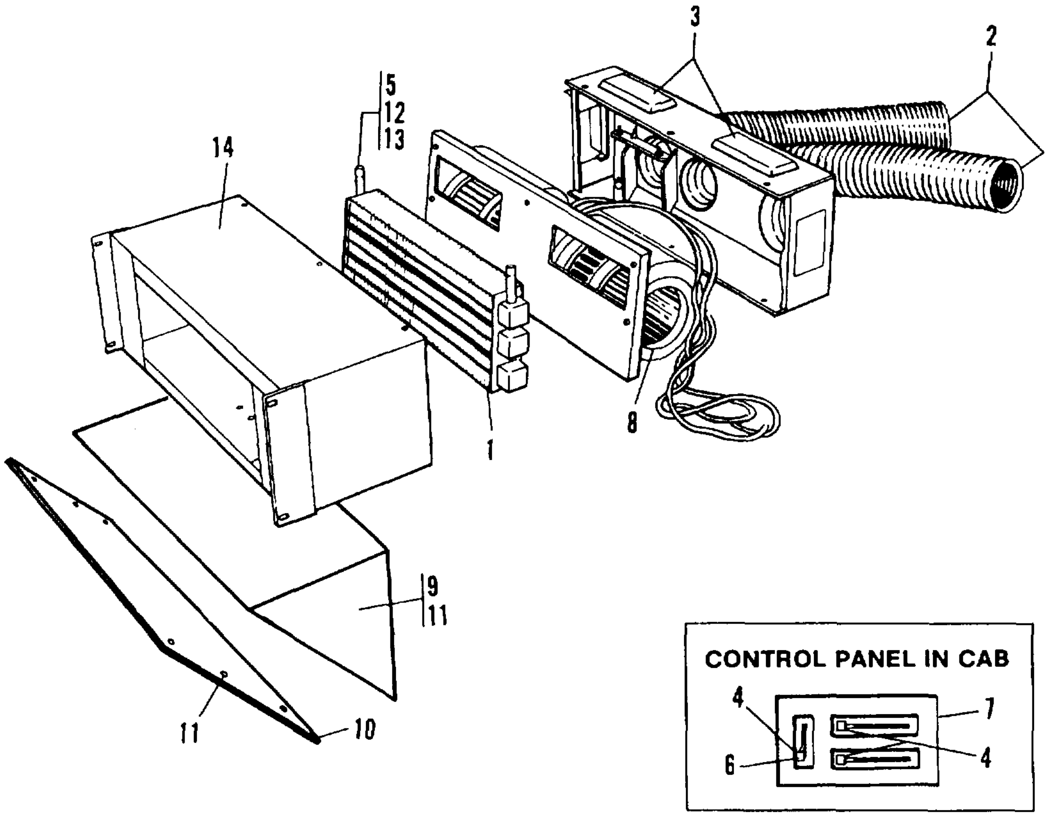
Model D-350



Item	Part No.	Description	Qty.
1	7605-4105	Rear Partition Window	1
	7605-5373	Partition Glass	2
2	7605-4102	Dome Light	4
3	7605-0275	Sunvisor	2
	7605-0276	Sunvisor Clip	2
4	7611-6863	Door Glass Channel (Top) 23" Lg.	2
5	7611-6864	Door Seal Rubber (Specify Length)	2
6	7611-6865	Door Window Rubber	2
7	7611-6866	Door Grab Handle	4
8	7611-6902	Remote Assembly R.H. (Shown)	1
	7611-6908	Remote Assembly L.H.	1
9	7611-6909	Door Lock Assembly R.H. (Shown)	1
	7611-6910	Door Lock Assembly L.H.	1
10	7611-6867	Inside Door Handle	2
	7611-6872	Handle Escutcheon	2
11	7611-6869	Male Dovetail	2
12	7611-6871	Door Glass Lift Handle	2
	7611-6872	Handle Escutcheon	2
	7611-6873	Door Glass Lift Assembly R.H. (Shown)	1
	7611-6873	Door Glass Lift Assembly L.H.	1
13	7611-6870	Door Bottom Rubber	2
14	7605-4108	Door Check Strap	2
15	7605-1718	Front Rider Cushion – Black	1
	7605-1749	Front Rider Cushion – Red	1
16	7605-1750	Front Rider Back – Black	1
	7605-1751	Front Rider Back – Red	1
17	7605-3373	Seat Belt – Rider & Jump Seat	4
	7605-2430	Seat Belt Retractor – Rider & Jump seat (Not Shown)	4
	7605-3375	Seat Belt – Driver Seat (Not Shown)	1
	7605-33743	Tether Strap – Driver Seat (Not Shown)	1
18	7611-6880	Female Dovetail	2
19	7605-4099	Striker Plate	2

Note: Your chassis Vehicle Identification Number (V.I.N.), or Serial Number on older chassis must be supplied when Ordering replacement parts.

Heater Assembly



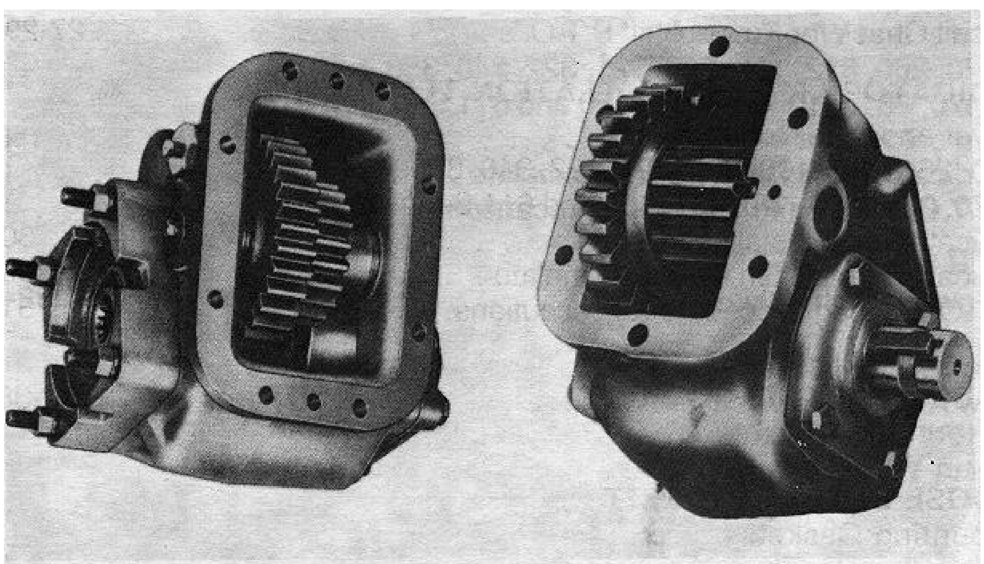
Item	Part No.	Description	Qty.
1	7605-7457	Core	1
2	7605-7458	Defroster Grille	1
3	7605-7459	Heater Grille	1
4	7605-7460	Control Panel Knob	3
5	7605-7461	Elbow (Not Shown)	2
6	7605-7462	Blower Switch	1
7	7605-7463	Control Panel	1
8	7605-7464	Blower Assembly	1
9	7605-3757	Heater Support	1
10	7605-3924	Heater Cover	1
11	8820-1002	Hex Head Capscrew	12
12	7605-5376	Hose Clamp	2
13	7605-1601	Hose 5/8	AR
14	7605-3793	Heater & Kit	1
	7605-7465	Heater Defroster Control Cable (Not Shown)	1
	7605-7466	Heater Control Cable (Not Shown)	1
	7605-7467	Water Valve (Not Shown)	1

Note: Your chassis Vehicle Identification Number (N.I.N.), or Serial Number on older chassis must be supplied when ordering replacement parts.

Chelsea®

Owner's Manual
Installation & Shifting Options

Section VIII
MISCELLANEOUS



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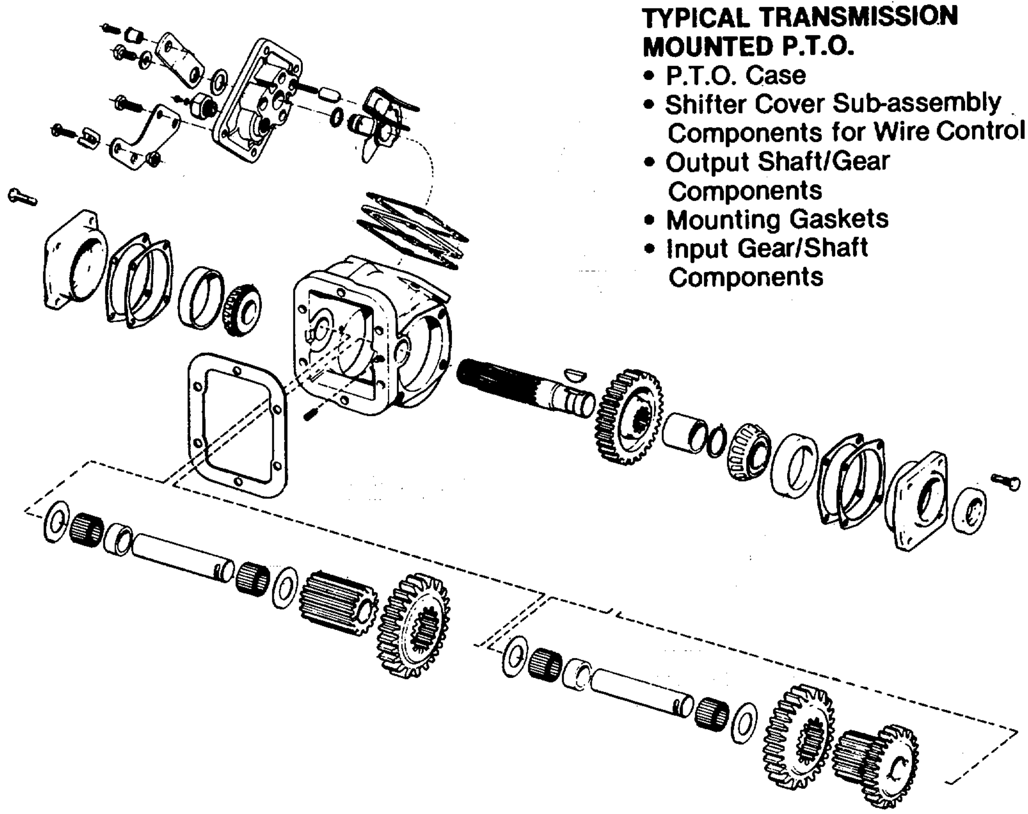
CONTENTS

FOREWORD

Since it is our major objective to show you how to get additional and more profitable miles from truck, tractor and trailer components, we want to provide you with information on the installation of 6 and 8 Bolt Chelsea Power Take-Offs. We all realize that an inadequate transmission will overwork any power take-off in a very short period of time. In addition, a mismatched transmission/P.T.O. combination can result in satisfactory performance of equipment right from the start.

Before you order new trucks be sure that you're getting the right transmission/P.T.O. combination. It is of vital importance for efficient performance to have adequate power. To help you select the proper type, size and design of P.T.O. it is advisable to discuss your specific requirements with a Chelsea P.T.O. specialist. He knows his products and has easy access to manufacturers of equipment, transmissions and power takeoffs. He can inform you about everything you need to know about power, at the right time, before you specify components.



EXPLODED VIEW OF A TYPICAL TRANSMISSION MOUNTED P.T.O.

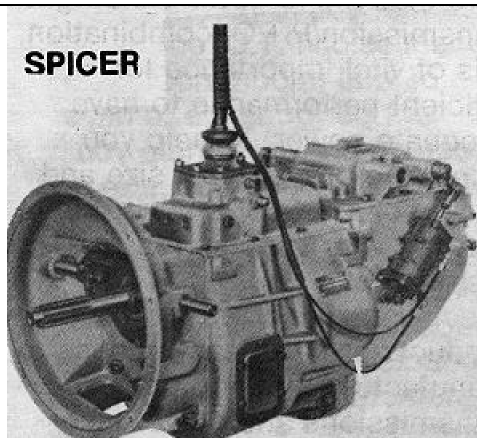
- P.T.O. Case
- Shifter Cover Sub-assembly Components for Wire Control
- Output Shaft/Gear Components
- Mounting Gaskets
- Input Gear/Shaft Components

CAUTION

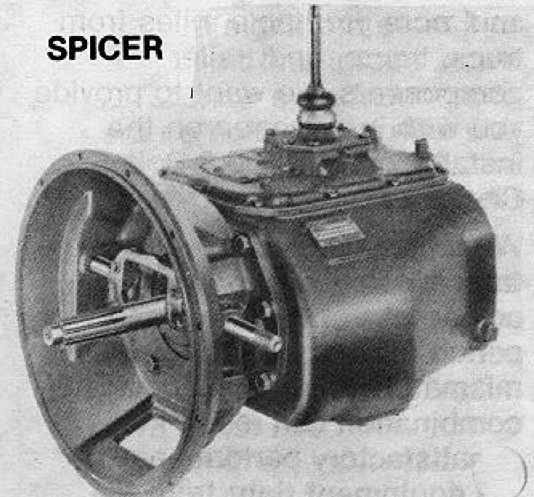
When a P.T.O. has the pump flange (direct mount) option, the pump being bolted to the 6 Bolt or Counter Shaft P. T. O. should weight no more than forty (40) pounds. If the pump is heavier, we suggest the use of a bracket or strap for support, bolted to engine or transmission. There is no pump weight limit on 8 Bolt P.T.O.'s.

TRANSMISSION TAG LOCATIONS

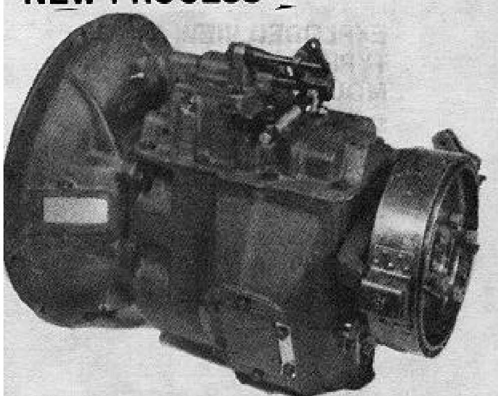
SPICER



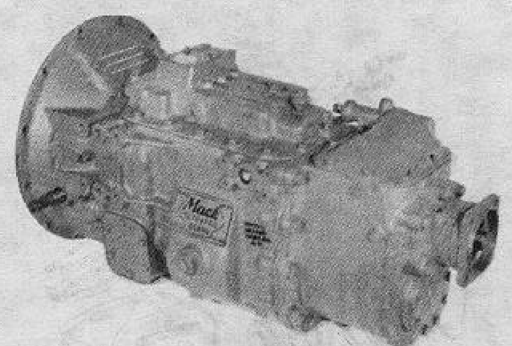
SPICER



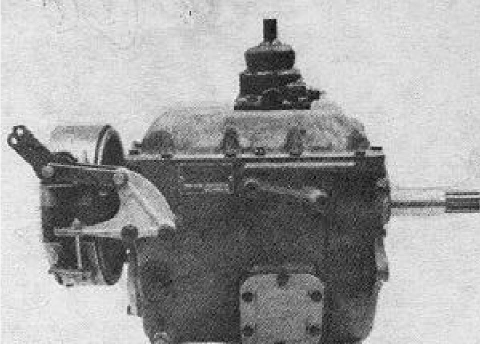
NEW PROCESS



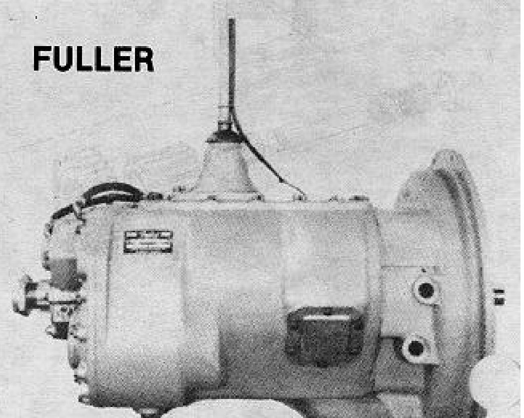
MACK



CLARK



FULLER



HORSEPOWER · TORQUE, · RPM CONVERSION CHART

TO FIND THE TORQUE. Given: 100 HP at 1750 RPM. Then: with a straight edge on HP scale at 100 (Left Side) and on RPM scale at 1750.

Find Answer on T scale = 300 foot pounds torque (Middle).

Formula:

$$\frac{HP \times 5252}{RPM} = \text{T Foot Pounds Torque}$$

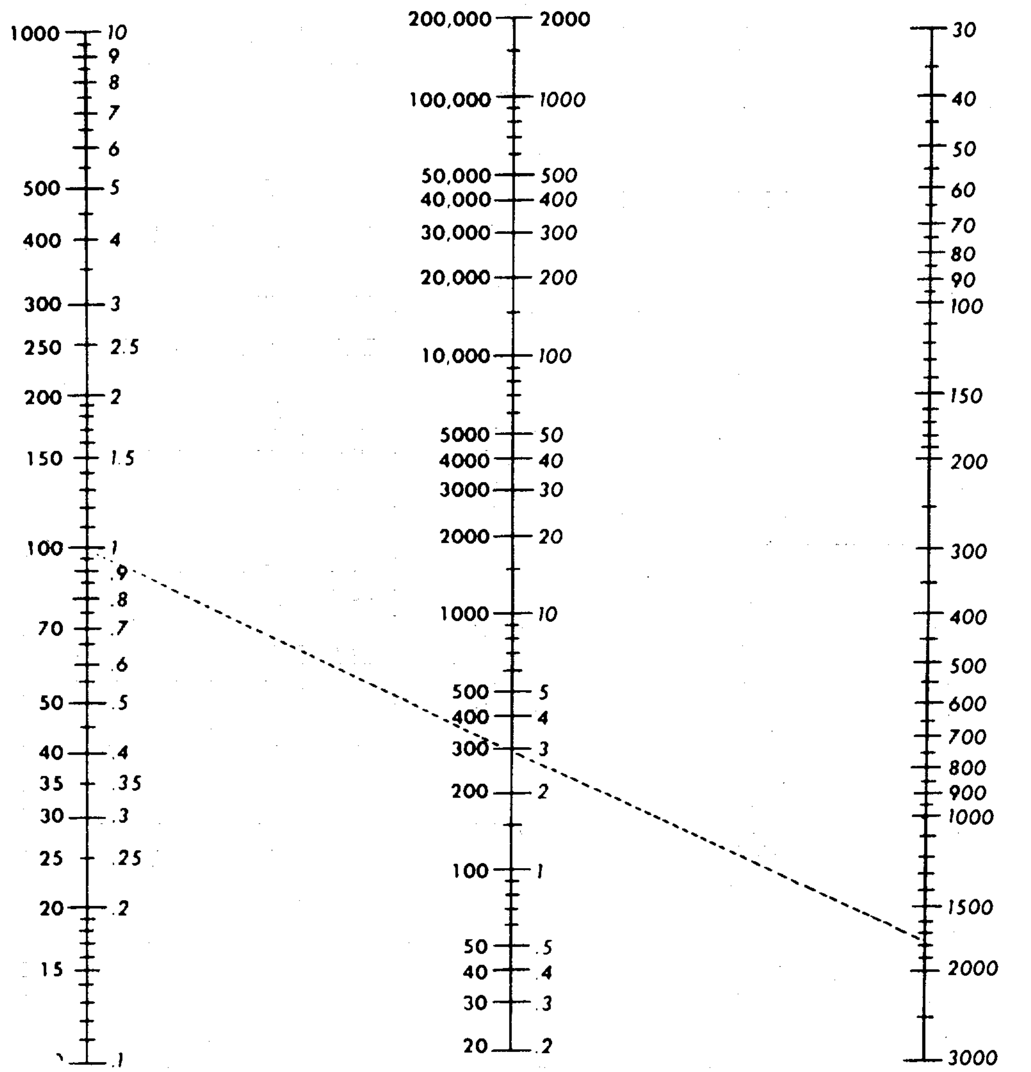
TO FIND THE HP. Given: 3 foot pounds- torque at 1750 RPM.

Then: with a straight edge on the "T" scale at 3 (Middle) and on the RPM scale at 1750.

Find Answer on the HP scale = 1 Horsepower (Left Side)

Formula:

$$\frac{T \times RPM}{5252} = \text{HP Horsepower.}$$



HP Horsepower Scale

T Torque Pounds Foot Scale

RPM Revolutions Per Minute Scale

P.T.O. RATINGS

Basic P.T.O. Models			Horsepower At		*	Weight
New Model No.	Old Model No.	SAE Aperture	500 rpm	1000 rpm	Torque Rating	Approximate Pounds
100	A1, 2, 3N	6-Bolt	11.9	23.5	125 lbs. ft.	10 lbs.
220L & P	A22C & D	6-Bolt	19	38	200 lbs. ft.	30 lbs.
220- E & C	A22L & LL	6-Bolt	23.5	47	250 lbs. ft.	30 lbs.
260	26	6-Bolt	23.5	47	250 lbs. ft.	28 lbs.
270	27	6-Bolt	23.2	47	250 lbs. ft.	45 lbs.
300	30	6-Bolt	13.2	26.5	140 lbs. ft.	45 lbs.
321 Hel.	320	6-Bolt	13.2	26.5	140 lbs. ft.	39 lbs.
322 Spur.	S320	6-Bolt	13.2	26.5	140 lbs. ft.	39 lbs.
340	34L	6-Bolt	19	38	200 lbs. ft.	32 lbs.
350	S35, 36, & 37	6-Bolt	13.2	26.5	140 lbs. ft.	37 lbs.
370	SR35, 36, & 37	6-Bolt	13.2	26.5	140 lbs. ft.	45 lbs.
381	S380	6-Bolt	13.2	26.5	140 lbs. ft.	23 lbs.
OBS 6-1-80	41C	6-Bolt	13.2	26.5	140 lbs. ft.	26 lbs.
410__U	41D	6-Bolt	11.9	23.5	125 lbs. ft.	[illegible]
410__W	41K	6-Bolt	10	20	110 lbs. ft.	26 lbs.
410__X	41X	6-Bolt	8	16	85 lbs. ft.	26 lbs.
	42	6-Bolt	19	38	200 lbs. ft.	26 lbs.
420		6-Bolt	21.4	42.8	225 lbs. ft.	26 lbs.
	430D	6-Bolt	17	32	180 lbs. ft.	30 lbs.
431__U		6-Bolt	18.6	37.1	195 lbs. ft.	30 lbs.
	430K	6-Bolt	15	30	160 lbs. ft.	30 lbs.
431__W		6-Bolt	16.7	33.3	175 lbs. ft.	30 lbs.
450	S45, 46 & 47	6-Bolt	13.2	26.5	140 lbs. ft.	37 lbs.
Same	510	Countershaft	47.6	95.2	500 lbs. ft.	18 lbs.
Same	540-P	Countershaft	47.6	95.2	500 lbs. ft.	37 lbs.
Same	540-R	Countershaft	38.1	76.2	400 lbs. ft.	37 lbs.
Same	540-S	Countershaft	28.5	57	300 lbs. ft.	37 lbs.
611	610(Z)	6-Bolt	13.2	26.5	140 lbs. ft.	53 lbs.
700	A2625	Gear Box	11.9	23.5	125 lbs. ft.	39 lbs.
710	A2627	Gear Box				
Single Speed Shaft			10	20	110 lbs. ft.	
Two Speed & Input Shaft			11.9	23.5	125 lbs. ft.	39 lbs.
720	2615	Gear Box	13.2	26.5	140 lbs. ft.	49 lbs.
730	2536	Gear Box	13.2	26.5	140 lbs. ft.	49 lbs.
740	2538	Gear Box	13.2	26.5	140 lbs. ft.	49 lbs.
800	810	8-Bolt	33	66	350 lbs. ft.	38 lbs.
812	811	8-Bolt	38	76	400 lbs. ft.	50 lbs.
822	821	8-Bolt	47	94	500 lbs. ft.	76 lbs.
832	831	8-Bolt	28.5	57	300 lbs. ft.	76 lbs.
822	841	8-Bolt	47	94	500 lbs. ft.	76 lbs.
852	851	8-Bolt	47	94	500 lbs. ft.	88 lbs.
862	861	8-Bolt	47	94	500 lbs. ft.	96 lbs.
900	4600	Split Shaft P.T.O.			4300 lbs. ft.	185 lbs.
910	4700	Split Shaft P.T.O.			4500 lbs. ft.	126 lbs.
930	5551	Split Shaft P.T.O.			250 lbs. ft.	102 lbs.
Front Mounted						
492	491	Air Clutch	28.5	57	300 lbs. ft.	34 lbs.
2381	2740	Gear Box	13.2	26.5	140 lbs. ft.	[illegible]
	2642	Gear Box	19	38	200 lbs. ft.	69 lbs.
2420		Gear Box	21.4	42.8	225 lbs. ft.	69 lbs.

This chart provides a guide to the many different models of P.T.O.'s which may be used in a given application.

From this group, a model can be selected to meet the exact horsepower, speed and rotation requirements of the accessory to be driven.

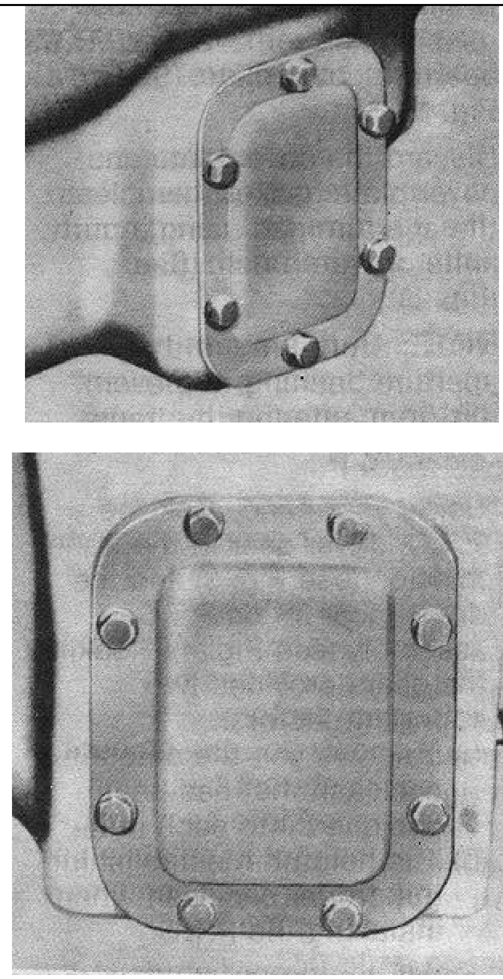
*Based on intermittent service.

Here are some of the questions that are relevant to the Proper Selection of a Transmission Mounted Power Take-Off

1. What is the make and model of your transmission?
2. Which P.T.O. opening will be used?
3. What accessory is to be driven?
4. How much horsepower is required to drive the accessory?
5. What is the required rotation of the P.T.O. ?
6. What is required P.T.O. output shaft speed as a percent of engine speed?
7. What is the required method of shifting the P.T.O. cable, lever of air?

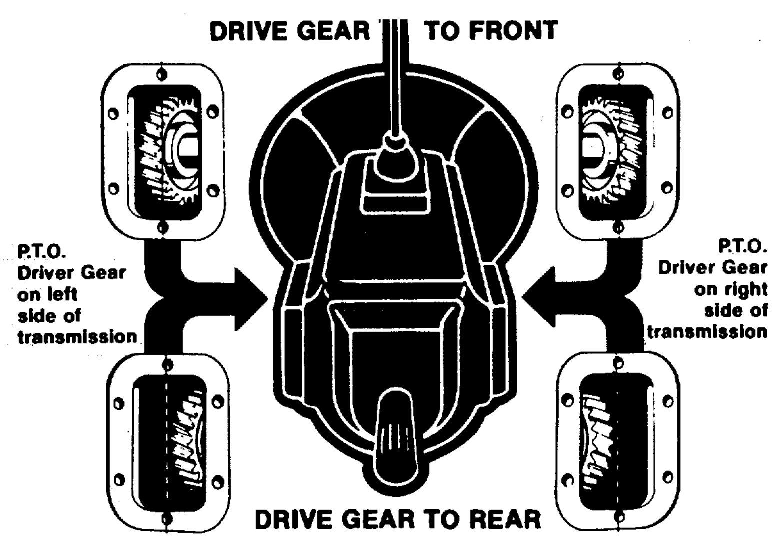
Once all of the answers to these questions have been determined, a transmission mounted P. T. O. can be selected to meet the horsepower, speed and rotation that you require.

Having made the selection of a P.T.O. , you are ready to start the installation.



SAE 8 Bolt Standard SAE Power Take-Off Apertures

P.T.O. Drive Gear Location
The standard location for the P.T.O. drive gear in the transmission is ½" to the front or ½" to the rear of vertical center line.



MOUNTING P.T.O. TO TRANSMISSION
For 6 or 8 Bolt Applications

1. Drain the oil from the transmission and remove the P.T.O. aperture cover plate. (See Fig.1.)

2. Discard the cover plate and cover plate gasket then clean the aperture pad using a putty knife or wire brush. (See Fig. 2.)

   NOTE: Stuff a rag in the aperture opening to prevent dirt from entering the transmission while you are cleaning it.

3. Using your hand, rock the P.T.O. driver gear in the transmission (see Fig.3) and the driven gear in the P.T.O. assembly (see Fig. 4). Rocking the gears provides two important factors.

   (a) It shows you the amount of backlash that has been designed into each unit.

   (b) It is helpful in establishing the proper backlash when installing the P.T.O.

4. Install the proper studs in the P.T.O. aperture pad using a stud driver. (See Fig. 5.)

5. Where holes are tapped through the transmission case, use Permatex or equivalent to prevent leaks. NOTE: Avoid contact of Permatex with automatic transmission fluid in automatics. Always check to be sure that the studs do not interfere with transmission gears.

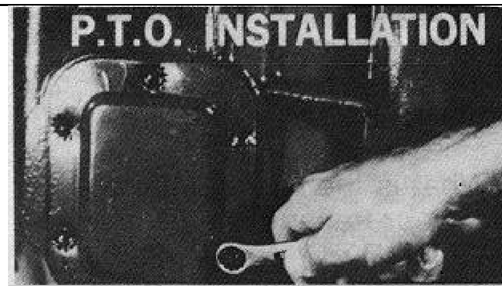


Fig. 1

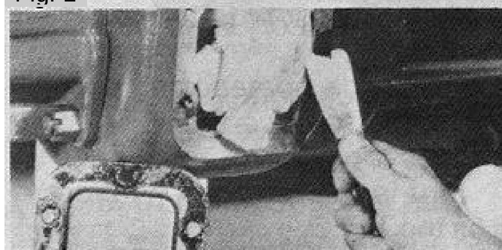


Fig. 2

Fig 3

Fig. 4

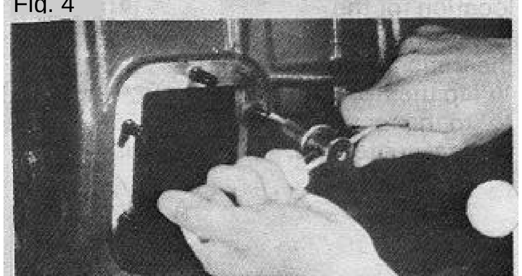


Fig. 5

MOUNTING P.T.O. TO TRANSMISSION (continued)

6. Tighten the studs securely and torque to 30-35 lbs. ft. (4.14-4.84 kg meters) for 6 bolt and 45-50 lbs. ft. (6.22-6. 91 kg meters) for 8 bolt. (See Fig. 6.)

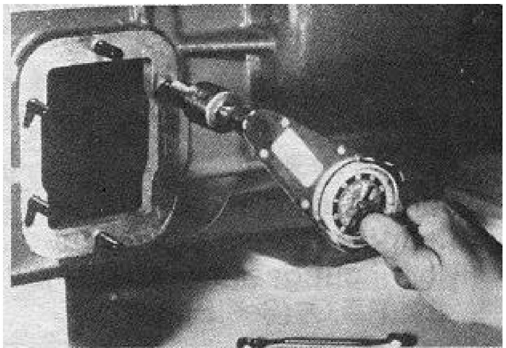


Fig. 6

7. Place the correct number of gaskets over studs. (See Fig. 7.). Do not use Permatex between gaskets because you may want to add or subtract gaskets to obtain proper backlash.

- When mounting a P.T.O. use gaskets between all mounting surfaces.
- Do not stack more than 3 gaskets together.
- Usually one thick gasket .020 (.50mm) will be required.
- Remember the lubricant in the transmission also lubricates the P.T.O. Therefore, at least one gasket must always be used on either side of filler blocks, adapter assemblies or adapter plates. More gaskets may be required when establishing proper backlash.

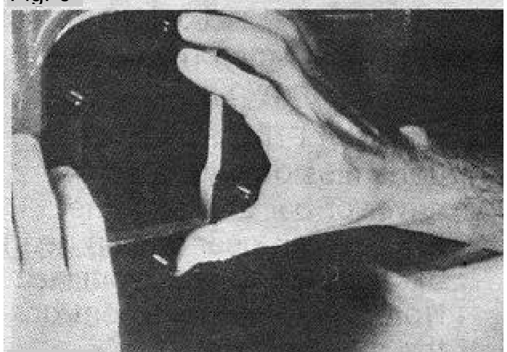


Fig. 7

8. Secure P.T.O. to the transmission.

- Copper gaskets are used as a guard against leaks under cap screw, head. (See Fig. 8.)
- NOTE: If holes in the P.T.O. aperture are not drilled through, discard the copper gaskets and replace them with lock washers. The 220 Series must always have a copper washer under its one cap screw head that goes through inside of housing.

Fig. 8

9. Fasten the P.T.O. to the transmission torquing 6 bolt to 30-35 lbs. ft. (4.14-4.84 kg meters) and 3 bolt to 45-50 lbs. ft. (6.22-6.91 kg meters.) (See Fig. 9.)

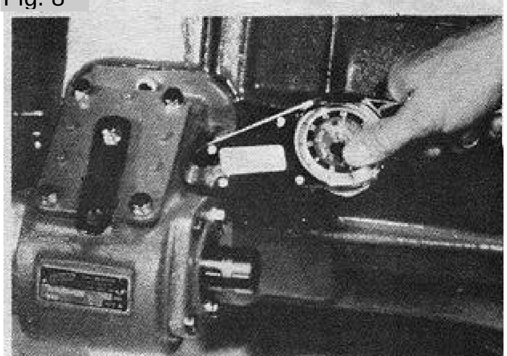


Fig. 9

To check for proper backlash on P.T.O.'s with shift cover

1. Remove the P.T.O. shift housing and/or inspection plate.

2. Mount the dial indicator so that it registers movement of the input gear (driven gear) of the P.T.O. (See Fig. 10.)

   NOTE: See Figure 11 for proper location of dial indicator contact point. (Two common type dial indicators shown.)

3. Hold the P.T.O. driver gear in transmission with a screwdriver or bar and rock the P.T.O. input gear (driven gear) back and forth with your hand Note the total movement on the dial indicator.

4. Establish backlash at .006"-.012" (.15mm-.30mm) by adding or subtracting gaskets.

   General rule-A Chelsea .010" gasket will change backlash approx. .006". A .020" gasket changes backlash approx. .012".

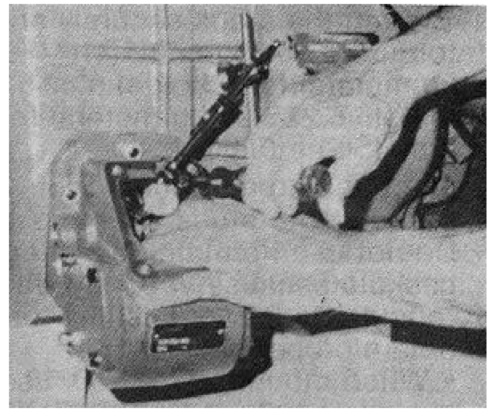


Fig. 10

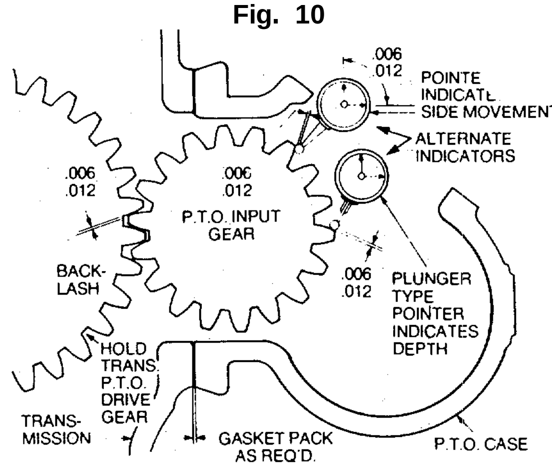


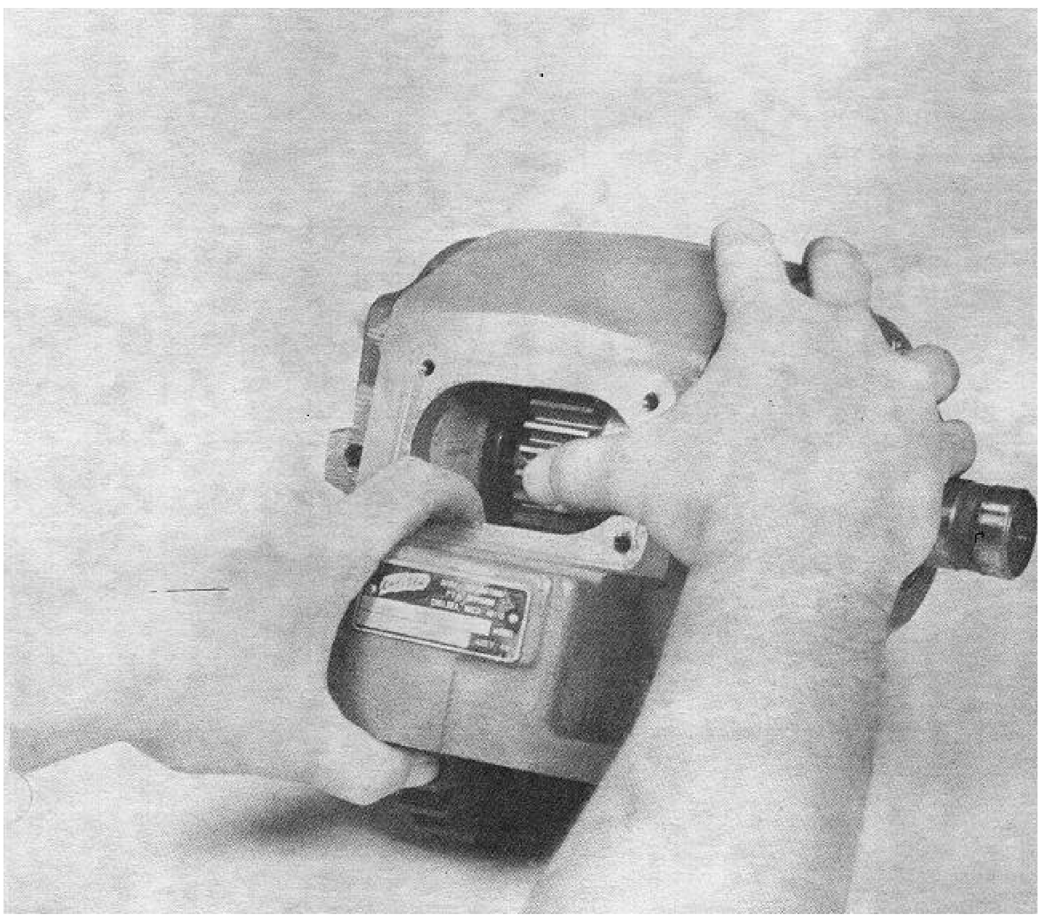
Fig. 11

NOTE: *When using a 220,260 or 270 Series P.T.O. with the New AJ gear designation on an Allison Automatic transmission with a six bolt opening, a special gasket (35-Fl41) is supplied. When installed with the P.T.O. this gasket reduces the need for backlash adjustment.*

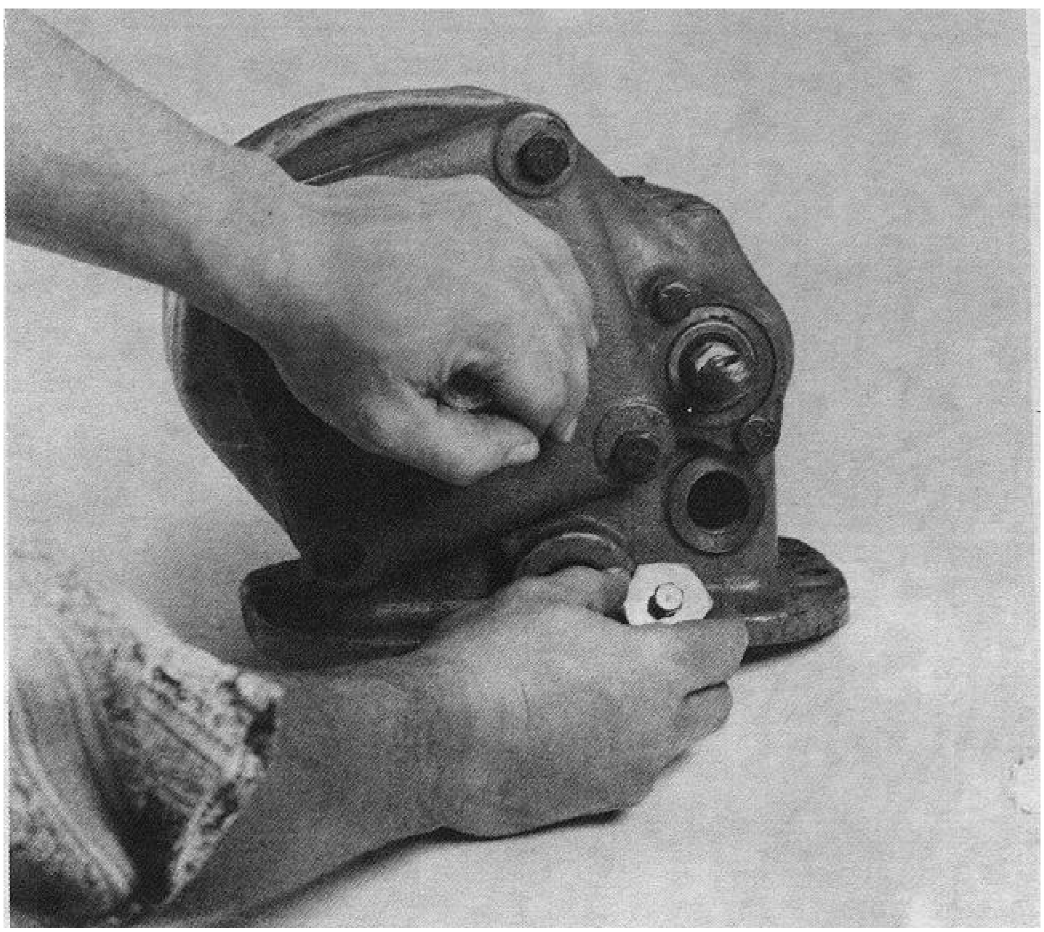
Remove the Dump-Back Plate on the side of the housing and rock the P.T.O. Input Gear with your hand.

Correlate this backlash to the unmounted backlash found in Step 3 on page 7. Use Gaskets to get backlash feel as close to unmounted condition as possible.

NOTE: *The 270 - AAJ & BAJ come with a special gasket (35-P-4 1) which when installed with the P. T. 0. on a six (6) bolt opening on an Allison automatic reduces the need for backlash adjustment.*



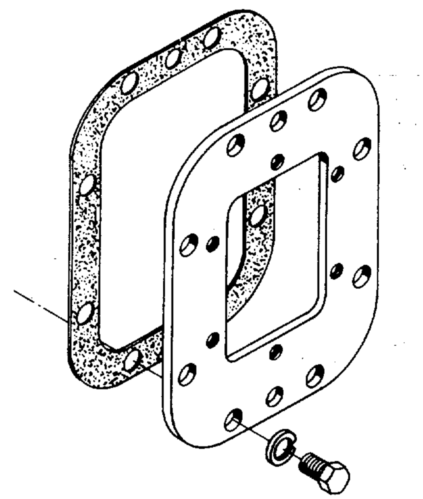
An inspection hole is provided in the P. T. O. housing for feeling, the mounted backlash. Rock the P. T. O. Input Gear with your hand and correlate this backlash to the unmounted backlash found in Step 3 on page 7. Use Gaskets to get backlash feel as close to unmounted condition as possible.



ADAPTER PLATES

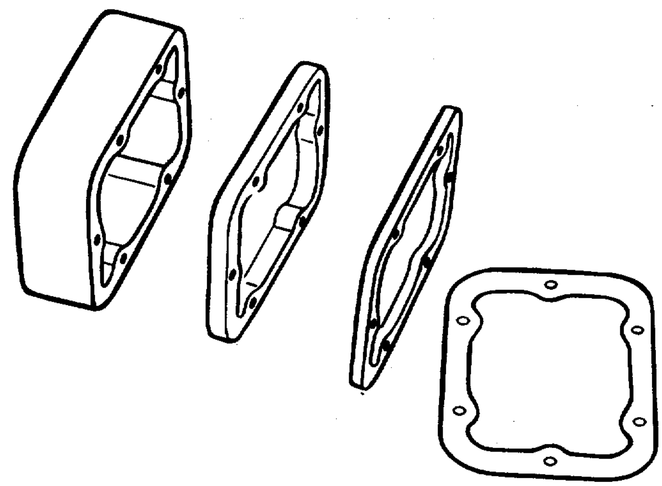
Adapter plates are used to permit mounting a 6 bolt P. T. O. on a transmission that has an 8 bolt aperture.

NOTE: A wire locking stud kit is recommended when mounting a 6 Bolt P. T. O. to an adapter plate on a bottom opening.



FILLER BLOCKS

Filler blocks may be required where it is necessary to use a spacer to mount the power take-off to a particular transmission.



P.T.O. APPLICATION AND ADAPTER ASSEMBLY

Figure 13 illustrates typical adapter assembly configurations. Some P.T.O. applications require adapter assemblies because it is impossible to reach the P.T.O. driver gear in the transmission without this assembly.

An adapter assembly will change the rotation of the P.T.O. and this may be necessary for driving pumps or other accessory equipment. Obstructions, such as a bulge in the transmission, exhaust pipes or motor mounts can sometimes be compensated for through the use of an adapter.

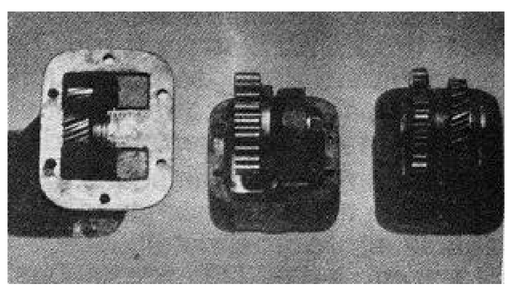


Fig. 13

MOUNTING ADAPTER ASSEMBLY
How to mount an adapter assembly to the transmission and P.T.O.

1. Use same procedure for mounting the adapter and checking backlash as was used when mounting the P.T.O. to transmission. (See Fig.14.)
2. After checking for proper backlash remove the adapter, gaskets and filler block (if required) from the transmission. Keep the gaskets and filler block as a "package"' (See Fig.15.)
3. Bench mount the adapter to the P.T.O. using appropriate length studs. (See Fig.16.)
4. Proper backlash will determine the number of gaskets to be used between the adapter and the P.T.O. (See Fig.17.)
5. Remount the adapter assembly, all gaskets and the P.T.O. to the transmission in their respective sequence. (See Fig.18.)
6. Secure all nuts and cap screws to proper torque.

Now....run the P.T.O. momentarily and check for noise!

CAUTION: The transmission and P.T.O. have no lubrication at this time so running time should be as short as possible.

- If the P.T.O. whines it may be mounted too tight, too little backlash. This indicates that gaskets should be added.
- If the P.T.O. clatters it may be mounted too loose, too much backlash. This indicates that gaskets should be removed.

General Rule: A Chelsea .010 (.25mm) gasket will change backlash approximately .006 (.15mm) and a .020 (.50mm) gasket changes backlash approximately .012 (.30mm).

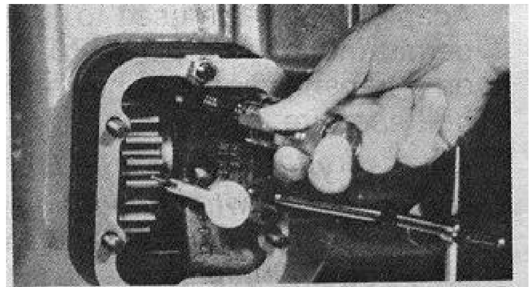


Fig. 14

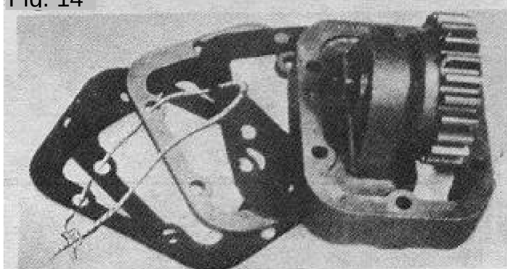


Fig. 15

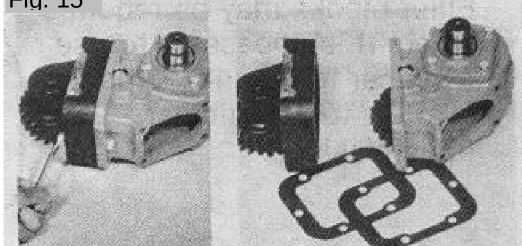


Fig. 16

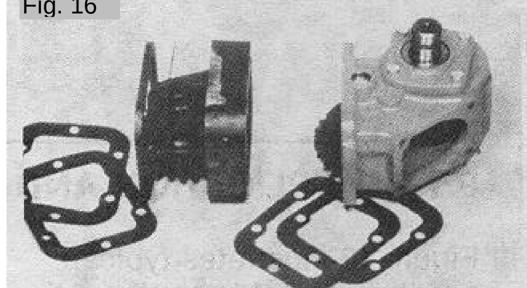


Fig. 18

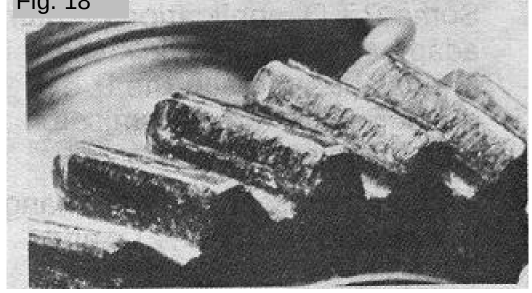


Figure 19 illustrates a typical input gear (driven gear) in a P.T.O. that was mounted too deep-insufficient backlash. Extreme heat turned the gear blue and resulted in gear and bearing failure.

1. Remove the filler plug from the transmission and add recommended transmission lubricant to the level prescribed by the transmission or truck manufacturer. (See Fig. 20.)

   NOTE: If the P.T.O. is mounted below oil level, additional lubricant will be required.

2. Run the P.T.O. for 5-10 minutes and check for oil leaks and noise.

3. Should a quiet P.T.O. become noisy after the universal joint connection is made, check the P.T.O. driveline components for an out of phase condition, excessive or unequal joint angles or possibly worn parts in the driven accessory.

4. Re-torque all mounting bolts, nuts, cap screws and set up inspection routine of the P.T.O. driveline components and the driven auxiliary equipment.

   NOTE: Anticipate slight increase in P. T. 0. noise level as oil thins out at operating temperatures. Fig. 20

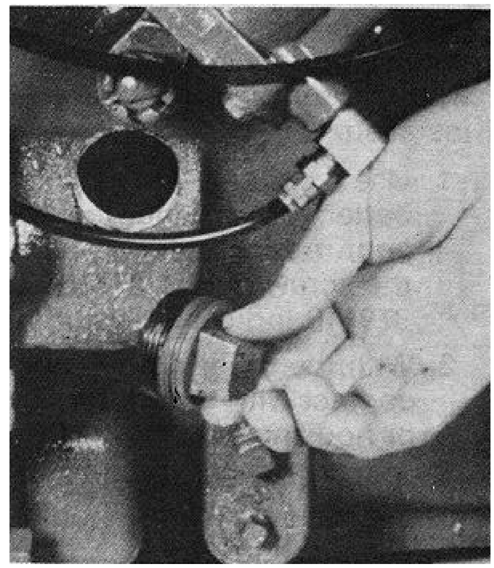


Fig. 20

P.T.O. Installation Tips For Automatic Transmissions
The procedure for installing a P.T.O. on an automatic is basically the same as for a mechanical transmission. Power take-offs for automatic transmissions are assembled with a special drilled input shaft which allows the input gear to be pressure lubricated during operation. (see page 21).

After installing a P.T.O. on an automatic transmission, connect pressure lubrication hose to the P.T.O. and the transmission per installation instructions shown on page 22 of this booklet.

WARNING: Adapter assemblies are never used on an automatic transmission because they do not have pressure lubricated design features.

WARNING: Use only wire control with P.T.O. made for wire cable control. If lever is desired, order P.T.O. for lever control. The internal shifting mechanism for wire is not designed for heavy forces usually encountered with lever control linkage.

CONTINUITY CHECK
378969 and 379110 INDICATOR SWITCHES

In order to insure that the switch is functioning properly, the following procedure can be used with the unit on a bench, or installed.

1. Use a continuity checker, battery type, either meter or light. Attach one (1) probe to the screw on the 378969 or 379110 Indicator Switch .

2. With the other probe, make contact with the shifter cover or housing (see Figs. #1 & 2).

3. Actuate shifting device and the meter or light* should be actuated when P.T.O. gear is engaged (see Figs. #3 & 4).

4. Shift unit out of gear and the meter or light* should return to normal as shown (see Figs. #1 and 2).

This test procedure can be used to check Chelsea wire, lever, and air shifter covers, although an air source would be necessary for the latter.

*If a meter is not available the light in the 328751 X can be used (see Figs. #2 & 4). A six volt battery is all that is necessary for a power source.

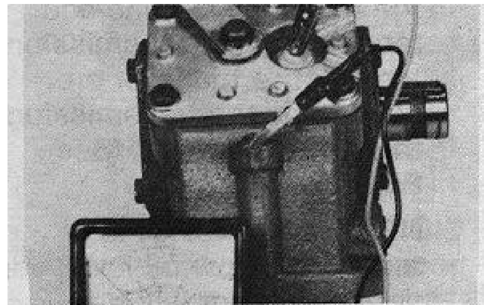


Fig. 1

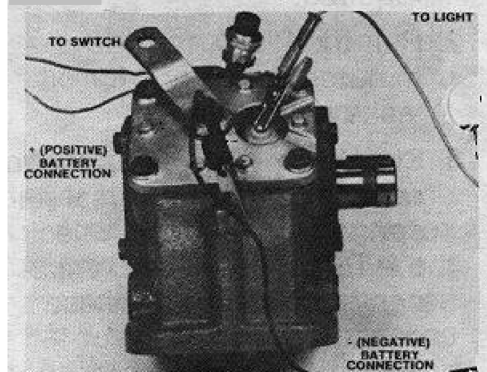


Fig. 2

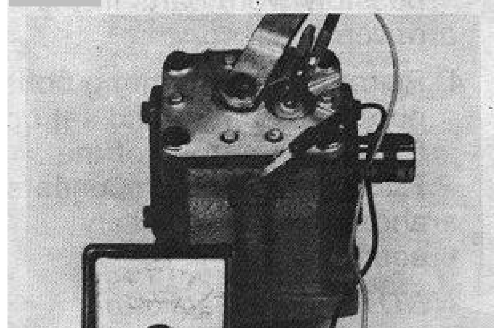


Fig. 3

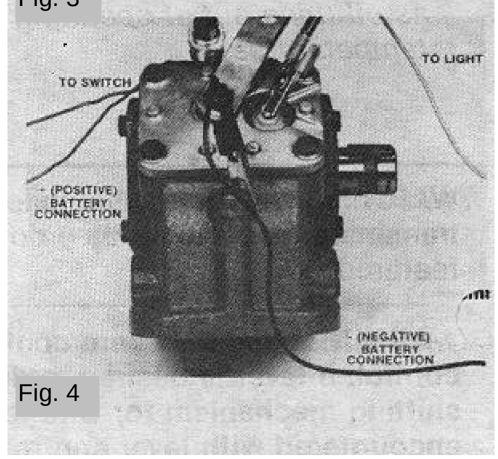


Fig. 4

WIRE SHIFT P.T.O.'s'*
Cable Control Installation Instructions

1. Find a suitable area on the dash to install the cable control and the control plate indicator light.

   NOTE: The location of the cable control and the control plate should be as close to each other as possible and easily accessible by the driver or operator, but should not be an obstacle to driver movement nor interfere with other controls, instruments, or equipment.

2. Drill a 1/2" (. 5") diameter hole for the control cable.

3. Install the control cable on the dash using the hex nuts supplied with the cable. The knob can then be screwed into place. The length of cable can then run through the firewall and back to the P. T. O. making sure it is kept away from the exhaust, moving parts, etc. (Fig. #1, 2)

   NOTE: Do not kink the cable. In order for the cable to operate properly,. there can be no bends smaller than 6 inch radius. Total bends in the cable should not exceed 3600 (example four 900 bends in cable).

