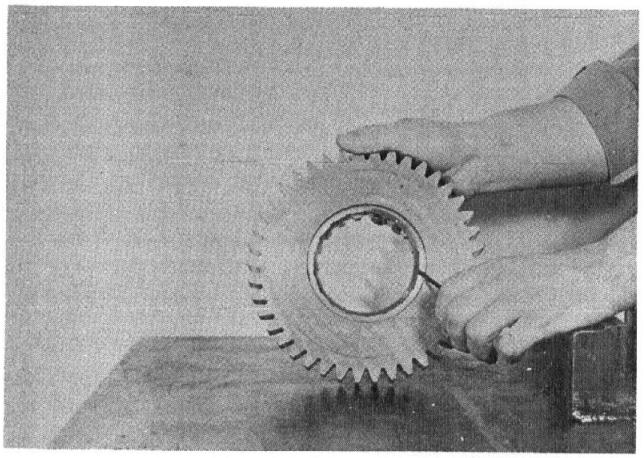
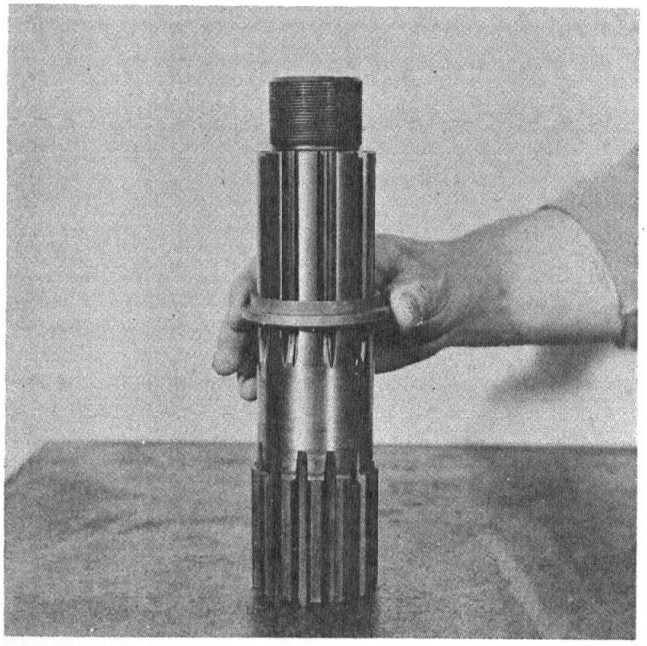
III. AUXILIARY REAR HOUSING

A. Reassembly of the Tailshaft and Rear Bearing Assembly

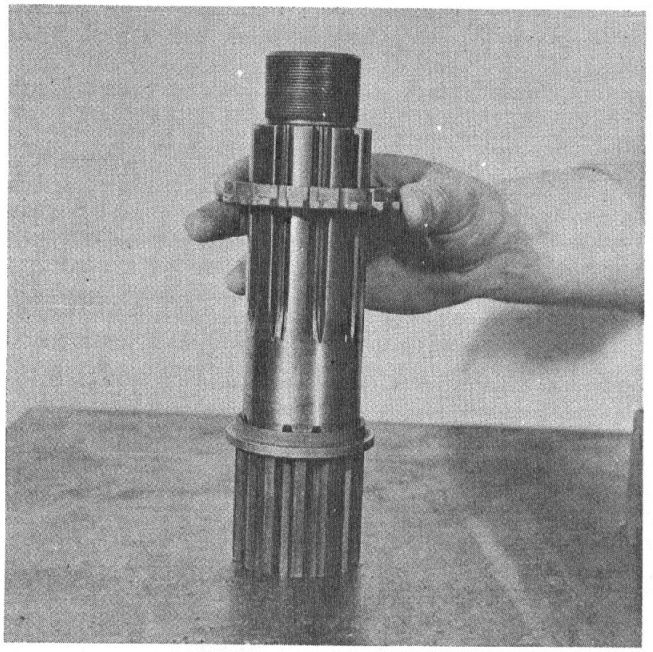


1. If previously removed, install the snap ring in the low speed gear.

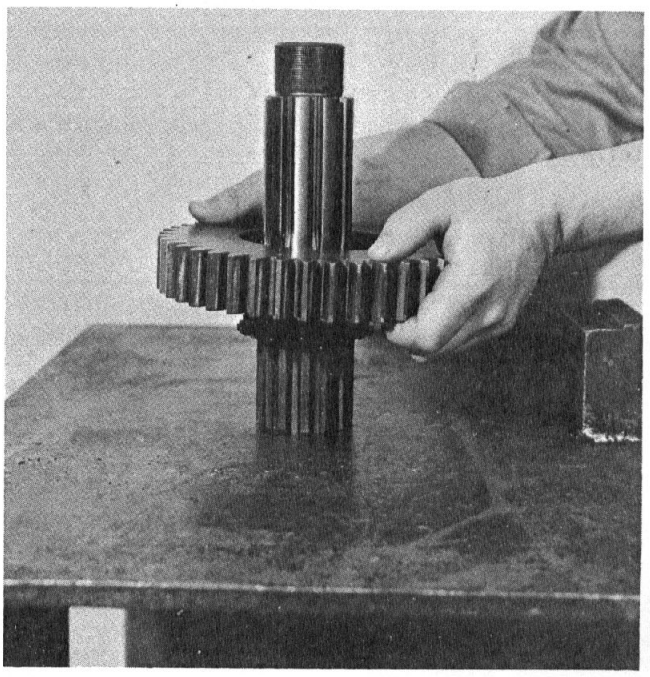
IMPORTANT: For timing purposes, mark two adjacent teeth on the low speed gear and mark the two teeth directly opposite.



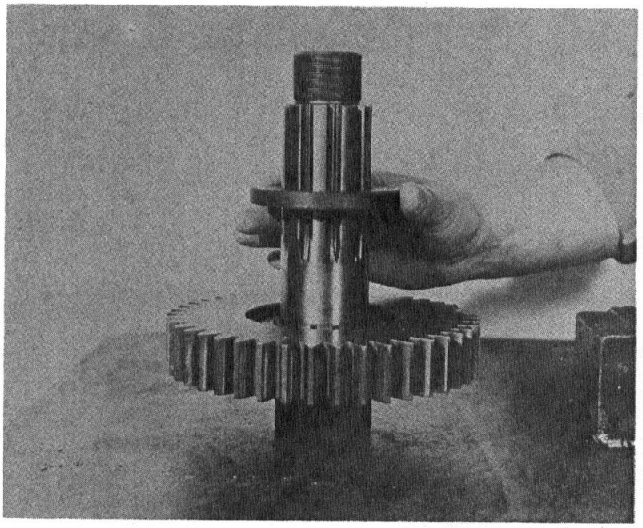
2. Set the tailshaft on a bench with the threaded end up and install the low speed gear stepped washer, large diameter down.



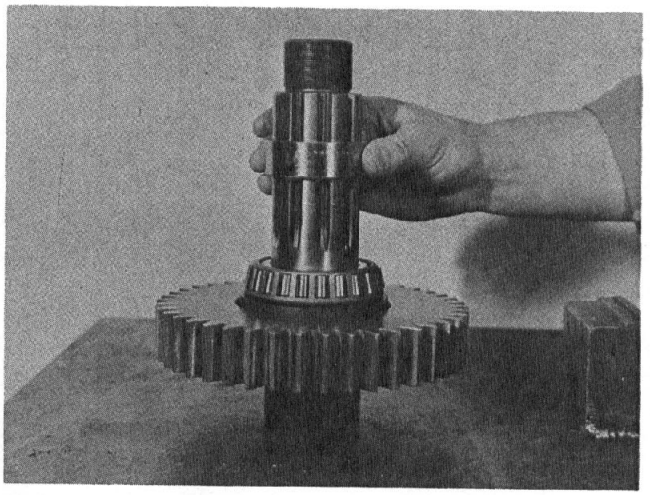
3. Install the splined spacer onto the shaft and washer.



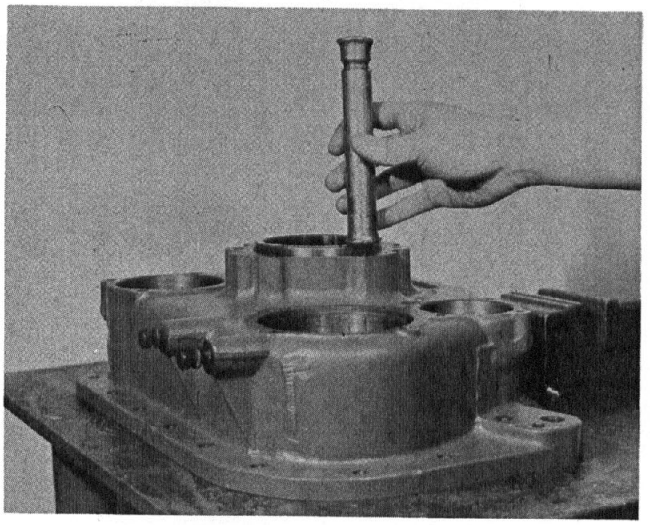
4. Install the low speed gear on the splined spacer, clutching teeth down.



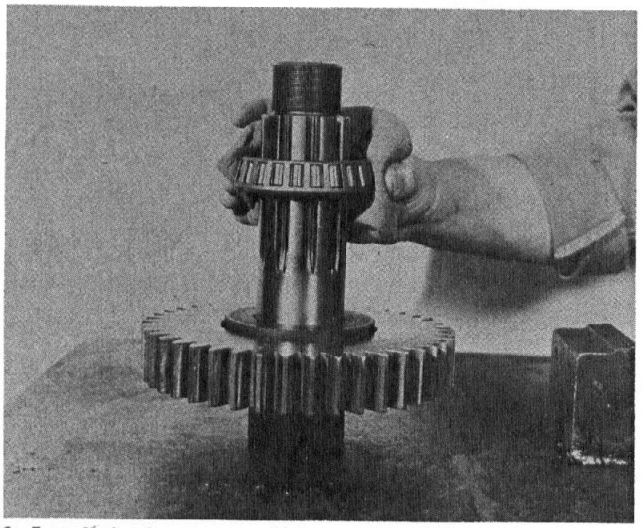
5. Install the low speed gear rear washer on the shaft, chamfered ID up.



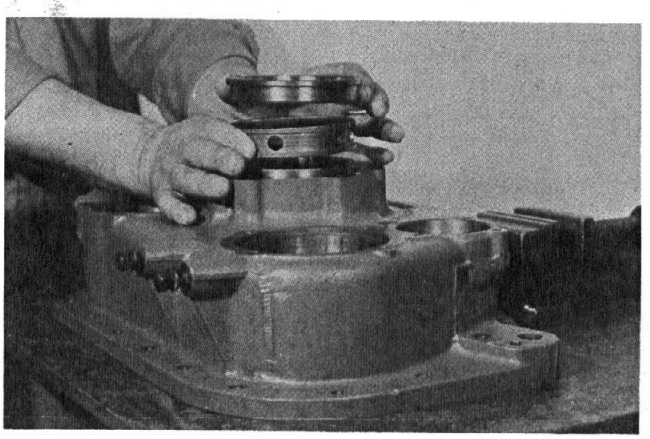
7. Install the bearing inner spacer on the shaft.



8. Place the front bearing cup partially into the bore of the housing, taper to the inside.

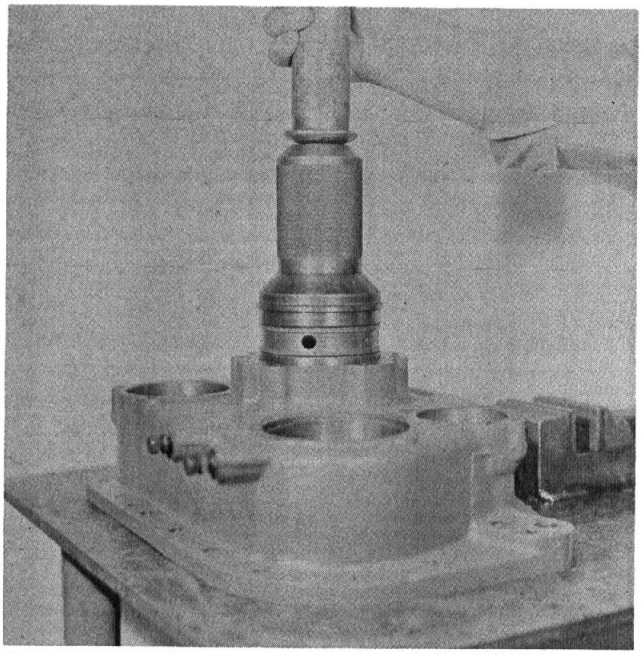


6. Install the front cone of the rear bearing on the shaft and against the washer. (Heating of the bearing will facilitate installation. Use heat lamps but do not heat over 275° F.)

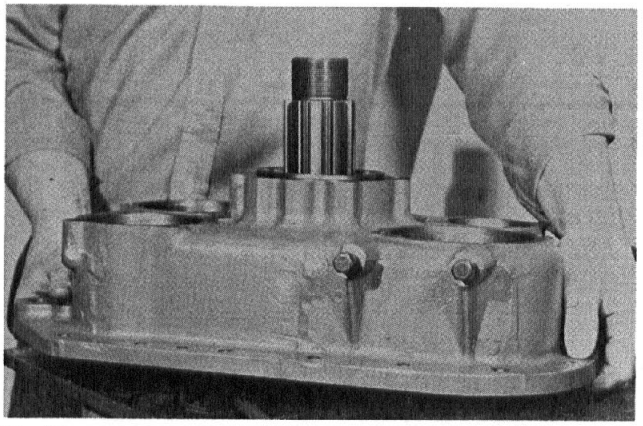


9. Place the bearing outer spacer on the front cup and place the rear bearing cup on the spacer.

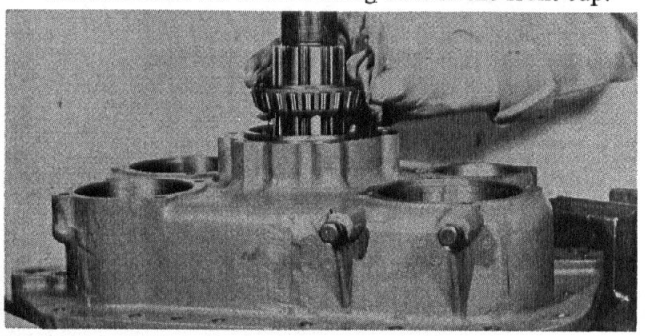
A. Reassembly of the Tailshaft and Rear Bearing Assembly – Continued



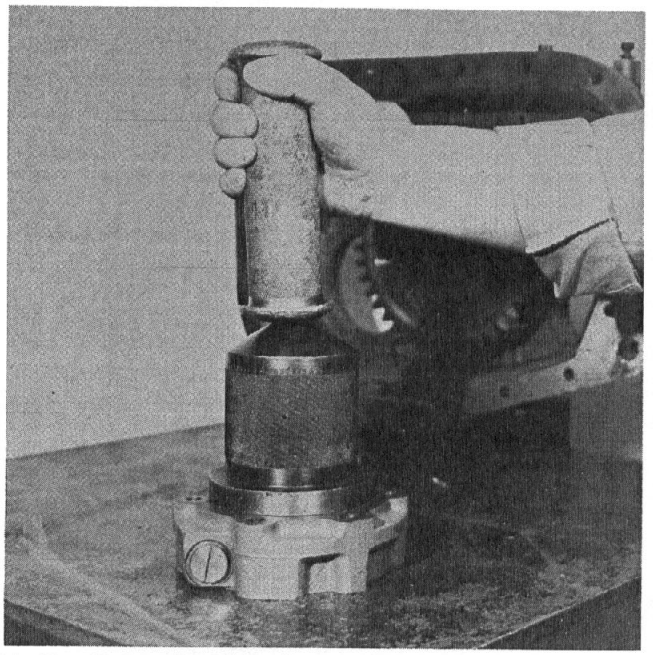
10. Tap all three units evenly into the rear bore until the lip of the rear cup seats against the housing.



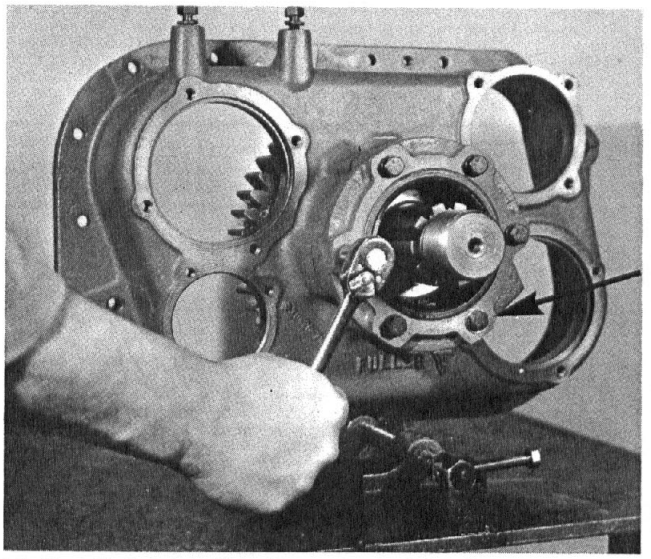
11. Place the auxiliary rear housing over the end of the shaft and seat the front bearing cone in the front cup.



12. Install the bearing rear cone on shaft and into the rear cup. (Heating of the bearing cone will facilitate installation, but do not heat over 275° F.)

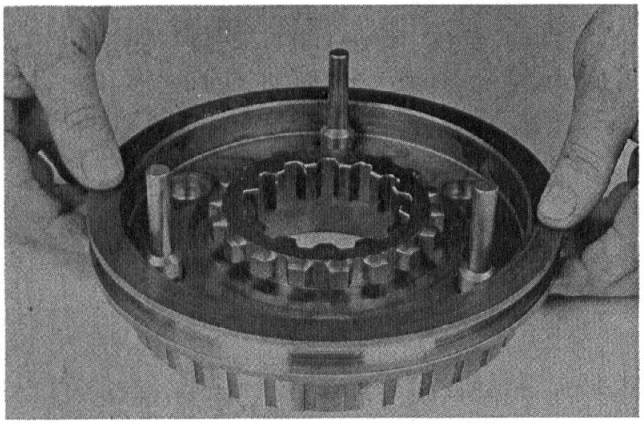


13. Install the oil seal in the rear bearing cover.

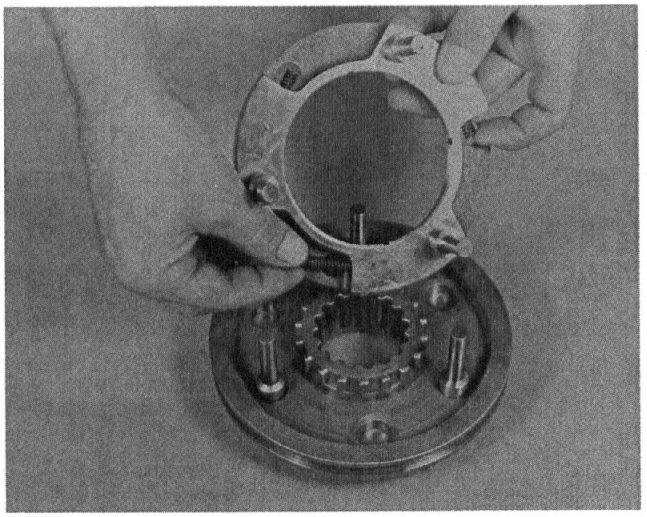


14. Install the rear bearing cover, using a brass washer at the speedometer gear location.

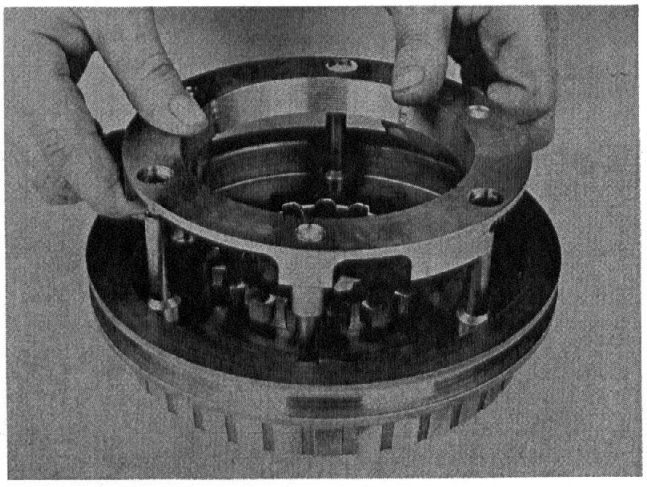
B. Reassembly and Installation of the Synchronizer Assembly



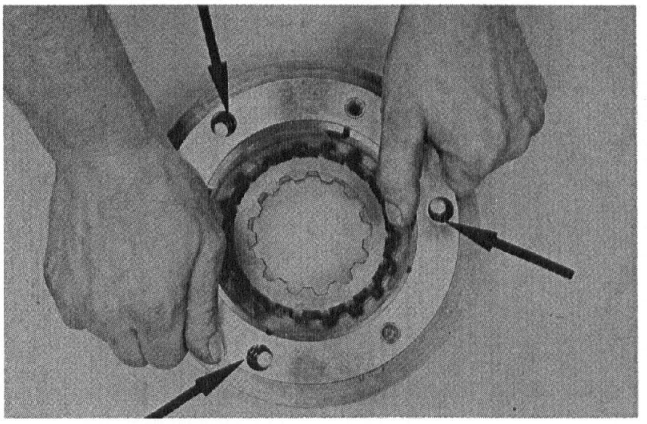
1. Install the sliding clutch on the pins of the low speed synchronizer, recessed side up.



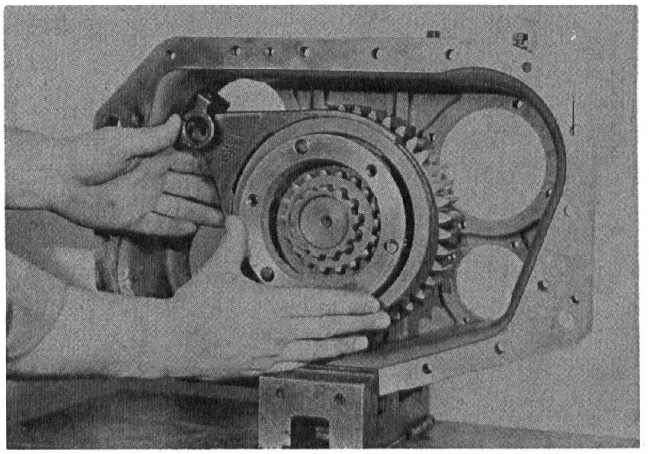
2. Install the three springs in the direct synchronizer.



3. Place the direct synchronizer over the low speed blocker pins, seating the springs against the pins.

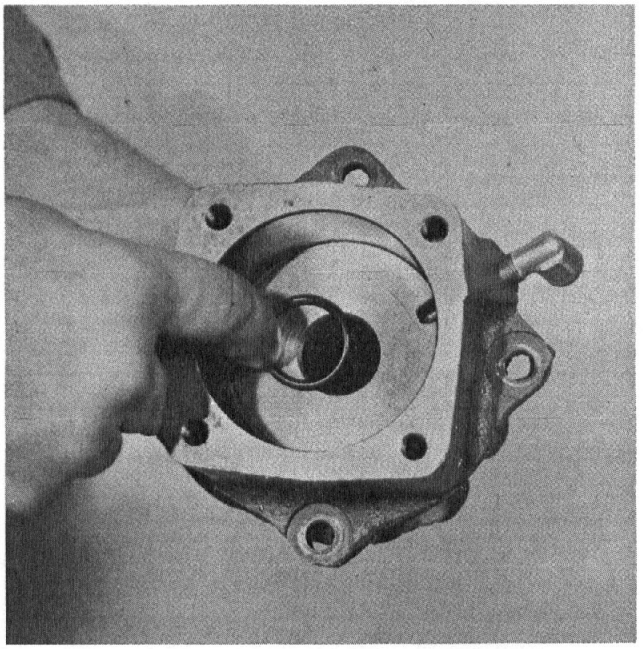


4. Compress the springs to fully seat the direct synchronizer on the pins of the low speed synchronizer.

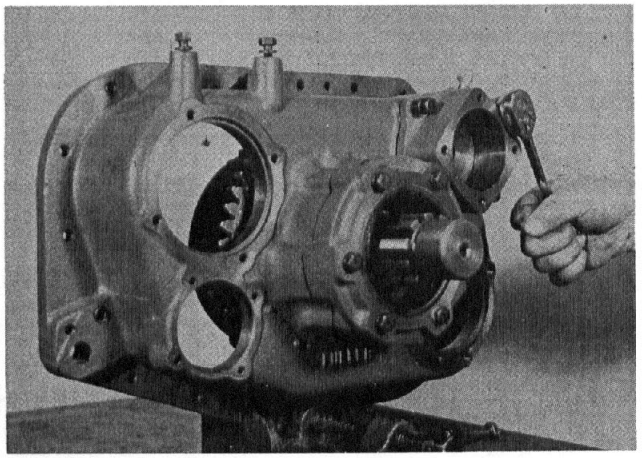


5. Place the direct-low shift fork into the yoke slot of the sliding clutch, short hub to the rear, and install the synchronizer assembly on the splines of the output shaft.

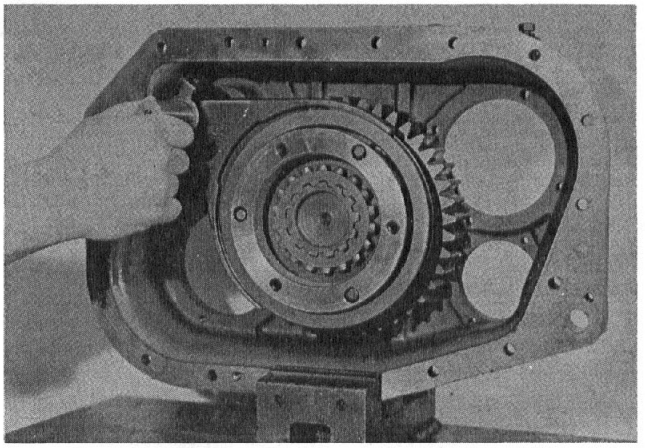
C. Reassembly and Installation of the Auxiliary Shift Cylinder



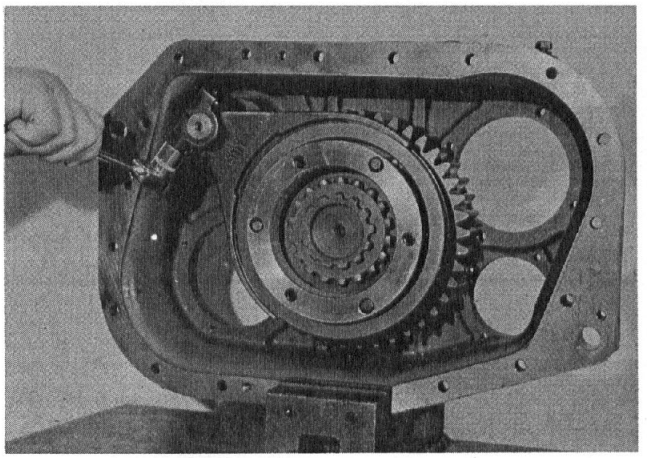
1. Install the O-ring in the bore of the shift cylinder.



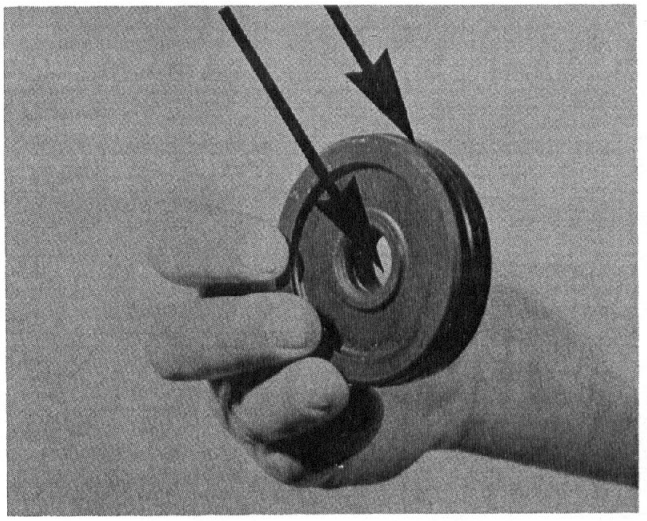
2. Install the cylinder housing into the rear housing bore and secure with four capscrews, noting that the air fitting is on the top right of the housing.



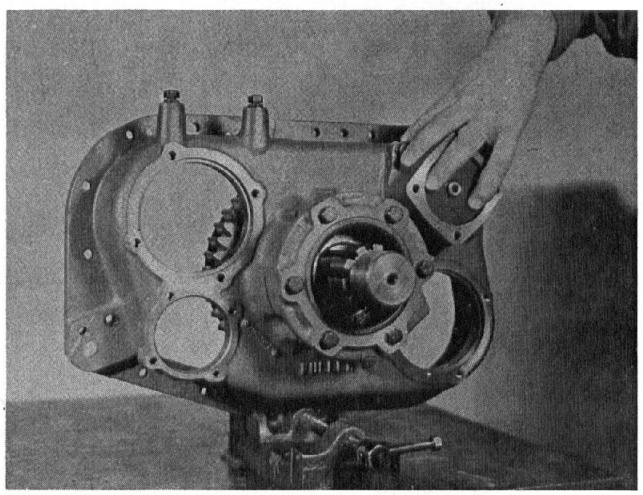
3. Install the shifting shaft from the front through the yoke hub and cylinder, aligning the notches with the lockscrew bores in the yoke hub.



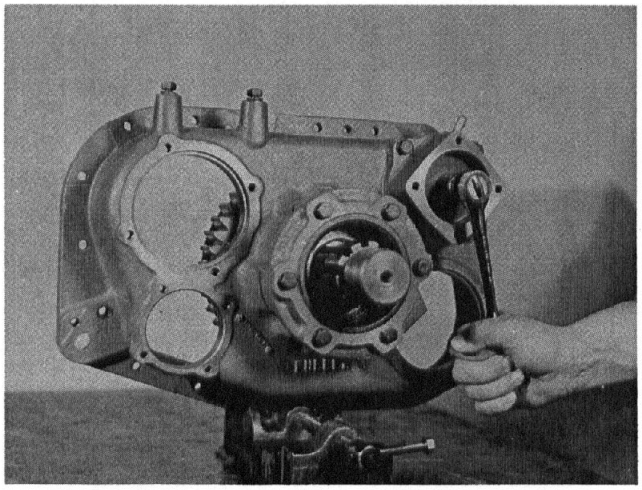
4. Install the two yoke lockscrews, tighten and wire securely.



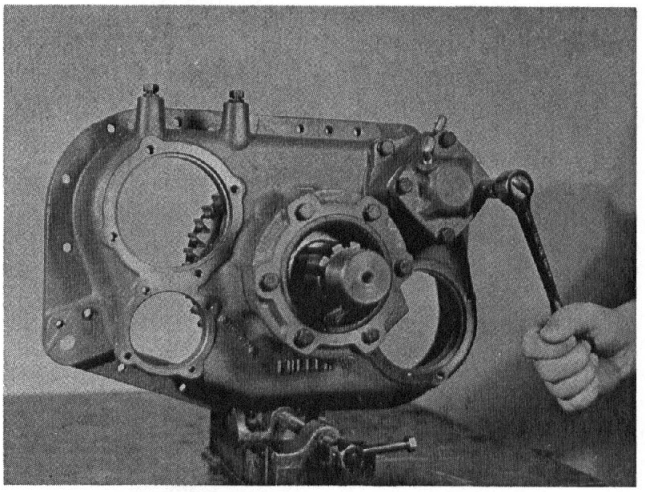
5. Install O-rings in the OD and ID of the piston.



6. Install the piston on the shifting shaft, flat side out.



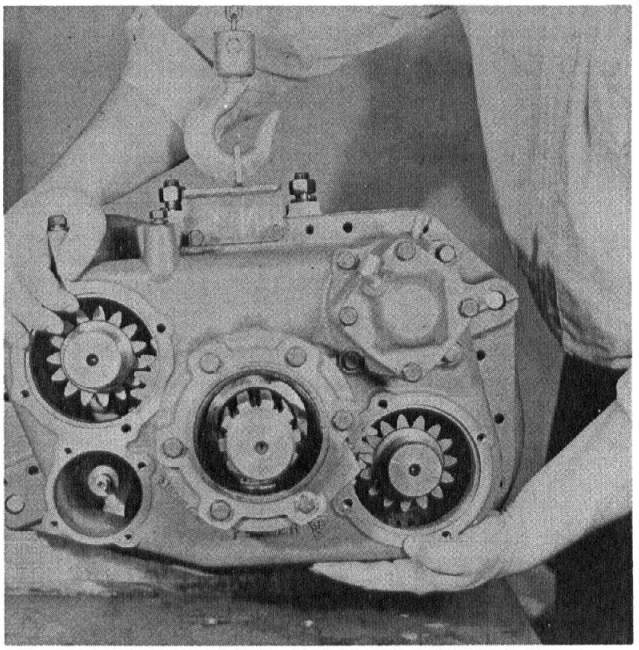
7. Install the locknut on the shifting shaft.



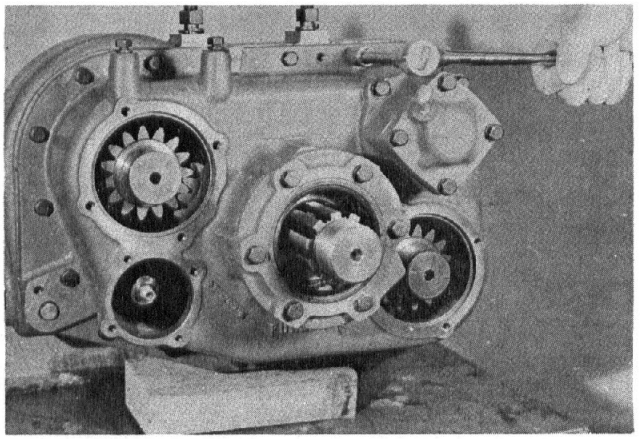
8. Install the shift cylinder cover with four capscrews, noting that the air fitting is on the top left side.

D. Installation of the Auxiliary Rear Housing

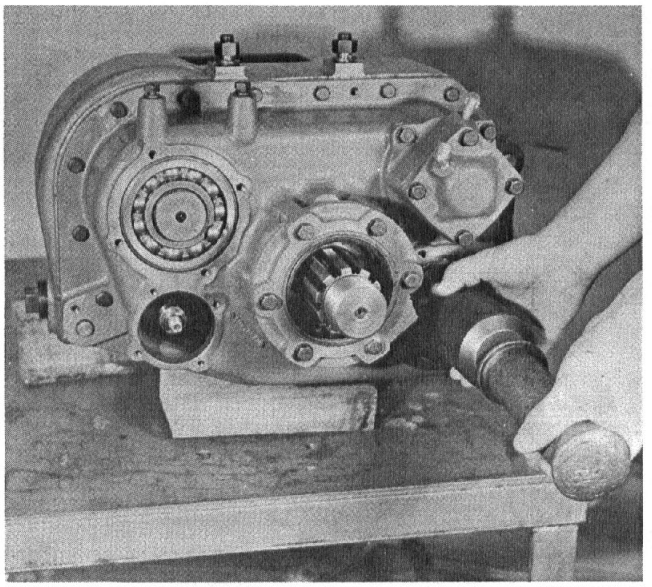
NOTE: Make sure that prior to installation the synchronizer assembly is as far forward as possible on the tailshaft and that the marked teeth on the auxiliary countershafts are facing each other.



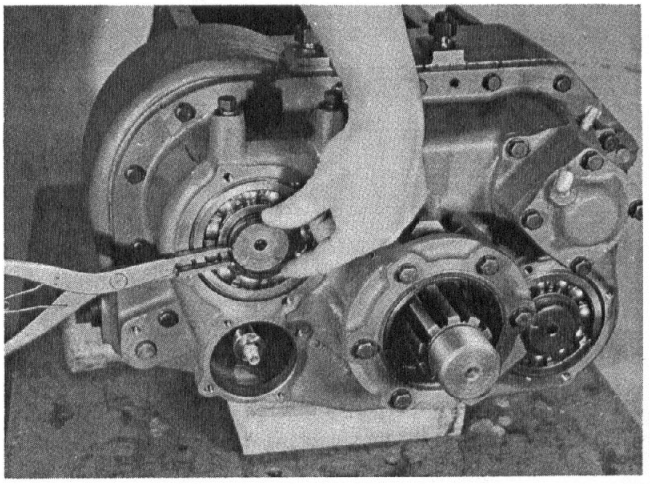
1. Using a hoist, move the rear housing up to the intermediate housing and start the rear housing into position with the top tipped back slightly to allow the synchronizer assembly to pass between the auxiliary countershafts. Check the synchronizer occasionally to make sure that the direct synchronizer is not sliding off the low speed blocker pins. Look through the rear bearing bores and mesh the marked tooth on each countershaft between the two marked teeth on each side of the auxiliary low speed gear. Move the rear housing evenly onto the two dowel pins, using caution to prevent damage to the oil trough.



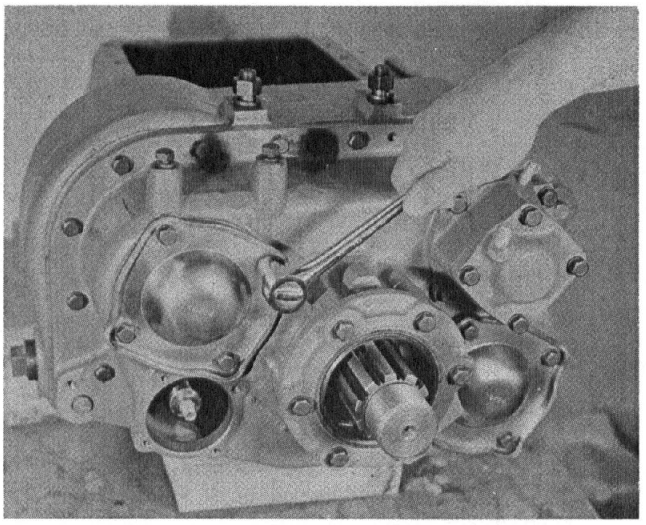
2. Secure the rear housing with the retaining capscrews.



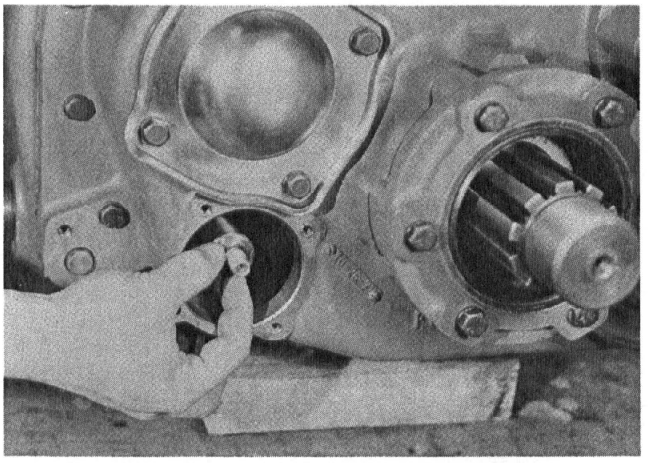
3. Use a soft bar and mall against the rear of both auxiliary countershafts to seat the front bearings and use a bearing driver to install the rear bearings on the shafts and in the bores.



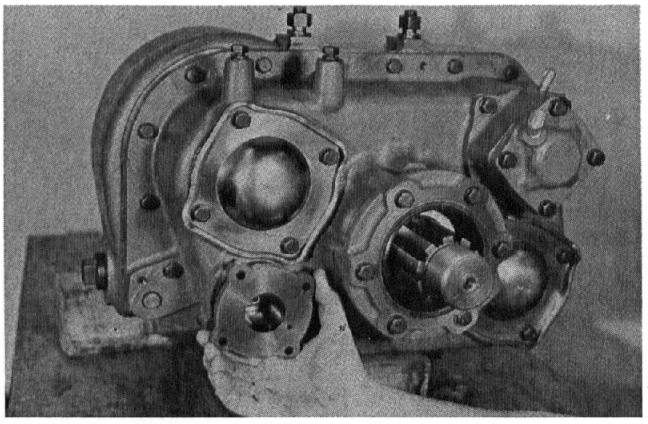
4. Install the rear bearing retaining snap rings in the countershaft grooves.



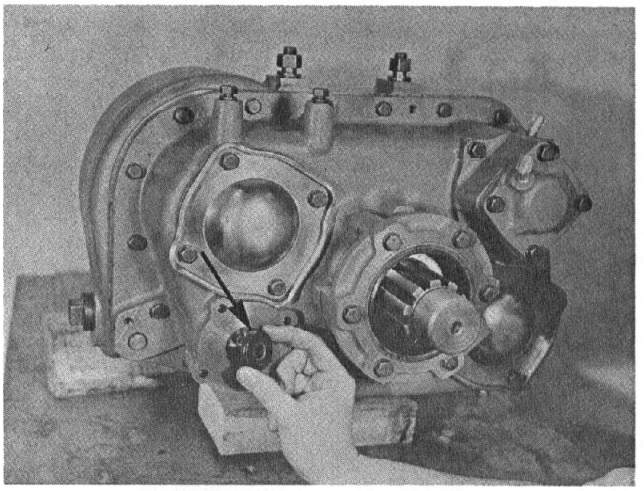
5. Install the rear bearing covers.



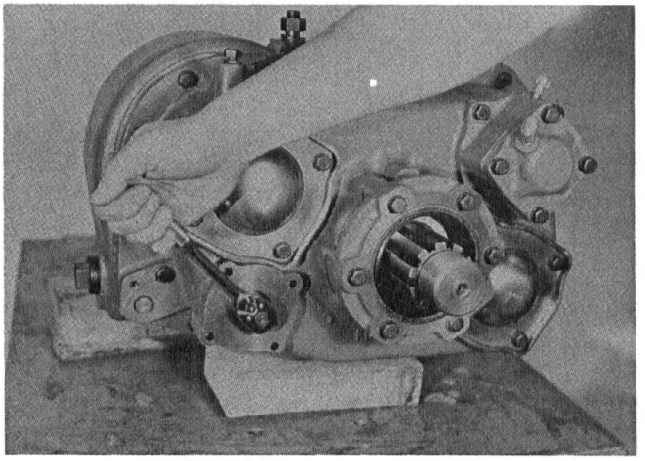
6. Install the O-ring on the intermediate shift shaft.



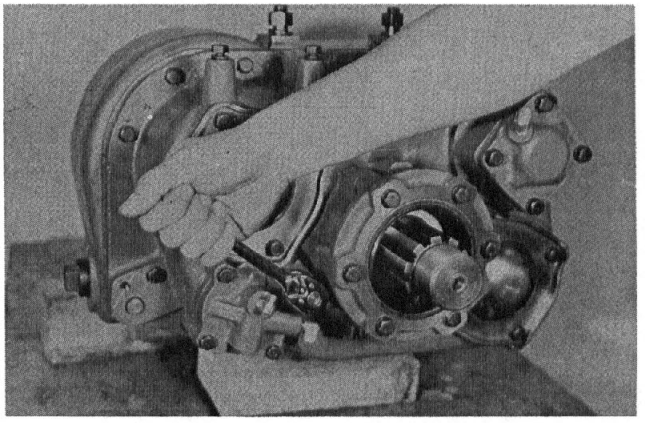
7. Install the intermediate shift cylinder in the rear housing, fitting the shift shaft through the cylinder bore. Cylinder is installed with the small air channel in the housing to the right.