4. Using the template found on page 30 drill the necessary holes for the control plate-indicator light (Fig. #3 & 4).

   All six bolt wire shifts with the exception of the reversibles, dual shift units, and some gear boxes.

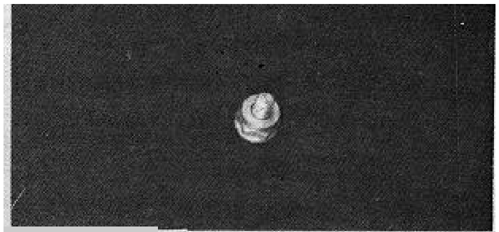


Fig. 1

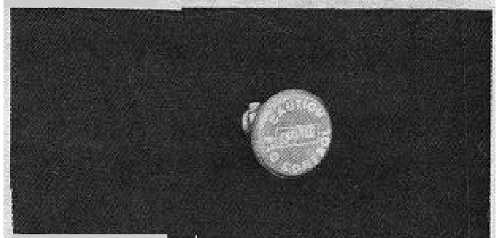


Fig. 2

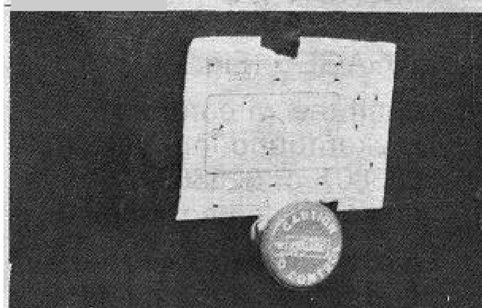


Fig. 3

Fig. 4

Fig. 5

5. Install the control plate indicator light on the dash using the hardware supplied in the 328751Xparts bag. (Fig. #5)
6. Determine from which direction the cable must come in order for the unit to be disengaged when the knob is all the way in.
   NOTE: The shifter must always be installed in the following manner: CABLE IN: P.T.O. DISENGAGED (Fig. #6) CABLE OUT: P.T.O. ENGAGED (Fig. #7)
7. Install the wire control bracket found in either the 328380X or 328380-1 X wire control parts bag. (Fig. #8)
8. Line the cable up with the wire control bracket and shifter lever (disengaged position) on the P.T.O. cover assembly (Fig. #9)
   NOTE: It may be necessary to change the position of the shifter lever on the P.T.O. To do this, remove the shifter cover from the unit. This will prevent the possible loss of the poppet and/or spring into the transmission if the shifter post assembly should be pushed through the cover when reinstalling the lever.

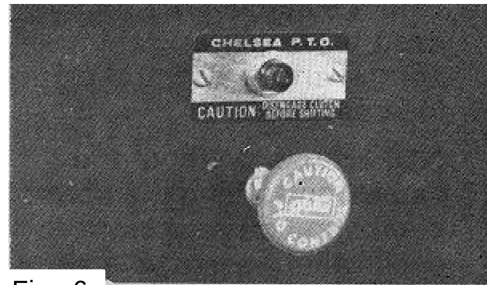


Fig. 6

Fig. 7

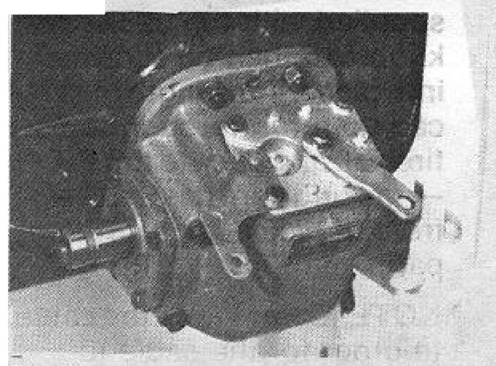


Fig. 8

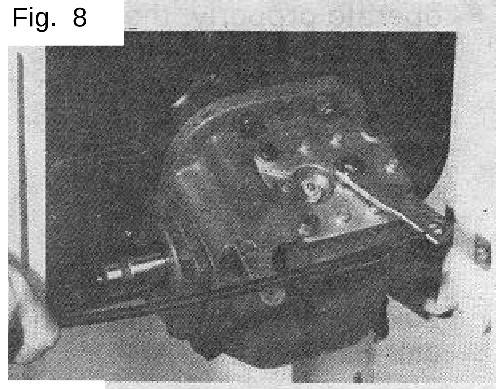


Fig. 9

9. Shift the P.T.O. to the engaged position to see how much of the cable casing must be cut to allow the lever enough travel to shift in and out completely. The casing need only go just beyond the bracket, whereas, the wire must be long enough to go through the swivel pin in the shifter lever. (Fig. #10)

   NOTE: In some instances the cable control may not be long enough. Chelsea has available four longer lengths than the standard ten-foot cable. These come in five foot increments (i.e., 328346-15X = 15-foot cable).

10. When the length of the casing has been determined, pull the wire back through until the case can be cut without cutting the wire. Use a hacksaw or heavy pair of side cutters to cut the casing. (Fig. #11)

    NOTE: The cable can be held by a bench vise as long as the jaws are not tightened to the point where the case mushrooms. If a vise is not accessible, a pair of vise grips will do the job.

11. Push the wire back through and install the cable using the hardware from the previously mentioned wire control parts bag (Step #7), (Fig. #12). See exploded drawing.

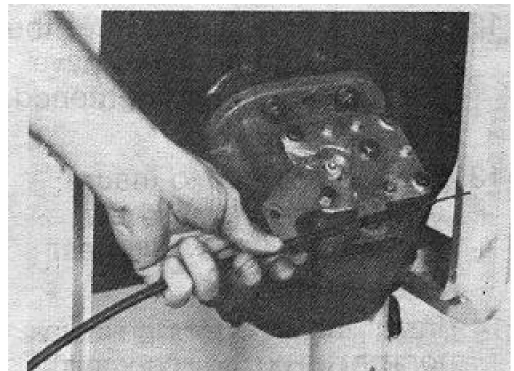


Fig. 10

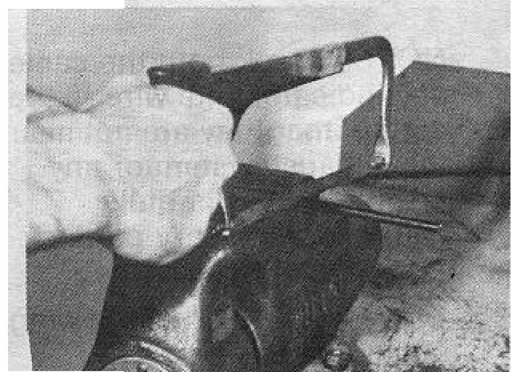


Fig. 11

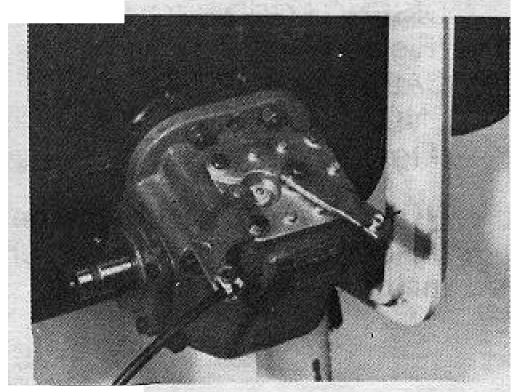


Fig. 12

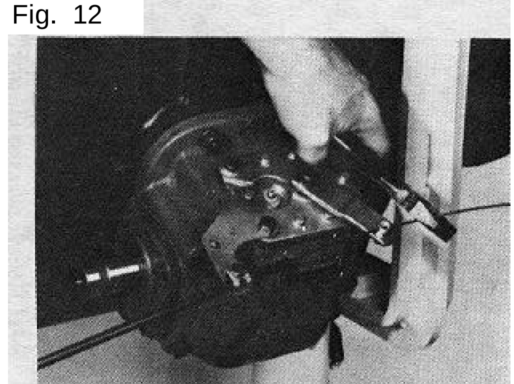


Fig. 13

12. Cut the excess wire after the cable casing and wire have been installed and tightened. (Fig. #13)
13. Shift the P.T.O. to insure enough casing has been removed to allow full gear engagement.
14. Install the wiring for the indicator light using the schematic from page 30 (Fig. #14).
    NOTE: Check both the cable and indicator light wires to be certain that they are not near the exhaust system or any moving parts. Carefully fasten to stationary parts of the vehicle if necessary.
15. Shift the P.T.O. The following should be adhered to: CABLE IN: P.T.O. DISENGAGED: LIGHT OUT (Fig. #14 & 15) CABLE OUT: P.T.O. ENGAGED: LIGHT ON (Fig. #16 & 17)
    NOTE: The P.T.O. should be checked for continuity as per the instructions in this manual.

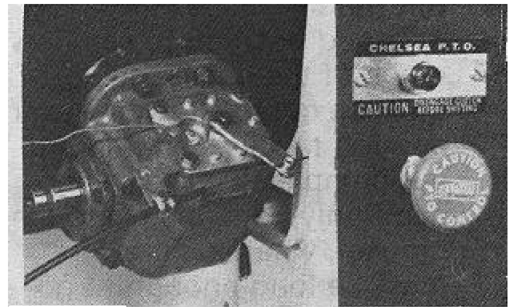


Fig. 14

Fig. 16

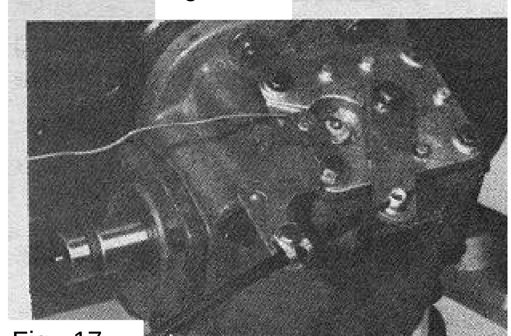
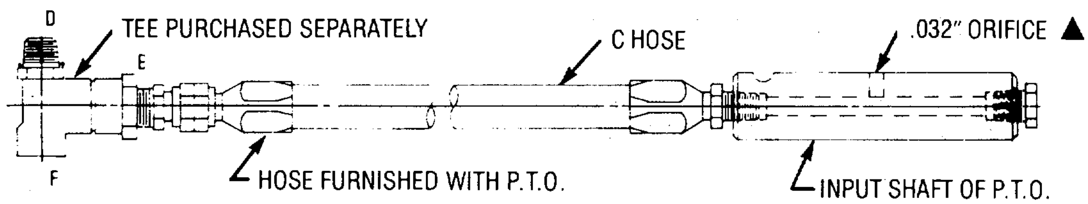


Fig. 17

WIRE SHIFT INSTALLATION INSTRUCTIONS
(Reversibles, dual shift units, and some gear boxes)

1. Use step #1 #5 from previous instructions.
2. In step #6 the cable can come from either direction since the P.T.O. will always be engaged when all the way in or out.
3. Follow step #7 and #8.
4. In step #9 shift the P.T.O. from forward to reverse or vice versa to determine the amount of travel needed and the length of casing to be cut. Follow step #10 - #14.
5. Step #15 will show the following:

   CABLE IN:. P.T.O.
   ENGAGED: LIGHT ON
   CABLE OUT (1st position):
   P.T.O. DISENGAGED:
   LIGHT OUT
   CABLE OUT (2nd position):
   P.T.O. ENGAGED: LIGHT ON



TEE FITTING	378840	378880	378970	378897
D	.750-16 U.N.F.2A	.875-14 U.N.F.2A	1.062-16 U.N.F.2A	1.312-12 U.N.2A
E	.250-18 N.P.T.F.	.250-18 N.P.T.F.	.250-18 N.P.T.F.	.250-18 N.P.T.F.
F	.750-16 U.N.F.2B	.875-14 U.N.F.2B	1.062-16 U.N.F.2B	1.312-12 U.N.2B

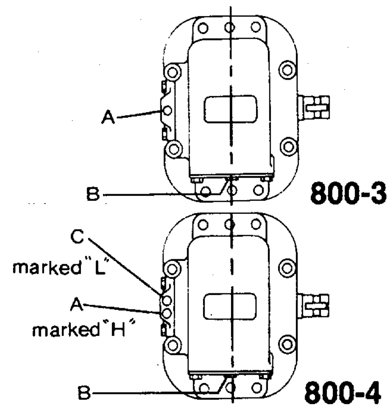
The specific "T" Fitting for each Automatic Transmission is called out at the bottom of each transmission's application sheet. If a "T" fitting is not called out, then a standard pipe tee will adapt.

▲**NOTE**: The .032" orifice is built into all pressure Tubed idler shafts. No additional orifices are required when using these pressure lubed shafts.

A. High Pressure Line From Valve.

B. Dump Line to P.T.O. From 3 Way Valve.

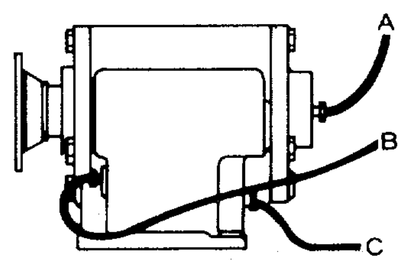
C. Lubrication Line From Transmission



A. High Pressure Line From Valve.

B. Dump Line to P.T.O. From 3 Way Valve.

C. Lubrication Line From Transmission.
Attach to either End of IDLER Shaft.

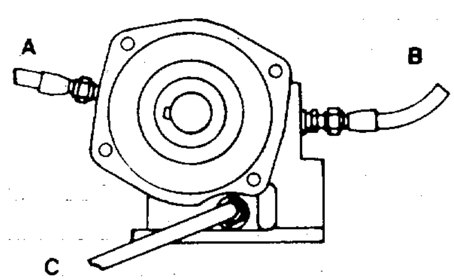


852 Series

A. High Pressure Line From Valve.

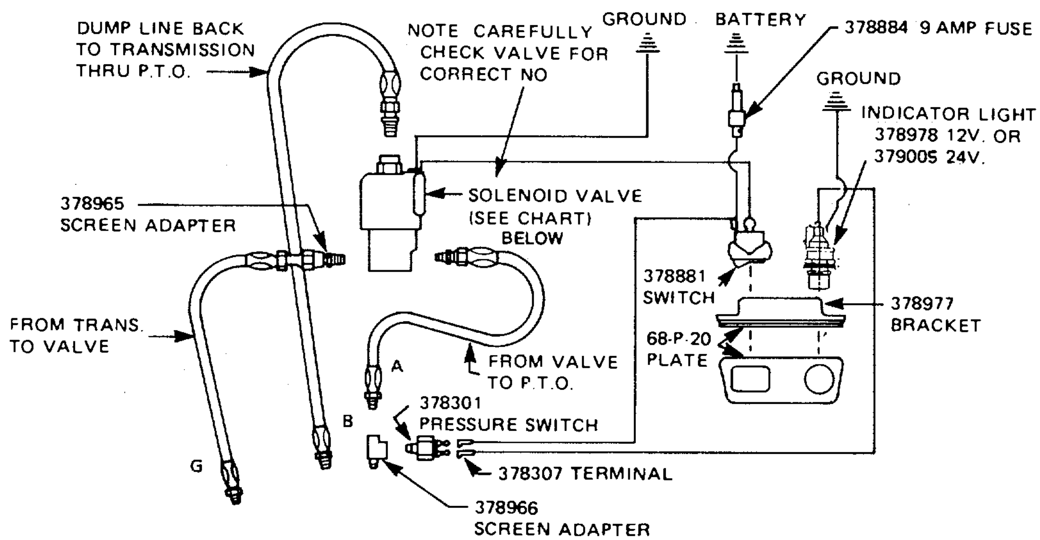
B. Dump Line to P.T.O. From 3 Way Valve.

C. Lubrication Line From Transmission.
Attach to either End of IDLER Shaft.



270 Series

Shifter Component Installation Sketch For Power Shifts

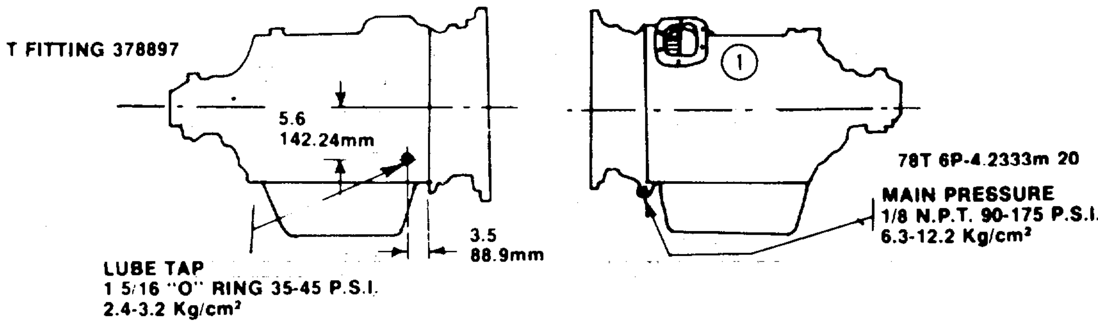


SOLENOID VALVE APPLICATION

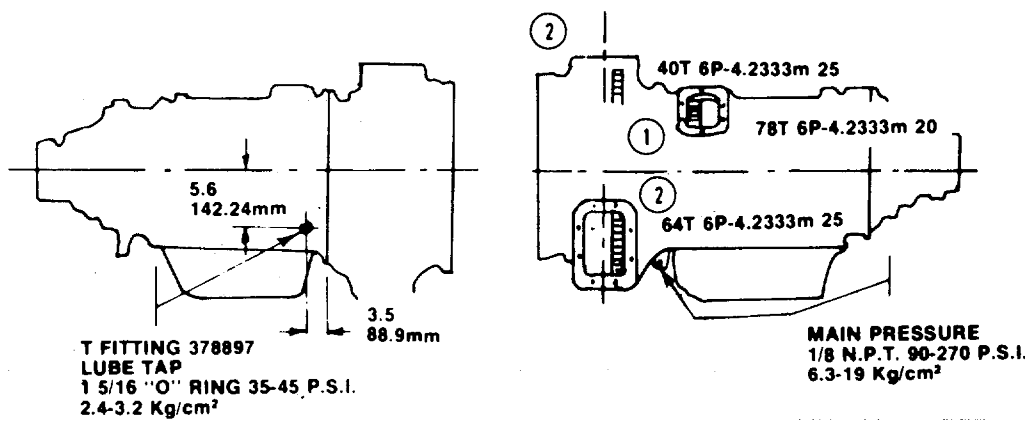
TRANSMISSION	VOLTAGE	SOLENOID VALVE NO.	COLOR CODE
ALL ALLISON (260 P.S.I.)	12 V. 24 V.	378882-1 * 378882-2*	Black Blue
300 P.S.I. 300 P.S.I.	12V 24V	379193-1 399193-2	Green Brown

***NOTE**: These two valves are being phased out and are being replaced by 379193-1 & 2.

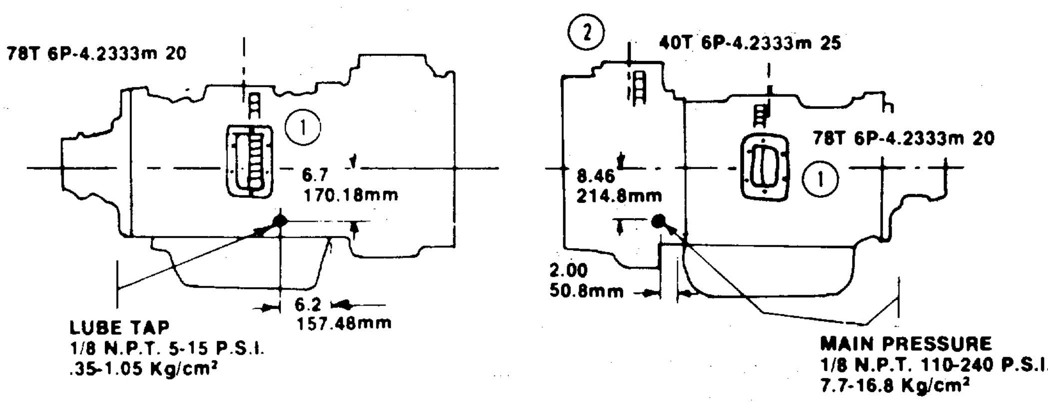
HT-740
HT-750D



CLT-750

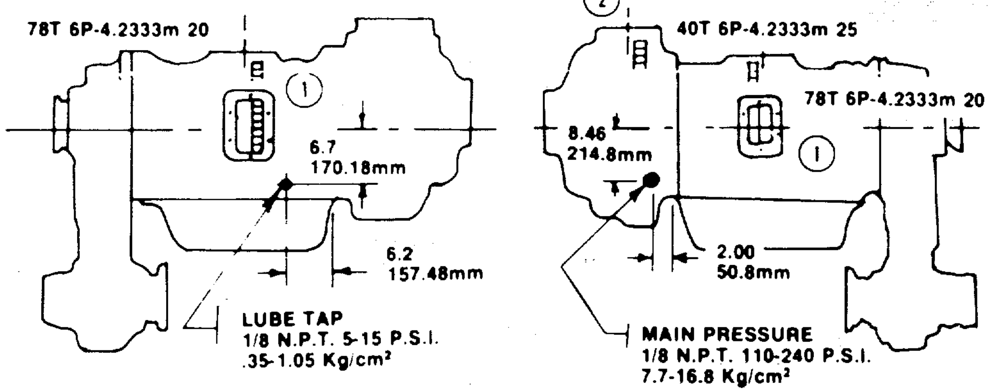


HT-70

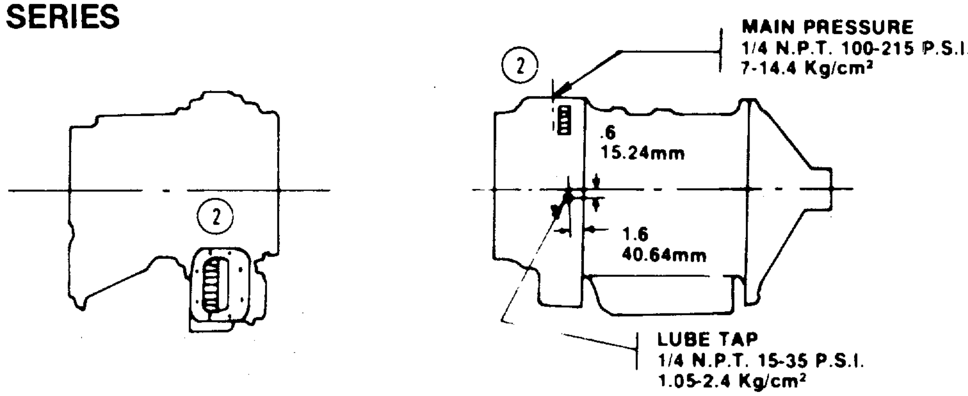


P.T.O. OPENINGS (Continued)

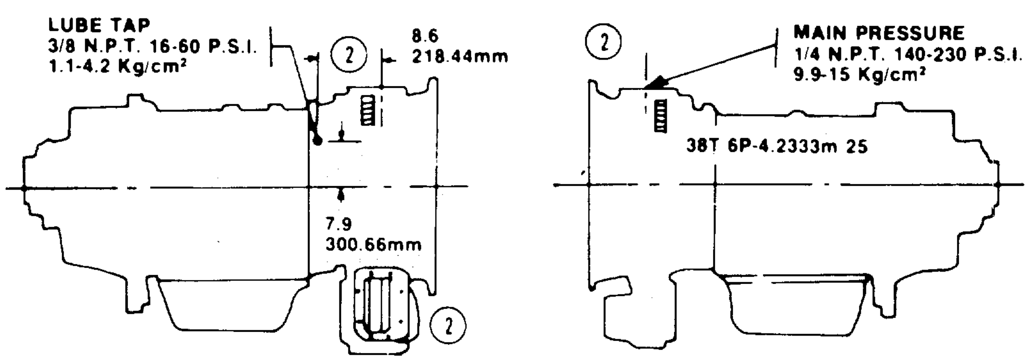
4460



5000 SERIES

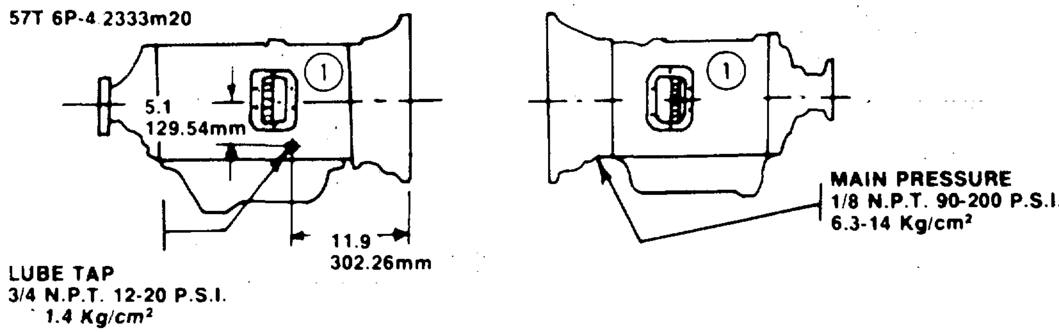


8000 SERIES

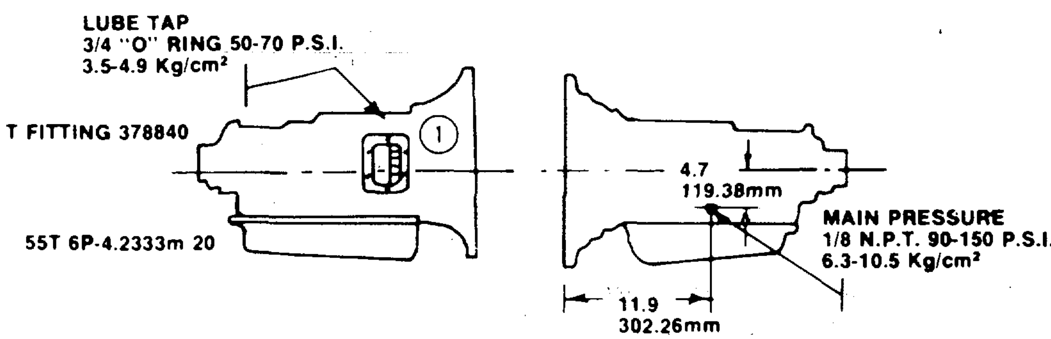


1. Converter driven P.T.O. Drive Gear
2. Engine driven P.T.O. Drive Gear

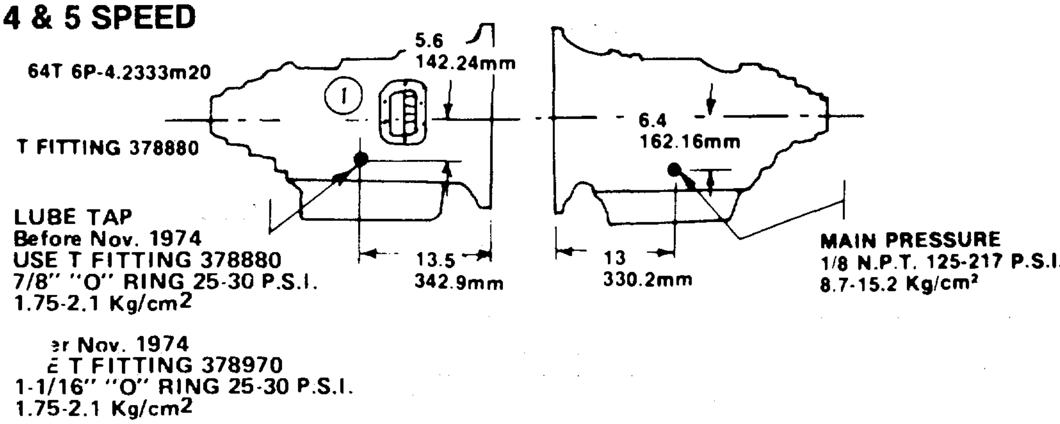
MT-30-42
6 SPEED
3341-3441



AT-540
4 SPEED



MT-640
MT-650
4 & 5 SPEED

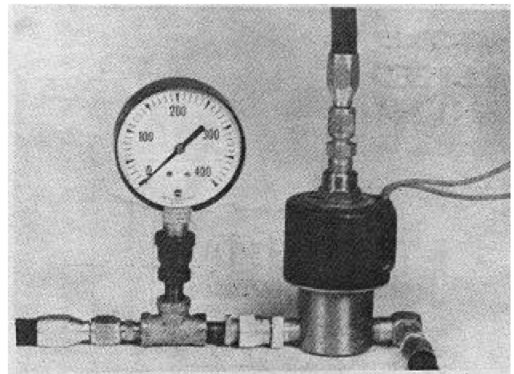


1. Converter driven P.T.O. Drive Gear

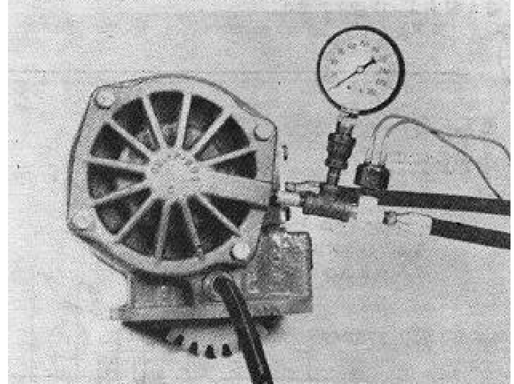
CIRCUIT CHECK
For Power Shift P.T.O.'s on Automatic Transmission
270, 800 and 852 Series

Perform the following and record the results when installing the P.T.O. originally, as a replacement, or while trouble shooting.

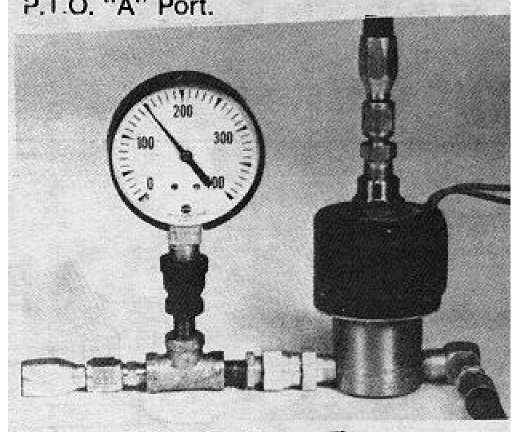
1. Install two (2) Pressure Gauges in the circuit, as shown: 300-400 PSI Gauges for Allisons



Before 378965 Screen Adapter @ "In" Port of Solenoid Valve



Between 378966 Screen Adapter and P.T.O. "A" Port.



For Allisons should be 90-270 PSI.

2. With Solenoid Valve "Off" record the pressures- at inlet to Solenoid Valve for the transmission both cold (ambient) and at operating temperature for engine idle rpm and engine maximum rpm

RPM	Transmission Cold (Ambient)	Transmission At Operating Temperature
Engine Idle	PSI	PSI
Engine Maximum	PSI	PSI

3. With the Solenoid Valve "On" record the corresponding pressures at the two (2) gauges with the transmission both cold (ambient) and at operating temperature for engine idle rpm and engine maximum rpm.

For Allisons should be 90-270 PSI.

	Transmission Cold (Ambient)		**Transmission At Operating Temperature**	
Engine RPM	**Into Solenoid**	**Into P.T.O.**	**Into Solenoid**	**Into P.T.O.**
Idle	PSI	PSI	PSI	PSI
Maximum	PSI	PSI	PSI	PSI

If at any time the above pressures are below 90 PSI or there is a 50 PSI or more difference in two of the corresponding readings in Part 3:

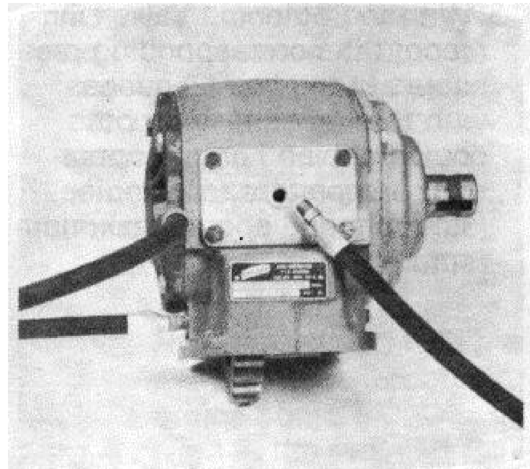
(a) Check circuit for correct installation

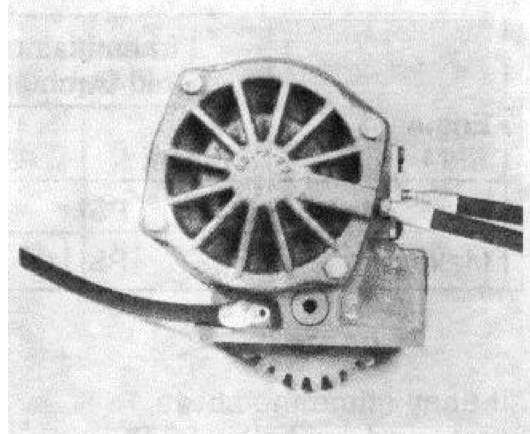
(b) Check hoses and screens (2) for obstruction

4. Remove the "B" line from the P.T.O. with the Solenoid Valve "On" no oil should appear from line. Then turning the Solenoid Valve to "Off" should dump the oil from the P.T.O. Clutch Pack through this line.

5. Remove the "C" line from the P.T.O. Idler shaft end (except 800 P.T.O.) and confirm that oil is running to this shaft for lubrication.

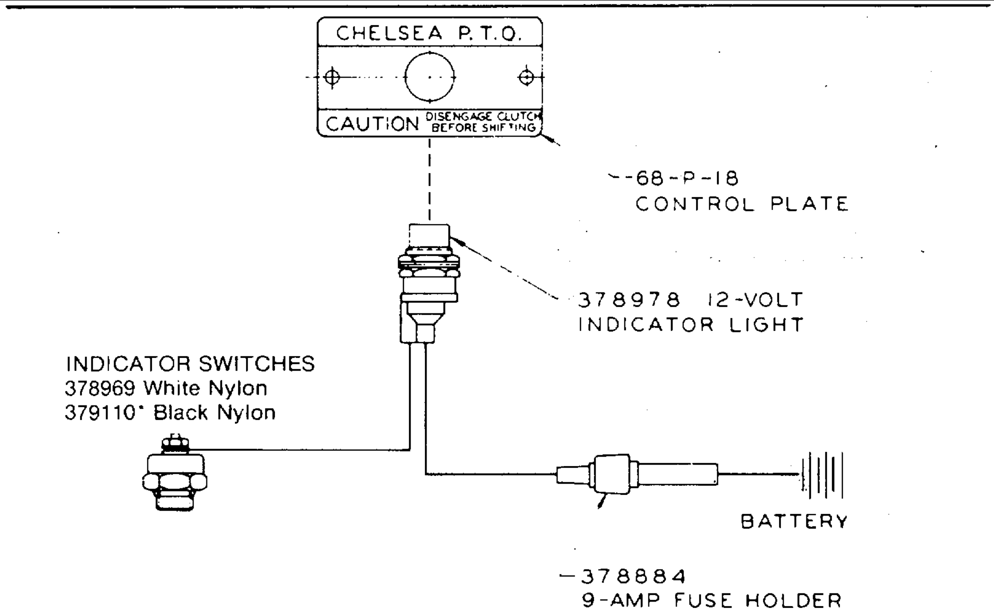
   Retain the findings of these tests for future comparison. Re-check oil level in tranmission after testing is complete.



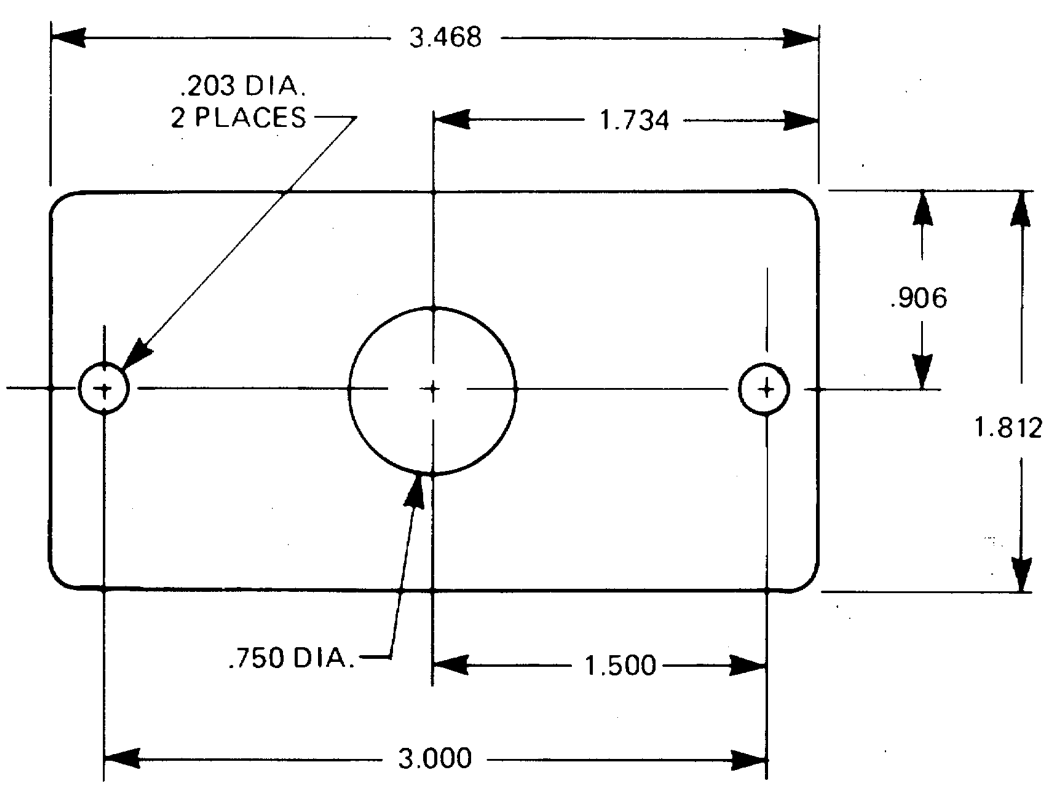


INDICATOR LIGHT INSTALLATION/ DASH DRILLING TEMPLATE

For Indicator Light Installation of 220, 260, 812,100, 300, 321, 322, 340, 350*, 370▲*, 381, 410, 420, 431, 450* and 611 Series Wire and Lever Control



*Special Indicator Switch for these models.
▲Uses Two Switches, Two Lights, and one fuse.



This vehicle is equipped with a Power Take-off. Consult operating instructions before using. (See sun visor).

POWER TAKE-OFF OPERATION -VEHICLE STATIONARY

I. Mechanical Transmission

1. A power take-off is, and should be, operated as an integral part of the main transmission.
2. Before shifting the power take-off into or out of gear disengage the clutch and wait for transmission or P.T.O. gears to stop rotating.

II. Automatic Transmission with Manual Shift P.T.O.'s (Includes Air Shift)

On automatic transmission , the gears in the transmission turn when the transmission is in neutral, therefore, gear clashing will occur if the power take-off is shifted into gear at this time.

A. With Converter Driven Gear

1. Shift transmission lever into any of the drive positions (This will stop transmission gear from turning.)
2. Shift power take-off into gear.
3. Shift transmission into neutral. (This will start transmission gears turning).

B. With Engine Driven Gear

1. Shift. P.T.O. into gear before starting engine. This procedure should eliminate gear clash.

III. Automatic Transmission with Power Shift P.T.O.'s

Engage P.T.O. with engine at idle speed. Power Shift P.T.O.'s: Engine must be at idle when P.T.O. is engaged. See transmission manufacturer's instructions for special procedures.

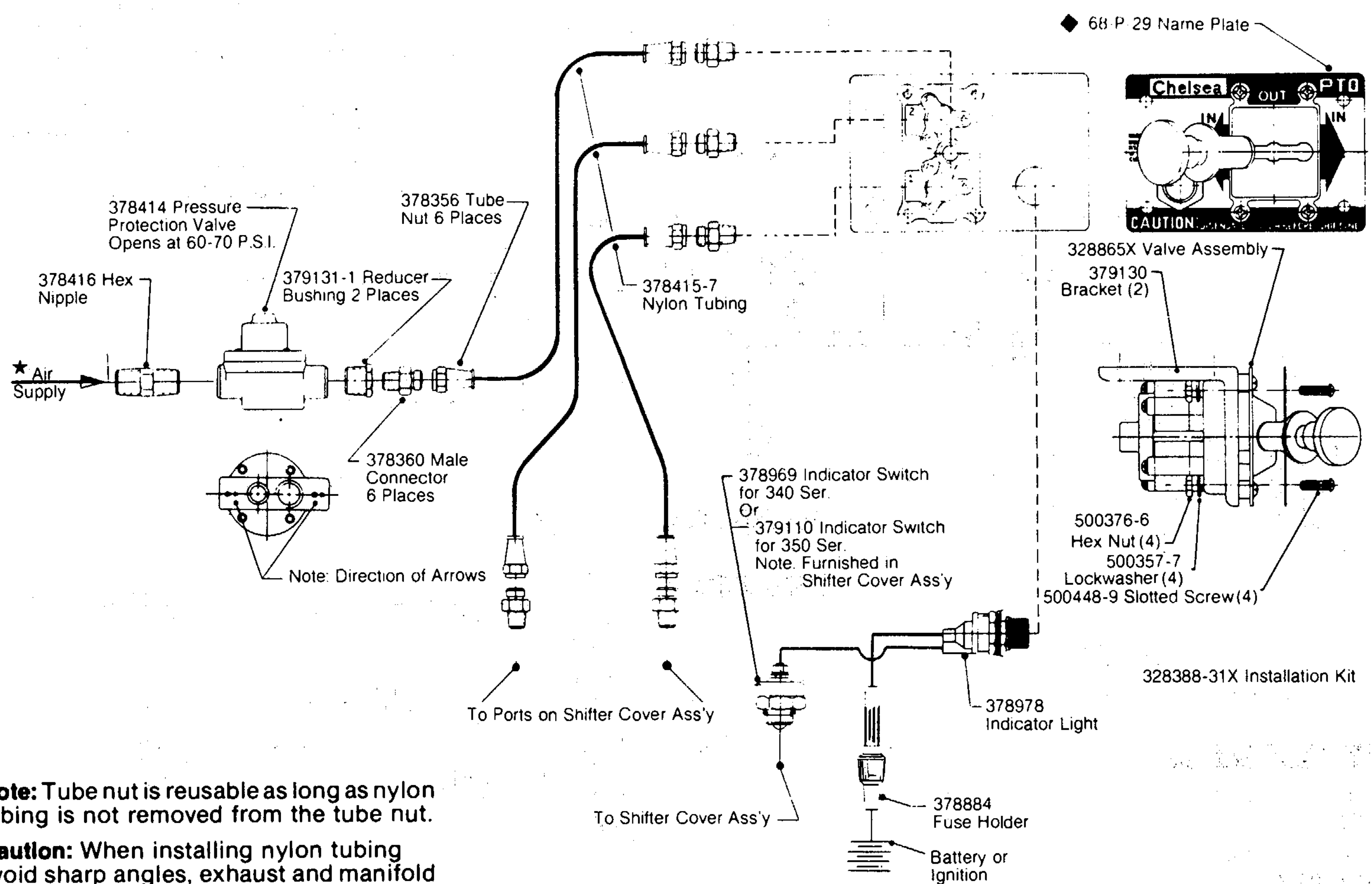
IMPORTANT: Failure to follow proper shifting or operating sequences will result in premature P.T.O. failure with possible damage to other equipment.

WARNING

Use only wire control with P.T.O. made for wire cable control. If lever control is desired, order P.T.O. for lever control. The internal shifting mechanism for wire is not designed for heavy forces usually encountered with lever control linkage. Do not attempt to work on an installed power take off with the engine running.

Make sure to block any moving or raised device that may injure a person working on or under the truck. A lever or its linkage may be accidentally moved causing movement of the device which could cause injury to a person near the device.

AIR SHIFT
Installation Sketch for 340 and 350 Series Using:
New Williams Valve



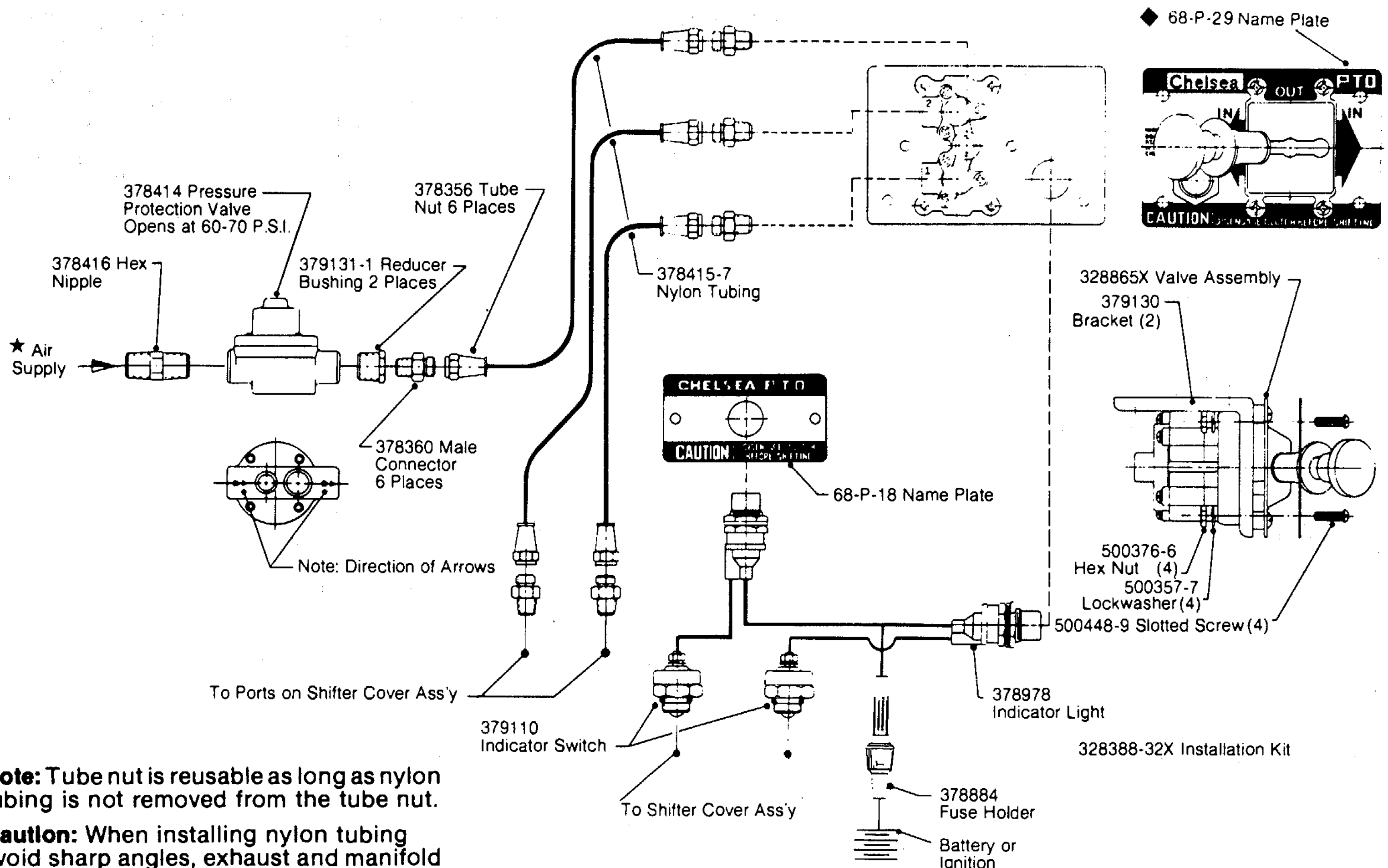
Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

◆ Template for control plate on page 38.

★**Warning:** Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

AIR SHIFT
Installation Sketch for 370 Series Using:
New Williams Valve



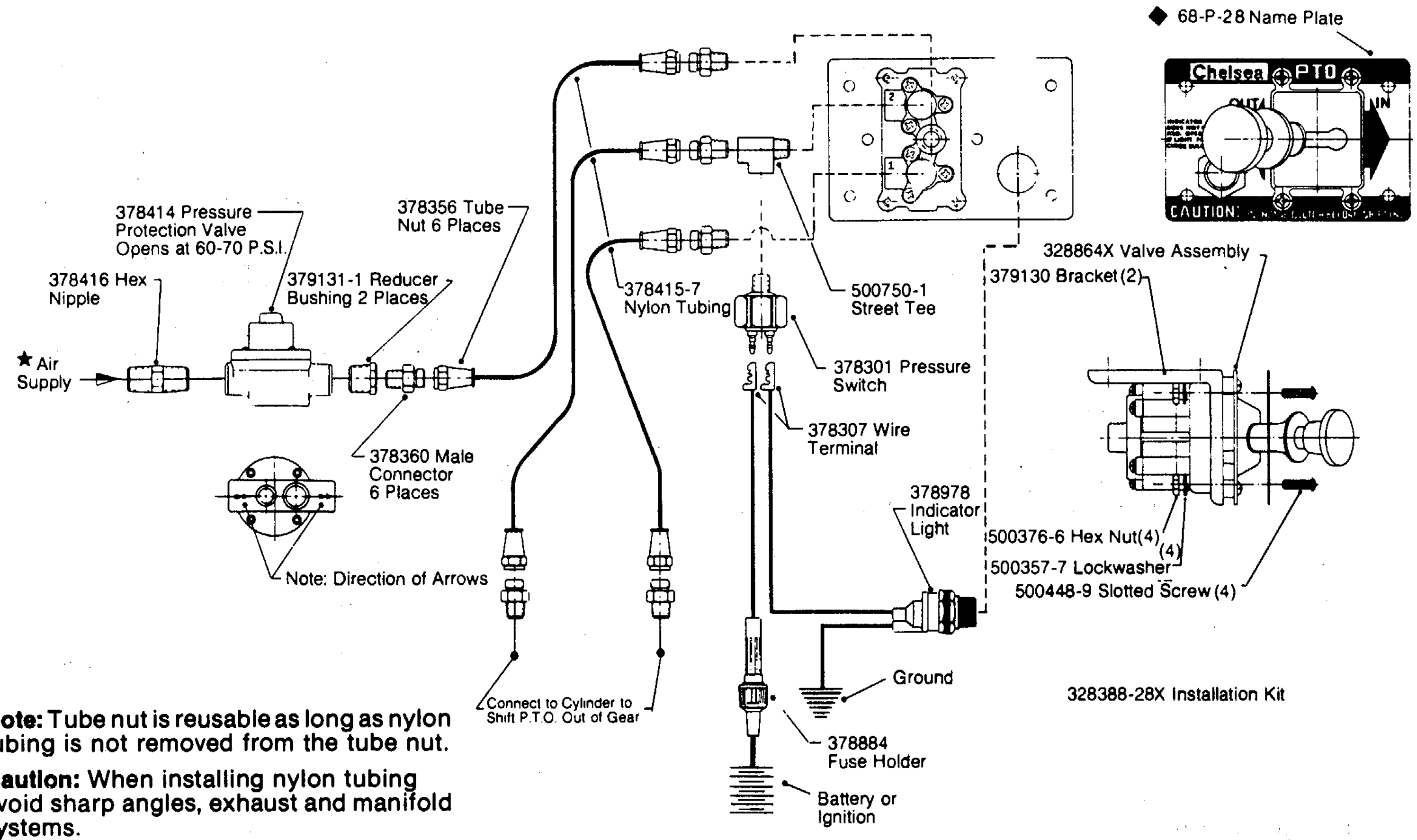
Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

◆ Template for control plate on page 30 and 38.

★ **Warning:** Connect directly to air supply. Do not use tubing between air supply and press' protection valve.

AIR SHIFT
Installation Sketch for 822, 832, 900, 910, and 920 Series Using:
New' Williams Valve



Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

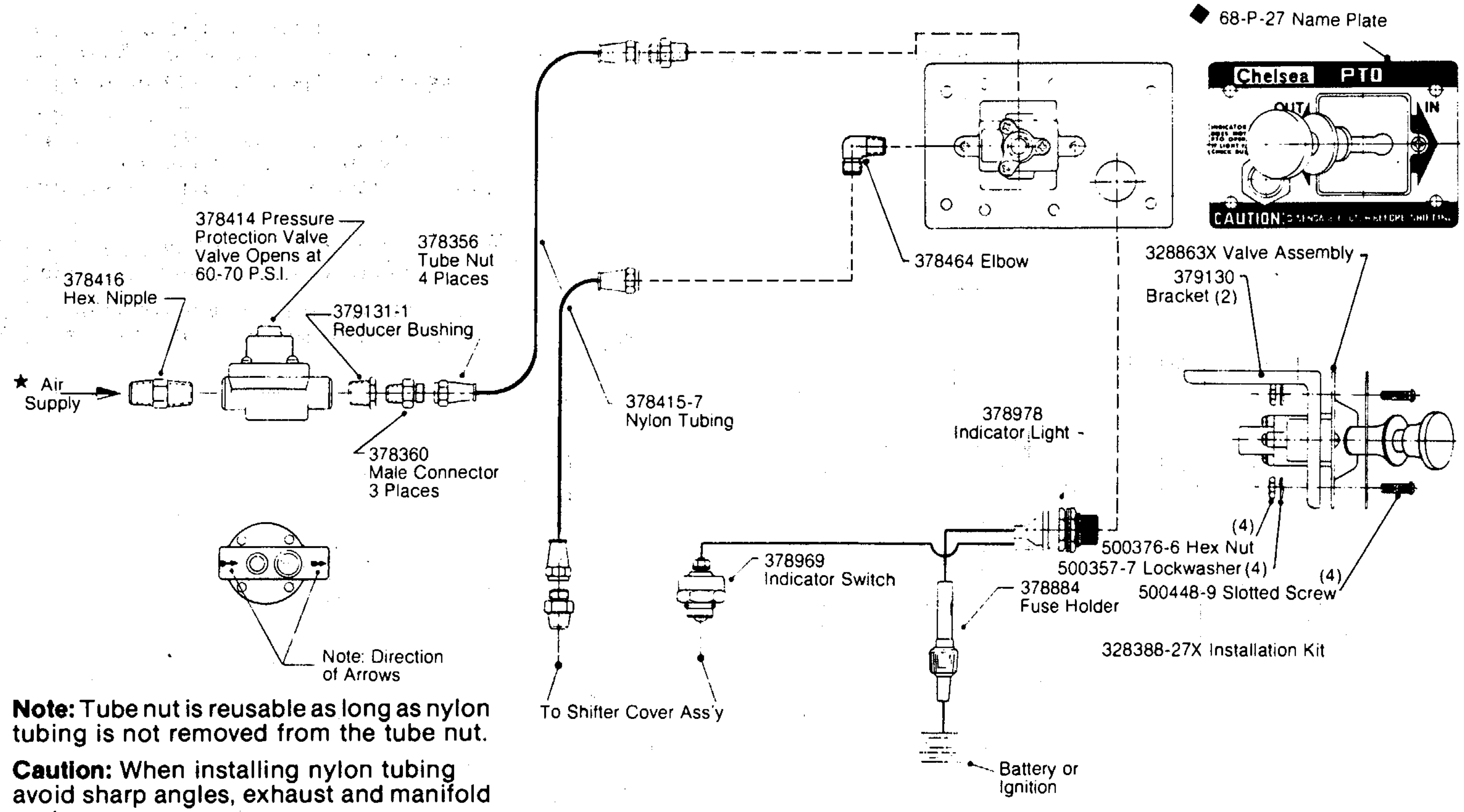
Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

Important: When this installation is used on vehicles with automatic transmissions, the P.T.O. drive gear must be stopped before shifting.

◆ Template for control plate on page 38.