8. Install the O-ring on the outer diameter of the piston and install the piston on the shaft in the cylinder.

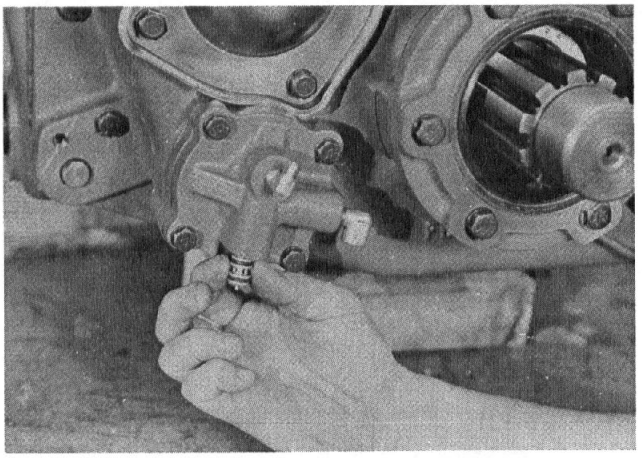


9. Install the elastic stop nut on the shift shaft.

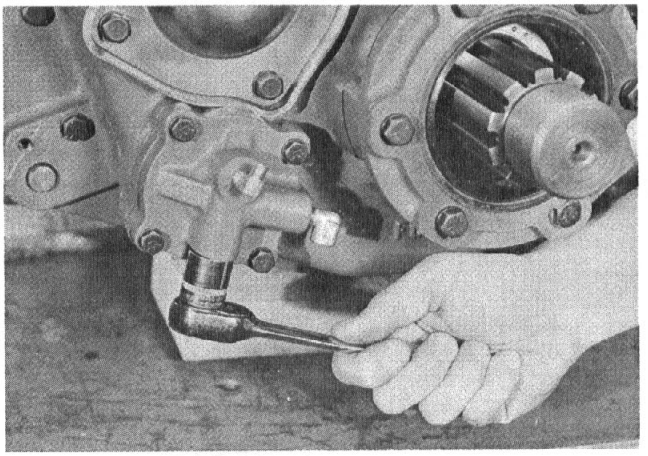


10. Install the shift cylinder cover, aligning the small air channel on the cover with the channel in the housing. The insert valve opening on the cover will be facing down.

D. Installation of the Auxiliary Rear Housing – Continued



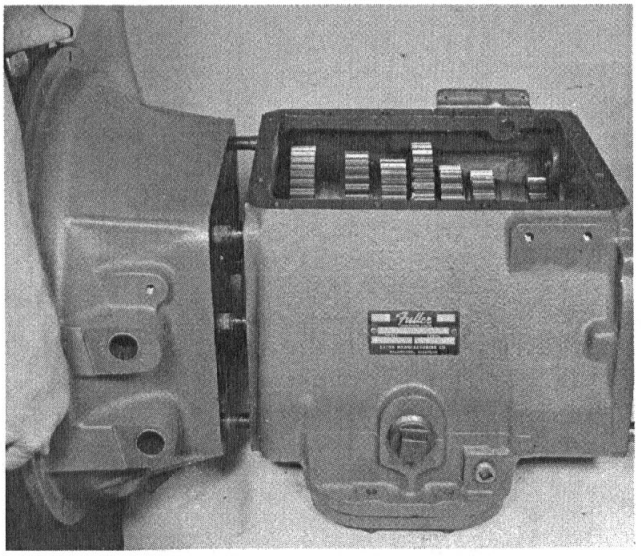
11. If previously removed, install the insert valve in the cover with the flat end facing up.



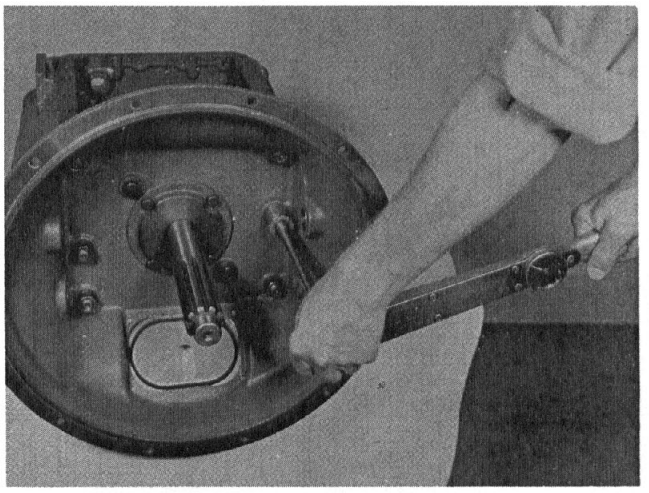
12. Install the insert valve retaining nut in the cover.

IV. COMPANION FLANGE AND CLUTCH HOUSING

A. Installation of the Clutch Housing

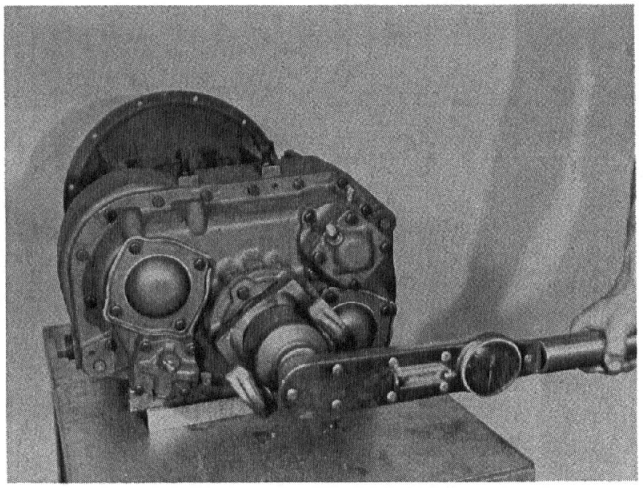


1. Install the clutch housing on the studs in the front case.



2. Install the washers and nuts on the studs and then install the washers and bolts, using the correct torque:
   Nuts 170-185 ft./lbs.
   Bolts 70- 75 ft./lbs.

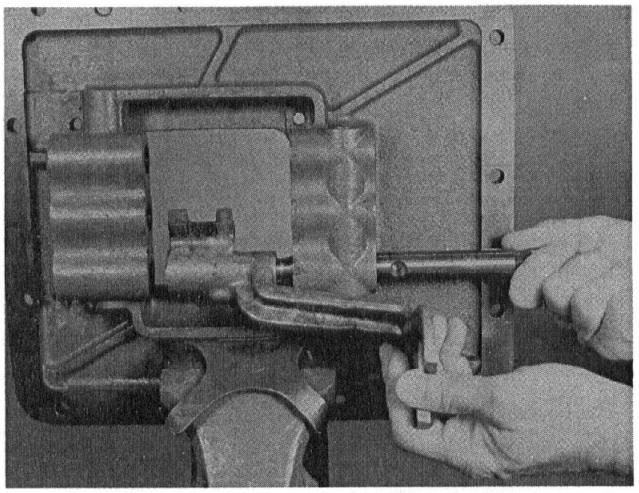
B. Installation of the Companion Flange



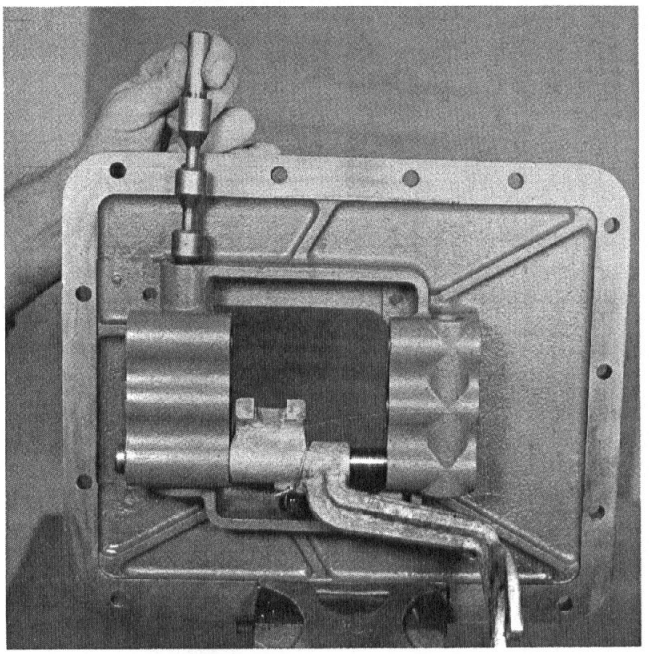
1. Install the speedometer drive gear or replacement spacer on the hub of the yoke or flange, lock the transmission in two speeds and install the yoke or flange on the splines of the tailshaft. Install the tailshaft nut and torque to 450-500 ft./lbs.

V. SHIFTING CONTROLS

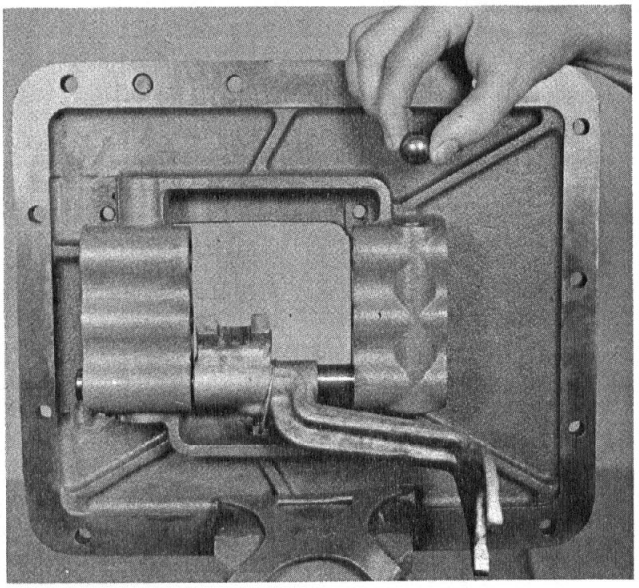
A. Reassembly and Installation of the Shift Bar Housing



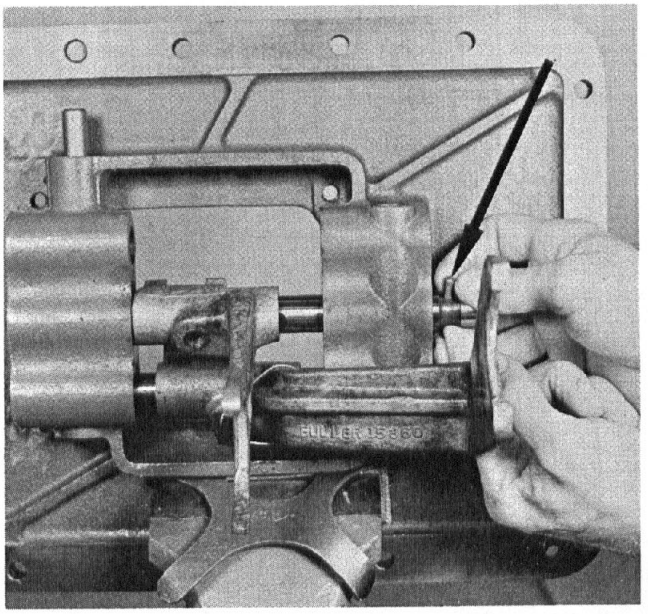
1. Install the 4th-5th speed shift bar and yoke. Install the yoke lockscrew and tighten and wire securely. Keep the bar in the neutral position.



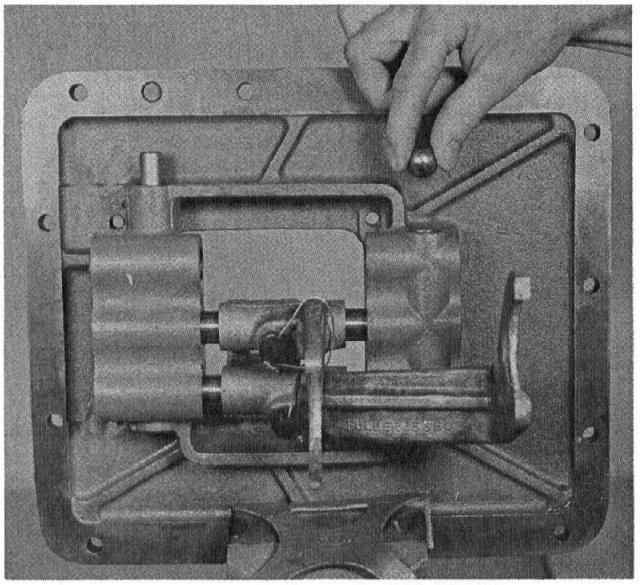
3. Install the actuating plunger in the rear web.



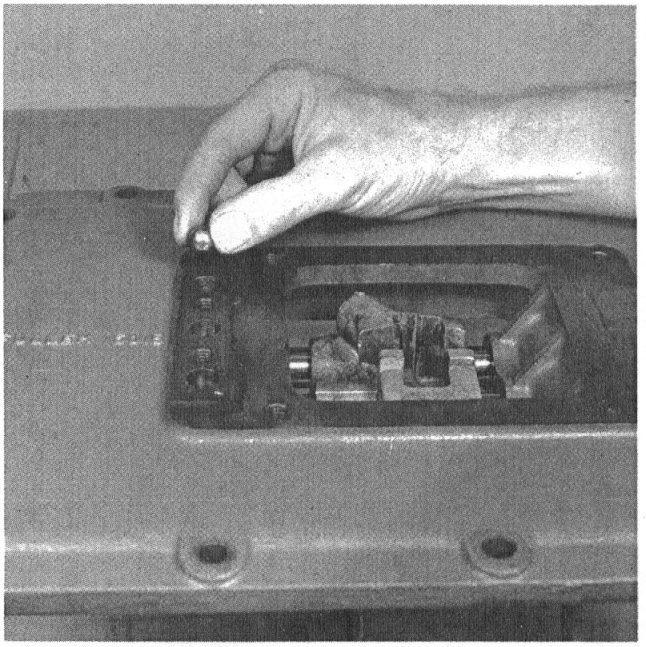
2. Install an interlock ball in the front web.



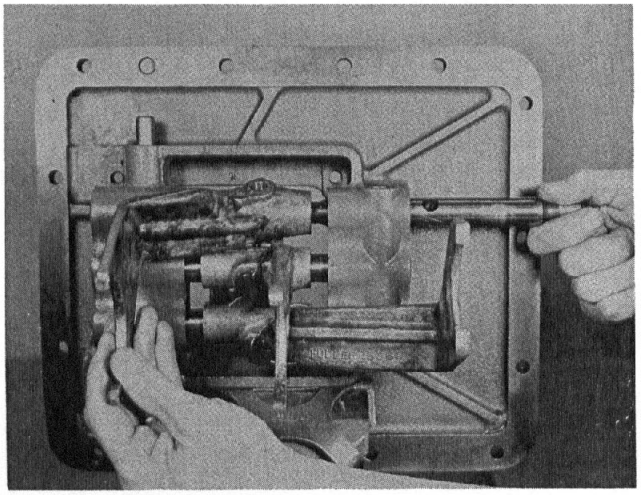
4. Install the 2nd-3rd speed shift bar and yoke, inserting the interlock pin in the bore of the neutral notch. Install the yoke lockscrew and tighten and wire securely.



5. Install an interlock ball in the front web.



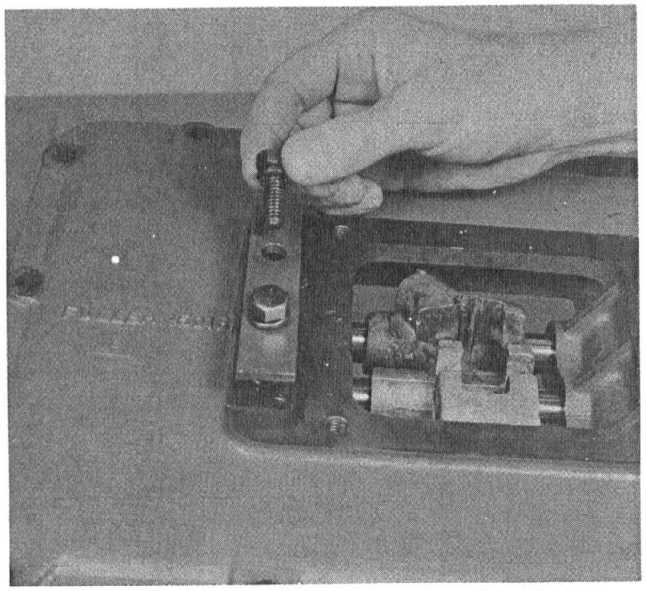
7. Remove the assembly from the vise and install the three tension balls, one in each bore in the top of the housing.



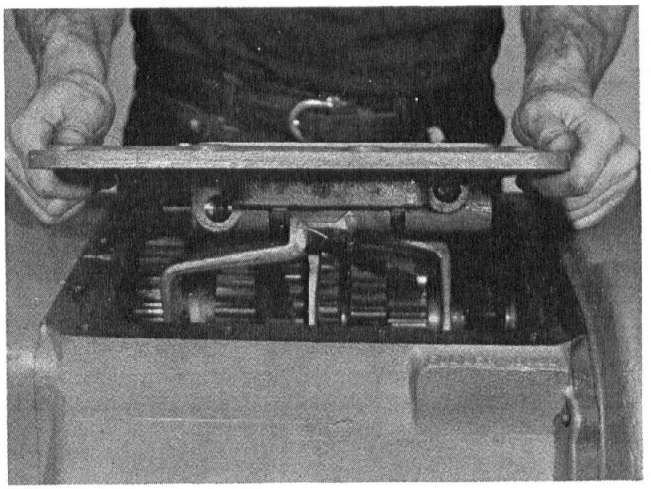
6. Install the 1st-reverse shift bar and yoke. Install the yoke lockscrew and tighten and wire securely.

8. Install the tension springs on top of the balls in the bores.

A. Reassembly and Installation of the Shift Bar Housing – Continued

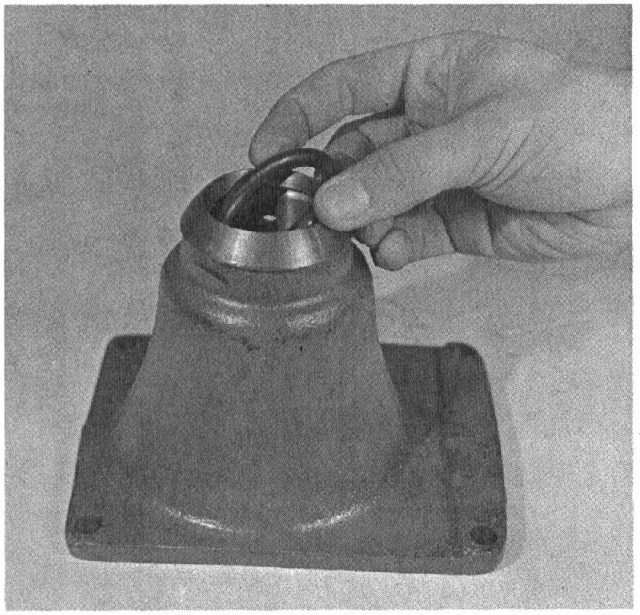


9. Install the tension spring cover and retain with the two capscrews.



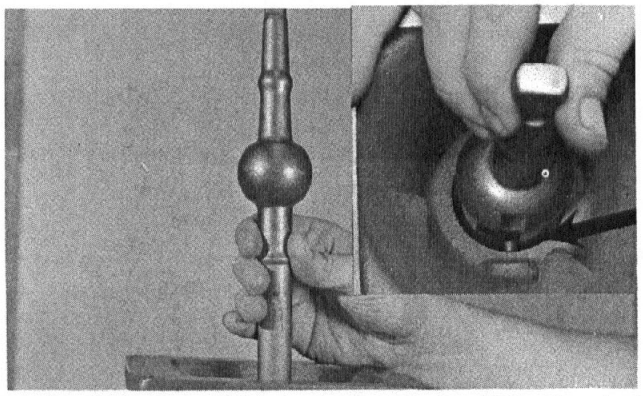
10. Check to make sure that the shift yokes and sliding clutches are in the neutral position and install the shift bar housing on the transmission, tension spring cover to the front and the yoke forks in the sliding clutches. Secure with the 13 capscrews.

B. Reassembly and Installation of the Gear Shift Lever Housing

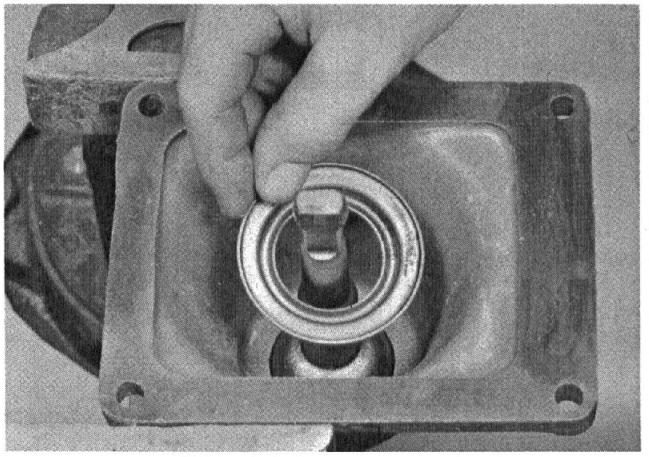


1. If so equipped, install the O-ring in groove in the housing.

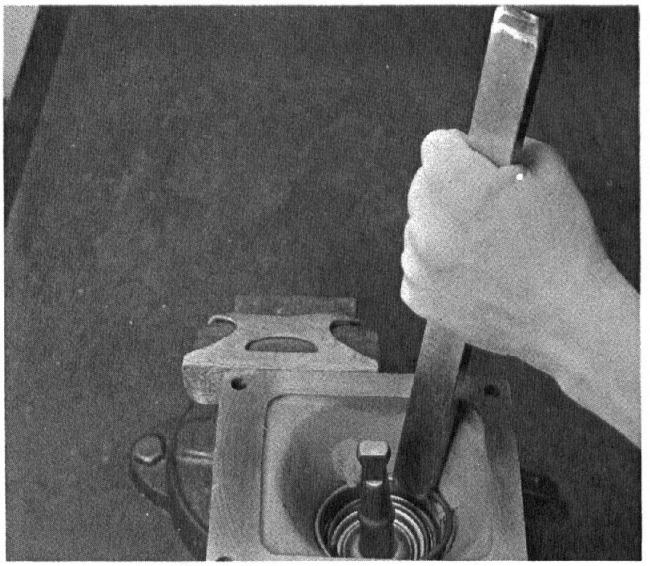
2. Install the lockwasher and nut to secure the pivot pin.



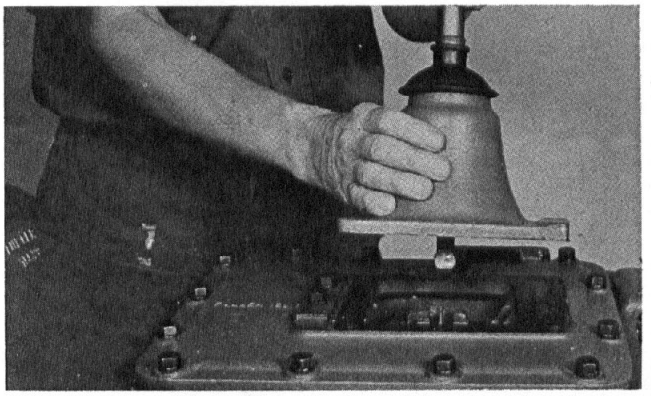
3. Install the gear shift lever in the housing, fitting the pivot pin in the slot in the lever.



4. Install the tension spring washer in the housing.

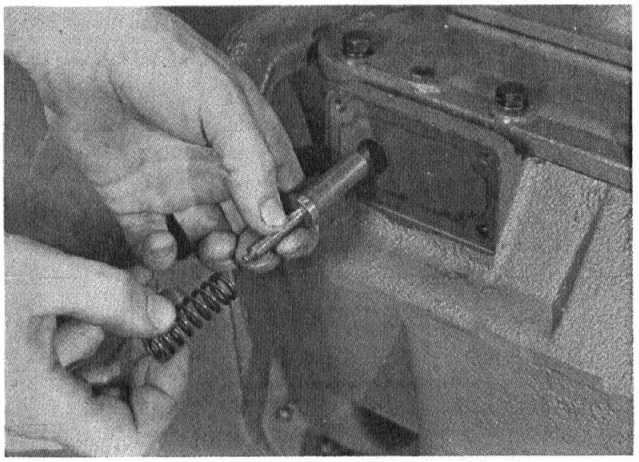


5. Seat the tension spring under the lugs in the housing.

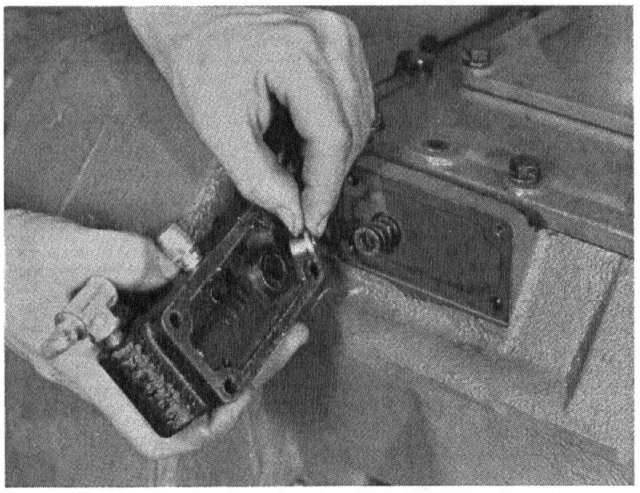


6. Check to make sure that the shift bar housing is in the neutral position and install the gear shift lever housing, fitting the lever into the shifting slots in the forks. Secure with four capscrews.

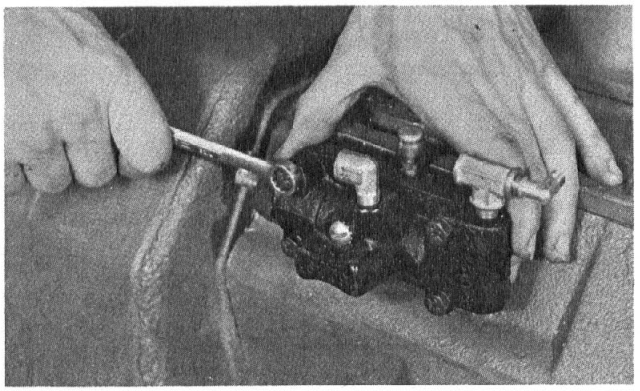
C. Installation of the Air System



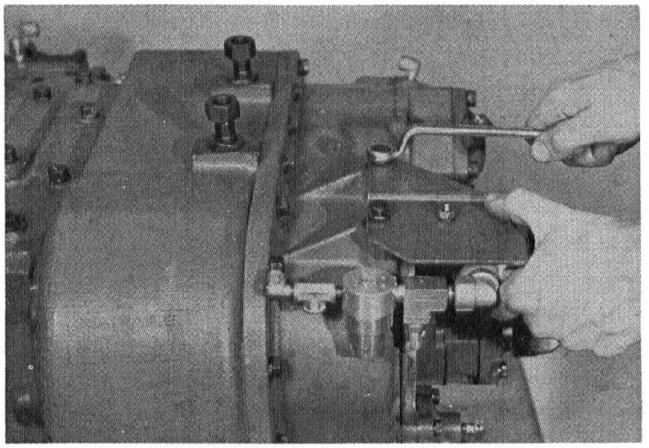
1. Install the actuating pin and spring in the bore in the case.



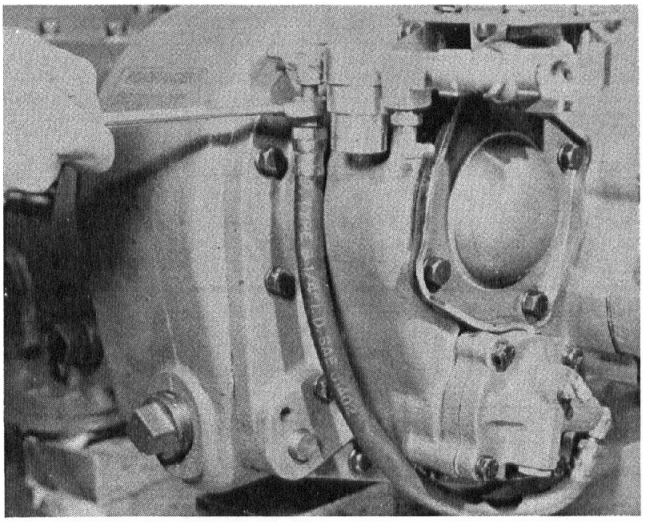
2. Install the hat-type alignment sleeve in the air valve.



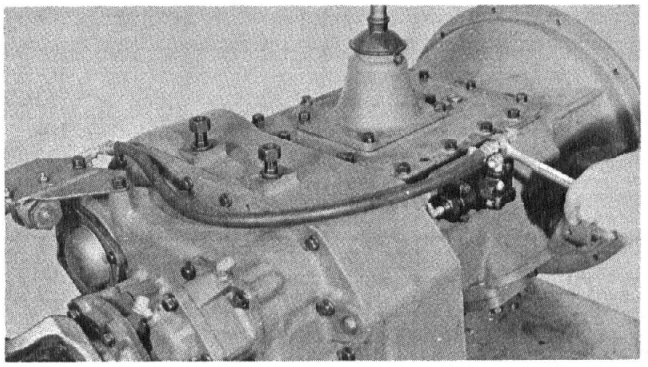
3. Install the air valve on the transmission, using air to move the piston all the way forward or to the rear before installing the air valve.



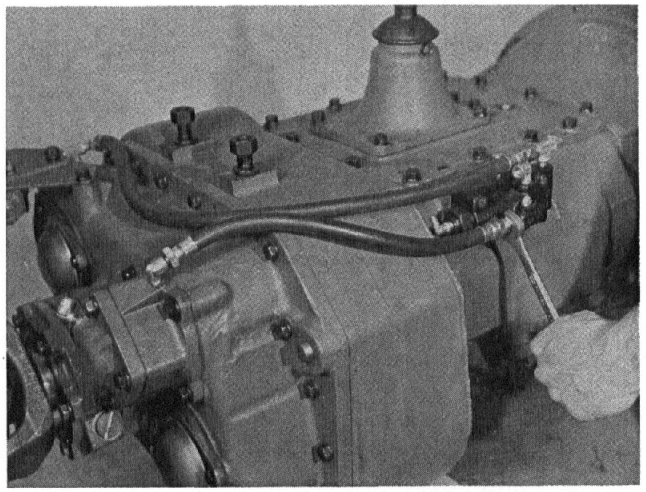
4. Attach the air filter/regulator assembly to the rear housing with the two retaining capscrews.



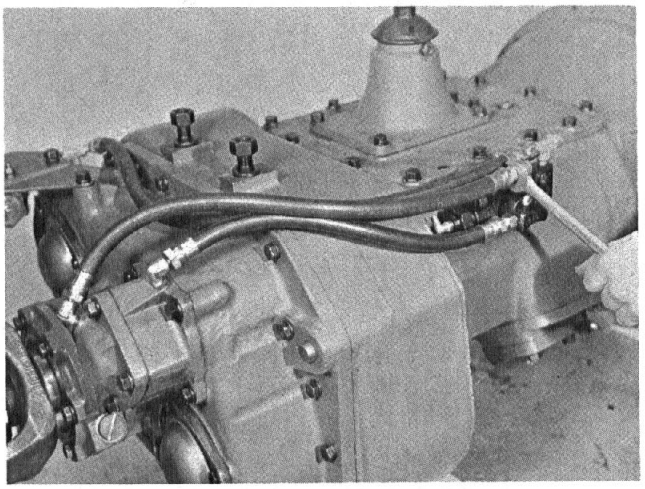
5. Connect the ¼" air line between the intermediate shift cylinder and the air filter/regulator assembly.



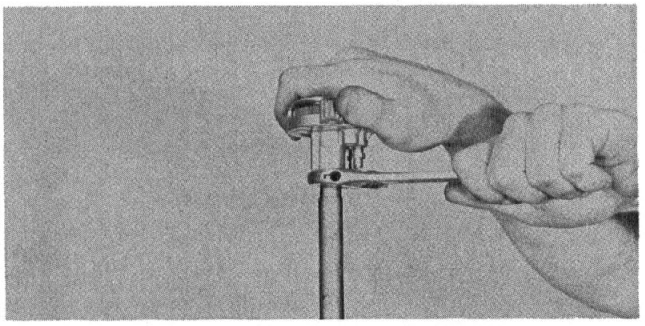
6. Connect the ¼" ID air line between the air filter/regulator assembly and the rear port of the tee fitting on top of the air valve.



7. Connect the ¼" ID air line between the air valve and the low range port of the auxiliary shift cylinder.

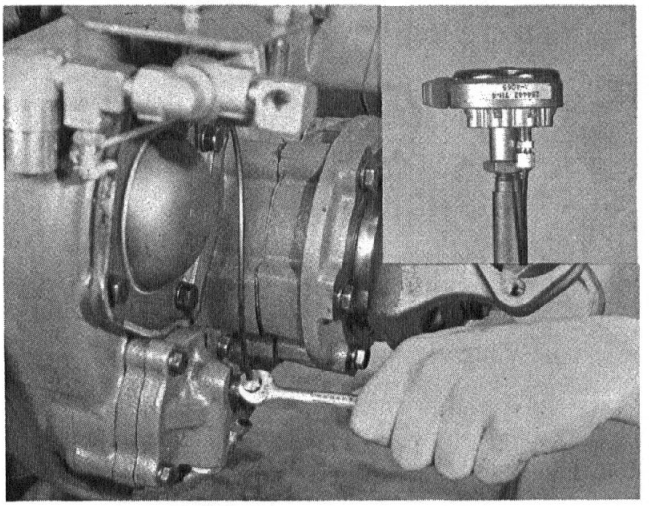


8. Connect the ¼" ID air line between the air valve and the direct range port of the auxiliary shift cylinder.

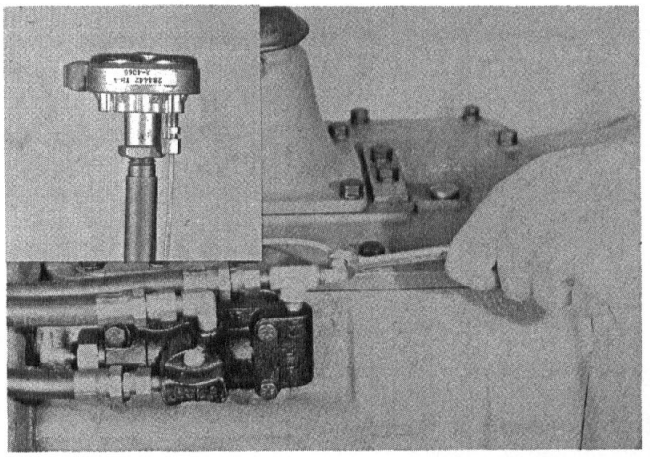


9. Install the ⅛" OD air lines, sheathing and O-rings on the shifting lever. Install the jam nut and control valve and back the jam nut up against the control valve to secure it in the desired position.

NOTE: To avoid confusion, only the air line being installed in each of the following three steps is shown attached to the control valve.

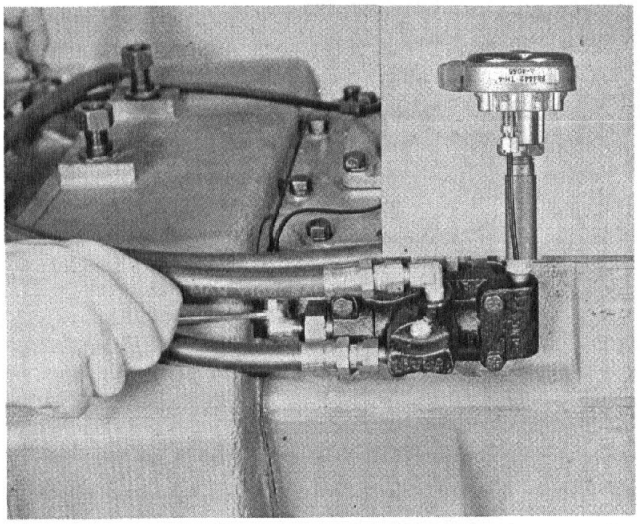


10. Connect the ⅛" OD long black air line between the intermediate shift cylinder and the port in the control valve identified with an "F". (See insert.)

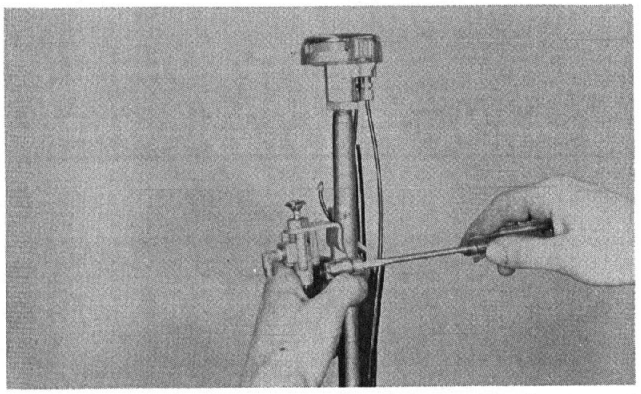


11. Connect the ⅛" OD white air line between the forward fitting on the slave air valve and the port in the control valve identified with an "S". (See insert.)

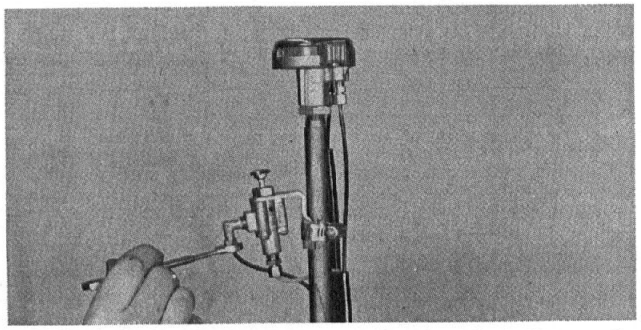
C. Installation of the Air System – Continued



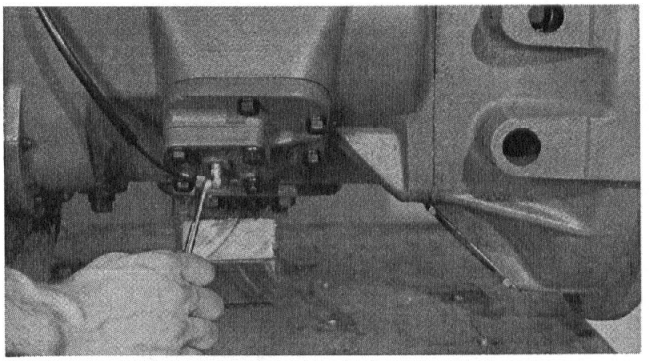
12. Connect the ⅛" OD short black air line between the rear fitting on the slave air valve and the port in the control valve identified with an "R". (See insert.)



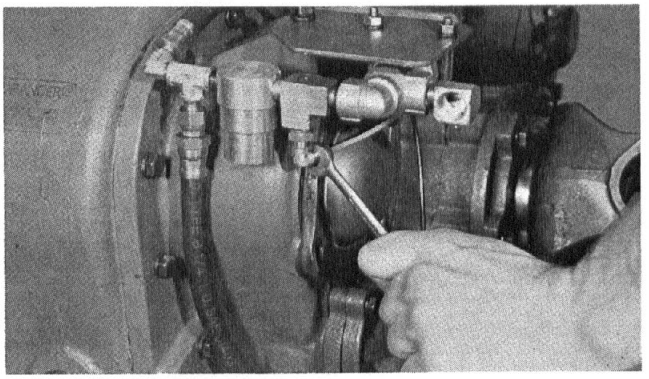
13. If so equipped, attach the countershaft brake control valve and clamp to the shift lever and secure the valve by tightening the screw on the clamp.



14. Attach the black ⅛" OD brake control air line to the elbow fitting on the front of the valve and attach the white air line to the fitting on the bottom of the valve.

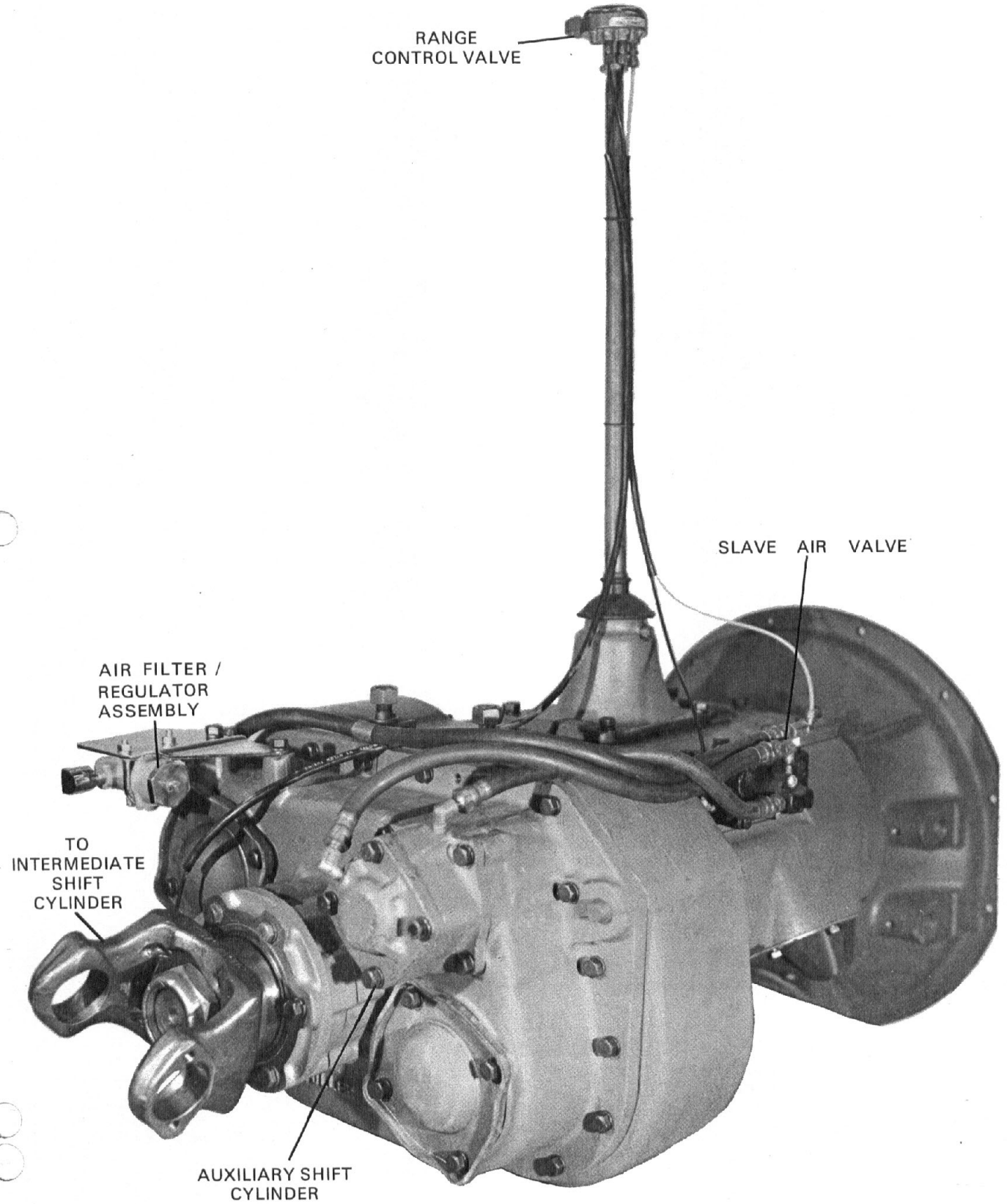


15. Attach the black ⅛" OD air line to the TCB-6 countershaft brake located on the right PTO opening.



16. Attach the white ⅛" OD air line to the tee block between the air filter and regulator.

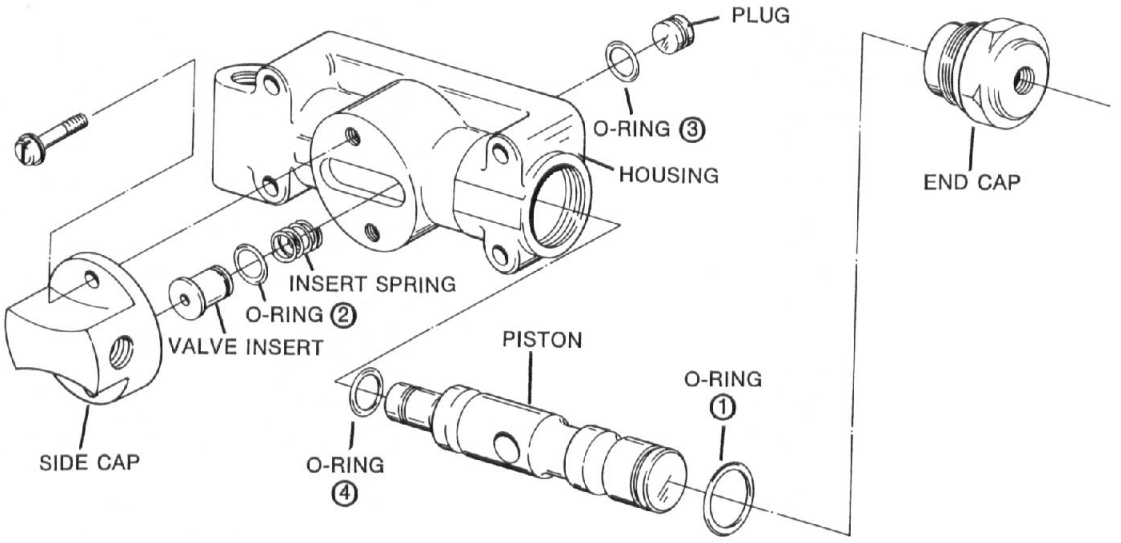
RANGE SHIFT AIR SYSTEM



Air Valve Operation

When in "low" and "intermediate" the control valve shuts off the air supply to the end cap. Thus, the constant air entering at the constant supply port forces the piston to the rear. The constant air also flows through a channel in the center of the piston and to an external port which is aligned with the low range port of the air valve.