★ **Warning:** Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

AIR SHIFT
Installation Sketch for 100, 220, 260, 381, 410, 420, 431 and 812 Series
Using: New Williams Valve



Note: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

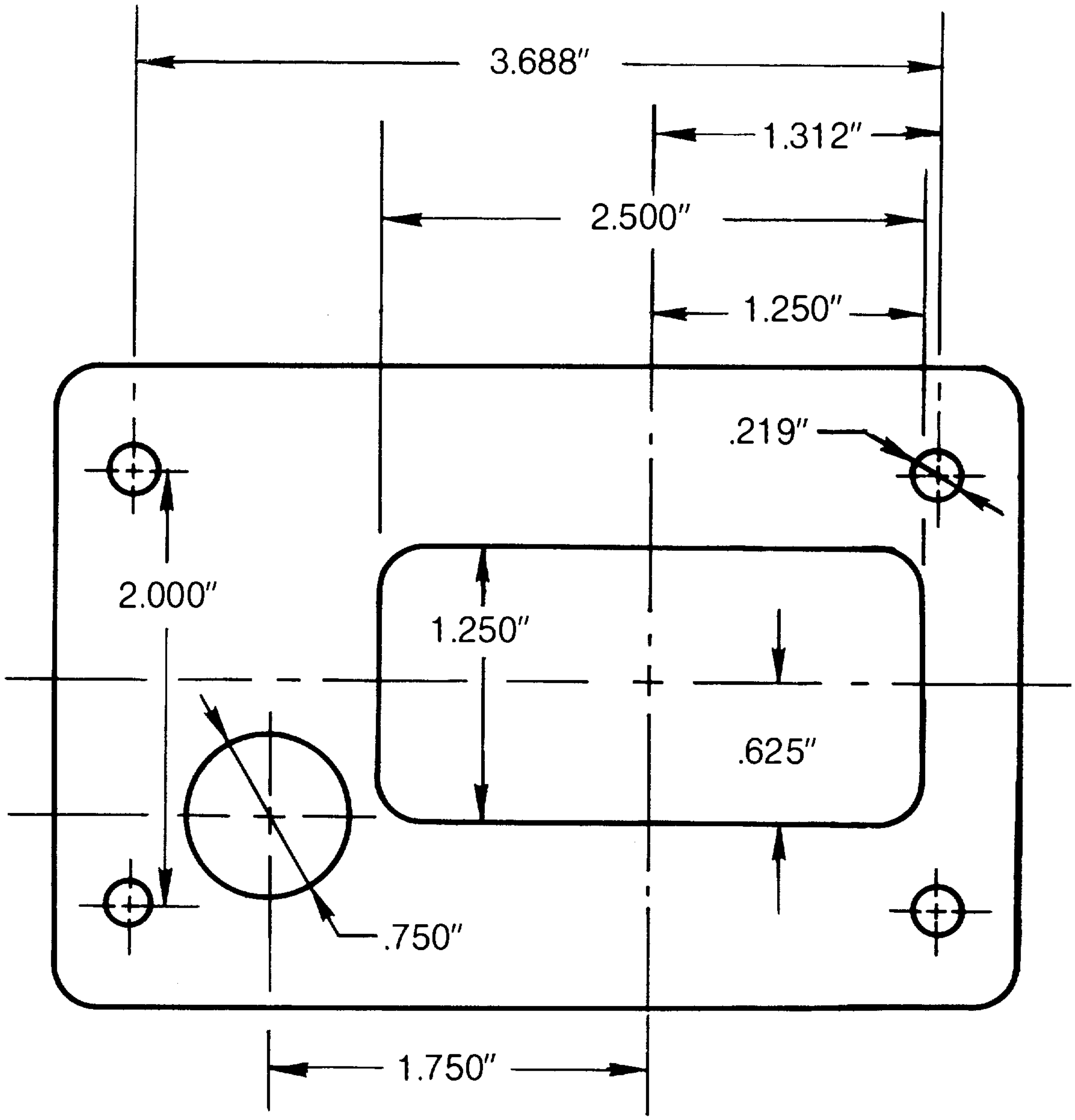
Caution: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

Important: When this installation is used on vehicles with automatic transmissions, the P.T.O. drive gear must be stopped before shifting.

◆ Template for control plate on page 36.

★**Warning:** Connect directly to air supply. Do not use tubing between air supply and pressu' otection valve.

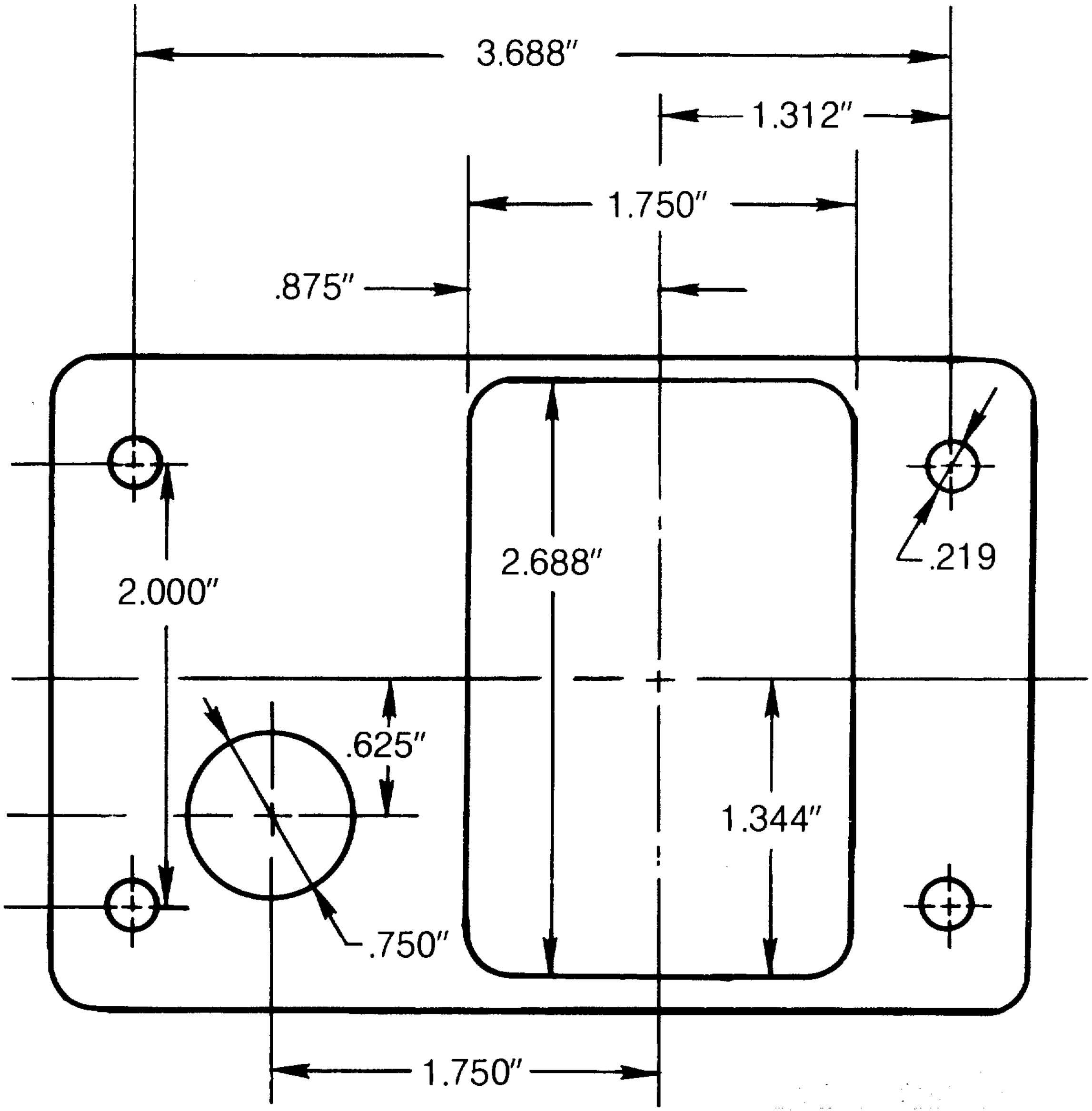
DASH DRILLING TEMPLATE
For 6 & 8 Bolt Air Shift for New Williams Valve



For use with Installation sketch on Page 35.

DASH DRILLING TEMPLATE

For 6 & 8 Bolt Air Shift for New Williams Valve



For Use with installation Sketches on Pages 32, 33 and 34.

Chelsea
DANA
DANA CORPORATION
DRIVETRAIN SERVICE DIVISION
P.O. BOX 3217TOLEDO, OH 43691

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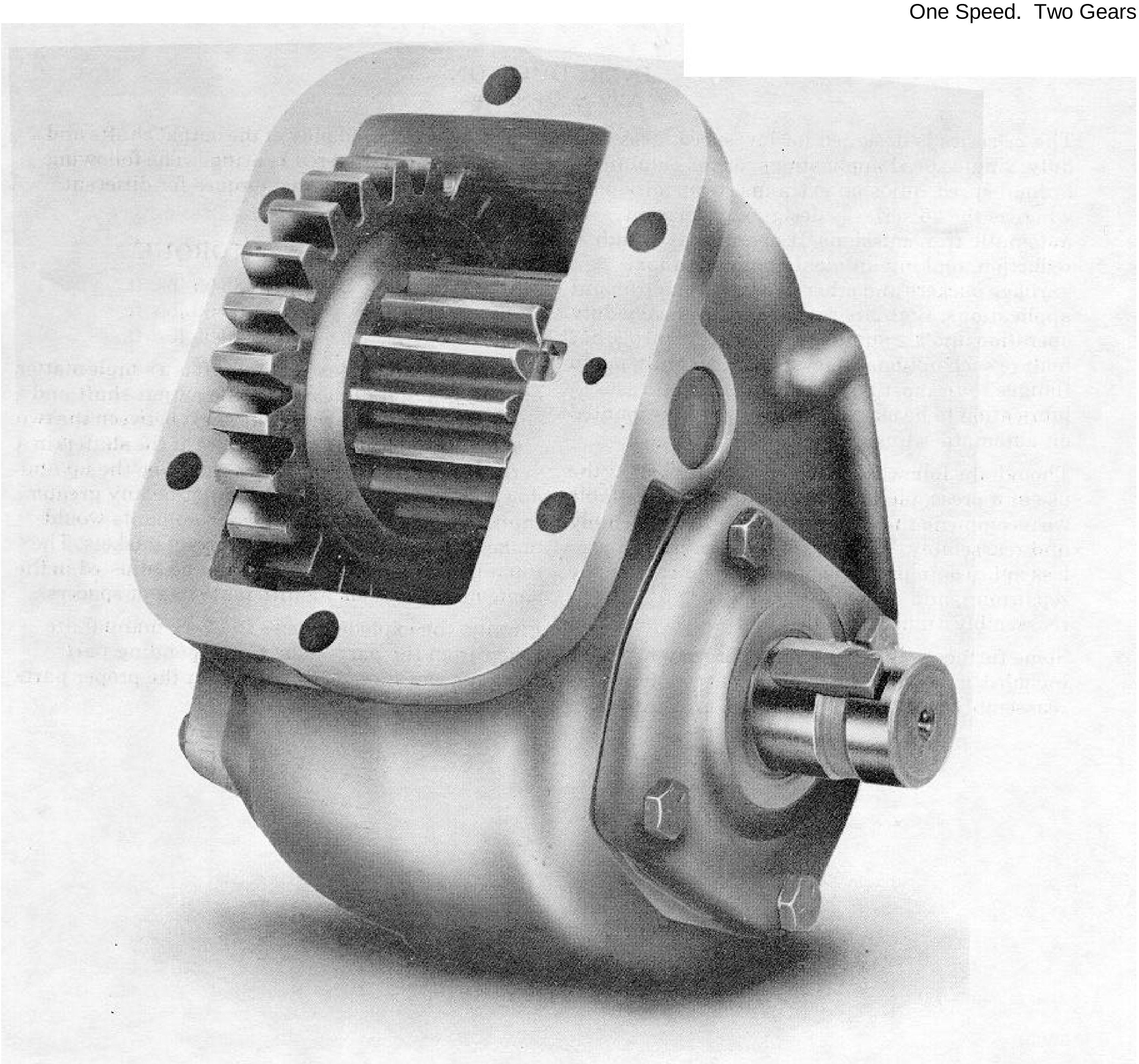
P40DS
P4304-DSD
Date: **July, 1979**

Chelsea

A22 & 26 Series P.T.O.
Service Manual

Side Mounted, S.A.E. Six Hole
One Speed. Two Gears



INTRODUCTION
A22 & 26 Series

The 22 series is designed for low-speed, heavy duty, single-speed applications, or for obtaining normal speed ratios on extra-fast transmissions, whereas the 26 series is designed for use on automatic transmissions. It operates at a high reduction, making an ideal application for garbage packers and other hydraulic pump mount applications. Both are rated for extra-heavy-duty operation and are standard with wire controls, but feature such options as lever shift, air shift, pump flanges to fit most popular pumps and pressure lubrication to be used when the P.T.O. is mounted on automatic transmissions.

Though the following instructions do not show the use of a press, please note that if one is available we recommend that it be used for both disassembly and reassembly. With the use of a press you are less apt to damage parts, it saves wear on you, the repairman, and makes disassembly and reassembly a much smoother and easier operation.

Some further points which may or may not be included, and which could also be necessary in the reassembly portion of the manual, are the torques for bolts and the end play of the output shafts and input gears with tapered bearings. The following chart shows the necessary torques for different sizes of bolts:

SIZE	TORQUE
1/2"	85-95 lbs. ft.
7/16"	55-60 lbs. ft.
3/8"	30-35 lbs. ft.

Adjusting the end play of the shaft is a simple matter of setting a dial indicator on the output shaft and checking the movement of the shaft between the two sets of tapered bearings. Therefore, if the shaft is in a vertical position, the end play would be the up and down movement, which should not be any greater than .006". Any greater or lesser amounts would make it necessary to add or subtract gaskets. The input gear (42, S380, 430, etc.) can be adjusted in the same manner by using different sizes of spacers.

Finally, the exploded views in every manual are taken from the parts lists. Corresponding part numbers can therefore be found in the proper parts list.

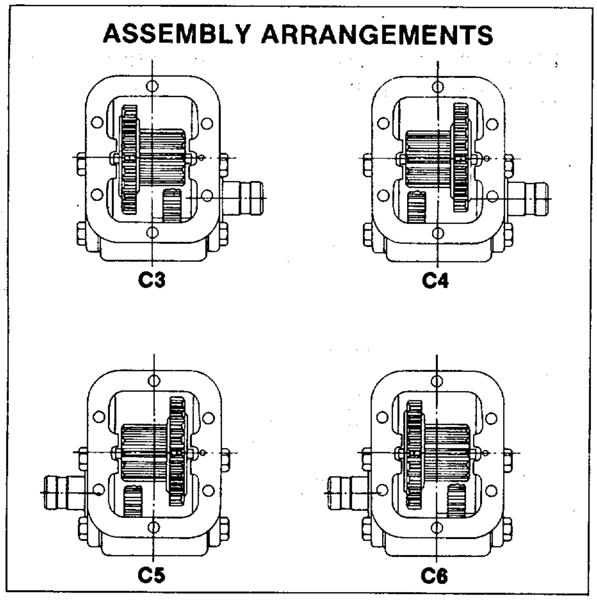


Figure 2

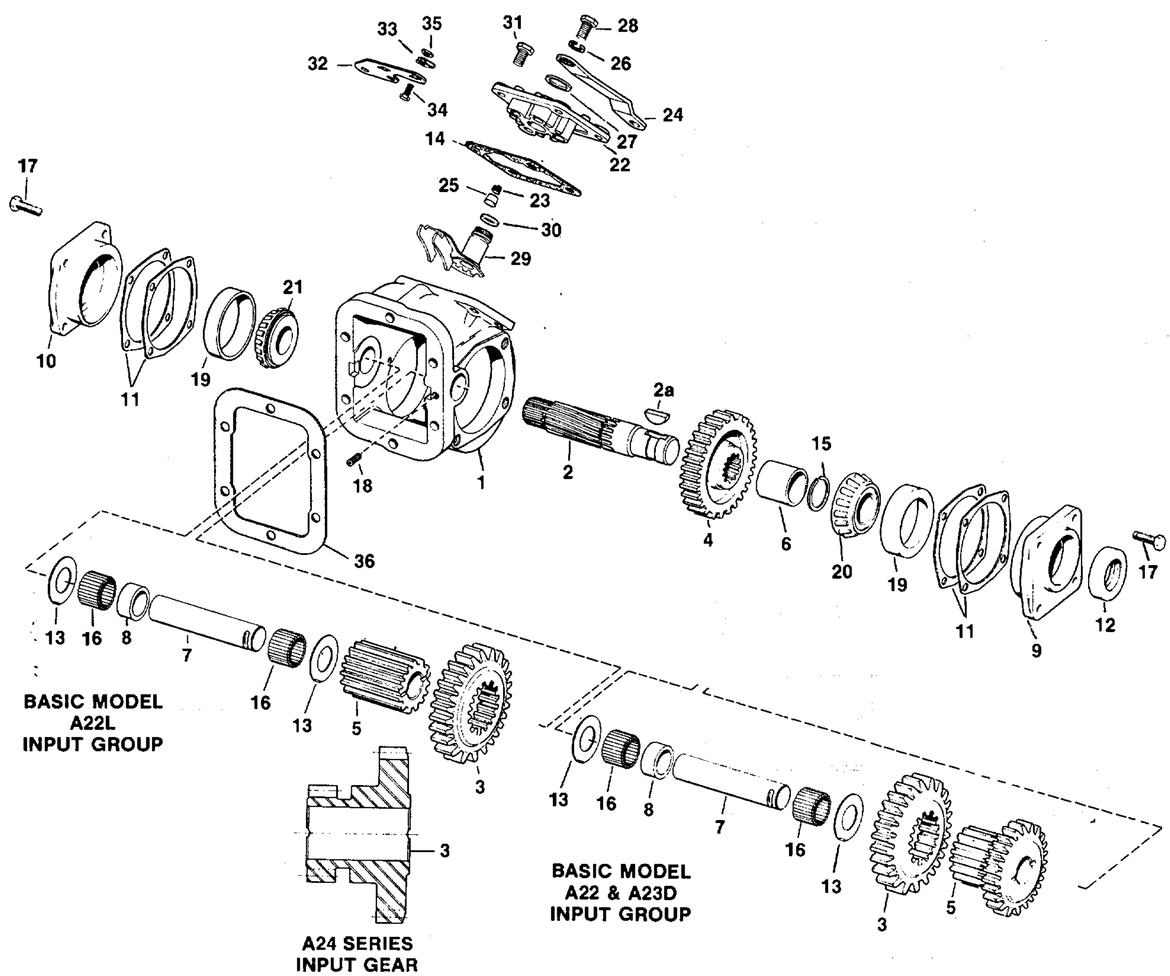


Figure 1

DISASSEMBLY - A22 - 26 Series

1. Using chisel and hammer, remove key from shaft (Fig. 1 #2a). Photo 1

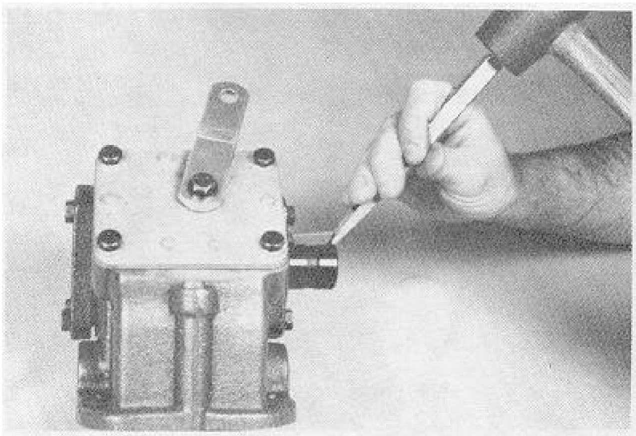


Photo 1

2. Remove four capscrews (Fig. 1 #31) from shifter cover (Fig. 1 #22) using 1/2" wrench and remove shifter cover from P.T.O. Discard gaskets. Photos 2 & 3

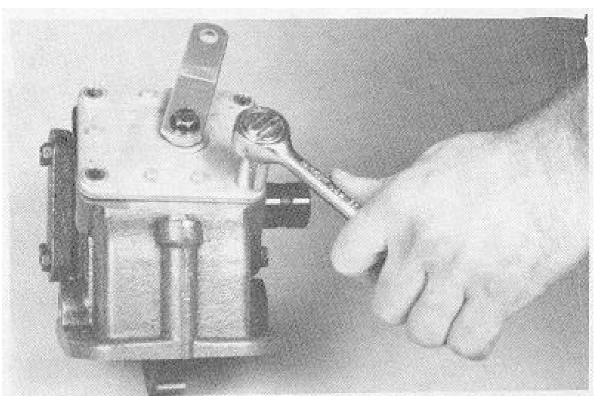


Photo 2

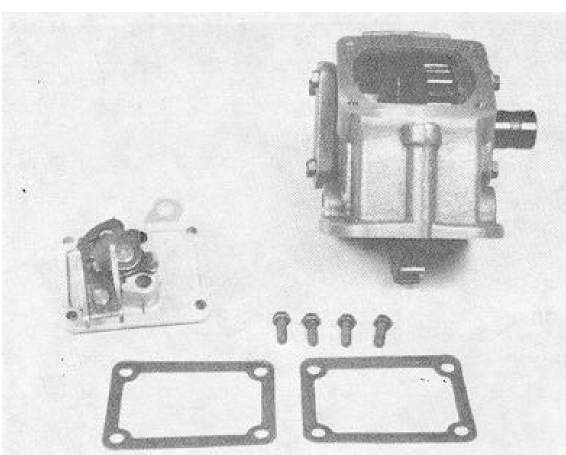


Photo 3

3. With 1/8" allen wrench, remove allen screw (Fig. 1 #18) from base of housing. Photo 4

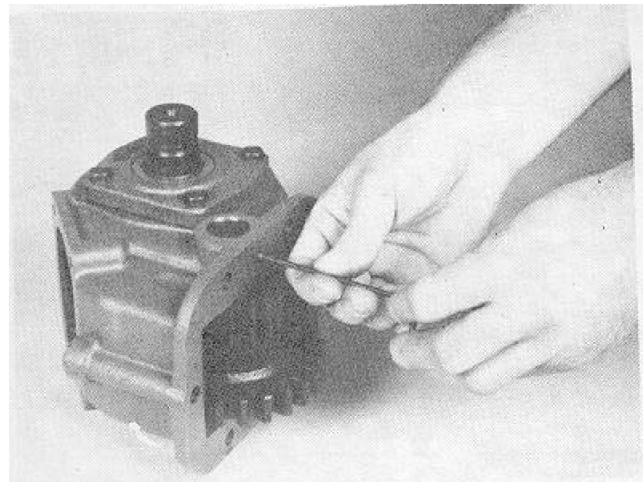


Photo 4

4. Using a suitable piece of bar stock or a punch, drive idler pin shaft (Fig. 1 #7) through housing using a soft hammer or press. Photos 5 & 6

NOTE: If P.T.O. has pressure lube pin, plug will have to be removed.

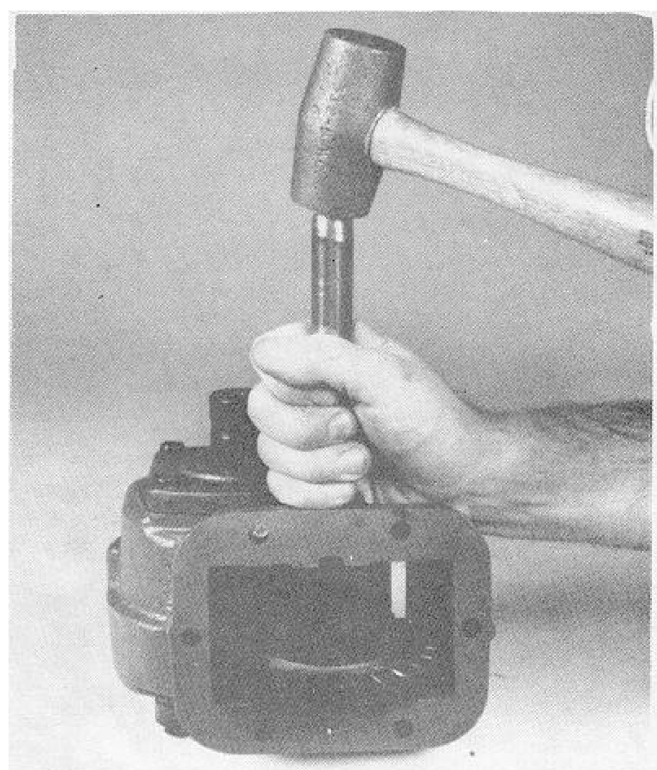


Photo 5

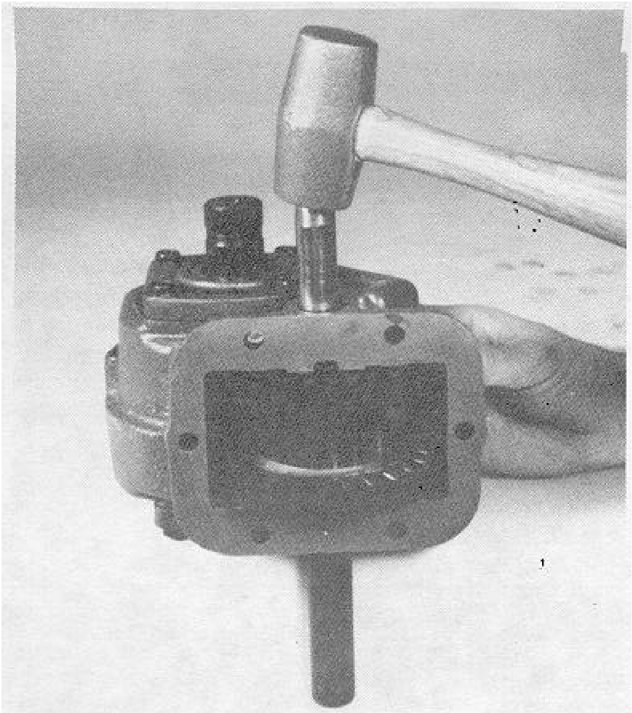


Photo 6

5. Remove gears (Fig. 1 #3 & 5), and washers (Fig. 1 #13) from housing. The bearings (Fig. 1 #16) and spacer (Fig. 1 #8) can also be removed from the input idler gear so they can be cleaned, inspected and repacked with new bearing grease. Photo 7

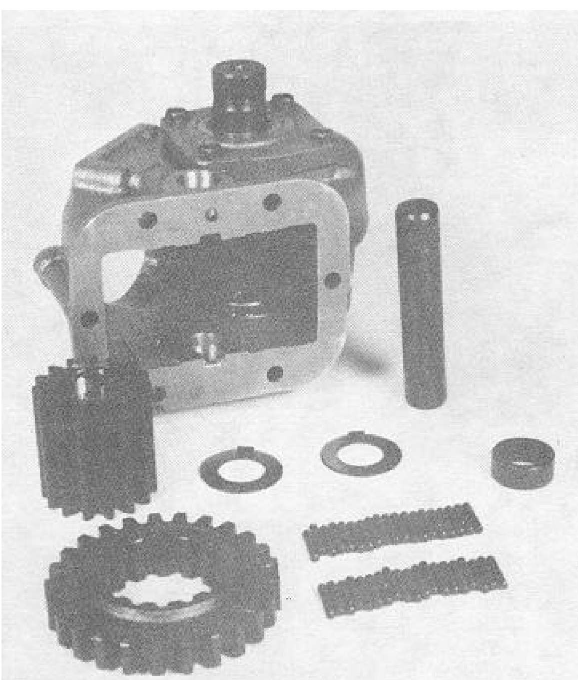


Photo 7

6. Set P.T.O. on its side (output shaft up) and unbolt four capscrews (Fig. 1 #17) and remove open bearing cap (Fig. 1 #9). Discard gaskets. Photos 8 & 9

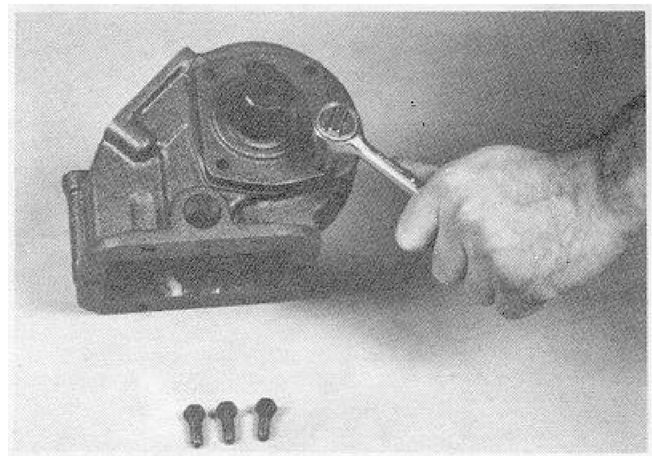


Photo 8

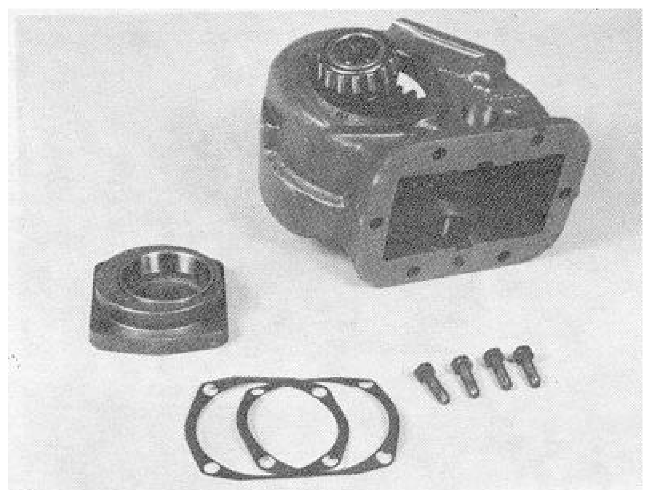


Photo 9

7. Turn P.T.O. over and proceed as in step #6, removing closed bearing cap (Fig. 1 #10). Photos 10 & 11

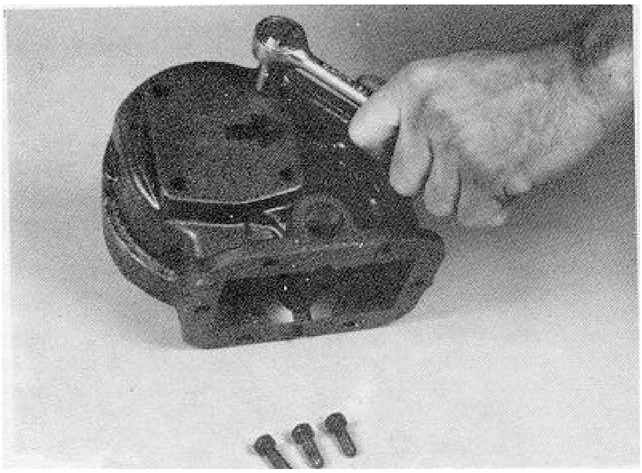


Photo 10

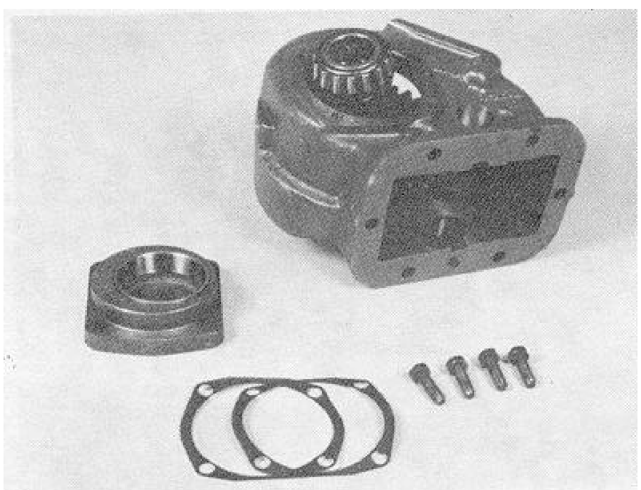


Photo 11

8. Using bearing pullers, remove tapered bearing (Fig. 1 #21) from input end of shaft. (For C4 and C6 assemblies shaft can be removed; C3 or C5 follow step #9.) Photos 12 & 13

NOTE: It is not necessary to remove the bearing (Fig. 1 #20) on the output end of the shaft unless it has been damaged or is worn excessively. If it has to be removed, this can be done using the bearing pullers after the shaft has been removed from the housing.

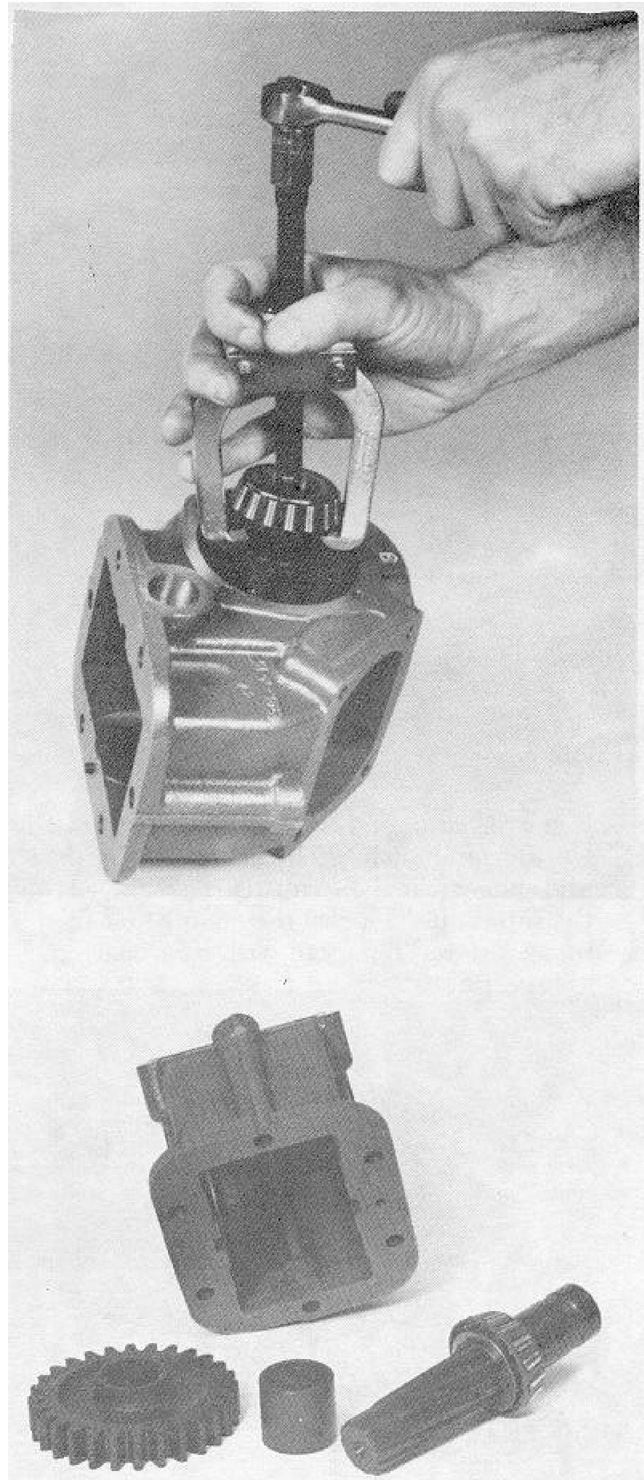


Photo 13

9. Remove snap ring (Fig. 1 #15) on C3 and C5 assemblies only, using a chisel and hammer. Photo 14

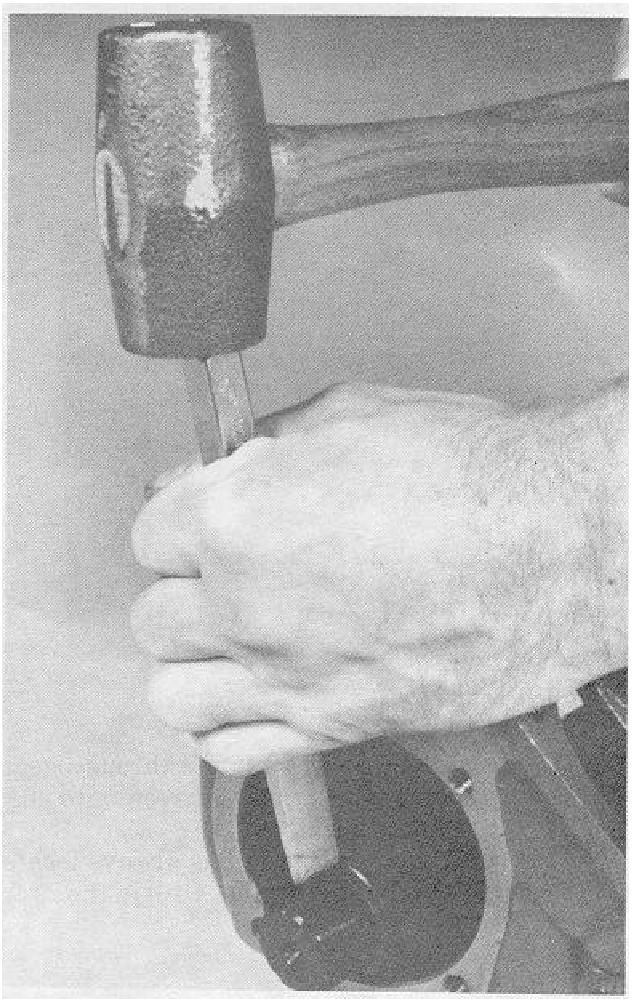


Photo 14

10. After removing the shaft (Fig. 1 #2), the gear (Fig. 1 #4) and spacer (Fig. 1 #6) will simply fall out of the housing. Photo 15

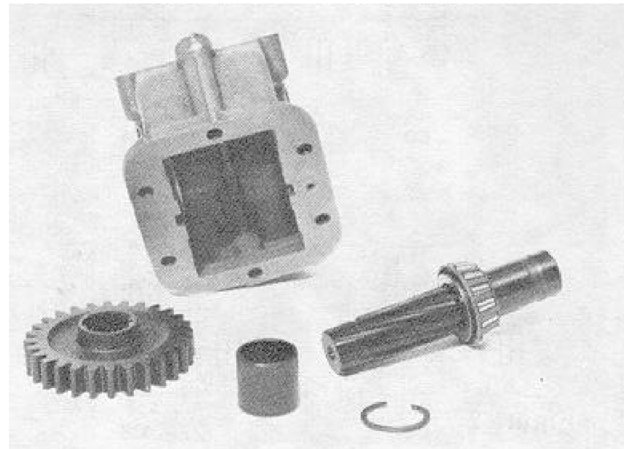


Photo 15

11. Inspect all parts for excessive wear or other damage. All gaskets and seals should be discarded and all milled surfaces on the housing should be cleaned of any excess gasket material.

ASSEMBLY ARRANGEMENTS

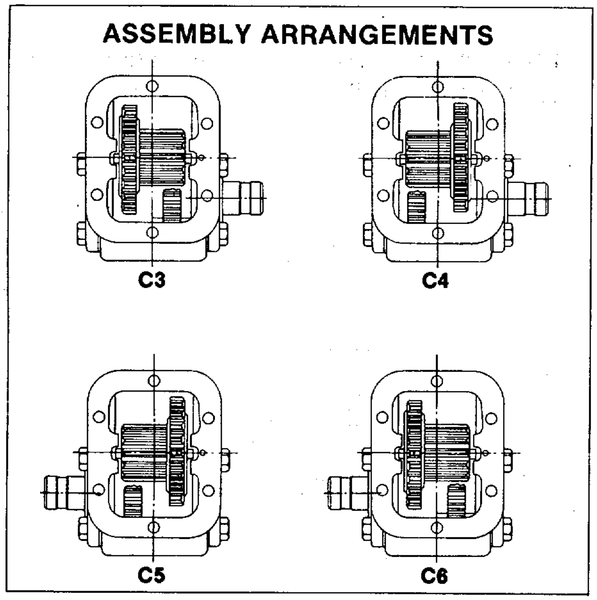


Figure 2

Assembly Arrangements

1. Output Shaft Assembly
   A. Select proper assembly arrangement (Fig. 2) and place output gear (Fig. 1 #4) in housing Photo 1

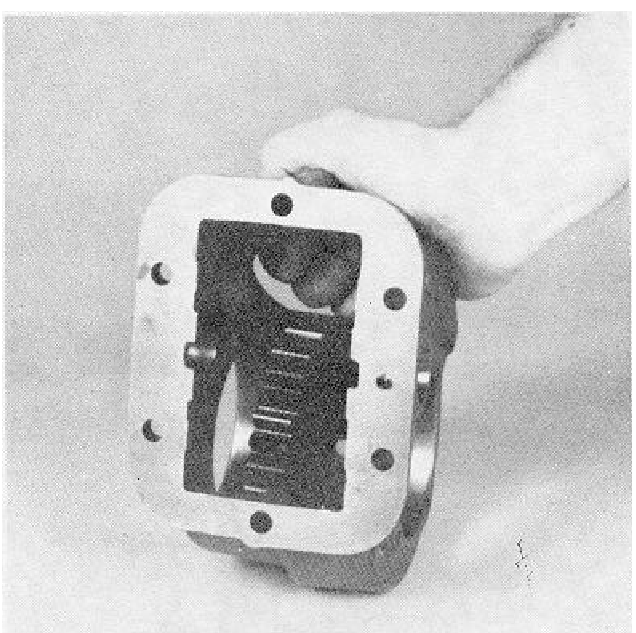


Photo 1

   B. Determine snap ring placement 1. C4 & C6 snap ring is on shaft before putting through gear. Photo 2

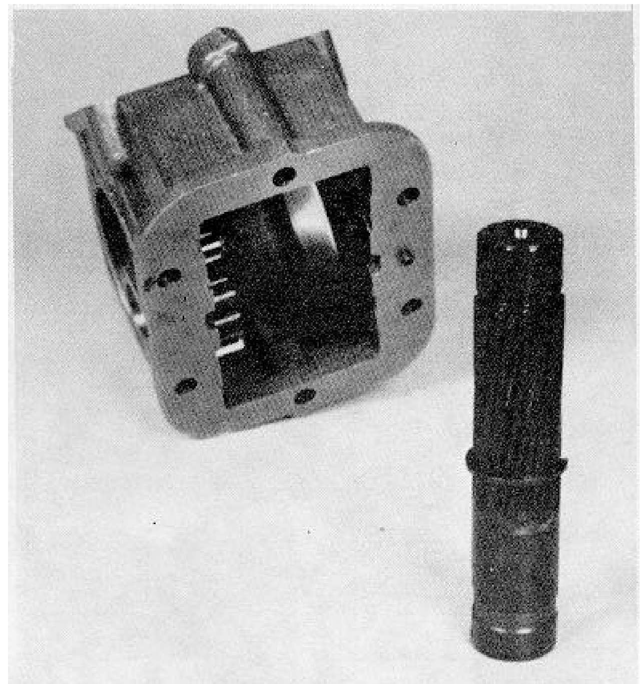


Photo 2

2. C3 & C5 shaft is put through gear before snap ring is driven onto shaft. Photos 3 & 4

NOTE: Snap ring (Fig. 1 #15) is always located next to the spacer (Fig. 1 #6) in the 22 & 26 series.

Photo 3

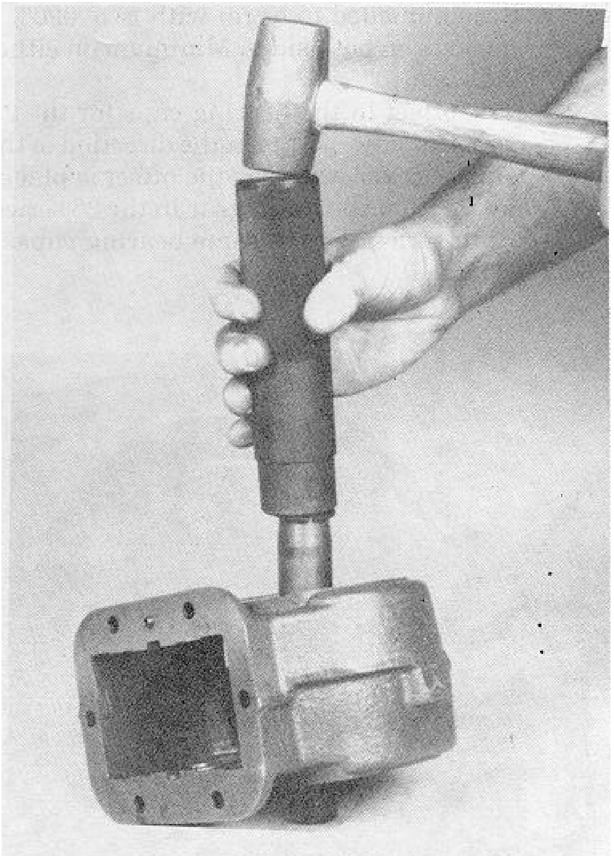


Photo 4

C. Start small bearing (Fig. 1 #21) on shaft. Then turn unit over and start large bearing (Fig. 1 #20). Press or drive into place with a soft hammer or a hydraulic or arbor press. Photos 5, 6 & 7

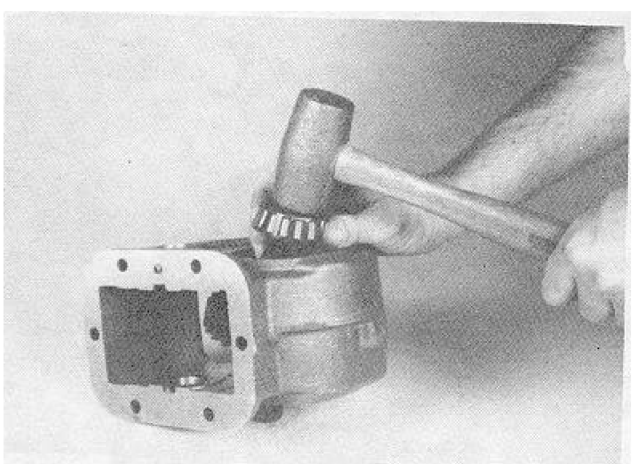


Photo 5

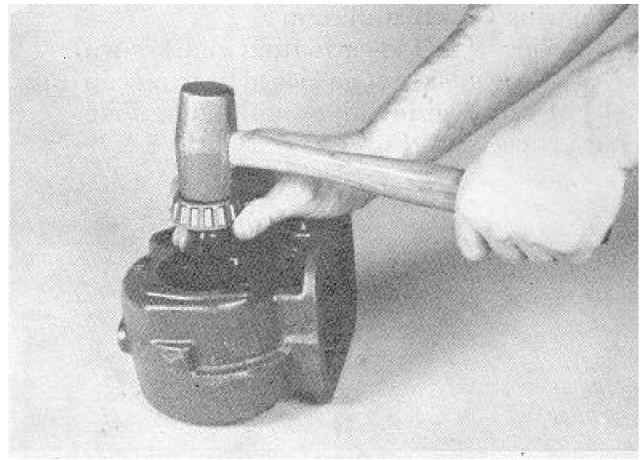


Photo 6

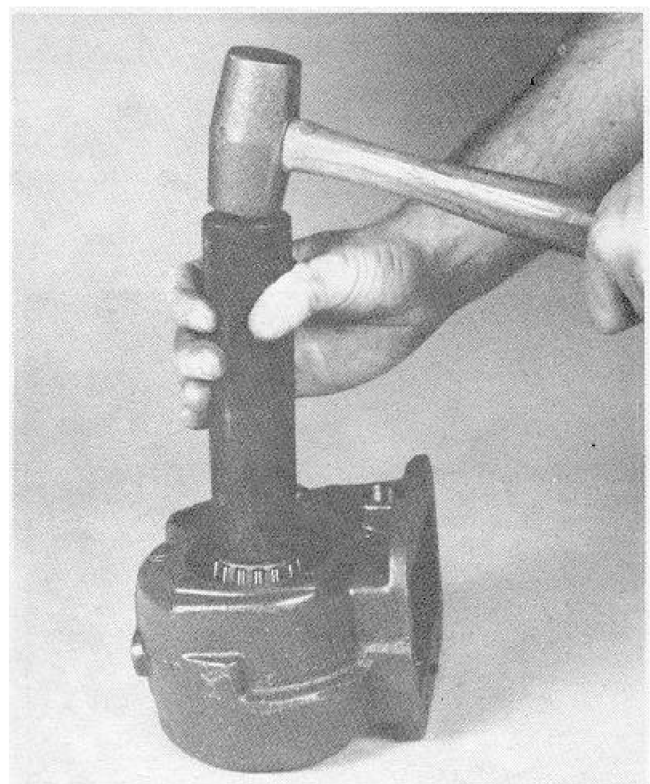
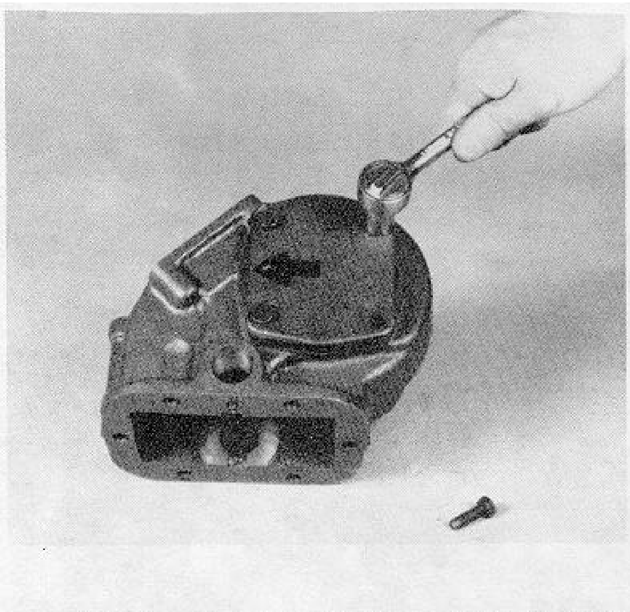


Photo 7

2. Bearing Cap Installation

   A. Turn P.T.O. over (output shaft down). Place gasket(s) on closed bearing cap (Fig. 1 #10) and install on unit using four capscrews (Fig. 1 #17). Photos 8 & 9



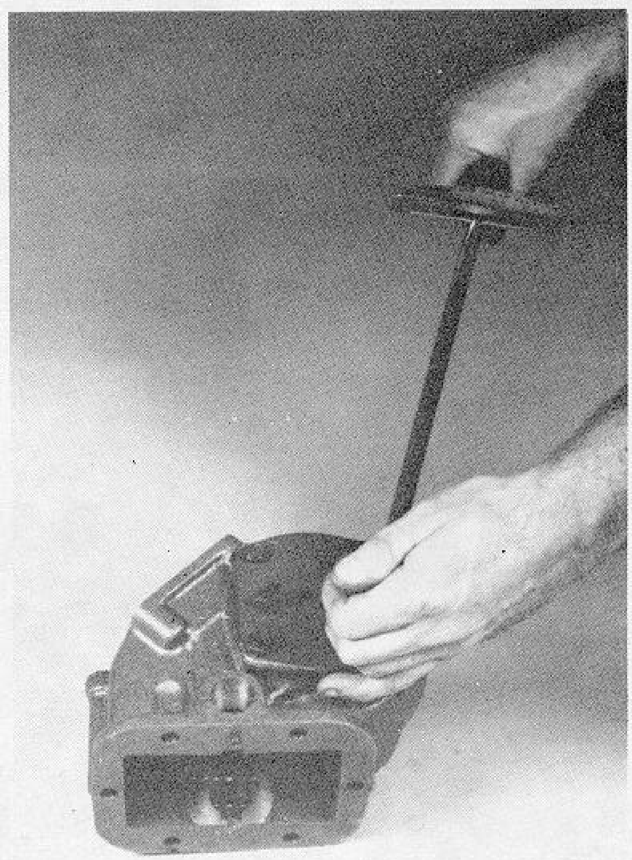


Photo 9

NOTE: Recommended to begin with two .020" gaskets on both sides. Minimum on either side is .010". The offset in the bearing caps for the 22 series always points in the direction of the shifter cover, whereas the offset is placed away from the input gear in the 26 series. Both series use the same bearing caps. Photo 10

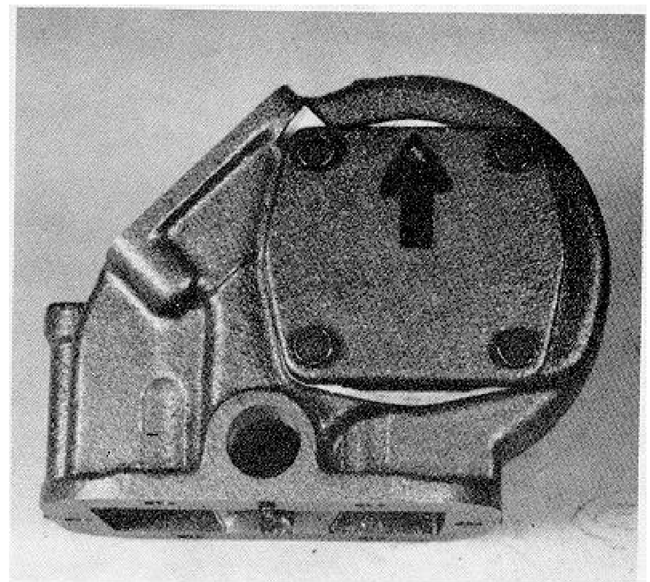


Photo 10

B. Turn unit over and install open bearing cap (Fig. 1 #9) using previous procedure. (Step A) Shaft should turn freely with a minimum of end play (less than .006). Photos 11 & 12

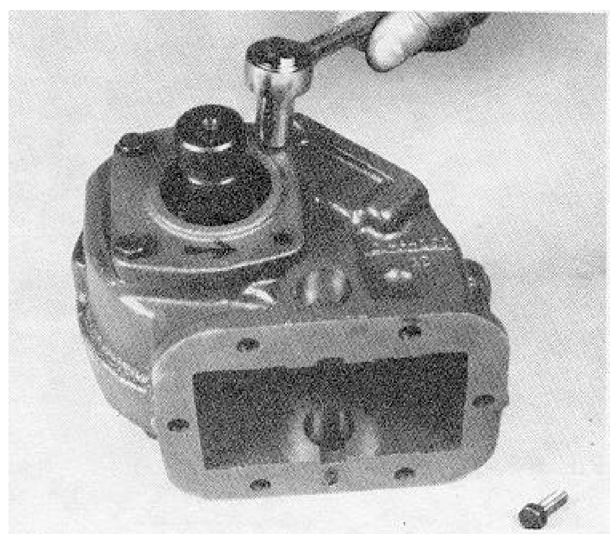


Photo 11

Photo 12

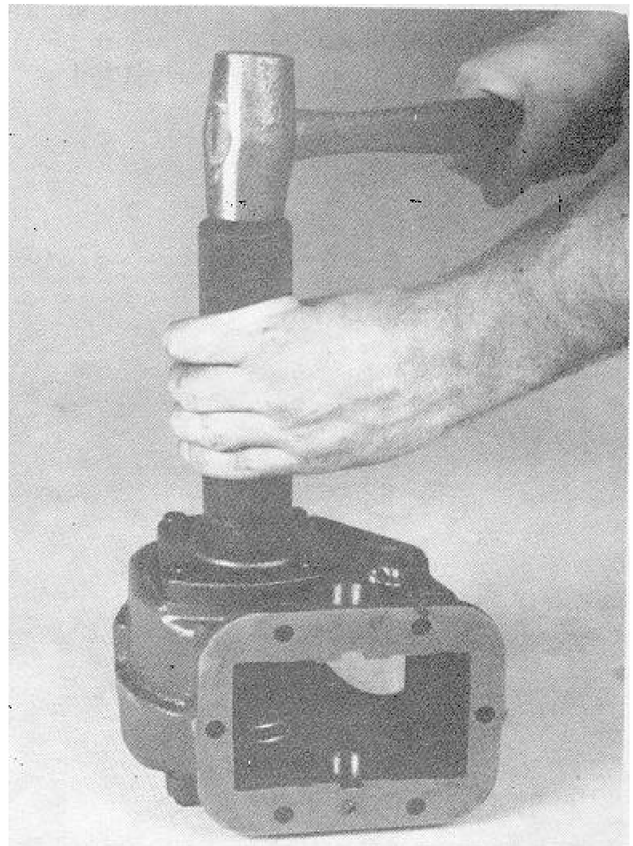


Photo 14

C. Make sure bearings are seated by first tapping the shaft; then place the driver over the shaft and strike it with the hammer. Photos 13 & 14

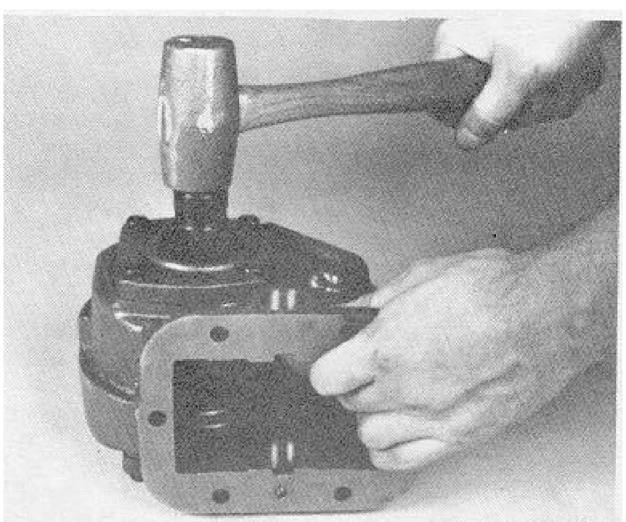


Photo 13

D. Check end play of shaft with indicator. Shaft should turn freely with a minimum amount of end play (.006 or less). Photo 15

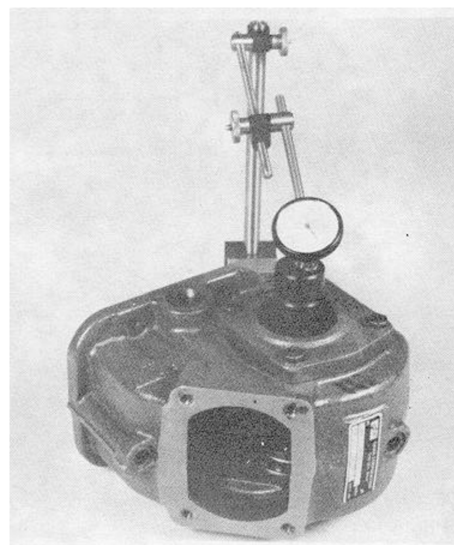


Photo 15

E. Install oil seal (Fig. 1 #12) using slide and driver. Seal should be flush with bearing cap when installed properly. Photos 16 & 17

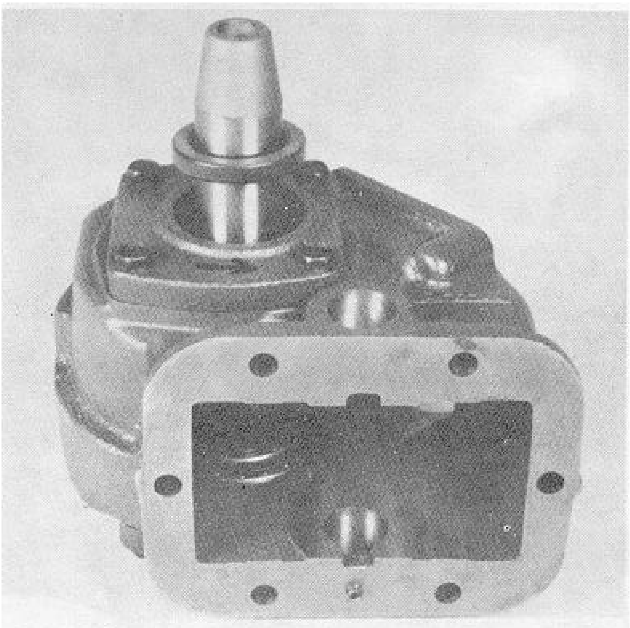


Photo 16

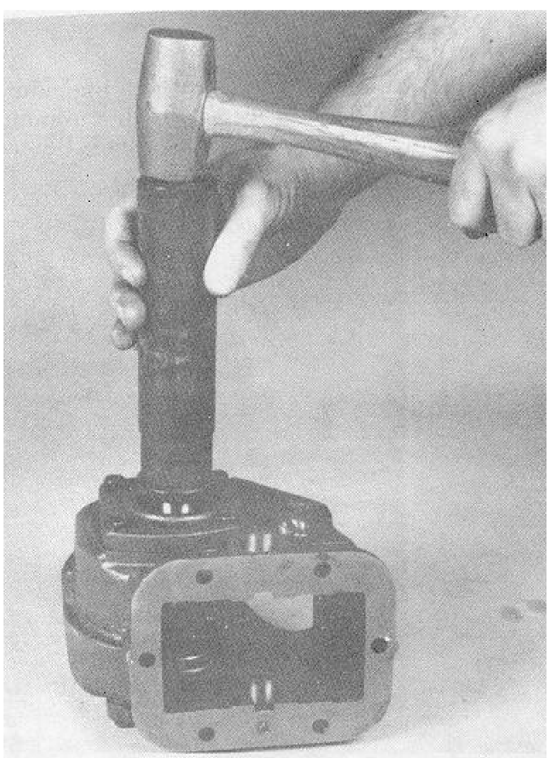


Photo 17

3. Input Gear Assembly And Installation

   A. Fit two gears (Fig. 1 #3 & 5) together. Sliding gear (Fig. 1 #3) should move freely on mating gear (Fig. 1 #5). Photo 18

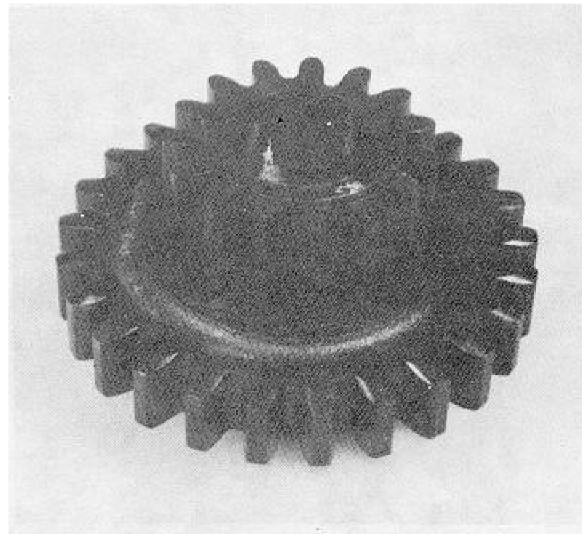


Photo 18

   B. Load gear (Fig. 1 #5) in the following manner:
      1. Place small amount of bearing grease in I.D. Photo 19

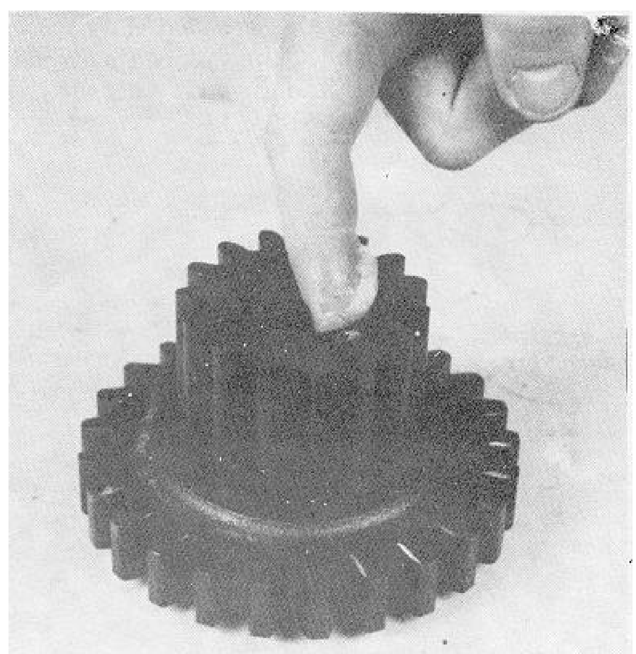


Photo 19

2. Put load pin in gear. Photo 20

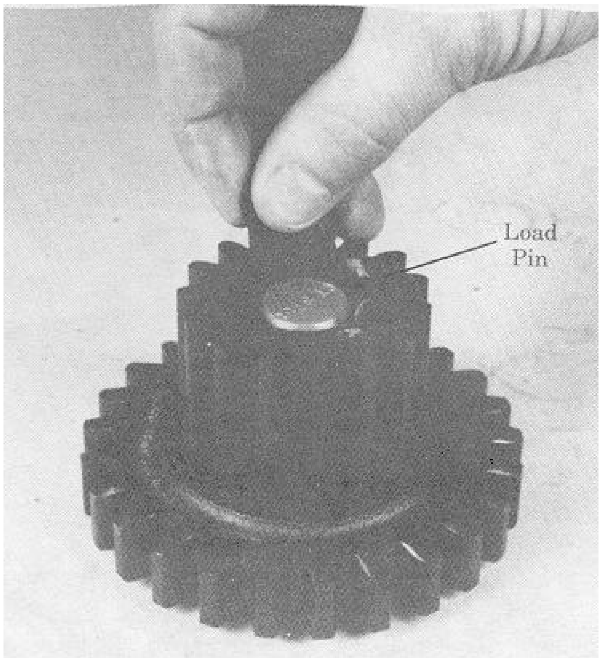


Photo 20

3. Load first row of 19 bearings (Fig. 1 #16) around load pin. Photo 21

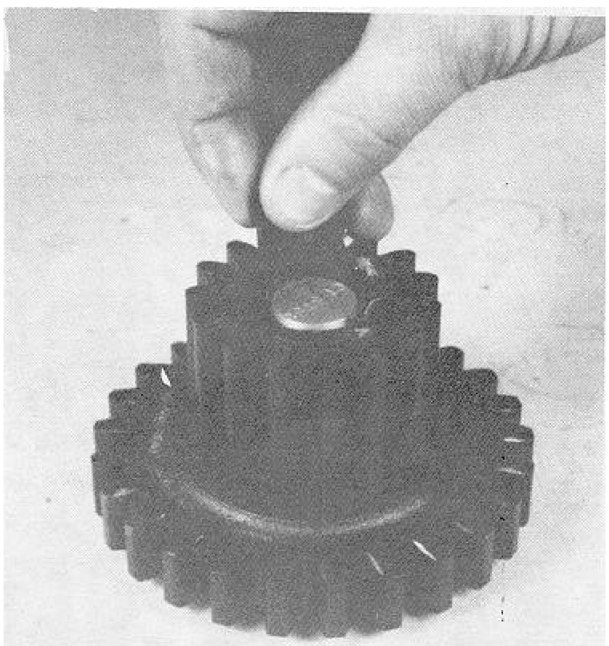


Photo 21

4. Place spacer (Fig. 1 #8) in gear. Photo 22

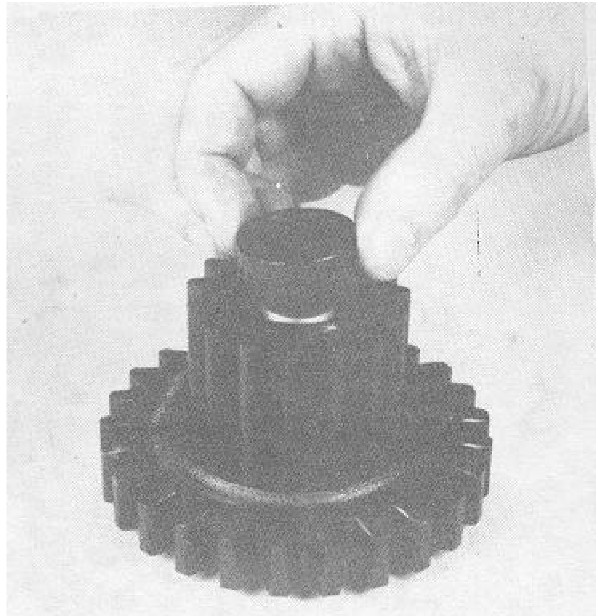


Photo 22

5. Load second row of 19 bearings (Fig. 1 #16) around load pin. Photo 23

NOTE: 26 series uses caged roller bearings, thus, it, doesn't need a load pin or grease.

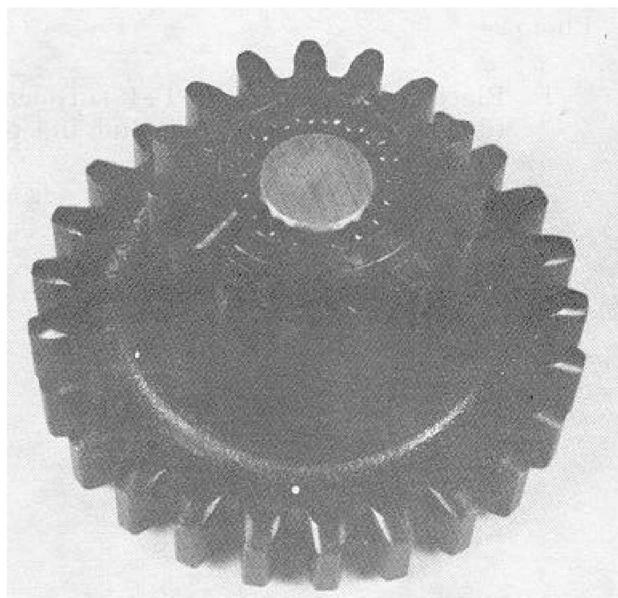


Photo 23

C. Start idler pin (Fig. 1 #7) into housing from set screw side and drive until pin breaks through inside wall. Photo 24

NOTE: Idler pin groove has to line up with set screw hole.

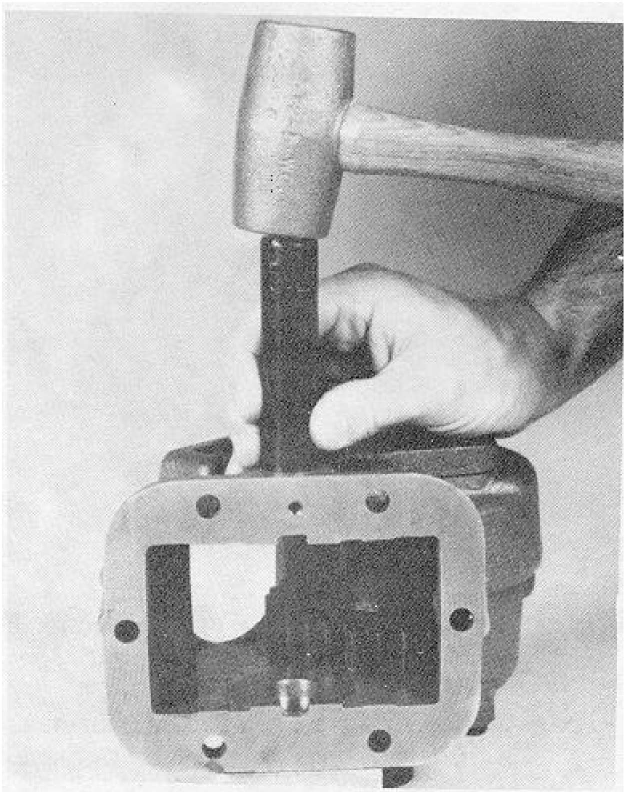


Photo 24

D. Place thrust washer (Fig. 1 #13) in housing (line up with idler pin hole - tab in slot). Photo 25

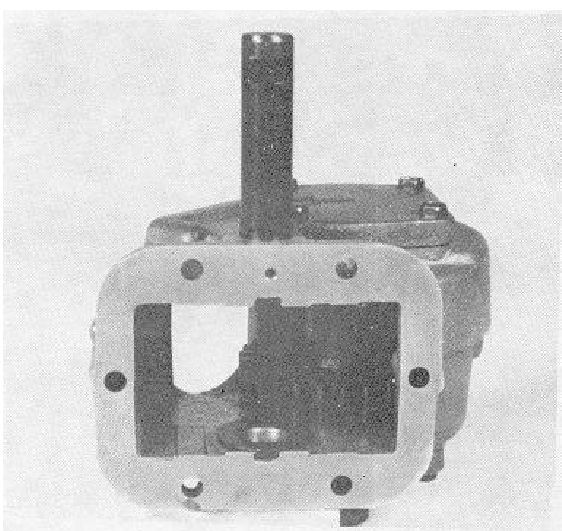


Photo 25

E. Place loaded gear (load pin still in place) in housing. Load pin should fall through idler pin hole if lined up properly. Photos 26 & 27

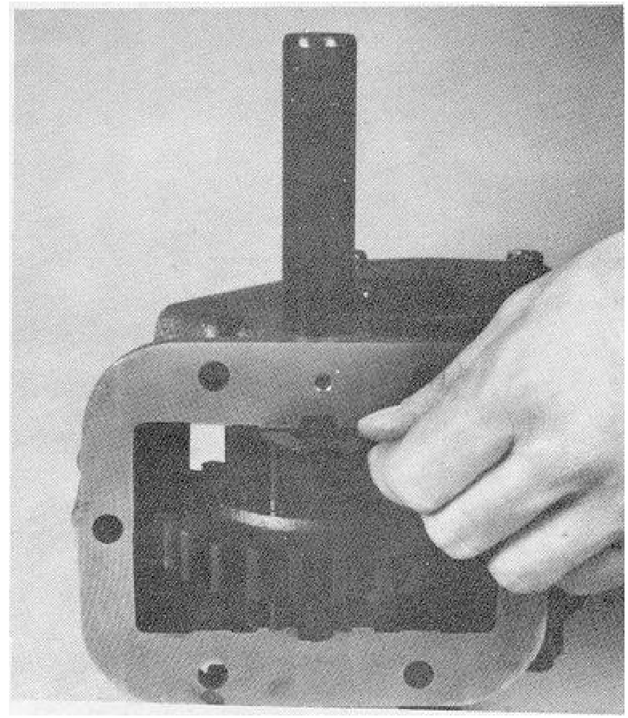


Photo 26

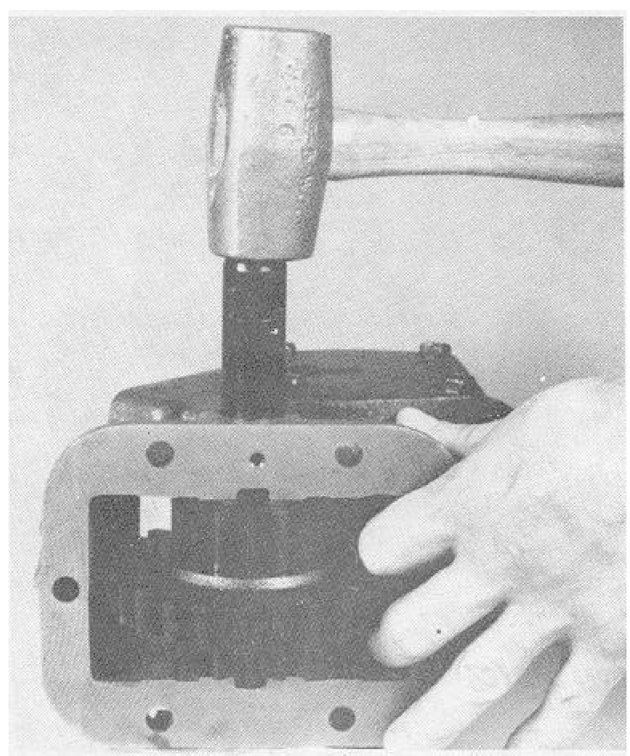


Photo 27

F. Insert thrust washer (Fig. 1 #13) and drive idler pin through so it goes into gear. Press idler pin through until it is flush with the housing. Photos 28 & 29

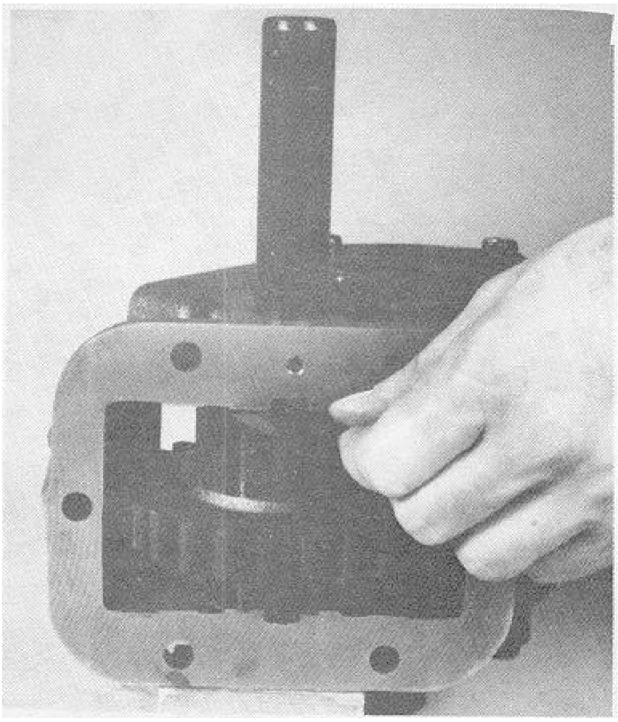


Photo 28

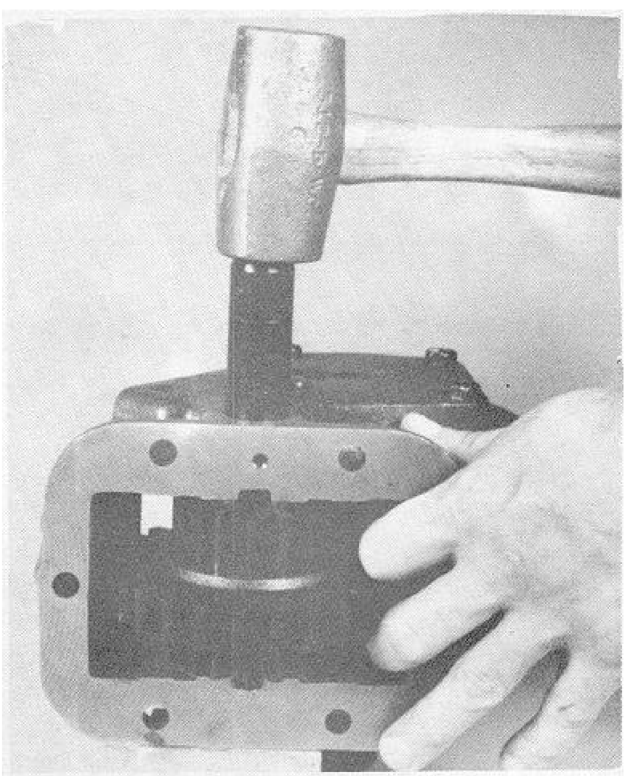


Photo 29

G. Insert proper set screw (Fig. 1 #18) in base of housing. Photo 30

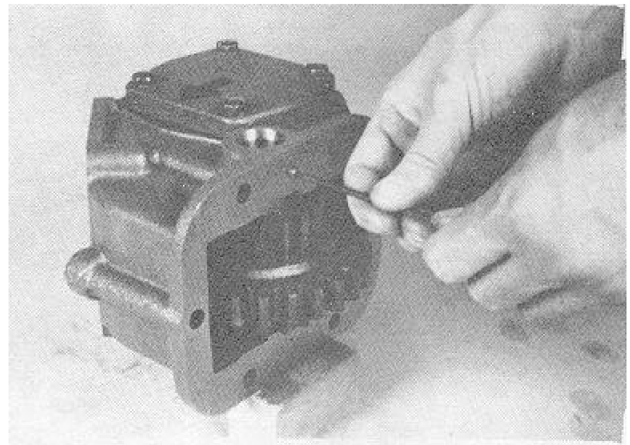


Photo 30

4. Installation Of Shifter Cover
   A. Place gasket (Fig. 1 #14) on cover (Fig. 1 #22) and put on P.T.O. Photo 3]

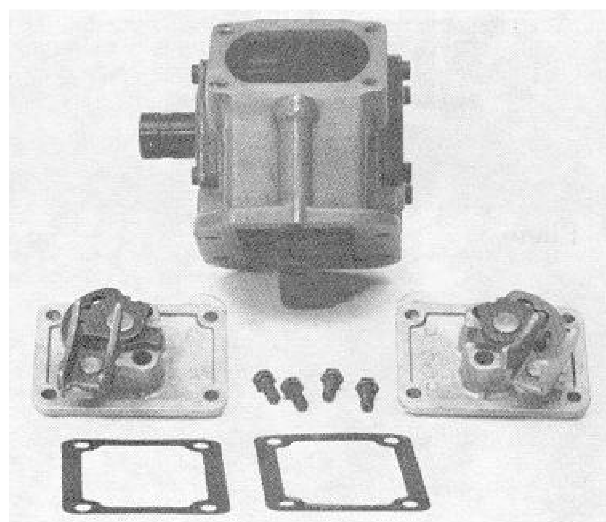


Photo 31

B. Using four capscrews (Fig. 1 #31) boltcover to P.T.O. Photo 32

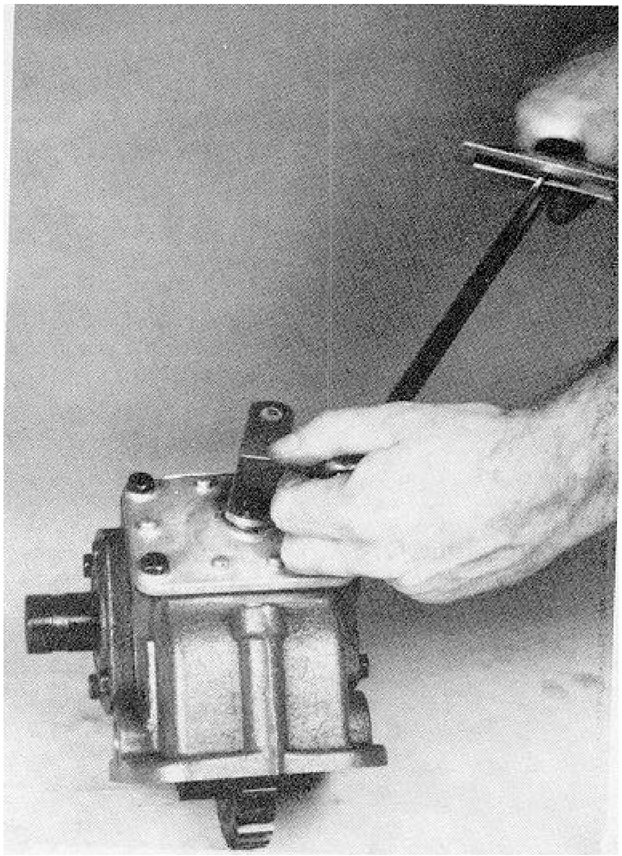


Photo 32

5. P.T.O. should now be checked to see that it shifts properly and rolls freely.

P.T.O. Change-Over Tool Kit - T-7000 See Photo 34

Item	Description	Part No.
1	Seal Slide	T-7626
2	Snap Ring Slide	T-7627
3	Hammer 2#	--
4	Bearing Driver	T-7627-2
5	Bearing Puller Includes Jaws T-7625 & Proto 4060A)	T-7624-1
6	Bearing Loading Pin 41 Series	T-7625
7	Bearing Loading Pin 22 Series	CT-8788

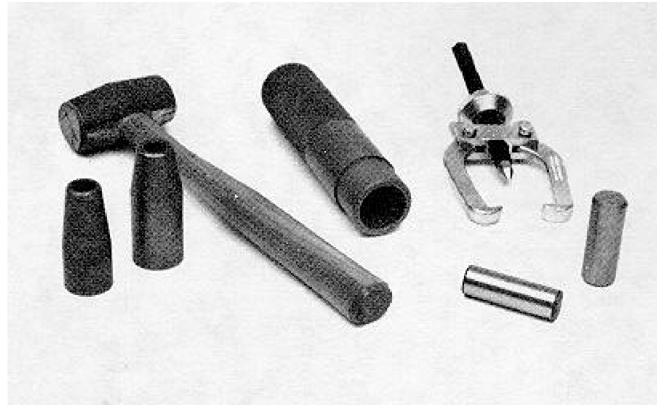


Photo 34

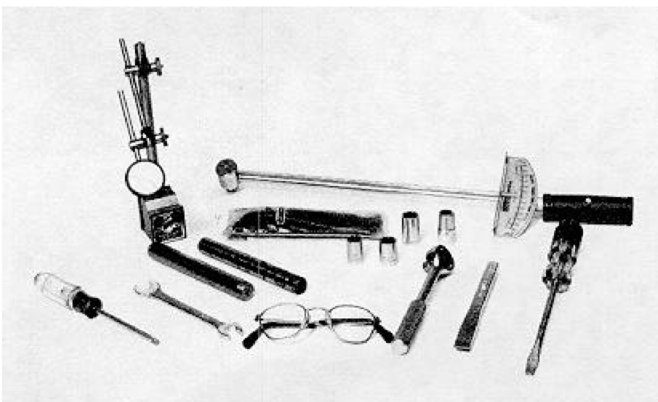
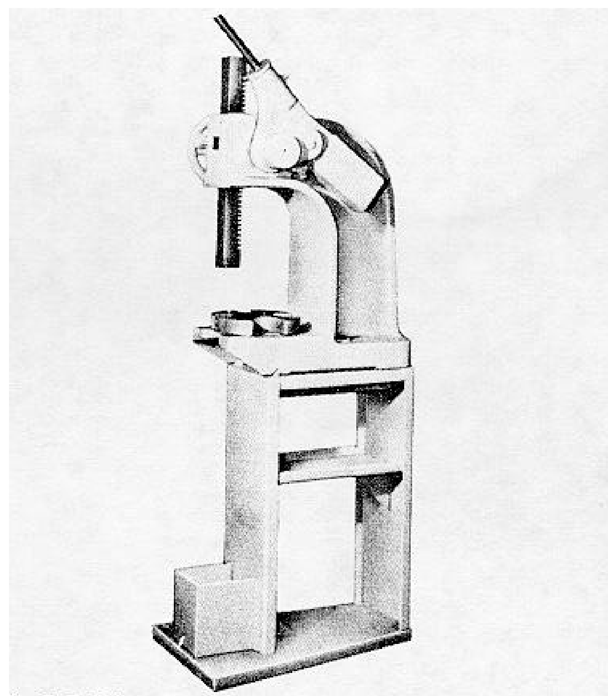


Photo 33

Required Tools For Servicing P.T.O.'s
See Photo 33

1. P.T.O. changeover tool kit
2. Soft steel drift - 5" long x 3/4" diameter
3. Hydraulic or arbor press
4. Socket set and torque wrench with 1/2" socket (open or boxed end wrench would also be helpful)
5. Allen wrench set
6. Cold chisel
7. Soft hammer (2 or 3 lb.) in tool kit
8. Dial indicator
9. Safety glasses

The No. 3A Press, shown mounted on a pedestal, is a larger machine for heavier classes of work up to 5 tons. The No. 3A press comes equipped with a hand-operated brake to hold the ram in position.



Model 3A

Chelsea®

DANA

Dana Corporation
Drivetrain Service Division
P.O. Box 321, Toledo, Ohio 43691

P.T.O.'S Chelsea®

P4304-DSD S.T. 25M

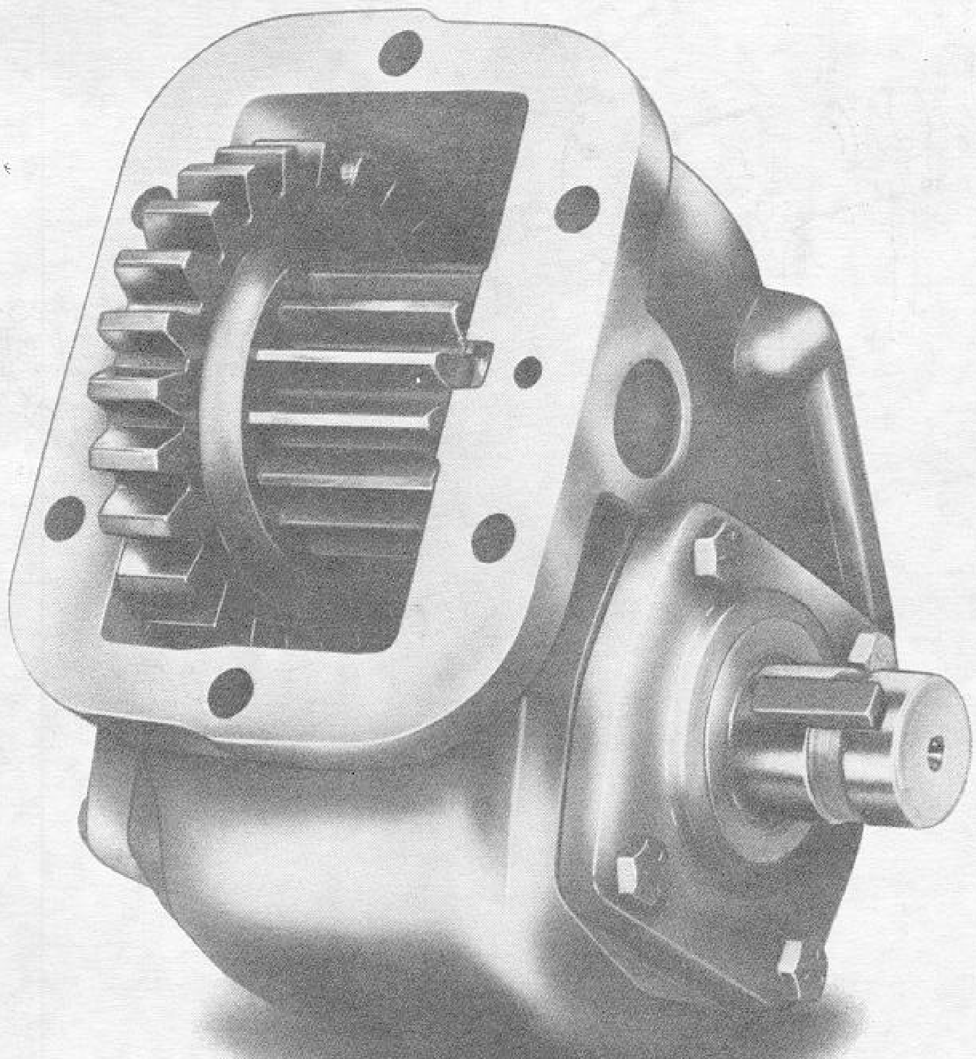
CHELSEA®

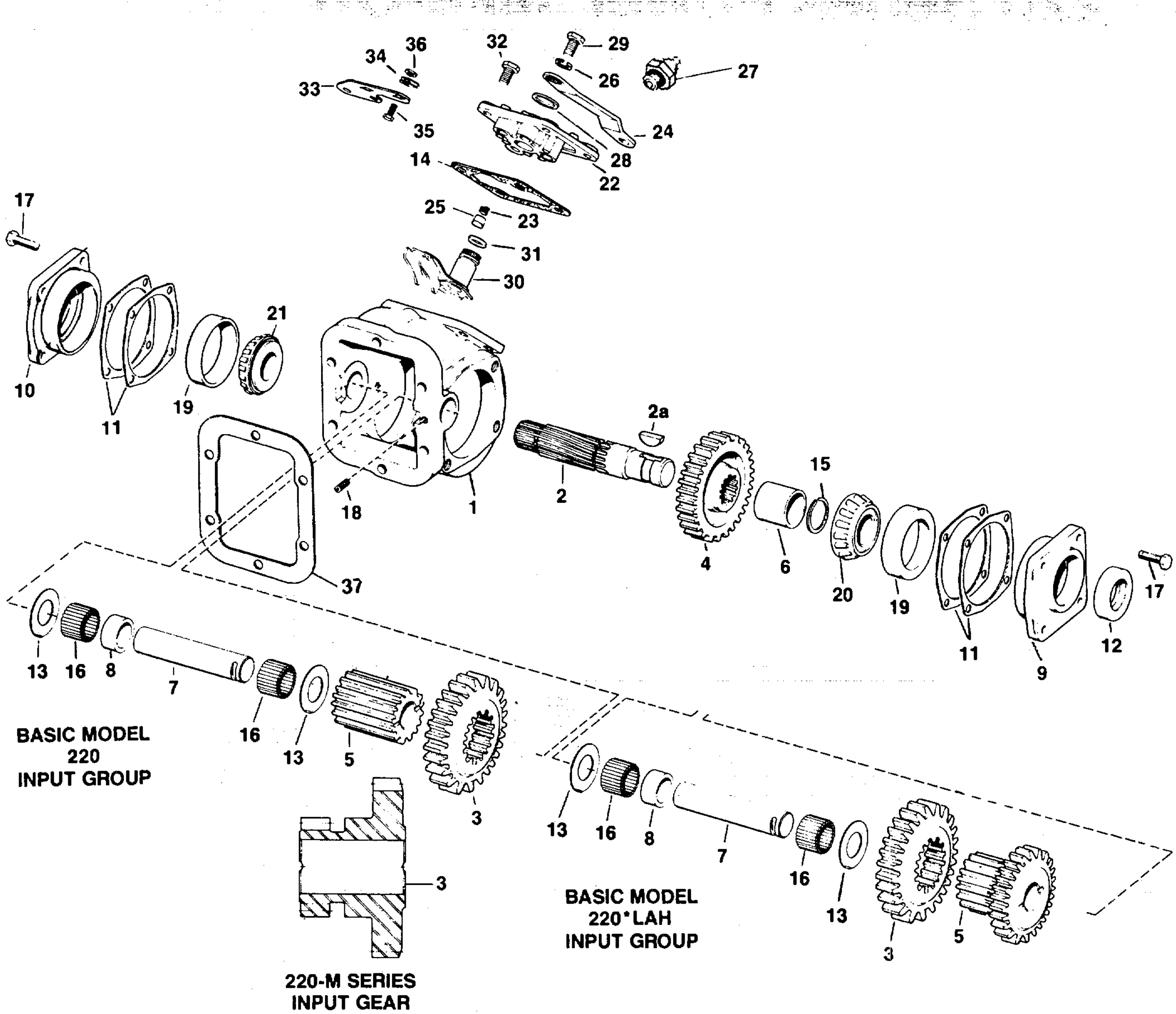
Section VIII
MISCELLANEOUS

WEATHERLY INDEX 086
P.T.O. Parts List
P410-220
March, 1984
220 Series
Supersedes P410-A22
Dated April, 1979

220 Series Power Take-Off

Side Mounted, S.A.E. Six Hole, One Speed-Two Gears

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BASIC MODEL
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INPUT GROUP
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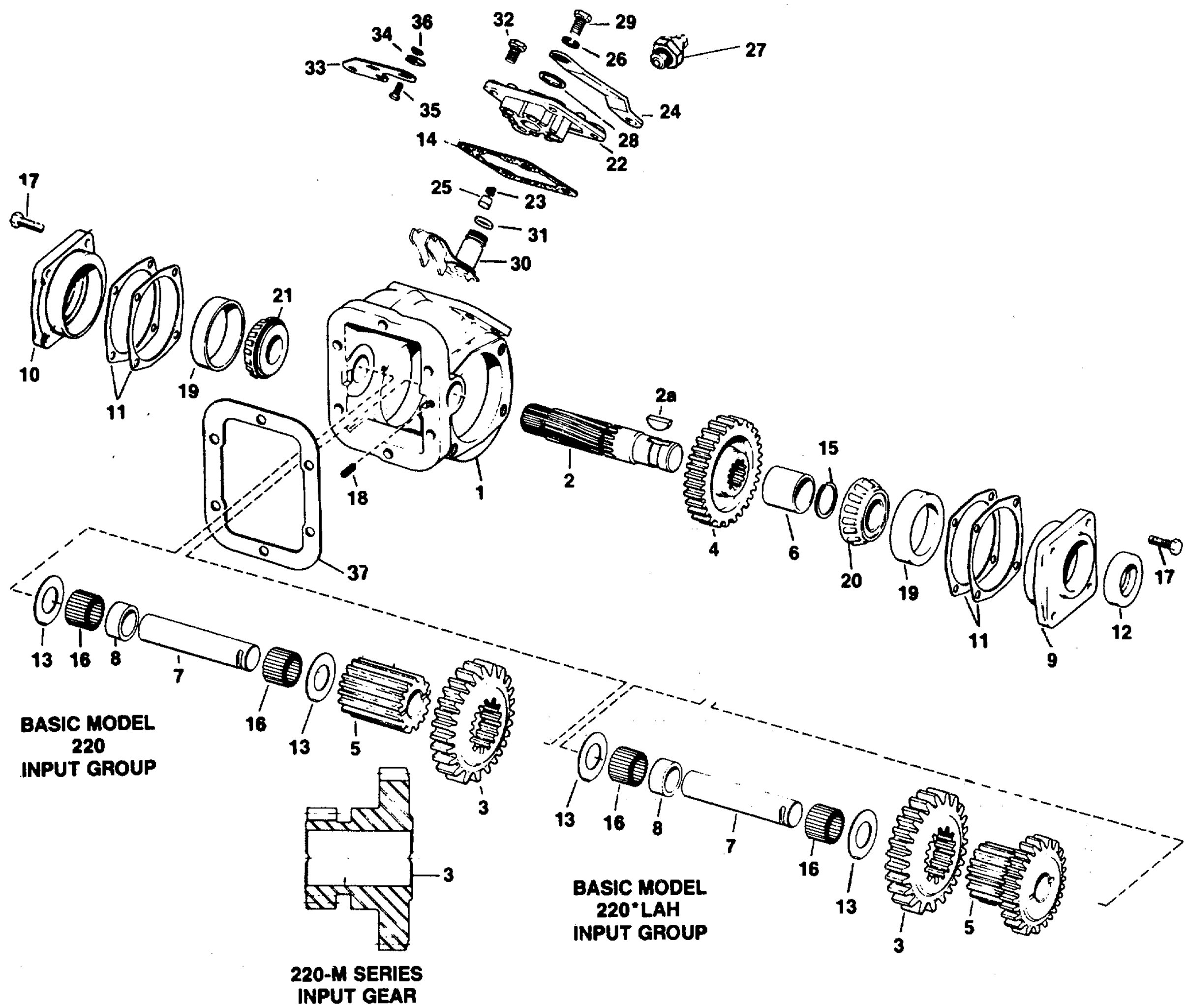
BASIC MODEL
220*LAH
INPUT GROUP
220-M SERIES
INPUT GEAR

Item	Part Number	Description	Quantity
1		P.T.O. HOUSING	1
	1-P-166	Standard Mount	
	1-P-167	Extra Deep Mount	
	1-P-168	Deep Mount	
	1-P-406	Special Low Profile Clearance Mount	
2		SHAFT, output	1
	3-P-202	1¼″ Rd. uses $\frac{5}{16}$″ Key 500007-29-item 2a	
3		GEAR, Input	1
4	See Chart Pg. 6	GEAR, Output	1
5		GEAR, Drive	1
6	4-P-45	DRIVESHAFT SPACER	1
7	9-P-39	IDLER SHAFT (No Pressure Lube)	1
8	14-P-36	NEEDLE BEARING SPACER	1
9	328273X	BEARING COVER, Open End (Includes 21-P-130 & 550221)	1
10	328274X	BEARING COVER, Closed End (Includes 21-P-131 & 550221)	1
11	22-P-24-1	BEARING COVER GASKET (.010″ thick)	A.R.
11	22-P-24-2	BEARING COVER GASKET (.020″ thick)	A.R.
11	22-P-24-3	BEARING COVER GASKET (.015″ thick)	A.R.
12	28-P-52	OIL SEAL	1
13	31-P-27	THRUST WASHER	2
14	35-P-8	SHIFTER COVER GASKET	1
15	378391	DRIVESHAFT LOCKRING	1
	328297-6X	NEEDLE ROLLER REPLACEMENT KIT (50 Rollers)	1
16	378545	NEEDLE ROLLER (2 sets 19 per set)	2 sets
17	378430-10	HEX CAPSCREW (Nylock $\frac{5}{16}$″-18 × 1″)	8
18		SET SCREW	1
	378452-3	Deep Mount	
	378452-5	Extra Deep Mount	
	378452-7	Standard Mount	
19	550221	BEARING CUP	2
20	550397	BEARING CONE, Open End	1
21	500532	BEARING CONE, Closed End	1
	328805-1X	SHIFTER ASS'Y., Wire Control (For arrangements 3 & 6) (Contains items 22 thru 31)	1
	328805-2X	SHIFTER ASS'Y., Wire Control (For arrangements 4 & 5) (Contains items 22 thru 31)	1
22	34-P-74	COVER	1
23	37-P-19	SHIFTER SPRING	1
24	51-P-22	SHIFTER LEVER	1
25	63-P-16	POPPET	1
26	378003	LOCKWASHER	1
27	378969	INDICATOR SWITCH	1
28	378004	FLAT WASHER	1
29	500409-6	HEX CAPSCREW ($\frac{5}{16}$″-24 × $\frac{5}{8}$″)	1
30	328803-1X	SHIFTER PLATE ASS'Y. (For Arrangements 3 & 6)	1
30	328803-2X	SHIFTER PLATE ASS'Y. (For Arrangements 4 & 5)	
31	28-P-49	"O" RING	1
32	378430-10	HEX CAPSCREW ($\frac{5}{16}$″-18 × 1″)	4
		A.R.—As required	


BASIC MODEL
220
INPUT GROUP
220-M SERIES
INPUT GEAR
BASIC MODEL
220*LAH
INPUT GROUP

Item	Part Number	Description	Quantity
	328156X	PRESSURE LUBRICATION KIT	1
N.S.	9-P-35	IDLER SHAFT, Pressure Lube	1
N.S.	500118-3	PLUG, Oil Hole	1
N.S.	328075X	OIL LINE, (Flexible 24″ Long)	1
	328346-10X	CABLE CONTROL ASS'Y. (Includes 1-378502 Knob)(10X = 10 Foot Cable)	1
	328380X	CABLE CONTROL MOUNTING PARTS KIT (Contains items 33-36)	1
33	50-P-17	BRACKET, Wire Control	1
34	50-P-19	BRACKET, Swivel	1
N.S.	378019	PIVOT PIN	1
35	378326	HEX NUT (1/4″-20)	1
N.S.	500568-4	SET SCREW, (1/4″-20 × 1/2″)	1
36	500396-8	CAPSCREW, Hex Hd. (1/4″-20 × 3/4″)	1
37	35-P-9-1	GASKET, Mounting (.010″thick)	1
	35-P-9-2	GASKET, Mounting (.020″ thick)	
N.S.	328170-1X	P.T.O. MOUNTING KIT, Standard Mount	1
	500398-30	CAPSCREW (3/8″-16 × 4″)	1
	378041-4	CAPSCREW (3/8″-16 × 7″)	1
	378478-15	STUD	2
	378018	WASHER, Copper	6
	500371-3	HEX NUT (3/8″-24)	2
	500398-12	CAPSCREW (3/8″-16 × 1 1/4″)	2
N.S.	328170-26X	P.T.O. MOUNTING KIT, Deep Mount	1
	500398-29	CAPSCREW (3/8″-16 × 3 3/4″)	1
	378041-15	CAPSCREW (3/8″-16 × 6 3/4″)	1
	378478-14	STUD	2
	378018	WASHER, Copper	6
	500371-3	HEX NUT (3/8″-24)	2
	500398-10	CAPSCREW (3/8″-16 × 1″)	2
N.S.	328170-155X	P.T.O. MOUNTING KIT, for "R" Housing	1
		GASKET & SEAL KIT	
N.S.	328356-13X	Must be Ordered Separate (contains 4 pieces Item 11; 2 pieces Item 14; 1 piece each Items 12, 31, 15 & 37)	1

N.S.—Not Shown

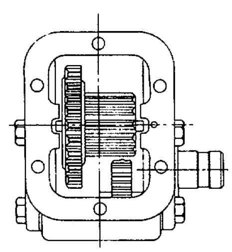
220 SERIES
P.T.O. PITCH MODELS & GEAR DATA

CHELSEA

Pitch Model	Item No. 3 Sliding Input Gear		Application	Pitch & Pressure Angle	Item No. 5 Drive Gear		Item No. 4 Output Gear	
LO-LO SPEED								
220*CAB	5-P-227	21T	General all 5 or 5/7	5-20°	5-P-320	14T	2-P-283	29T
220*CAH	5-P-319	26T	General all 6 or 6/8	6 or 6/8-20°	5-P-320	14T	2-P-283	29T
220*CAJ	5-P-569	25T	Allison	6-20°	5-P-320	14T	2-P-283	29T
220*CDD	5-P-686	22T	Spicer 1214-2A & -4A	5.85-20°	5-P-320	14T	2-P-283	29T
220*CAK	5-P-226	25T	Allison/4700 A Series	6-25°	5-P-320	14T	2-P-283	29T
220*CDA	5-P-633	27T	Mack T-2000 Series	6.48-17.6528	5-P-320	14T	2-P-283	29T
LOW SPEED								
220*EAB	5-P-227	21T	General all 5 or 5/7	5-20°	5-P-248	15T	2-P-179	28T
220*EAH	5-P-202	25T	General all 6 or 6/8	6 or 6/8-20°	5-P-248	15T	2-P-179	28T
220*EDD	5-P-686	22T	Spicer 1214-2A & -4A	5.85-20°	5-P-248	15T	2-P-179	28T
220*EAJ	5-P-569	25T	Allison	6-20°	5-P-248	15T	2-P-179	28T
220*EDA	5-P-633	27T	Mack T-2000 Series	6.48-17.6528	5-P-248	15T	2-P-179	28T
■ **220QEAM**	5-P-276	22T	Spicer 8012 & 8016	6N.P.-17½°L.H.	5-P-317	15T	2-P-190	27T
220*EAD	5-P-504	20T	Spicer R8516	5-17½°L.H.	5-P-503	15T	2-P-479	27T
220*EAK	5-P-226	25T	Allison/4700 A Series	6-25°	5-P-248	15T	2-P-179	28T
• **220*EAH**	5-P-551	25T	General	6/8-20°	—	15T	2-P-179	28T
• **220*EAK**	5-P-552	25T	Allison	6-25°	—	15T	2-P-179	28T
MEDIUM HIGH SPEED								
220*LAB	5-P-227	21T	General all 5 or 5/7	5-20°	5-P-394	18T	2-P-388	25T
220*LAH	5-P-202	25T	General all 6 or 6/8	6 or 6/8-20°	5-P-394	18T	2-P-388	25T
220*LDD	5-P-686	22T	Spicer 1214-2A &-4A	5-85-20°	5-P-394	18T	2-P-388	25T
220*LAK	5-P-226	25T	Allison/4700A Series	6-25°	5-P-394	18T	2-P-388	25T
220*LDA	5-P-633	27T	Mack T-2000 Series	6.48-17.6528	5-P-394	18T	2-P-388	25T
HIGH SPEED								
220*PAB	5-P-227	21T	General all 5 or 5/7	5-20°	5-P-316	20T	2-P-256	23T
220*PAH	5-P-202	25T	General all 6 or 6/8	6 or 6/8-20°	5-P-316	20T	2-P-256	23T
220*PDD	5-P-686	22T	Spicer 1214-2A & -4A	5.85-20°	5-P-316	20T	2-P-256	23T
220*PAK	5-P-226	25T	Allison/4700 A Series	6-25°	5-P-316	20T	2-P-256	23T
220*PDA	5-P-633	27T	Mack T-2000 Series	6.48-17.6528	5-P-316	20T	2-P-256	23T

• Constant Mesh
■ For Deep Mount 220QEAM use case 1-P-167

ASSEMBLY ARRANGEMENT



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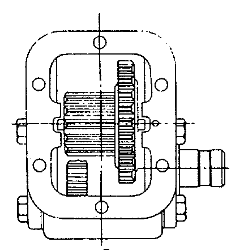

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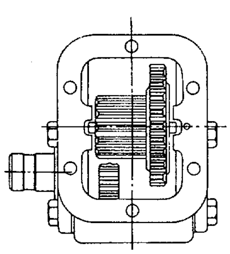

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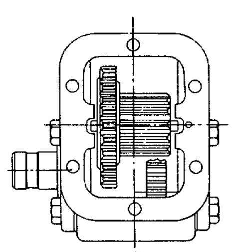
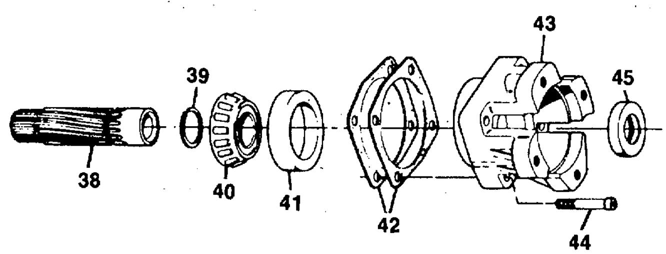


6

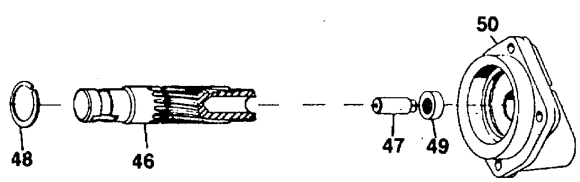
PUMP ADAPTOR FLANGES & OUTPUT SHAFTS



Pump Mounting Suffix	*Flange Assembly Item No. 43	Output Shaft Item No. 38	Capscrew & Dimensions Quantity Required-Four Item No. 44	Conversion Kit ▲
F	21-P-118	3-P-349	378447-8 (5/16"-18 x 1½")	328591-6X
G	328580X	3-P-281	378447-8 (5/16"-18 x 1½")	328591-10X
J	328580X	3-P-284	378447-8 (5/16"-18 x 1½")	328591-11X
K	328333X	3-P-282	378447-7 (5/16"-18 x 1¼")	328591-16X
L	328580X	3-P-283	378447-8 (5/16"-18 x 1½")	328591-18X
M	328583X	3-P-284	378447-7 (5/16"-18 x 1¼")	328591-20X
N	328584X	3-P-282	378447-8 (5/16"-18 x 1½")	328591-21X
O	328328X	3-P-284	378447-8 (5/16"-18 x 1½")	328591-26X
P	328328X	3-P-282	378447-7 (5/16"-18 x 1¼")	328591-23X
Q	328589X	3-P-282	378447-8 (5/16"-18 x 1½")	328591-17X
R	328710X	3-P-283	378918 Studs & 328711X (washers & nuts)	328591-25X

▲All Conversion Kits include items listed plus Item No. 45 Oil Seal 28-P-52, Item No. 42 Gaskets 22-P-24-1 & 22-P-24-2 & Item No. 41 Bearing Cup 550221.
*All Flange Assemblies use Item No. 40 Cone Bearing 550397 EXCEPT "F" which uses 550698.
Item No. 39 378391 Lockring used on standard shaft.

OPTIONAL FIELD CONVERSION KIT FOR HOLLY GOVERNOR DRIVE



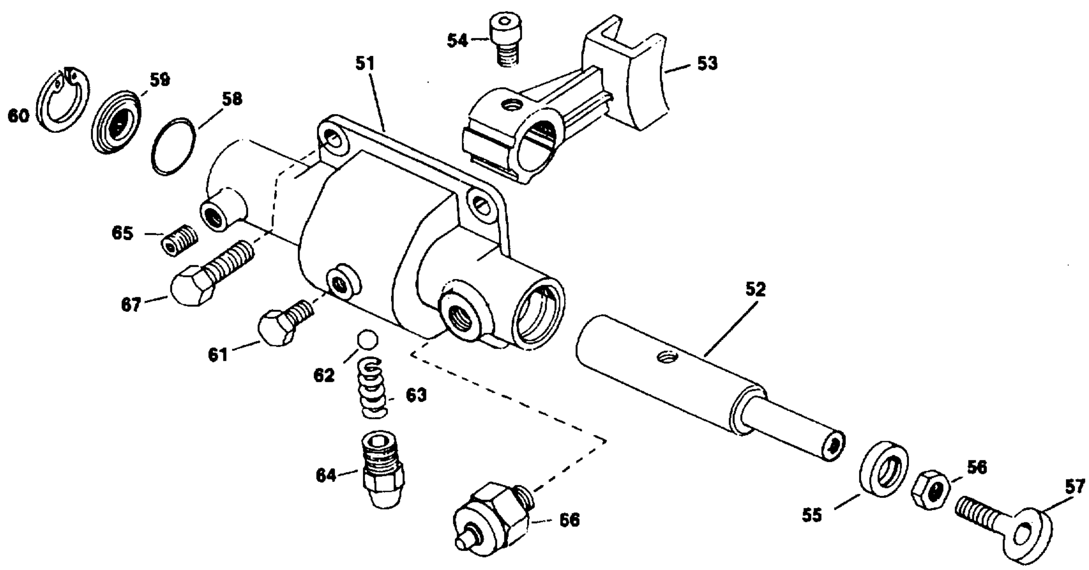
Item	Part Number	Description	Quantity
	† 328648X	HOLLY GOVERNOR DRIVE KIT (Contains items 46-50)	1
	328060X	DRIVE SHAFT & SPINNER ASS'Y. (Contains items 46 & 47)	1
46	3-P-270	SHAFT	1
47	378178	SPINNER	1
48	378391	LOCKRING	.
49	28-P-53	OIL SEAL	1
50	328588X	BEARING CAP, with Bearing Cup 550221	1

†Governor Drive Kit consists of parts shown plus gaskets, 22-P-24-1 & 22-P-24-2

PUMP SHAFTS AND SPINNER ASS'Y.