When in "direct" the control valve opens and supplies air to the end cap. Since the piston area is larger on this end of the piston, it is forced in the opposite direction. The external air port in the piston is now aligned with the direct range port of the air valve.



Exploded view of air valve. The alignment sleeve is not part of the assembly, but must be installed in housing for proper pre-select operation.

The four O-rings are indicated by circled numbers. If any of these are defective, there will be a constant air leak out of the exhaust on the air valve. In normal operation, exhaust will occur only for an instant as the range shift is made. The following chart is to be used as a guide to determine defective O-rings.

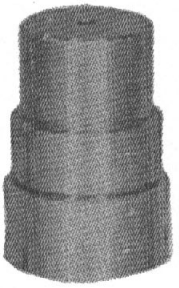
Defective O-Rings	RESULT
①	Constant leak through exhaust in low range only.
②or③	Constant leak through exhaust in both ranges.
④	Constant leak through exhaust in high range; steady but low volume leak through exhaust in low range.

To Disassemble Air Valve

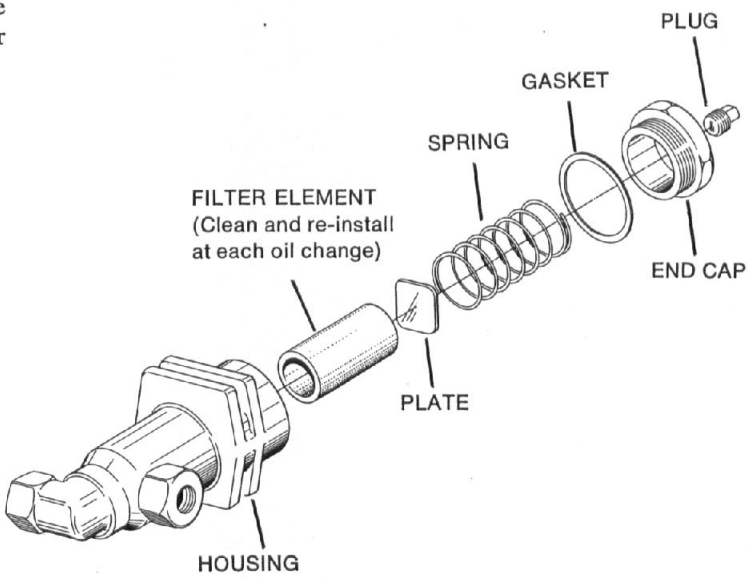
1. Turn out the two capscrews and remove the side cap from valve body.
2. Remove the valve insert from piston and remove O-ring from the valve insert.
3. Remove the spring from piston.
4. Turn end cap from valve body, and withdraw piston from bore.
5. Remove the two-rings from piston.
6. Remove the nylon plug from piston and remove O-ring from plug.

AIR REGULATOR

The air regulator is not serviceable. If defective replace the air regulator unit. Reading at output of air regulator should be 57 to 62 psi.



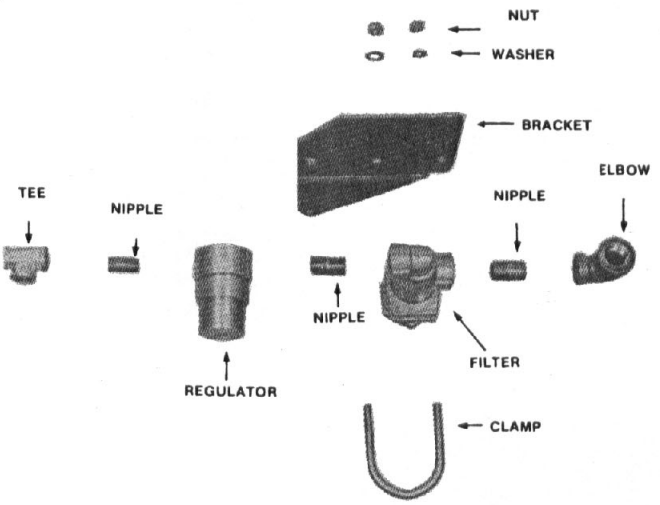
AIR FILTER



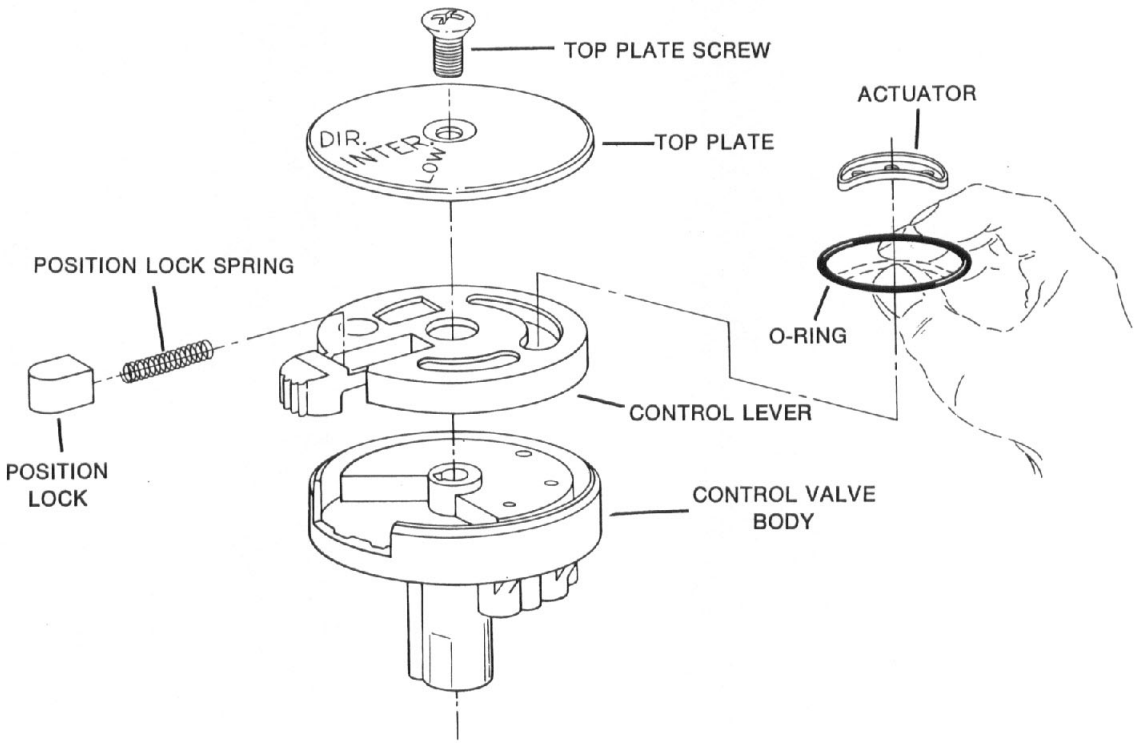
AIR VALVE PRE-SELECTION

An actuating pin protruding from the shifting bar housing prevents the actuating piston in the air valve from moving while the gear shift lever is in a gear position and releases the piston when the lever is moved to or through neutral. See detailed installation of air valve for installation precaution concerning the actuating pin.

AIR FILTER & REGULATOR ASSEMBLY



RANGE CONTROL VALVE



DESCRIPTION

1. Porting — There are four ports in the bottom of the control:
   a. The port stamped "S" is the supply port and is the constant air line from the air valve.
   b. The port stamped "E" is the exhaust port and is left open.
   c. The port stamped "R" is the signal line to the slave air valve.
   d. The port stamped "F" is the signal line to the intermediate shift cylinder.
2. Maintenance and Assembly — The range control valve is easily disassembled by removing the top plate screw. Individual parts can be obtained in an A number kit. Critical assembly factors are:
   a. Make sure that the jam nut locking the control valve to the shifting lever is secure.
   b. Make sure that, when reassembled, the top plate screw is torqued with 90 to 120 inch-pounds. A loose top plate screw can affect valve operation.
   c. When reassembling, lubricate the O-ring and O-ring carrier with a barium base grease.

TROUBLE SHOOTING

1. With the range control in "LOW" position, disconnect the the two lines connected to port "R" and "F". There should be no air coming out of these ports.

   Move the range control to "INTER.". There should now be a steady flow of air coming from the "F" port, but still no air coming from the "R" port.

   Move the range control valve to the "DIR." position. There should now be a steady flow of air coming from both the "F" and "R" ports.

   If the above results are not obtained, disconnect the supply air line at the "S" port and make sure that a steady flow of air is coming through the line. If air is present, this would indicate a faulty control valve. Cause can be defective parts, damaged O-ring or loose top plate screw.
2. Any steady flow of air from the range control valve exhaust port indicates a faulty range control valve or incorrect hook-up. Cause can be damaged O-ring, defective parts, loose top plate screw or reversed air lines on the control.

INSERT VALVE – ALL MODELS

The insert valve located in the shift cylinder cover is a small 1-3/16" Humphrey valve. It is installed with the flat surface to the inside towards the center port, and it is secured with a special nut in bottom bore of cover.

When installing insert valve apply Dow Corning #200 lubricant or its equivalent to cylinder walls. When installing special nut apply Loctite hydraulic sealant to threads.

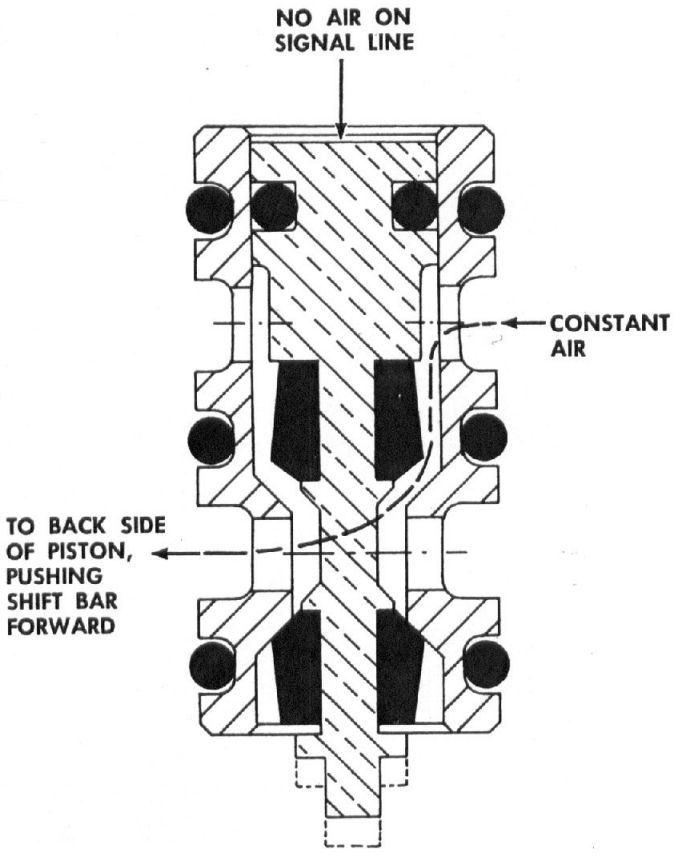
The insert valve is self-contained and can not be disassembled except for the three O-rings on outer diameter. These three O-rings are a stationary seal and do not move in cylinder.

Travel of the small piston in insert valve is only 3/16". The insert valve is a normally-open valve. Thus, when there is no signal or delivery of air to top side of insert piston, the constant air from regulator passes through the insert valve and to the backside of the piston and moves the shift bar forward (low range).

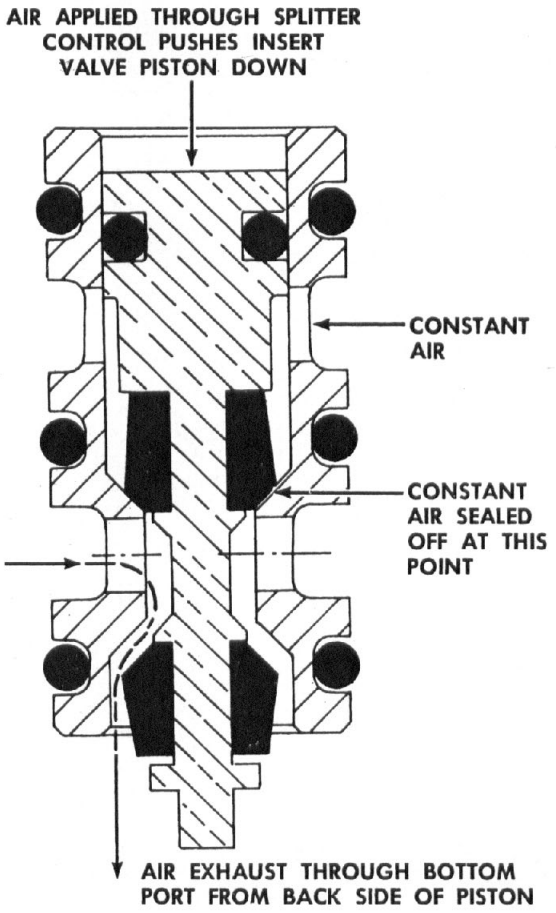
When the insert valve piston is activated by a signal or delivery of air, the insert valve is closed and shuts off the constant air to backside of shift piston. Air in shift cylinder is exhausted out through insert valve and bottom bore of cover.

When air is removed from backside of shift piston, constant air on frontside of shift piston moves the shift bar to the rear (intermediate and direct range).

LOW RANGE



INTERMEDIATE AND DIRECT RANGE



INTERMEDIATE SHIFT CYLINDER AND COVER ASSEMBLY

Operation — Constant, regulated air is channeled through the cover to the front side of shift piston — air is always on this side of piston.

The shift piston is moved by removing or applying air (from constant supply) to the backside of piston. This piston area is larger and can overcome area of front side of piston. The removal or application of air on backside of piston is controlled by the insert valve in cylinder cover; this valve in turn is controlled by the range control valve.

Trouble Shooting Cylinder

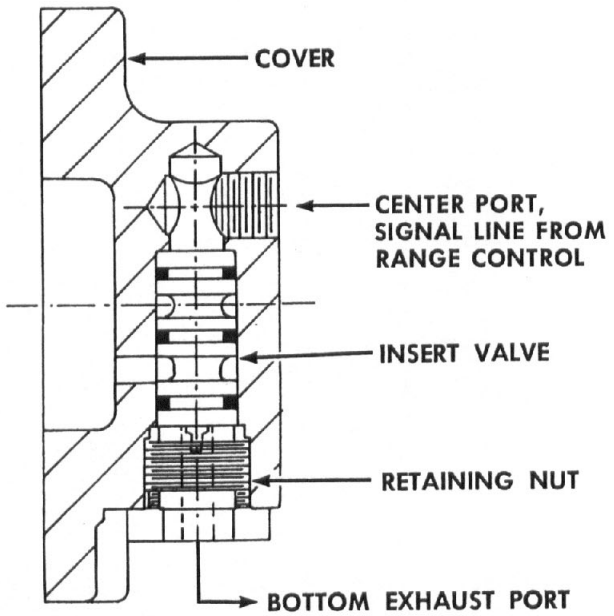
There are two O-ring seals in the shift cylinder.

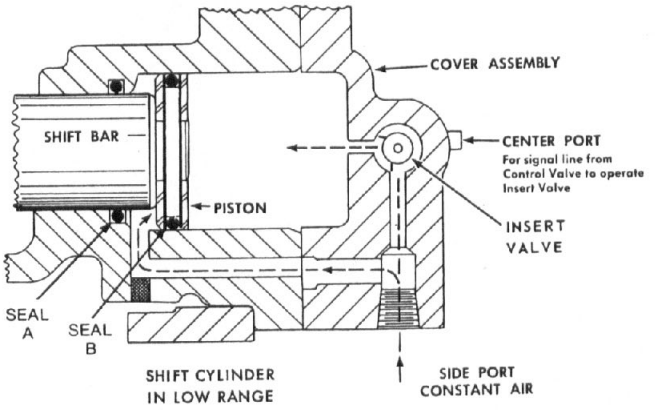
1. *Leak at seal A* — Possible failure to shift or slow shift to intermediate or direct plus pressurizing of transmission.
2. *Leak at seal B* — Slow range shift between low and intermediate plus leak out cover exhaust when in intermediate or direct.

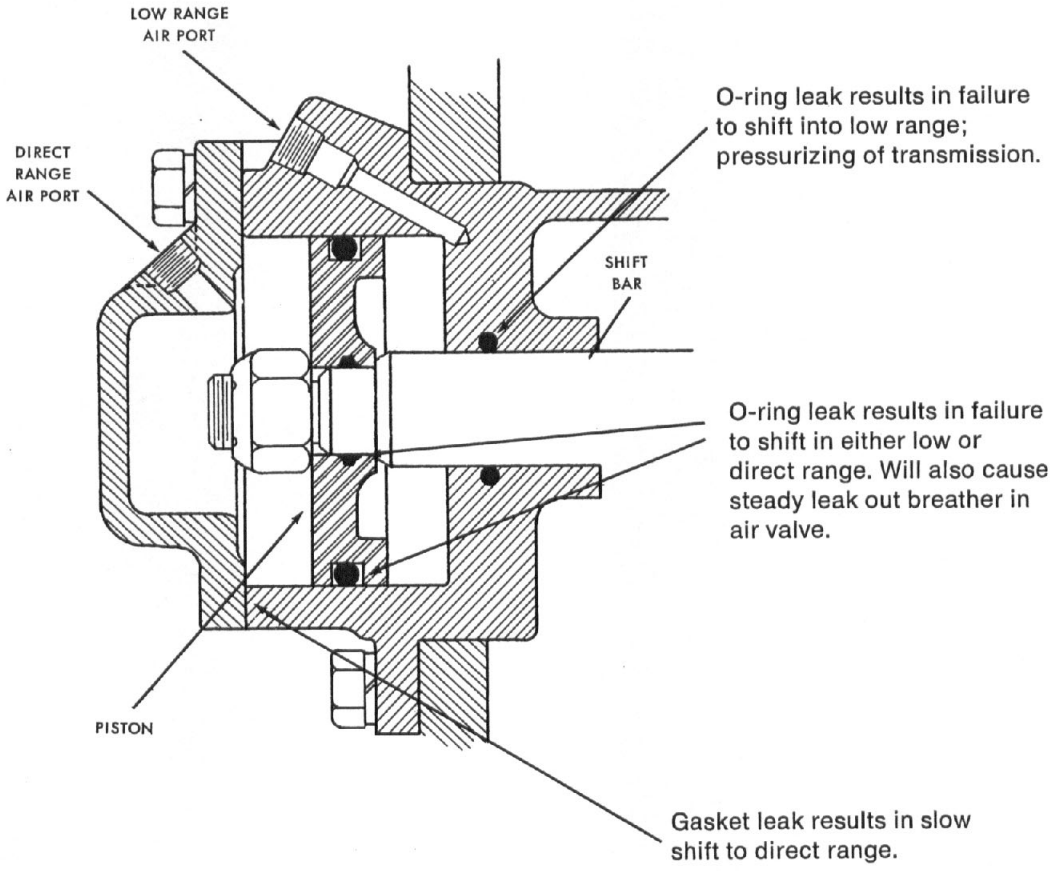
Trouble Shooting Cover Assembly

1. *Exhaust port* — Any constant flow of air out the cover exhaust port usually indicates a faulty insert valve. Exhaust should occur briefly ONLY when the splitter control is moved from "low" to "intermediate."
2. *Insert valve* — A faulty insert valve, leaking at the outer diameter O-rings or inner seals will result in failure to shift. Two indications of O-ring or seal failures are:
   a. Constant leak out cover exhaust.
   b. Constant leak out splitter control exhaust with splitter control in "low," (providing range control valve is operating properly.)

The three O-rings on outer diameter of the insert valve can be replaced. If an inner seal is damaged, the entire insert valve will have to be replaced.

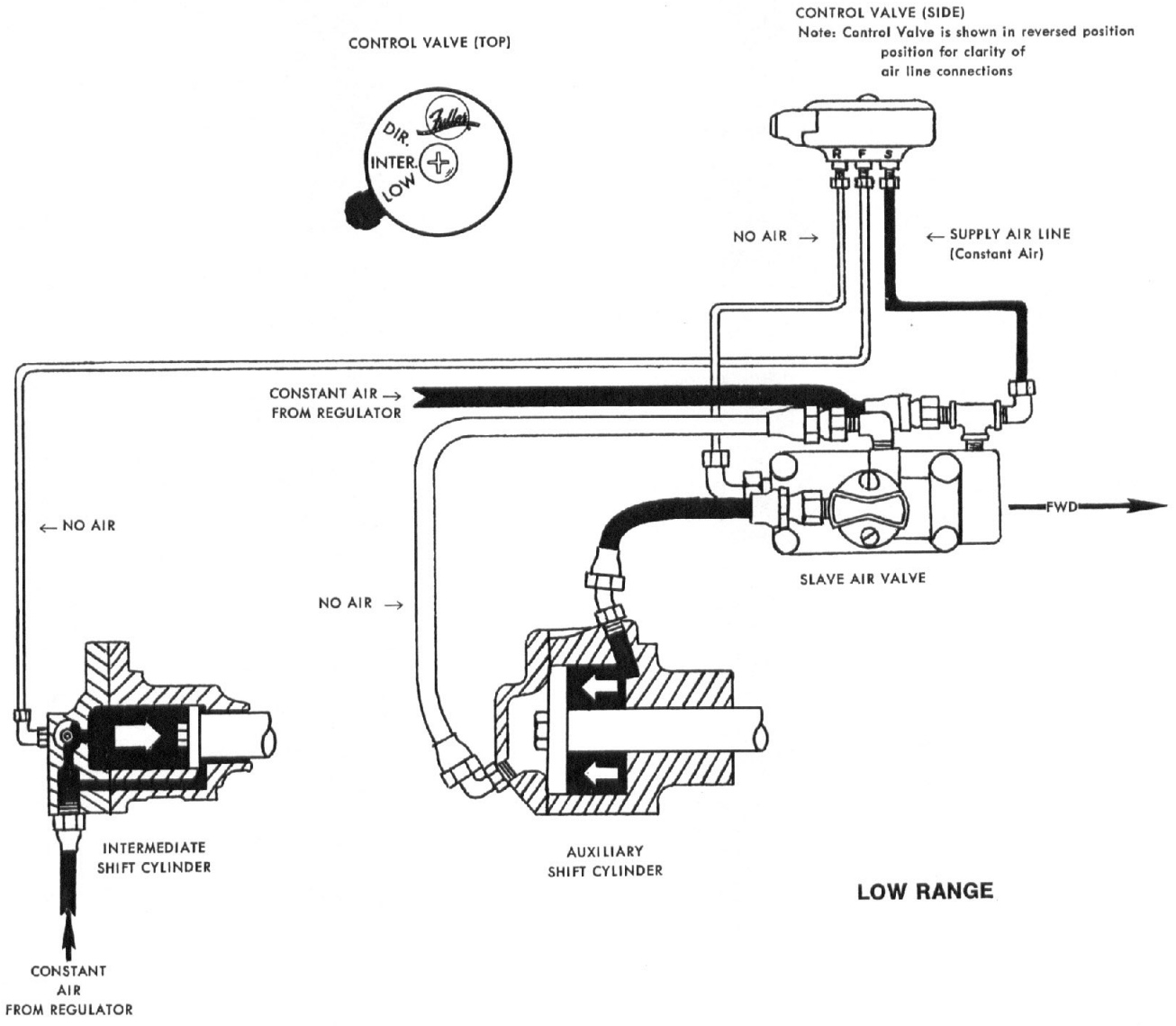




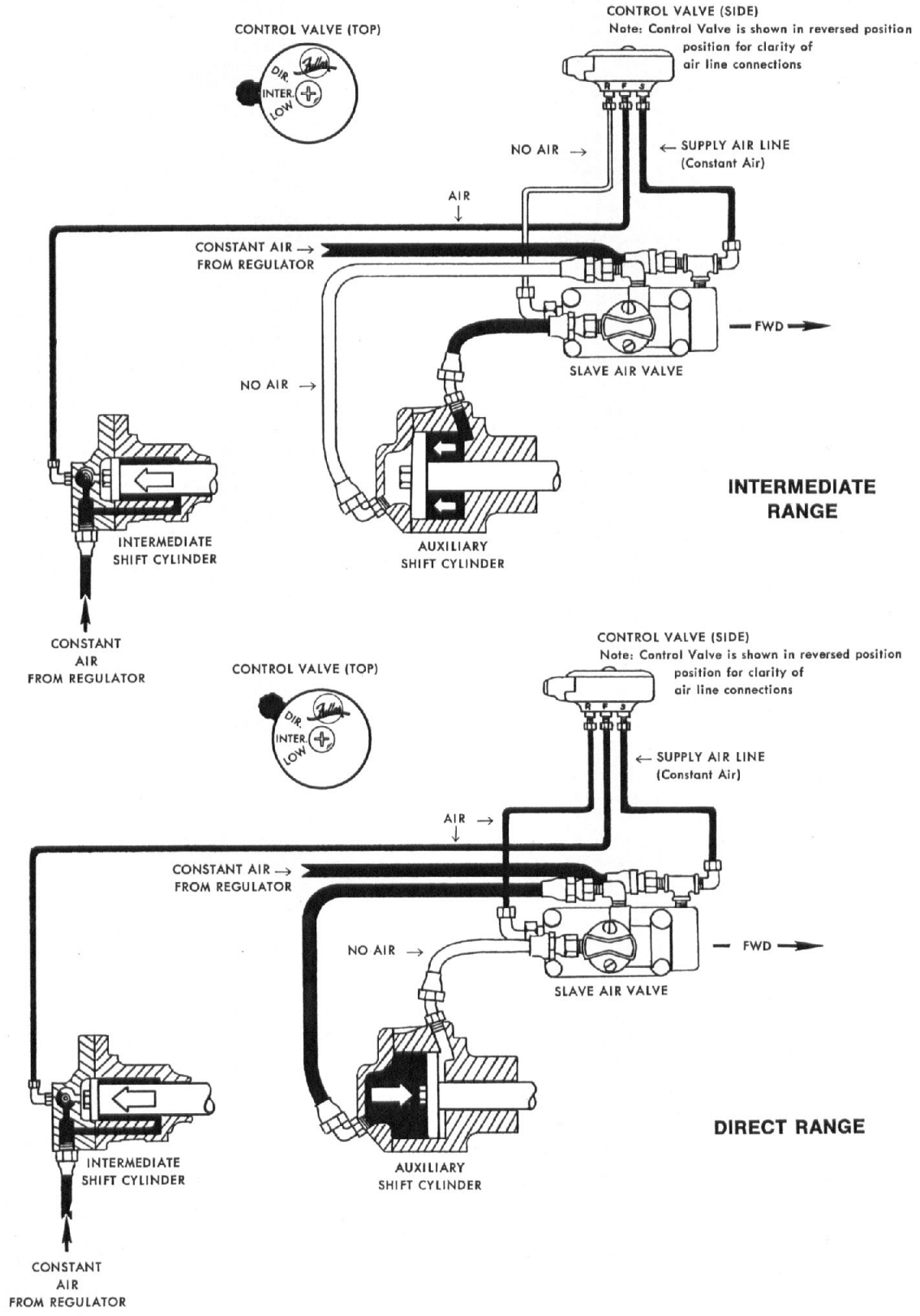


CROSS SECTION OF AUXILIARY SHIFT CYLINDER

AIR FLOW DIAGRAMS



LOW RANGE


CONTROL VALVE (TOP)
DIR.
INTER.
LOW
CONTROL VALVE (SIDE)
Note: Control Valve is shown in reversed position
position for clarity of
air line connections
R F S
NO AIR →
← SUPPLY AIR LINE
(Constant Air)
AIR
CONSTANT AIR →
FROM REGULATOR
FWD
SLAVE AIR VALVE
NO AIR →
INTERMEDIATE
SHIFT CYLINDER
AUXILIARY
SHIFT CYLINDER
INTERMEDIATE RANGE
CONSTANT
AIR
FROM REGULATOR
CONTROL VALVE (TOP)
DIR.
INTER.
LOW
CONTROL VALVE (SIDE)
Note: Control Valve is shown in reversed position
position for clarity of
air line connections
R F S
← SUPPLY AIR LINE
(Constant Air)
AIR →
CONSTANT AIR →
FROM REGULATOR
NO AIR →
FWD
SLAVE AIR VALVE
INTERMEDIATE
SHIFT CYLINDER
AUXILIARY
SHIFT CYLINDER
DIRECT RANGE
CONSTANT
AIR
FROM REGULATOR

TOOL REFERENCE

Some illustrations in this manual show the use of specialized tools. These tools are recommended for transmission repair as they make repair easier, faster and prevent costly damage to critical parts.

Some of these tools can be obtained from a regular tool supplier, while others can be made either from prints or dimensions as required by the individual user.

Listed below are illustrations which show these specialized tools, the tool name and how it can be obtained. Prints are available for tools which have a Fuller tool number; send requests to the Service Department.

Eaton Corporation
Transmission Division
222 Mosel Avenue
Kalamazoo, Michigan 49001

Page No.	Illustration	Tool	Fuller Tool No. or Source
24	13	Bearing Puller	T-10325
25	14	Lift Bracket	T-22823
34-37	8-8	Small Jaw Puller	Tool Supplier
53-61	10-3	Bearing Driver	T-7551
58-68	3-10	Bearing Driver	T-10324
59	7	Sleeve Driver	T-16552-1-AP-2, or make from 3/16″ thick, 8″ long steel tubing with an inner diameter of 2″.
60	5	Drive Gear Bearing Driver	T-18042-69
68	13	Oil Seal Driver	T-18088-23
72	3	Bearing Driver	TL-18042-50
75	2	Torque Wrench, 185 ft.-lb. cap.	Tool Supplier
75	1	Torque Wrench, 500 ft.-lb. cap.	Tool Supplier

EATON Truck Components

Eaton Corporation
Transmission Division
Kalamazoo, Michigan

ILLUSTRATED PARTS LIST

Fuller Roadranger® Transmissions

RT-613 Series

Fuller Model RT-613 Series

THIS BOOKLET IS DESIGNED TO IDENTIFY ALL PARTS IN THE RT-613 SERIES TRANSMISSIONS AND TO RECOMMEND PARTS WHICH SHOULD BE KEPT IN STOCK. THE SUGGESTED QUANTITIES ARE BASED ON AN INVENTORY SUFFICIENT FOR 25 RT-613 SERIES.

REBUILD WITH CONFIDENCE
USE GENUINE FULLER PARTS

SERVICE ASSEMBLIES AVAILABLE FOR THE RT-613 SERIES

Page	Sym.	Part #	Description	Stocking Qty.
4	A	A-3656	Slave valve repair	2
4	B	A-3596	Slave valve "O" rings	4
4	†	A-4198	Repair kit air cleaner	2
5	P	A-4105	Case assembly	1
5	*a*	A-2268	Yoke assembly	1
5	*b*	A-219	Arm assembly	1
5	*y*	PA-854-00	Oil Filter	—
6	c	A-4269	Lever housing assembly	1
8	M	DA-16224-00	Input shaft assy. *push*	4
8	N	DA-16281-00	Input shaft assy. *pull*	4
9	Ψ	A-4195	Upshift brake	—
10	C	A-4007	Internal "O" rings	6
10	*r*	A-4113	Intermediate case assy.	1
10-11	Γ	K-1019	Oil trough rep. kit	1
11	*h*	K-1027	Cover assembly	1
11	*s*	A-4145	Cover w/valve	1
11	*t*	A-4092	Cylinder assembly	1
11	Ω	K-1037	Oil plate w/screws	1
11	ϒ	S-1000	Housing plate assy.	1
11	Σ	S-1001	Housing plate assy.	1
—	—	K-1039	Gaskets	6
—	S	A-4205	Small parts	2

OPERATING LABELS AND INSTRUCTIONS

16903	Shift label RT-613
17161	Shift label RTO-613
17011	Shift label TCB-6—TCB-8
52055	Drivers instructions RT-613
52063	Drivers instructions RTO-613
71004	Installation instructions TCB-6—TCB-8

SEALANTS AND LUBRICANTS

71201	50CC Fuller adhesive/sealant
71202	50CC Fuller sealant
71203	8 oz. Fuller silicone lubricant
71204	0.5CC carded tube—Fuller adhesive/sealant
71205	2CC carded tube (shrink pack) Fuller sealant
71206	1/2 oz. Fuller silicone lubricant

K-1018 (1 ea. 71201—71202—71203)

MAINTENANCE AND REPAIR

DETAILED AND ILLUSTRATED DISASSEMBLY AND REASSEMBLY PROCEDURES
RT-613 SERIES SERVICE MANUAL FORM NUMBER 161

PART NUMBERS LISTED IN THIS BOOKLET APPLY ONLY AT THE TIME OF PRINTING AND ARE SUBJECT TO CHANGE.

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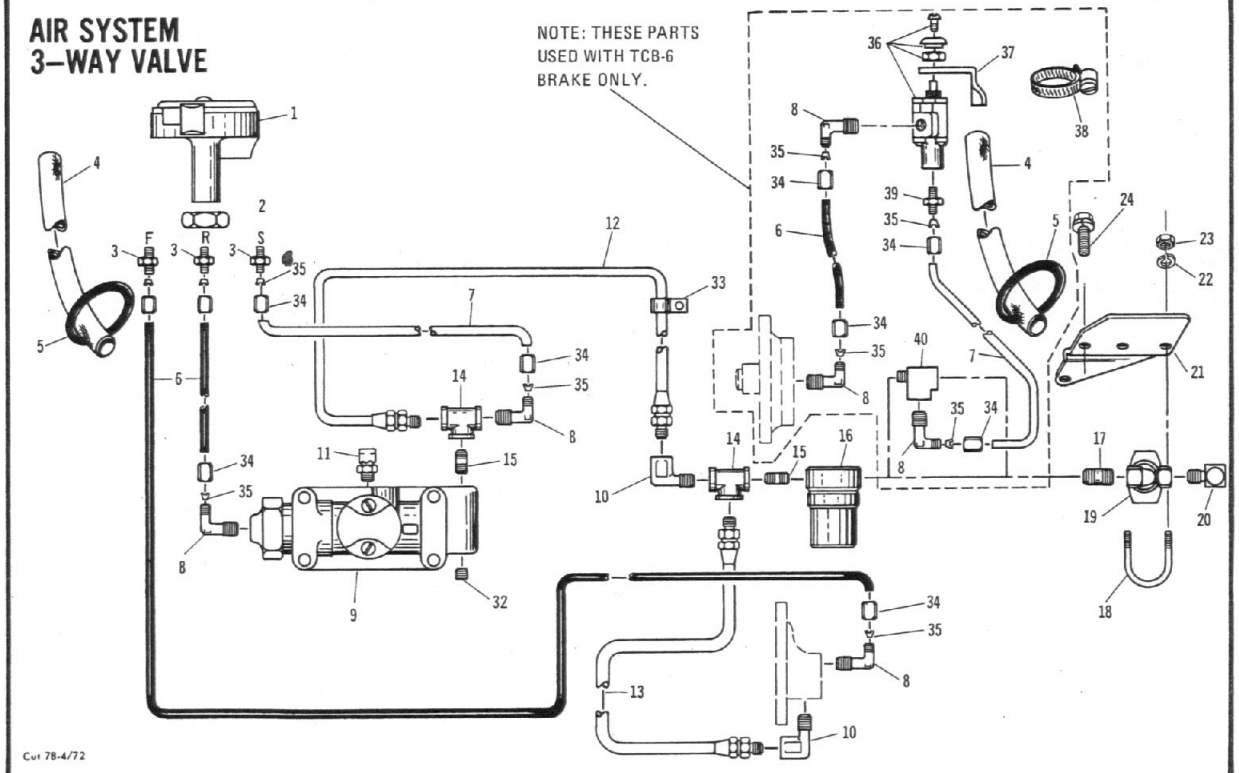
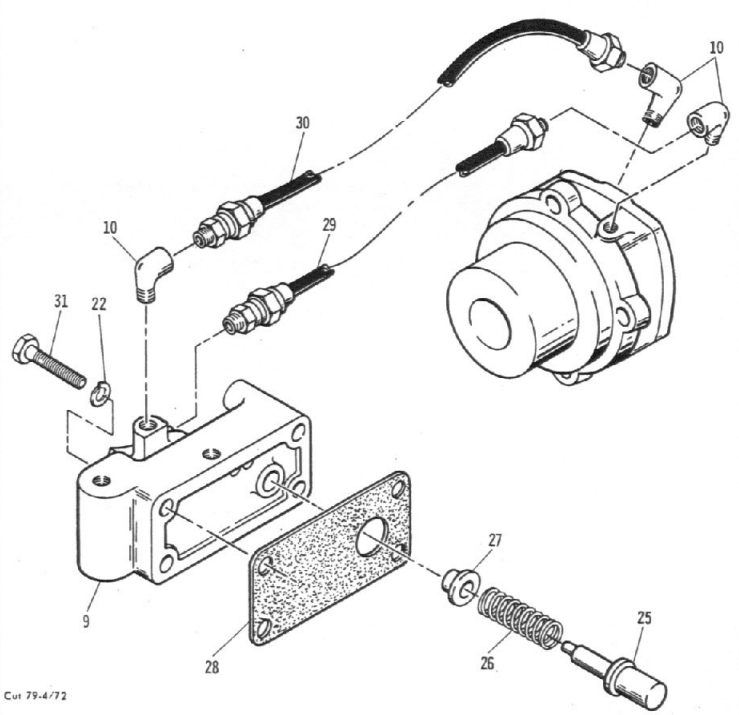
Transmission Division — 1973

ITEM	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	A-4065	Valve 5/8-11		4
	A-4115	Valve 1/2-13		4
	A-4116	Valve 1/2-20		4
	A-4117	Valve 7/16-14		4
	A-4118	Valve 3/8-24		4
2	X-9-1001	Nut 5/8-11		1
	X-1-807	Nut 1/2-20		1
	X-9-802	Nut 1/2-13		1
	X-9-701	Nut 7/16-14		1
	X-1-612	Nut 3/8-24		1
3	82501	1/16 pipe connector		1
	or 84001	1/16 pipe connector assy.		1
4	80000	Sheathing		1
5	13571	"O" ring clamp		1
6	82000	Nylaflow tube black		1
7	68500	Nylaflow tube white		1
8	84502	1/8 pipe connector		1
	or 85002	1/8 pipe connector assy.		1
9	A-3991	Valve		4
10	12845	1/8 street ell		1
11	7935	Breather		1
12	55522	Hose assembly 28"		1
13	55505	Hose assembly 16"		1
14	12881	1/8 tee		1
15	12769	1/8 nipple		1
16	16743	Air regulator		1
17	16741	1/4 nipple		1
18	16742	1/4-20 "U" bolt		4
19	A-4041	Air filter		1
20	16865	Street ell		1
21	16744	Bracket		1
22	X-3-400	1/4 lockwasher		1
23	X-1-401	1/4 nut		1
24	X-8L-601	3/8-16 x 3/4 capscrew		1
25	15102	Pin		1
26	6392	Spring		1
27	12751	Sleeve		1
28	15758	Gasket		1
29	55527	Hose assembly 15"		1
30	55507	Hose assembly 20"		1
31	X-8-411	1/4-20-x 1-3/4 capscrew		1
32	X-12-208	1/8 Plug		1
33	11665	Clamp		1
34	83501	Nut		1
35	83001	Sleeve		1
36	16859	Valve		4
37	16914	Bracket		1
38	16924	Clamp		1
39	82502	1/8 pipe connector		1
	or 84002	1/8 pipe connector assy.		1
40	16975	Tee		1

AIR SYSTEM
3–WAY VALVE



AIR SYSTEM

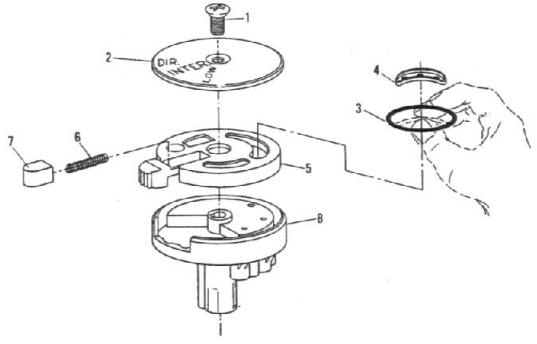


ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	1	15887	Screw		–
2	1	16808	Cover		–
3	1	15772	"O" ring		–
4	1	15879	Actuator		–
5	1	15878	Lever		1
6	1	15886	Spring		–
7	1	15885	Lock		–
8	1	16818	Body 5/8-11		–
	or 1	16871	Body 1/2-13		–
	or 1	16927	Body 1/2-20		–
	or 1	16926	Body 7/16-14		–
	or 1	16925	Body 3/8-24		–
22	1	15125	Housing		–
23	1	13653	"O" ring	BD	–
24	2	15114	"O" ring	BD	–
25	1	15128	Plug	B	–
26	1	15126	Piston		1
27	1	15131	Cap		–
28	1	14033	"O" ring	BD	–
29	1	16429	Cap (A-3991)		–
	or 1	15130	Cap (A-3547)		–
30	1	15127	Spring	B	–
31	1	15129	Insert	B	–
32	1	X-8S-401	1/4-20 capscrew A-3991		–
	and 1	X-8S-427	1/4-20 capscrew A-3991		–
40	1	16920	Element	†	–
41	1	16919	Spring	†	–
42	1	16918	Gasket or "O" ring	†	–
		A-3656	Repair kit A-3991	B	ℵ
		A-3596	"O" ring kit A-3991	D	ℵ
		A-4198	Repair kit air cleaner	†	ℵ

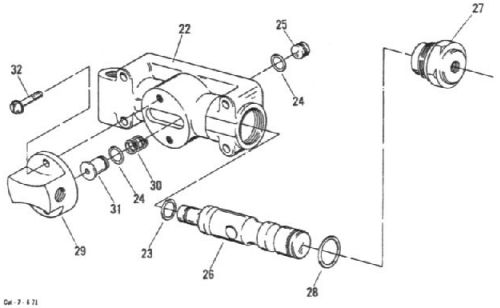
†NOT SOLD SEPARATELY - ORDER A-4198

ℵSEE PAGE 2 FOR STOCKING QTY.