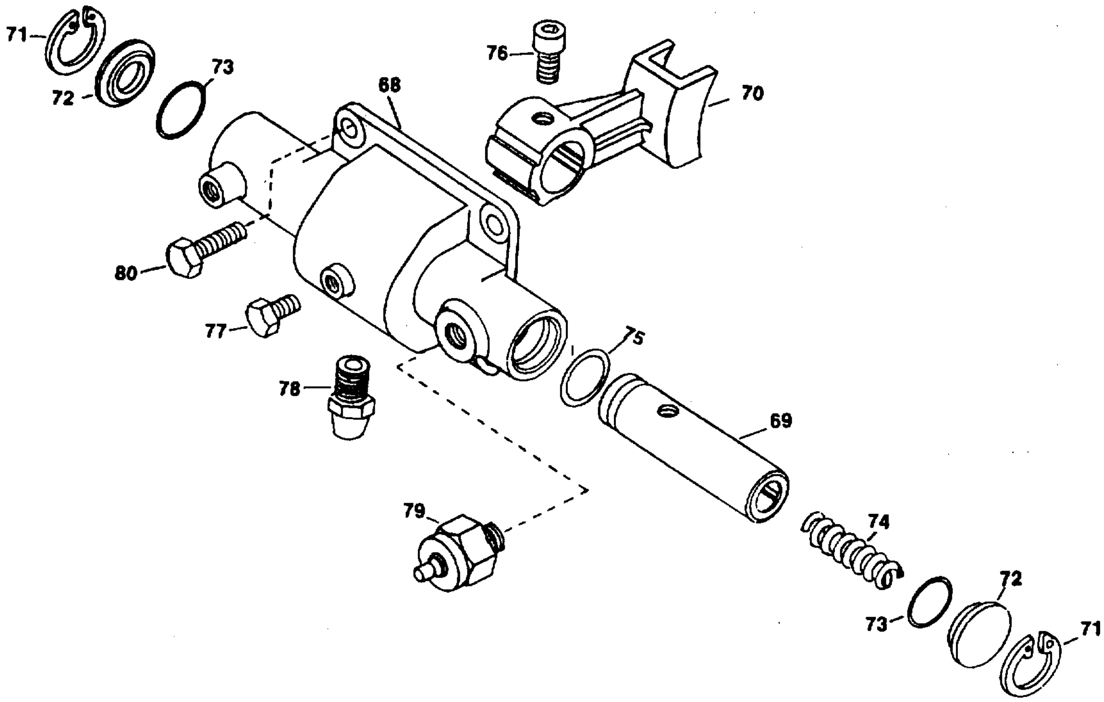
Pump Suffix	Part Number	Description	Quantity
G	328160X	PUMP SHFT & SPINNER ASS' Y, Includes Shaft 3-P-348 & Spinner 378178	1
J, M & O	328097X	PUMP SHAFT & SPINNER ASS' Y, Includes Shaft 3-P-311 & Spinner 378178	1
K, N,P & Q	328096X	PUMP SHAFT & SPINNER ASS' Y, Includes Shaft 3-P-310 & Spinner 378178	1
R	328743X	PUMP SHAFT & SPINNER ASS' Y, Includes Shaft 3-P-702 & Spinner 378178	1

LEVER CONTROL



Item	Part Number	Description	Quantity
	328724X	LEVER SHIFT COVER ASSY' Y., (Contains items 51-66)	1
51	34-P-60	COVER, Shiffter	1
52	11-P-117	SHAFT, Shiffter	1
53	32-P-129	FORK, Shiffter	1
54	378447-4	SCREW, Soc. Head	1
55	28-P-142	OIL SEAL	1
56	500381-3	JAM NUT, Hex	1
57	36-P-1	EYE BOLT	1
58	28-P-42	O-RING	1
59	378315	COVER PLUG	1
60	378316	SNAP RING	1
61	378285-1	SCREW, Guide	1
62	378002	POPPET BALL	1
63	37-P-14	POPPET SPRING	1
64	378554	CAP	1
65	500132-3	PLUG, Pipe (1/8" – 27)	1
66	378969	INDICATOR SWITCH	1
67	378430-8	SCREW, Hex Head (5/8" – 18 x 3/4")	4

AIR SHIFT

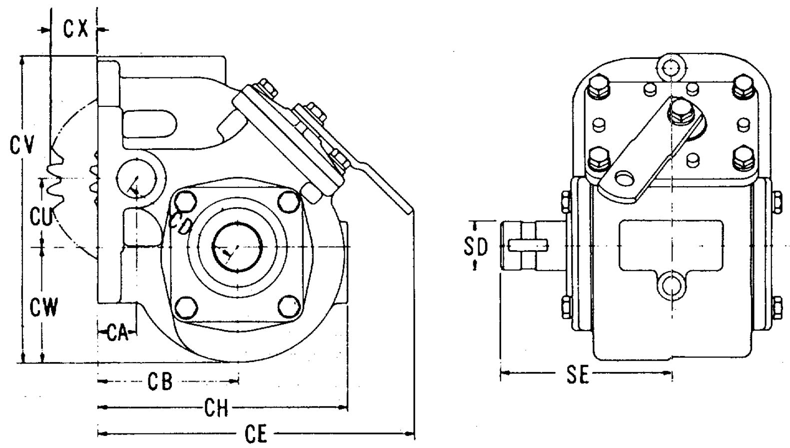


Item	Part No.	Description	Quantity
	328723X	AIR SHIFT ASSEMBLY(Inculdes item 68-79)	1
68	34-P-60	COVER, Shift	1
69	11-P-75	SHAFT, Shift	1
70	32-P-129	FORK, Shifter	1
71	378316	SNAP RING	2
72	378315	COVER PLUG	2
73	28-P-42	O-RING	2
74	37-P-21	SHIFTER SPRING	1
75	28-P-41	O-RING	1
76	378447-4	SCREW, Socket Head	1
77	378285-1	SCREW,Guide	1
78	378554	CAP	1
N.S.	500897-3	SHIPPING PLUG	1
79	378969	INDICATOR SWITCH	1
80	378430-8	SCREW, Hex Head (5/8" -18x3/4")	4
	328388-27X	AIR SHIFT INSTALLATION KIT	1

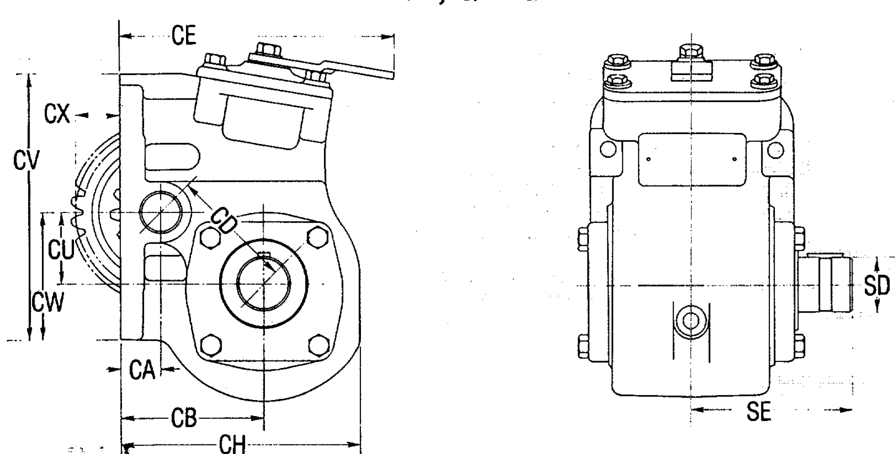
220 SERIES PARTS LIST
CASE DIMENSIONS

Dimension Symbol	Description	Case Part Number and Dimensions			
		1-P-166 220X	1-P-167 220Q	1-P-168 220Z	1-P-406 220R
CA	Face of Case to Center Line of Input Hole	0.972″	0.667″	0.752″	0.500″
CB	Face of Case to Center Line of Output Shaft Hole	3.516″	3.211″	3.296″	2.543″
CD	Center Distance Between Input Gear & Output Shaft	3.087″	3.087″	3.087″	3.087″
CE	Face of Case to End of Shift Lever	8.000″	7.687″	7.781″	8.000″
CH	Face of Case to extreme Horizontal Edge of Case (d)	6.281″	5.984″	6.062″	6.190″
CU	Output Shaft BELOW Center Line of Input Gear	1.750″	1.750″	1.750″	1.941″
CV	Top to Bottom of Case—Clearance (d)	7.750″	7.750″	7.750″	7.906″
CW	Center Line of Output Shaft to Bottom of Case (d)	2.875″	2.875″	2.875″	2.875″
CX	Face of Case to Pitch Line of Gear	1.110″	1.295″	1.330″	1.110″
	P.T.O. Output Shaft Dimensions				
SD	Outside Diameter of Standard Shaft—For U-Joint	1 1/4″ Rd. 5/16″ Key	1 1/4″ Rd. 5/16″ Key	1 1/4″ Rd. 5/16″ Key	1 1/4″ Rd. 5/16″ Key
SE	Center Line of P.T.O. to End of Output Shaft	4 1/4″	4 1/4″	4 1/4″	4 1/4″

(d)—Approximate Dimension for estimating clearance in installations.



220X, Q and Z



220R

CHELSEA MODEL NUMBER CONSTRUCTION

220 SERIES EXTRA HEAVY DUTY P.T.O.

220 X C AB P-Y 3 H D

BASIC MODEL
220 (Old 22 Series)

MOUNTING TYPE
Q = Extra Deep Mount
R = Special Clearance Housing
X = Standard Mounting
Z = Deep Mount

GEAR RATIO
C = .445 (A22LL) E = .514 (A22L)
L = .691 (A23) P = .835 (A22C & D)

INPUT GEAR DESIGNATOR

LUBRICATION
X = No Lubrication
P = Pressure Lube

OUTPUT TYPE
D = 1.250 Rd. M = 130 Pump Mtg.
F = 75C Pump Mtg. N = 159 Pump Mtg.
G = 96A Pump Mtg. O = New Pump Mtg.
J = 102 Pump Mtg. P = 220 Pump Mtg.
K = 113 Pump Mtg. Q = 222 Pump Mtg.
L = 114 Pump Mtg. R = 225 Pump Mtg.

HOLLEY GOVERNOR DRIVE
X = No Governor Drive
H = Holley Governor Drive
(Available on D,G,J,K,M,N,O,P,Q & R Outputs Only)

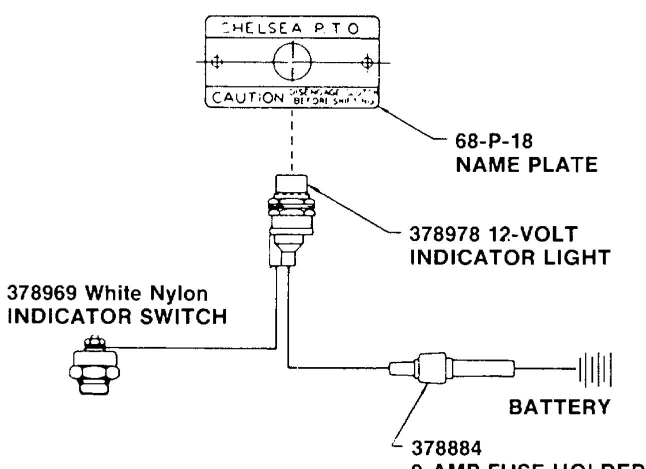
ASSEMBLY ARRANGEMENT
3, 4, 5, 6

SHIFTER TYPE
A = Air Y = Lever
W = Wire M = Constant Mesh (No Shifter)

AIR SHIFT CONVERSION KITS

Description	Part Number	Quantity
AIR-O-MATIC		
Wire to Air	328390-72X	1
Lever to Air	328390-73X	1

WIRE & LEVER CONTROL INDICATOR LIGHT INSTALLATION KIT 328751X*



* This kit does not contain Indicator Switch 378969.

HAYES DANA, INC.
Mobile Power Division
P.O. Box 6000
Beamsville, Ontario. LOR 1BO
Telephone: (416) 563-4991
Telex: 061-5242

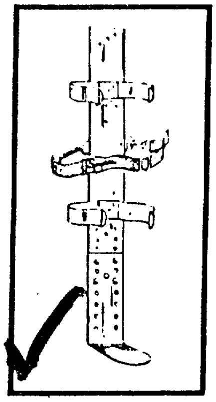
HAYES DANA

WALKAWAY® brackets

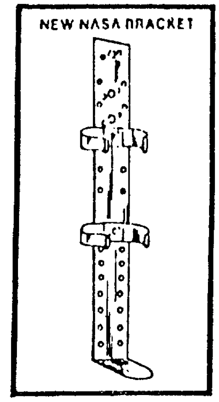
There is a ZICO WALKAWAY bracket that is ideal for all uses and any self-contained breathing apparatus manufactured in the United States. You can select spring tension clips to hold the cylinder firmly in place or you may prefer the spring instead. Choose a foot plate or a yoke support. For additional safety, you can specify the Newark Hold-down, a high-tensile nylon webbing with a quick release hook and lever fastener—recommended when no protective cover is to be used.

The new NASA-40 WALKAWAY bracket was designed specifically for the Scott Air-Pak* 4.5 SCBA unit. The black nylon coated clips will not mar the finish on the cylinder, which can be easily and smoothly released. Standard foot-plate or yoke support and Newark Hold-down available. QUIC-PAC holder also available.

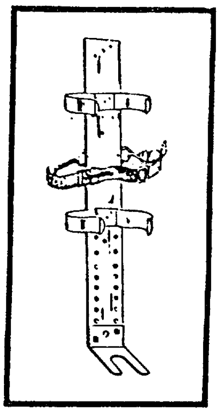
* Scott Aviation Lancaster, N.Y.



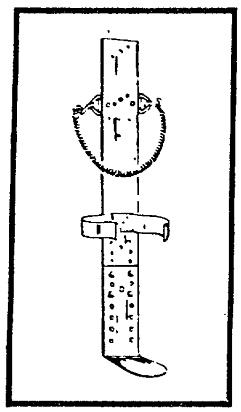
Model U-45FNH
Model 45 Spring Clips
Model U Back Plate
Model F Foot Plate
Model NH Newark Hold-down



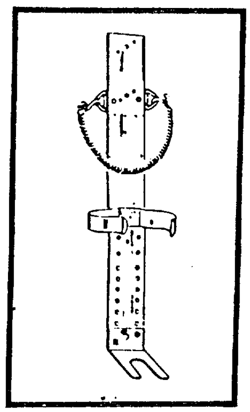
Model NASA-40F
Model 40 NASA Spring Clips
Special Bracket for Scott 4.5
Nylon coated clips
Model F Foot Plate



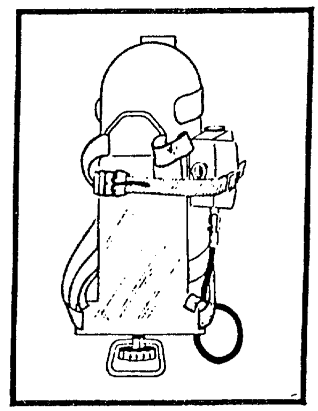
Model U-45YNH
Model 45 Spring Clips
Model U Back Plate
Model Y Yoke Support
Model NH Newark Hold-down



Model US-45F
Model S-Spring instead of top clip
Model U Back Plate
Model F Foot Plate



Model US-45Y
Model S-Spring instead of top clip
Model U Back Plate
Model Y Yoke Support



Newark Hold-down in position, with air cylinder in the WALKAWAY bracket showing hold-down straps around the bottle and regulator

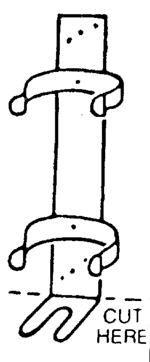
Note: See mounting and ordering instructions—page 15

TO MODIFY OLD STYLE WALKAWAY BRACKETS

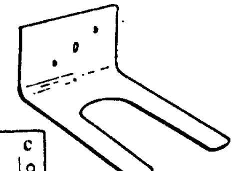
(Models 15J, 30J, 45J, and 50J) with Model F Foot Plate

1. Cut off existing bracket at point where vertical back bends to form horizontal yoke support
2. Attach new base plate (Model F) using existing holes in bracket. New holes may be drilled in bracket to match up with holes in the foot plate base plate. Cap nuts and machine screws are provided with foot plate.

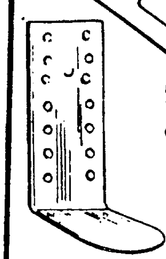
OLD STYLE BRACKET



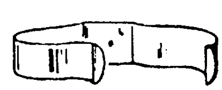
THE FOLLOWING ITEMS MAY BE PURCHASED SEPARATELY:



Model Y
Yoke Support only



Model F
Foot Plate only



Model C
Clip only

C-15/NASA 40
For 15 min. rated air cylinder and new Scott 4.5 cylinder

C-45
For 30, 45 and 50 min. rated air cylinders

SCUBA-72
For SCUBA cylinders

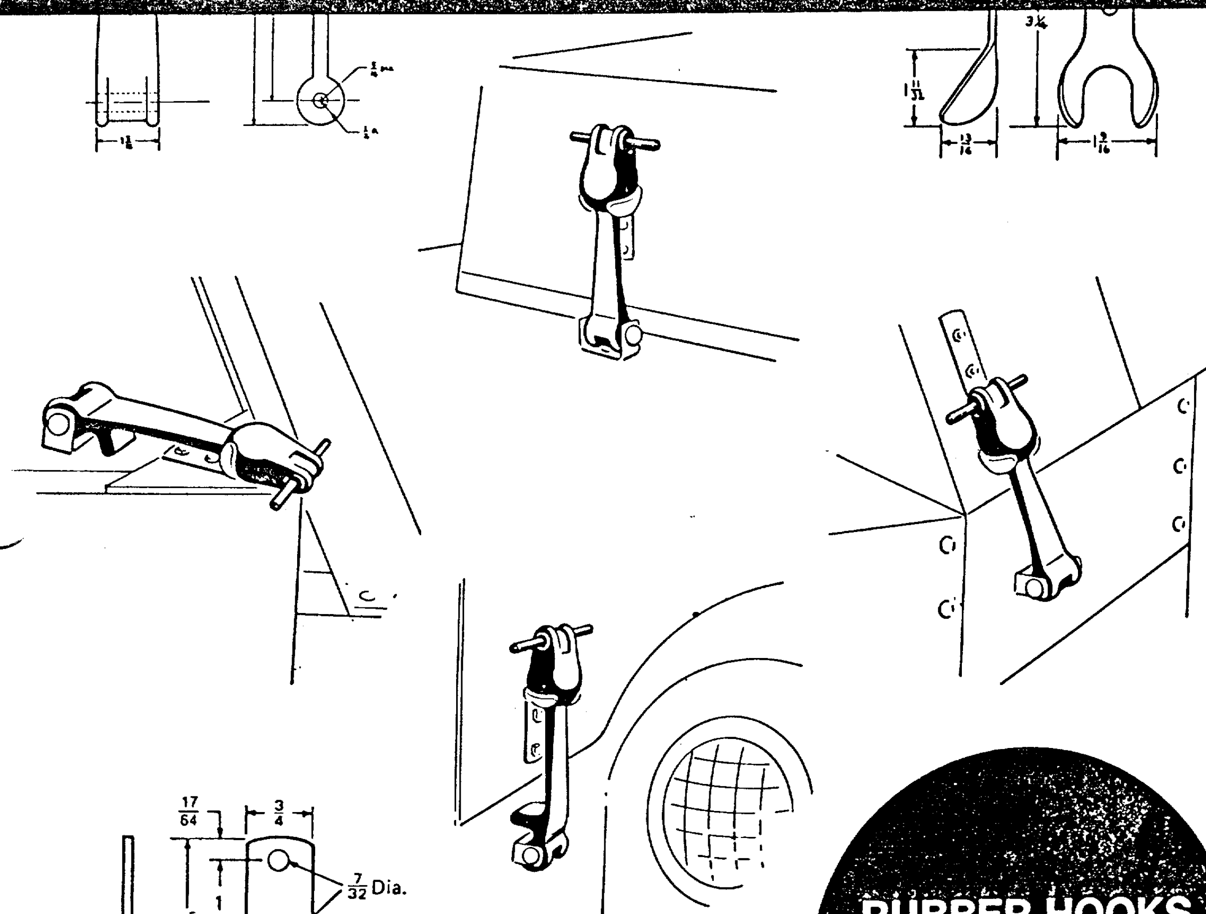
SPECIFY SIZE REQUIRED

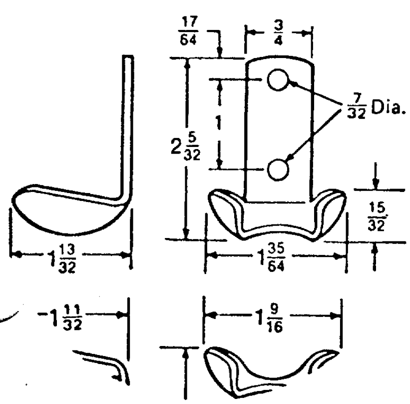
OVER 60 YEARS SERVING INDUSTRY ACROSS THE NATION

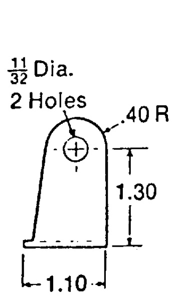
Section VIII
MISCELLANEOUS

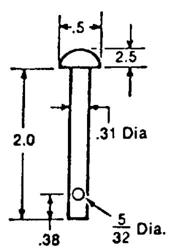
Huntington RUBBER CORPORATION

P.O. BOX 570 • PORTLAND, OREGON 97207 • 503/246-5411 • TELEX 36-0457



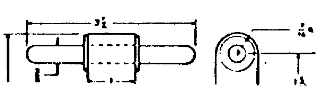


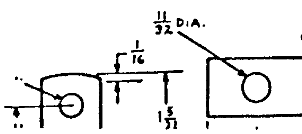




RUBBER HOOKS
HARDWARE

BROCHURE NO. 675



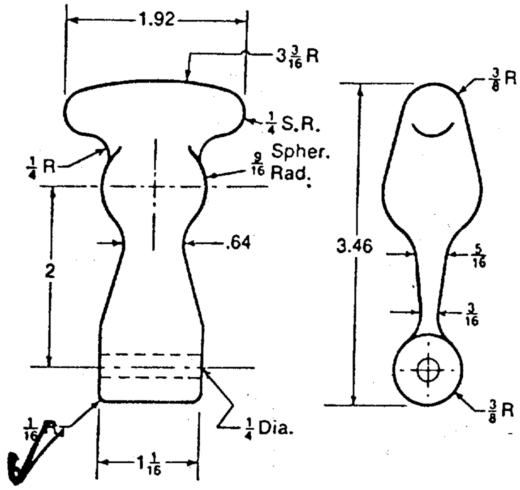


376

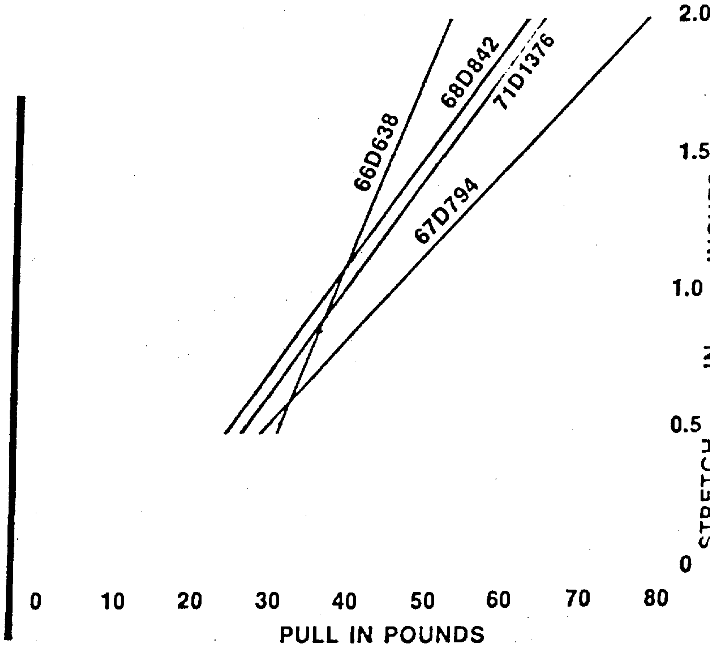
'ruck hood, battery box, hatch cover fasteners

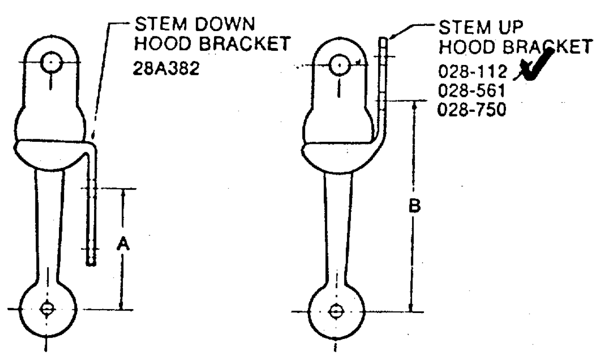
to plus 350°F.) Flexible, quiet Huntington Hood Hooks
rust, never corrode. Require no lubrication, yet provide
positive fastening and unfastening with smooth, effortless
, with a temperature range from −65°F. to +250°F. Normal
ned length = 115% of overall as-manufactured length.

ULTIMATE BREAKING LOAD IN EXCESS OF 350 POUNDS



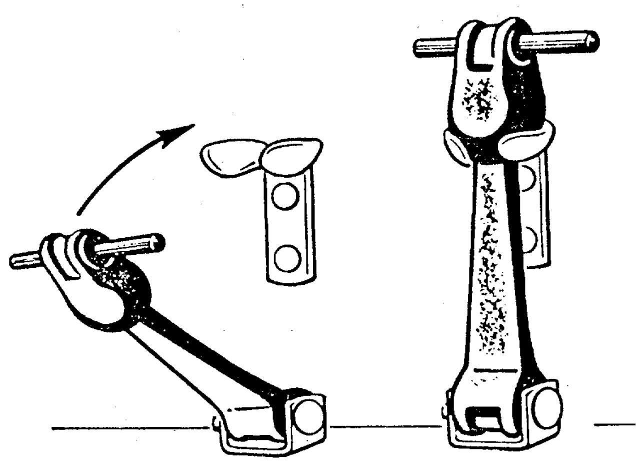
PEEWEE MODEL: HRC No. 71D1376—our smallest model. Ideal size for small hoods and access panels.





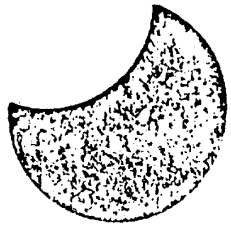
NOTE: Determine stretch or holding force required from load deflection chart and add zero-stretch dimension (A or B) to locate hood bracket in relation to anchor bracket.

EASY, POSITIVE FASTENING ACTION

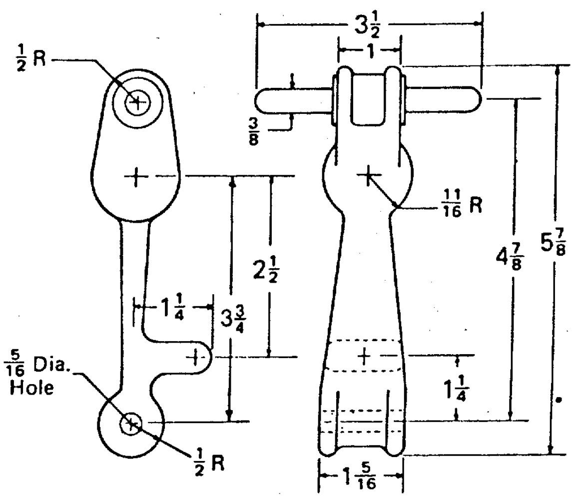


D HOOK	28A382	028-112	028-561	028-750
842	A = 2 5/8	B = 3 7/8	B = 3 7/8	B = 6 11/16
68D842-1101	A = 2 5/8	B = 3 7/8	B = 3 7/8	B = 6 11/16
638	A = 4 3/4	B = 6 1/16	B = 6 1/16	B = 8 5/8
D794	A = 2	B = 3 3/16	B = 3 3/16	B = 6
67D794-1101	A = 2	B = 3 3/16	B = 3 3/16	B = 6
71D1376	A = 1 1/16	B = 2 3/8	B = 2 3/8	B = 4 13/16

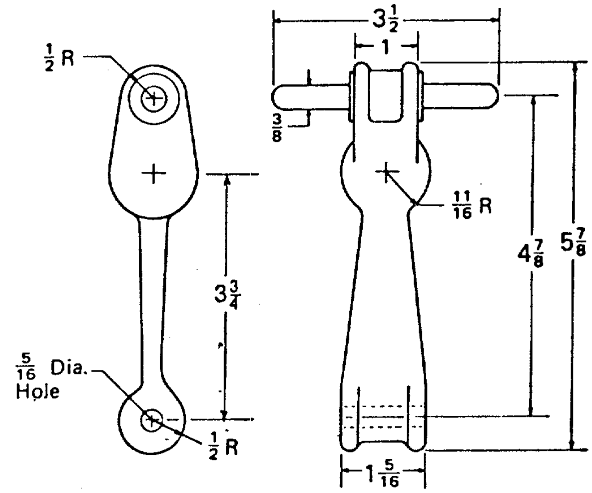
. . . low cost, easy to inst.



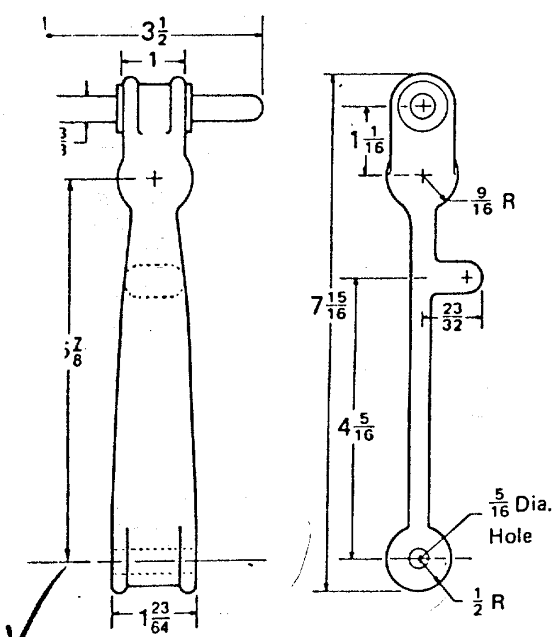
Snug-fit fastening with never a squeak! Neat, trim appeara
Special formula high-impact resin handles and quality ru
body are impervious to weather, oils, chemicals and dir
HRC Rubber Hood Hooks have molded poly-carbonate r
handles.(Naval weapons spec. OS-12531 temp. range of min



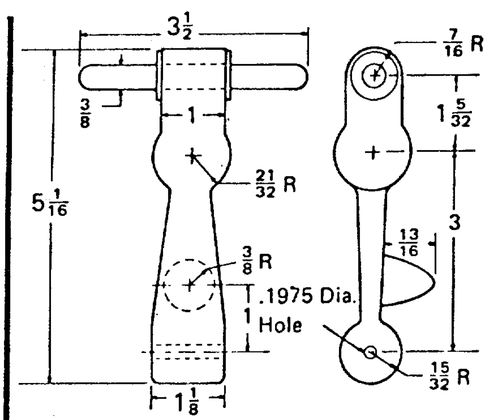
STAR MODEL: HRC No. 68D842, *with* anti-rattle nub. Our standard model. Especially suited to fastening truck hoods and for heavy duty applications.



STAR MODEL: HRC No. 68D842-1101, *without* anti-rattle nub.

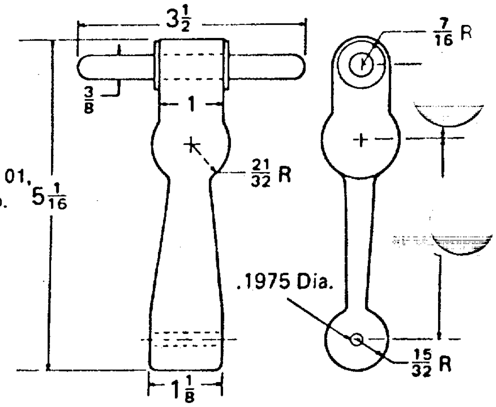


MAXI MODEL: HRC No. 66D638, *with* anti-rattle nub. Our largest model. Long reach for extra stretch and around corner fastening.



MINI MODEL
HRC No. 67D794, *with* anti-rattle nub. Our compact model. Excellent size for securely fastening battery box covers in limited space

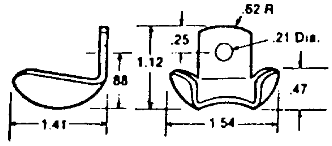
MINI MODEL
HRC No. 67D794-1101, *without* anti-rattle nub.



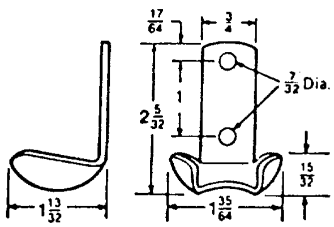
Section VIII
MISCELLANEOUS

. . . designed especially for Huntington Rubber Hooks

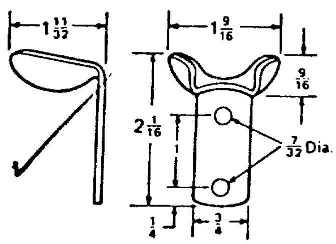
Precision made from high-quality steel with a special hot-zinc bright finish. Attractive appearance or easily painted in your shop if desired. This heavy duty hardware accurately fits the Huntington Rubber Hood Hooks. Also available chrome plated on special order.



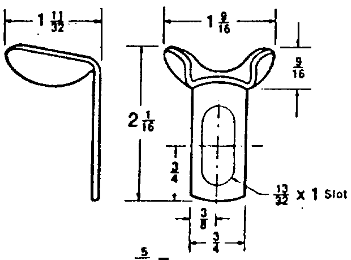
HOOD BRACKET
Short stem-up type
12 gauge zinc plated steel.
HRC No. 028-112
Use with all hooks.



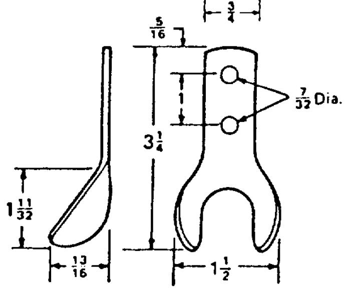
HOOD BRACKET
Stem-up type,
12 gauge zinc-plated steel.
HRC No. 028-561
Use with all hooks.



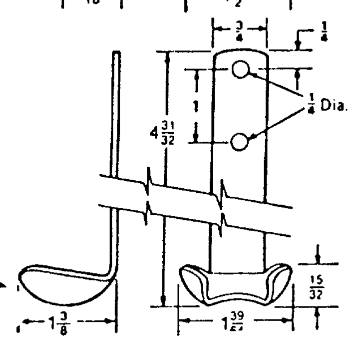
HOOD BRACKET
Stem-down type,
12 gauge zinc-plated steel.
HRC No. 28-A-382
Use with all hooks.



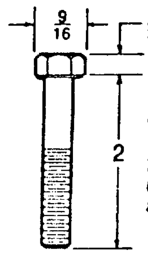
HOOD BRACKET
Stem-down type with slot. Zinc plated 12-ga. steel.
HRC No. 28A400.
Use with all hooks



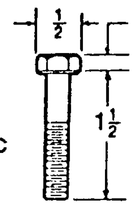
HOOD BRACKET
Stem-flat type,
12 gauge zinc-plated steel.
HRC No. 028-562
Use with all hooks.



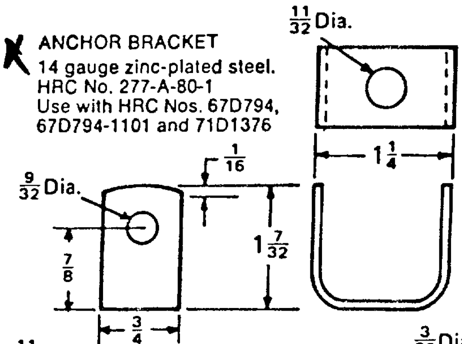
HOOD BRACKET
Stem-up special length type,
12 gauge zinc-plated steel.
HRC No. 028-750
Use with all hooks.



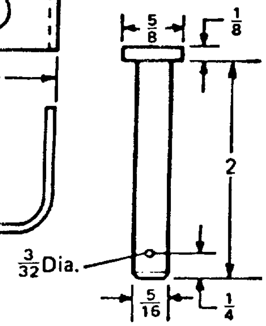
ANCHOR BOLTS
5/16 NF x 2 HH
Cad. Pl. Bolt
W/Self-Locking Nut. Use with HRC Nos. 68D842, 68D842-1101, and 68D638



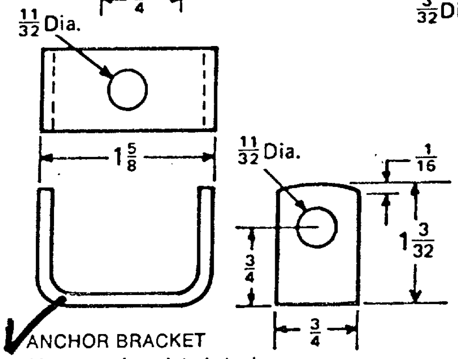
ANCHOR BOLTS
¼ NC x 1½" HH
Cad. Pl. Bolt
W/Self-Locking Nut. Use with HRC Nos. 67D794, 67D794-1101 and 71D1376



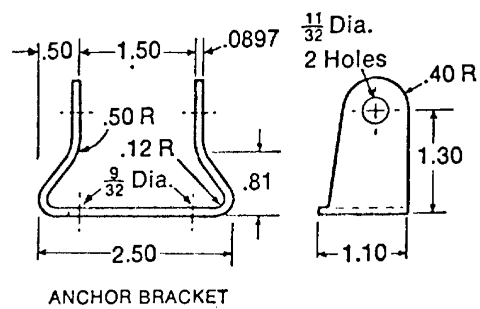
ANCHOR BRACKET
14 gauge zinc-plated steel.
HRC No. 277-A-80-1
Use with HRC Nos. 67D794, 67D794-1101 and 71D1376



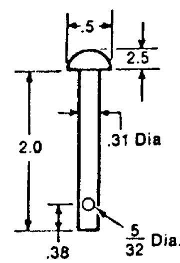
ANCHOR PIN
Zinc-plated steel.
HRC No. 179-A-54
Use with HRC Nos. 68D842, 68D842-1101, and 66D638



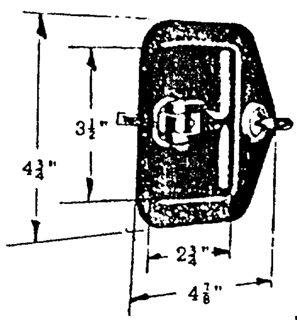
ANCHOR BRACKET
11 gauge zinc-plated steel.
HRC No. 277-A-80
Use with HRC Nos. 68D842, 68D842-1101, and 66D638.



ANCHOR BRACKET
Chrome-plated steel. HRC No. 277-A-80-2
Use with HRC Nos. 68D842, 68D842-1101, and 66D638.



ANCHOR PIN
Chrome-plated steel
HRC No. 179-A-55
Use with HRC Nos. 68D842, 68D842-1101, and 66D638



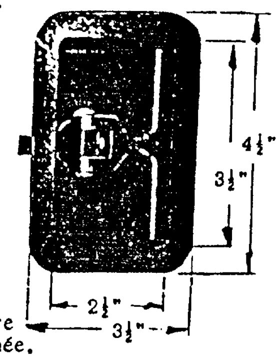
No. 4874

Folding T-Handles in a rectangular steel pan. A stainless steel spring holds handle in folded position.

NO.	FINIS / FINISHES plain	cad.	chrome	poids weight
4874	x	stock		1
5630-A	stock	x		5/8

Profondeur 3/4" Deep

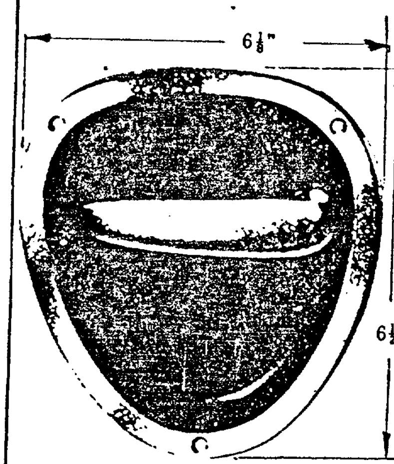
Poignée en "T" se repliant dans soucoupe rectangulaire en acier. Un ressort retient la poignée en position fermée.



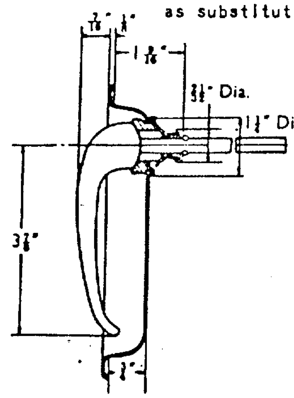
No. 5630-A

Voir poignées No. 80 et No. 280 AU VERSO DE CETTE PAGE pour substitut à 12372/73.

SEE OVERLEAF for No. 80 and No. 280 which may be used as substitute to Nos. 12372/73.



No. 12372-B Plain RH



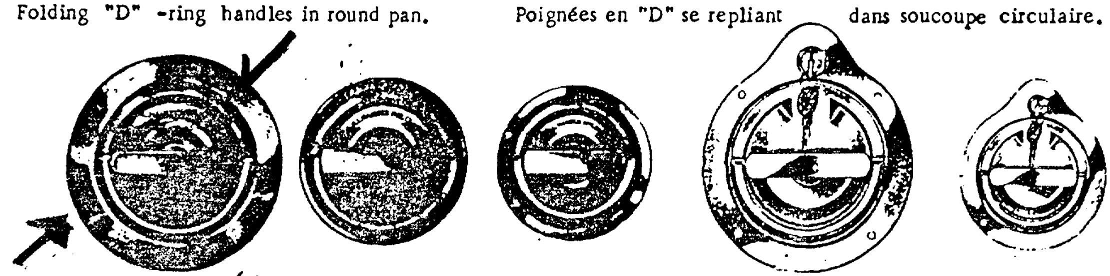
VARIATIONS TO ILLUSTRATED MODEL.
Variations du modèle illustré.

No. 12372-B Plain RH (illust.)
No. 12372-C Locking RH
No. 12373-B Plain LH
No. 12373-C Locking LH

Poignée chromée, encastrée dans plaque de montage en acier non-plaqué.

Chromed handle in a plain steel recessed mounting plate.

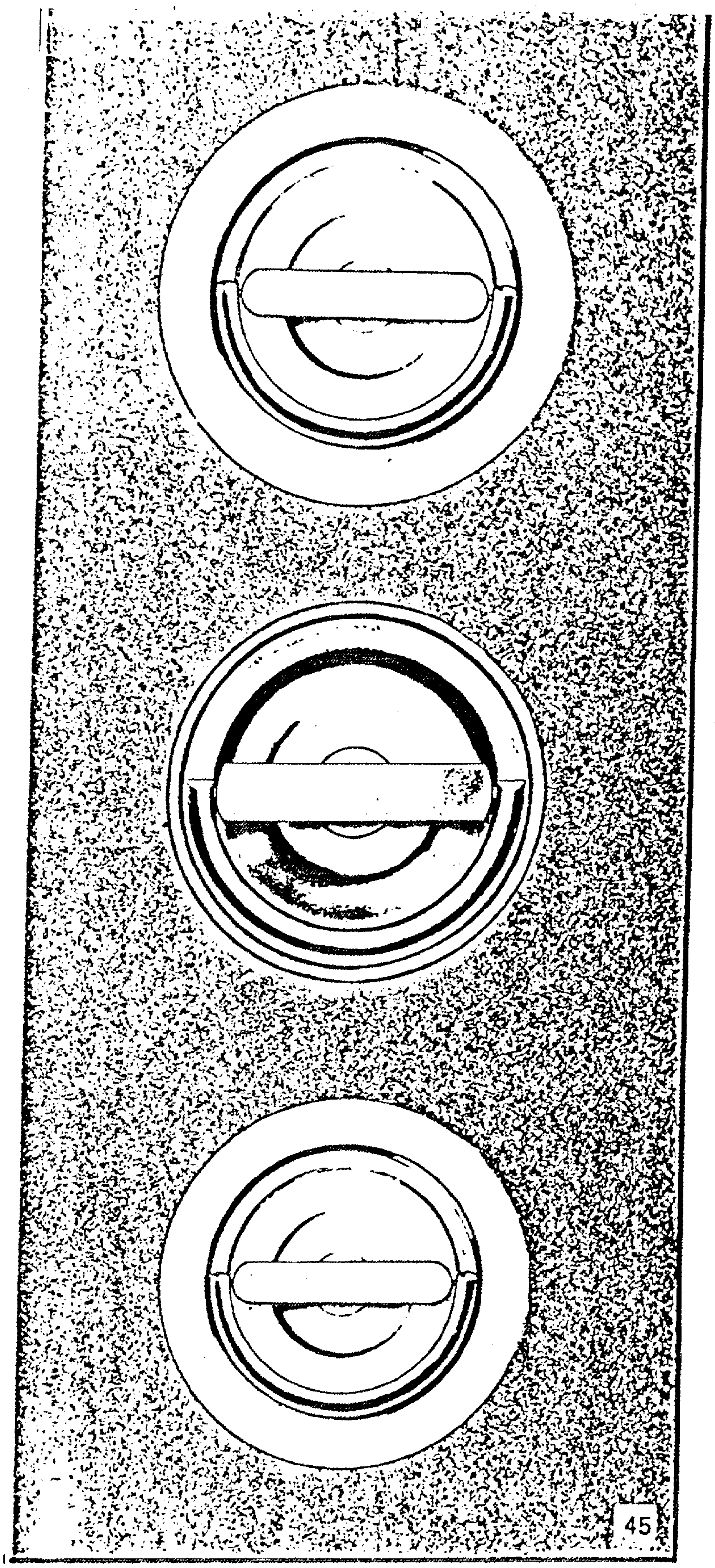
Folding "D" -ring handles in round pan. Poignées en "D" se repliant dans soucoupe circulaire.



Stock NO.	79-L SS	No. 79-M	No. 79-S	No. 279-L	No. 279-S
Diam. Total Outside Diam.	6 3/16"	4 15/16"	4 7/16"	6 3/16"	4 7/16"
Rebord Flange width	3/4"	1/8"	1/2"	3/4"	1/2"
Tige: 3⅛" lg Shank: 3⅛" lg		Profondeur 1/2" Deep		FINISHES: Plain steel in stock, Cad. and chrome available.	
Poids Weight LB	1 1/8	3/4	3/4	1 5/16	1

A.L. HANSEN Mfg. Co.

HANDLES
Flush-Type



No. 79-L FLUSH HANDLE S/S

Handle 6-1/8" dia. Recess 1/2" deep. Shank 3-1/8" long, 5/16" square. Flange 3/4". Plain finish is standard; zinc or chromium finish also available. Weight 1 lb., 3 oz.

Special length shanks available on special order.

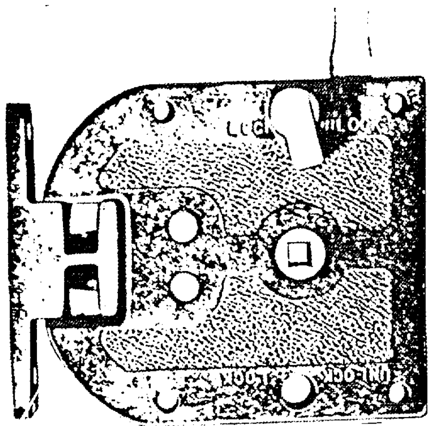
No. 79-M FLUSH HANDLE

Handle 4-15/16" dia. Recess 1/2" deep. Shank 3-1/8" long, 5/16" square. Flange 5/32". Plain finish standard; zinc or chromium finish also available. Wt. 1 lb.

Special length shanks available on special order.

No. 79-S FLUSH HANDLE

Handle 4-7/8" dia. Recess 1/2" deep. Shank 3-1/8" long, 5/16" square. Flange 1/2". Plain finish standard; zinc or chromium finish also available. Wt. 13 oz.



No. 206U

Left-hand shown; right- opposite.

dimensions:

$4\frac{3}{8}$ in. length of case
5 in. width of case
$5\frac{27}{64}$ in. width of case with striker
$\frac{3}{4}$ in. depth of case
$1\frac{11}{64}$ in. depth of case with striker
$\frac{17}{64}$ in. mounting holes (4)
on 3″ x $3\frac{5}{8}$″ (HxV) pattern
$\frac{9}{32}$x$1\frac{3}{32}$ in. oval mounting slots (2)
on $3\frac{1}{8}$″ centers on striker
4x$1\frac{1}{8}$ in. mounting face of striker
$\frac{5}{16}$ in. square hole for handle shank
Weight depends on system used. Consult factory.

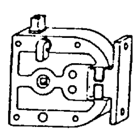
general description:

This lock is intended primarily for passenger doors on vehicles. Certified to meet the Federal Motor Vehicle Safety Standard No. 206 and to comply with established OSHA safety standards, this lock can be installed on doors as thin as $1\frac{3}{16}$ inches inner skin to inner skin . . . or the inner surface of a door panel. It can be used for direct operation, remote operation or a combination of both. The lock is designed so there is no concern about accidental lockouts, because the inside thumb latch kicks out automatically when the door is slammed. The split tumbler allows locking or unlocking from inside or outside. Provision is made for vertical or thumb-rotary locking and unlocking from the inside. And the mechanism is enclosed to minimize damage from foreign objects. The striker is designed for primary and secondary latching capability.

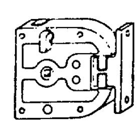
Accessories for this lock are: independent pillar locking cylinders, single or double remote control levers, and recessed paddle handles and L-type handles (both available key-locking or non key-locking).

Available for left-or right-hand installation. Left-hand shown. Specify, when ordering.

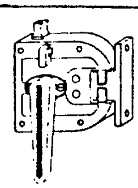
No. 206U and VARIATIONS (Right-hand shown; left opposite.)



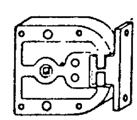
No. 206U
with striker (standard).



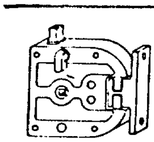
No. 1-206U
Same as No. 206U except with cut-off lock button No. 1-206-11.



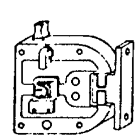
No. 2-206U
Same as No. 206U except with stainless steel non key-locking inside handle No. 24-5551.



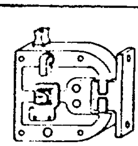
No. 3-206U
Same as No. 206U except less locking feature.



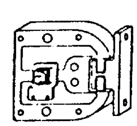
No. 207U
Same as No. 206U except with one remote control lever on back cover.



No. 1-207U
Same as No. 207U except remote control lever is on front cover.



No. 208U
Same as No. 206U except with two remote control levers.

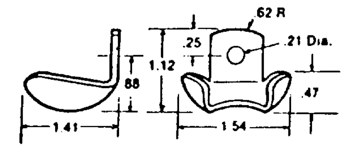


No. 1-208U
Same as No. 208U except less locking feature.

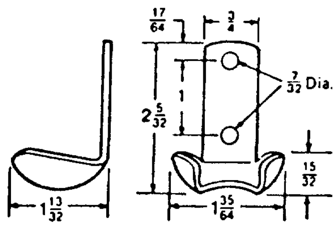
EBER-EAST PRODUCTS LIMITED, TILLSONBURG, ONT. N4G 4H8

. . . designed especially for Huntington Rubber Hooks

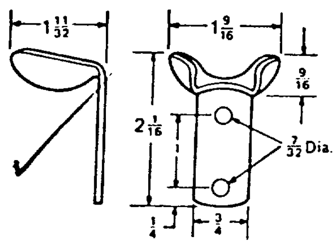
Precision made from high-quality steel with a special hot-zinc bright finish. Attractive appearance or easily painted in your shop if desired. This heavy duty hardware accurately fits the Huntington Rubber Hood Hooks. Also available chrome plated on special order.



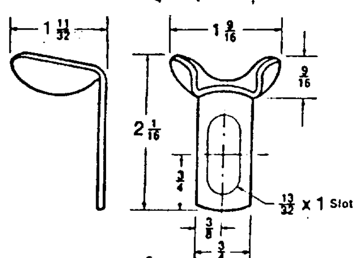
HOOD BRACKET
Short stem-up type
12 gauge zinc plated steel.
HRC No. 028-112
Use with all hooks.



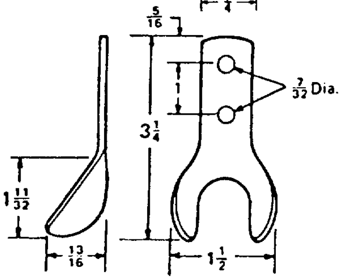
HOOD BRACKET
Stem-up type,
12 gauge zinc-plated steel.
HRC No. 028-561
Use with all hooks.



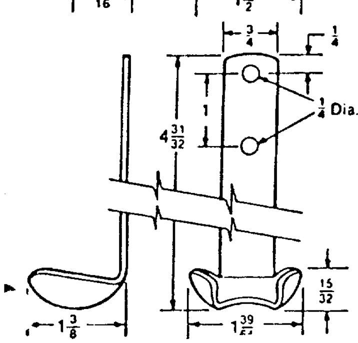
HOOD BRACKET
Stem-down type,
12 gauge zinc-plated steel.
HRC No. 28-A-382
Use with all hooks.



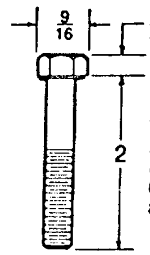
HOOD BRACKET
Stem-down type with slot. Zinc plated 12-ga. steel.
HRC No. 28A400.
Use with all hooks



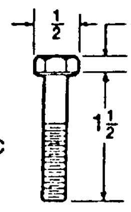
HOOD BRACKET
Stem-flat type,
12 gauge zinc-plated steel.
HRC No. 028-562
Use with all hooks.



HOOD BRACKET
Stem-up special length type,
12 gauge zinc-plated steel.
HRC No. 028-750
Use with all hooks.

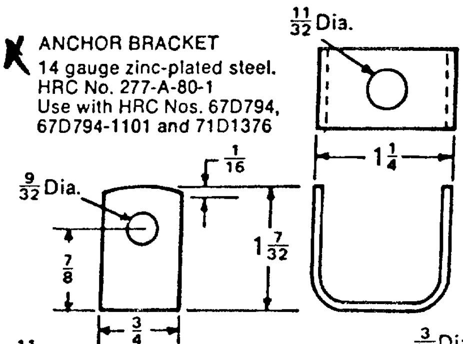


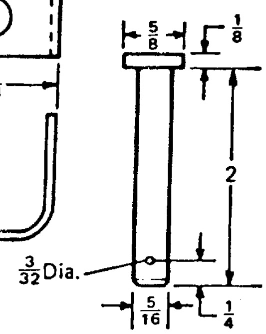
ANCHOR BOLTS
5/16 NF x 2 HH
Cad. Pl. Bolt
W/Self-Locking Nut. Use with HRC Nos. 68D842, 68D842-1101, and 68D638



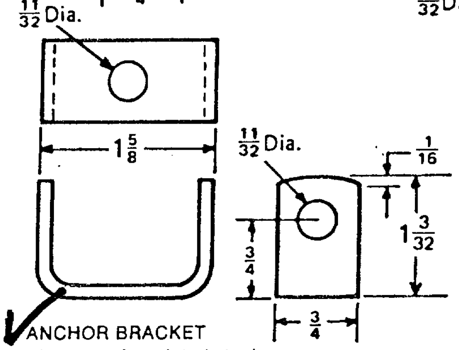
ANCHOR BOLTS
1/4 NC x 1 1/2" HH
Cad. Pl. Bolt
W/Self-Locking Nut. Use with HRC Nos. 67D794, 67D794-1101 and 71D1376

ANCHOR BRACKET
14 gauge zinc-plated steel.
HRC No. 277-A-80-1
Use with HRC Nos. 67D794, 67D794-1101 and 71D1376

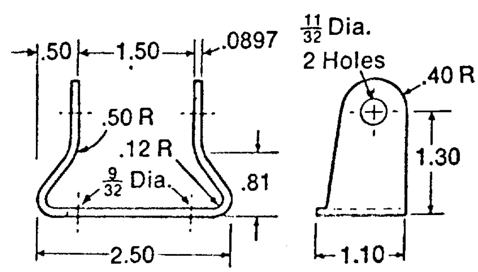




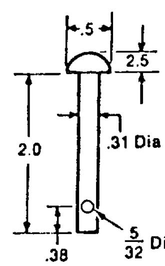
ANCHOR PIN
Zinc-plated steel.
HRC No. 179-A-54
Use with HRC Nos. 68D842, 68D842-1101, and 66D638



ANCHOR BRACKET
11 gauge zinc-plated steel.
HRC No. 277-A-80
Use with HRC Nos. 68D842, 68D842-1101, and 66D638.

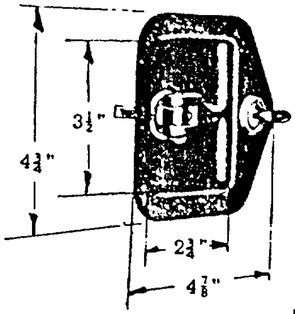


ANCHOR BRACKET
Chrome-plated steel. HRC No. 277-A-80-2
Use with HRC Nos. 68D842, 68D842-1101, and 66D638.



ANCHOR PIN
Chrome-plated steel
HRC No. 179-A-55
Use with HRC Nos. 68D842, 68D842-1101, and 66D638

Section VIII
MISCELLANEOUS



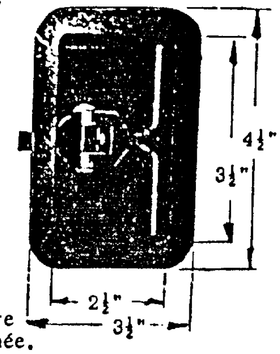
No. 4874

Folding T-Handles in a rectangular steel pan. A stainless steel spring holds handle in folded position.

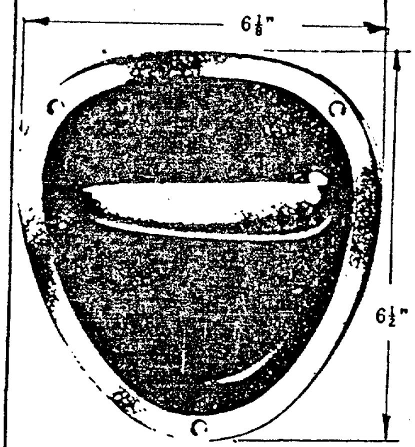
NO.	FINIS / FINISHES plain	cad.	chrome	poids weight
4874	x	stock		¾
5630-A	stock	x		5/8

Profondeur 3/4" Deep

Poignée en "T" se repliant dans soucoupe rectangulaire en acier. Un ressort retient la poignée en position fermée.