SPLITTER KNOB ASSEMBLY



AIR VALVE ASSEMBLY A-3991

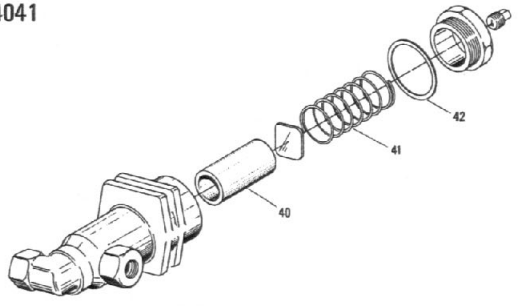


AIR REGULATOR

ITEM 16 PAGE 3

REPLACE UNIT IF DEFECTIVE

AIR CLEANER ASSEMBLY A-4041



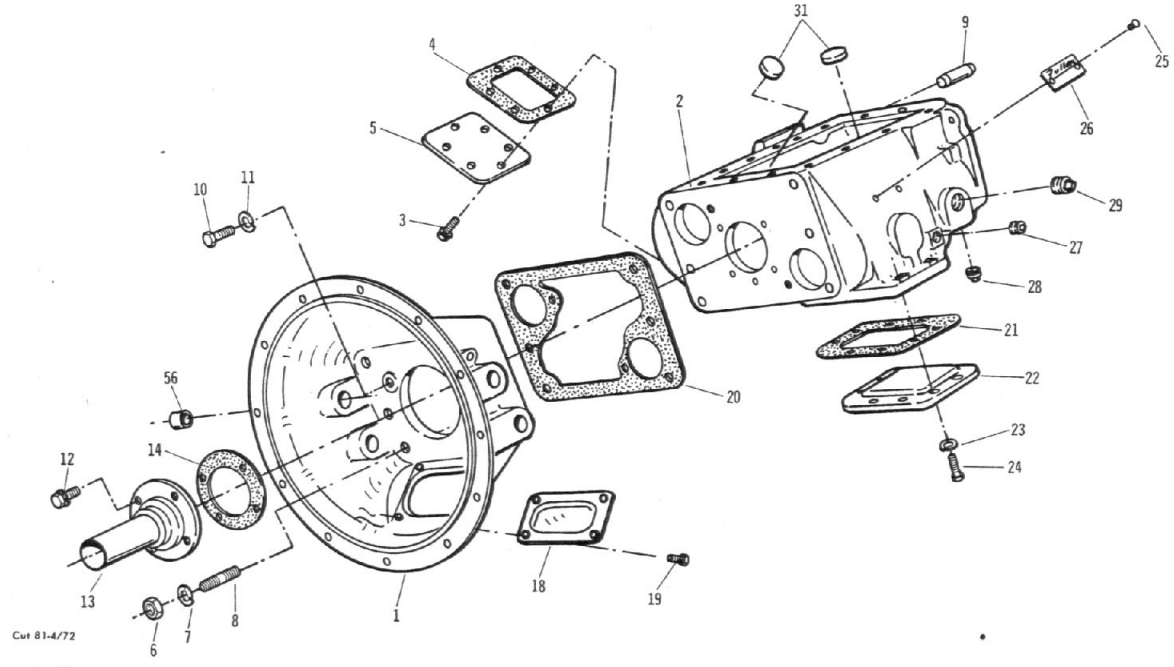
ITEM	QTY. USED	PART No.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	1	A-3711	Clutch housing - *push - pull*		1
2	1	16800	Case *order A-4105*	P	1
3	6	X-8S-601	3/8-16 x 3/4 capscrew		—
4	1	1684	Gasket		—
5	1	14575	Cover		—
6	6	X-1-1000	5/8-18 nut		—
7	6	X-3-1000	5/8 lockwasher		—
8	6	1632	Stud		—
9	2	14334	Dowel pin		—
10	2	X-8-808	1/2-13 x 1-1/4 capscrew		—
11	2	X-3-801	1/2 lockwasher		—
12	4	X-8-678	3/8-16 x 1 soc. hd. *pull*		—
or	2	X-8L-604	3/8-16 x 1-1/4 capscrew *push*		—
and	2	X-8-619	3/8-16 x 1-1/4 capscrew *push*		—
and	2	X-3-600	3/8 lockwasher *push*		—
13	1	15020	Cover *push*		2
		NOTE: FOR *PULL* COVER SEE PAGE 9			
14	1	15059	Gasket		—
18	1	1565	Cover *push*		—
or	1	11453	Cover *pull*		—
19	4	X-8-509	5/16-18 x 1/2 cpscw.		—

ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
20	1	15060	Gasket	Ψ	—
21	1	16929	Gasket		—
22	1	16596	Cover		—
23	8	X-3-700	7/16 lockwasher		—
24	8	X-8-703	7/16-14 x 1 capscrew		—
25	2	X-13-206	Self-tapping screw		—
26	1	88000	Nameplate		—
27	1	X-12-800	1/2 pipe plug		—
28	1	X-12-1201	3/4 pipe plug		—
or	1	X-12-1202	3/4 magnetic plug		—
29	1	X-12-2001	1-1/4 pipe plug		—
31	2	14373	Magnetic disc	P	—
32	1	14494	Shaft		1
33	2	X-7-603	3/8-24 x 1 capscrew	*a*	—
34	1	12817	Yoke	*a*	1
35	2	9293	Spring		2
36	1	X-6-11	Key		—
37	1	1983	Shaft (std.)		1
38	1	X-8-802	1/2 set screw	*b*	—
39	1	X-9-800	1/2 nut	*b*	—
40	1	1966	Arm	*b*	1

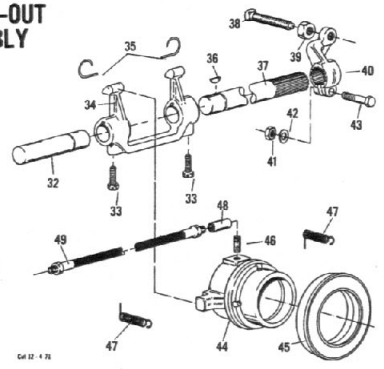
ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
41	1	X-1-600	3/8 nut	*b*	—
42	1	X-3-600	3/8 lockwasher	*b*	—
43	1	X-7-601	3/8-24 x 1-3/4 capscrew	*b*	—
44	1	8696	Carrier (std.)		1
45	1	6168	Bearing		4
46	1	3230	1/8 nipple		—
47	2	4425	Spring		4
48	1	3233	1/8 coupling		—
49	1	51006	Hose 8"		—
50	1	1684	Gasket	*y*	—
51	1	8547	Plate	*y*	—
52	1	14086	Gasket	*y*	—
53	1	8548	Filter	*y*	6
54	1	8546	Housing	*y*	—
56	8	12815	Bushing		8
		A-4105	Case assembly	P	ℵ
		A-2268	Yoke assembly	*a*	ℵ
		A-219	Arm assembly	*b*	ℵ
		PA-854-00	Oil Filter	*y*	ℵ

Ψ SEE A-4195 PAGE 9
ℵ SEE PAGE 2 FOR STOCKING QTY.

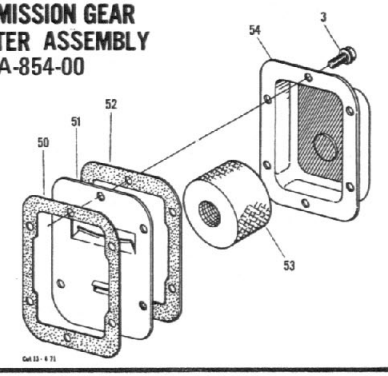
MAIN HOUSING ASSEMBLY



THROW–OUT ASSEMBLY



TRANSMISSION GEAR OIL FILTER ASSEMBLY PA-854-00



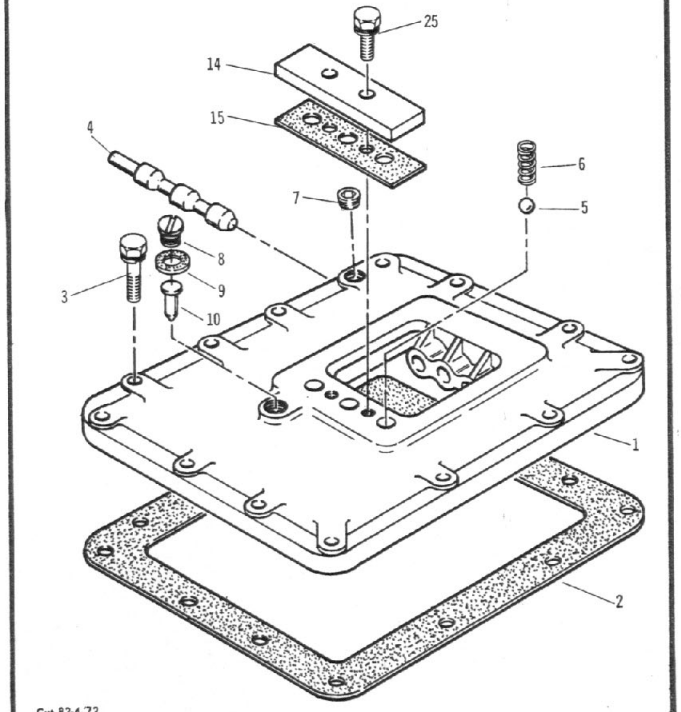
ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	1	15888	Housing		1
2	1	15605	Gasket		—
3	15	X-8L-604	3/8-16 x 1-1/4 capscrew		—
4	1	17177	Shaft		1
5	3	X-14-800	1/2 ball	S	9
6	3	1064	Spring	S	36
7	1	X-12-404	1/4 pipe plug		—
	or 1	15276	Breather		—
8	1	15917	Plug		—
9	1	15900	Gasket		—
10	1	15899	Pin		—
11	1	15910	Rev. Bar		2
12	1	8968	Plug		—
13	1	6392	Spring		1
14	1	15132	Cover		—
15	1	15133	Gasket		—
16	1	10019	Plunger		1
17	3	3220	Lockscrew		—
18	1	15096	Rev. yoke		2
19	2	X-14-1200	3/4 ball	S	6
20	1	15100	2nd speed bar		2
21	1	15097	2nd speed yoke	S	2
22	1	1634	Pin	S	1
23	1	16300	Direct Yoke		2
24	1	15101	Direct Bar		2
25	2	X-8L-600	3/8-16 x 1 capscrew		—
26	1	10427	Boot		1
27	1	17163	Housing *order A-4269*	c	1
28	1	2271	Pivot pin		2
29	1	X-3-500	5/16 lockwasher		—
30	1	X-1-500	5/16-24 nut		—
31	1	1642	Gasket	c	—
32	1	8503	Lever (std.)		—
33	1	2538	Washer		1
34	1	2536	Spring		—
35	1	15722	Baffle (optional)		—
*43	1	17162	"O" ring special	c	2
		A-4269	Lever housing assy.	c	※

S—Small parts A-4205

*INSTALLED INSIDE ITEM 27 HOUSING (17163 only)

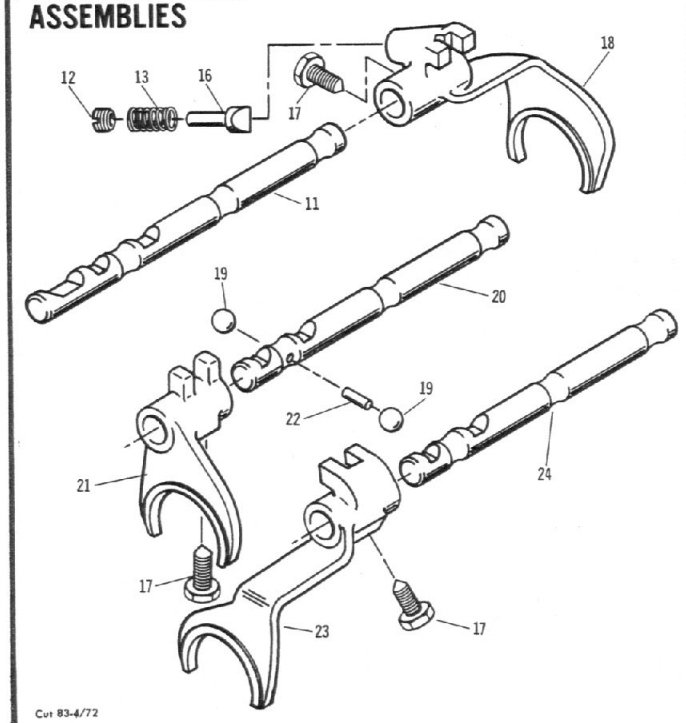
※SEE PAGE 2 FOR STOCKING QTY.

HOUSING ASSEMBLY



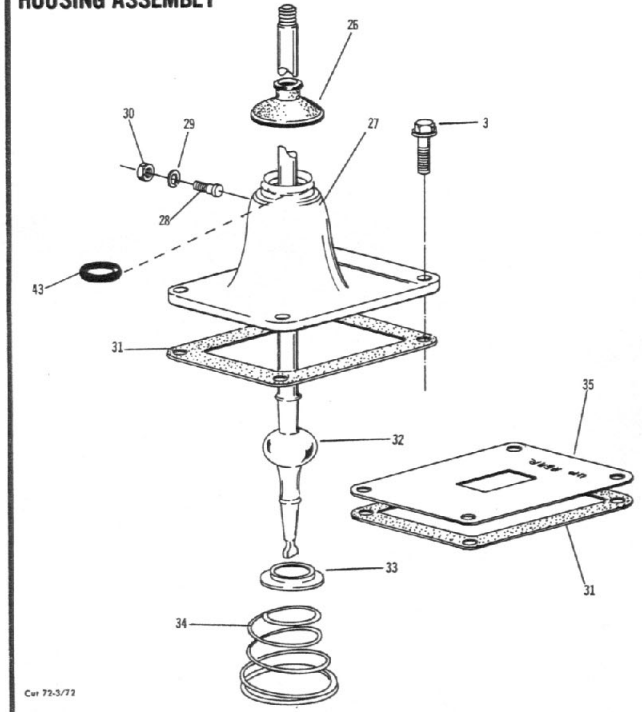
Cut 82-4-72

YOKES AND BARS ASSEMBLIES



Cut 83-4/72

GEAR SHIFT LEVER HOUSING ASSEMBLY

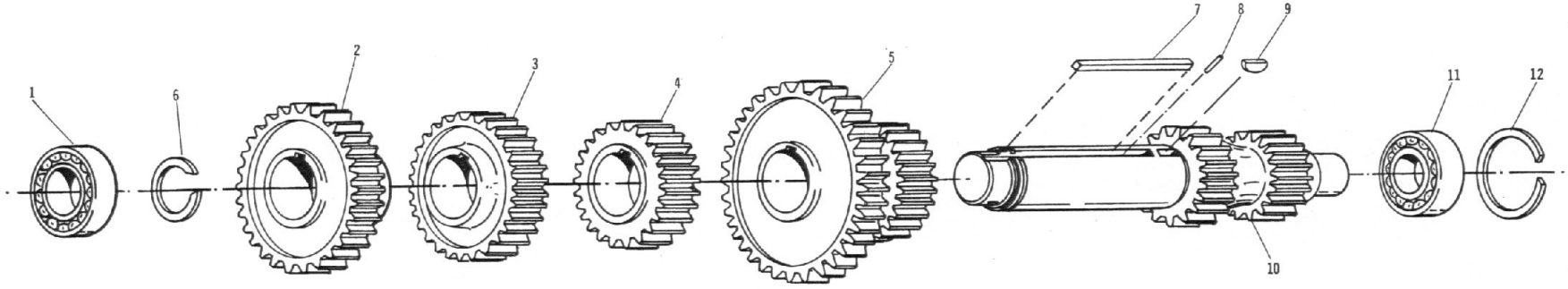


Cut 72-3/72

ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	2	81045	C/S front brg.		8
2	2	16250	C/S D/G RT-613		4
	or 2	16251	C/S D/G RTO-613		4
3	2	16251	C/S 4th RT-613		2
	or 2	16250	C/S O/D RTO-613		3
4	2	16252	C/S 3rd		2
5	2	16253	C/S 2nd and PTO		2
6	2	14286	Snap ring		2
7	2	16662	Key		2
8	2	62511	Roll pin	S	2
9	2	X-6-128	Key	S	2
10	2	16249	Countershaft		1
11	2	81046	C/S rear brg.		8
12	2	15050	Snap ring	S	6
13	1	15974	4th - 5th clutch gear		3
14	1	A-3990	Key and pin assy.	S	2
16	1	16805	Mainshaft		2
17	1	15980	Snap ring	S	1
18	1	15976	Washer .259 - .261	S	2
	or 1	17434	Washer .263 - .265		2
	or 1	17435	Washer .268 - .270		2
	or 1	17436	Washer .273 - .275		2
	or 1	17437	Washer .278 - .280		2
19	1	16231	M/S 4th RT-613		2
	or 1	88533	M/S O/D RTO-613		3
20	1	16230	M/S 3rd		2
21	4	15446	Washer .259 - .261	S	8
	or 4	17259	Washer .264 - .266		8
	or 4	17260	Washer .269 - .271		8
	or 4	17261	Washer .274 - .276		8
	or 4	17262	Washer .279 - .281		8
22	2	16226	Clutch gear		6
23	1	16229	M/S 2nd		1
24	1	16228	M/S 1st		1
25	1	16227	M/S rev.		1

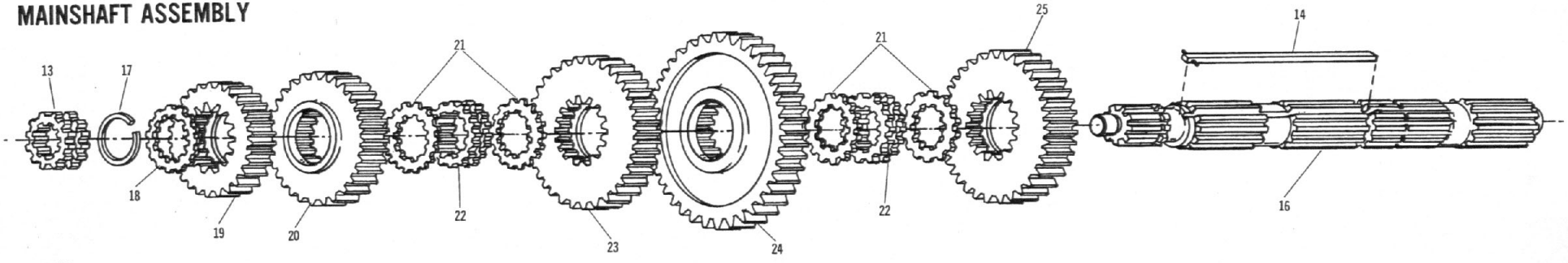
S—Small parts A-4205

COUNTERSHAFT ASSEMBLY



Cut 84-4/72

MAINSHAFT ASSEMBLY



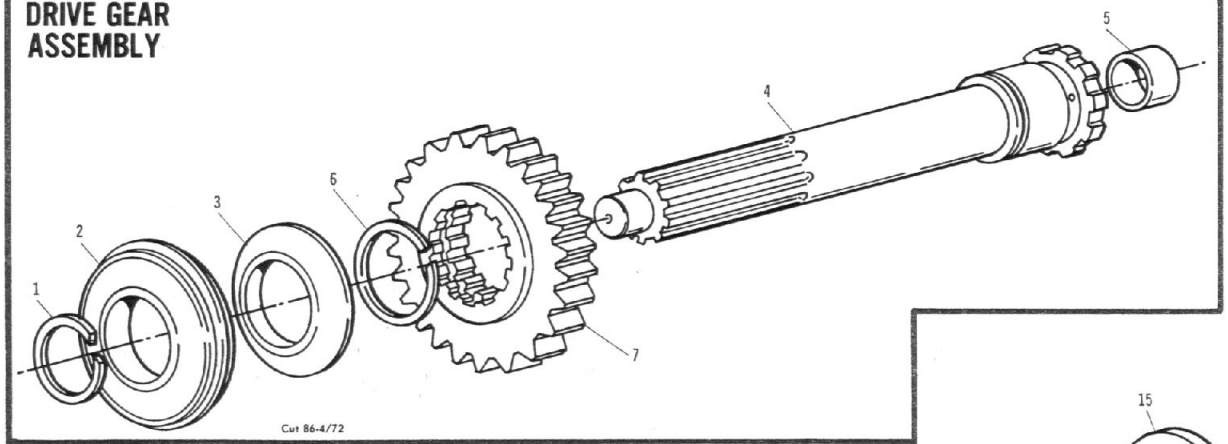
Cut 85-4/72

ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	1	15046	Snap ring	S	4
2	1	81551	Bearing		4
3	1	15971	Spacer		–
4	1	16224	Drive shaft push type *order DA-16224-00*	M	※
	or 1	16281	Drive shaft pull type *order DA-16281-00*	N	※
5	1	15977	Bushing	MN	4
6	1	15973	Snap ring	S	3
7	1	15972	Drive gear RT-613		3
	or 1	88534	Drive gear RTO-613		3
8	2	X-1-803	1/2 nut		2
9	2	X-10-801	1/2 washer		–
10	2	16789	Washer	S	2
11	2	15045	Bearing		8
12	2	16234	Gear		2
13	2	A-4081	Shaft and pin assy.		2
14	1	81505	Bearing		4
15	1	16790	Washer	S	1
16	6	1813	Spring		12
17	1	16793	Ring		1
18	1	16792	Retainer		–
19	1	14993	Snap ring		3
20	2	15981	Retainer		–
21	2	15748	Spec. lockwasher		6
22	4	X-8-600	3/8-16 x 1 capscrew		–
		DA-16224-00	Input shaft assy. push type	M	※
		DA-16281-00	Input shaft assy. pull type	N	※

S—Small parts A-4205

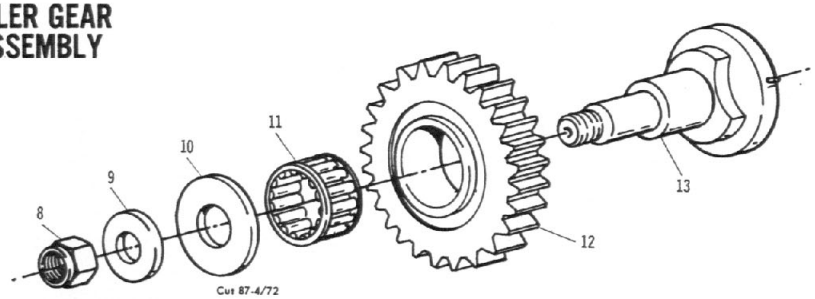
※SEE PAGE 2 FOR STOCKING QTY.

DRIVE GEAR ASSEMBLY



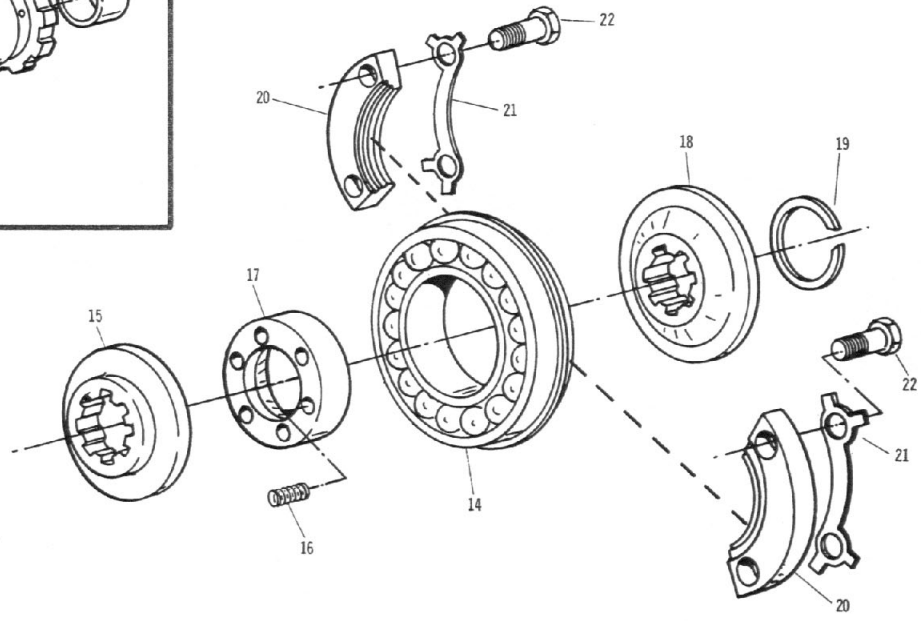
Cut 86-4/72

IDLER GEAR ASSEMBLY



Cut 87-4/72

MAINSHAFT BEARING ASSEMBLY



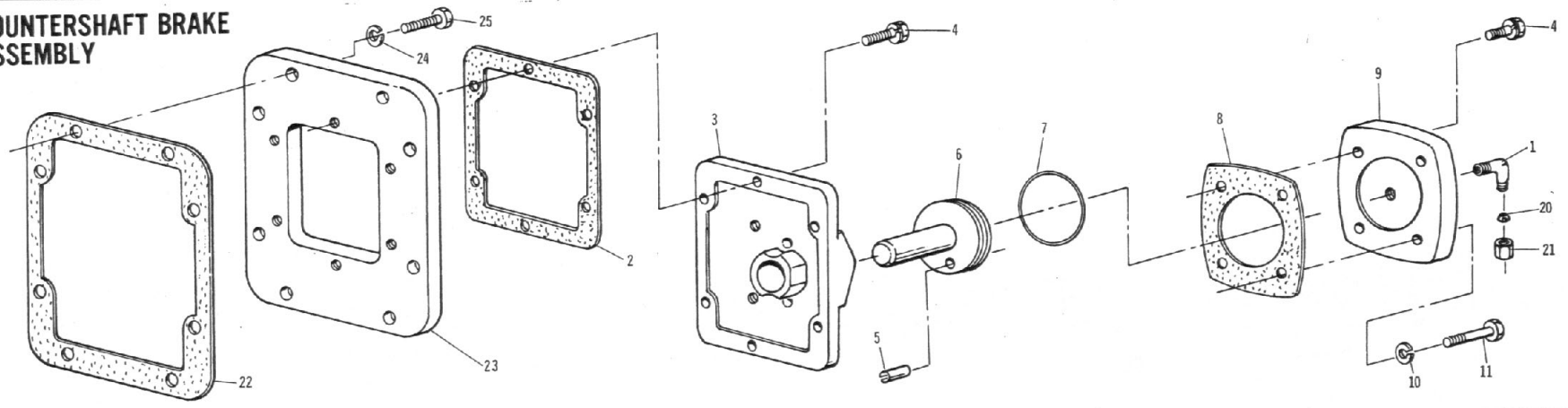
Cut 88-4/72

ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	1	84502	1/8 pipe connector		—
	or 1	85002	1/8 pipe connector assembly		—
2	1	1684	Gasket		—
3	1	16656	Housing		1
4	6	X-8L-604	3/8-16 x 1-1/4 capscrew		—
5	1	62515	Roll pin		1
6	1	16658	Piston		2
7	1	16660	"O" ring		4
8	1	16661	Gasket		4
9	1	16659	Cover		1
10	2	X-3-600	3/8 lockwasher		—
11	2	X-8-607	3/8-16 x 2-1/4 capscrew		—
12	2	X-8-677	3/8-16 x 1 capscrew	Ψ	—
13	2	16971	Sleeve	Ψ	3
14	1	16969	Plate	Ψ	2
15	1	16972	Spring	Ψ	3
16	2	16973	Disc assembly	Ψ	6
17	1	16970	Cover	Ψ	1
18	1	15059	Gasket	Ψ	—
19	4	X-8-678	3/8-16 x 1 socket head	Ψ	—
20	2	83001	Sleeve		—
21	2	83501	Nut		—
22	1	16929	Gasket		—
23	1	15594	Adapter (to 8 bolt)		—
24	8	X-3-700	7/16 lockwasher		—
25	8	X-8-703	7/16-14 x 1 capscrew		—
		A-4195	Upshift brake	Ψ	8

also see page 5

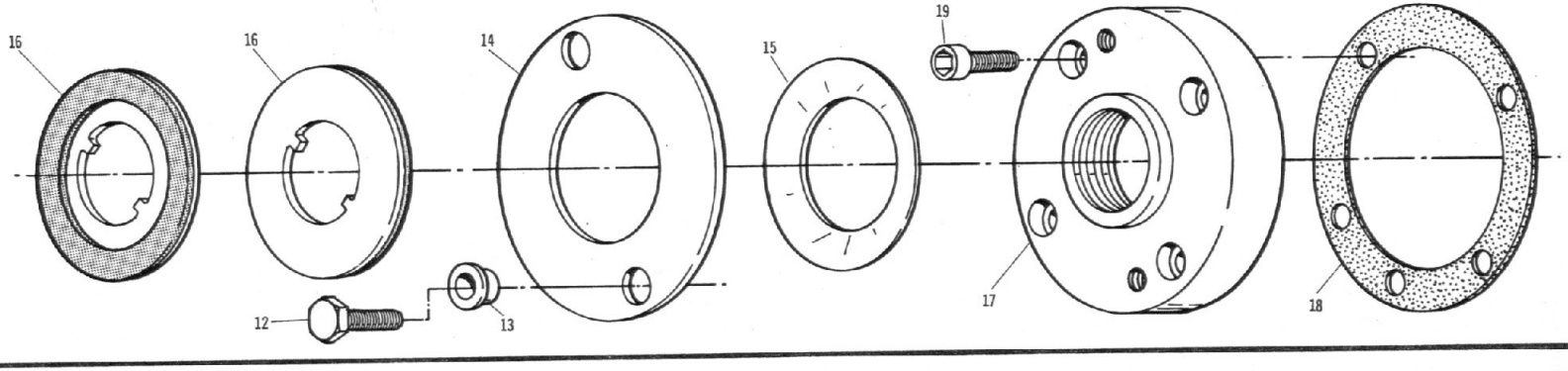
8 SEE PAGE 2 FOR STOCKING QTY.

COUNTERSHAFT BRAKE ASSEMBLY



Cut 89-4-72

UPSHIFT BRAKE ASSEMBLY



Cut 90-4/72

ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	3	14897	Spring	S	18
2	1	A-4194	Synchronizer		6
3	1	16716	Clutch gear		3
4	1	A-3154	Synchronizer		6
5	2	16807	Spacer		—
6	2	16817	Bearing		8
7	2	A-4096	Countershaft assembly		
			(D/G 16797 - Int. 16814 - C/S 16806) *		
8	2	81008	Bearing		8
9	2	16723	Snap ring	S	8
10	1	15061	Gasket		—
11	1	16810	Housing *order A-4113*	*r*	1
12	1	A-4074	Trough assy.		2
13	1	15701	5/16 plug	*r*	—
14	1	16824	Spacer		—
15	1	X-8-430	1/4-20 x 7/8 capscrew		—
16	1	16827	Gasket	*r*	—
17	1	16828	Oil reservoir	*r*	1
18	4	X-13-215	Drive screw	*r*	4
19	1	X-12-1201	3/4 plug		—
20	1	14373	Magnet	*r*	—
21	1	X-12-2001	1-1/4 plug		—
22	4	X-8-679	3/8-16 x 1-3/4 capscrew		—
	and 11	X-8-680	3/8-16 x 1-1/2 capscrew		—
23	2	14334	Dowel pin		2
24	2	6579	5/8 stud		—
25	2	X-3-1000	5/8 lockwasher		—
26	2	X-1-1000	5/8-18 nut		—
27	1	16796	Mainshaft		2
28	1	14332	Washer	S	4
29	1	14331	Spacer	S	4
30	1	14326	Low gear		2
31	1	14327	Snap ring	S	2
32	1	16791	Washer	S	4
33	1	11956	Nut		6
34	1	16809	Gear		3
35	1	16812	Snap ring	S	2
36	1	16815	Gear		2
37	1	16811	Clutch gear		3
38	1	16816	Retainer		1
39	2	X-7-506	5/16-24 x 1 capscrew		—
40	1	16795	Retainer		1
41	2	16798	Snap ring	S	4
42	1	16799	Washer	S	2
43	1	17504	Trough †	Γ	2
		A-4113	Case assembly	*r*	⁂
		K-1019	Oil trough rep. kit	Γ	⁂

also see page 11

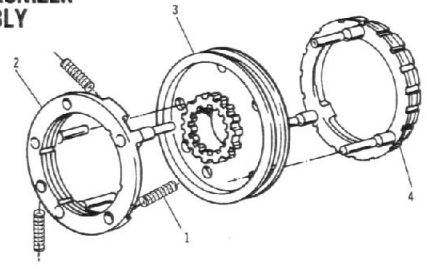
S—Small parts A-4205

*MAJOR PARTS OF WELDED ASSY.

†USE ONLY WITH 17503 OIL PLATE ITEM 54 PAGE 11

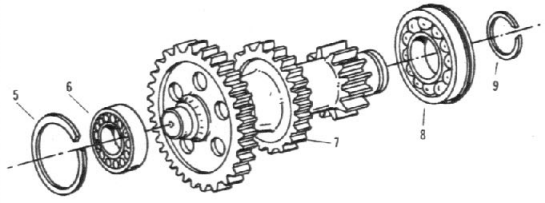
⁂SEE PAGE 2 FOR STOCKING QTY.

SYNCHRONIZER ASSEMBLY



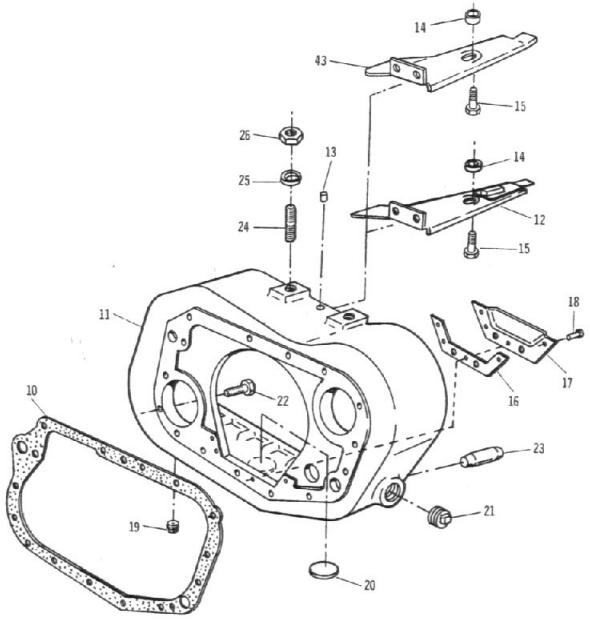
Cut 26 - 4/71

AUXILIARY COUNTERSHAFT ASSEMBLY



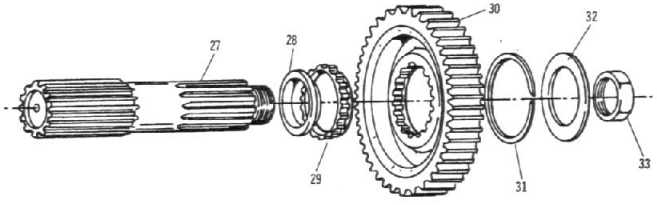
Cut 91-4/72

INTERMEDIATE SECTION



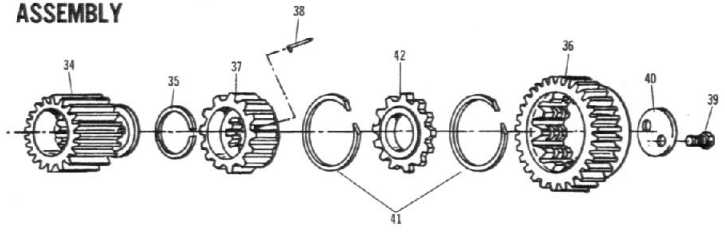
Cut 92-4/72

OUTPUT SHAFT



Cut 93-4/72

AUXILIARY DRIVE GEAR ASSEMBLY

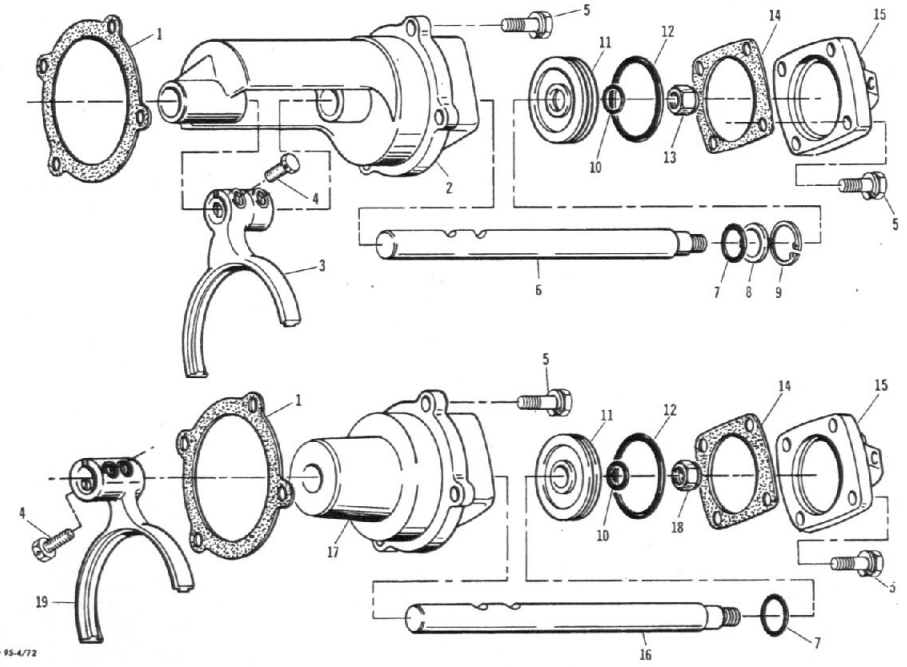


Cut 94-4/72

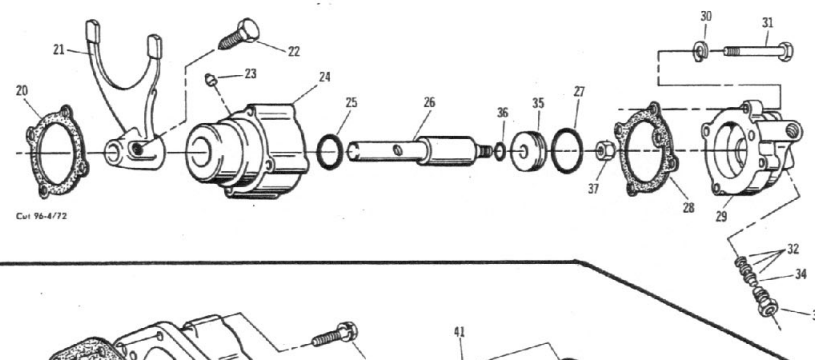
ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK-ING QTY.
1	1	14347	Gasket		—
2	1	14784	Cylinder		2
3	1	14338	Yoke		2
4	2	X-7-810	1/2-20 x 2 capscrew		—
5	8	X-8L-604	3/8-16 x 1-1/4 capscrew		—
6	1	14339	Yoke bar		2
7	1	14765	"O" ring		—
8	1	14766	Ring		—
9	1	14767	Snap ring		4
10	1	14345	"O" ring		—
11	1	14341	Piston		2
12	1	14344	"O" ring		—
13	1	X-1-1005	5/8-18 elas. stop nut		2
14	1	14349	Gasket		—
15	1	14799	Cover		1
16	1	16993	Yoke bar		2
17	1	16778	Cylinder		2
18	1	X-1-1010	5/8-11 eslok nut		2
19	1	16775	Yoke		2
20	1	14632	Gasket		—
21	1	16813	Yoke		2
22	1	3220	Screw		—
23	1	14635	Plug	*t*	2
24	1	16801	Cylinder *order A-4092*	*t*	ℵ
25	1	14644	"O" ring		—
26	1	16804	Yoke bar		2
27	1	14621	"O" ring		—
28	1	15720	Gasket		—
29	1	16963	Cover	*s*	1
30	4	X-3-500	5/16 lockwasher		—
31	4	X-8-507	5/16-18 x 1-7/8 capscrew		—
32	3	13653	"O" ring (part of item 34)		3
33	1	15719	Plug	*s*	1
34	1	15512	Valve	*s*	4
35	1	14643	Piston		2
36	1	14645	"O" ring		—
37	1	X-1-702	7/16-20 elas. stop nut		2
38	1	16843	Housing *order S-1000*	Υ	ℵ
	or 1	17391	Hsg. (w/cooler) *order S-1001*	Σ	ℵ
39	1	14335	Gasket		—
40	17	X-8L-602	3/8-16 x 1-1/4 capscrew		—
	and 2	X-3-600	3/8 lockwasher		—
	and 2	X-8-614	3/8-16 x 2 capscrew		—
41	1	14367	Bearing		4
42	2	17097	Gasket		—
43	2	16724	Cover		1
44	8	X-8L-600	3/8-16 x 1 capscrew		—
45	1	15532	Gasket	*h*	—
46	1	14961	Housing	*h*	1
47	1	7992	Bushing	*h*	—
48	1	2237	Plug	*h*	—
49	1	17106	Brass washer		—
50	5	X-8-616	3/8-16 x 2-3/4 capscrew		—
	and 1	X-8-682	3/8-16 x 3 eslok capscrew		—
51	5	X-3-600	3/8 lockwasher		—
52	1	14337	Seal	*h*	6
53	1	14375	Speedo replacement		ℵ
54	1	17503	Oil plate	ΓΥΣΩ	ℵ
55	4	X-13-217	Drive screw	ΓΥΣΩ	ℵ
		A-4092	Cylinder assembly	*t*	ℵ
		A-4145	Cover w/valve	*s*	ℵ
		K-1019	Oil trough rep. kit	Γ	ℵ
			also see page 10		
		K-1027	Cover assembly	*h*	ℵ
		K-1037	Oil plate w/screws	Ω	ℵ
		S-1000	Housing plate assy.	Υ	ℵ
		S-1001	Housing plate assy.	Σ	ℵ

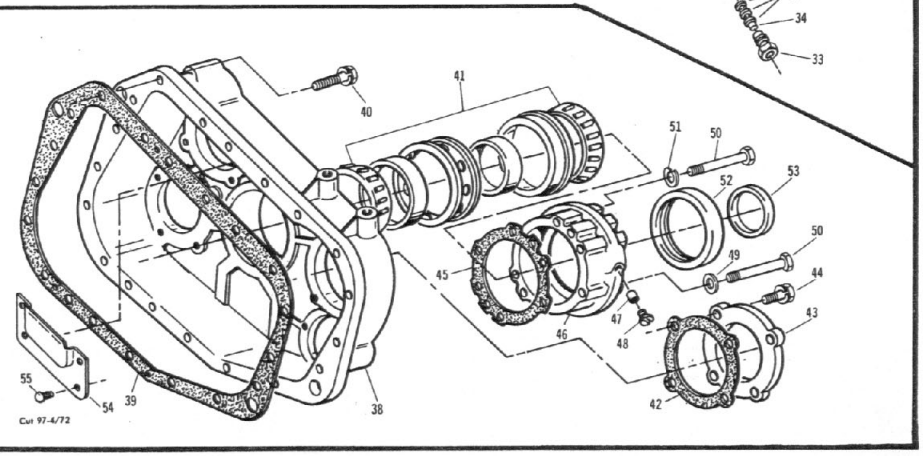
ℵ SEE PAGE 2 FOR STOCKING QTY.