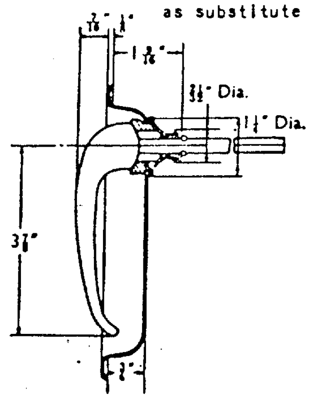
No. 5630-A



No. 12372-B Plain RH

Voir poignées No. 80 et No. 280 AU VERSO DE CETTE PAGE pour substitut à 12372/73.

SEE OVERLEAF for No. 80 and No. 280 which may be used as substitute to Nos. 12372/73.



VARIATIONS TO ILLUSTRATED MODEL.

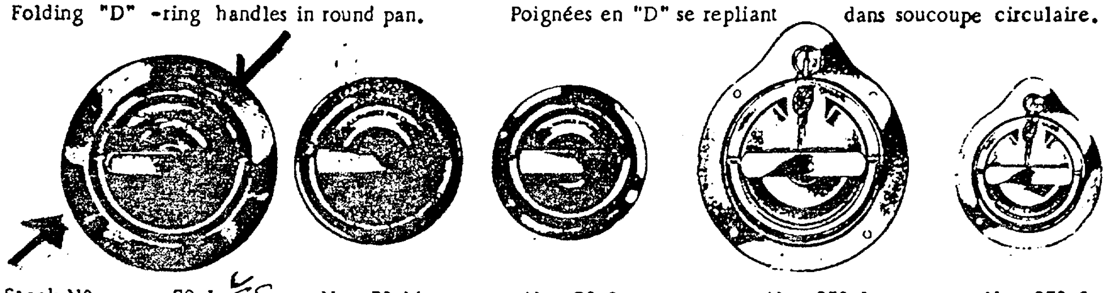
Variations du modèle illustré.

No. 12372-B Plain RH (illust.)
No. 12372-C Locking RH
No. 12373-B Plain LH
No. 12373-C Locking LH

Poignée chromée, encastrée dans plaque de montage en acier non-plaqué.

Chromed handle in a plain steel recessed mounting plate.

Folding "D" -ring handles in round pan. Poignées en "D" se repliant dans soucoupe circulaire.



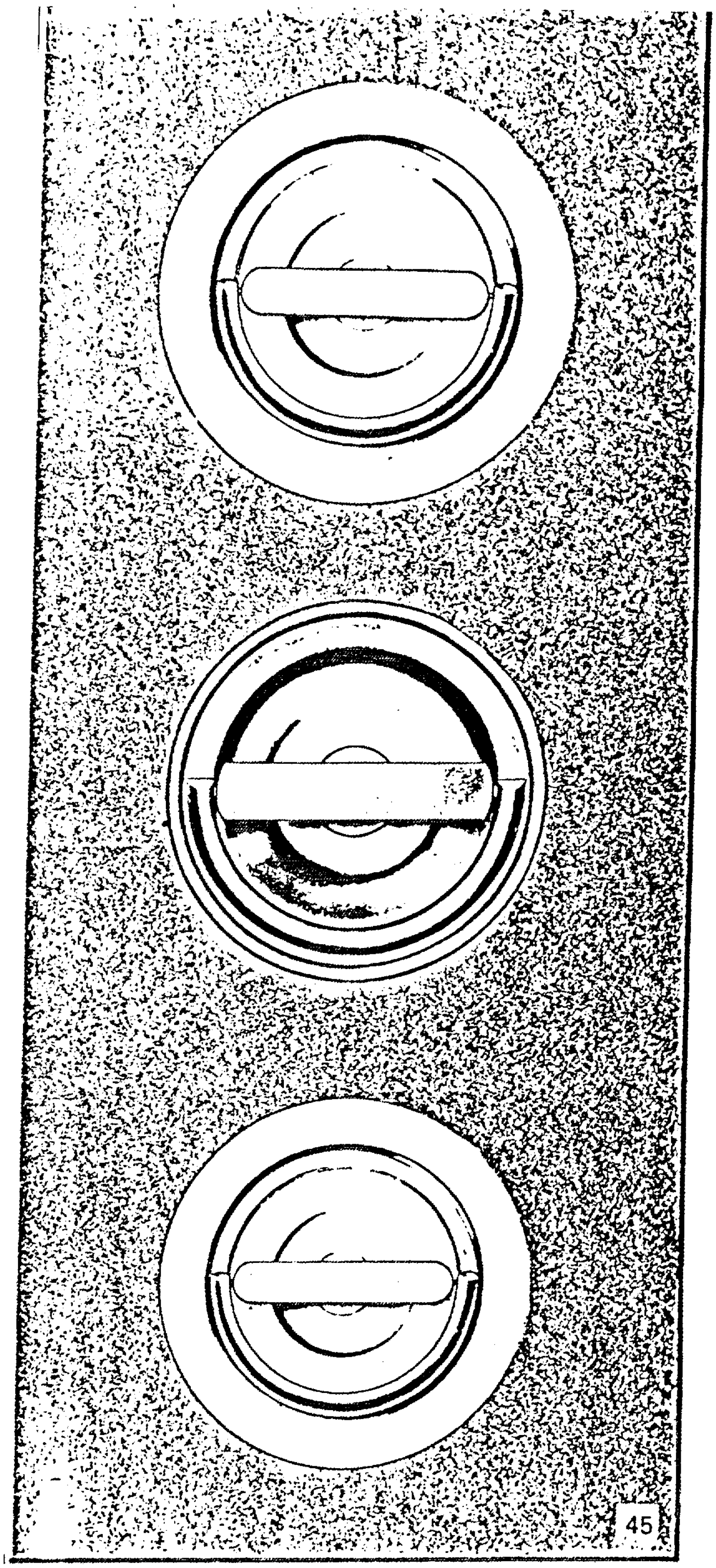
Stock NO.	79-L SS	No. 79-M	No. 79-S	No. 279-L	No. 279-S
Diam. Total Outside Diam.	6 3/16"	4 15/16"	4 7/16"	6 3/16"	4 7/16"
Rebord Flange width	3/4"	1/8"	1/2"	3/4"	1/2"
Tige: 3⅛" lg Shank: 3⅛" lg		Profondeur 1/2" Deep		FINISHES: Plain steel in stock, Cad. and chrome available.	
Poids Weight LB	1 1/8	3/4	3/4	1 5/16	1

FAUCHER & FILS INDUSTRIES (1964) LIMITÉE LIMITED
MONTRÉAL – TORONTO - EDMONTON – VANCOUVER

A.L. HANSEN Mfg. Co.

Section VIII
MISCELLANEOUS

HANDLES
Flush-Type



No. 79-L FLUSH HANDLE S/S

Handle 6-1/8" dia. Recess 1/2" deep. Shank 3-1/8" long, 5/16" square. Flange 3/4". Plain finish is standard; zinc or chromium finish also available. Weight 1 lb., 3 oz.

Special length shanks available on special order.

No. 79-M FLUSH HANDLE

Handle 4-15/16" dia. Recess 1/2" deep. Shank 3-1/8" long, 5/16" square. Flange 5/32". Plain finish standard; zinc or chromium finish also available. Wt. 1 lb.

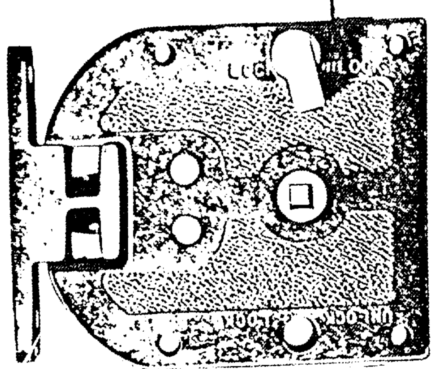
Special length shanks available on special order.

No. 79-S FLUSH HANDLE

Handle 4-7/8" dia. Recess 1/2" deep. Shank 3-1/8" long, 5/16" square. Flange 1/2". Plain finish standard; zinc or chromium finish also available. Wt. 13 oz.

CANADIAN AND FOREIGN PATENTS

No. 206U



Left-hand shown; right- opposite.

dimensions:

- $4\frac{3}{8}$ in. length of case
- 5 in. width of case
- $5\frac{27}{64}$ in. width of case with striker
- $\frac{3}{4}$ in. depth of case
- $1\frac{11}{64}$ in. depth of case with striker
- $\frac{17}{64}$ in. mounting holes (4) on 3" x $3\frac{5}{8}$" (HxV) pattern
- $\frac{9}{32}$x$\frac{13}{32}$ in. oval mounting slots (2) on $3\frac{1}{8}$" centers on striker
- 4x$1\frac{1}{8}$ in. mounting face of striker
- $\frac{5}{16}$ in. square hole for handle shank

Weight depends on system used. Consult factory.

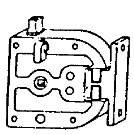
general description:

This lock is intended primarily for passenger doors on vehicles. Certified to meet the Federal Motor Vehicle Safety Standard No. 206 and to comply with established OSHA safety standards, this lock can be installed on doors as thin as $\frac{13}{16}$ inches inner skin to inner skin . . . or the inner surface of a door panel. It can be used for direct operation, remote operation or a combination of both. The lock is designed so there is no concern about accidental lockouts, because the inside thumb latch kicks out automatically when the door is slammed. The split tumbler allows locking or unlocking from inside or outside. Provision is made for vertical or thumb-rotary locking and unlocking from the inside. And the mechanism is enclosed to minimize damage from foreign objects. The striker is designed for primary and secondary latching capability.

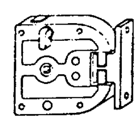
Accessories for this lock are: independent pillar locking cylinders, single or double remote control levers, and recessed paddle handles and L-type handles (both available key-locking or non key-locking).

Available for left-or right-hand installation. Left-hand shown. Specify, when ordering.

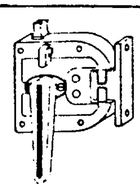
No. 206U and VARIATIONS (Right-hand shown; left opposite.)



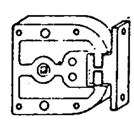
No. 206U
with striker (standard).



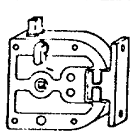
No. 1-206U
Same as No. 206U except with cut-off lock button No. 1-206-11.



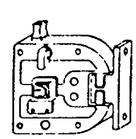
No. 2-206U
Same as No. 206U except with stainless steel non key-locking inside handle No. 24-5551.



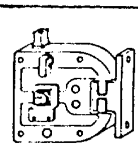
No. 3-206U
Same as No. 206U except less locking feature.



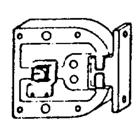
No. 207U
Same as No. 206U except with one remote control lever on back cover.



No. 1-207U
Same as No. 207U except remote control lever is on front cover.



No. 208U
Same as No. 206U except with two remote control levers.



No. 1-208U
Same as No. 208U except less locking feature.

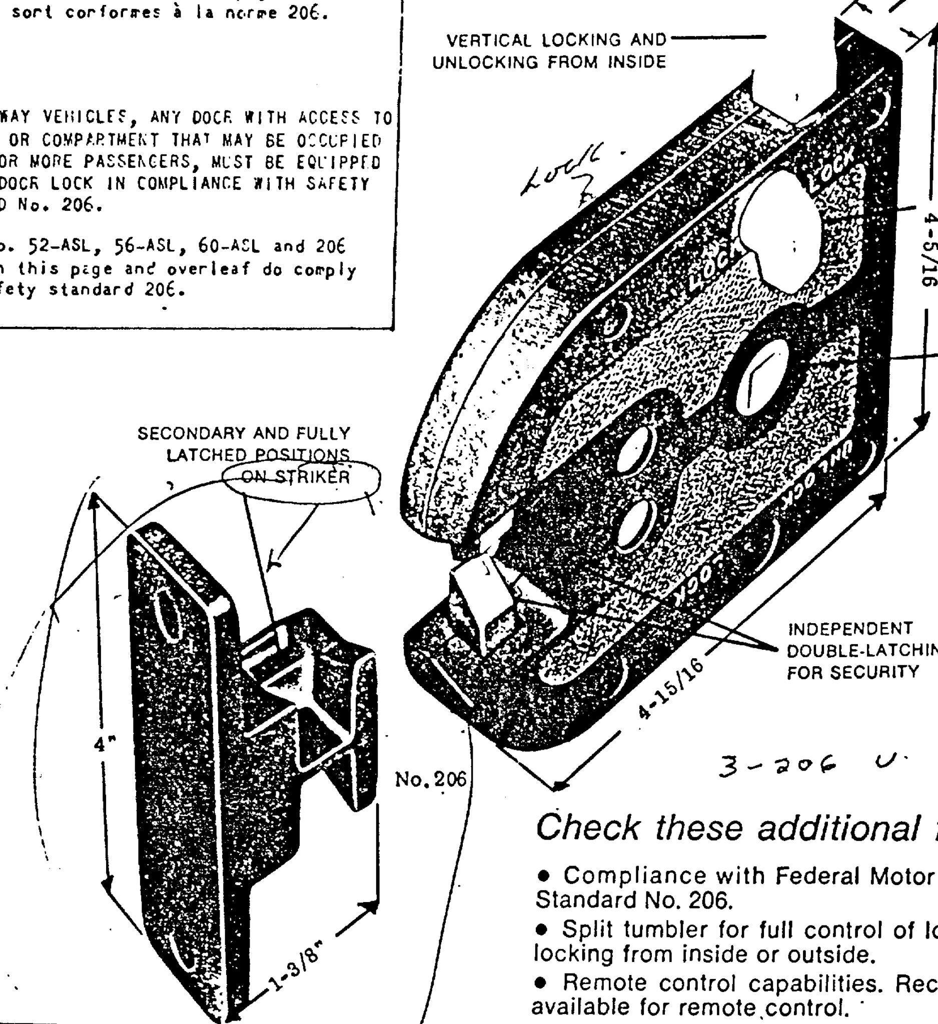
Section VIII
MISCELLANEOUS

SUR LES VÉHICULES ROUTIERS, TOUTE PORTE DONNANT ACCÈS À UN ESPACE POUVANT ÊTRE OCCUPÉE PAR UN OU DES PASSAGERS, DOIT ÊTRE MUNIE D'UNE SERRURE CONFORME À LA NORME DE SÉCURITÉ No. 206

Les serrures Nos. 52-ASL, 56-ASL, 60-ASL et 206 illustrées sur cette page et au verso, sont conformes à la norme 206.

ON HIGHWAY VEHICLES, ANY DOOR WITH ACCESS TO A SPACE OR COMPARTMENT THAT MAY BE OCCUPIED BY ONE OR MORE PASSENGERS, MUST BE EQUIPPED WITH A DOOR LOCK IN COMPLIANCE WITH SAFETY STANDARD No. 206.

Locks No. 52-ASL, 56-ASL, 60-ASL and 206 shown on this page and overleaf do comply with safety standard 206.



EBERHARD

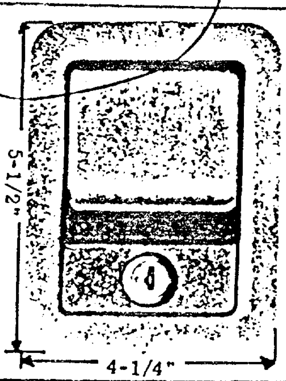
3-206 U

Recessed handles for remote control of lock No. 206 above.

NOTE. Links are not supplied they must be custom made with rod or cable.

No. 249 non locking

No. 250 key locking



Check these additional features:

- Compliance with Federal Motor Vehicle Safety Standard No. 206.
- Split tumbler for full control of locking and unlocking from inside or outside.
- Remote control capabilities. Recessed handles available for remote control.
- Automatic kickout of inside thumb locking when door is slammed to prevent accidental lock-outs.
- Outside locking or unlocking with provision for pillar locking cylinder.
- Striker can be made to accommodate post design.
- Lock can be mounted on surface of door panel or contained between outer and inner skins of door.
- Fully enclosed mechanism.

The Eberhard 206 Safety Slam Lock has been designed and built to bring automotive safety standards to:

Truck cabs and passenger compartments
Agricultural equipment • Construction equipment
Motor homes

FAUCHER & FILS INDUSTRIES (1964) LIMITÉE LIMITED
MONTRÉAL — TORONTO — EDMONTON — VANCOUVER

A.L. HANSEN Mfg. Co.

LOCKS
Cab

No. 55 CAB LOCK*
(left-hand shown)

Inside handle. No mortising required. Built-in pull handle integral with lock bushing. Die-formed steel bushing; 1" striker bolt. Size 3-3/8" high, 2" wide, 3-1/4" handle. Weight 5/8 lb. (283.5 grams). Both left-and right-hand models.

Available with reverse bolt when specified. Also specify plain or zinc finish.

NOTE: Available with new .093 case matl. by ordering 55-HD.

No. 55-B CAB LOCK *
(right hand shown)

Inside Handle. No mortising required. Built-in Push Handle integral with lock bushing. Die-formed steel bushing; 1" striker bolt. Size 3-3/8" high, 2" wide, 1-1/4" handle. Weight 1 lb. (453.6 grams). Both left and right hand models.

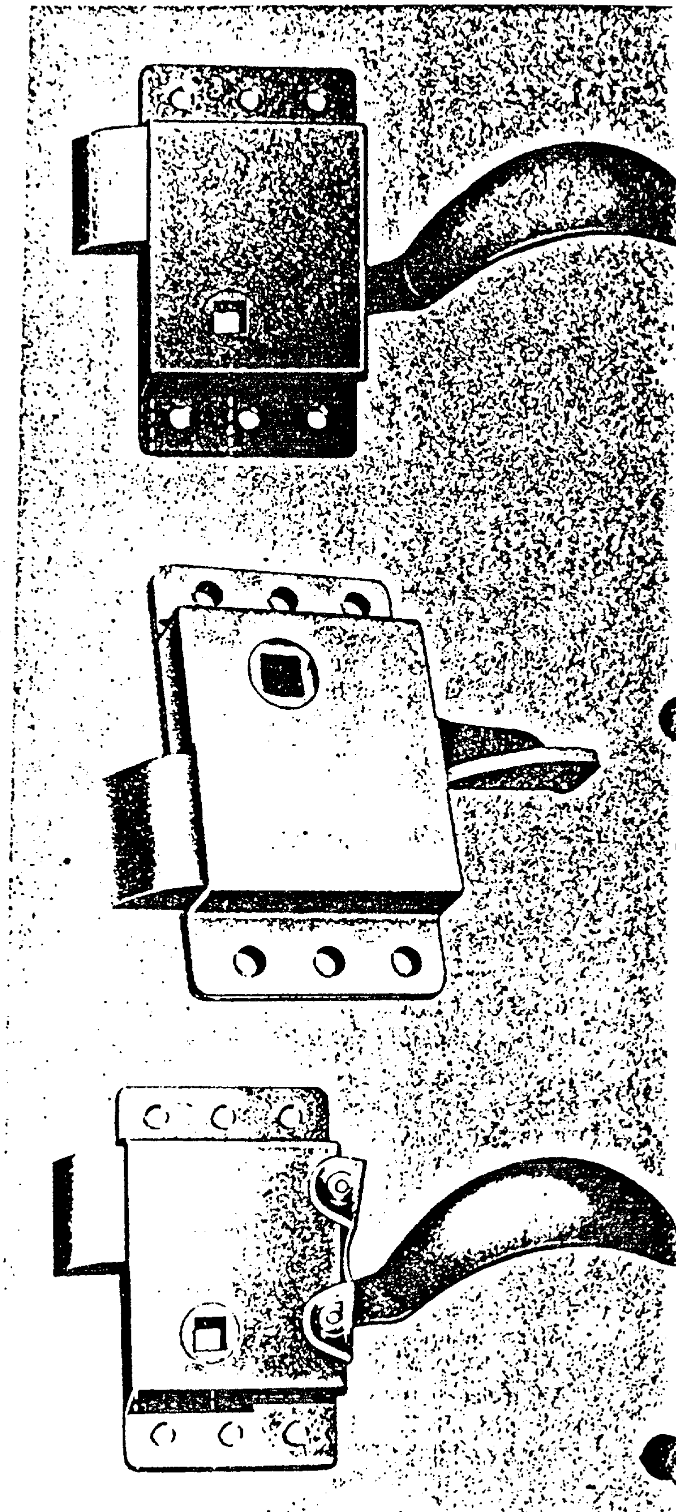
Available with reverse bolt when specified. Also specify plain or zinc finish.

No. 56 CAB LOCK*
(left-hand shown)

Inside handle. No mortising required. Locking device inside lock and unlocks by easy thumb pressure. Size 3-3/8" high, 2" wide, 3-1/4" handle, 1" striker bolt. Weight 3/4 lb. (340.2 grams). Both left and right-hand models.

Available with reverse bolt when specified. Also specify plain or zinc finish.

*All locks marked with asterisk are available with flanged back plate if desired-order by adding "F" to lock number.



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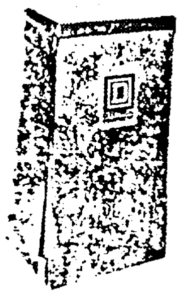
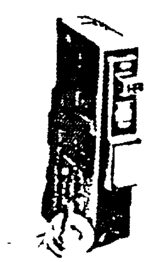


PART NO.	DESCRIPTION	DIM. OF COMP'T		
		H	L	P
QO2R1	PROTRUDE COMP'T	305	152	133

THE DISJONCTOR QUIK-GARD
OFFER PROTECTION AGAINTS
OVERLOAD AND SHORT CIRCUIT



***Qwik-Gard**

UNIPOLAR WITH PILOT LIGHT VISI-TRIP 120V CA
10,000 A.P.C.
30 AMPS
PART NO: QO130GF1

F2098 B (1/82) OWNER'S CERTIFICATE OF WARRANTY INITIATION Sec. 1.1

I ,VERTER MODEL #__________ OWNER:__________

I' IVERTER SERIAL #__________ ADDRESS:__________

ALTERNATOR MODEL #__________ CITY:__________

F ATED AMPERAGE:__________ STATE:__________ ZIP__________

I certify that I installed the above listed A Series Inverter on the date shown, in accordance with installation instructions in the A Series Inverter Installation Manual, that the Inverter v is operating properly after installation, and that required harness and alternator check-out c.ta were recorded on the warranty initiation card and sent to DYNAMOTE Corporation.

I s..lling Company Name:__________ Signature of Installer:__________

WARRANTY INITIATION CARD

DYNAMOTE SERIES "A/A" INVERTERS

Inverter Model #__________
I-verter Serial #__________
, .ternator Model #__________
Rated Amperage:__________
\ ehicle Make:__________
Model:__________
Use:__________
(wner:
Name:__________
Address:__________
____
City:__________
State:__________

READ VOLTAGE FROM: Condition:	BLACK to GREEN	RED to GREEN	BLUE to GREEN	ORANGE to GREEN	BROWN to GREEN
Ignition OFF, Inverter Start Button pushed					
Ignition OFF, no other action taken					
Engine ON at 1000 RPM					
Engine ON at idle, Inverter Start But. pushed					
Engine On, 1000 up to 2500 RPM; Commutation fuses removed; Inverter Start But. pushed					

(ERTIFICATE OF PROPER INSTALLATION. I certify that:

1) The figures above are the results of the Harness Check-Out Procedure, Section 3.6 of the Installation Instructions as performed by me.

2, ' hat the alternator checked out properly according to the Alternator Check-Out Procedure ection 3.6. of the Installation Instructions.

(That the entire Inverter power system worked properly after installation.

4) The Owner's Certificate of Warranty Initiation has been filled out and signed.

! .gned:__________ Date of Installation:__________

Company Name:__________ Address:__________

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO 8847 SEATTLE, WA

POSTAGE WILL BE PAID BY ADDRESSEE

DYNAMOTE

THE ELECTRONIC POWER HOUSE

1200 W. NICKERSON

SEATTLE, WASHINGTON 98119

Section VIII
MISCELLANEOUS

OWNER'S INSTALLATION/ OPERATION/ SERVICE MANUAL

"A" Series Dynamic Inverters

DYNAMOTE CORPORATION
1200 W. Nickerson
Seattle, WA 98119
(206) 282-1000

SECTION 1. DYNAMOTE LIMITED WARRANTY

1.0 LIMITED WARRANTY

1.1 DYNAMOTE CORPORATION (Manufacturer) warrants, to the original user, that each DYNAMOTE Product is free from defects in materials and factor workmanship if, and only if, the following requirements are complied with:

A. The product is installed and checked out properly, according to all guidelines, instructions, and checkout procedures set forth in the product Installation/Operation/Service Manual, and

B. The installer records all checkout data required and completes, signs, and returns the warranty initiation card to the DYNAMOTE office within ten (10) days after installation.

1.2 Manufacturer's obligation under this warranty is limited to correcting without charge any part or parts of such products which shall be returned to its factory or one of its authorized service facilities, transportation charges prepaid, within one (1) year from first installation or within eighteen (18) months from date of manufacture, whichever comes first, provided examination discloses to Manufacturer's satisfaction that such parts were originally defective. Correction of such defects by repair to, or supplying of replacements for defective parts, shall constitute fulfillment of all obligations to original user.

1.3 This warranty shall not apply to any of Manufacturer's products which must be replaced because of normal wear, which have been subject to misuse, negligence, or accident, or which shall have been repaired or altered outside of Manufacturer's factory, unless authorized by Manufacturer.

1.4 MANUFACTURER SHALL NOT BE LIABLE FOR ANY CLAIMS, LOSS, DAMAGE, OR EXPENSE WHATSOEVER RESULTING DIRECTLY OR INDIRECTLY FROM THE USE OF ITS PRODUCT OR FROM ANY OTHER CAUSE. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THESE LIMITATIONS MAY NOT APPLY TO YOU.

1.5 ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARISING BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OR TRADE OR OTHERWISE, INCLUDING BUT NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO A PERIOD OF ONE (1) YEAR AFTER FIRST INSTALLATION OR EIGHTEEN (18) MONTHS FROM DATE OF MANUFACTURE, WHICHEVER COMES FIRST. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU. NO PERSON, AGENT, OR DEALER IS AUTHORIZED TO GIVE ANY WARRANTIES ON BEHALF OF MANUFACTURER OR TO ASSUME FOR MANUFACTURER ANY OTHER LIABILITY IN CONNECTION WITH ANY OF ITS PRODUCTS UNLESS MADE IN WRITING AND SIGNED BY AN OFFICER OF MANUFACTURER.

SPECIAL NOTICE TO PURCHASER REGARDING WARRANTY PROCEDURE

It is absolutely necessary that the requirements of Paragraph 1. 1 above be complied with for warranty to be in effect. MAKE SURE THE INSTALLER HAS COMPLETED AND SIGNED YOUR PORTION OF THE WARRANTY INITIATION CARD, CERTIFYING THAT THOSE REQUIREMENTS HAVE BEEN COMPLIED WITH.

If any trouble occurs with this product during installation or before the warranty has expired, follow these instructions:

With model number and serial number available for reference, as well as all available installation test readings, dial the DYNAMOTE toll-free WATS line, 1-800-426-2838, and advise the receptionist that the call is regarding WARRANTY SERVICE ASSISTANCE.

DYNAMOTE CORPORATION - 1200 W. Nickerson, Seattle, WA. 98119 - 206-282-1000

SECTION 2. GENERAL INFORMATION
DYNAMIC INVERTERS

2.0 INTRODUCTION AND PRINCIPLE OF OPERATION:

2.0.1 Your new DYNAMOTE Series A Inverter is designed to provide 120 volt, 60 Hz AC power from the DC (rectified AC) output of a standard 12 volt electrical system (12 volt alternator in a vehicle or boat). The inverter is compact, lightweight, and operates silently. It can be placed in any convenient location in the vehicle or boat. Inverters, when installed in a 12 volt electrical system according to these instructions, can safely operate all electric tools, lights, appliances, electronic and heavy motor loads up to their rated capacity. Models are available to provide continuous 120 volt power up to 60 amps.

2.0.2 The relationship of a Dynamic Inverter to the vehicle electrical system is illustrated by the two diagrams below:

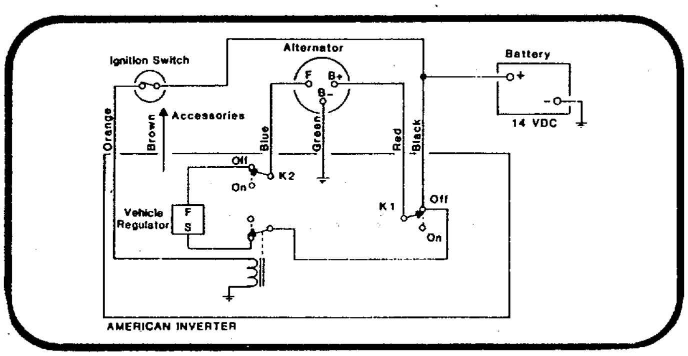


Figure 2.0.2A Inverter OFF

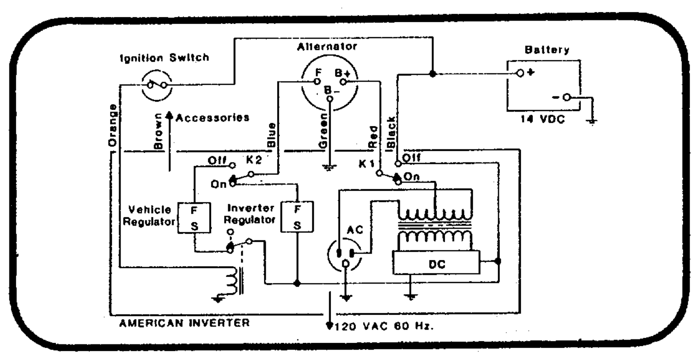


Figure 2.0.2B Inverter ON
(Nominal alternator output voltage, Inverter ON, Series A = 60 volts)

As shown in Figure 2.0.2A, when the inverter is OFF, the alternator and battery function as in normal 12 volt operation. The only differences are 1) that Dynamote Regulator CB3 controls the output of the alternator, and 2) that alternator output travels through the Dynamote harness on its way to the battery.

As shown in Figure 2.0.2B, when the inverter is ON, the system operates as follows:

a. All output of the alternator is switched away from the battery and into the inverter;

b. The alternator field is regulated by Dynamote Voltage Regulator CB1 inside the inverter. (See Note 1 below.)

c. The Dynamote regulator controls alternator output at 45 volts (A40) or 60 volts (A30/60) rather than the standard 14.2 volts;

d. The high voltage output enters the inverter transformer, the inverter produces 120 volt, 60 Hz power, and at the same time charges the vehicle battery and services the vehicle DC system at 14. 2 volts. (See Note 2 below.)

NOTES: 1. When the inverter is energized, the Dynamic Voltage Regulator CB1 senses voltage at the secondary output of the inverter and regulates the alternator field with battery power to maintain 14. 2 volts DC (rectified AC) at the BLACK wire of the inverter harness, which charges the battery.

2. The inverter transformer is wound so that at an average AC output of 120 volts, the vehicle battery is charged at 14. 2

2.0 INTRODUCTION AND PRINCIPLE OF OPERATION (continued)

volts DC. Both AC and DC voltages are regulated simultaneously by the Dynamote Voltage Regulator. If AC output voltage is below or above 120 volts, battery charging voltage will be reduced or increased proportionately. For determining proper voltage settings after the inverter is installed, see Section 3. 8, "Checkout Inverter Operation."

2.1 SPECIFICATIONS

1. DC (rectified AC) Input: 45 volts (A40), 60 volts (A30/60).
2. Input Source: 12 volt alternator.
3. Input Electrical System: From 12 volt negative ground alternator systems only.
4. Input Voltage Regulation: Solid-state voltage regulator inside inverter .
5. Output: Simultaneous output of:
   a. 120 volt AC + 5%, 60 Hz + . 1 Hz and
   b. 14. 2 volt DC for vehicle system battery charging
6. Output Voltage Regulation: Solid-state voltage regulator inside inverter.
7. Output Frequency Regulation: Solid-state, crystal controlled oscillator inside inverter.
8. Output Wave Form: Modified square wave with no limitations on operation of electronic or electromechanical loads. Filters are available for wave form modification to sine wave, if required.
9. Ambient Air Requirements: Full load capability at 120°F ambient if properly vented. Output may be derated above 120 °F.
10. Cooling Air Requirements: Exhaust air must be vented away from the ambient. Intake air must be true ambient, and must be the amounts shown in Figure 2.1.A below for each model.

11. Miscellaneous: See following page.

2.1.1 INVERTER SPECIFICATIONS

Model Number	Watts, 120VAC Out-put	Amps, 120VAC Out-put	Surge Cap. AC Amps	Max. DC Char-ging	Dimensions H x W x D	Ship-ping Wt. Lbs.	Required Intake Cooling Air, CFM
A30-70B	3600	30	60	70	9 3/4"x 14 1/4"x15"	70	120
A40-120A	4800	40	60	120	9 3/4"x 17"x 14½-"	105	200
A60-120B	6000	50	75	120	9 3/4"x 17"x 14½"	105	200
*A60-120A	7200	60	80	120	9 3/4"x 17"x 14½"	90	200
MPA30A	3600	30	60	70	9 3/4"x 14 1/4"x15"	72	120
MPA40A	4800	40	75	120	9 3/4"x 17"x 14 1/2"	105	200
MPA60A	6000	50	75	120	9 3/4"x 17"x 14½"	92	200

*A60-120A has non-isolated transformer; all other models have isolated output transformer

Figure 2.1.1A Inverter Specifications

2.2 PRODUCT CONFIGURATION

2.2.1 Chassis - Dynamic Inverters are housed in a durable aluminum chassis, with four shock absorbing rubber feet. Cooling air is drawn in through louvers in each side wall and exhausted out through the back panel. Tie down brackets are provided with the hardware kit; they attach to the four heavy bolts at the bottom of the front and rear panels of the chassis.

2.2.2.1 Load Demand start/Stop Feature (Dynamic ("A" series) Inverter

Your dynamic inverter may be equipped with the optional Load Demand Start/Stop feature. If the feature is installed, there will be a /LD after the model number in the specification aria on the front panel and a small toggle switch on the instrument panel of the inverter labeled "Load Demand-Auto-Manual. " When the toggle is in the "Manual" position, the inverter. must be started and stopped with the "Start" "Stop" push button switch on the panel or the remote control.

When the toggle switch is in the "Auto" position the inverter will start automatically when a load is applied to the inverter and the engine is running. If there is an Autothrottle installed on the vehicle, it will be automatically activated when the inverter turns on as long as the vehicle is in park or neutral and the emergency brake is engaged.

In the "Auto" position, when the load is removed from. the inverter, there is a waiting period of approximately 15 seconds after which the inverter turns off and the Autothrottle is disengaged. This waiting period is to prevent constant increase and decrease of engine speed when short intermittent loads such as power tools are being run on the inverter. The time period resets every time a load is applied.

Note: During check out and troubleshooting procedures, the AutoManual switch should be in the Manual position.

2.2.2 Instrument Panel - Momentary START and STOP buttons, AC voltage indicator, and remote control receptacle are provided. Two 15 amp convenience receptacles are provided on the-front panel. Each receptacle is separately fused. A control circuit fuse, commutation (input) fuses, and an "on-off" indicator light are also located on the front panel.

2.2.3 AC Hardware - A knock-out plug is located in the back panel of the chassis for hardwiring AC output to an external electrical system. A Romex cable clamp for attachment of a flexible metal "BX" cable housing which should shield and restrain the AC leads is provided in the hardware kit. AC hardwiring instructions are set forth. in Section 3. 9 of the Instruction Manual.

2.2.4 Hookup Harness - All inverters come standard with Quick Disconnect, 20 foot, six wire harness. Harness is separate from the inverter to provide for easy installation and checkout according to the official instructions. Once properly installed to the vehicle electrical system, harness MUST be checked out according to the procedure set forth in Sec. 3. 6, and the. results MUST be recorded on warranty initiation card. The 4-2600 Dynamic Installation Test Module plugs into the test receptacle on the front of the inverter and provides the readings necessary to checkout the installation and to record the information on the warranty card.

2.2.5 Chassis Configuration - Shown on the following page in Figures 2.2.5A and 2.2.5B.

2.2.5 Chassis Configuration

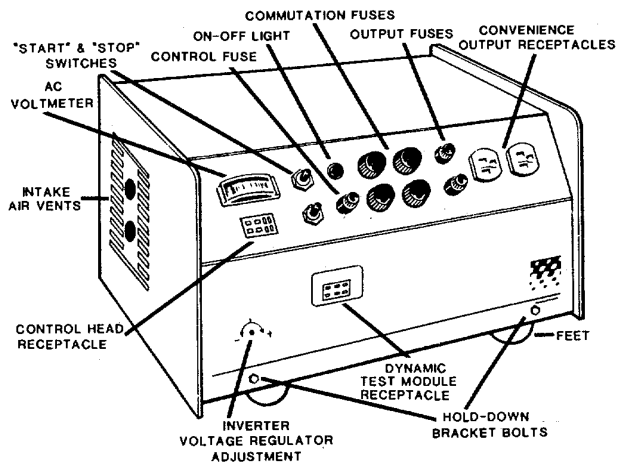


Figure 2.2.5A
Dimensions shown are for A40, MPA40, A60, and MPA60.

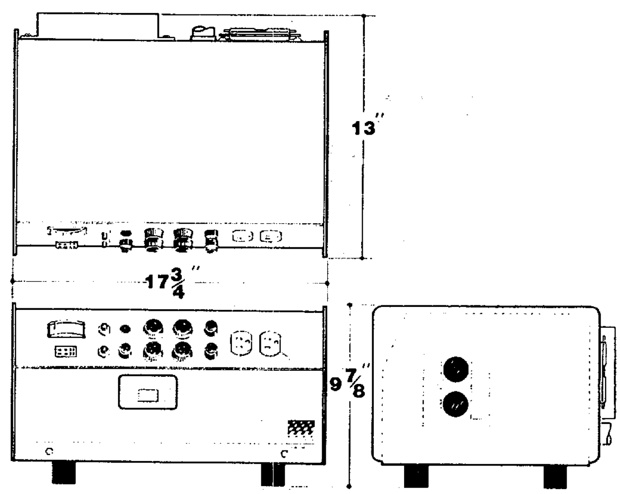


Figure 2.2.5B
A30 and MPA:30 dimensions are:
H = 9 3/4"; W = 14½; D = 15"

2.2.6 Mounting Configuration

Diagram 2.2.6A below shows the mounting dimensions for the A30 Series.

Diagram 2.2.6B below shows the mounting dimensions for the A4(0/A60 Series.

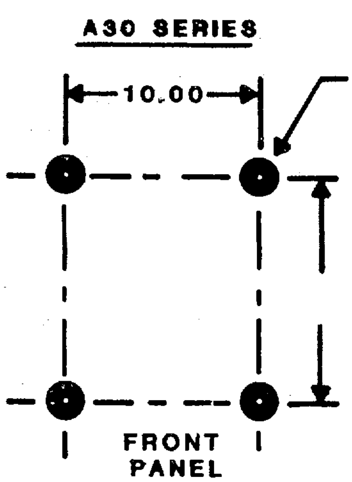


Figure 2.2.6A

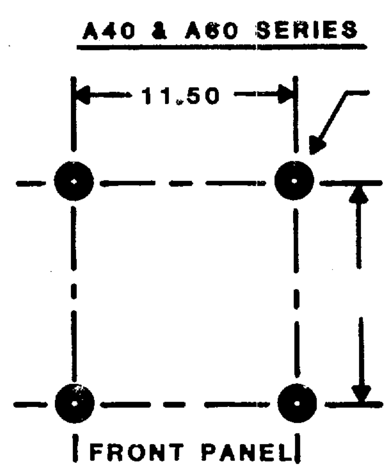


Figure 2.2.6B

2.2.7 Miscellaneous - Installation hardware, spare fuses, warranty statement and registration card, and instruction manual accompanies each new inverter. The manual should be kept with the inverter at all times.

2.3 SELECTION OF ALTERNATOR AND INVERTER - AMPERAGE REQUIREMENTS OF VARIOUS LOADS

Average amps for operating various frequently used loads are shown in Figure 2.3A below.

* Air Conditioners	8 - 15
Automatic Pilot	1 - 2
Blender	3- 7
Broiler	10- 15
Coffee Maker (12 cup), Fry Pan	8 - 12
Depthmeter	1/2 - 1
Drills: 1/4" to 1/2"	1- 6
Electric Blankets	1/2 - 3
Fans	1/2 - 3
Grinders	5 - 10
Heaters: Water	8 - 40
Space	5 - 15
Hot Plate Element	5- 10
Impact Wrench	3 -6
* Ice Maker	2-4
Irons: Hand	4 - 12
Soldering	1- 5
* Microwave Ovens	10- 13
Radar	4- 12
Radios	1/2 - 3
Ranges (per element)	8 - 15
* Refrigerator	2- 5
Sanders	1/2 - 10
Saws: Sabre	3 - 10
Builders	5- 13
Sewing Machine	2- 4
Skillet	10 - 15
TV Sets	1 - 5
Toasters	3 - 12
Vacuum Cleaners	1 - 8

*Inductive loads require intermittent starting surge amperage up to four times running amperage.

Figure 2.3A Average Amps for Appliances and Tools

2.3 SELECTION OF ALTERNATOR AND INVERTER - AMPERAGE REQUIREMENTS OF VARIOUS LOADS (continued)

The approximate amps required to start and run various sizes of electric motors is shown in Diagram 2.3B below:

Motor Loads		Approximate Amps Required to Start	
Motor H P Rating	Approx. Running Amps.	Repul. Or Capac. Induc Type	Split Phase Type
1/6	4.4	8	12
1/4	5.8	9	14
1/3	7.2	11	16
1/2	9.8	15	22
3/4	13.8	22	
1	16.0	28	
1 1/2	20.0	39	
2	24.0	51	
3	34.0	76	

For hard starting loads, increase motor starting requirement by 25%.
NOTE: Motor load, running amperage - taken from Table 430-148, page 388, NFPA Handbook of the National Electrical Code, 3rd Edition, 1972.

Figure 2.3B Average Motor Loads, Starting and Running

2.4 SELECTION OF ALTERNATOR AND INVERTER - continued
ALTERNATOR PERFORMANCE DATA

The alternator is the basic power source for the inverter, so the inverter output is dependent on the size and type of alternator, and the speed at which the alternator is turning. The following power curves plot the total output of the inverter on the vertical axis vs. the alternator RPM on the horizontal axis. The most convenient way to use these curves is as follows:

1. Find the required power level on the vertical axis.
2. Move horizontally to the intersection with the power curve.
3. Read the alternator RPM on the horizontal axis below the intersect point.
4. To convert alternator RPM to engine RPM, divide alternator RPM by the pulley ratio.
5. To determine the pulley ratio, divide the crankshaft or drive pulley diameter by the alternator pulley diameter.

POWER OUTPUT: AC vs. DC

It is important to note that the output rating of a Dynamic Inverter is the combined 120VAC and 14 VDC output. A graph of the relationship of the 120VAC and 14VDC outputs of the Dynamic Inverters is shown in Figure 1.

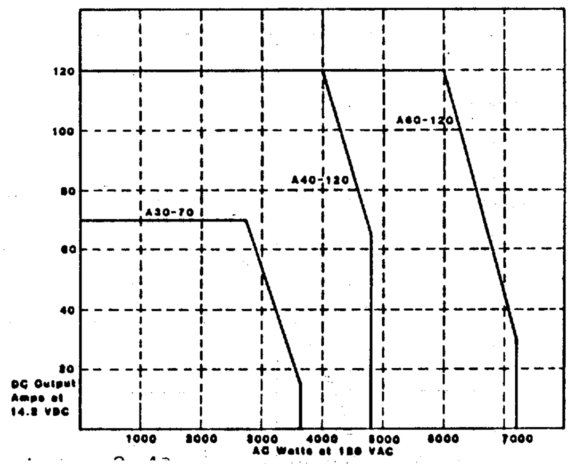
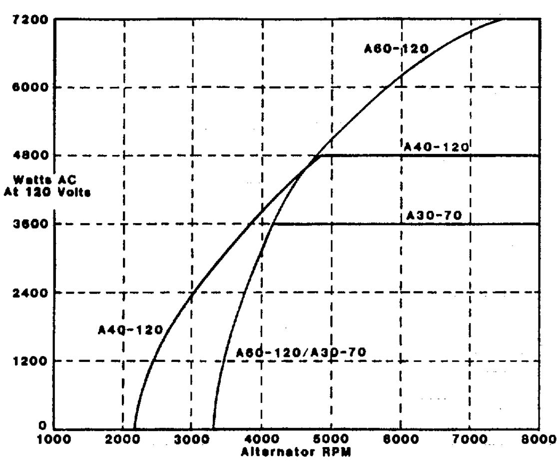
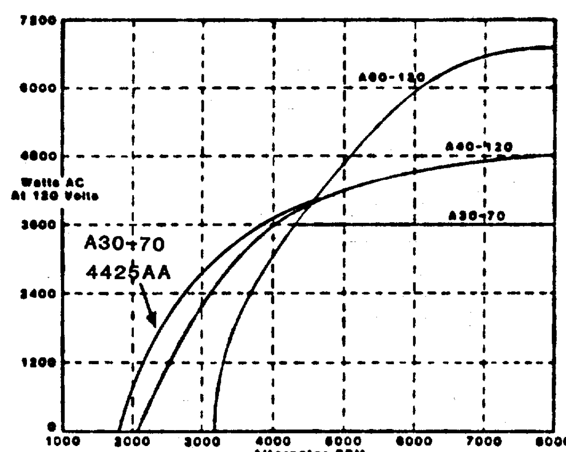


Figure 2.4A



Leece Neville 8050 – 140 Amps

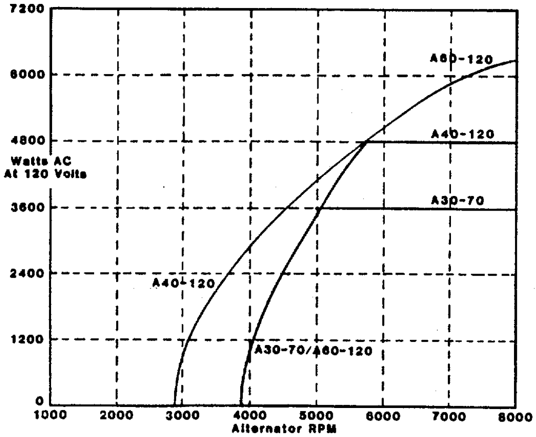


Leece Neville 4725 – 130 Amp

Figure 2.4B

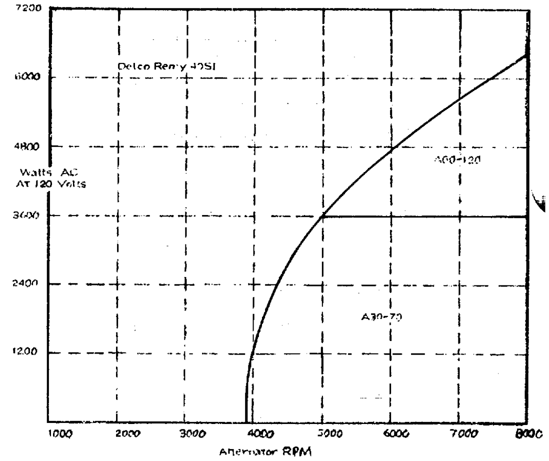
Figure 2.4C

ALTERNATOR PERFORMANCE DATA - Continued



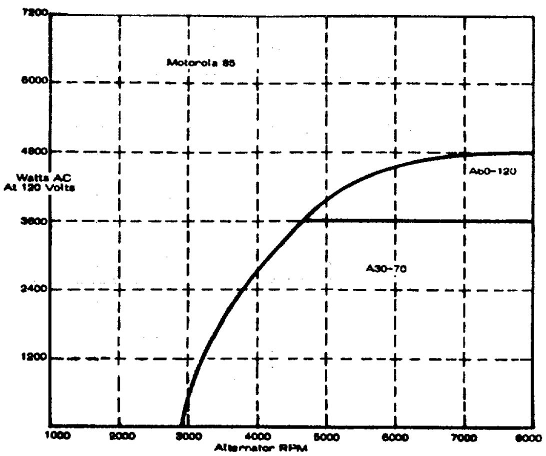
Leece Neville 7705/7706–165 Amps

Figure 2.4D



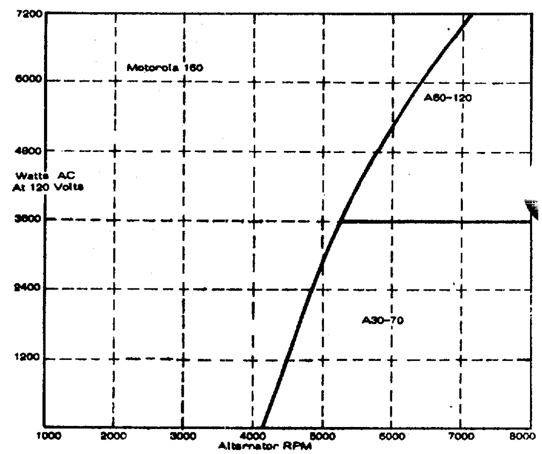
Delco Remy 40SI – 145 amps

Figure 2.4E



Motorola SA85 – 85 amps

Figure 2.4F



Motorola SA160 – 160 amps

Figure 2.4G

PERFORMANCE DATA AND CAPABILITY OF VARIOUS ALTERNATORS

Alternator Model	Inverter Series	AMPERAGE 4.17	8.33	12.50	16.67	20.83	25.00	29.17	33.33	37.50	41.67	45.83	50.00	Alternator Data: Amp. Rating @ 14VDC	Cont. Amp. Cap. @ 120VAC	Intermittent Starting AC Amp. Cap.
		WATTAGE 500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000			
Delco Remy 40SI	A40 A30/A60	3900	3950	4050	4200	4400	4650	4900	5300	5750	6350	6900	7500	145	40	55
Motorola 68	A40 A30/A60	2900	3000	3200	3500	4000	4700	6500						68	22	30
Motorola 84	A40 A30/A60	3100	3250	3450	3700	4100	4500	5050	6350					84	30	35
Motorola 85	A40 A30/A60	2950	3100	3300	3500	4000	4250	4600						85	30	40
Motorola 120	A40 A30/A60	3600	3750	3900	4100	4300	4550	4800	5150	5650	6500	7750		120	42	45
Motorola 160	A40 A30/A60	4250	4350	4500	4700	4850	5050	5250	5450	5650	5850	6100	6350	160	60	65
Leece Neville 4400	A40 A30/A60	2000	2100	2290	2600	3060	3850							75	25	38
Leece Neville 4600	40 A30/A60	2725	2875	3100	3450	3850	4350	5350	8000					105	35	43
Leece Neville 4725	A40 A30/A60	3300	3425	3550	2775 3700	3250 3850	3400 4100	3850 4350	5000 4650	5000	5350	5800	6450	130	50	55
Leece Neville 7600	A40 A30/A60	3700	3850	2850 3975	3750 4200	5900 4500	4900	5300	5725	6200	7000			105	35	43
Leece Neville 7705/7706	A40 A30/A60	3900	4100	2700 4250	3100 4500	3675 4700	4350 4950	5200	5500	5900	6350	6950	7650	130	50	50
Leece Neville 8050	A40 A30/A60	3600	3750	2200 3850	2375 4000	2650 4150	3050 4300	4500	4650	4850	5050	5300	5550	140	60	65

Figure 2N Alternator Performance Data and Capability Ratings

Figure 2.4H

2.5. OPERATING GUIDELINES:

Follow these four basic rules, and your Dynamic Inverter will provide continuous satisfactory performance at its rated capacity:

2.5.1 Use an alternator and Inverter capable of sufficient power for all your requirements. See Section 2. 4 for guidelines in selecting proper alternator and Inverter. Remember that too small an alternator will limit motor starting and provide erratic voltage output.

2.5.2 Turn the alternator fast enough to generate the required power. The Inverter does not generate power, so you must provide the input necessary for the desired AC output. Use an automatic throttle for. stationary applications, or a GUARDIAN for underway applications, to assure safe operation.

2.5.3 Keep it cool. Solid-state components are affected by temperature. The Inverter has an internal cooling fan which will cool the components if sufficient cooling. air is provided to the intake louvers. If installed in a cabinet, provide intake louvers equal in area to the louvers on the chassis end panels, and provide an air route for the fan's output away from the Inverter louvers, thus preventing recirculation of hot air through the Inverter. Air flow requirements are set forth in Section 2. 2.

2.5.4 Use the right size wire for your entire installation. Wire which is too small will starve your system and provide poor results even though you follow the other three rules. The wire in the harness . of each. Inverters of sufficient size for the length of the harness provided. However, if the harness length is extended, larger wire must be used according to the following wire size chart. The wire size chart should be followed explicitly.

Inverter Model Code	Wire Color to Alt.	Distance Inverter,, 0 - 20'	21' - 40'	41' - 60'	61' - 100'
A30	RED	6	6	4	2
BLACK		6	6	4	2
GREEN		8	6	4	
A40/A60,	RED	4	2	1	
1/0					
BLACK	4	2		1	1/0
GREEN	4	2 .		1	1/0
ALL	BLUE/GREY/	16	14	12	10
BROWN					
AC Hard-	15 amps	14	14	14	14
wiring	30 amps	10	10	10	10
	45 amps	8	8	8	8
	60 amps	6	6	6	6

Figure 2-0 Harness Wire Size Required

2.6. OPTIONAL MODIFICATIONS AND ACCESSORIES

2. 6. 1. Modification The following optional features are available on your inverter as factory modifications. They can be ordered from the factory by designating on the order the inverter model number, followed by the appropriate suffix designation.

a. /240: Simultaneous output of 120 volts and 240 volts from the same inverter. Maximum volt-amperage output at 240-volts is 67% of maximum volt-amperage at 120 volts.

b. MP: The MP (Marine) option includes the Low Voltage Cutout feature which disconnects the AC load from the inverter when the AC output voltage drops below a safe level, such as when the engine RPM falls below the minimum. This feature is particularly applicable to boats. 4-201 or 4-202 Remote Control is also included with the MP option.

c. 240/50Hz: Export models available with 50 Hz 240 volt output.

d. Load DemandStart/Stop: This feature senses load to start inverter and operate automatic throttle control. When the load is removed, inverter turns off and auto throttle returns to normal. There is a 5-30 second delay before the Stop Mode. The extent of this delay is subject to adjustment of Delay Control Knob on front panel.

e. Isolated Output (ISO): A means to ground one of the AC output leads for protection from electrical shock hazard when vehicle operates under conditions making shock a problem. ISO is recommended for operation of electronic equipment.

2.6.2. Accessories. The following convenience and safety accessories can be ordered from DYNAMOTE for use with the Dynamic Inverter:

a. Control Head (4-101): Provides remote "Start/Stop" switches and voltmeter on 15 foot harness. Plugs into receptacle on inverter instrument panel and mounts on top of or under a convenient surface where remote control is desired.

b. Autothrottle (4-306): Throttle control to automatically in crease engine to one preset speed when inverter energizes. (Energized by BROWN wire in inverter harness.)

2.7. OTHER DYNAMOTE PRODUCTS:

2.7.1 Static Inverters 500 to 6000 watts of dependable 120/240 VAC power from batteries, at input voltage levels of 12 to 120 VDC. Easy to install, offering high surge capacity with quiet, nonpolluting operation.

2.7.2 Battery Chargers From 10 to 40 amps precision charging capacity at 12, 24, and 32 VDC. You can rely on continuous charging at rated capacity, automatic equalization between battery cells, a constant float voltage, and input voltage compensation.

2.7.3 Alternator Boosters Boosts alternator capacity to 200 amps from 130 amps, to handle heavy DC loads.

2.7.4 Power Switch Automatically changes power source from inverter power to utility shore power. 15 to 30 amps capacity.

2.7.5 Voltage Guard Digital battery voltage monitor with visual and audible alarm when charging system voltage falls below safe level. Useful in vehicles with heavily loaded DC systems such as emergency and utility vehicles. Available for 12, 24, 32 volt systems.

2.7.6 Self-Contained Power Unit. Portable, self-contained inverter/ charger on wheels with batteries. Will run power tools on average usage for one to two days before recharge. 1800 watts of 120 VAC.

2.7.7 Inverter/Charger Units - Combination inverter/battery chargers -. from 800 to 1800 watts, for 12 or 24 VDC systems.

SECTION 3. INSTALLATION INSTRUCTIONS
DYNAIOTE SERIES "A" DYNAMIC INVERTERS

FOR INSTALLATION ON VEHICLES AND BOATS WITH 12 VOLT NEGATIVE GROUND ELECTRICAL SYSTEMS ONLY.

3.0 READ THE INSTRUCTIONS FIRST.

The Dynamote Dynamic Series "A" AC Power : Inverter, is a precision engineered and manufactured instrument capable of providing reliable AC electric power for thousands of hours. However, in order for the inverter to perform its job reliably, it is very important that each component of the system be installed carefully, and that each step be performed correctly. Therefore, before proceeding with the installation, it is suggested that you take a few minutes to familiarize yourself with the components of the system and how they are to operate when properly installed.

3.0.1. IMPORTANT NOTE:

There are nine distinct steps which must be followed in sequence to assure proper installation and operation of the entire system. These steps are summarized below, and described in detail beginning on the next page.

(1) Select inverter location.