RANGE CYLINDER ASSEMBLIES



SPLITTER CYLINDER ASSEMBLY





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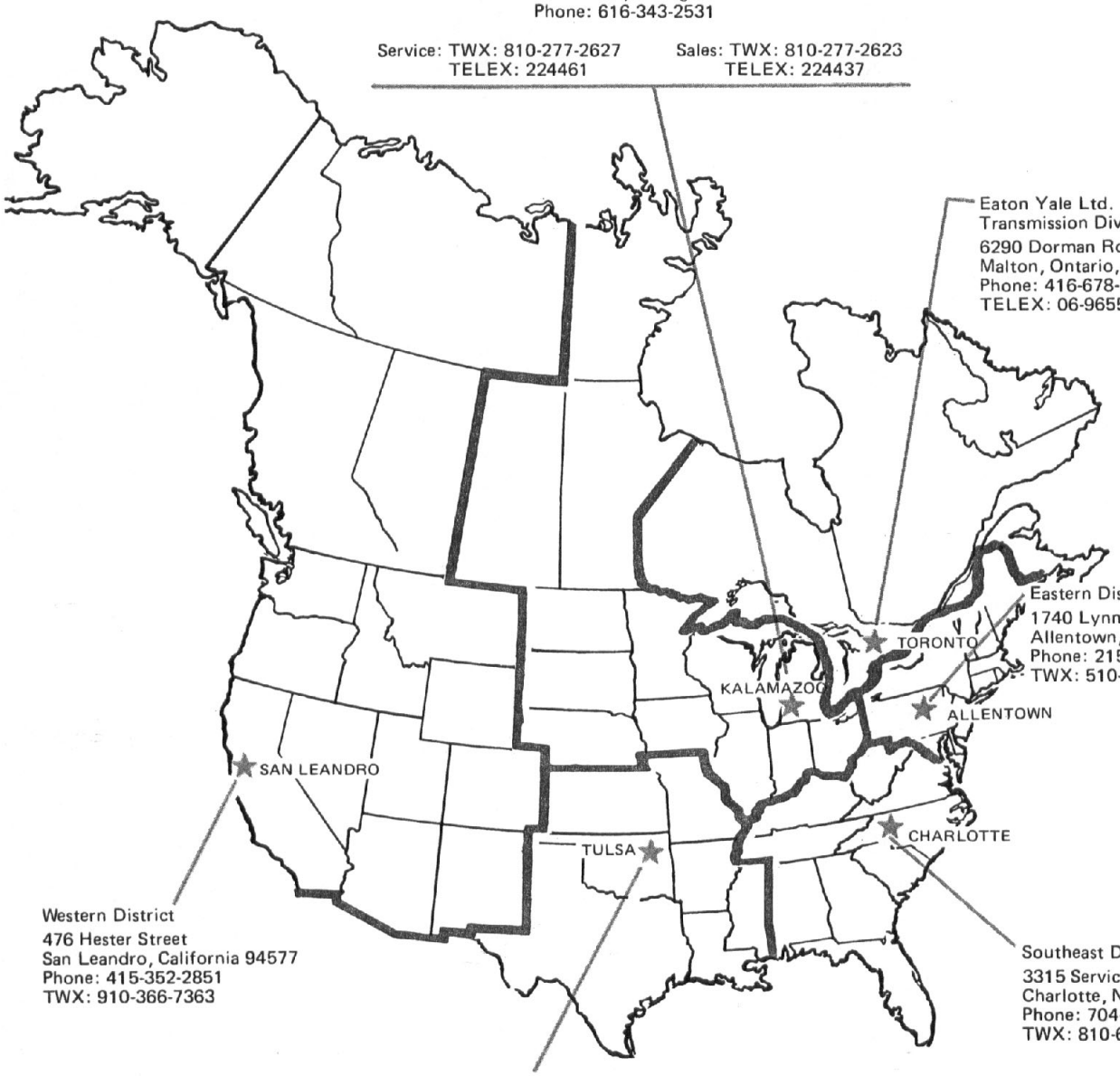

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ILLUSTRATED PARTS LIST

Fuller

Remote Controls

SRC Series

Fuller SRC Series

Form No. P-515-R-4 2/75 - 5.85
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THIS BOOKLET IS DESIGNED TO IDENTIFY ALL PARTS IN THE SRC CONTROLS AND TO RECOMMEND PARTS WHICH SHOULD BE KEPT IN STOCK. THE SUGGESTED QUANTITIES ARE BASED ON AN INVENTORY SUFFICIENT FOR 25 SRC CONTROLS.

SERVICE KITS AND ASSEMBLIES AVAILABLE FOR THE SRC CONTROLS

Sym.	Part #	Description	Stock Qty.
A	A-2931	Housing assembly	1
B	A-3940	Housing assembly	1
C	A-2932	End cap assembly	1
D	A-3941	End cap assembly	1
E	A-4259	Housing replacement	1
F	A-4260	Housing replacement	1
G	A-4264	Housing replacement	1
H	A-3848	"U" joint assembly	—
J	A-4247	Housing assembly	1
K	K-1416	Housing assembly	1
L	S-1138	SRC-1 master *see des. below*	1
M	S-1139	SRC-10 slave " " "	1
N	S-1140	SRC-118 slave " " "	1
P	A-3753	SRC-bushing kit	1
Q	A-3987	SRC-1 bushing kit	1

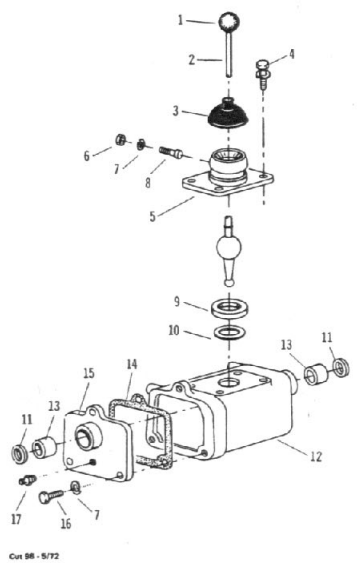
SRC O - SRC 18 - SRC 30 replaced by SRC 10 - SRC 118 - SRC 130

The SRC 4 is special for T-955 Series and is available in the 0°, 18° and the 30° housing. The inner finger, item 27, is the only part that changes in the slave unit.

PART NUMBERS LISTED IN THIS BOOKLET APPLY ONLY AT THE TIME OF PRINTING AND ARE SUBJECT TO CHANGE.

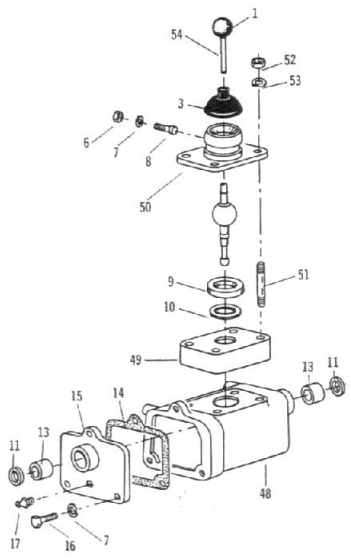
See Back Page For Optional Installations

SRC–1 MASTER

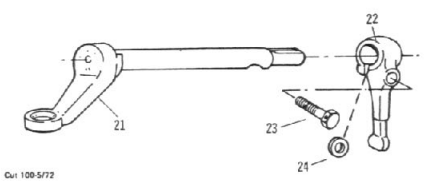


Cut 98 - 5/72

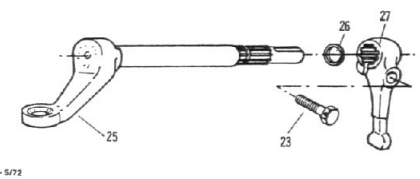
SRC–4-1 MASTER



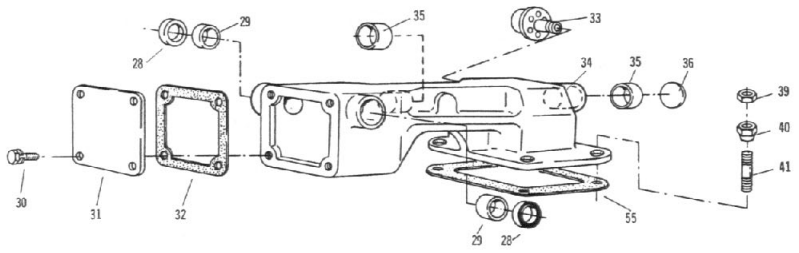
Cut 99 - 5/72



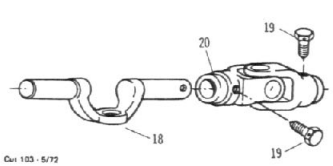
Cut 100-5/72



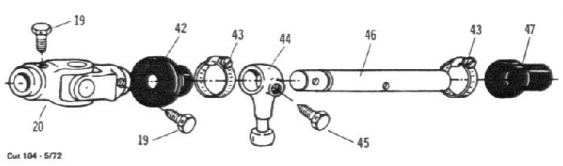
Cut 101 - 5/72



Cut 258 - 10/74



Cut 103 - 5/72



Cut 104 - 5/72

REBUILD WITH CONFIDENCE USE GENUINE FULLER® PARTS

ITEM	QTY. USED	PART NO.	DESCRIPTION	SYM-BOL	STOCK QTY.
1	1	1075	Ball 5/8-11		—
	or 1	4715	Ball 3/8-24		—
	or 1	17560	Ball 1/2-13	L	—
2	1	17675	Lever (std.)	L	—
3	1	13951	Boot	L	3
4	4	X-8L-600	3/8-16 x 1 capscrew	L	—
5	1	13950	Cap	L	1
6	1	X-1-500	5/16-24 nut	L	—
7	4	X-3-500	5/16 lockwasher	L	—
8	1	2271	Pin	L	6
9	1	13948	Seat	L	2
10	1	13949	Washer	L	2
11	2	16388	Seal	ξ BDJL	12
12	1	13945	Housing *order A-2931*	A	ℵ
	or 1	16402	Housing *order A-3940*	BL	ℵ
13	2	15313	Bushing	ABCDJL	12
14	1	13952	Gasket	L	6
15	1	13946	End cap *order A-2932*	C	ℵ
	or 1	16401	End cap *order A-3941*	DL	ℵ
16	3	X-8-518	5/16-18 x 7/8 capscrew	L	—
17	1	4759	Zert fitting	DL	—
18	1	13847	Shift yoke	L	1
19	4	14016	Lockscrew	HLMN	—
20	2	14015	"U" joint	HLMN	2
21	1	A-3599	Shaft and lever assy.		
			SRC-0 10-3/8		1
	or 1	A-3600	SRC-0 11-1/8		1
	or 1	A-3604	SRC-30		1
	or 1	A-3605	SRC-18		1
22	1	15275	Finger		2
23	1	X-7-706	7/16-20 x 1-3/4 capscrew	EFGKMN	—
24	1	15269	Washer		1
25	1	A-3925	Shaft and lever assembly		
			SRC-10 11-1/8	EF	1
	or 1	A-3926	SRC-10 10-3/8, SRC-118	MN	1
	or 1	A-3927	SRC-130	GK	1
26	1	16387	Snap ring	EFGKMN	2
27	1	16386	Finger	EFGKMN	2
	or 1	17062	Finger (SRC-4 only)		2
28	2	15571	Seal	* P	12
	or 2	16388	Seal	† EFGKMNQ	12
29	2	15313	Bushing	PQ	12
30	4	X-8L-500	5/16-18 x 3/4 cpscw.	MN	—
31	1	13788	Cover	MN	—
32	1	13789	Gasket	KMN	6
33	1	15276	Breather	MN	—
34	1	13785	Hsg. SRC-0 11-1/8 *left*		
			replaced by A-4259		ℵ
	or 1	14068	Hsg. SRC-0 11-1/8 *right*		
			replaced by A-4260		ℵ
	or 1	14968	Hsg. SRC-0 10-3/8 *left*		1
	or 1	14969	Hsg. SRC-0 10-3/8 *right*		1
	or 1	15107	Hsg. SRC-18 *repl. by A-4264*		ℵ
	or 1	14985	Hsg. SRC-30 *repl. by K-1416*		ℵ
	or 1	16375	Hsg. SRC-10 11-1/8 *left*	E	1
	or 1	16376	Hsg. SRC-10 11-1/8 *right*	F	1
	or 1	16377	Hsg. SRC-10 10-3/8 *left*	M	1
	or 1	16378	Hsg. SRC-10 10-3/8 *right*		1
	or 1	16379	Hsg. SRC-118	GN	1
	or 1	16380	Hsg. SRC-130	K	1
	or 1	17030	Hsg. SRC-10 8-1/2 *right*		1
35	2	15314	Bushings	* P	12
	or 1	16493	Bushing (end)	† Q	6
	and 1	16368	Bushing (middle)	† Q	6
36	1	6716	Plug	MN	6
39	4	X-1-601	3/8-24 jam nut	MN	—
40	4	X-1-603	3/8-24 conical nut	MN	—
41	4	11066	3/8 stud	MN	—
42	1	14975	Boot	MN	3
43	2	14441	Clamp	MN	—
44	1	13790	Finger	MN	1
45	1	3220	Lockscrew	MN	—
46	1	16385	Outer shaft	EFGKN	1
	or 1	16389	Outer shaft universal	M	1
47	1	14974	Boot *use w/16385*	N	3
	or 1	15283	Boot *use w/16389*	M	3
48	1	17185	Housing *order A-4247*	J	ℵ
49	1	17183	Adapter		—
50	1	17184	Cap		1
51	4	13883	Stud		—
52	4	X-1-600	3/8-24 nut		—
53	4	X-3-600	3/8 lockwasher		—
54	1	17186	Lever (std.)		—
55	1	1642	Gasket	EFGKMN	—

PART NO.	DESCRIPTION	SYM-BOL	STOCK QTY.
A-2931	Housing assembly	A	ℵ
A-3940	Housing assembly	B	ℵ
A-2932	End cap assembly	C	ℵ
A-3941	End cap assembly	D	ℵ
A-4259	Housing replacement	E	ℵ
A-4260	Housing replacement	F	ℵ
A-4264	Housing replacement	G	ℵ
A-3848	"U" joint assembly	H	ℵ
A-4247	Housing assembly	J	ℵ
K-1416	Housing assembly	K	ℵ
S-1138	SRC-1 Master control complete	L	ℵ
S-1139	SRC-10 Slave *L.H. front* 10-3/8 offset complete	⊕ M	ℵ
S-1140	SRC-118 Slave *L.H. front* 10-3/8 offset complete	N	ℵ
A-3753	SRC Bushing kit	P	ℵ
A-3987	SRC-1 Bushing kit	Q	ℵ

⊕ RELOCATION OF BOOTS ITEM 42 AND 47 ALLOWS FOR OPTIONAL REAR PROJECTION

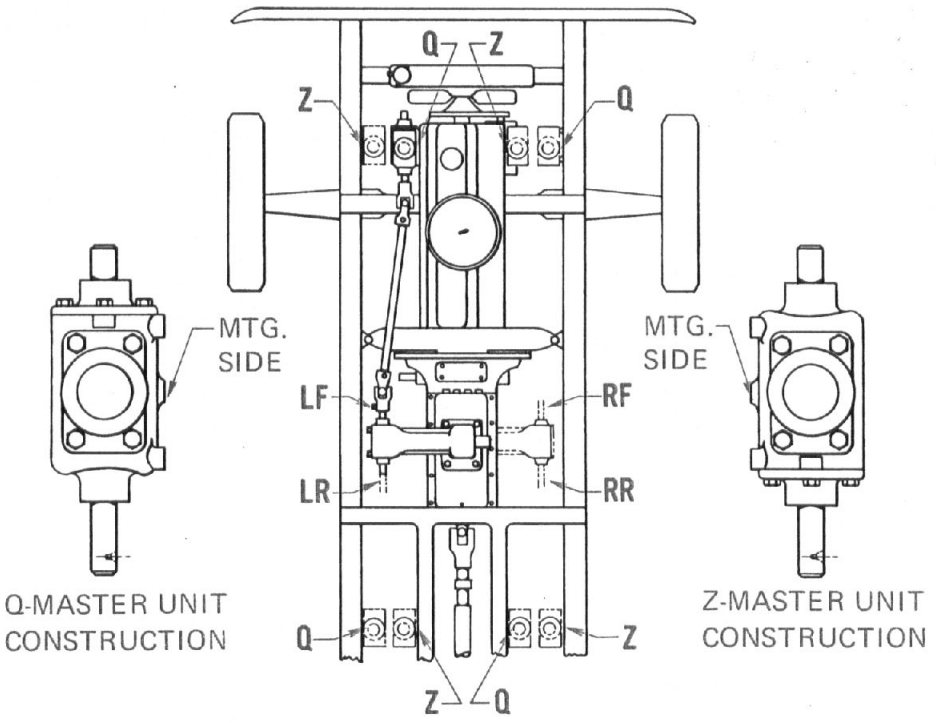
* W/13785–14068–14968–14969–15107–14985 Hsg.

† W/16375–16376–16377–16378–16379–16380 Hsg.

ξ W/16402–16401 only

ℵ SEE PAGE 2 FOR STOCKING QTY.

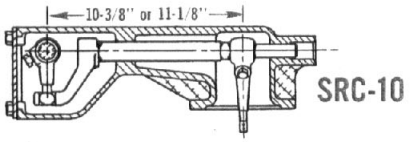
SRC CONTROL OPTIONAL INSTALLATIONS



SLAVE UNIT:

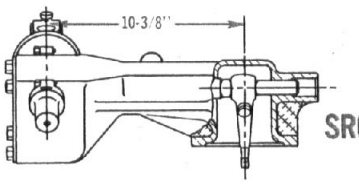
LF -LEFT HAND FORWARD
LR -LEFT HAND REARWARD
RF -RIGHT HAND FORWARD
RR -RIGHT HAND REARWARD

Model	Application	Shift Shaft Angle	Centerline Offset	Shift Shaft Projection	Housing Projection	Weight
SRC-10	3 or 4 rail transmission	0°	10-3/8" 11-1/8"	Front or Rear	Right or Left	13 lbs.
SRC-118	3 or 4 rail transmission	18°	10-3/8"	Front	Left	13 lbs.
SRC-130	3 or 4 rail	30°	8-1/2"	Front	Left	12 lbs.



SRC-10

Cut 106 - 5/72



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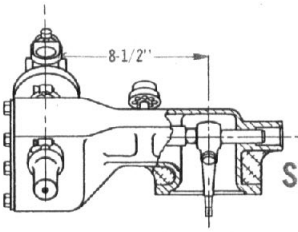

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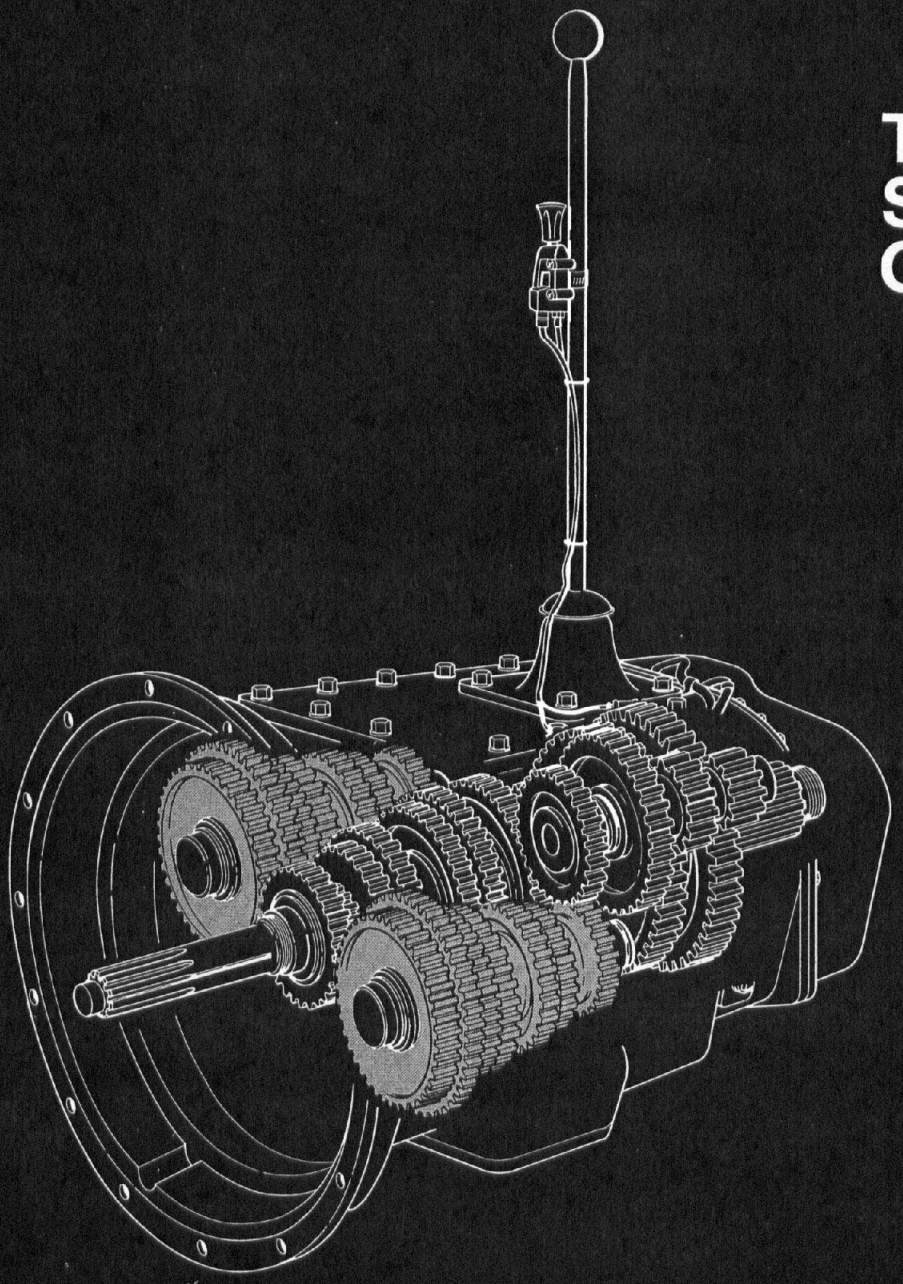
EATON Truck Components

Printed in U.S.A.

Eaton Corporation
Transmission Division
222 Mosel Avenue
Kalamazoo, Michigan 49007

Heavy Duty
Truck Transmissions

Fuller®

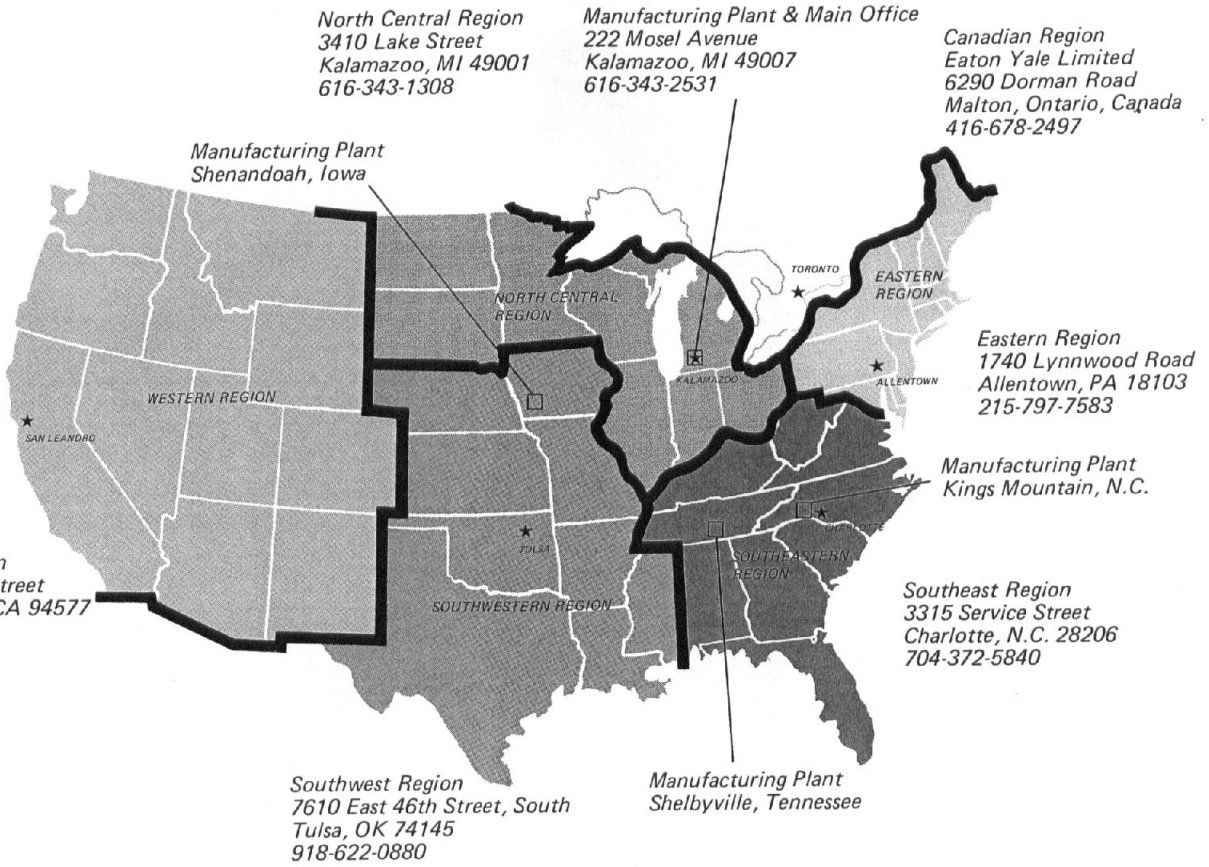


Trouble Shooting Guide

EATON Truck Components

Eaton Corporation
Transmission Division
Kalamazoo, Michigan 49007

"You're close to Fuller transmission parts and service"



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Trouble Shooting Guide Fuller® Transmissions

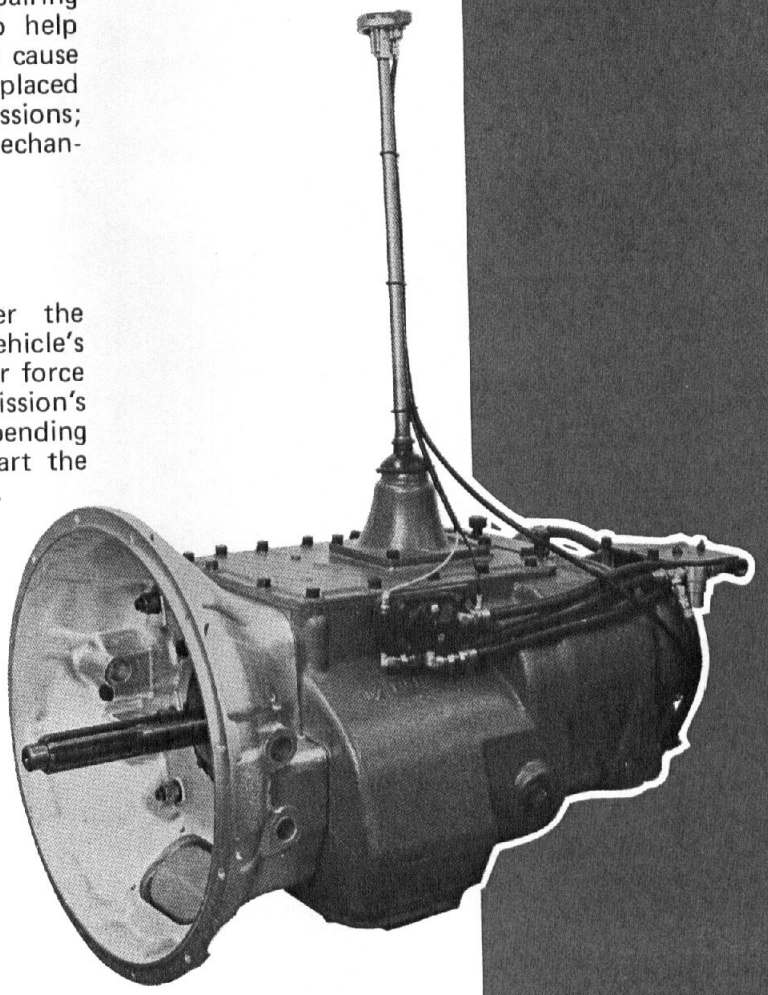
Foreword

The purpose of this publication is to provide basic technical information for servicing and repairing heavy duty truck transmissions. A guide to help the mechanic locate the trouble, analyze the cause and make the necessary repairs. Emphasis is placed on servicing Fuller twin countershaft transmissions; however, some sections are common to all mechanical transmissions.

Transmission Function

The transmission must efficiently transfer the engine's power, in terms of torque, to the vehicle's rear wheels. Torque is the twisting or circular force delivered by the engine's flywheel. The transmission's gear ratios increase or decrease torque depending on the requirements needed to move or start the load. Gearing also increases or decreases speed. The gear ratios are correctly spaced so that the engine will operate in its most efficient RPM range with progressive speed changes.

To meet the vehicle's requirements, the transmission must have ratios low enough to start the vehicle moving, to maintain movement up grades, and to keep engine operating in its peak efficiency range. The transmission, too, must provide an easy method for gear selection.



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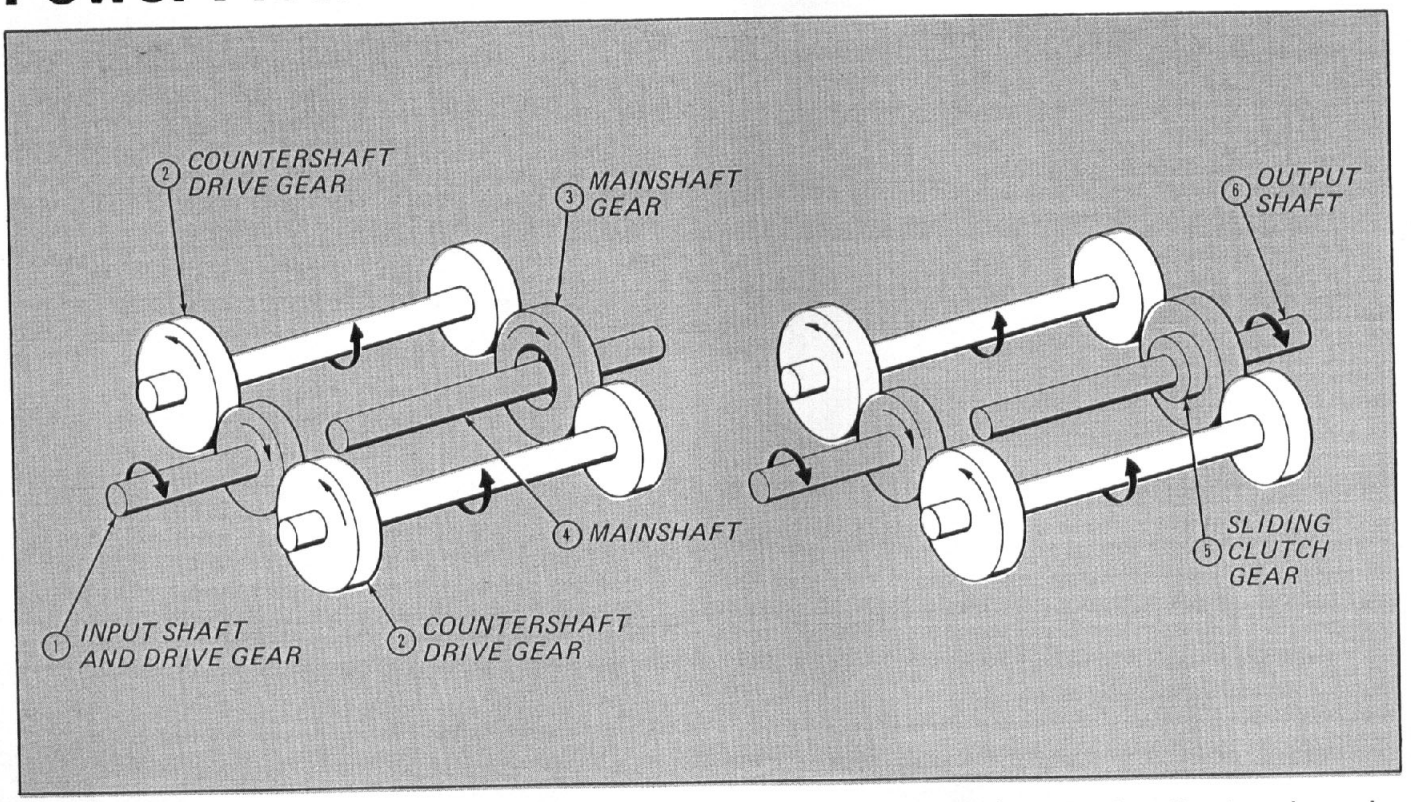
Power Flow



A simplified diagram of the power flow through a Fuller twin countershaft transmission will help show how torque and speed are changed, and how torque is divided between the two countershafts.

The input shaft and drive gear (1) are in constant mesh with both countershaft drive gears (2); when the input shaft turns, the countershafts turn. The countershaft gears are in constant mesh with the "floating" mainshaft gears (3). The mainshaft gears are simply free-wheeling on the mainshaft (4). A sliding clutch gear (5), which is splined to the mainshaft, is engaged into the internal clutching teeth of the mainshaft gear, coupling it to the mainshaft. The mainshaft will now be turning at the selected gear ratio.

Fuller twin countershaft Roadranger transmissions commonly consist of a five speed front section and either a two or three speed auxiliary section, both in one case.

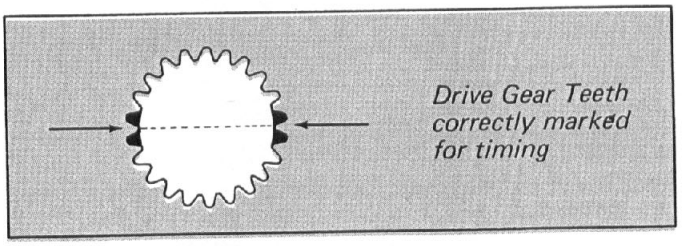
Timing

All Fuller twin countershaft transmissions are "timed" at assembly. It is important that proper timing procedures are followed when reassembling the transmission. Timing assures that the countershaft gears will contact the mating mainshaft gears at the same time, allowing mainshaft gears to center on the mainshaft and equally divide the load.

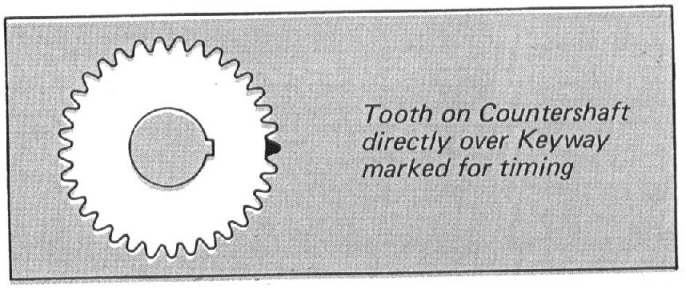
One set of gears must be timed in the front section, and one set in the auxiliary section. Timing consists of marking the proper teeth before installation and meshing the marked teeth during assembly. Following is a step by step procedure for timing:

Front Section

1. Main Drive Dear – Mark any two adjacent teeth on the drive gear, then mark the two adjacent teeth which are directly opposite the first set marked. There must be an equal number of teeth between the markings on each side of the gear.

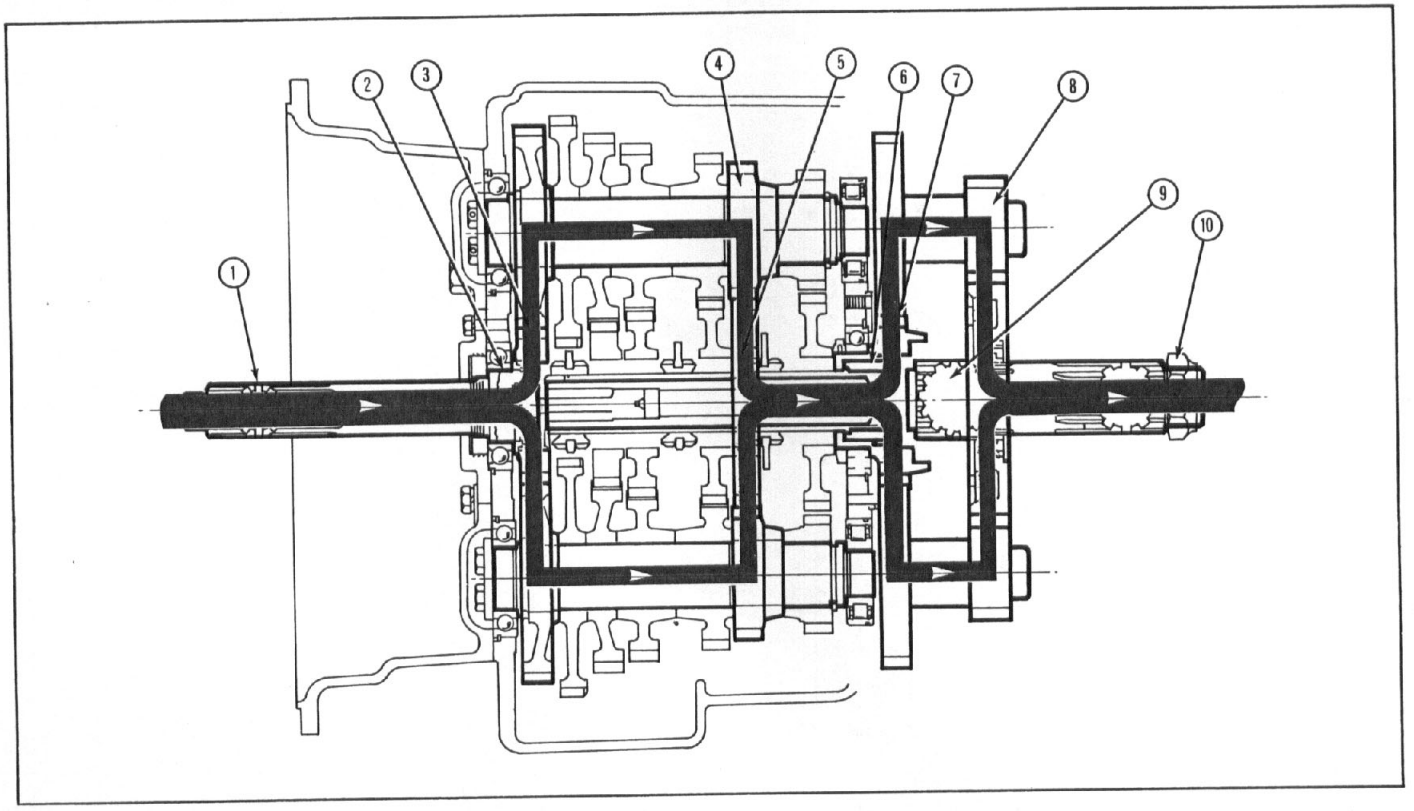


Drive Gear Teeth correctly marked for timing

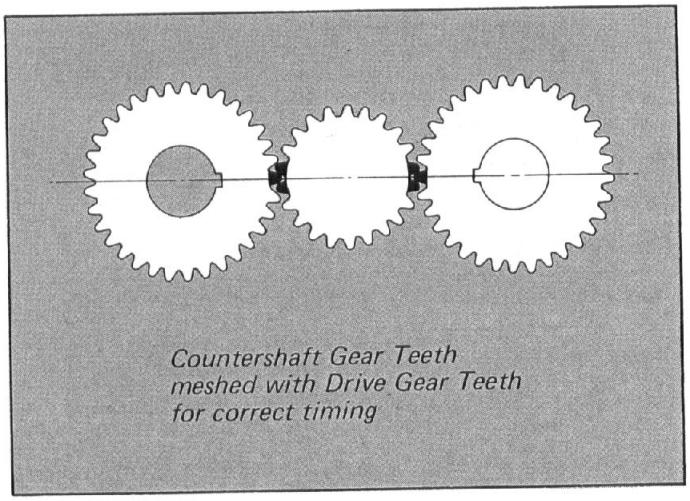


Tooth on Countershaft directly over Keyway marked for timing

2. Countershaft Drive Gears – Mark on each drive gear the gear tooth which is directly over the keyway. This tooth is stamped with an "O" for identification.



1. Power (torque) from the engine flywheel is transferred to the input shaft.
2. Splines on input shaft engage internal splines in hub of drive gear.
3. Torque is split between the two countershaft drive gears.
4. Torque delivered by two countershaft gears to mainshaft gear ratio which is engaged. Diagram shows first speed gear engaged.
5. Internal splines in hub of mainshaft gear transfers torque to mainshaft through sliding clutch gear.
6. Mainshaft transfers torque to range drive gear through a self-aligning coupling gear located in hub of range drive gear.
7. Torque is split between the two range countershaft drive gears. (In direct drive or high range, power is delivered to the output shaft from the range drive gear through a self-aligning sliding clutch gear.)
8. Torque is delivered by the two countershaft low speed gears to the range low speed gear.
9. Torque delivered to output shaft through self-aligning sliding clutch gear.
10. Output shaft attached to drive line.



Countershaft Gear Teeth meshed with Drive Gear Teeth for correct timing

3. Meshing Countershaft Gears and Main Drive Gear – Install the drive gear assembly. Mesh the marked left countershaft gear tooth between the two marked teeth on the drive gear. Repeat the procedure with right countershaft.

Auxiliary

The gear set which is marked for timing in the auxiliary section varies, depending on the model. Usually the gear at the rear of the auxiliary is used.

1. Mainshaft Gear – Mark any two adjacent teeth on the mainshaft gear, then mark the two adjacent teeth directly opposite.
2. Countershaft Gears – On each countershaft assembly mark the gear tooth which is stamped with "O".

Lubrication

Proper lubrication is the key to a good all-round maintenance program and long transmission life. If the oil is not doing its job, or if the oil level is ignored, damage to the transmission will result and transmission life will be shortened.

Effective transmission oils must have the following characteristics:

Provide a protective film, to protect surface of heavily loaded parts such as gear teeth and bearings, thus preventing metal to metal contact which causes scoring, scuffing and seizure.

Act as coolant, to dissipate heat.

Have sufficient fluidity, to follow, coat and cushion all loaded surfaces.

Be chemically stable, to withstand heat and agitation without separation, gumming-up, oxidizing or corroding.

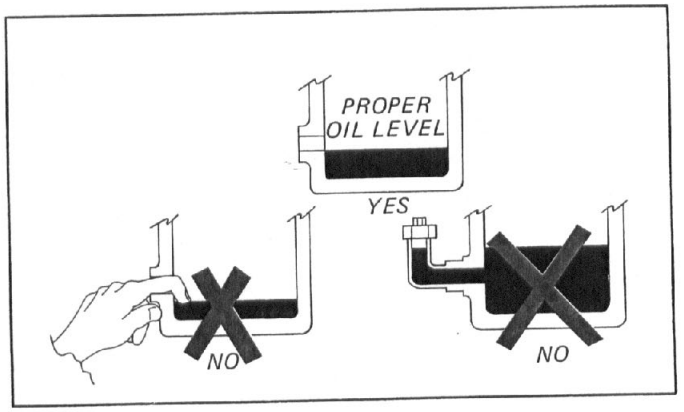
Be non-foaming, to prevent excessive foam and increased volume under severe conditions.

Be free of sediment and water, to prevent sludge and rust.

Fuller transmissions are designed so that internal parts operate in a bath of oil circulated by the motion of gears and shafts. Thus, all parts will be amply lubricated if these important procedures are closely followed:

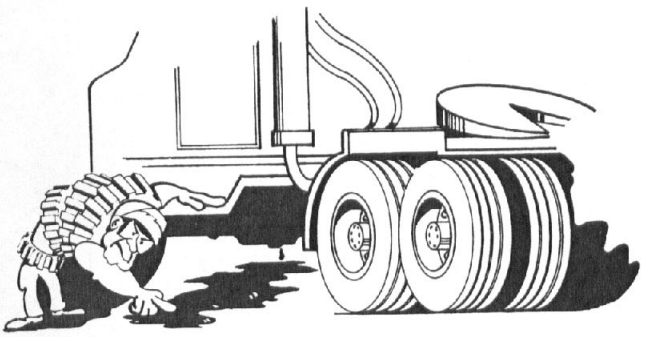
1. Maintain oil level. Inspect regularly.
2. Change oil regularly as recommended.
3. Use the correct grade and type of oil.
4. Buy quality lubricants.

Oil Level



Make sure oil is level with the filler opening. Because you can reach the oil with your finger does not mean oil is at proper level. Low oil will cause damage to moving parts; overfilling will cause overheating and cause oil to be forced out of the case at breather and front and rear seals.

Changing Oil



1. Check for oil leaks and determine cause before refilling.
2. Drain transmission while oil is warm by removing drain plug at bottom of case. On models with two drain plugs, both must be removed.
3. Flush the transmission with flushing oil or petroleum spirits. Fill transmission to the proper level with the flushing fluid; idle engine for one minute with the clutch engaged and the transmission in neutral.
4. Drain the flushing fluid and, if so equipped, change the filter element. Re-install drain plugs.
5. Refill the transmission with recommended oil to the level of the filler opening. On models having two filler openings, fill to the level of both openings. The exact amount of oil will depend on the transmission inclination and model. In every instance, fill to the level of the filler opening.