(2) Route harness to alternator.

(3) Install proper alternator.

(4) Install automatic throttle, if used.

(5) Attach harness to alternator.

(6) Checkout alternator connections.

(7) Checkout inverter.

(8) Wire AC output.

(9) Complete, sign, and mail warranty registration card.

3.0.2. RECOMMENDED TOOLS AND EQUIPMENT FOR INVERTER INSTALLATION

(1) Socket wrench set (1/4" or 3/8" drive) with 1/4", 3/8", 7/16", 1/'2", and 3/4" socket, rachet; and 6" extension.

(2) " mechanic's screwdriver.

(3) 1/2" and 7/16" open end wrenches.

(4) V0 M (volt-ohm-milliamp meter) #4 Fluke 8020A, Simpson 463, or equivalent; Dynamote 4-2600

(5) Wire crimpers and lineman's pliers.

(6) Wire stripper.

(7) Electrical tape and electrical putty.

(8) Dynamote4-2600, Installation Tester

3.0.3. HARDWARE KITS INCLUDED WITH INVERTERS

Figure 3.0.3A on the following page-lists all the hardware items included with the various "A" Series inverters. Check and identify the various items as you unpack the shipping carton.

Figure 3.0.3A
HARDWARE KIT

Part #	Qty	Description	Used In: A30	A40	A60	MPA 30	MPA 40	MPA 60
2283-00014	1	Harness - Input - Power	x	x	x	x	x	x
4283-00010	1	Harness - Control	x	x	x	x	x	x
1		Field Grounding #16						
		White Wire (1')	x	x	x	x	x	x
	1	Bat. Isolator Defeat #16						
		Black Wire (20')				x	x	x
4200-06400	2	Fuses, ABU 40	x			x		
4200-06400	4	Fuses, ABU 40		x	x		x	x
4200-02150	3	Fuses AGC 15	x	x	x	x	x	x
4282-00006	2	Holders, Spare Fuse	x			x		
4282-00006	4	Holders, Spare Fuse		x	x		x	x
3056-11451	4	Brackets, Tie Down	x	x	x	x	x	x
4442-60920	2	Lugs, RB-257	x	x	x	x	x	x
4442-15200	2	Lugs, B-71	x	x	x	x	x	x
4442-14200	4	Lugs, B-87	x	x	x	x	x	x
4323-00417	1	Rubber Cap	x	x	x	x	x	x
4722-37008	1	1/4-20 x 3/8" Bolt	x	x	x	x	x	x
4520-27000	1	1/4-20 Kept Nut	x	x	x	x	x	x
4722-40008	4	#14 x 1" Screws	x	x	x	x	x	x
4442-16600	3	Lugs F-72	x	x	x	x	x	x
4-7211	1	Relay, High Amp. Bypass	*	*	*	*	*	*
4760-14000	5	Ty Raps	x	x	x	x	x	x

* Optional

Figure 3.0.3A HARI)WARE KIT CONTENTS

3.0.4 Start your installation with the first step and follow each step through in sequence to successful final testing. As it is completed, check off each step in the space provided adjacent to the step number of the test/warranty registration card.

DO NOT PROCEED TO ANOTHER STEP UNTIL ALL PREVIOUS STEPS HAVE BEEN SUCCESSFULLY COMPLETED.

INSTALLATION INSTRUCTIONS

3.1.0 SELECT INVERTER LOCATION

Place the inverter in a convenient location, such as in the vehicle cab or in a service compartment outside. Do not secure the inverter or tie it down at this time, and do not connect the harness to the inverter. Be sure that:

3.1.1 the harness will reach to the alternator, while providing proper length for bends and obstructions;

3.1.2 the inverter is in as cool a place as possible, and that there is adequate cooling air available. If in a closed cabinet, provide louvers or screened openings in the cabinet surfaces to supply cool intake air to the chassis end panels, and duct the inverter exhaust air to the outside of the cabinet. A flange (Part #41230000) is available from Dynamote for attaching dryer hose to the inverter exhaust;

3.1.3 it is protected from weather, inside the vehicle or in a service compartment or special cabinet.

3.2.0 ROUTE HARNESS TO ALTERNATOR

BURNING OR CHAFING THROUGH HARNESS INSULATION WILL DAMAGE THE INVERTER AND THE VEHICLE ELECTRICAL SYSTEMS. YOU SHOULD BE AWARE THAT THIS IS A COMMON INSTALLATION PROBLEM.

Route the wiring harness to the alternator, using existing holes where possible. Use tie wraps and tape liberally to secure the harness wires so they cannot come in contact with the hot engine exhaust or other heat producing components. Grommets should be used to protect the wiring harness where it comes in contact with hard or sharp edges.

NOTE: Do not attach any wires to the inverter at this time.

3.3.0 INSTALL PROPER ALTERNATOR ON ENGINE:

This step requires two things, as explained below. First is selection and preparation of a proper alternator. Second is proper installation on the engine.

3.3.1 To be a proper alternator, the alternator being installed must;

(1) Provide necessary power, according to the guidelines set forth in Section 2.4.

(2) Be properly wired to install with the inverter. If the alternator has an external regulator, no modification is necessary. IT IS STRONGLY RECOMMENDED THAT ALTERNATORS WITH EXTERNAL REGULATORS BE USED. THIS WILL SIMPLIFY INSTALLATION BY ELIMINATING ALTERNATOR MODIFICATION. IF THE ALTERNATOR HAS AN INTERNAL REGULATOR IT MUST BE MODIFIED BEFORE IT IS A "PROPER ALTERNATOR." For modification instructions for specific alternators, please refer to Figure 3.3.1A.

3.3 INSTALL PROPER ALTERNATOR ON ENGINE (continued)

Delco Remy 27SI Series, 200 Type	See Section 3.5.5.1
Delco Remy 40SI Series, 150 Type	See Section 3.5.5.2
Leece Neville Series 2000JB	See Section 3.5.5.3
Leece Neville Series 4000JA & 7000JA	See Section 3.5.5.4

Figure 3.3.1A INDEX TO MODIFICATION PROCEDURES FOR INTERNALLY REGULATED ALTERNATORS

3.3.2 The "Proper Alternator" must be installed correctly on the engine, according to the following general guidelines:

(1) Alternator Pulley Alignment: The requirements of the alternator mechanical installation are several: (1) solid, vibration-free attachment of the mounting bracket to the engine, and of the alternator to the mounting bracket; (2) correct belt alignment; and (3) protection from road spray or marine water spray, and from engine exhaust heat. Hardened steel flat washers should be substituted for spring lock washers on bracket and alternator as mounting hardware. Flat washers tend to provide and retain greater surface tension.

Correct belt alignment is essential for maximum alternator and belt service life. The center line of all pulleys related to the alternator drive must be within 1/32" of true center; see Figure 3.3.2A.

Dual belts are recommended for heavy duty alternators. Best results are obtained if the belts wrap the alternator pulley 100° or more. Lesser wrap induces belt slippage, belt and alternator bearing wear; see Figure 3.3.2B.

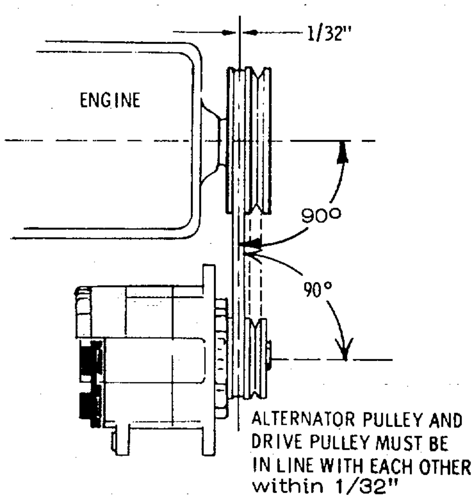


Figure 3.3.2A

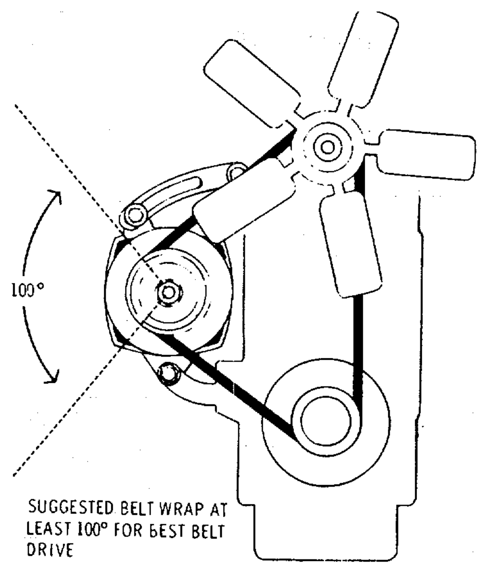


Figure 3.3.2B

Sec. 3.3 INSTALL PROPER ALTERNATOR ON ENGINE (continued)

(2) Pulley Ratio: The diameters of the crankshaft pulley and the alternator pulley will determine alternator RPM for a given engine speed. The largest possible crankshaft pulley and the smallest possible alternator pulley are most advantageous.

(a) For full output with Dynamic Inverter Models A30, A40, and A60, use single 5/8" belt or double 3/8" or 1/2" belts.

(b) Do not drive alternator in excess of 10,000 RPM.

(c) Design the installation so that average continuous speed of alternator at full load is less than 8000 RPM.

(d) Smallest alternator pulley diameter should be 2 1/2". Specially made 2 1/2" diameter double groove pulleys are available from Dynamote.

Tighten pulley nut to alternator manufacturer's specifications;-if specification is unavailable, tighten to 40 to 50 foot pounds. Tighten drive belts by applying pressure to the rear housing or stator. Set belt tension to engine manufacturer's recommendations. If this information is not available, tighten belts to the point at which the alternator fan cannot be turned by hand, or approximately 100 pounds of belt strand tension.

3.4.0 INSTALL AUTOMATIC THROTTLE (If used).

An automatic throttle provides automatic increase in engine speed to a preset RPM when the inverter is energized. It is designed for stationary use only, and should not be used while underway. IT MUST ALWAYS BE WIRED THROUGH THE NEUTRAL SAFETY SWITCH OF THE VEHICLE TRANSMISSION.

If the automatic throttle is used, refer now to automatic throttle instruction manual. NOTE: Brown wire from Dynamic Inverter Harness is to be attached to black wire from Autothrottle Harness.

If automatic throttle is not used, proceed to harness installation instructions, Section 3.5.

3.5.0 ATTACH HARNESS TO ALTERNATOR:

Installation of all Dynamic Inverters is exactly the same, electrically. The only differences will be that some installations will require the K3 High Amperage Bypass Relay, as explained in 3.5.1, Step 2, Note 3.

(a) The harness for the larger capacity inverters includes three BLACK AWG #4 wires. Two of these are marked at the ends with RED and GREEN tape. If these wires are shortened, be sure to color-code the ends properly.

(b) Alternators with internal regulators must be modified before the inverter harness can be installed. Please refer to Section 3.3.1, Figure 3.3.1A

(c) Instructions for the installation of the inverter harness begin with Section 3.5.1. Drawings of specific alternators showing the location of the terminals referenced in the instructions are listed in Figure 3.5.0A.

Motorola - 8SA20009R	See Figure 3.5.4A
Motorola - 12SA106	See Figure 3. 5.4B
Leece Neville - 4000AA Series	See Figure 3.5.4C
Leece Neville,- 7000AA Series	See Figure 3.5.4D
Leece Neville - 8000AA Series	See Figure 3.5.4E

Figure 3.5.0A INDEX TO EXTERNALLY REGULATED ALTERNATOR DIAGRAMS

3.5.1 BASIC INSTALLATION STEPS

1. Disconnect the battery negative ground cable from the vehicle system battery

NOTE 1: If a battery isolator is used in the electrical system, the inverter must be modified as shown in Section 3. 5. 2.

NOTE 2: If an electronic tachometer which is driven from an alternator AC tap or an alternator tachometer tap is, used in the system, a Dynamote Relay #4-1160 must be used when the Dynamic Inverter is installed. The relay provides for proper reading of the tachometer(s) both when the inverter is OFF and when it is ON. Refer to Section 3. 5. 3.

2. Disconnect all wiring from the positive output (B+) terminal of the alternator.

NOTE 3: If the wires disconnected in step #2 above are #10 AWG or smaller, attach a #4 AWG wire to the positive terminal of the battery. Route and connect this lead to the alternator wires disconnected in Step #2. This will bypass the vehicle ameter, if there is one, to avoid burning out with the larger alternator. It is recommended that a voltmeter be installed to monitor the battery condition and inverter operation.

NOTE 4: A High Amperage Bypass Relay , K3, (Dynamote sales part #4-7211) must be installed if your alternator output capacity exceeds the limits listed below for each inverter model:

A30 .... 141 amps
A40, A60 .... 141 amps

If K3 is required, install according to the instructions in Step 3.5.1., Step 3 below, and Figure 3.5.1A.. If K3 is not required, skip to Step 4 below and proceed following Figure 3.5.1B.

Section X
INSTALLATION INSTRUCTIONS

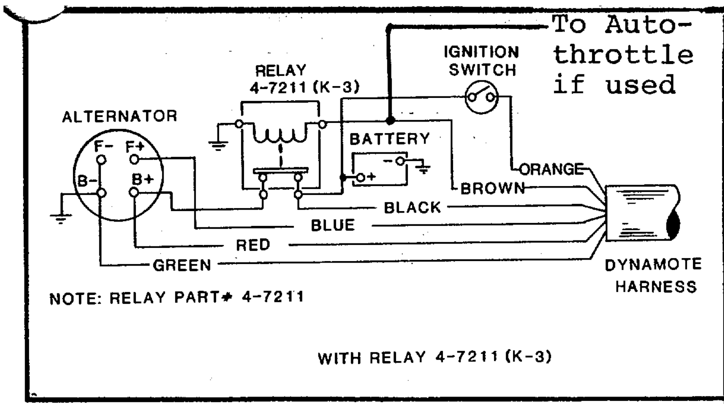


Figure 3.5.1A

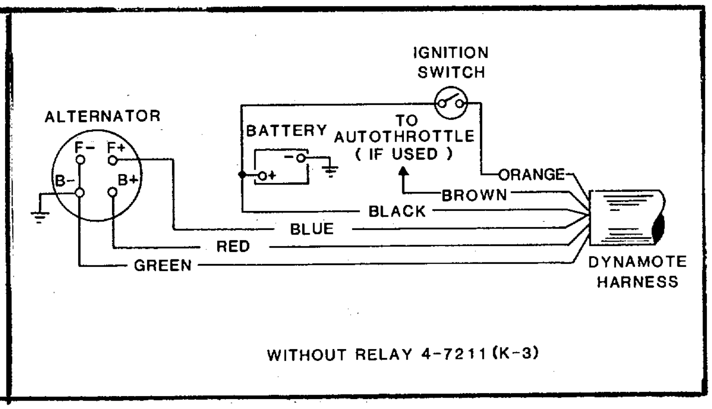


Figure 3.5.1B

3. High Amperage Bypass Installation

   (a) Securely mount relay K3 as close to the alternator as is practical with large (5/16") studs down. (Mounting of this relay with the studs up or horizontal would result in improper operation of the relay.) Use the large #4x3/4self-tap screws in the hardware kit for this purpose.

   (b) Connect the wires removed from the alternator positive output terminal in Step 2 above, along with the BLACK wire from the Dynamote harness to one of the large (5/16") studs of Relay K3. This connection provides charging current to the vehicle battery system.

   (c) Connect a length of #4 AWG wire from the other large (5/16") stud to the positive output terminal of the alternator.

   (d) Connect a #16 or #18 AWG wire from the chassis of Relay K3 to ground.

   (e) Connect the BROWN wire from the Dynamote harness to the small (#10) stud of Relay K3. This may have to be done through a jumper wire to the BROWN wire connected to the autothrottle solenoid} valve, if used.

4. This step is required only if relay K3 is not installed. Connect the wires removed in Step 2 above to the BLACK wire from the Dynamote harness using the small bolt and nut provided in the hardware package (Items 3,4,5). Tape this connection to prevent an electrical short. This connection provides charging current to the vehicle battery system.

3.5.1 BASIC INSTALLATION STEPS (continued)

5. Connect the RED wire from the Dynamote harness to the positive output (B+) terminal of the alternator. The ONLY other wire that can be attached to this terminal is the #4 AWG wire to the K3 Relay if that is installed.

6. Connect the GREEN wire from the Dynamote harness to the negative ground (B-) terminal of the alternator. Leave any previously attached wires connected to this ground terminal.

   NOTE: The B - terminal of the alternator and the negative (-) battery terminal must be securely grounded to the engine block.

7. Remove the wire from the alternator FIELD TERMINAL. Tape the end of this wire to prevent electrical short, and secure the wire. It will no longer be used, as the field will be regulated from the inverter.

8. Crimp the appropriate terminal in the hardware kit to the BLUE #16 Dynamote harness wire and attach to the Field (+) Terminal of the alternator from which the wire was removed in Step 7. There should be no wire attached to the FIELD (+) terminal except the BLUE harness wire.

9. If there is a negative (-) Field Terminal on the alternator check to see that it has been grounded to the negative (B-) terminal of the alternator. If not, use a piece of #16 AWG wire and the ring terminals provided in the hardware kit to accomplish this.

   NOTE: If the alternator has an internal regulator, the modification instructions referenced in Figure 3.3.1A accomplish the grounding of the negative field lead.

10. Attach the ORANGE wire from the Dynamote harness to a 12 volt source which is hot only when the ignition is on. This can be the switched side of the ignition switch, the ACC terminal on the ignition switch. Use ring terminals provided in the hardware kit.

11. If Autothrottle is used, attach brown lead from Dynamote control harness to black lead from 4-306 harness.

12. Reconnect the battery negative ground cable at this time. Proceed to Section 3. 6, CHECKOUT OF HARNESS INSTALLATION AND ALTERNATOR OUTPUT, unless your installation involves a battery isolator (Section 3.5.2) or an electronic tachometer relay (Section 3.5.3).

3.5.2 INVERTER MODIFICATION INSTRUCTIONS WHEN BATTERY ISOLATOR IS USED IN THE SYSTEM

1. Open the inverter by removing the front, back, and top panel fasteners. Carefully lay the front and back panels down and remove the top panel.

3.5.2 INVERTER MODIFICATION INSTRUCTIONS FOR BATTERY ISOLATOR (continued)

2. Remove the small BLACK #16 AWG wire between Terminal Strip Pin #6 in the front of the inverter and the B+ Terminal in back of the inverter.

3. Attach a #16 AWG or larger wire from Terminal Strip Pin #6 directly to the BATTERY POSITIVE (+) or to one of the battery terminals on the battery isolator. Terminals are available in the hardware kit for this purpose.

4. Close the inverter cabinet.

3.5.3 INSTRUCTIONS FOR INSTALLATION OF ELECTRONIC TACHOMETER RELAY

If an electronic tachometer which is driven from an alternator AC tap or an alternator tachometer tap is used in the system, a Dynamote Relay #4-1160 must be used when the Dynamic Inverter is installed. The relay provides for proper reading of the tachometer(s), both when the inverter is OFF and when it is ON. The relay has two identical sets of contact, so it can be used with either one or two tachometers. An adjustable trim pot is provided on each set of contacts, for accurate adjustment.

At a convenient location near where the relay is to be mounted, cut the wire presently leading from the tachometer to the alternator AC tap. Attach the two parts of this wire according to the diagram below. If two tachometers are used, attach one tachometer to each side of the relay board, as shown.

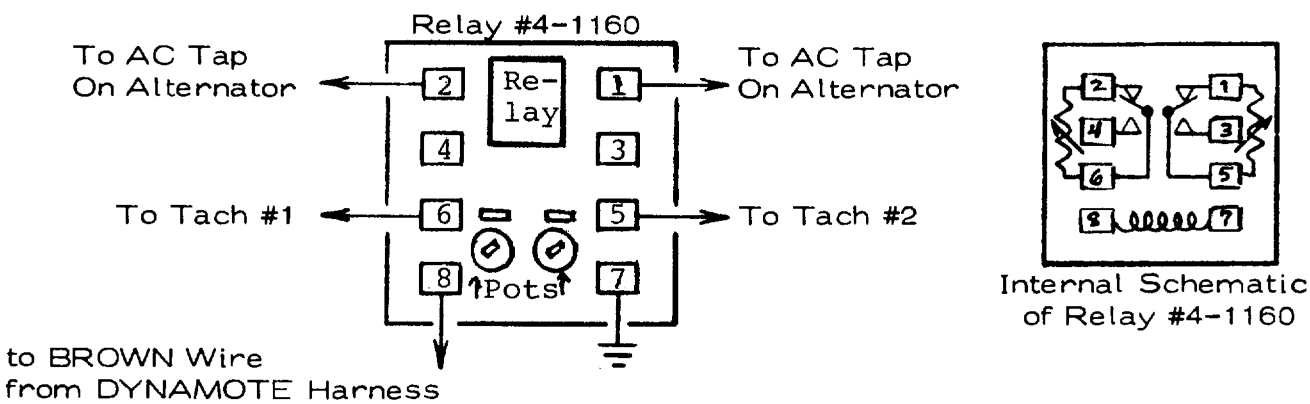


Figure 3.5.3A

For adjustment: With inverter OFF, increase engine speed to normal operating speed. Note the tachometer reading. Turn inverter ON and adjust trim pot on side of relay so that tachometer reads the same with the inverter ON as it reads with the inverter OFF. Repeat procedure for second tachometer.

Return to Section 3.5.1, Step 2.

3.5.4 DIAGRAMS FOR EXTERNALLY REGULATED ALTERNATORS

The diagrams which follow in this section show the essential features and terminals of frequently used externally-regulated series of alternators. Using the diagrams, proceed to the installation instructions contained in Section 3.5.1.

Diagram 3.5.4A shows the Motorola 8SA 2009R Series.

Diagram 3.5.4B shows the Motorola 12SA 106 Series.

Diagram 3.5.4C shows the Leece Neville 4000AA Series.

Diagram 3.5.4D shows the Leece Neville 7000AA Series.

Diagram 3.5.4E shows the Leece Neville 8000AA Series.

INSTALLATION INSTRUCTIONS

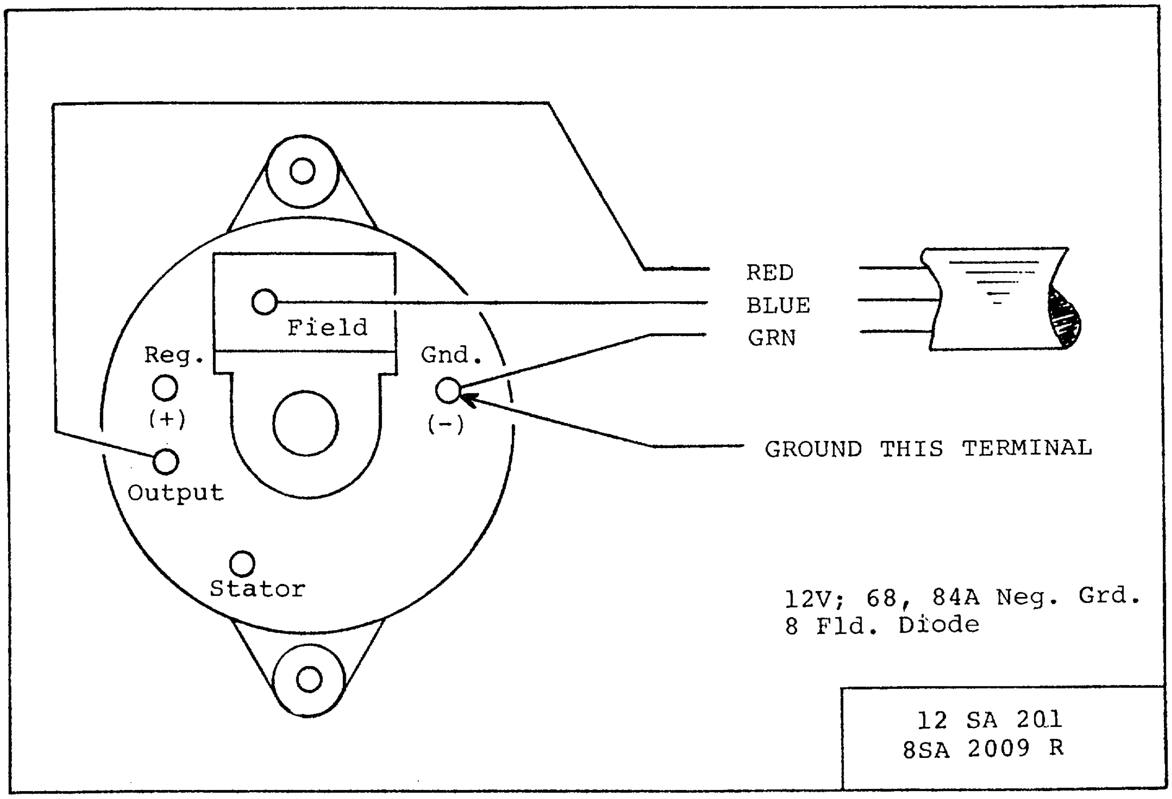


Figure 3.5.4A DIAGRAM OF MOTOROLA - 8SA 2009R

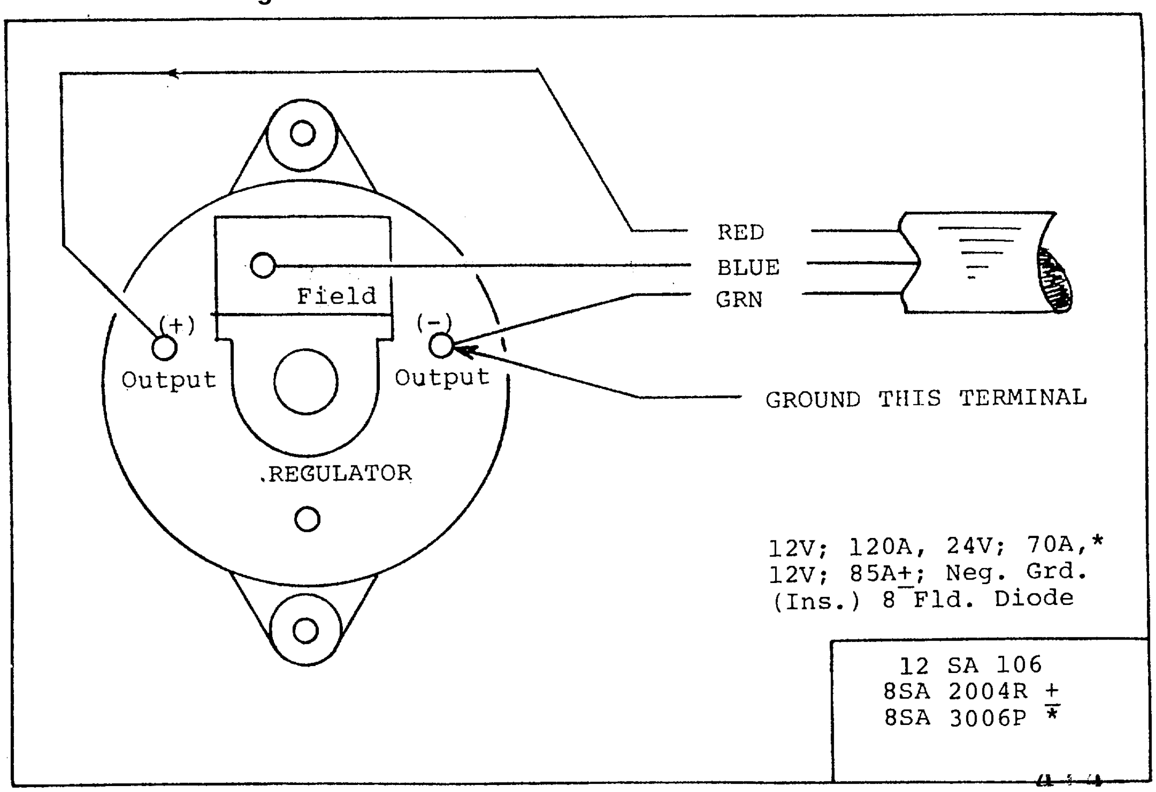


Figure 3.5.4B DIAGRAM OF MOTOROLA - 12SA 106

INSTALLATION INSTRUCTIONS

3.5.4 (continued)

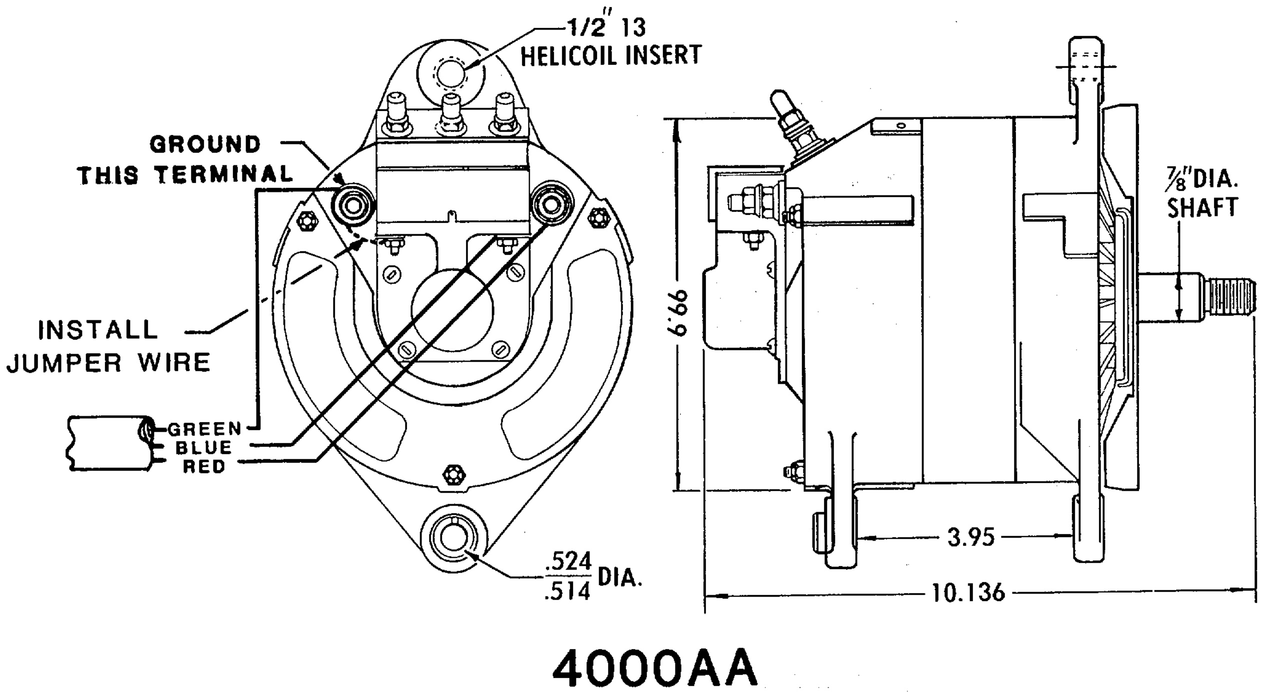


Figure 3.5.4C DIAGRAMS OF LEECE NEVILLE 4000AA SERIES ALTERNATORS

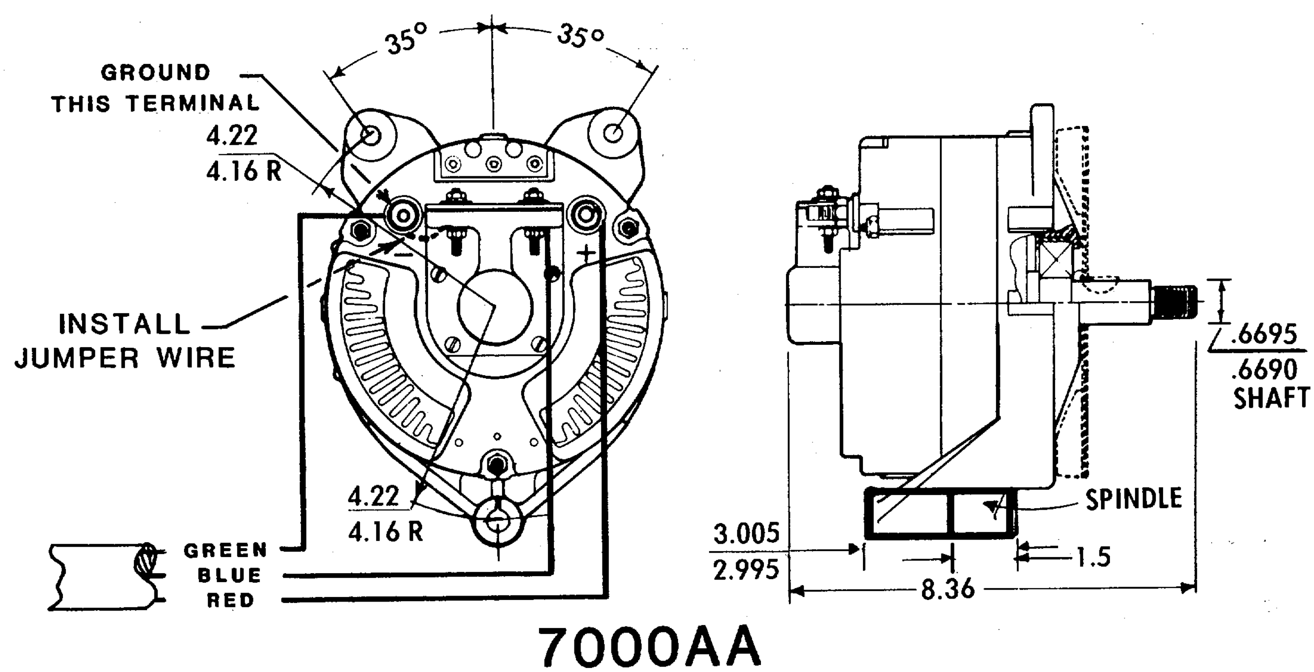


Figure 3.5.4D DIAGRAMS OF LEECE NEVILLE 7000AA SERIES ALTERNATORS

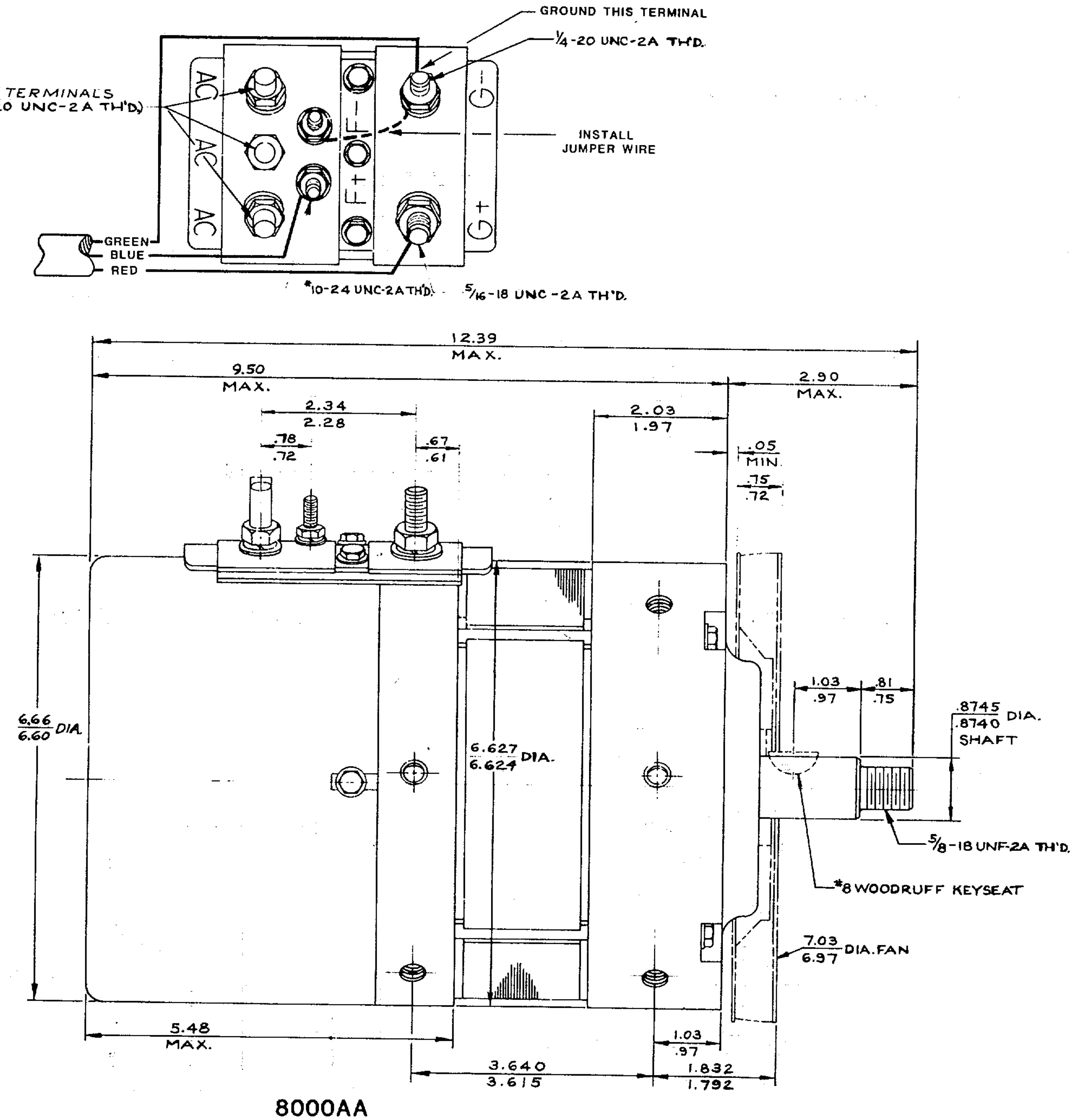


Figure 3.5.4E DIAGRAMS OF LEECE NEVILLE 8000AA SERIES ALTERNATORS

INSTALLATION INSTRUCTIONS

3.5.5.1 ALTERNATOR MODIFICATION INSTRUCTIONS FOR DELCO REMY 27SI SERIES, TYPE 200

The purpose of this modification is to provide a means to ground the negative field brush permanently for use with positive switching regulator.

1. Disconnect the battery grounding cable and remove the alternator from the engine mounting brackets. (If alternator can be left on vehicle, be sure to disconnect the battery grounding cable.)

2. Remove four thru-bolts from drive end frame on the alternator.

3. Separate slip ring and frame and stator assembly from drive end frame and rotor assembly. During modification and reassembly, hold brushes and springs in holder with a pin or toothpick inserted through end frame hole.

4. Separate stator from end frame by removing three stator lead attaching nuts.

5. Place tape over bearing and shaft to protect from dirt. . Use pressure-sensitive tape and not friction tape that would leave a gummy deposit.

6. Remove the diode trio from the alternator and discard. It will not be used for this installation.

7. Prepare a 12-inch length of WHITE #16 wire by putting a ring type (A-87) terminal connector on one end. Connect this wire terminal to the negative field terminal by using the negative brush terminal screw. Wire terminal must be under the insulating washer so that good electrical contact is made to the brush terminal.

8. Locate the black lead connecting the ceramic portion of the voltage regulator to the positive output terminal of the alternator (See Figure 3.5.5.1A.) Remove and discard this wire.

9. Thread WHITE wire to the exterior rear of the alternator by using convenient ventilating holes or else drill a hole in the end plate and use a rubber grommet to pass the leads through. Make sure the lead is routed and secured go that it will not interfere with moving rotor parts.

10. Reassemble the alternator by reversing procedures 2 thru 5. Connect WHITE wire, protruding through rear of alternator to ground (or alternator negative output terminal). Use #1 Regulator Terminal as BLUE wire (from DYNAMOTE Harness) connector terminal.

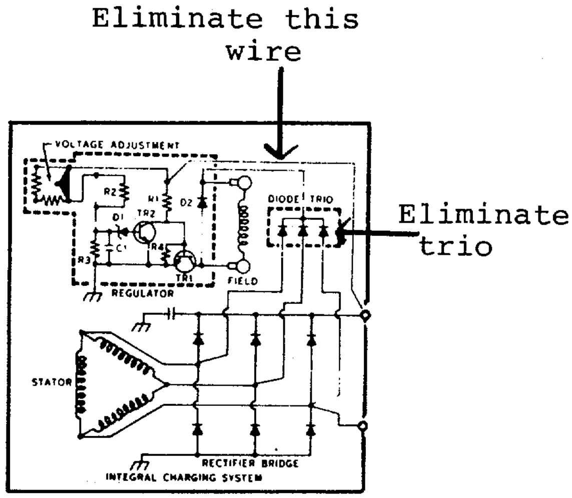


Figure 3.5.5.1A Delco Remy 27SI, Type 200, BEFORE MODIFICATION

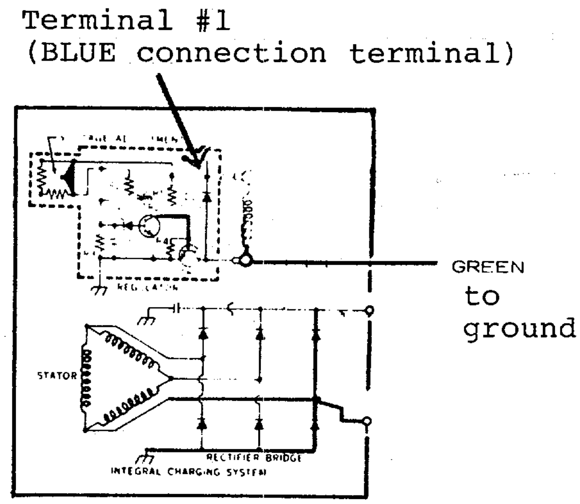


Figure 3.5.5.1B Delco Remy 27SI, Type 200, AFTER MODIFICATION

3.5.5.2. ALTERNATOR MODIFICATION INSTRUCTIONS FOR DELCO REMY 40SI SERIES, TYPE 150

NOTE: If you know you will be installing a Series "A" Dynamic Inverter on a Delco Remy 40SI alternator, order alternator #1117152. This alternator is factory designed for use with Dynamic Inverters and REQUIRES NO FIELD MODIFICATION. Remove jumper between "trio" terminal and "F+" terminal and proceed to Section 3.5.1.

The purpose of this modification is to provide a means to ground negative field brush permanently for use with positive switching regulators.

1. Disconnect the battery grounding cable and remove the alternator from the engine mounting brackets. (If alternator can be left on vehicle, be sure to disconnect the battery grounding cable.)

2. Remove end plate of alternator from slip ring and frame.

3. Hold shaft with hex wrench inserted into hex hole in end of shaft while removing shaft nut. Remove washer, pulley, fan, and slinger.

4. Remove four thru-bolts from drive end frame.

5. Separate slip ring end frame and stator assembly from drive end frame and rotor assembly.

6. Separate stator from end frame by removing three stator lead attaching nuts. Fig. 3.5.5.2B shows end frame with stator removed.

3.5.5.2 MODIFICATIONS FOR DELCO REMY 40SI SERIES (continued)

___ 7. Remove the diode trio from the alternator and discard it. It will not be used.

___ 8. Prepare a 12-inch length of WHITE #16 AWG wire by putting a ring type terminal (A87) connector on one end. Connect this wire to the negative brush terminal on the voltage regulator by using the negative brush terminal screw. Wire terminal must go under the insulating washer so that good electrical contact is made to the brush terminal.

___ 9. Locate the BLACK "regulator jumper lead" connected between the voltage regulator and the positive output (BAT) terminal of the alternator. Remove and discard. It will not be used.

___ 10. Thread the end of the lead from Step 8 to the exterior rear of the alternator by using convenient ventilating holes or else drill a hole in the end plate and use a rubber grommet to pass the leads through. Make sure the leads are routed and secured so that they will not interfere with moving rotor parts.

___ 11. Reassemble the alternator by reversing procedures in steps 2 through 6. Attach WHITE lead from rear of alternator to ground (or negative output terminal of alternator). Use #1 Regulator Terminal as BLUE wire from Dynamote connection terminal.

Fiq. 3.5.5.2A below is a schematic diagram of the- Delco Remv 40SI before modification.

Return to Section 3.5.1.

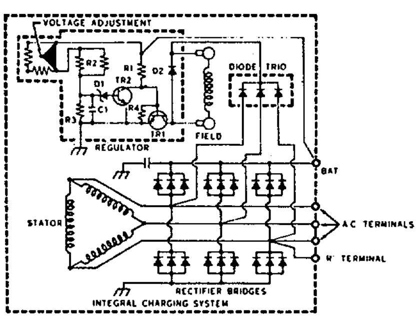
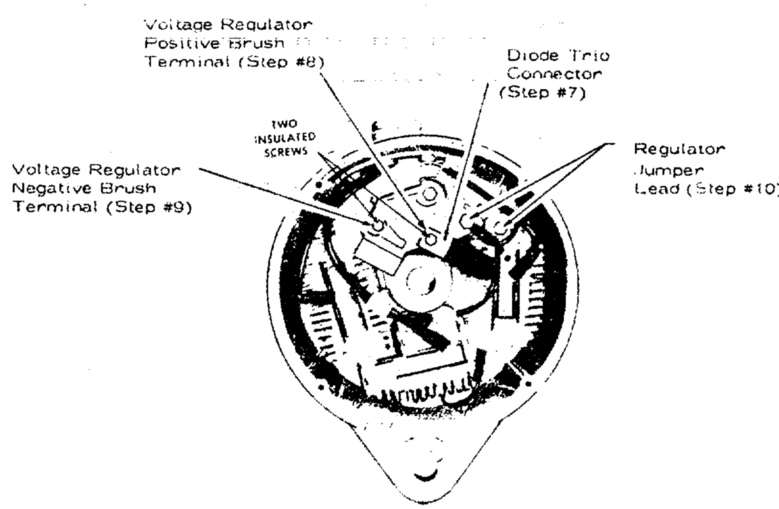


FIG. 3. 13. D.C. DELCO – REMY 40SI REGULATOR — BEFORE MODIFICATION



3.5.5.3 ALTERNATOR MODIFICATION INSTRUCTIONS FOR LEECE NEVILLE SERIES 2000JB

The purpose of this modification is to provide a means to ground negative field brush permanently for use with positive switching regulators.

___ 1. Remove four screws and carefully lift regulator free of housing. Remove RED and BLACK leads from regulator, noting their positions to facilitate assembly of new regulator. Only the BLACK lead will be replaced. The RED lead will not be used.

___ 2. Remove diode trio lead from diode trio terminal on outside of regulator housing.

___ 3. Loosen or remove inner nut, which allows BLUE regulator lead (or WHITE with BLUE tracer) to be withdrawn from under head of diode trio terminal screw (inside the regulator housing.)

___ 4. Remove regulator.

___ 5. Compress brush springs. and hold them in place by passing a pin through the retainer hold. A suitable pin can be made from a piece of 1/32" rod or a paper clip.

___ 6. Cut and tape securely the RED lead and tuck it into the bottom of the regulator housing. Be sure that it does not interfere with brush and spring assemblies. This lead will no longer be used.

___ 7. Take the 12" length of #16 AWG WHITE wire from the hardware kit and solder this wire to the negative brush terminal (the terminal nearest the alternator body).

___ 8. Route the white wire lead through the alternator housing and attach it to the alternator negative output terminal .

___ 9. Replace the regulator into the housing by reversing the procedure in Steps 1 through 5 above, except for Step 2. Do not reconnect the trio lead at this time. Tape and securely tuck trio lead away at this time.

3.5.5.3 <u>MODIFICATION INSTRUCTIONS FOR LEECE NEVILLE 2000JB</u> (continued)

____10. Alternator is now properly modified for installation of Dynamote harness. Connect BLUE wire from Dynamote harness to BLUE connection terminal. Proceed to Section 3.5.1.

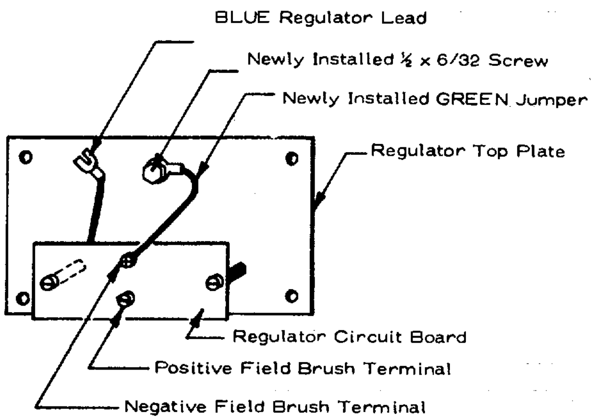


Figure 3.5.5.3A

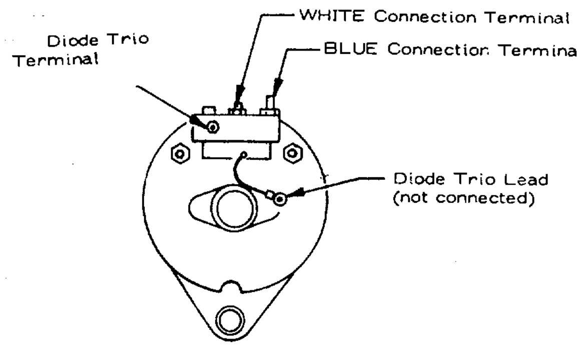


Figure 3.5.5.3B

3.5.5.4 <u>ALTERNATOR MODIFICATION INSTRUCTIONS FOR LEECE NEVILLE SERIES 4000JA and 7000JA</u> (Internal #77973)

The purpose of this modification is to provide a means to ground negative field brush permanently for use with positive switching regulators.

___ 1. Disconnect the battery grounding cable and remove the alternator from the engine mounting brackets. (If alternator can be left on vehicle, be sure to disconnect the battery grounding cable.)

___ 2. Remove the positive and negative output terminal nuts so terminal tabs from regulator can be removed. See Figure 3.5.5.4A.

___ 3. Remove the diode trio connector wire from diode trio terminal on top of the regulator.

___ 4. Remove the regulator (black aluminum assembly) from the white ceramic brush holder housing (see drawing) by removing the two nuts securing the terminal tabs underneath the brush holder housing.

___ 5. A. Prepare a 12" length of #16 AWG WHITE wire by putting a ring tongue lug connector for a #6 stud on one end.

B. With a 17/64" open end wrench, loosen and remove the negative brush contact nut (see Fig. 3.5.5.4B). The negative brush is the brush nearest the 90° angle of the regulator housing.

3.5.5.4 MODIFICATION INSTRUCTIONS FOR LEECE NEVILLE 4000JA & 7000JA (continued)

C. Attach the lugged end of the WHITE wire to the negative brush stud and replace and securely tighten the brush contact nut.

D. Drill a 1/8" hole in the bottom of the regulator ho, sing on the positive terminal side. See Figure 3.5.

E. Thread the #16 WHITE wire down through the newly drilled 1/8" hole in the bottom of the regulator housing.

___ 6. Replace regulator into regulator housing.

A. Replace the regulator into the ceramic housing, making sure the 900 angle of the regulator is to the rear of the brush holder. Slide the brushes all the way into the brush guides, making sure that the WHITE wire does not interfere with the positive brush spring.

B. To retract brushes into the guides, insert a pin or paper clip into the small hole in the brush holder. Using a bent wooden match or the flat end of an allen wrench, push the first brush back into the brush guide, holding it back in the guide with the pin or clip. Do the same thing with the second brush.

C. Referring to Fig. 3.5.5.4A, replace the NEGATIVE terminal tab to negative regulator housing bolt on the bottom of the brush holder housing and secure with the original lock washer and nut. DO NOT replace the positive connecting terminal tab, as it will no longer be used. Replace the lock washer and nut only.

___ 7. Remove the pin or paper clip, releasing the brushes so they make contact with regulator contacts.

___ 8. The alternator should now have a WHITE wire from bottom of regulator housing. Attach WHITE wire to ground (or negative output terminal of alternator.)Positive brush terminal should be used as Dynamote BLUE wire connection terminal. Reinstall the alternator and proceed to Section 3.5.1.

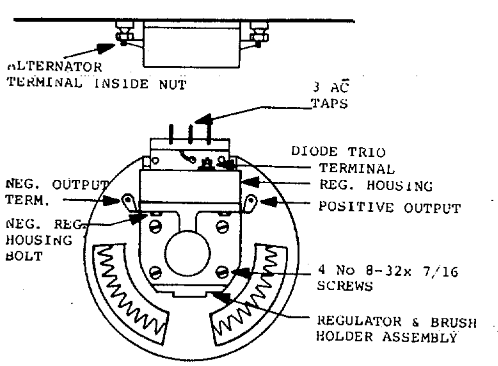


Figure 3.5.5.4A

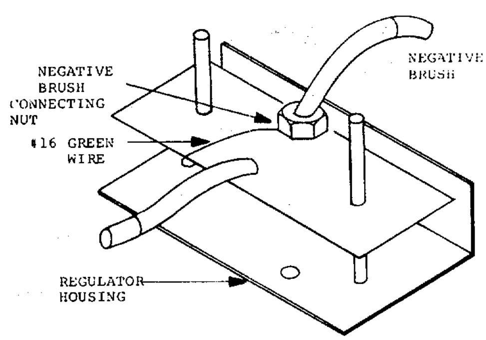


Figure 3.5.5.4B

3.6.0 CHECKOUT OF HARNESS INSTALLATION AND ALTERNATOR OUTPUT

Put Auto-Manual Switch in Manual position. See 2.2.2.1.

This is one of the most important steps in the installation. Its purpose is to insure that the harness is properly connected to the alternator and that the alternator functions properly. Proper performance of this step will help to pinpoint installation errors and prevent possible damage to the inverter.

To help you in doing this checkout correctly, a summary of the readings to be taken is provided in tabular form after Section 3.6.10, in Figure 3.6.10A.

THE RESULTS OF THIS CHECKOUT PROCEDURE MUST BE RECORDED ON THE WARRANTY INITIATION CARD AND RETURNED TO THE DYNAMOTE OFFICE. FAILURE TO DO SO WILL PREVENT THE INVERTER WARRANTY FROM BECOMING EFFECTIVE.

There are two ways to perform the Harness and Alternator Checkout Procedure:

(1) Using the 4-2600 Dynamic Inverter Test Module. See Section 3.6.1.

(2) Using a standard V 0 M (Volt Ohm Meter) with scales of 15VDC, 5OVDC, and IO0VDC. (Fluke 8020A or Simpson 463 or equivalent.) See Section 3.6.2.

3.6.1 CHECKOUT OF HARNESS INSTALLATION WITH DYNAMOTE 4-2600, DYNAMIC INVERTER TEST MODULE

If the Dynamote 4-2600 Dynamic Inverter Test Module is available, perform the following steps for checkout of harness installation. If the 4-2600 is not available, see Section 3.6.2.

___ 1. Follow the instructions in Section 3 to install the, inverter harness.

___ 2. Put the test module sequence switch in the OFF position before connecting the module to the Dynamic Inverter. The vehicle ignition should also be in the OFF position.

___ 3. Plug the six-pin test module into the Test Module Receptacle on the inverter front panel.

NOTE 1: Do not plug the test module into the control head receptacle on the inverter.

Do not plug the inverter Remote Control head plug into the Test Module Receptacle.

NOTE 2: If the BLACK (B+) lead is connected to a battery selector switch, the switch should be in the ON (that is, the B1, B2, or both) position.

___ 4. Follow the steps on the chart on the following pages, Figure 3.6.1A.

Figure 3.6.1A INSTALLATION AND INVERTER CHECKOUT USING 4-2600 DYNAMIC INVERTER TEST MODULE

Figure 3.6.1A INSTALLATION AND INVERTER CHECKOUT USING 4-2600 DYNAMIC INVERTER TEST MODULE

Switch Position	Terminal or Wire Being Read	Inverter Start Button Depressed	Vehicle Ignition ON	Proper Meter Reading	Remarks
1	A+ (Red)	No	No	11-13 VDC	If voltage reading is outside proper limits, recheck installation of inverter harness, RED and BLACK wires. Also check at K1 relay, Section 4.3.3 and K3 relay, Sec. 4.3.5.
2	Ignition (Orange)	No	No	0 VDC	If meter reads battery voltage, then the ORANGE wire is connected to a post which has battery voltage with the ignition ON or OFF. This will allow the battery to drain through the voltage regulator.
3	B+ (Black)	Yes	No	11-13 VDC	If the reading with the Auxiliary Start Button depressed is 0, then the harness leads to the K3 relay should be switched.
		No	No	11-13VDC	
4	A+ (Red)	Yes	No	0 VDC	If meter reads any voltage, check out K3 relay, Section 4.3.5.
5	F Out (Blue)	Yes	No	10-12 VDC	If voltage reading is outside proper limits, follow Voltage Regulator Checkout Procedure, Section 4.3.7.
6	Ignition (Orange)	No	Yes	10-12 VDC	If meter reading is outside proper limits, recheck wiring of ORANGE wire to be sure it is wired to a source of battery voltage with the ignition ON.
For Switch Positions 7 - 10, start the engine and run at approximately 1500-1800 RPM. Also turn ON vehicle headlights to put some load on the vehicle charging system.					
7	B+ (Black)	No	Yes	14.0-14.2 VDC	If meter reading is outside proper limits, follow procedure to check out and adjust Voltage Regulator CB3, Section 4.3.12.
8	A+ (Red)	No	Yes	14.0-14.2 VDC	If meter reading is outside proper limits, repeat test on Position 7.