Lubrication Change and Inspection	
On-highway	
First 3,000 to 5,000 miles (4827 to 8045 Km)	Change transmission oil on new units.
Every 5,000 miles (8045 Km)	Inspect oil level. Check for leaks.
Every 50,000 miles (80450 Km)	Change transmission oil.
Off-highway	
First 30 hours	Change transmission oil on new units.
Every 40 hours	Inspect oil level. Check for leaks.
Every 500 hours	Change transmission oil where severe dirt conditions exist.
Every 1,000 hours	Change transmission oil (Normal off-highway use).
Change oil filter element, if so equipped, at each oil change.	

Oil changes should be made at the recommended intervals as shown above.

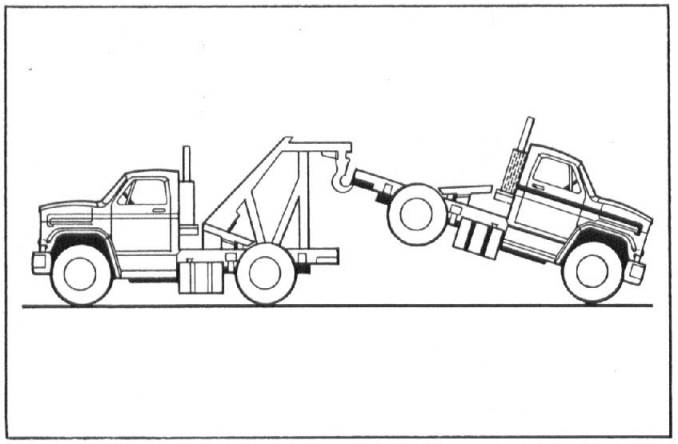
For severe operating conditions, operators should make oil changes based on their own particular operation. Oil suppliers will analyze samples of oil at various mileages to determine the contamination point.

Adding Oil

It is recommended that types and brands of oil not be intermixed becuase of possible incompatibility. Refer to the chart below for recommended lubricants.

Recommended Lubricants		
On-highway		
Type	**Grade**	**Temperature**
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 50 or SAE 40	Above + 10°F. (−12.5°C.)
	SAE 30	Below + 10°F.
Mineral Gear Oil R and O Type	SAE 90	Above + 10°F.
	SAE 80W	Below + 10°F.
Off-highway		
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 50 or SAE 40	Above + 10°F.
	SAE 30	Below + 10°F.
Special Recommendation — For extreme cold weather where temperature is consistently below 0°F.		
Heavy Duty Engine Oil MIL-L-2104C, or MIL-L-46152, or API-SE, or API-CC	SAE 20W	Below 0°F. (−18°C.)

Towing or Coasting



Fuller transmissions require rotation of the front section countershaft and mainshaft gears to provide adequate lubrication. These gears do not rotate when the vehicle is towed with the rear wheels on the ground and the drive train connected. The mainshaft, however, is driven at a high rate of speed by the rear wheels. The friction between the mainshaft splined washers, due to the lack of lubrication and the extreme difference in rotational speeds, will severely damage the transmission. Coasting with the transmission in neutral will produce the same damage.

To prevent this type of damage:

Never coast with the transmission in neutral.

Never coast with the clutch depressed.

When towing, pull the axle shafts, or disconnect the drive line, or tow with the drive wheels off the ground.

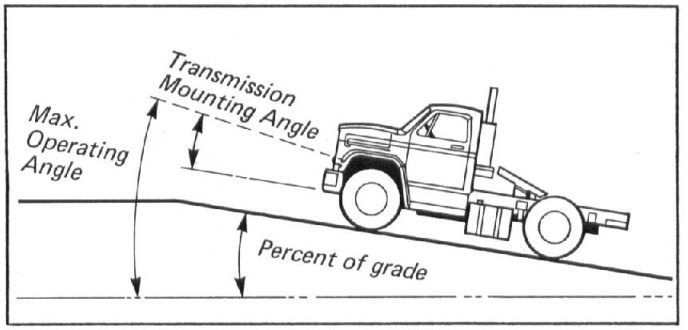
Operating Temperature

It is important that the transmission operating temperature does not exceed 250°F. (120°C.) for an extended period of time. Operating temperatures above 250°F. will cause breakdown of the oil and shorten transmission life.

The following conditions in any combination can cause operating temperatures of over 250°F.: (1) operating consistently at roadspeeds under 20 MPH, (2) high engine RPM, (3) high ambient temperature, (4) restricted air flow around transmission, (5) exhaust system too close to transmission, (6) high horsepower, overdrive operation. High operating temperatures may require more frequent oil changes.

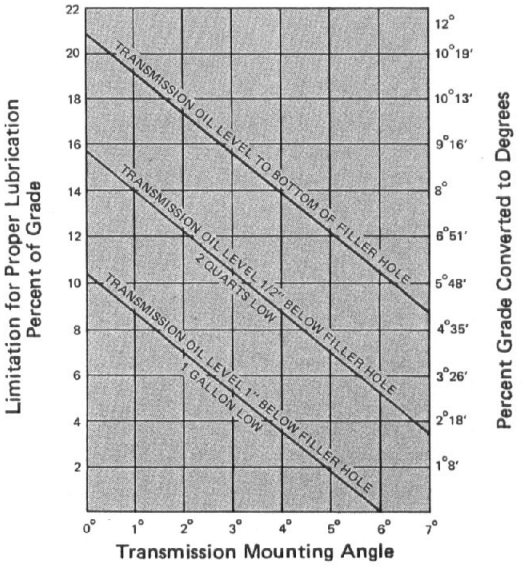
External cooler kits are available to keep the transmission operating temperature under 250°F. when the conditions described above are encountered.

Operating Angle



If the transmission operating angle is more than 12 degrees, improper lubrication can occur. The operating angle is the transmission mounting angle in the chassis plus the percent of grade (expressed in degrees).

When the transmission operating angle of 12 degrees is exceeded for an extended period of time, the transmission should be equipped with an oil pump or cooler kit, (illustrated parts number P-528) to insure proper lubrication.



Air Systems

Fuller Roadranger transmissions use a regulated air system to operate range and splitter shifts in the auxiliary section. The air system consists of a control valve, slave valve, filter, regulator and connecting lines. There are four types of control valves: 1) two-position range control, push-pull type; 2) two-position splitter valve, button type; 3) three-position combination range/splitter valve, button type and 4) deep reduction or lo-lo gear, in and out lever type. A faulty air system can result in: failure to shift, slow shift, incorrect shift, or damaged parts in the transmission. By understanding the operation of the air system and using a few simple checks, problems can be easily located and corrected.

Range Shift Air System – All Roadranger Transmissions

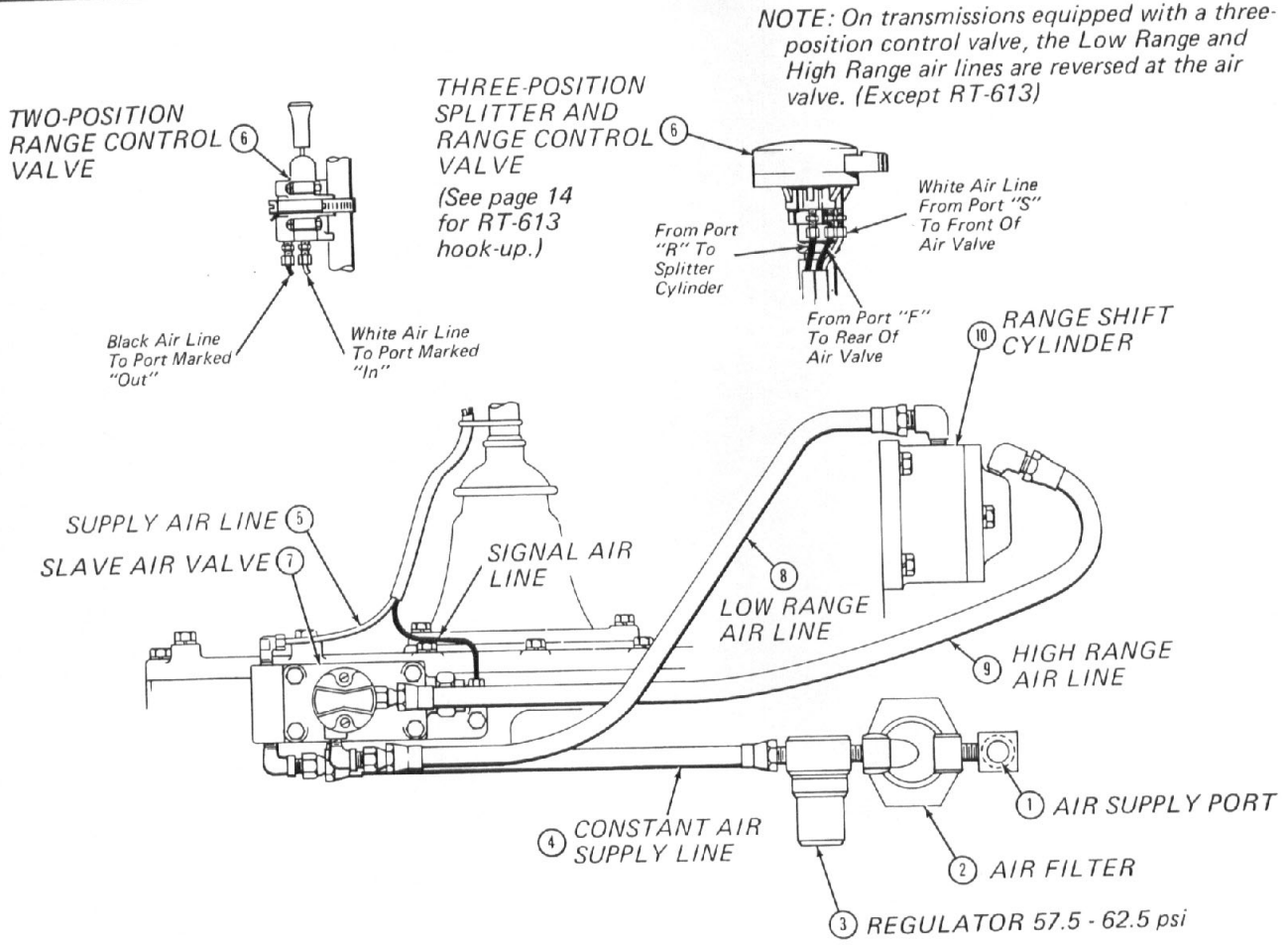


Figure 1. Range Shift Air System

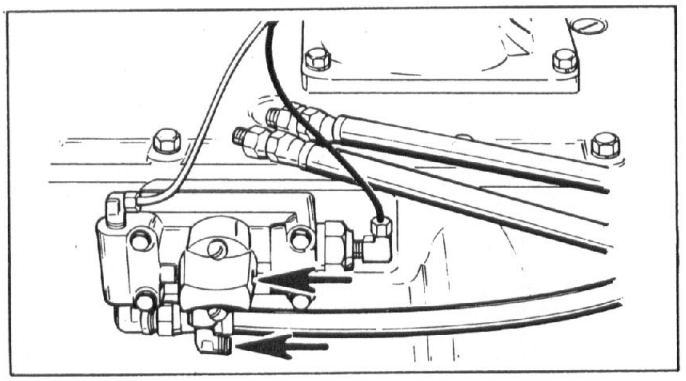
Operation

Air is supplied to the system at the AIR SUPPLY PORT (1) by the vehicle's air system. The AIR FILTER (2) removes foreign matter from the air then allows it to pass through the AIR REGULATOR (3) where the pressure is adjusted for 57.5 to 62.5 PSI (4.0 daN/cm^2). From there the air passes through the 1/4" ID SUPPLY AIR LINE (4) and the 1/8" OD CONTROL VALVE SUPPLY AIR LINE (5) to the supply ports of the RANGE CONTROL VALVE (6) and the SLAVE AIR VALVE (7). Depending upon the position of the knob on the RANGE CONTROL VALVE, air will pass through either the LOW RANGE AIR LINE (8) or the HIGH RANGE AIR LINE (9) to the RANGE SHIFT CYLINDER (10).

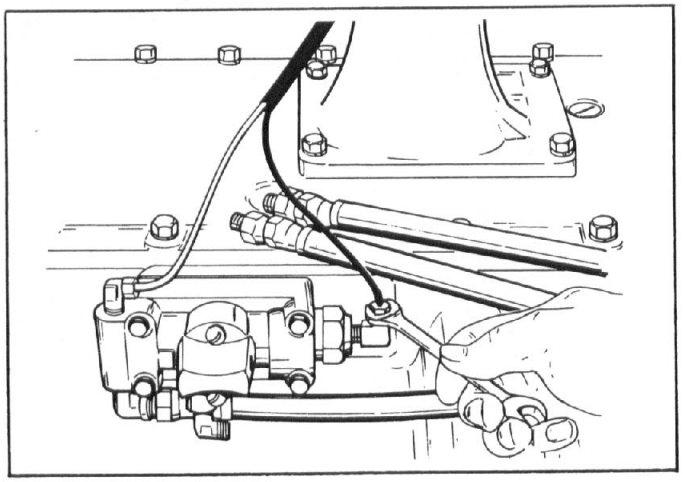
The following steps have been designed to aid in the recognition and correction of problems which may result in unsatisfactory performance of the range shift operation of applicable Fuller transmissions. It is advised that the checks be made in the sequence set down to avoid unnecessary double-checking and delay, unless the problem has already been narrowed down to a specific part of the system. In this case, refer to the appropriate heading of this section.

Troubleshooting the Range Shift Air System

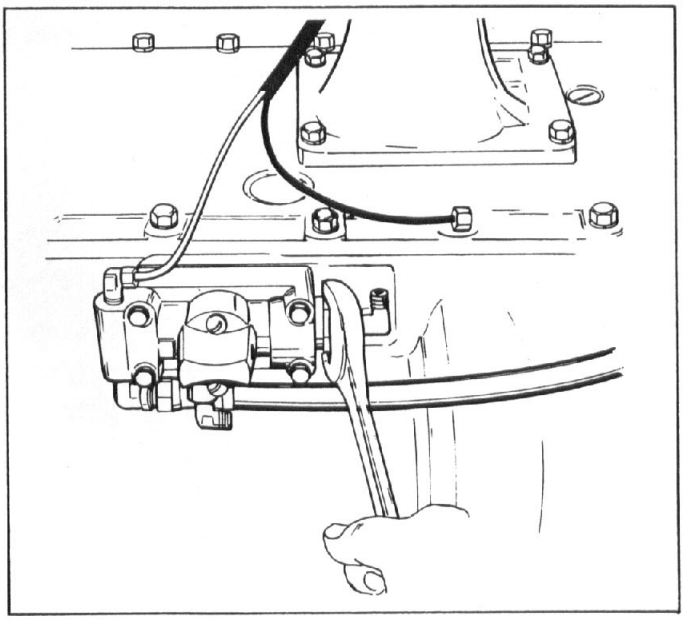
IMPORTANT: In many instances failure to shift between Low and High Range on cold mornings or slow range shifting is the result of water and rust build-up in the end cap of the air valve. If either of these problems exist, use the following short check before proceeding with the complete air system troubleshooting procedure.



1. Disconnect the two 1/4" ID air lines from the side cap on the air valve.



2. Disconnect the 1/8" OD black air line from the end cap on the air valve.



3. Remove the end cap from the air valve.
4. Clean the inside of the end cap with emery cloth and lubricate with a thin application of silicone Lubricant.
5. Install the end cap and connect the air lines. Refer to Illustration for correct attachment of the 1/4" ID air lines.

CAUTION: Do not install the end cap with more than 40 pounds of torque. Excessive torque may result in binding the piston in the valve bore.

If the above check does not solve the shifting problem, proceed with the following troubleshooting procedure.

NOTE: The other end of the air valve has a constant air supply from the vehicle air system. As this is always constant and never exhausts when the air valve is shifted, most of the rust and sludge collects at this point.

Air Lines

NOTE: The following checks are to be made with the engine off but with full normal vehicle air pressure.

1. Refer to Illustration 1. to make sure that the air lines are installed properly and not crossed.
2. Check all air lines for leaks at the attachment points, including splitter gear or hole gear air systems if so equipped.

NOTE: Air lines can be checked for leaks by covering the attachment points with soapy water.

3. Check all air lines for cracks, cuts or areas that are worn by rubbing against another surface.
4. Make sure that none of the air lines are restricted be being pinched against chassis members.
5. Check the 1/8" OD air lines for bends or cracks.
6. Replace any defective air lines, using hydraulic sealant at the attachment points.

Air Systems (continued)

Range Shift Air System (continued)

Air Regulator

1. With normal vehicle air pressure and the gear shift lever in neutral, check the exhaust port on the side of the regulator. There should be no air leaking from the port. If there is a steady leak of air from this port, this indicates a defective regulator which should be replaced.

2. Cut off the vehicle air pressure and install an air guage in the output port of the regulator. Bring the vehicle air pressure back to normal. Regulated air pressure should be 57.5 to 62.5 psi. If correct pressure readings are not obtained, replace the regulator.

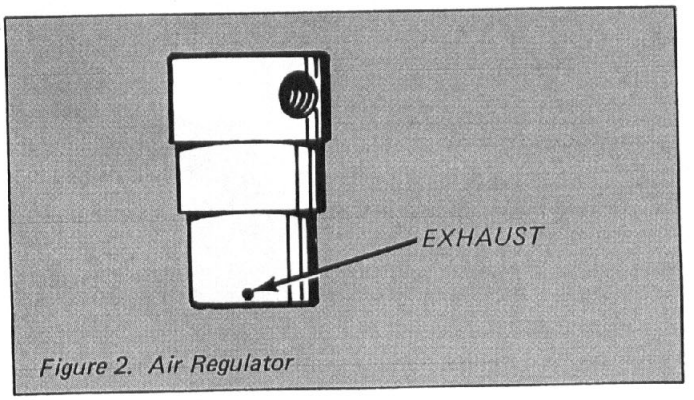


Figure 2. Air Regulator

Two-Position Control Valve

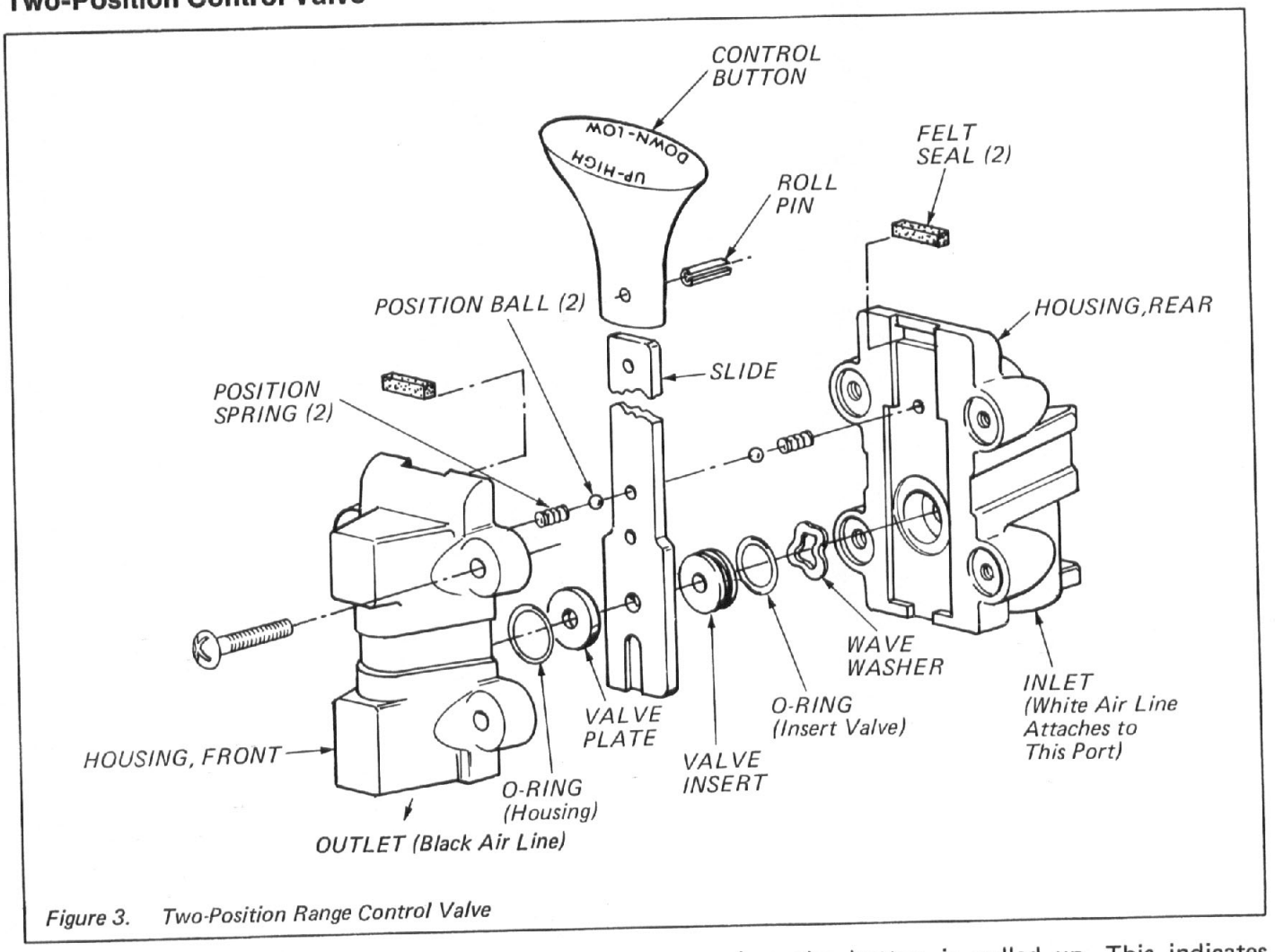


Figure 3. Two-Position Range Control Valve

1. With the gear shift lever in neutral, pull the control button up to high range and disconnect the black 1/8" OD nylon air line at the air valve. When the control button is pushed down into low range, there should be a steady blast of air from the disconnected line. The air should stop when the button is pulled up. This indicates that the control valve is operating correctly.

2. If the control valve does not operate correctly, refer to the remainder of the two-position control valve section for further breakdown.

Defective Parts

If the O-rings or parts in the control valve are defective there will be a constant air leak out the exhaust located on bottom of control valve.

A defective insert valve O-ring will result in a constant leak through exhaust in both ranges and valve will not make range shifts.

A defective housing O-ring will result in a constant, low volume leak through exhaust in low range only.

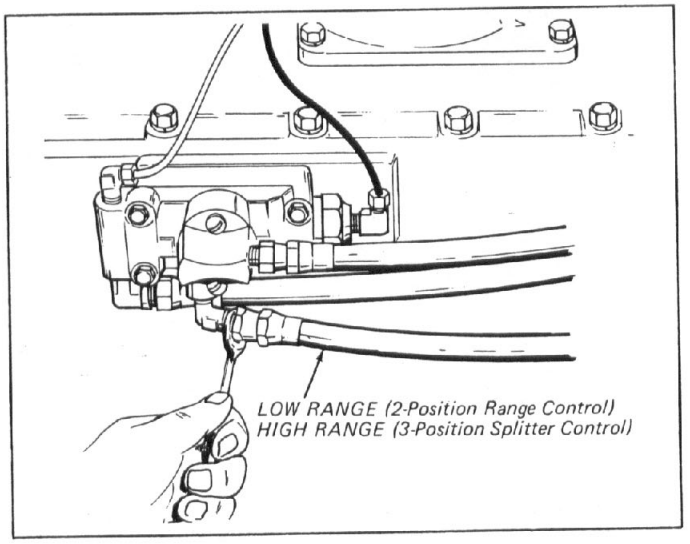
If the slide is assembled backwards, there will be a constant leak through exhaust in high range. When installing slide in control valve make sure that slot in slide faces the outlet port.

To Disassemble the Control Valve

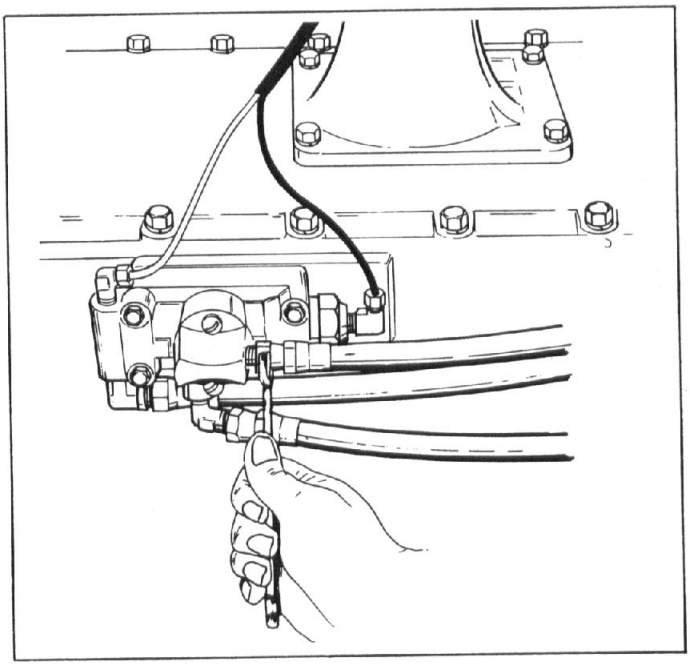
1. Remove the four screws to separate front and rear housings.
2. Remove the slide and the two position balls and springs.
3. Remove the flat metal seal from outlet side and remove the O-ring from body.
4. Remove the valve insert from front housing and remove the O-ring from valve insert.
5. Remove the wave washer installed under valve insert.
6. Remove the two felt wipers from valve housings.
7. Punch out roll pin and remove control button from slide.

Slave Air Valve

NOTE: The following instructions are shown with the two-position range control hook-up. On transmissions equipped with three-position splitter control, the 1/4" ID air lines between the air valve and range shift cylinder will be reversed. Disconnect the OPPOSITE air line in each of the following steps, if the transmission is equipped with a three-position splitter control.



1. Place the range control button in the "HIGH" range position and disconnect the Low Range air line at the air valve side cap. Place the control button in the "LOW" position. There should be a steady flow of air from the Low Range port on the air valve side cap. When the control button is returned to the "HIGH" position, the air should stop. Reattach the air line, using a small amount of hydraulic line sealant on the threads.



2. Place the range control button in the "LOW" position and disconnect the High Range air line at the air valve side cap. Place the control button in the "HIGH" position. There should now be a steady flow of air from the High Range port on the air valve side cap. When the control button is returned to the "LOW" position, the air should stop. Reattach the air line, using hydraulic line sealant.
3. Check the breather on the air valve with the control button in both ranges. Any steady flow of air from the breather indicates defective O-rings. Refer to the remainder of this section for disassembly procedures.

Air Systems (continued)

Range Shift Air System (continued)

Slave Air Valve (continued)

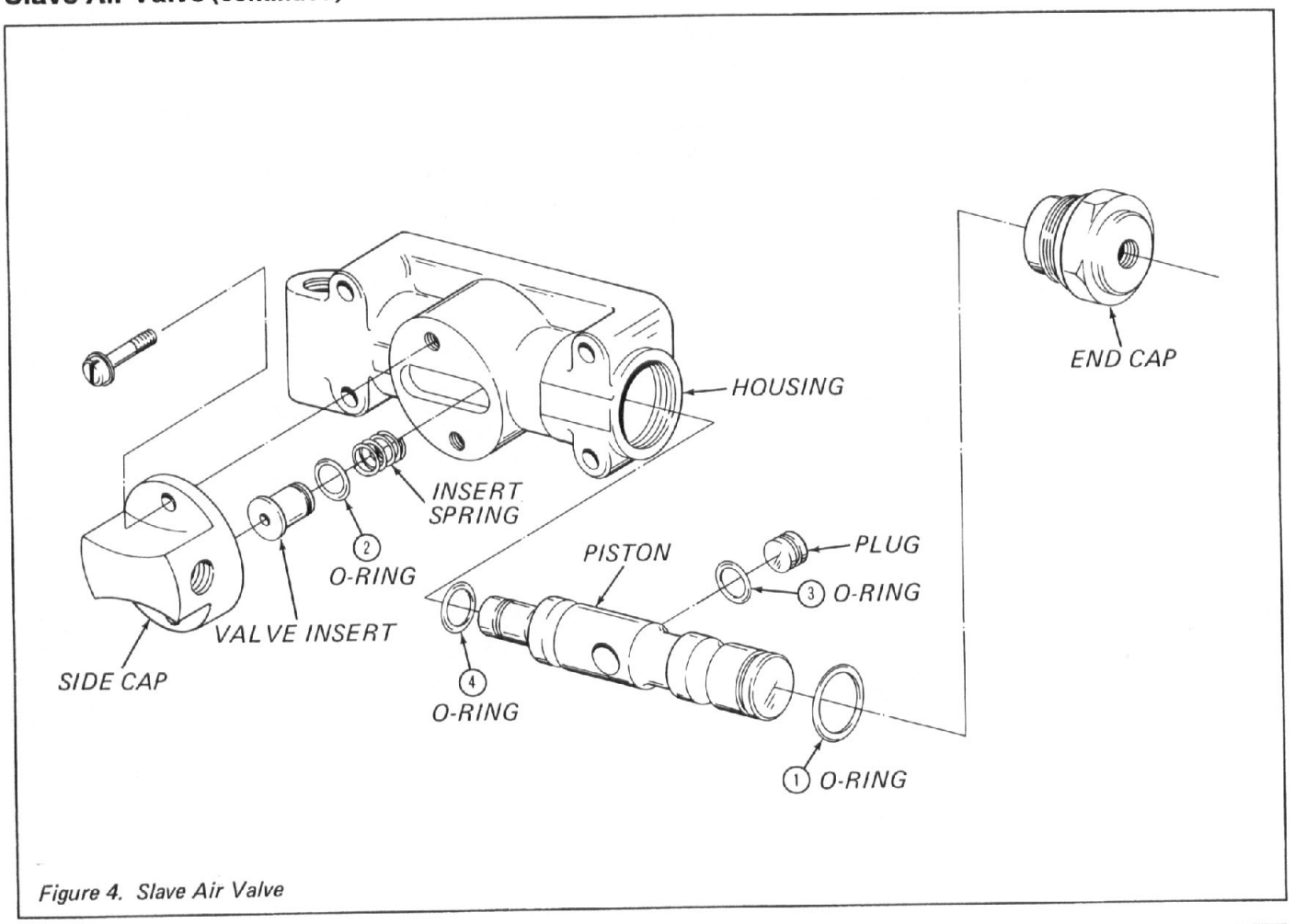


Figure 4. Slave Air Valve

The four O-rings are indicated by circled numbers on Figure 4. If any of these are defective, there will be a constant air leak out of the exhaust on the air valve. In normal operation, exhaust will occur only for an instant as the range shift is made. The chart at right is to be used as a guide to determine defective O-rings.

Defective O-Rings	RESULT
1	Constant leak through exhaust in low range only.
2 or 3	Constant leak through exhaust in both ranges.
4	Constant leak through exhaust in high range; steady but low volume leak through exhaust in low range.

To Disassemble the Slave Air Valve

1. Disconnect all air lines, turn out the four cap-screws and remove the air valve from the transmission.
2. Turn out the two screws and remove the side cap.
3. Remove the valve insert from the piston and remove the O-ring from the valve insert.
4. Remove the spring from the piston.
5. Turn the end cap from the valve body and remove the piston from the bore.
6. Remove the two O-rings from the piston.
7. Remove the nylon plug from the piston and remove the O-ring from the plug.
8. Clean the piston and air valve bore as necessary with emery cloth or a wire brush. Lubricate all O-rings and the piston with silicone lubricant and reassemble the air valve.
9. When reinstalling the end cap, do not use more than 40 pounds of torque. Excessive torquing may result in binding the piston in the valve bore.

Range Shift Cylinder

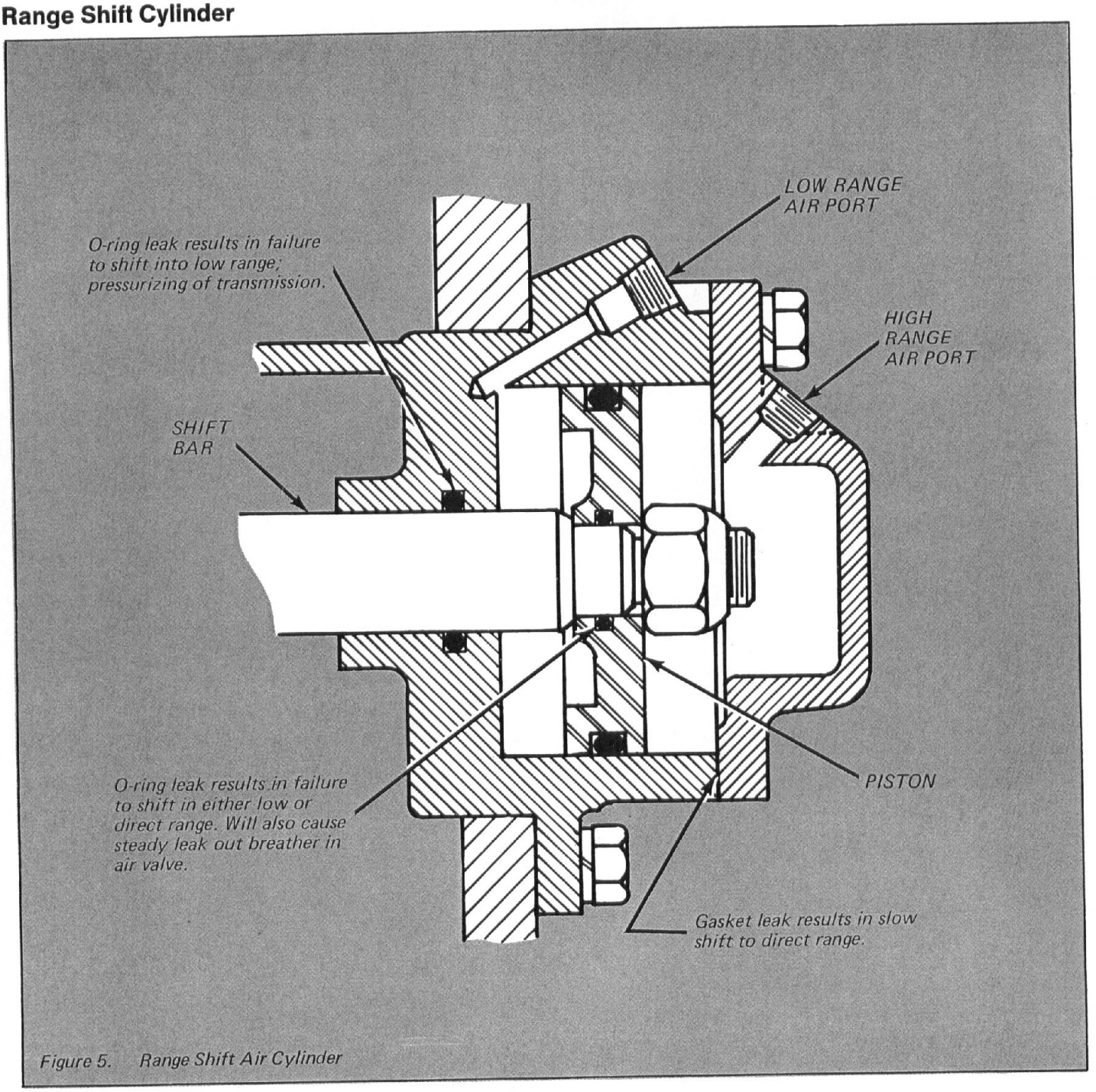


Figure 5. Range Shift Air Cylinder

If shifting problems are still encountered, the O-rings on the range shift cylinder piston may be defective.

If any of the seals in the range shift cylinder are defective the range shift will be affected. The degree of lost air, of course, will govern the degree of failure, from slow shift to complete failure to shift.

1. Turn out the four capscrews and remove the range shift cylinder cover.
2. Remove the stop nut from the shift bar.
3. Apply air to the Low Range air line to pop the piston from the cylinder housing. **Use caution.**
4. Remove the O-rings from the OD and ID of the piston.
5. Install new O-rings, lubricate with silicone lubricant and reassemble the cylinder assembly. Install a new gasket but do not use permatex or gasket sealant.

Air Systems (continued)

Deep Reduction Air System

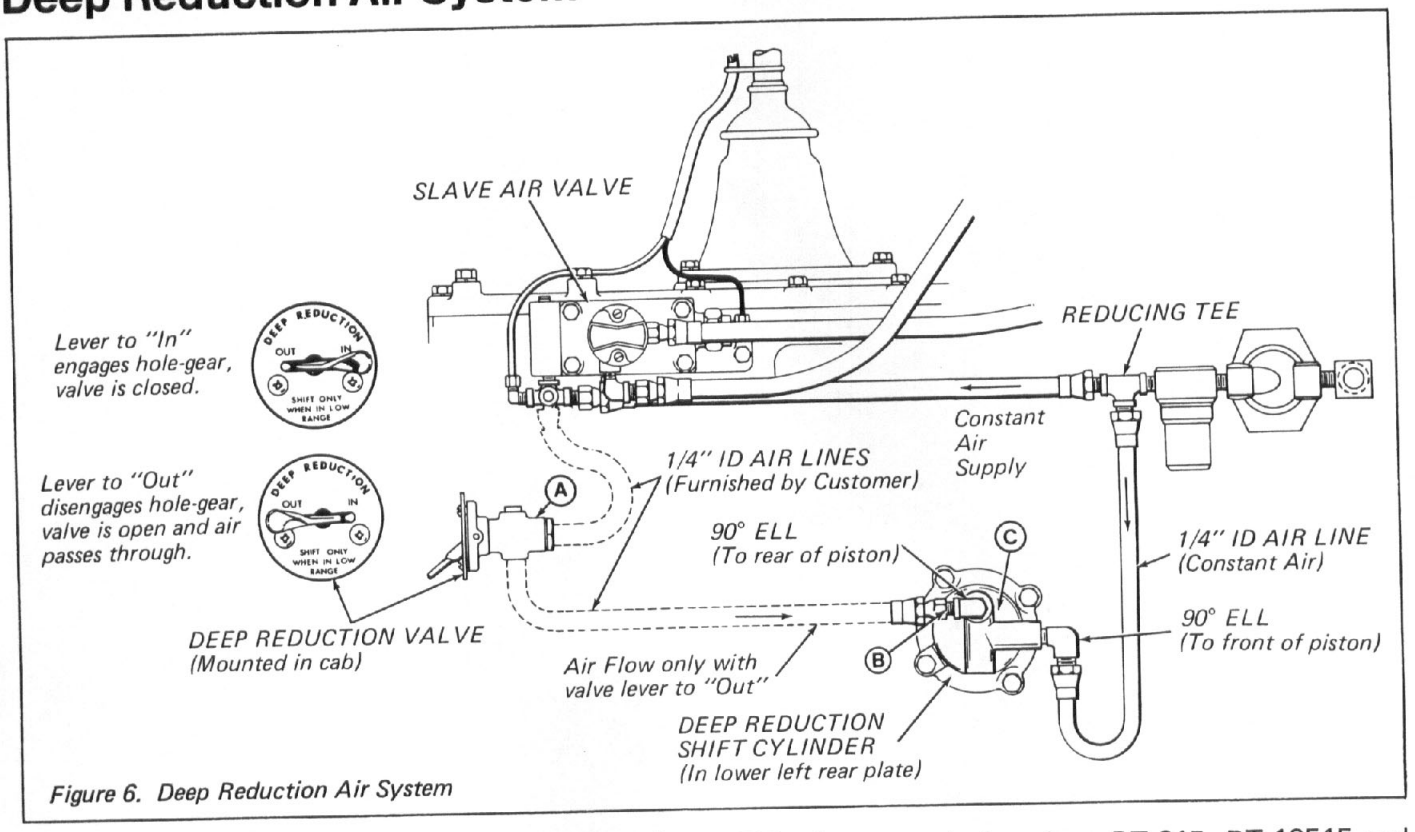


Figure 6. Deep Reduction Air System

The system consists of a set of deep reduction gearing and shift cylinder in the auxiliary section and a deep reduction control valve mounted in the vehicle's cab.

This air system is found on RT-915, RT-12515 and T-955ALL series transmissions and on the RTO-958LL transmissions.

1. Air Input — Check Point A

With gear shift lever in neutral and normal vehicle air pressure, loosen the connection at input (end port) of the deep reduction valve until it can be determined that there is a constant flow of air at this point. Reconnect line.

If there is no air at this point, there is a restriction in the line between the deep reduction valve and air valve. Also check to make sure this line is connected to constant supply.

2. Deep Reduction Valve — Check Point B

With the deep reduction valve lever to "IN", remove the line from the deep reduction valve at the port in hole-gear shift cylinder; there should be no air at this point.

Move the deep reduction valve lever to "OUT". There should now be a constant air flow from line. Move lever to "IN" to shut off air. If the above conditions do not exist, deep reduction valve is faulty or there is a restriction in air line.

3. Deep Reduction Shift Cylinder — Check Point C

If any of the seals in the shift cylinder are defective the shift will be affected. The degree of lost air will govern the degree of failure, from slow shift to complete failure to shift.

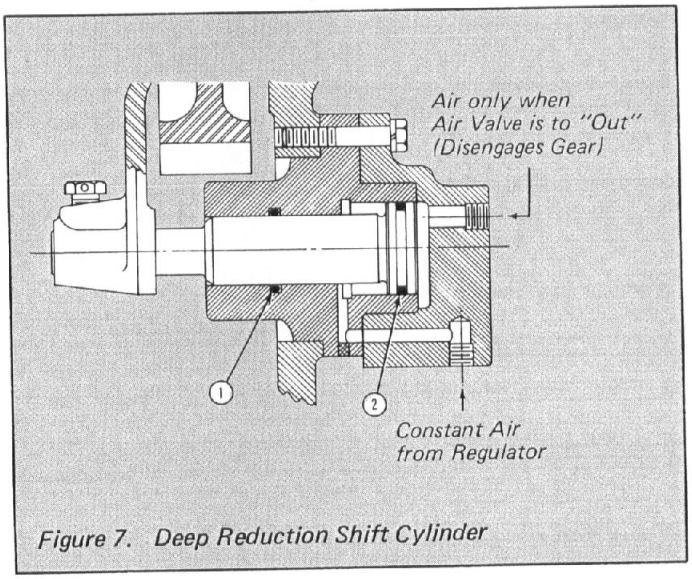


Figure 7. Deep Reduction Shift Cylinder

Refer to Figure 7 for location of O-rings:

Leak at O-ring 1

Failure to engage gear; pressurizing of transmission; gear can be disengaged.

Leak at O-ring 2

Failure to engage gear; leak from deep reduction valve exhaust port when valve is "IN".

Splitter Gear Air System

THREE-POSITION SPLITTER CONTROL (COMBINATION SPLITTER AND RANGE CONTROL)

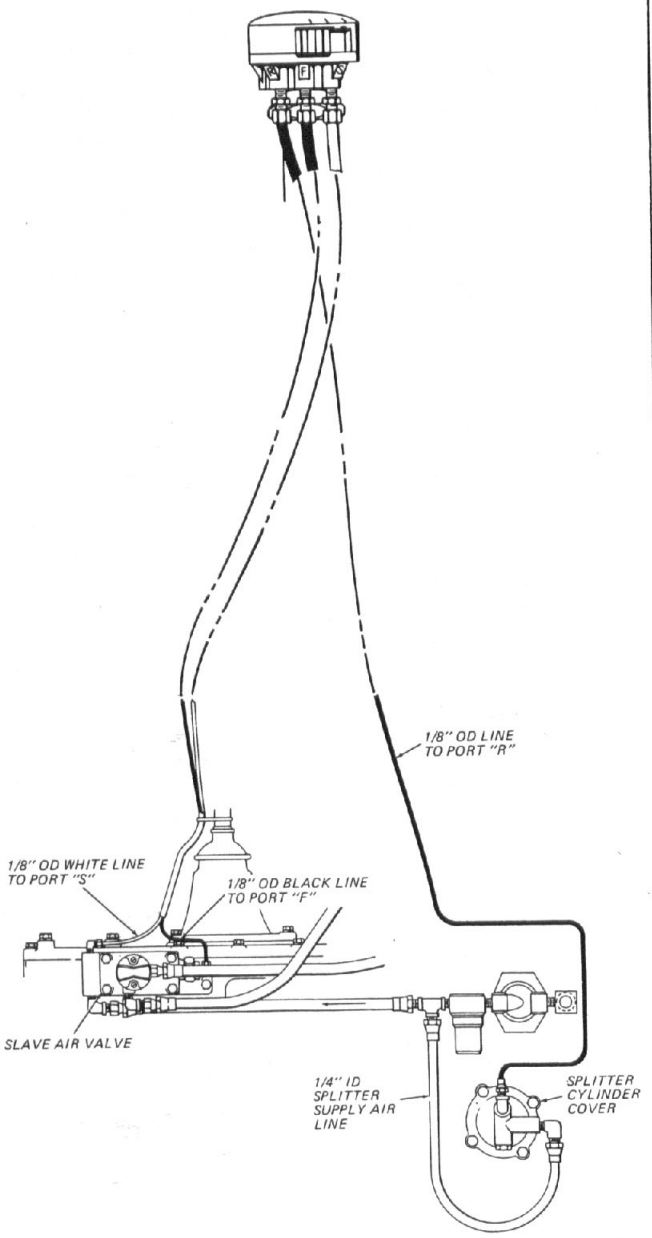


Figure 8. Splitter Gear Air System with Three-Position Splitter Control.

TWO-POSITION SPLITTER CONTROL WITH TWO-POSITION RANGE CONTROL

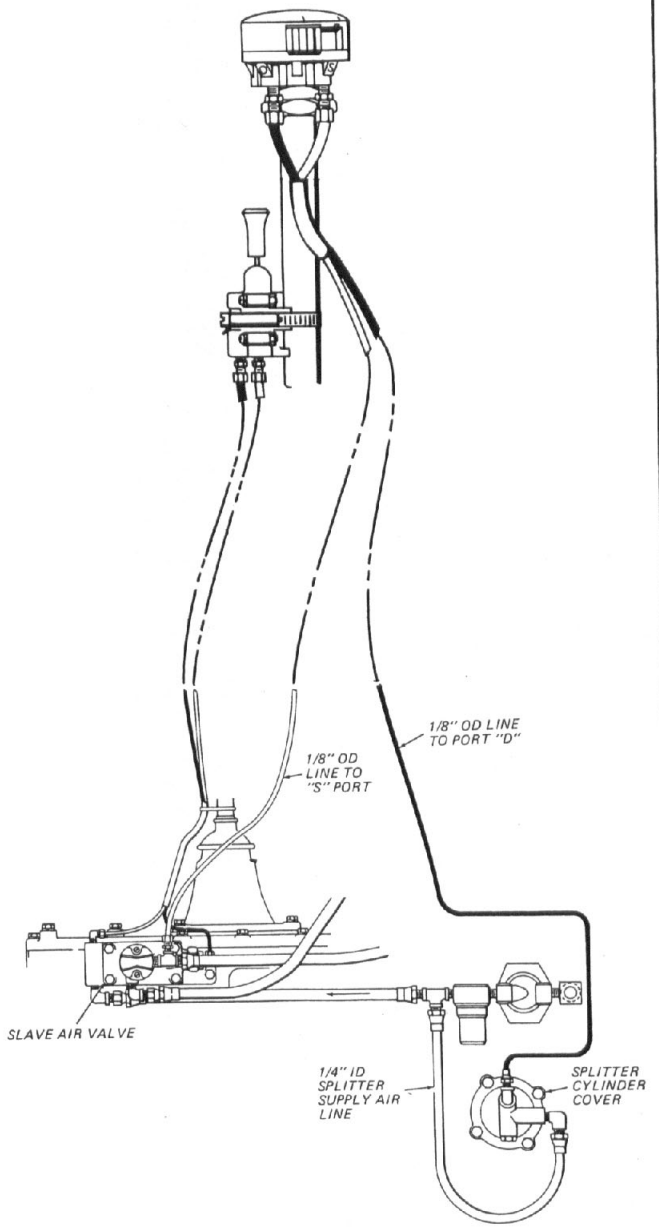


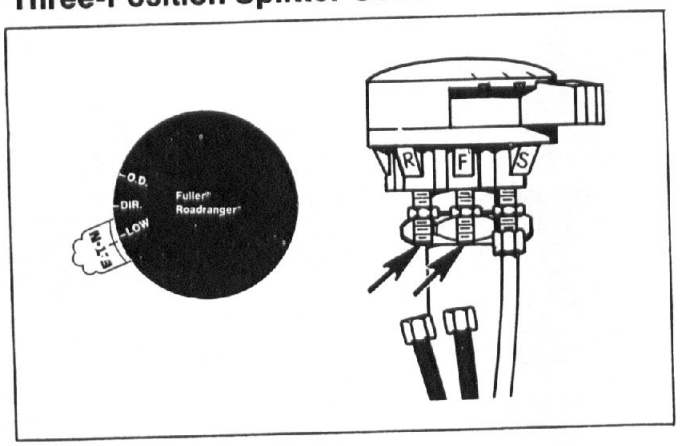
Figure 9. Splitter Gear Air System with Two-Position Splitter Control and Range Control.

This air system is found on RT-9513 and RT-12513 Series Roadranger transmissions. The splitter gear system is used only while in HIGH RANGE and splits the high range gearing either into OVERDRIVE or UNDERDRIVE ratios depending upon the transmission model. This system consists of either a two or three-position splitter control and a splitter shift cylinder and gearing located in the auxiliary section of the transmission.

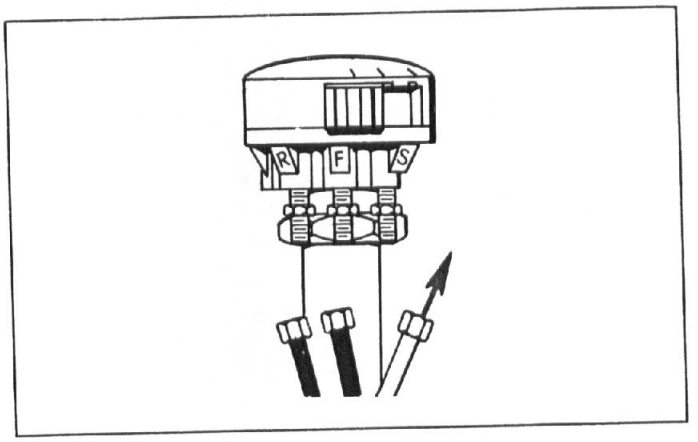
Air Systems (continued)

Splitter Gear Air System (continued)

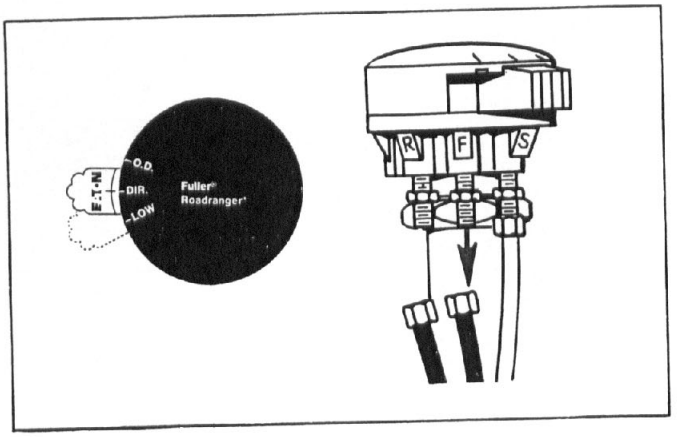
Three-Position Splitter Control Valve



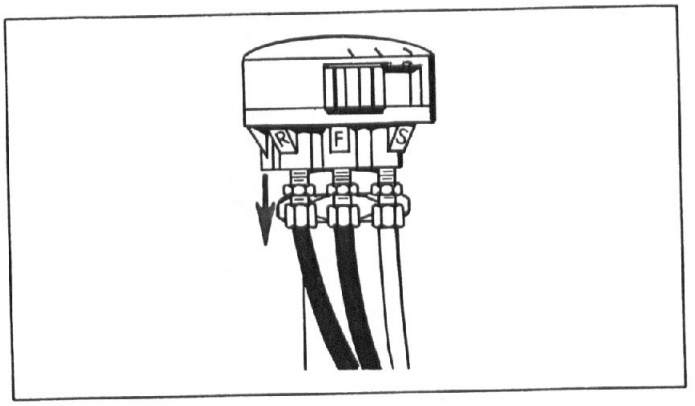
1. With the control button in the "LOW" position, disconnect the two black air lines connected to the ports on the valve marked, "F" and "R". There should be no air coming from these ports.



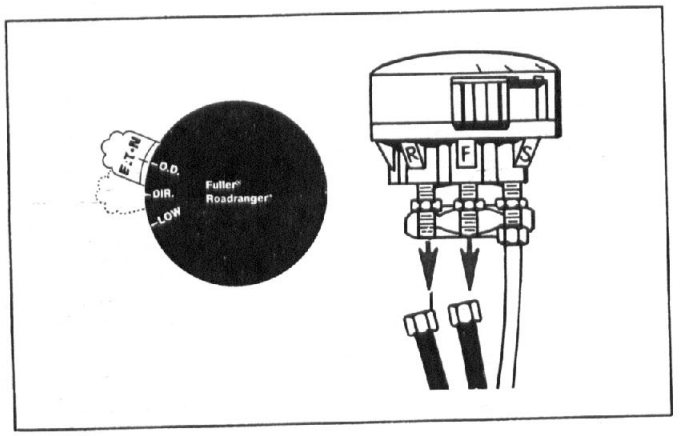
4. If these results are not obtained, disconnect the supply air line at the "S" port and make sure that a steady flow of air is coming through the line. If air is present, this indicates a faulty control valve. The cause can be defective parts, damaged O-ring or a loose top plate.



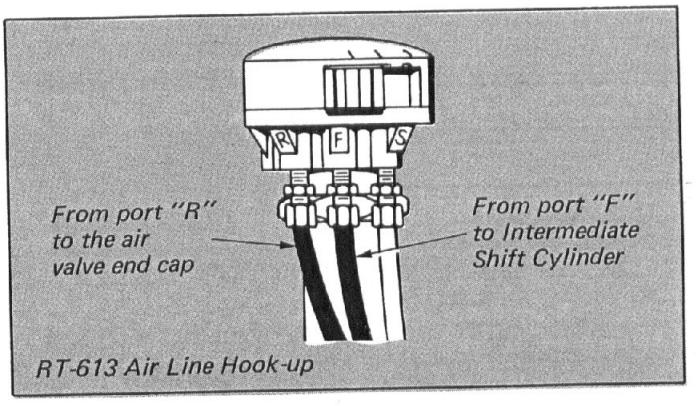
2. Move the control button to the "DIR." position. There should now be a steady flow of air coming from the "F" port, but still no air coming from the "R" port.



5. Any steady flow of air from the exhaust "E" port indicates a faulty control valve or incorrect air line hook-up. Refer to the remainder of this section for further break down.



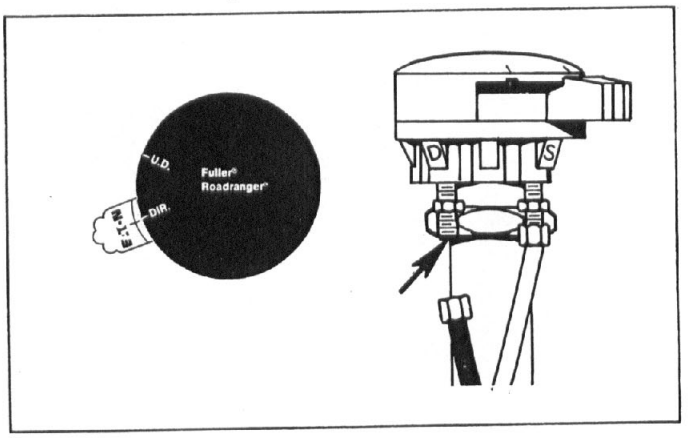
3. Move the control button to the "OD" or "UD" position. There should now be a steady flow of air coming from both the "F" and "R" ports.



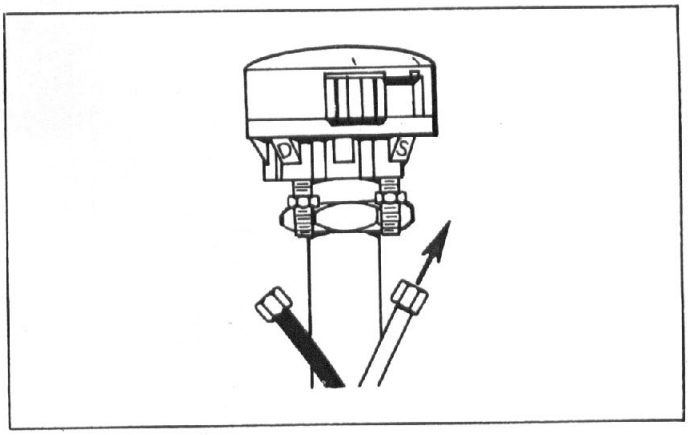
RT-613 Air Line Hook-up

NOTE: Control valve check for the RT-613 is the same as for the RT-9513 and RT-12513. However, "DIR." will read as "INTER." and "OD" or "UD" will read as "DIR." on the valve top plate.

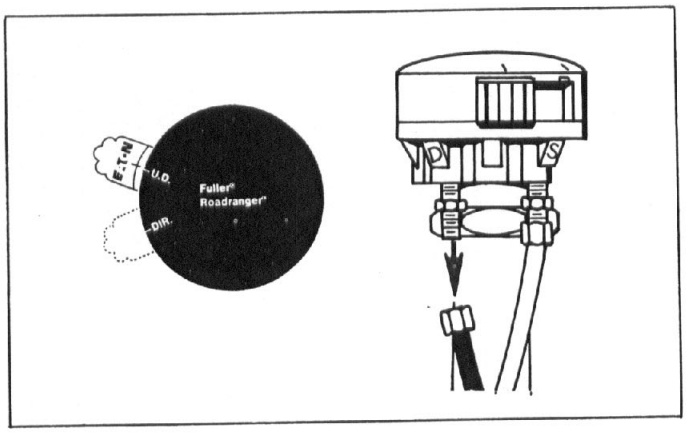
Two-Position Splitter Control Valve



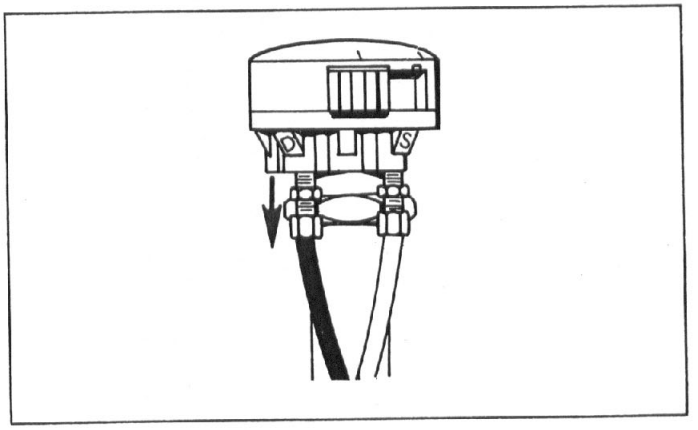
1. With the control button in "DIR." position, disconnect the black air line at the port marked "D". There should be no air coming from this port.



3. If these results are not obtained, disconnect the white supply air line at port "S". There should be a steady flow of air coming from this line. If air is present, this indicates a faulty control knob.



2. Move the control button to the "OD" or "UD" position. There should now be a steady flow of air coming from port "D".



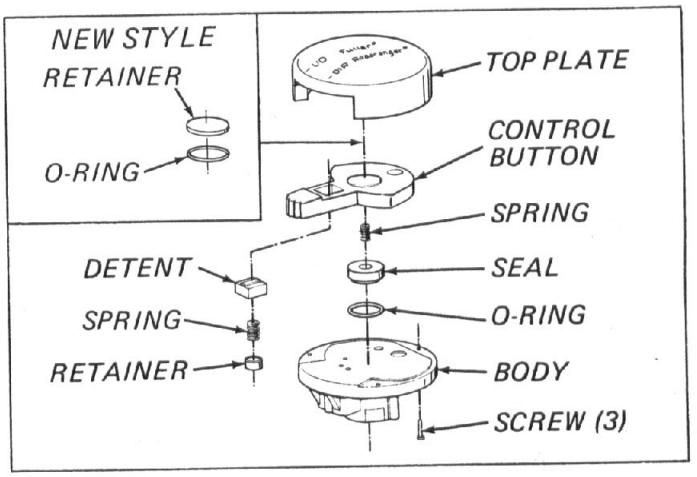
4. Any steady flow of air from the exhaust "E" port, indicates a faulty control valve.

Control Valve Disassembly and Maintenance

The control valve is easily disassembled by turning out the three screws on the underside of the body.

When reassembling, lubricate the O-ring with a light coat of silicone lubricant.

Do not overtighten the three screws to avoid stripping the threads or distorting the top plate.



Air Systems (continued)

Splitter Gear Air System (continued)

Splitter Gear Shift Cylinder

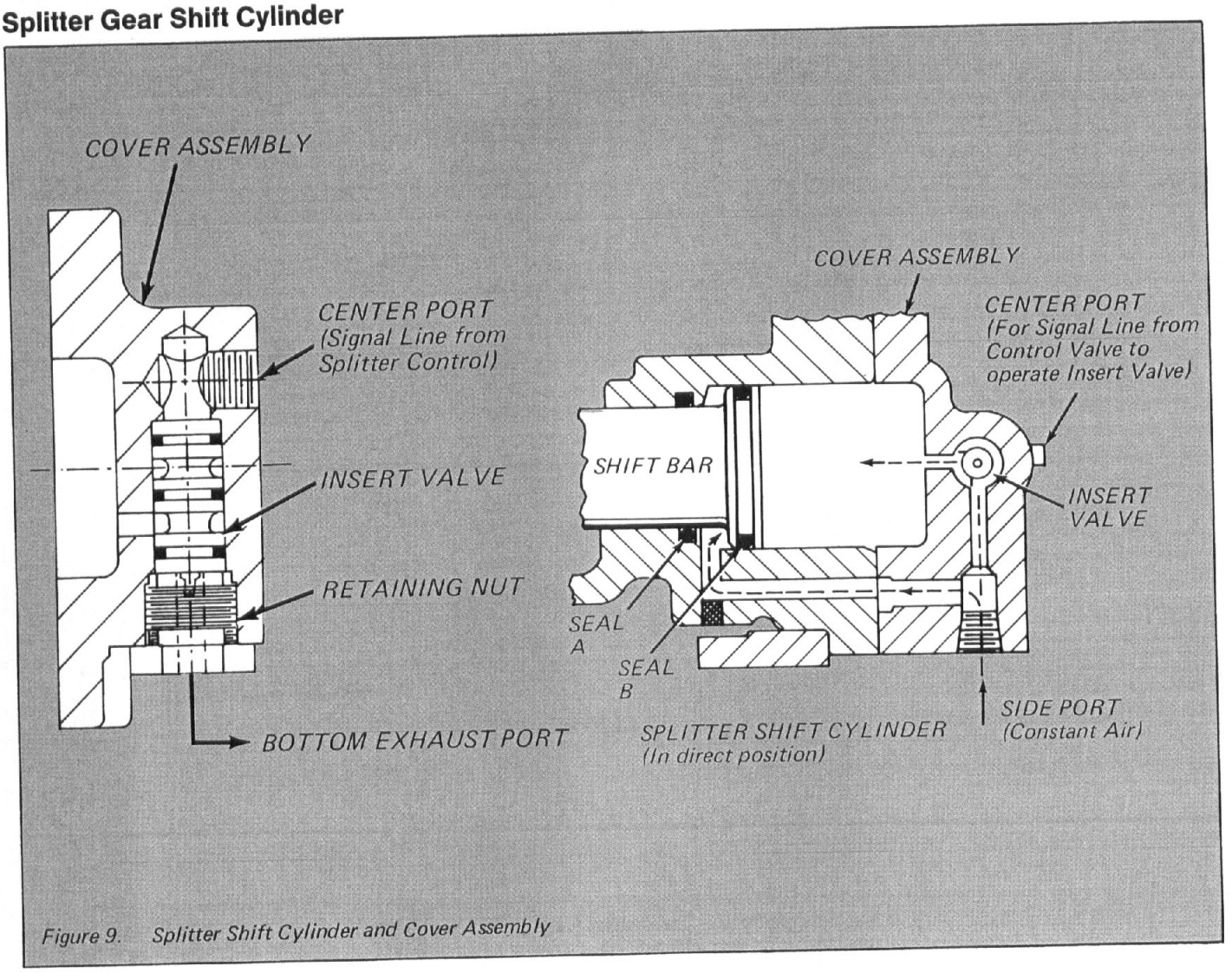


Figure 9. Splitter Shift Cylinder and Cover Assembly

Operation – Constant, regulated air is channeled through the cover to the front side of shift piston – air is always on this side of piston.

The shift piston is moved by removing or applying air (from constant supply) to the backside of piston. This piston area is larger and can overcome area of front side of piston. The removal or application of air on backside of piston is controlled by the insert valve in cylinder cover; this valve in turn is controlled by the splitter control valve.

Trouble Shooting Cylinder

There are two O-rings in the shift cylinder.

1. **Leak at seal A** – Possible failure to shift or slow shift to overdrive, or underdrive, plus pressurizing of transmission.
2. **Leak at seal B** – Slow shift in either direction, plus leak out cover exhuast when in overdrive or underdrive.

Trouble Shooting Cover Assembly

1. **Exhaust port** – Any constant flow of air out the cover exhaust port usually indicates a faulty insert valve. Exhaust should occur breifly ONLY when the splitter control is moved from "DIRECT" to "OVERDRIVE" or "UNDERDRIVE".
2. **Insert valve** – A faulty insert valve, leaking at the outer diameter O-rings or inner seals will result in failure to shift. Two indications of O-ring or seal failures are:
   a. Constant leak out cover exhaust.
   b. Constant leak out splitter control exhaust with splitter control in "DIRECT".

   The three O-rings on outer diameter of the insert valve can be replaced. If an inner seal is damaged, the entire insert valve will have to be replaced.

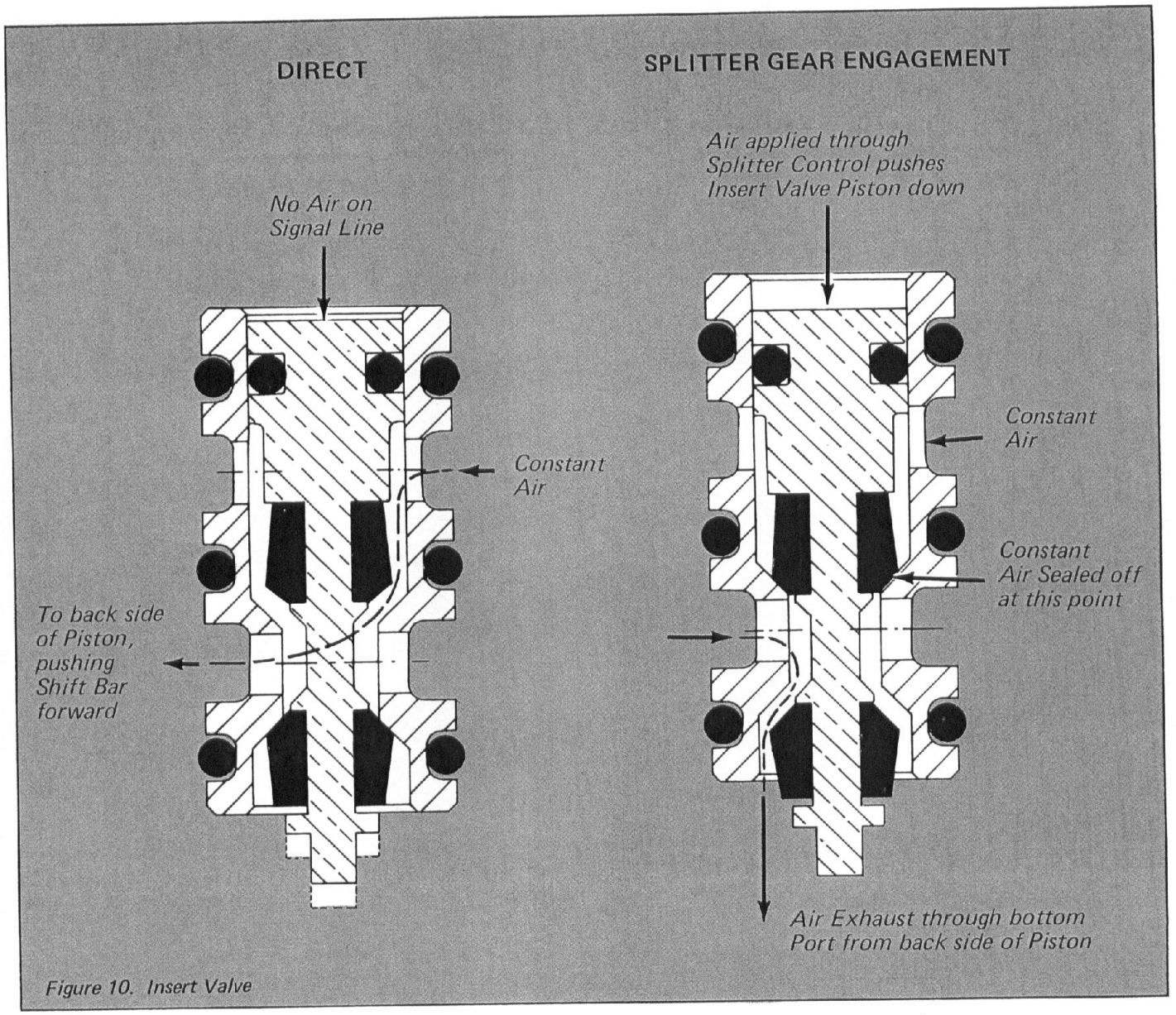


Figure 10. Insert Valve

Insert Valve

The insert valve located in the shift cylinder cover is a small 1-3/16" valve. It is installed with the flat surface to the inside towards the center port, and it is secured with a special nut in bottom bore of cover.

When installing insert valve apply Fuller transmission silicone lubricant to cylinder walls. When installing special nut apply hydraulic sealant to threads.

The insert valve is self-contained and can not be disassembled except for the three O-rings on outer diameter. These three O-rings are a stationary seal and do not move in cylinder.

Travel of the small piston in insert valve is approximately 1/32". The insert valve is a normally-open valve. Thus, when there is no signal or delivery of air to top side of insert piston, the constant air from regulator passes through the insert valve and to the backside of the piston and moves the shift bar forward (direct).

When the insert valve piston is activated by a signal or delivery of air, the insert valve is closed and shuts off the constant air to backside of shift piston. Air in shift cylinder is exhausted out through insert valve and bottom bore of cover.

When air is removed from backside of shift piston, constant air on front side of shift piston moves the shift bar to the rear.

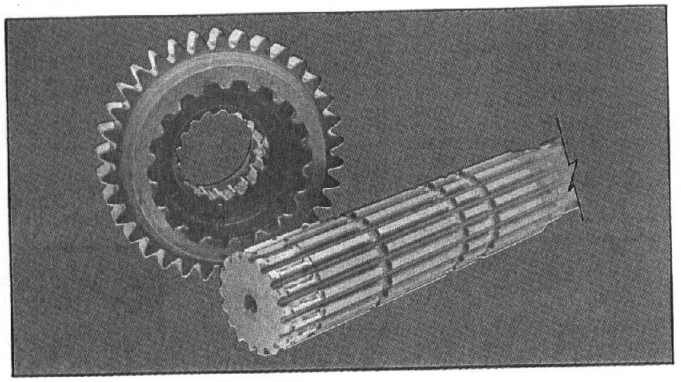
Common Transmission Complaints

Vibration

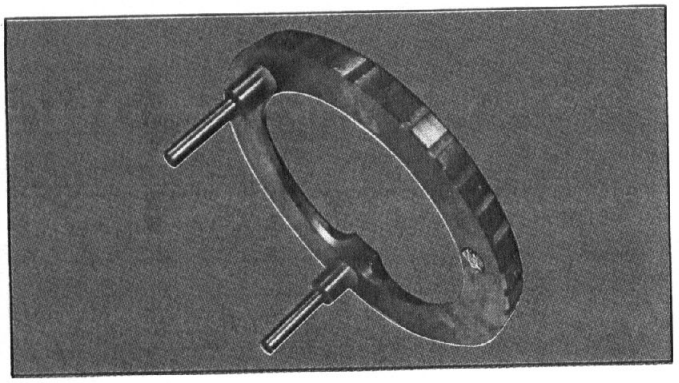
Although the effects of vibration will show up in the transmission, vibration usually originates somewhere else in the drive train. Vibration can usually be felt or heard by the driver; however, in some cases, transmission damage caused by vibration will occur without the driver's knowledge. (Refer to the "Torsional Vibration" section for the causes and cures of vibration problems.)

Some of the problems found in the transmission due to drive train vibration are:

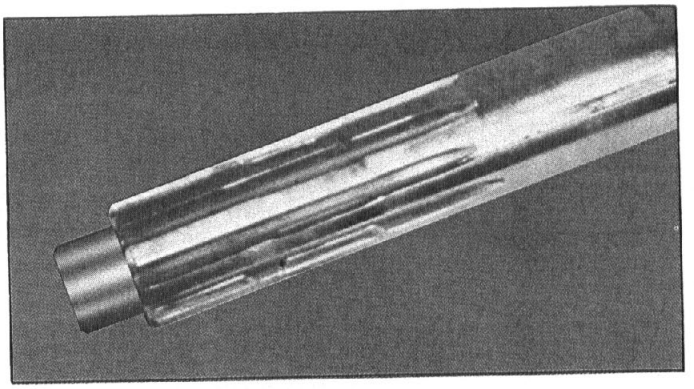
1. Gear rattle at idle. (See "Gears and Shafts" section.)



2. Gear and Shaft splines "fretted".



3. Broken or loose synchronizer pins.
4. Noise. (See "Noise", this section.)
5. Fretted bearings. (See "Bearing" section.)
6. Repeated rear seal leakage.
7. Continuous loosening of capscrews, brackets and mountings.



8. Input shaft spline wear.
9. Worn universal joints. (Not a transmission symptom, but an indicator of vibration.)

Some of the causes of vibration are:

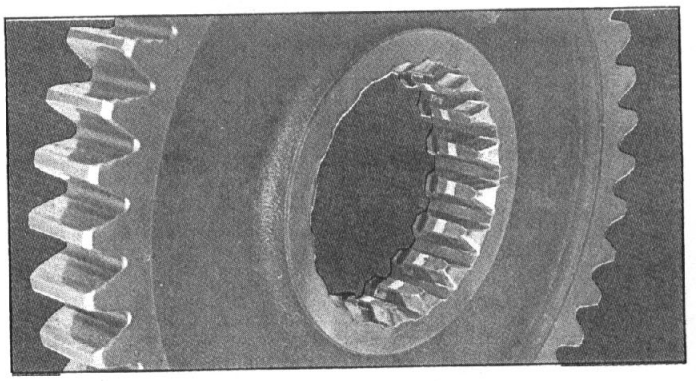
1. Drive line unbalance or misalignment. (See "Alignment" section.)
2. Unbalanced wheels or brake drums.
3. Rough running engine.
4. Broken or worn engine mounts.
5. Worn suspension.

Gear Slipout and Jumpout

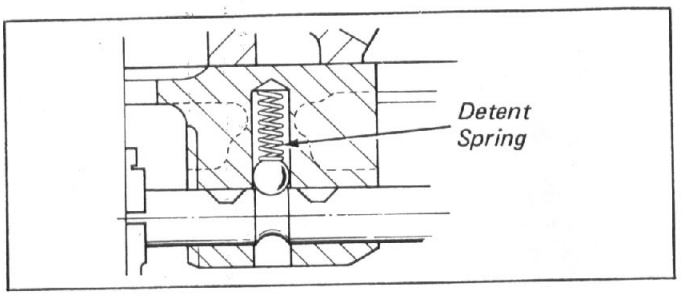
Front Section

When a clutching gear is moved to engage with a mainshaft gear, the mating teeth must be parallel. Tapered or worn clutching teeth will try to "walk" apart as the gears rotate. Under the right conditions, slipout will result. Some of these conditions are:

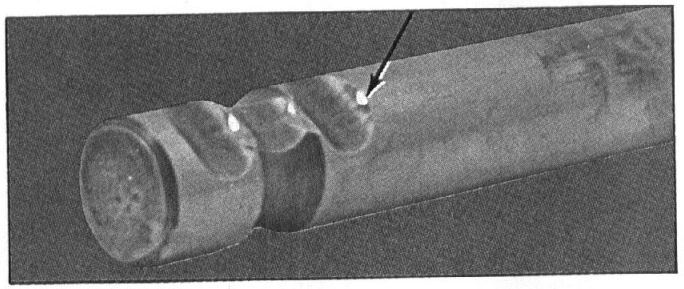
1. Transmission mounted eccentrically with engine flywheel pilot.
2. Excessive gear clashing which shortens clutching teeth.



3. Gear clutching teeth wearing to a taper.



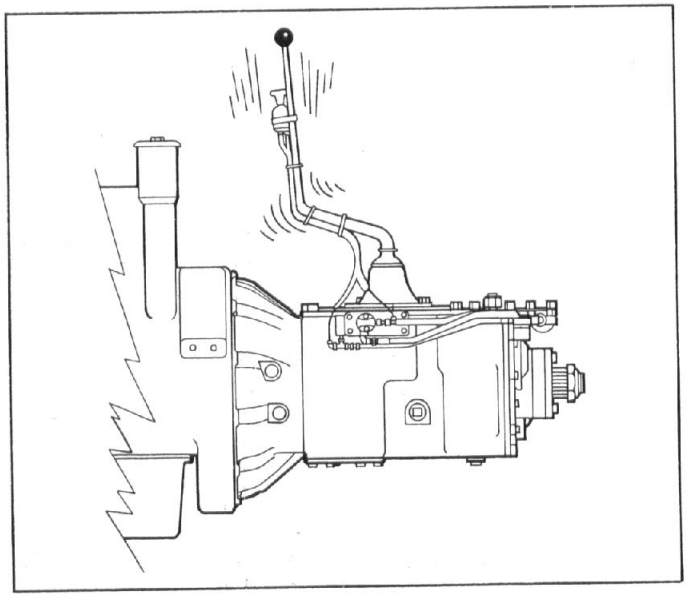
4. Insufficient pressure on detent ball from weak or broken detent spring.



5. Excessive wear on detent notch of yoke bar.
6. Incorrect adjustment of remote shift control linkage resulting in partial engagement. Also check for loose connections and worn bushings.

Slipout will generally occur when pulling with full power or when decelerating with the load pushing.

Jumpout will occur when a force sufficient to overcome the detent spring pressure is applied to the yoke bar, moving the clutch gear to a neutral position. Conditions which may produce jumpout are:



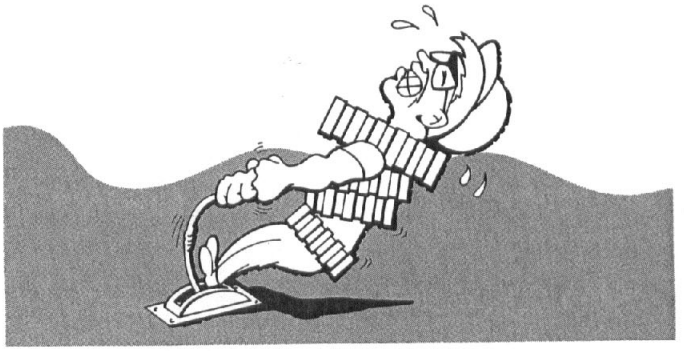
1. Extra heavy and long shift levers which swing, pendulum fashion, from operating over uneven terrain. Whipping action of the lever overcomes detent spring tension.
2. Mechanical remote controls with the master mounted to the frame. Relative movement between engine-transmission package and frame can force transmission out of gear. Worn or broken engine mounts increase the effects of this condition.

Auxiliary Section

Slipout in the auxiliary section may be caused by the clutching teeth being worn, tapered , or not fully engaged. These conditions cause the clutch gear to "walk" out of engagement as the gears turn. Causes of these types of clutching defects are: clashing or normal wear after long life. Vibrations set up by an improperly aligned drive line and low air pressure add to the slipout problem.

Jumpout in the auxiliary section usually occurs with the splitter gear set. If torque is not sufficiently broken during splitter shifts, the sliding clutch gear may not have enough time to complete the shift before torque is reapplied to the gears. As torque is reapplied, the partially engaged clutch gear "jumps" out of the splitter gear. Since the gears have torque applied to them, damage will be done to the clutching teeth of the mating gears.

Hard Shifting



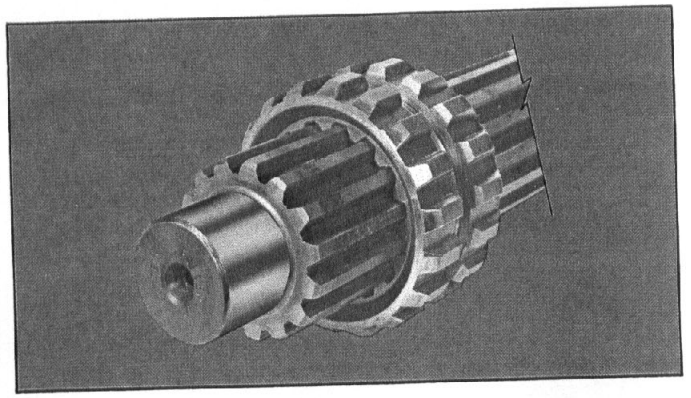
The effort required to move a gear shift lever from one gear position to another varies. If too great an effort is required, it will be a constant cause of complaint from the driver.

Most complaints are with remote type linkages used in cab-over-engine vehicles. Before checking the transmission for hard shifting, the remote linkage should be inspected. Linkage problems stem from worn connections or bushings, binding, improper adjustment, lack of lubrication on the joints or an obstruction which restricts free movement. (See page 34.)

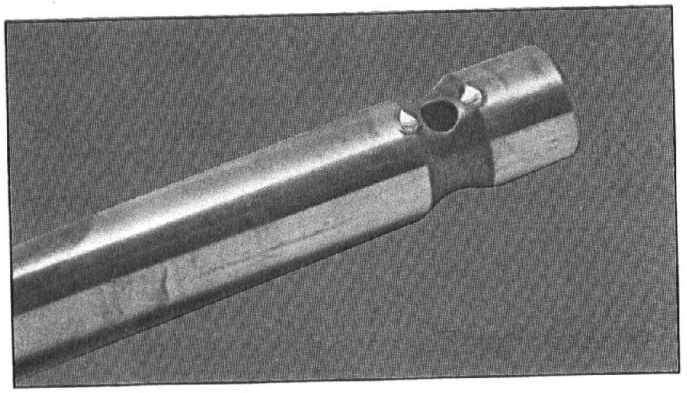
Common Transmission Complaints (continued)

Hard Shifting (continued)

To determine if the transmission itself is the cause of hard shifting, remove the shift lever or linkage from the top of the transmission. Then, move the shift blocks into each gear position using a prybar or screwdriver. If the yoke bars slide easily, the trouble is with the linkage assembly. If the trouble is in the transmission, it will generally be caused by one of the following:



1. **Splines of sliding clutch gear binding on mainshaft** as a result of a twisted mainshaft, bent shift yoke or bowed mainshaft key.
2. **Yoke bars binding in the bar housing** as a result of cracked housing, overtorqued shift block lockscrew, sprung yoke bar, or swelled areas on the yoke bar.



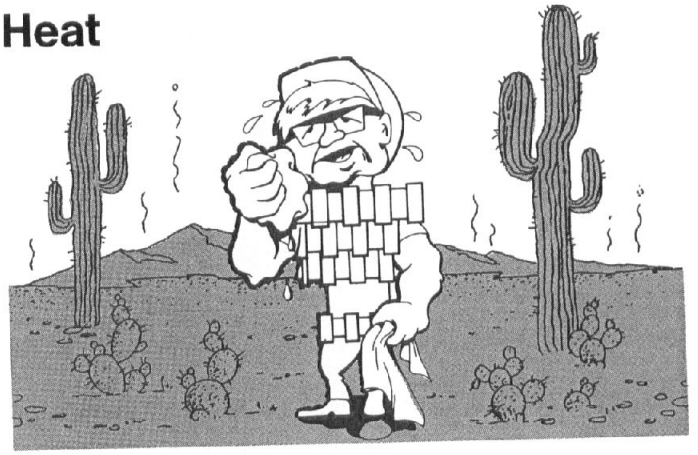
Swelling may occur at the edges of the interlock ball notches of the yoke bar if the shift lever is positioned so as to try to shift two bars at once. If this is repeated, the swelling becomes larger until it restricts the free movement of the bar.

Swelled areas may be ground off and smoothed with emery paper. Sprung rails should be replaced.

If hard shifting occurs only in first and reverse, the shift block detent plunger movement may be restricted. This can result from burrs on the plunger, or from overtightening the plunger spring plug. With the plunger blocked in the depressed position, the plug should be tightened until it bottoms out against the spring, then backed out 1/4 to 1/2 turns.

Gear clashing should not be confused with hard shifting. Gear clashing occurs when an attempt is made to engage the clutch gear before it has reached synchronization with the mainshaft gear. (See "Gears and Shafts" section.)

Heat



The transmission operating temperature should never exceed 250°F. (120°C.) for an extended period of time. If it does, the oil will breakdown and shorten transmission life.

Because of the friction of moving parts, transmissions will produce a certain amount of heat. Normal operating temperature is approximately 100°F. (40°C.) above ambient. Heat is dissipated through the transmission case. When conditions prevent the proper dissipation of heat, then overheating occurs.

Before checking for possible causes of overheating, the oil temperature gauge and sending unit should be inspected to make sure they are giving correct readings.

Following are some of the causes of overheating. (See also "Lubrication" section.)

1. Improper lubrication. Oil level too low or too high, wrong type of oil, or an operating angle of more than 12 degrees.
2. Operating consistently under 20 MPH.
3. High engine RPM.
4. Restricted air flow around transmission, due to transmission being "boxed in" by frame rails, deck lids, fuel tanks and mounting brackets, or by a large bumper assembly.
5. Exhaust system too close to transmission.
6. High ambient temperature.
7. High horsepower, overdrive operation.

In some cases an external oil cooler kit can be used to correct overheating problems.

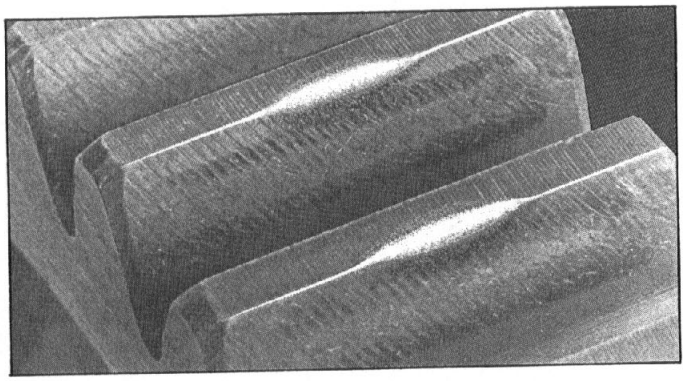
Noise

There will always be a certain level of noise due to normal transmission operation. However, excessive noise, or unusual noise such as a whine, growl or squeal indicates some kind of problem.

The transmission itself can be the cause of excessive or unusual noise. Also, noise can originate elsewhere in the vehicle, but be picked-up and amplified by the transmission.