3.6.1A INSTALLATION AND INVERTER CHECKOUT USING 4-2600 DYNAMIC INVERTER TEST MODULE (continued)

Switch Position	Terminal or Wire Being Read	Inverter Start Button Depressed	Vehicle Ignition ON	Proper Meter Reading	Remarks
9	B+ (Black)	Yes	Yes	14.0-14.2 VDC	If meter reading is outside proper limits, perform alternator check given for Switch Pos. 11 (below), reading IMPORTANT NOTE first. Follow checkout procedure and adjust inverter Voltage Regulator CB1. NOTE: Be sure engine is running at or above the speed at which the voltage reading is at its maximum. This could be higher or lower than 1500 RPM, but will be the point at which increasing the RPM will no longer increase the voltage reading.
10	A+ (Red)	Yes	Yes	11-12 VDC (A30, A60) 8-9 VDC (A40)	This reading shows alternator output with inverter ON, divided by 5; that is, the actual voltage is 5 times the reading. If alternator voltage fails to come up to this level, perform alternator check in the next step.
IMPORTANT NOTE: The test at Switch Position 11 is to check for a faulty alternator. Before moving the switch to Position 11, return the engine to an idle, turn the inverter OFF, and remove the commutation fuses on the inverter front panel. When the switch is in Position 11, the voltage regulator is taken out of the circuit and battery voltage is applied directly to the field of the alternator. This causes the voltage output of the alternator to increase directly with engine RPM. Rotate switch to Position 11, and slowly increase engine RPM until the voltmeter reads 20VDC. At this point the actual alternator voltage is 100VDC (5 times the meter reading). If the alternator will not come up to this voltage, then either the alternator or the installation is faulty. The alternator should be removed and sent to an alternator repair shop.					
11	A+ (Red)	No	Yes	Increase to 20 VDC	Read IMPORTANT NOTE above. DO NOT MOVE SWITCH TO OR FROM POSITION 11 WHEN ENGINE IS ABOVE IDLE.

Figure 3.6.1A INSTALLATION AND INVERTER CHECKOUT USING 4-2600 DYNAMIC INVERTER TEST MODULE

3.6.1 <u>CHECKOUT OF HARNESS INSTALLATION WITH DYNAMOTE 4-2600, DYNAMIC INVERTER TEST MODULE</u> (continued)

___ 5. If procedures on Switch Position 1 - 10 check out, you may replace the covers on the inverter. Your electrical system is ready for operation.

Any problems found during this test procedure can be discussed with the DYNAMOTE Service Department by calling our toll-free number, 1-800-426-2838.

3.6.2 <u>CHECKOUT OF HARNESS INSTALLATION AND ALTERNATOR OPERATION WITHOUT 4-2600 DYNAMIC INVERTER TEST MODULE</u>

NOTE: FOR THIS TEST, DO NOT PUSH OR RELEASE START SWITCH WHEN ENGINE IS RUNNING ABOVE IDLE.

Perform the checkout with a V 0 M capable of reading 15VDC, 5OVDC, and 100VDC (Simpson 463, Fluke 8020A or equivalent).

Access to the terminal posts can be obtained either through the use of a Dynamic Test Strip plugged into the Test Receptacle on the inverter front panel, or by removing the. inverter panels carefully and exposing the terminals inside the back of the inverter.

TO CHECKOUT THE HARNESS, FOLLOW THIS PROCEDURE: (Colors refer to wires attached to the indicated terminal posts.)

___ 1. If automatic throttle is being used, disconnect the auto throttle linkage from carburetor linkage.

___ 2. Remove warranty initiation card from Section 1 of the Instruction Manual. Record in pencil the readings from all the following steps.

___ 3. Turn ignition OFF. Connect harness to inverter at-this time.

___ 4. Connect battery negative ground cable.

___ 5. A. With ignition OFF and Dynamote Start Button ON, readings should be as follows:

Ground (GREEN) post to Battery + (BLACK) post = 12-12.8V
Ground (GREEN) post to Alternator B+ (RED) post = 0V
Ground (GREEN) post to F Out (BLUE) post = 12-12.8V
Ground (GREEN) post to Ignition (ORANGE) post = 0v
Ground (GREEN) post to Accessory (BROWN) post = 12-12.8V

B. With ignition ON, engine OFF, and inverter Start Button NOT depressed, readings should be as follows:

Ground (GREEN) post to F Out (BLUE) post = 10-12.8V
Ground (GREIEN) post to Ignition (ORANGE) post = 10-12.8V

3.6.2 HARNESS & ALTERNATOR CHECKOUT WITHOUT 4-2600 (continued)

Trouble Shooting Steps for Step 5.

1) If GREEN to BLACK is less than 12 volts DC, there could be a faulty ground condition (GREEN wire or battery ground strap). If properly grounded, the battery may be dead or defective. Return battery to a charged state before continuing. If battery is acceptable, the BLACK wire could have faulty connections.

2) If GREEN to RED is greater than zero without K3 Relay, the alternator is still connected directly to the battery. Check to be sure the Dynamote RED harness wire is the only one attached to the output terminal of the alternator.

3) If GREEN to RED is greater than zero with K3 Relay, the K3 Relay is incorrectly installed or not energizing. Refer to Section 3.5.1, Step 3.

4) If GREEN to ORANGE is larger than zero, ORANGE wire is incorrectly connected to the ignition switch.

___ 6. Start engine and increase engine speed to about 1000 RPM (equivalent to engine speed at about 20 MPH. Voltages should read as follows:

Ground (GREEN) post to Battery + (BLACK) post = 13.5-14.2V
Ground (GREEN) post to Alternator B+ (RED) post 13.5-14.2V
Ground (GREEN) post to F Out (BLUE) post = variable up to 14.2V
Ground (GREEN) post to Ignition (ORANGE) post = 12.0-14.2V
Ground (GREEN) post to Accessory (BROWN) post = OV

Trouble Shooting Tips for Step 6.

1) If BLACK and RED are greater than 14.2VDC or less than 13.5VDC, adjust the vehicle voltage regulator CB3. If adjusting the CB3 does not correct the DC voltage at BLACK, proceed to the applicable step following:

a) If BLACK and RED are less than 13.5VDC and BLUE is greater than 11VDC, check if BLACK voltage varies with the engine speed. If it does, either the pulley ratio is too low or the alternator is overloaded. Verify that BLUE is the only wire on the alternator positive FIELD terminal, and that the alternator negative FIELD terminal is grounded. If all wiring conditions are correct, then the alternator is faulty or the belts are slipping.

b) If BLACK and RED are greater than 14.2VDC and BLUE is greater than 12VDC, verify that BLUE is the only wire connected to FIELD positive terminal.

c) If BLACK and RED are less than 13.5VDC and BLUE is less than 10VDC, CB3 is defective and should be replaced.

3.6.2 HARNESS & ALTERNATOR CHECKOUT WITHOUT 4-2600 (continued)

___ 7. With engine still running at about 1000 RPM, remove commutation fuses on inverter, and push Dynamote Start Button. Voltage readings should be as follows:

Ground (GREEN) post to Battery + (BLACK) post = 12-12.8VDC
Ground (GREEN) post to Alternator B+ (RED) post = 15.OVDC or greater
Ground (GREEN) post to F Out (BLUE) post = 12-12.8VDC
Ground (GREEN) post to Ignition (ORANGE) post = 12-12.8VDC
Ground (GREEN) post to Accessory (BROWN),post = 12-12.8VDC

Trouble Shooting Tips for Step 7.

1) If BLACK post voltage is above 12.8VDC, harness is wired improperly or K3 Relay (if used) is not functioning properly.

Correct this defect before proceeding. This step assures proper disconnect of alternator output from vehicle battery when inverter is energized.

2) If RED post voltage reads below 15.OVDC, harness wiring is incorrect or alternator may be defective. Correct wiring defect, if any, at this time. Alternator defect, if any, will be determined in Step 8 below.

___ 8. DO NOT PUSH OR RELEASE START SWITCH WHEN ENGINE IS ABOVE IDLE FOR THIS TEST

With commutation fuses removed and inverter Start Button depressed as in Step 7 above, slowly increase engine speed. Voltage from GREEN post to RED post should increase to about lO0VDC at or below 2500 engine RPM. Do not increase engine speed in excess of 100VDC reading, and maintain this condition only long enough to check voltage output. This step assures that alternator diodes are satisfactory and that the alternator can provide the voltage necessary for proper operation of the inverter. Readings should be as follows:

Ground (GREEN) post to Battery + (BLACK) post	= 12-12.8VDC
Ground (GREEN) post to Alternator B+ (RED) post	= Up to 100VDC
Ground (GREEN) post to F Out (BLUE) post	= 12- 12.8VDC
Ground (GREEN) post to Ignition (ORANGE) post	= 12-12.8VDC
Ground (GREEN) post to Accessory (BROWN) post	= 12-12.8VDC

NOTE: Failure to obtain the specified reading is an indication of improper wiring or a defective alternator. If voltage is above 15VDC at idle but does not increase to 100VDC at higher engine speeds, the alternator is defective, usually caused by open or shorted diodes. The remedy is to replace the faulty alternator diode(s). Most alternators have six diodes, three with forward polarity and three with reverse polarity. It is best to replace a complete set of three diodes when replacing. Use 200 PIV diodes available from an auto electric *or electronic parts supply house.

Refer to alternator manufacturer's service manual for details of checking and repairing alternator diodes.

___ 9. Now compare your readings with the following summary, given in Figure 3.6.2A.

Read Voltage from: Condition	BLACK to GREEN	RED to GREEN	BLUE to GREEN	ORANGE to GREEN	BROWN to GREEN
Ignition OFF, Inverter Start Button pushed	12.0 to 12.8	0	10.0 to 14.0	0	12.0 to 12.8
Ignition OFF, no other action taken	12.0 to 12.8	12.0 to 12.-8	0	0	0
Engine ON at 1000 RPM	13.5	13.5 to 11.0 (13.5- 14.2)	Variable 14.2)	(13.5-	0
Engine ON at idle, Inverter Start Button pushed	12.0 to 12.8	15.0 or more	10.0 to 12.8	10.0 to 12.8	12.0 to 12.8
Engine ON, 1000 RPM up to 2500 RPM; Commutation Fuses removed, Inverter Start Button pushed	12.0 to 12.8	up to 100 VDC	12.0 to 12.8	10.0 to 12.8	12.0 to 12.8

Figure 3.6.2A SUMMARY OF TEST VOLTAGE READINGS

___ 10. Reinstall commutation fuse.

If all steps check out correctly, CONGRATULATIONS. The harness is properly attached to the alternator system and the alternator is capable of operating the inverter properly. BE SURE ALL CHECKOUT DATA IS RECORDED ON THE.WARRANTY INITIATION CARD BEFORE PROCEEDING.

3.7.0 CHECKOUT INVERTER OPERATION 8/84
(Put Auto Manual Switch in Manual position. See 2.2.2.1)

3.7.1 Disengage Automatic Throttle (if used) by disconnecting autothrotte linkage from carburetor.

3.7.2 Check battery charging voltage with inverter OFF. Turn inverter OFF, and increase engine speed to about 1000 RPM (medium fast idle). Check battery voltage. It should read 13.5 to 14.2 volts DC. If it does not, adjust CB3.

3.7.3 Start Inverter. Start engine, and manually increase engine speed to approximately 1500. RPM (equivalent to engine speed at about 30 MPH). Depress the Start Button. The inverter should START, that is, you should hear the inverter "hum," the indicator light should turn ON, the cooling fan should be exhausting air through the fan shroud in the rear chassis panel, and the voltmeter should register AC voltage up to 130 volts. If the inverter does not START, refer to Troubleshooting Section 4.

3.7.4 Check for proper charging voltage with Inverter ON. With vehicle engine still running at approximately 1500 RPM, and with inverter ON, allow .3 5 minutes of inverter operation for charging voltage to stabilize. With inverter still ON, using an accurate DC voltmeter, check voltage on vehicle system battery. It should read 14.0 14.2 volts DC. If it does not, adjust CB1. If this does not correct the problem, refer to the Troubleshooting Section 4.

3.7.5 Check AC voltage stability under load. With inverter still operating at 120 volts output, apply the normal AC load you intend to operate on the inverter. If actual load is not available, simulate the actual load with an equivalent wattage and type of load (resistive or inductive).
If AC load does not operate properly, or if inverter output voltage drops more than 10 volts, or if inverter shuts off when AC load is applied, remove AC load, turn inverter OFF and refer to Troubleshooting Section 4.
FOR MPA SERIES ONLY: This unit is equipped with a Low Voltage Cutout Circuit. Its function is to disconnect the inverter output from the AC loads in case of low AC output voltage (e.g., throttle slowdown or overload). When output voltage falls below 95 VAC for a sustained period of time (approximately 20 seconds), the unit output is turned off. The inverter AC supply will not turn back on until unit is either 1) turned off and restarted, or 2) engine speed is accelerated to normal operating speed for the inverter unit.

3.7.6 Adjust Automatic Throttle. If optional automatic throttle is being used, reconnect autothrottle linkage to carburetor. Adjust chain initially so that there is about 1/2" droop in the chain at idle, with the servo-plunger fully retracted. Now, START the inverter. The autothrottle should energize when the inverter starts. Adjust turnbuckle on the autothrottle linkage to minimum engine speed that will maintain usable AC voltage when inverter is operating under normally expected AC load.

3.8.0 WIRE AC OUTPUT

CAUTION NOTE: The AC output hard-wiring for Series A Inverter A60-120C is different than for A30-70D, A40-120D and A60-120D and the MPA Series Inverters. Be sure to follow the appropriate instructions for your specific inverter.

3.8.0 WIRE AC OUTPUT (continued)

3.8.1 Model A60-120C

A. In this unit, both AC 1 and AC 2 wires are hot, relative to chassis ground. Therefore, neither AC 1 or AC 2 can be grounded. If either wire is grounded, the inverter will not operate.

B. The AC receptacles may be used up to the fused limit of 15 amps per AC receptacle on all models.

C. If permanent connection inverter output to external AC circuit breakers and receptacles is desired, follow these directions.

Connect BLACK AC leads from rear of unit to the external junction box, using circuit breaker of fuses for each separate circuit. Be sure that neither hot wire is grounded at this connection.

3.8.2 Models A30-70D, A40-120D, A60-120D and All MPA Models

A. In these units, AC output is a standard two-wire output, with a hot and neutral lead. Only the "hot" lead (AC 1) cannot be grounded.

B. The AC receptacles can be used up to their fused capacity of 15 amps per receptacle for all models.

C. If permanent connection of inverter is desired, follow these directions:

Connect AC leads to external AC junction box, using circuit breaker or fuses for each separate circuit. Only the "hot" (BLACK) wire should not be grounded.

3.9 COMPLETE, SIGN AND MAIL WARRANTY INITIATION CARD

The final step is to initiate the inverter warranty. Proper installation is not complete until warranty is properly initiated, as follows:

A. Fill in the final customer's name and address and vehicle data.

B. Enter all checkout data from the harness and alternator checkout procedures in Section 6.

C. Sign your name and the company name and address, certifying that the installation was properly completed, and enter the date of installation.

D. Fill in and sign the Owner's Certificate of Warranty Initiation card from the first section of the manual.

E. Mail the stamped, self-addressed warranty initiation card to DYNAMOTE CORPORATION.

DYNAMOTE CORPORATION, 1200 W. Nickerson, Seattle, WA 98119 - 206-282-1000

SECTION 4. SERVICE AND TROUBLE SHOOTING INSTRUCTIONS FOR DYNAMOTE SERIES "A" DYNAMIC INVERTERS

4.1.0 General Information. PLEASE READ CAREFULLY.

The only reason to be at this point in the manual is that the inverter and/or vehicle charging system are not working properly.

If this is a new installation and has not yet been in service, be sure to go through the checkout procedures in Section 3.6 before proceeding further. If you have completed the checkout procedure in 3.6 and the inverter still does not work, continue with this section.

If the inverter has been in service and working properly prior to this failure, and if the installation has not been tampered with, such as for servicing the vehicle in some way, then the likely cause of failure is in the inverter and can be found through the trouble shooting procedure.

It is easiest to troubleshoot the inverter while it is installed in the vehicle or boat, as the electrical system provides a power source to check out all inverter functions. Another alternative is a test bench which includes alternator and battery, and simulates a vehicle or boat electrical system.

If neither of these is available, many of the troubleshooting tests can be performed by connecting the inverter harness to a 12 volt battery as follows:

GREEN	to Battery Negative (-)
BLACK	to Battery Positive (+)
ORANGE	to Battery Positive (+)

Other wires not connected.

The Trouble Shooting Guide is to be found in Section 4.3.0.

4.2.0 INVERTER REMOVAL FROM VEHICLE SYSTEM FOR SERVICING AND TEMPORARY OPERATION OF VEHICLE WITHOUT INVERTER

NOTE: DO NOT REMOVE INVERTER UNTIL AFTER THE TROUBLESHOOTING PROCEDURE HAS BEEN COMPLETED AND IT IS DETERMINED THAT THE INVERTER MUST BE REMOVED FOR SERVICE.

___1. Remove inverter mounting screws.

___2. Pull inverter out to gain access to the Quick Disconnect plugs. Separate both connectors (control and power harness).

___3. Remove inverter from vehicle.

___4. Remove vehicle voltage regulator housing from behind the inverter front panel, under the AC outlet, by removing the screws at the four corners of the housing.

4.2.0 INVERTER REMOVAL FROM VEHICLE SYSTEM FOR SERVICING AND TEMPORARY OPERATION OF VEHICLE WITHOUT INVERTER (continued)

___5. Disconnect the wiring harness from vehicle voltage regulator in the housing.

___6. Locate vehicle voltage regulator adapter harness behind the inverter front panel, under the AC outlet.

___7. Connect the adapter harness to the vehicle voltage regulator circuit board with the BLUE wire closest to the edge of the board as shown on the label inside the housing.

___8. Connect the other end of the adapter harness to the vehicle end of the small inverter control harness.

___9. Mount the VVR housing and ground the GREEN wire from the adapter harness, using one of the inverter tie down bracket mounting screws and the large, spot-faced mounting hole on the flange of the VVR housing.

___10. Pull apart the RED and BLACK plastic connectors from the vehicle end of the inverter power harness and connect them together to connect alternator to battery.

4.3.0 TROUBLE SHOOTING GUIDE FOR DYNAMOTE SERIES "A" DYNAMIC INVERTERS

Introduction: This Troubleshooting Section takes the most common symptoms of inverter failure and suggests probable causes and solutions. The objective is to provide relatively simple solutions for 90% of the problems that will be encountered. Only the simplest of tools and instruments are required: a Volt-Ohm Meter which reads to 100VDC, socket wrenches, and a screw driver. A 10" extension on the socket wrench will be helpful if the cathode leads to the SCRs must be removed.

The remaining 10% of the possible problems are often intermittent or less obvious and require more sophisticated instruments and technical expertise to solve. This kind of capability can be found at the DYNAMOTE factory and major warranty and repair centers about the country. If the problem cannot be solved using this Troubleshooting Guide within approximately one hour, then help should be sought from one of these facilities.

The Inverter Electrical Schematics, included in Section 4.4.0 will be essential in understanding the checkout procedures, and the Inverter Wiring Diagrams in Section 4.5.0 Will be useful in locating parts and terminal points. The parts list is also located in Section 4.5.0, and gives Dynamote part numbers for all referenced components for use in ordering replacement parts.

Good luck and please drop us a line if you have ideas about how to improve this manual.

SPECIAL NOTE: If there is a battery isolator in the electrical system in which the inverter is installed, the inverter wire from the B+ terminal inside the back of the inverter to Pin #6 on terminal strip #1 at the front of the inverter will have been removed. An additional wire directly from a battery positive (+) source will have been connected by the installer to Pin #6. To perform the checkout procedures, it will be necessary to short around the battery isolator or temporarily remove it from the system, connecting the wire from the B+ inverter terminal directly to battery positive (+).

4.3.1 USE OF THE TROUBLESHOOTING GUIDE

If the symptom of failure is known, proceed directly to that symptom in the Troubleshooting Chart, Section 4.3.2. If the symptom is not known, begin the troubleshooting process by going to Symptom #1 in the Troubleshooting Chart, pushing the START Button and progressing through the chart steps until the applicable symptom is found.

4.3.2 TROUBLESHOOTING CHART
(Put the Auto-Manual Switch in Manual position. See 2.2.2.1)

The alternator should be turning approximately 4000 RPM, or about 1500 engine RPM for performing tests to determine the applicable symptom.

If the inverter is connected only to a battery and not an alternator, the test at Symptom #1 can be performed as well as the checkout procedures for the Voltage Regulators, Oscillator Board, Diodes, SCRs, and Relays K1, K2, and K3.

Section 4.3.2 TROUBLESHOOTING CHART

No.	SYMPTOM	PROBABLE CAUSE	SOLUTION
1	Start button pushed, no response.	Blown control fuse	Check control fuse F5 on inverter front panel. If there is no control fuse on the inverter, go on to the next probable cause.
	(Put Auto-Manual Switch in Manual position. See 2.2.2.)	Inoperative K2 Relay.	Follow procedure to check out K2 Relay, see Section 4.3.4.
		If new installation, battery isolator in system.	See special note in Paragraph 4.3.0 and Section 3.5.2.
2	Start button pushed, relays will not remain energized but chatter on and off.	Inverter harness improperly installed with RED wire attached to battery and BLACK wire attached to alternator output.	Install RED and BLACK wires properly according to installation instructions.
3	Start button pushed, relays energize with an audible click, but inverter will not start. (Fan does not turn.)	Blown commutation fuses.	Follow procedure to check commutation fuses, Section 4.3.6.
		Inoperative K3 Relay	Follow procedure to check K3 Relay, Section 4.3.5.
	(ENGINE MUST BE RUNNING APPROXIMATELY 1500 RPM FOR THIS AND REMAINING TROUBLESHOOTING STEPS)	Inverter voltage regulator inoperative or fuse is blown	Follow procedure to checkout voltage regulator, Section 4.3.7.
		Shorted SCR.	Follow procedure to checkout SCRs, Section 4.3.9.
		Oscillator circuit board inoperative.	Follow procedure to checkout oscillator board. Section 4.3.8.
		Diode D5 or D6 open.	Follow procedure to checkout Diodes D5 and D6, Section 4.3.10.
		Diode D3 and/or D4 shorted.	Follow procedure to checkout Diodes D3 and D4, Section 4.3.10.
4	Start button pushed, inverter turns on, (fan turns), but stops when start button is released	Diode D2 is open	Replace Diode D2.

No.	SYMPTOM	PROBABLE CAUSE	SOLUTION
5	Low output voltage, AC and DC	Loose alternator belts	Tighten belts by adjusting alternator bracket.
		Alternator RPM too slow.	Run engine at faster speed and see if output voltage goes up. (DYNAMOTE makes small diameter alternator pulleys.)
		K3 Relay inoperative	Follow procedure to checkout K3 Relay, Section 4.3.5.
		Inverter voltage regulator out of adjustment.	Adjust voltage regulator.
		Shorted or open diodes in the alternator.	Follow alternator diode test procedure, Section 4.3.11.
6	Inverter will not turn off, high output voltage, AC and DC.	Inverter voltage regulator inoperative or shorted.	Replace inverter voltage regulatcr, PCB1
7	Inverter will not turn off, output voltage normal	Inverter voltage regulator inoperative	Follow procedure for voltage regulator checkout, Section 4.3.7.
		K2 Relay points 3 and 9 not disengaging	Follow procedure for K2 Relay checkout, Section 4.3.4.
8	Inverter turns on, but will not carry AC load	Blocking Diode D5 and/or D6 shorted.	Follow procedure for Diode D5 and D6 checkout, Section 4.3.10.
9	High AC output voltage, low or normal DC output voltage.	Diodes D3 and/or D4 open	Check Diodes D3 and D4, according to checkout procedure, Section 4.3.10.
10	High DC output voltage, low AC output voltage	Faulty K3 Relay	Follow procedure to checkout K3 Relay, Section 4.3.5.
11	Improper or no charging with inverter off, proper operation with inverter on	Faulty Vehicle Voltage Regulator, PCB3.	Checkout Vehicle Voltage Regulator PCB3 according to procedure in Section 4.3.12
		Faulty K2 Relay	Follow procedure to checkout K2 Relay, Section 4.3.4.
		Faulty K4 Relay in installa-kit (Installation Kit only).	Checkout and replace.

4.3.2 TROUBLE SHOOTING CHART (continued)

MOST LIKELY FAILURES

Based on our experience at DYNAMOTE, the following, in order of descending frequency, are the most likely causes of inverter malfunction. In each case, there is a procedure to check it out.

1. K3 Relay
2. Blown Commutation Fuses
3. Shorted SCRs.
4. Inverter Voltage Regulator Board - no output.
5. Inverter Oscillator Board.

4.3.3 K1 RELAY CHECKOUT PROCEDURE

Tools Required: Ohm Meter and Voltmeter with 0-15VDC scale, 7/16" socket or open end wrench, screwdriver.

1) Open the inverter by removing the front, top and back panel fasteners. Carefully lay the front and back panels down and remove the top panel.

2) The engine and ignition should be OFF for the procedure.

3) Locate the K1-Relay, the larger cylindrical silver solenoid contactor on the right side of the inverter near the rear.

4) Depress the START button and there should be an audible click if the relay is operating.

5) With the Ohm Meter, check the resistance across the two large terminals at the top of the relay. WITHOUT depressing the START button the meter should read 100K Ohms to infinity, (∞).

WITH the START button depressed, the meter should read less than 5 Ohms. If the Kl Relay does not pass all of these tests, it should be replaced.

4.3.4 K2 CONTROL RELAY CHECKOUT PROCEDURE

Tools Required: Voltmeter with 0-15VDC scale, 7/16" socket or open end wrench, screwdriver.

1) If there is a control fuse on the inverter front panel, check it first.

2) Open the inverter by removing the front, top, and back panel fasteners. Carefully lay the front and back panels down and remove the top panel.

3) The engine and ignition should be OFF for this test.

4.3.4 K2 RELAY CHECKOUT PROCEDURE (continued)

4) Locate the K2 Relay. It is approximately l"xl"x3", encased in clear plastic and located on the bottom left side of the inverter.

5) Depress and release the start button and visually confirm that the relay contacts are moving. If the contacts do not move, the relay should be replaced.

6) With the START button depressed, check the voltage from the ACC terminal at the rear of the inverter to GROUND. It should read 10 VDC or higher. If not, the relay should be replaced.

7) With the START Button depressed, check the voltage from the F Out terminal at the rear of the inverter to GROUND. It should read 10VDC or higher. If there is no voltage at the F Out terminal, and if the Voltage Regulator has checked good, then replace the K2 Relay.

4.3.5 K3 RELAY CHECKOUT PROCEDURE

Tools Required: Volt Ohm Meter with 0-15VDC scale, screwdriver, 12" jumper wire.

1) The K3 Relay is the high amperage bypass relay and is a cylindrical silver solenoid contactor. It is installed either in the 4-2500 Dynamic Installation Kit or independently near the alternator under the hood. It can be found by following the wiring from the POSITIVE (+) terminal of the alternator.

2) The engine and ignition should be OFF for this test.

3) The small terminals on the relay are the coil terminals and the large terminals are the contacts.

4) Check the voltage from the positive to the negative coil terminal of the relay. With the inverter START button depressed there should be an audible click and the voltage should be 10VDC or higher. Without the START button depressed, the voltage should be 0.

If these conditions are present, go on to Step 5.

If the voltage is 0 with the START button depressed, carefully check the wiring to the positive relay coil terminal (the one that is not grounded). This should come from the ACC terminal in the rear of the inverter.

If the wiring is correct, then go through the K2 Relay checkout procedure to be sure that there is voltage at the ACC terminal when the START button is depressed.

5) Check the voltage from the relay contact that is wired to the alternator POSITIVE (+) terminal to GROUND.. Without the START button depressed, the voltage should be 10VDC or higher.

4.3.5 K3 RELAY CHECKOUT PROCEDURE (continued)

With the START button depressed, the voltage should read 0.

Otherwise, replace the K3 Relay.

4.3.6 COMMUTATION FUSE CHECKOUT PROCEDURE

Tools Required: Ohm Meter.

1) Commutation fuses are in the larger fuseholders on the front panel of the inverter. There are two commutation fuses on A30s, and four commutation fuses on A40s and A60s.

2) Remove the commutation fuses. They must be checked with an Ohm Meter, as they are solid fuses and visual inspection will not determine if they are good.

3) Check the fuses with the Ohm Meter by placing a probe at each end. If there is no resistance, the fuse is good. If there is high resistance, the fuse is blown.

4) If the fuses are blown, be sure to replace them with the same value fuses.

5) Recheck commutation fuses after new installation.

4.3.7 DYNAMIC INVERTER VOLTAGE REGULATOR PCB1 CHECKOUT PROCEDURE

Tools Required: Voltmeter with 0-15VDC scale, 7/16" socket or open end wrench, screwdriver.

1) Open inverter by removing the front and. top panel fasteners Carefully lay the front panel down on its face and remove the top panel.

2) Locate the inverter voltage regulator CB1 on the left side of the inverter. It is the forwardmost of the two circuit boards, and there are five wires attached to the board, or to a connector that is plugged into the board.

3) The engine and ignition are OFF for this test.

4) If the voltage regulator has a fuse mounted on the circuit board, check the fuse first.

5) With the inverter START button depressed, check the voltage from the BLUE wire on the voltage regulator circuit board to ground. Voltage should read 10 volts or more. If there is no voltage, the voltage regulator has failed in the open position and should be replaced.

6) If voltage at the BLUE wire is 10 volts or more, depress the inverter START button again and check the voltage from the F OUT terminal inside the rear of the inverter to GROUND. If the voltage at this terminal is not the same as the voltage at the BLUE wire on the voltage regulator, then the K2 Relay is faulty and should be replaced.

4.3.8 OSCILLATOR CIRCUIT BOARD CHECKOUT PROCEDURE

Tools Required: Voltmeter with 0-15VDC scale, 7/16" socket wrench or open end wrench, screwdriver.

1) Open inverter by removing the front and top panel fasteners. Carefully lay the front panel down on its face and remove the top panel.

2) The engine and ignition should be OFF for this test.

3) Locate the SCR gate leads. These are the small white leads to the SCRs which have a plastic connector in the lead. Separate this lead by disconnecting the plastic connector.

4) With the START button depressed, read the voltage to GROUND from each gate lead connector on the part of the gate lead which is connected to the Oscillator Circuit Board. The voltage should be between 2VDC and 7VDC, and should be equal ± .3VDC for the two leads. If it is not, the oscillator board should be replaced.

4.3.9 SCR CHECKOUT PROCEDURE

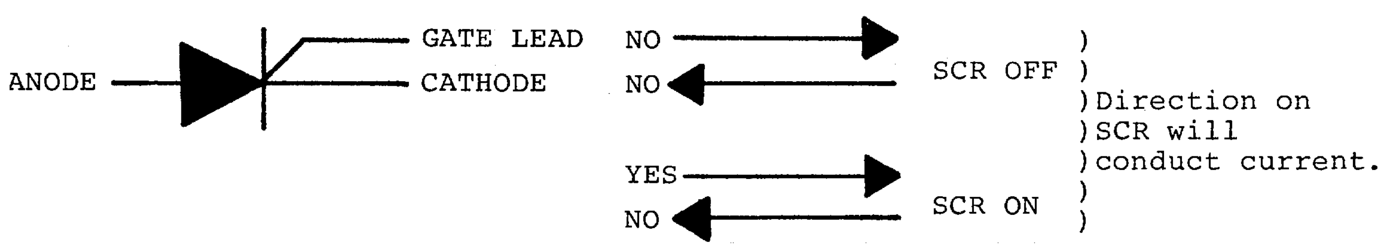
Tools Required: Ohm Meter or Continuity Tester, 7/16" socket wrench with extender, 3/4" socket wrench with extender (A40 and A60 only), screwdriver.

1) Prior to checking out the SCRS, be sure that the commutation fuses are good, by following the commutation fuse checkout procedure.

2) Open inverter by removing the front and top panel fasteners. Carefully lay the front panel down on its face and remove the top panel.

3) The engine and inverter are OFF for this test.

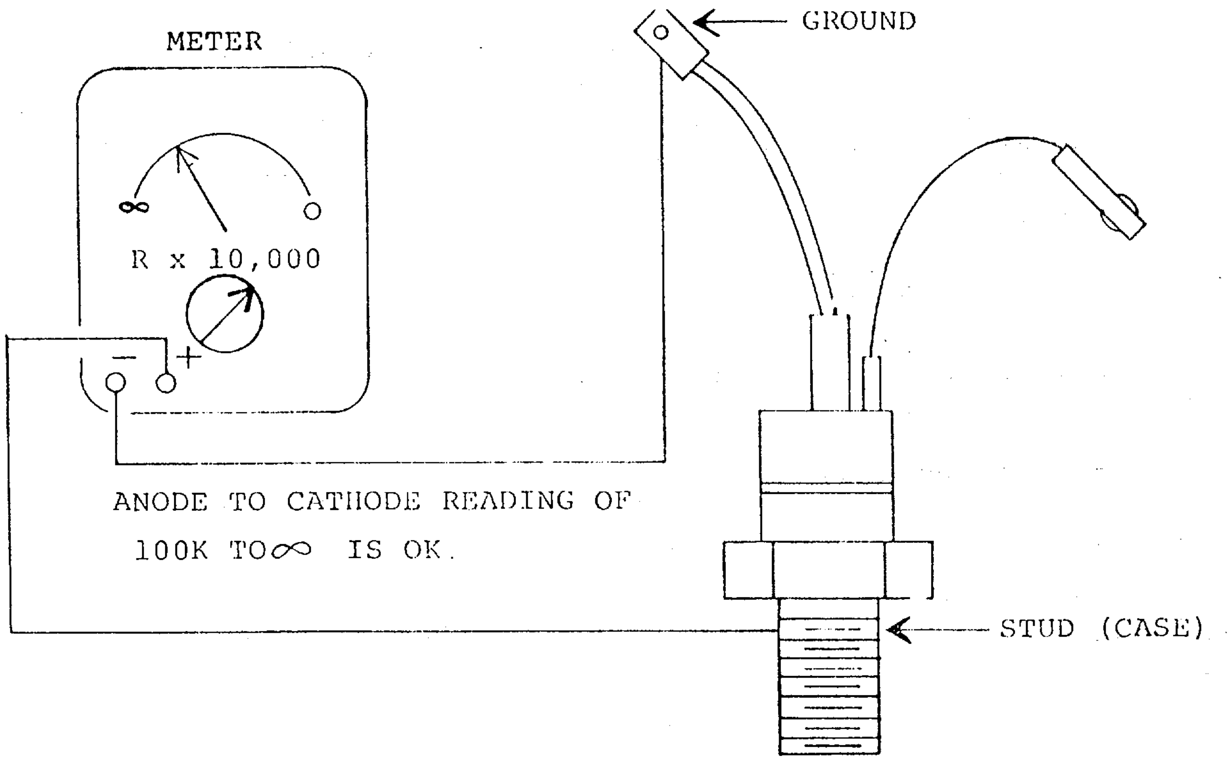
4) An SCR (Silicon Controlled Rectifier) is a semiconductor device which will not conduct electricity in either direction unless the GATE is impulsed to turn on the SCR. When the GATE is impulsed, turn the SCR ON, the SCR will conduct from ANODE to CATHODE only. The purpose of this test is to determine if the SCR will conduct (i.e., show low resistance) without the GATE being turned on. If so, the SCR is shorted and should be replaced.



4.3.9 SCR CHECKOUT PROCEDURE (continued)

5) Remove SCR cathode (ground) leads from ground. These are RED #8 wires for A40/A60, and GREEN wires for an A30, which are attached to the bottom of the inverter with a bolt and 7/16" nut. The SCR does not have to be removed from heat sink for this test. The heat sink and anode are at the same potential.

6) Check resistance across 5CR with positive (+) lead from Ohm Meter on heat sink, and negative (-) lead on the cathode which was removed from ground stud. (See illustration.) If resistance reading is less than 1000 Ohms, the SCR is shorted and should be replaced. A resistance reading of 100,000 Ohms to infinity (o3:) indicates that the SCR is not shorted.



NOTE: BE SURE EITHER STUD OR GROUND WIRE OF SCR IS REMOVED BEFORE CHECKING SCR.

7) To replace the SCR, do the following:

a) If the inverter has one-inch holes in the slotted area behind the heat sink, pop the plastic plugs out of these holes from the inside with a screwdriver. If the inverter does not have holes in the slotted or louvered area behind the heat sink, then the heat sink must be removed by removing the four screws at the corners.

b) Disconnect the small connector in the SCR gate lead.

c) Remove the SCR, using the 7/16" socket if it is an A30, or the 3/4" socket for an A40 or A60, leaving as much of the white thermal compound on the heat sink as possible.

4.3.9 SCR CHECKOUT PROCEDURE (continued)

d) Install the new SCR, making sure that the nut is on very tight.

e) Reconnect the Cathode (GROUND) lead.

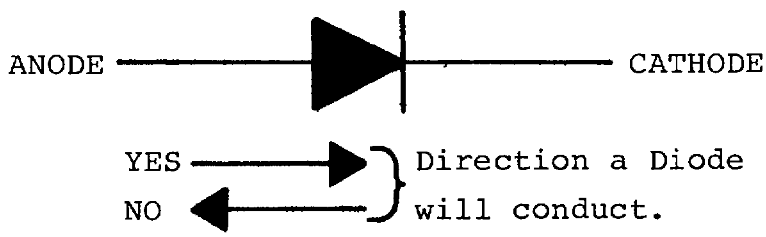
f) Reconnect the gate lead.

4.3.10 DIODE CHECKOUT PROCEDURE

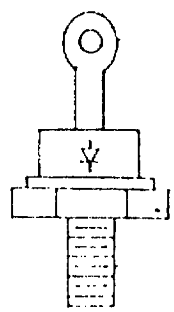
Tools Required: Ohm Meter or Continuity Tester, 7/16" socket wrench or open end wrench, screwdriver.

1) Open inverter by removing the front and top panel fasteners. Carefully lay the front panel down on its face and remove the top panel.

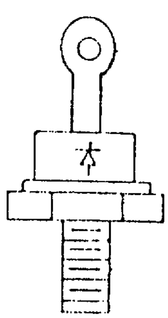
2) A DIODE (Rectifier) is a semiconductor device which functions as an electrical one-way street.



For stud-mounted diodes with normal or standard polarity, the stud is the CATHODE, and the tab or flag is the ANODE. See diagram below.



For stud-mounted diodes with reverse polarity, the stud is the ANODE and the flag or tab is the CATHODE. See diagram below.



4.3.10 DIODE CHECKOUT PROCEDURE (continued)

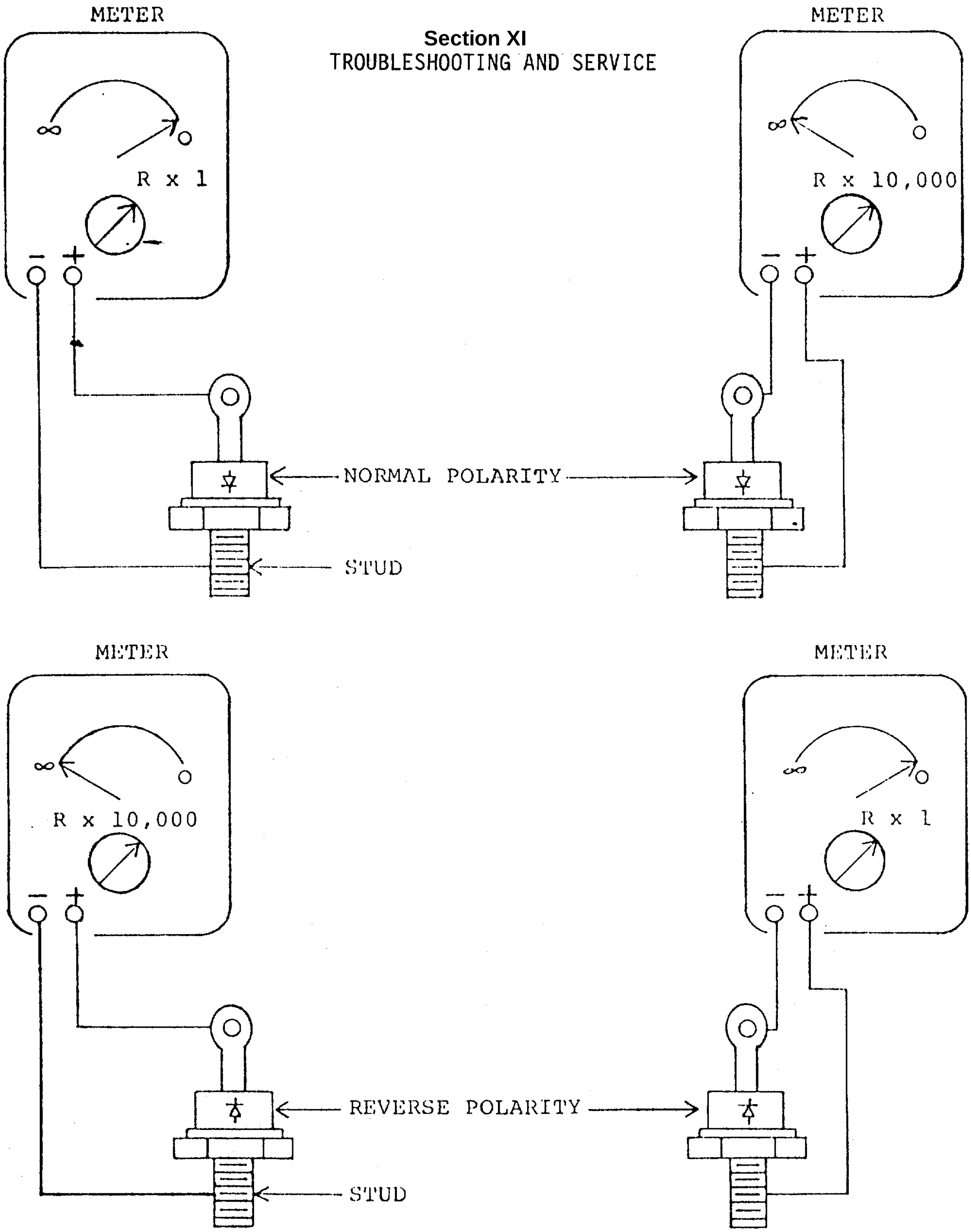
A diode which is not stud-mounted, but rather has axial leads, conducts in the direction , the band on the diode indicating the CATHODE end, the end opposite indicating the ANODE.

Following is the polarity of the diodes in the Dynamic Inverters:

Diode	Polarity
D1	Standard
D2	Axial Leads
D3, D4	Reverse
D5, D6	Standard
D7, D8	Standard
D9, D10	Axial Leads

3) The diodes can be located using the wiring diagram, Figures 4.5.0A to F. Not all models have all ten diodes.

4) Diodes should be removed from the heat sink or chassis before testing. Figure 4.3.10A on the following page gives the proper Ohm Meter readings.



NOTE: 1. BE SURE STUD OF DIODE IS REMOVED BEFORE TESTING DIODE.

2. REVERSE POLARITY DIODES WILL HAVE AN "R" IN THEIR NUMBER (R3720 OR IN1184R), ALSO ALL DIODES MOUNTED TO A DYNAMOTE CHASSIS WILL BE REVERSE POLARITY DIODE (EXCEPT THE PIONEER 205).

Figure 4.3.10A DIODE CHECKOUT PROCEDURE AND READINGS

4.3.11 ALTERNATOR DIODE TEST PROCEDURE

FOR THIS TEST, DO NOT PUSH OR RELEASE START SWITCH WHEN ENGINE IS ABOVE IDLE.

Tools Required: Voltmeter with 0-100 VDC scale.
1) Remove the commutation fuses from the inverter front panel.
2) Start the engine and run at approximately 1500 RPM.
3) Check the voltage from the POSITIVE (+) terminal on the alternator to GROUND.

With the START button depressed, the voltage should read 80 to 110VDC. If not, the alternator diodes are bad and should be replaced. This should be done by an alternator repair shop.

NOTE: If Step 3 is difficult because of the distance from the alternator to the inverter, the alternator voltage can be read from the A+ terminal inside the rear of the inverter.

4.3.12 VEHICLE VOLTAGE REGULATOR, PCB3, CHECKOUT PROCEDURE

Tools Required: Voltmeter with 0-15VDC scale, screwdriver

1) Remove the Vehicle Voltage Regulator (VVR) box from the front panel of the inverter by removing the four screws at the corners.

2) Remove the VVR Circuit Board from the box by removing the two screws on the outside of the box.

3) Check the fuse on the VVR Circuit Board and replace if blown. If not, proceed to the next step.

4) With the ignition ON, inverter OFF, and the inverter harnesses still connected, check the voltage from the connector pin #4, GREY wire, to GROUND. The pin next to the edge of the circuit board is pin #5. If the voltage reads 10 volts or more, proceed to Step 5. If there is no voltage, the voltage regulator has failed in the open position and should be replaced.

5) To determine if the voltage regulator is regulating properly, start the engine and run at approximately 1500 RPM. Turn on a moderate load, such as the headlights. With the inverter OFF, check the voltage from the inverter B+ (BLACK) terminal post to GROUND (GREEN). If the voltage is other than 13. 8 to 14. 2VDC, try to adjust it by turning the screw on the grey potentiometer on the vehicle voltage regulator circuit board with a very small screwdriver or knife blade. If the voltage cannot be adjusted to approximately 14. 2VDC, the voltage regulator circuit board should be replaced.

NOTE: The inverter voltage regulator, PCB1, inside the inverter front panel is identical to the vehicle voltage regulator and can be used to replace the vehicle voltage regulator until another board can be obtained. It can also be used to confirm 4 4-0 the diagnosis of a faulty vehicle voltage regulator circuit board.

4.4.0 DYNAMIC INVERTER ELECTRICAL SCHEMATICS

Following is an Index of Inverter Electrical Schematics

4.5.0 DYNAMIC INVERTER WIRING DIAGRAMS AND PARTS LIST

Following is an Index of Inverter Wiring Diagrams and Parts List

Fig. 4.5.0 G <u>DYNAMIC INVERTER PARTS LIST</u>

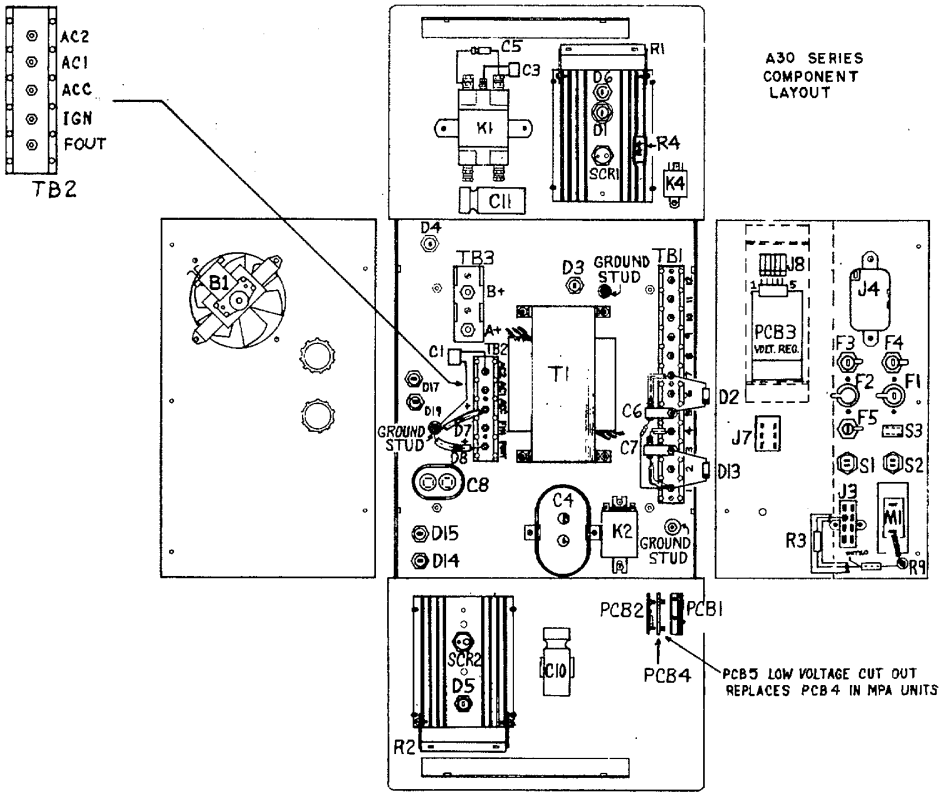
Circuit Designation	Dynamote Part #	Description	Used In: BOOSTED A30	A40	A60	MPA 30	MPA 40	MPA 60
C1	4092-40502	Output Capacitor	x	x	x			
C2	4092-40502	Output Capacitor	x	x	x	x	x	x
C3	4092-40502	XFMR Input Capac.	x	x	x	x	x	x
C4	4095-24712	Commutation Capac.	x	x	x	x	x	x
C5	4093-10147	Contactor Suppression Capacitor	x	x	x	x	x	x
C6,C7	4093-10147	Circuit Board Filter	x	x	x	x	x	x
C8	4093-74610	AC Output Capacitor		x	x		x	x
C9	4095-74606	AC Output Capacitor	x			x		
C10	4093-10825	Boosted Field Capacitor	x	x	x	x	x	x
C11	4093-10825	DC Input Capacitor	x	x	x	x	x	x
D1	4121-43700	Unit Isolation Diode	x	x	x	x	x	x
D2	4121-14005	K2 Relay Hold-in Diode	x	x	x	x	x	x
D3,D4	4121-23720	Battery Charging Diode		x	x		x	x
D3,D4	4121-11183	Battery Charging Diode	x			x		
D5,D6	4121-43700	AC Blocking Diode		x	x		x	x
D5,D6	4121-11186	AC Blocking Diode	x			x		
D8,D9	4121-14005	Spike Suppression Diode	x	x	x	x	x	x
D10,D12	4121-22030	Reverse Parallel Diode		x	x		x	x
D11	4121-43700	Battery Isolation Diode		x	x		x	x
D13	4121-10751	Isolation Diode	x	x	x	x	x	x
D14,D15	4121-20410	Rectification Diode	x	x	x	x	x	x
R1,R2	4681-10025	Stabilizing Resistors	x	x	x	x	x	x
R3	4681-00247	Current Limit Resistor	x	x	x	x.	x	x
R4	4681-08020	VR Stabilizing Resis.	x	x	x	x	x	x
R5,R6	4681-09005	Field Cur. Limit Resis.				x	x	x
R7,R8	4681-06910	Current Limit Resistor		x	x		x	x
R9	4602-20110	Meter Adjustment Potentiometer	x	x	x	x	x	x
F1,F2	4200-06400	Fuses ABU40	x			x		
F1,F2,F5,F6	4200-06400	Fuses ABU40		x	x		x	x
F3,F4	4200-02150	Fuses AGC15	x	x	x	x	x	x
F5	4200-02150	Fuses AGC15	x			x		
F7	4200-02150	Fuses AGC15		x	x		x	x
F1,F2	4282-00005	Fuse Holders Large HPC	x			x		
F1,F2,F5,F6	4282-00005	Fuse Holders Large HPC		x	x		x	x
F3,F4	4282-00003	Fuse Holders Small HKP	x	x	x	x	x	x
F5	4282-00003	Fuse Holders Small HKP	x			x		
F7	4282-00003	Fuse Holders Small HKP		x	x		x	x
K1	4685-43051	Power Relay	x	x	x	x	x	x
K2	4685-01156	Control Relay	x	x	x	x	x	x
K4	4685-02030	VVR Relay	x	x	x			
K5	4685-42592	LVCO Relay				x		
K5	4685-41051	LVCO Relay (Power)					x	x
K6	4685-02030	LVCO Relay (Control)					x	x
K3	4685-43051	High Amperage Bypass Relay	*	*	*	*	*	*

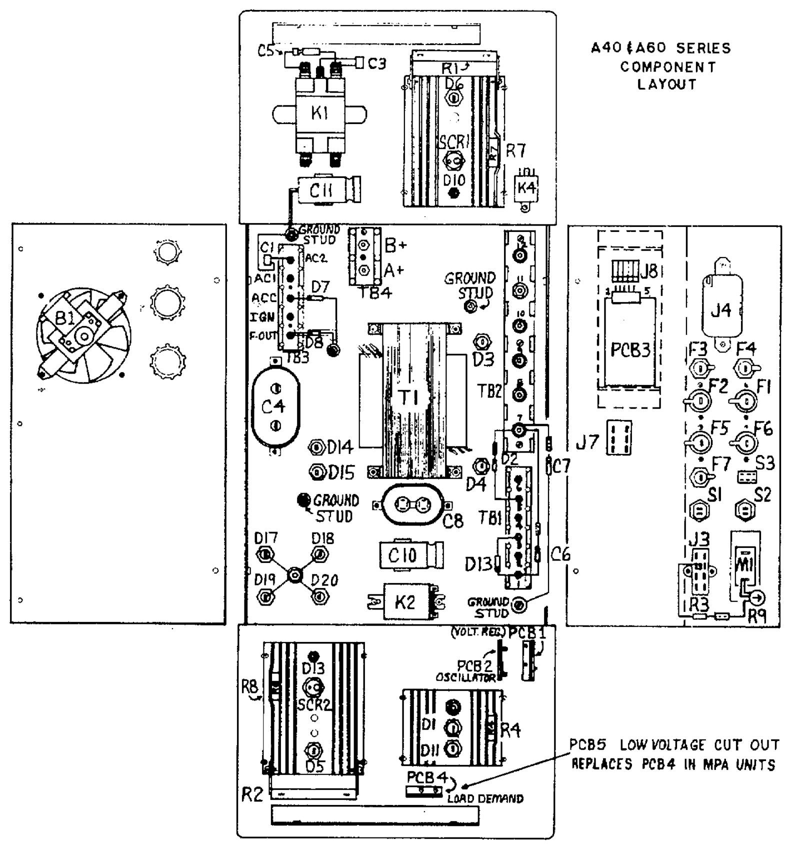
* Optional

Fig. 4.5.0 DYNAMIC INVERTER PARTS LIST(continued)

Circuit Designation	Dynamote Part #	Description	Used In: BOOSTED A30	A40	A60	MPA 30	MPA 40	MPA 60
S1,S2	4721-08411	Start/Stop Switch	x	x	x	x	x	x
S4	4721-00256	Field Selection Switch				x	x	x
B1	4046-12337	Fan Motor	x	x	x	x	x	x
M1	4481-20123	Voltmeter	x	x	x	x	x	x
PCB1	2081-00005	Regulator (Unit)	x	x	x	x	x	x
PCB2	2081-00930	Oscillator	x	x	x	x	x	x
PCB3	2081-00005	Regulator (Vehicle)	x	x	x	x	x	x
PCB4	2081-00200	Load Demand	*	*	*	*	*	*
PCB5	2081-02407	Low Voltage Cutout				x	x	x
T1	2764-02007	Transformer/Isolated	x		x			
T1	2764-01415	Transformer/Isolated		x		x		
T1	2764-01412	Transformer			x			
T1	2764-02022	Transformer/Isolated			x			x
SCR1,SCR2	2720-40125	Main SCRs	x			x		
SCR1,SCR2	2720-70100	Main SCRs		x	x		x	x
J3	4080-03080	Control Head Receptacle	x	x	x	x	x	x
J4	4683-25320	Output Receptacle	x	x	x	x	x	x
J7	4080-30160	Test Module Receptacle	x	x	x	x	x	x
X1	4080-04014	Quick Disconnect-Black	x	x	x	x	x	x
X2	4080-04013	Quick Disconnect-Red	x	x	x	x	x	x
X3	4080-04015	Quick Disconnect-Green	x	x	x	x	x	x
X1,X2,X3	4442-90000	Quick Disconnect-Lugs	x	x	x	x	x	

*-LD Units Only


A30 SERIES
COMPONENT
LAYOUT
TB2
AC2
AC1
ACC
IGN
FOUT
PCB5 LOW VOLTAGE CUT OUT
REPLACES PCB4 IN MPA UNITS


A40 & A60 SERIES
COMPONENT
LAYOUT
PCB5 LOW VOLTAGE CUT OUT
REPLACES PCB4 IN MPA UNITS
LOAD DEMAND
(VOLT. REG.) PCB1
PCB2 OSCILLATOR

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

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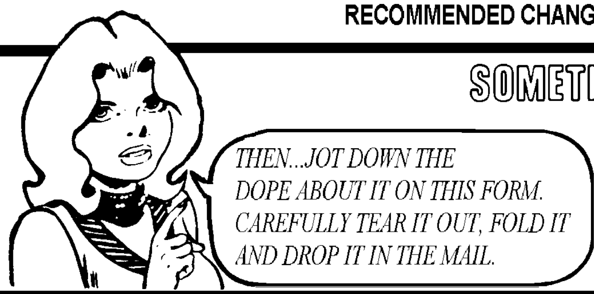

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3.38 fl. ounces
1 liter = 10 deciliters = 33.81 fl. ounces
1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

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