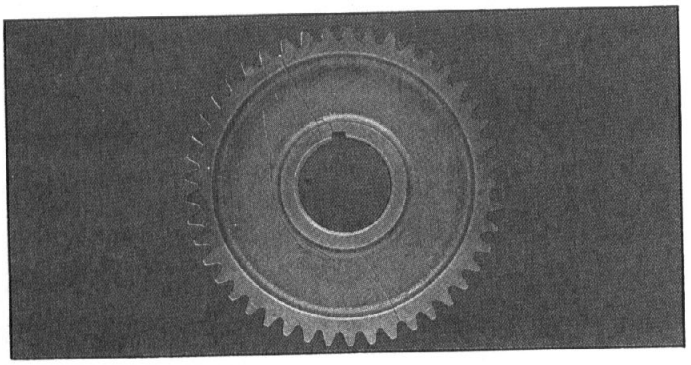
Noise Originating in Transmission

1. Knocking or Thudding.



a. Gears — Bumps or swells on gear teeth. Such bumps or swells can be removed with a hone or small hand grinder; these areas can be identified as highly polished spots on the face of the gear tooth. Generally, this noise is more prominent when the gear is loaded; thus, the problem gear can be located as the noise occurs in a specific gear position. Bumps or swells are caused by improper handling of gears before or during assembly.

b. Bearings — Noise comes in at low shaft speeds in any position. It is caused by bearings with damaged balls or rollers, or with pitted and spalled raceways. (See "Bearings" section.)



c. Cracked Gear — A gear cracked or broken by shock loading or by pressing on shaft during installation will produce this sound at low speeds. At high speeds a howl will be present.

2. High Pitched Whine or Squeal.
   a. Gear Wear — Result of normal gear wear, including gear tooth pitting from excessive use. In advanced deterioration, a howl will result.
   b. Mismatched Gear Sets — Such gear sets are identified by an uneven wear pattern on the face of gear teeth.
   c. Bearings — "Pinched" bearings, having insufficient axial or radial clearance. (See "Bearing" section.)
3. Growling
   a. Timing Error — Improper timing of the transmission during reassembly, or improper timing due to gear turning on the countershaft. Both conditions produce error in tooth spacing.
4. Jarring
   a. Bearings — Excessive axial and radial clearances in countershaft and mainshaft bearings. Excessive axial clearance in countershaft bearings result in jarring noise as torque reversals occur. Excessive radial clearance in countershaft bearings increases the center to center distance between shafts and results in loading tips of gear teeth. This can also contribute to tooth fracture.

Causes of Transmission Noise Originating Elsewhere in Vehicle
(see also "Alignment" section)

1. Rough idling engine. (See "Gears and Shafts", gear rattle.)
2. Engine operating noise.
3. Clutch driven plates in which the dampening action of springs or rubber blocks has been eliminated by wear set or fracture.
4. Drive line out of balance.
5. Unequal joint working angles.
6. Worn crosses in universal joints.
7. Loose or worn center bearings.
8. Worn or pitted teeth on ring gear and pinion of driving axle. Rear axle bearing failure.
9. Wheels out of balance.
10. Worn spring pivot bearing.
11. Loose "U" bolts.
12. Brake drums warped or out of balance.

Gears and Shafts

This section deals with analyzing gear and shaft failures to determine the type of failure. This in turn can give the mechanic a clue as to the cause.

Clashing

Snubbing and clashing gears while shifting are frequent abuses to which unsynchronized transmissions are subjected. Light snubbing will do little damage. The real damage is done by the hard clash shift caused by engaging gears which are far out of synchronization. This can break pieces of metal from the ends of the clutching teeth, Figure 1.

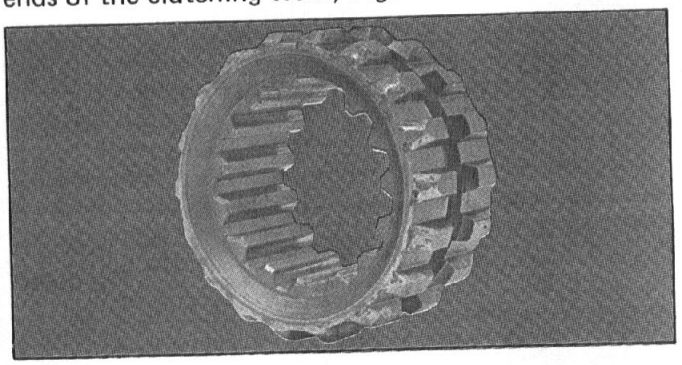


Figure 1. Broken and snubbed clutching teeth due to clashing.

Clashing gears can be traced to one of three causes:

1. **Improper shifting** – This applies to drivers who are not familiar with the shift pattern or have not learned the RPM spread between shifts.
2. **Clutch** – Clashing when starting up in first or reverse gear can be caused by insufficient clutch clearance or a dragging clutch not releasing properly. This makes the transmission countershafts and mainshaft gears continue rotating while the clutch pedal is depressed. Clashing results when the non-rotating clutch gear is forced to mesh with a rotating mainshaft gear.
3. **Inertial force** – Countershafts and mainshaft gears usually take from 3 to 5 seconds to stop rotating after the clutch has been disengaged. Attempting to mesh a clutch gear with a mainshaft gear before the mainshaft gear stops will result in clashing. If the transmission is not equipped with a clutch brake or countershaft brake, it is necessary to pause a few seconds after depressing the clutch pedal before attempting initial engagement of the transmission.

Gear Failures

Normal Wear

All gear teeth wear because of the sliding action which takes place as mating teeth mesh. Normal wear is a constant and slow wearing of the tooth surface. Transmission gear tooth life can be shortened by various adverse conditions. These conditions and the failures resulting from them are discussed in the following paragraphs.

Gear Tooth Fracture

A serious failure is the actual breaking of a tooth. Not only will the broken gear fail, but serious damage may occur as a result of the broken tooth running through the gearing.

Fractures which result from a severe shock load or occur after running only a very few cycles under a heavy load are considered impact fractures.

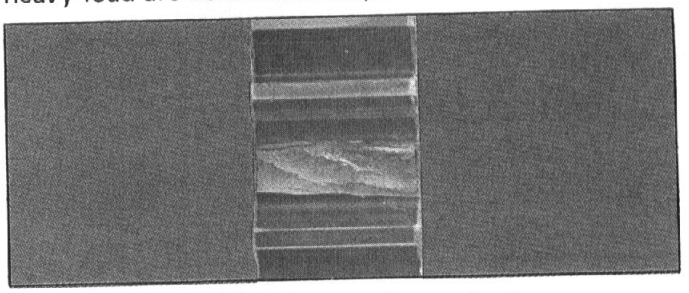


Figure 2. Broken tooth caused by impact fracture.

Impact fractures are identified by a "hump" on the compression side of the fractured area, Figure 2. The more cycles the gear has run, the smaller this hump will be.

Fatigue fractures occur after running many cycles under light to moderate overload or after a number of minor shock loads.

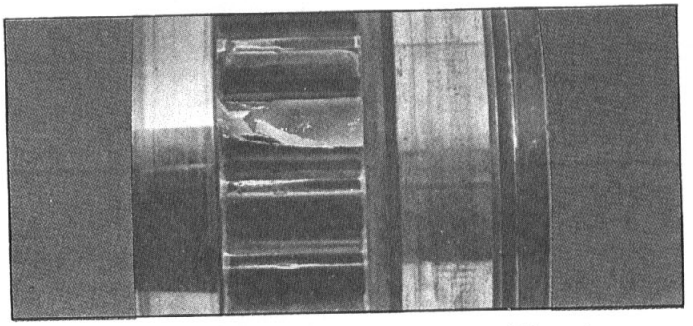


Figure 3. Fatigue fracture identified by "beach" marks.

Fatigue fractures are recognized by the presence of "beach marks" on the fractured area, Figure 3. These marks are made as the tooth progressively cracks under a load which is heavy enough to enlarge the crack, but not great enough to break the entire tooth off at one time. The tooth breaks off when there is insufficient gear tooth strength remaining to carry the load.

Pitting and Spalling

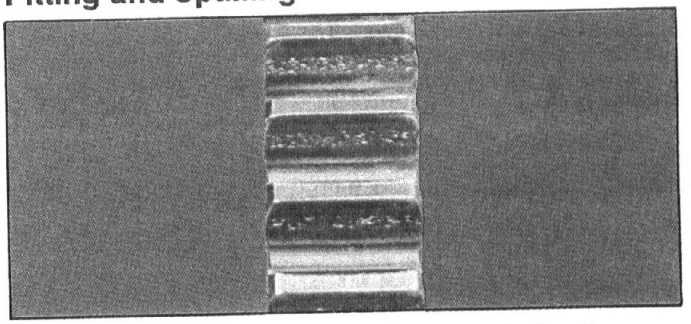


Figure 4. Gear tooth pitting caused by excessive loading.

Transmission gears which are run under excessive loads for long periods of time can begin to pit and spall, Figure 4. Using an improper type of oil or contaminated oil can also produce these tooth failures. If these gears continue to run, they will eventually fatigue fracture.

Scoring and Galling

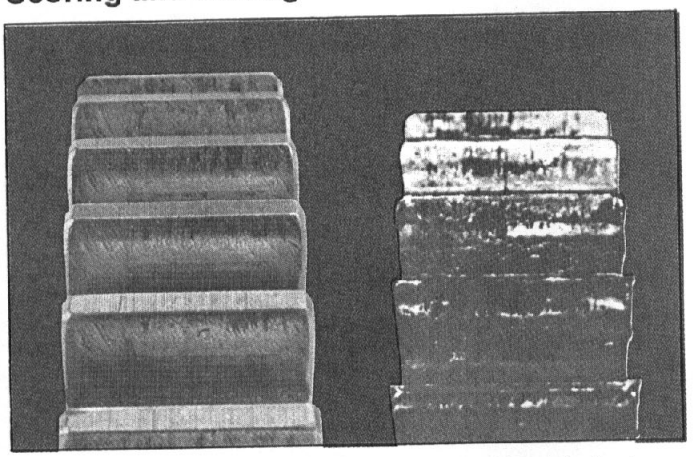


Figure 5. Vertical marks on gear teeth (left photo) indicate scoring. Galling (right photo) in advanced stage.

Scoring and galling are caused by metal to metal contact of mating gear teeth. High temperatures are produced as the metal surfaces slide over each other, causing the surface metal to soften. The softened metal will be picked up and smeared as the teeth slide against each other. Scoring can be identified by a number of scratches or ridges directed up and down the tooth, Figure 5. Galling is simply an advanced case of scoring in which sizable particles of metal have been torn from the tooth surface.

The principal causes of scoring and galling are poor quality oil, and a temporary lack of lubrication.

Abrasive Wear

The presence of contaminants in the oil, such as abrasive dust, will make the oil act as a lapping compound. Abrasive wear is a result of this lapping action. The use of overly active EP (extreme pressure) oil can also produce the same effects.

Abrasive wear can be identified by a satiny lapped-in appearance on the tooth surface and the presence of flat spots running across the surface of the tooth.

Manufacturing Blemishes

Sometimes gears are replaced or thought to be defective because of marks left on the gear by manufacturing processes. These blemishes, however, do not contribute to gear failure.

1. **Hob marks** — These are cutting marks or lines formed during the initial cutting of the gear teeth, Figure 6. Hob marks on the tooth face will be removed by the shaving process, but hob marks in the root of the tooth will most likely remain, and may be found even on gears with much wear on them.

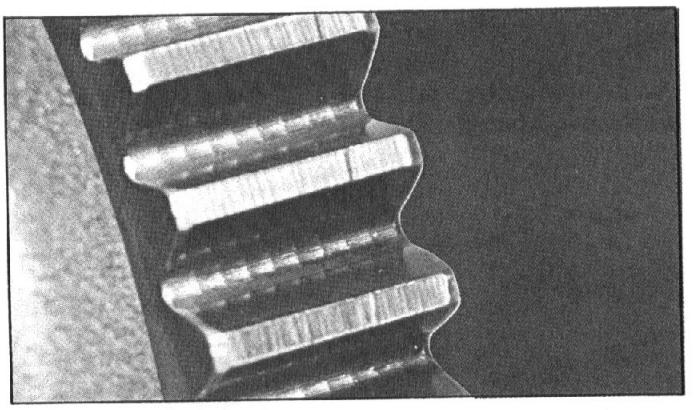


Figure 6. Hob marks

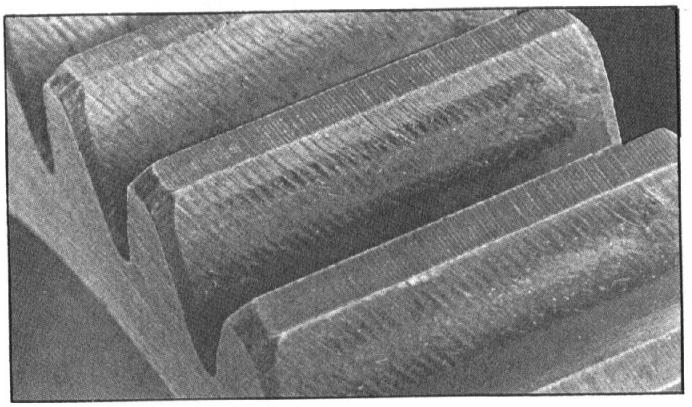


Figure 7. Shaving marks

2. **Shaving marks** — The shaving operation leaves distinct diagonal marks on the face of the gear tooth, Figure 7. These marks can be distinguished from scoring marks by the fact they are diagonal, while scoring marks are more nearly vertical. Most shaving marks are removed during normal gear operation.

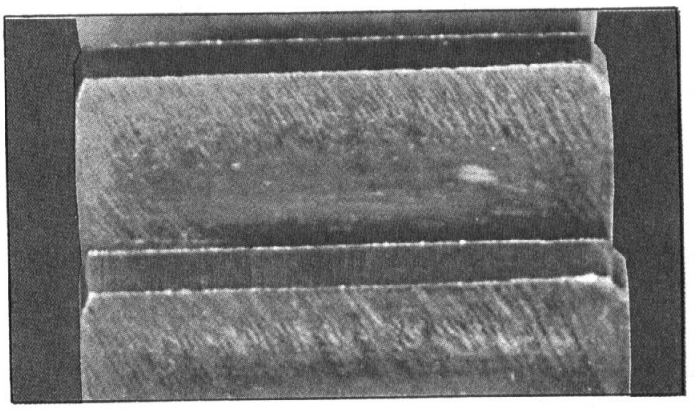


Figure 8. Lipping

3. **Lipping** — Lipping or shaving burrs, is the formation of "lips" at the tip of the gear teeth during machining, Figure 8. These "lips" will do no harm to the gear.

Gears and Shafts (continued)

Gear Rattle at Idle

Mainshaft gears are designed to have a specified amount of axial clearance which allows them to rotate freely on the mainshaft. The amount of clearance is governed by the use of washers. A rough idling engine can set up vibrations, causing the mainshaft gears to rattle as they strike mating gears. This condition can usually be cured by improving the idling characteristics of the engine. Tolerence washers may have to be changed to bring the axial gear clearance to within tolerance on high mileage units.

Shaft Twist and Fracture

Failure of transmission shafts through fracturing or twisting is caused when stresses are imposed on them which are greater than they were designed to withstand. The main causes for these failures are:

1. Improper clutching techniques.
2. Starting in too high of gear (either front or auxiliary section).
3. Lugging.
4. Attempting to start with brakes locked.
5. Transmission used for application it was not designed to withstand.
6. Bumping into dock when backing.
7. Improper mounting of adjustable 5th wheel.

As with gear teeth, shafts may fracture as a result of fatigue or impact. An example of an impact fracture is shown in Figure 9.

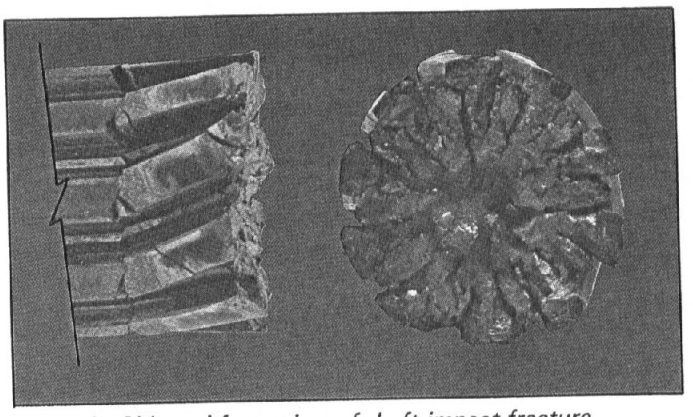


Figure 9. Side and front view of shaft impact fracture.

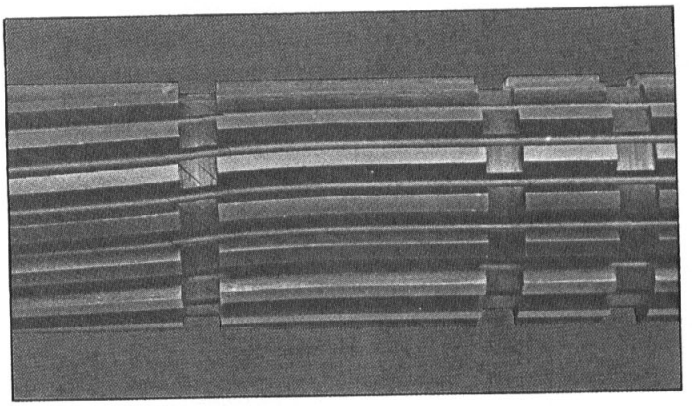


Figure 10. Shaft twist

Loads not severe enough to cause shaft fractures may cause the shaft to twist, Figure 10.

Bearings

Fatigue

Figure 1. Raceway metal breaking down causing flaking or spalling.

Bearing fatigue is characterized by flaking or spalling of the bearing raceway, Figure 1. Spalling is the granular weakening of the bearing steel which causes it to flake away from the raceway. Because of their rough surfaces, spalled bearings will run noisy and produce vibration.

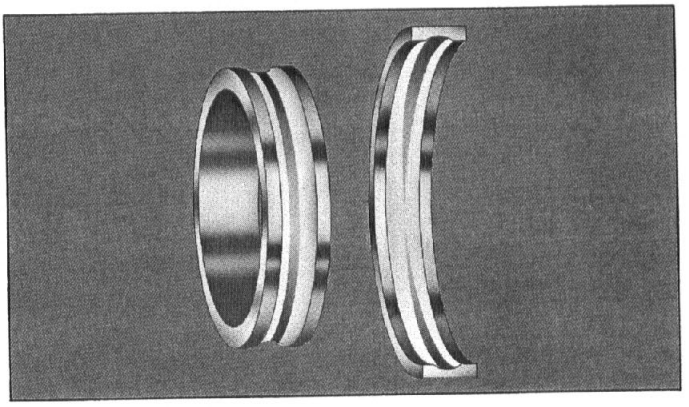


Figure 2. Ball path pattern caused by out of round squeeze.

Normal fatigue failure occurs when a bearing "lives out" its life expectancy under normal loads and operating conditions. This type of failure is expected and is a result of metal breakdown due to the continual application of speed and load. Premature fatigue failure may occur in transmissions when the bearing

bore is undersized or out of round, Figure 2, due to poor quality resleeving. Extreme care should be taken when reboring the housing. Boring the housing off center will result in misalignment of the shafts. Always use precision equipment such as a jig boring machine. Never prick punch the bearing bores to tighten the fit.

Lubrication

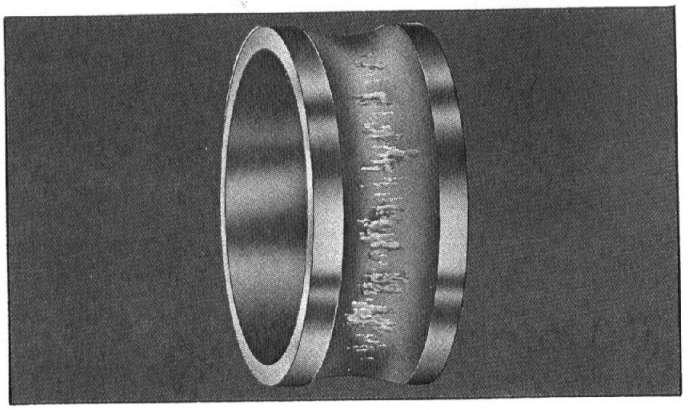


Figure 3. Spalled and discolored race.

Bearing failure due to poor lubrication is characterized by discoloration of the bearing parts, spalling of the raceway, Figure 3, and possible breakage of the retainer. Failure may result not only from a low oil level, but also from contaminated oil, improper grade oil, or mixing of oil types (including the use of additives).

To prevent this type of failure, the transmission should always be filled to the proper level, using a recommended type and grade of oil, and changed at regular intervals. (See "Lubrication" section.)

Brinelling

Brinelling can be identified as tiny identations high on the shoulder or in the valley of the bearing raceway, Figure 4. They can be caused by improper bearing installation or removal. Driving or pressing on one race, while supporting the other is the primary

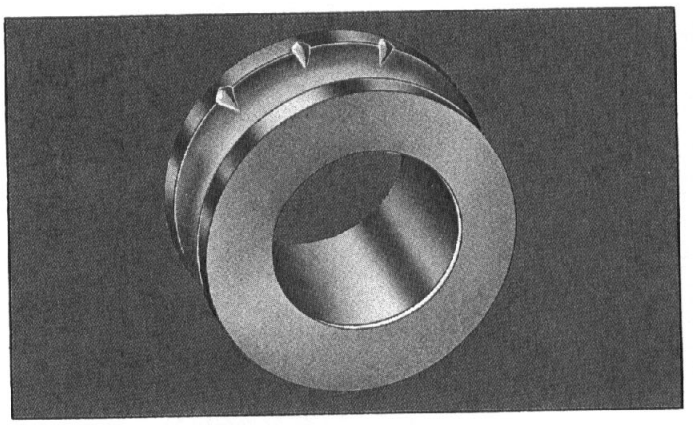


Figure 4. Brinelled race caused by improper assembly.

cause. To prevent brinelling, always support the race which has pressure applied to it. In addition to brinelling, damage can also occur to the bearing shields, retainers and snap rings by using a hammer and chisel to drive bearings. This damage can be avoided by using correct drivers or pullers.

Fretting

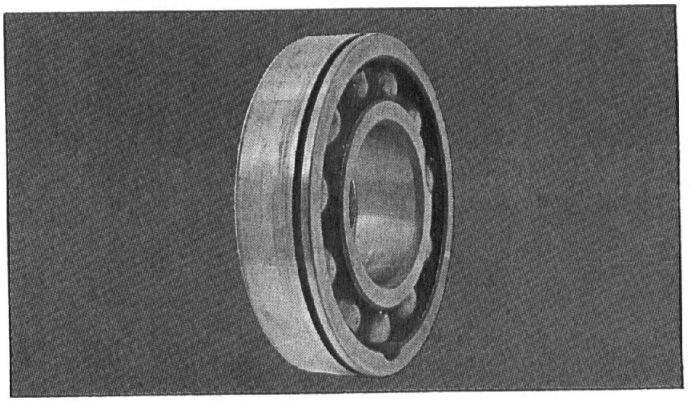


Figure 5. Fretted outer race from normal vibration.

The bearing outer race can pick up the machining pattern of the bearing bore as a result of vibration, Figure 5. This action is called fretting.

Many times a fretted bearing is mistakenly diagnosed as one which has spun in the bore. Only under extreme conditions will a bearing outer race spin in the bore.

Contamination

When bearings fail as a result of contamination, it is due to either contaminants entering the transmission case or the bearings having been improperly handled during service or storage. Bearings affected from contamination are identified by scoring, scratching or pitting of the raceways and balls or rollers, or a build up of rust or corrosion on the bearing parts, Figure 6. In addition, the presence of very fine particles in the oil, such as abrasive dust, or the use of overly active EP (extreme pressure) oils, will act as a

Bearings (continued)

Contamination (continued)

lapping compound and produce a very highly polished surface on the raceways and balls or rollers. This lapping process will significantly shorten the life of the bearing.

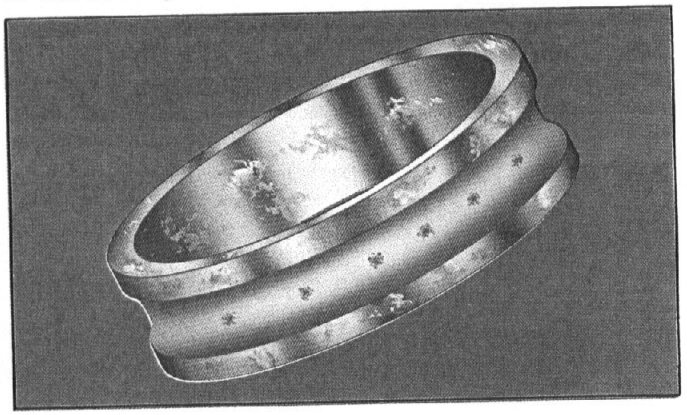


Figure 6. Inner race showing contamination.

Impurities will always enter the transmission during its normal breathing process. This will not seriously affect the bearings if the transmission oil is changed as recommended.

New bearings should be stored in their wrappers until ready for use. Used bearings should be thoroughly cleaned in solvent, light oil or kerosene, covered with a coat of oil and wrapped until ready for use. Always use a new wrapping after reoiling.

Misalignment

Misalignment, Figure 7, can possibly occur in the input shaft drive gear bearing if the transmission is mounted eccentrically with the pilot bearing bore in the flywheel. An indication of this condition would be damaged to the ball separators and shield.

The clutch housing, clutch housing mounting face, and pilot bearing should be checked for eccentricity, foreign matter and proper mounting position when trying to locate the cause of the misalignment. (See "Alignment" section.)

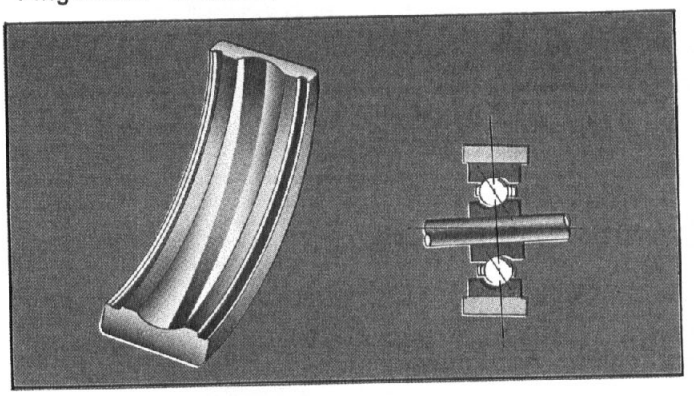


Figure 7. Angular ball path due to misalignment.

Electric Arcing

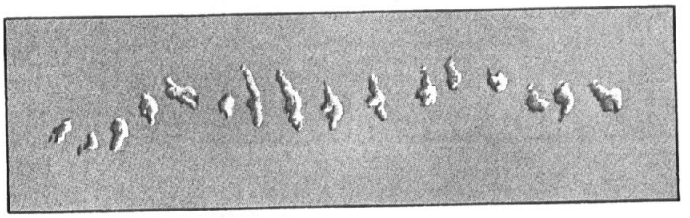


Figure 8. Electrical pitting on surface of raceway.

When an electric current passing through a bearing is broken at the contact surfaces of the ball and races, arcing results, which will pit the bearing components, Figure 8. In extreme cases, the balls or rollers may actually be welded to the bearing races, preventing the bearing from rotating.

This condition may occur in truck transmissions as a result of electric welding on the truck with an improper ground. When doing either A.C. or D.C. welding, never place the ground so as to allow current to pass through the transmission.

Transmission Alignment

Concentric Alignment of Transmission to Engine

To correct:

- **Direct gear slipout**
- **Drive gear bearing failure**
- **Premature input shaft spline wear from rear hub of two plate clutches.**

Concentric alignment means that the engine and transmission must have a common axis, Figure 1. The purpose of this section is to set forth the procedures to use in checking for possible misalignment.

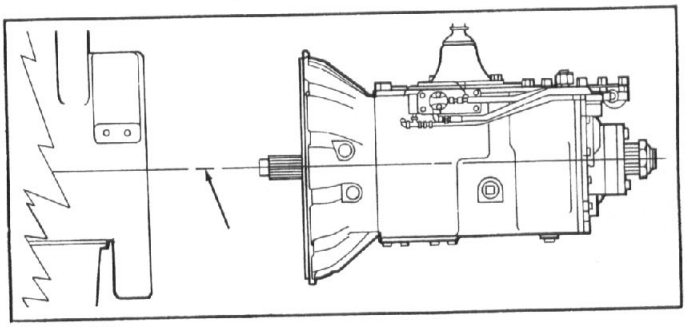


Figure 1. Concentric alignment, common axis.

Transmission Alignment (continued)

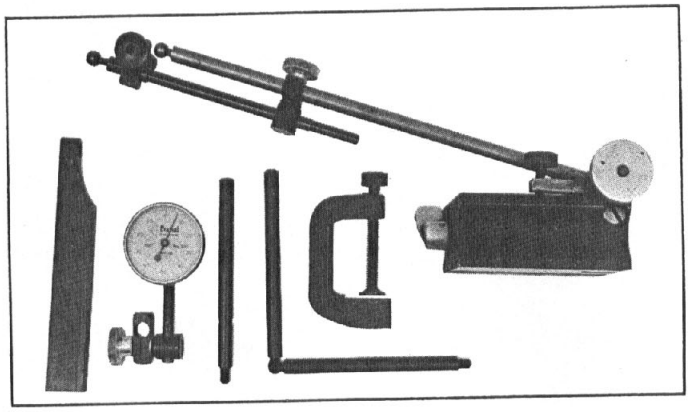


Figure 2. Dial Indicator Kit.

The basic instrument needed for taking readings is a dial indicator, Figure 2. Accuracy of readings is essential for correcting alignment problems. Clean all surfaces thoroughly before proceeding.

IMPORTANT: When taking the following readings, rotate engine by hand, do not crank engine with starter. Remove spark plugs on gasoline engines, and release compression on diesel engines. **NOTE:** Before dial indicating engine flywheel or flywheel housing, make sure engine crankshaft does not have excessive end-play. If it does, accurate readings cannot be obtained. Place dial indicator finger against flywheel. Force crankshaft back and forth with pry bar. If end-play movement exceeds maximum, it will have to be corrected.

Worn Housings

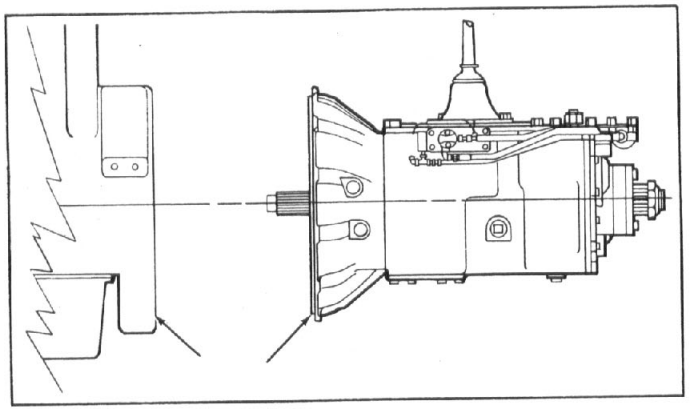


Figure 3. Inspect for worn or fretted pilot on transmission clutch housing and engine flywheel housing.

Inspect for worn or fretted pilot on both the transmission clutch housing and the engine flywheel housing, Figure 3. The 1/4" pilot lip of transmission clutch housing can wear into the flywheel housing either by transmission loosening up or after high mileage just from road and engine vibration. Any appreciable amount of wear on either part will cause misalignment and the part should be replaced. The wear will generally be found from the 3:00 o'clock to 8:00 o'clock position, Figure 4.

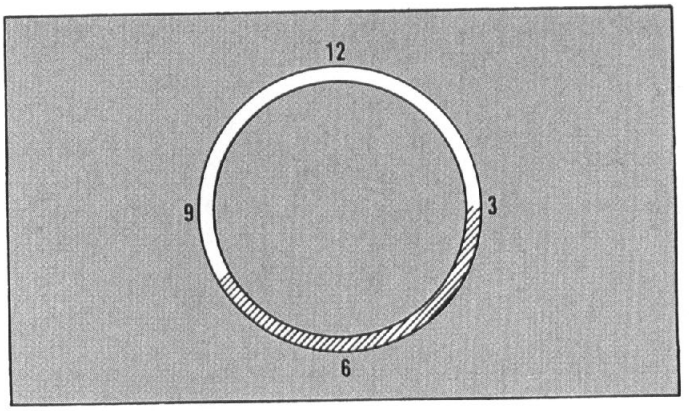


Figure 4. Area where wear is generally found.

Engine Flywheel Housing Pilot

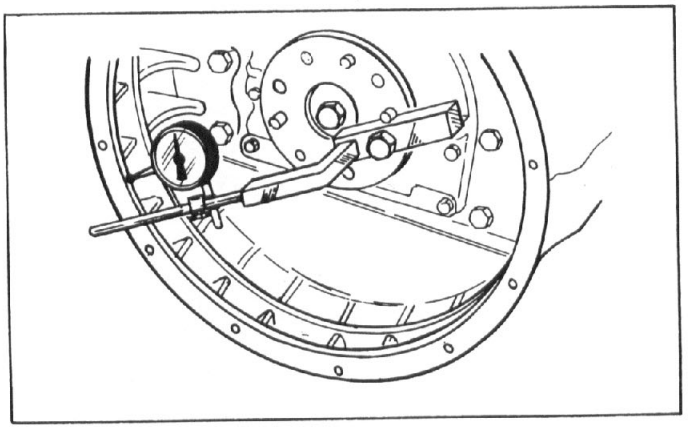


Figure 5. Dial indicating pilot of engine flywheel housing.

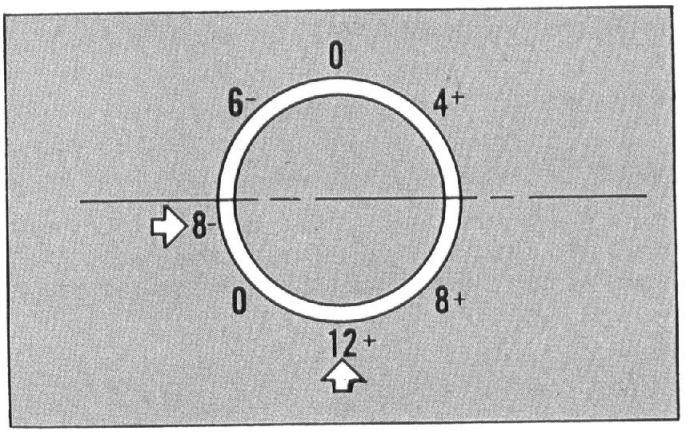


Figure 6. Total runout is difference between highest plus and minus readings.

Dial indicate the pilot or bore of engine flywheel housing. Secure dial indicator to engine flywheel with gauge finger against housing pilot, Figure 5. Rotate flywheel by hand and, with chalk or soap stone, mark high and low points of indicator as it is being rotated. The total runout will be the difference between the highest plus and minus readings, Figure 6. SAE maximum total runout for flywheel housing pilot is .008" with No. 1 and No. 2 SAE housings.

Transmission Alignment (continued)

Engine Flywheel Housing Face

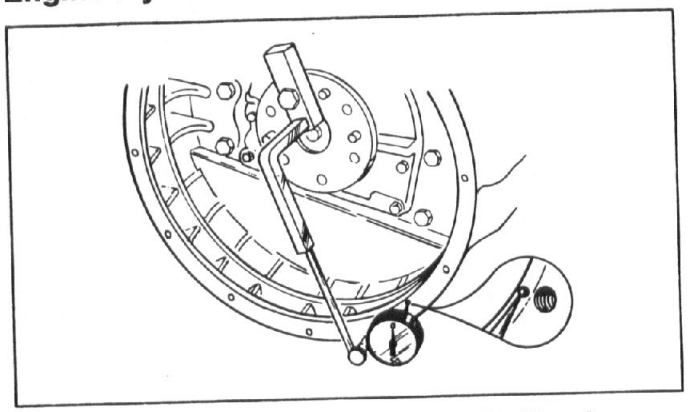


Figure 7. Dial indicating face of engine flywheel housing.

Dial indicate the face of engine flywheel housing. With dial indicator secured to flywheel, move gauge finger to contact face of flywheel housing, Figure 7. Mark high and low points in the same manner as in previous step. SAE maximum total runout for the flywheel housing face is .008" with SAE No. 1 and No. 2 housings. **NOTE:** Mark the high and low runout readings in clock positions if it is necessary to reposition the flywheel housing.

Flywheel Face

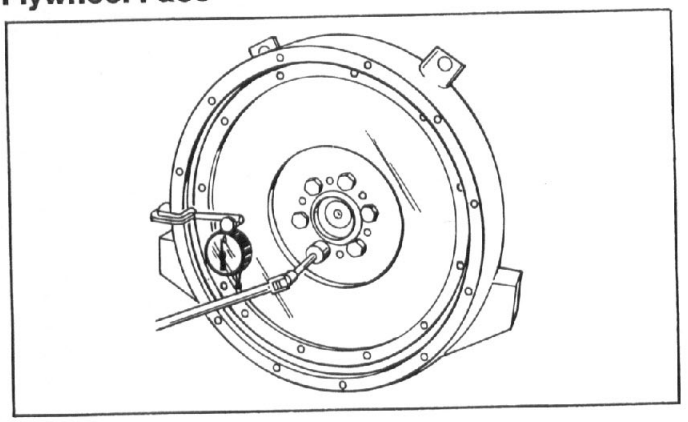


Figure 8. Dial indicating face of flywheel.

Dial indicate the flywheel face. Secure dial indicator to engine flywheel housing near the outer edge, Figure 8. Turn flywheel to obtain readings. Maximum allowed is .001" runout or face wobble per inch of flywheel radius. For example, if vehicle has a 14" clutch and readings are taken just off the outer edge of the clutch disc wear, maximum tolerence would be .007".

Flywheel Pilot Bore

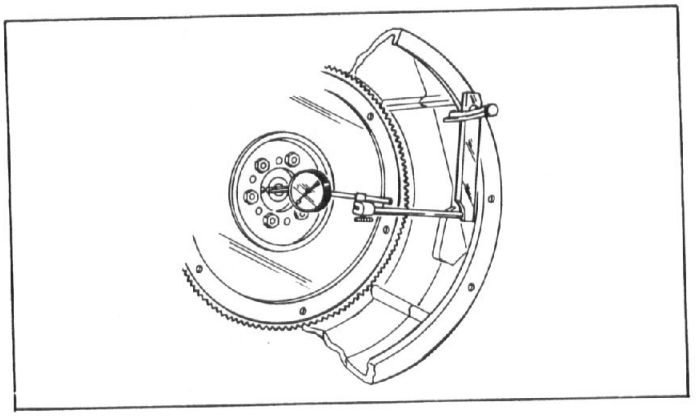


Figure 9. Dial indicating pilot bearing bore.

Dial indicate pilot bearing bore of flywheel. With indicator secured to flywheel housing, move gauge finger to contact pilot bearing bore surface, Figure 9. Turn flywheel and obtain readings. SAE maximum total runout for the pilot bearing is .005".

Transmission Clutch Housing

The transmission clutch housing face and pilot can not be checked accurately in the field without special measuring tools. Recommended maximum runout for the transmission clutch housing face and pilot is .003" with SAE No. 1 and No. 2 housings.

Torsional Vibration

Checking Drive Line U-Joint Operation Angles

The action of a drive line with a universal joint at either end working through an angle results in a peculiar motion. The drive line will speed up and slow down twice for each revolution. If the working angles at either end of the shaft are unequal, torsional vibration results. This torsional vibration will tend to cancel itself out if both joint working angles are equal.

Types of Noise

Noise or vibration which occurs only at certain road speeds and diminishes as speed increases is generally caused by unequal working angles of drive line joints.

Noise or vibration which is persistent throughout the speed range and varies in intensity with change of speed may be caused by unbalanced drive lines, unbalanced brake drums or discs, or drive lines with universal joints out of phase.

Preliminary Checks

Make checks of the following before taking angle readings:

1. Check companion flange or yoke nut for looseness and torque to proper specification if necessary.

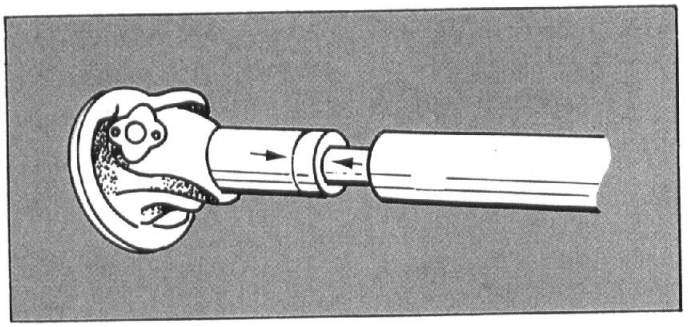


Figure 10. Drive line slip joint in phase.

2. Drive line slip joints that do not have the arrows or other markings pointing to each other will result in the drive line universal joints being out of phase, Figure 10. In other words, the transmission universal joint may be turned one spline or more to the right or left of being aligned with the universal joint at opposite end of the drive line. **NOTE:** Some computer designed drive lines are purposely built with U-joints out of phase. Check manufacturers specifications for proper setting. Also, check closely to make certain no twist has occured to the tubing, causing these two joints to be out of phase.

   Make sure the slip joint works freely and is not bound or seized. Slip joints must absorb axle housing movements.

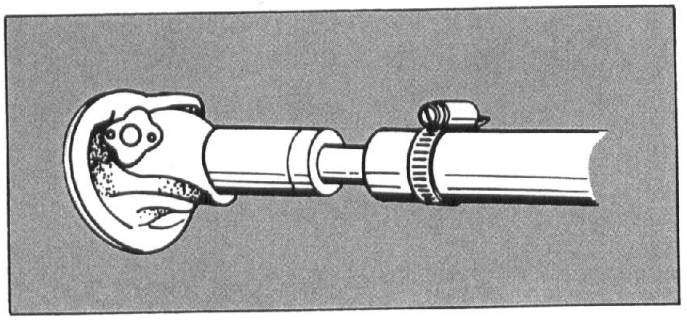


Figure 11. Weight attached to shaft to determine drive line balance.

3. Unbalanced drive lines can cause vibration that occurs throughout the speed range of vehicle and varies in intensity with change of speed. The drive line may be at fault in respect to balance and concentricity. A quick field check to determine drive line balance can be made by securing a small piece of metal or similiar weight with a hose clamp to the front of the tube where the splined shaft is welded, Figure 11. Road test the vehicle and continue to move the weight around tube until balance point is found and vibration disappears, or is minimized.

   Drive lines are dynamically balanced to their intended rotational velocity and not to infinite speeds. Thus, vibration can be expected when this rotational velocity is exceeded.

   Check concentricity of drive line by mounting on lathe centers and dial indicating. Check manufacturer's specifications for runout allowance.

4. Engine supports that are worn, broken or loose, and mounting pads that are worn or deteriorated must be corrected to restore the engine suspension to its original vibration tolerance.

Taking Readings

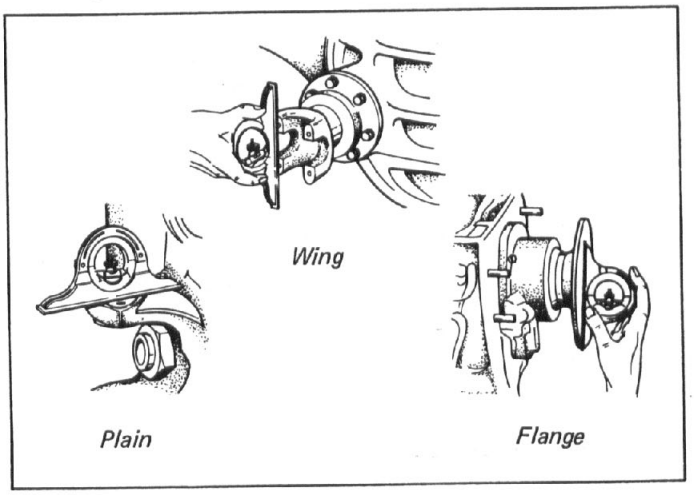


Figure 12. Taking readings from universal joints to obtain transmission angle.

Take readings with protractor from machined surfaces of yokes or companion flanges. Plain, wing or flange type joints may be encountered, Figure 12. Some will require partial disassembly to obtain accurate readings.

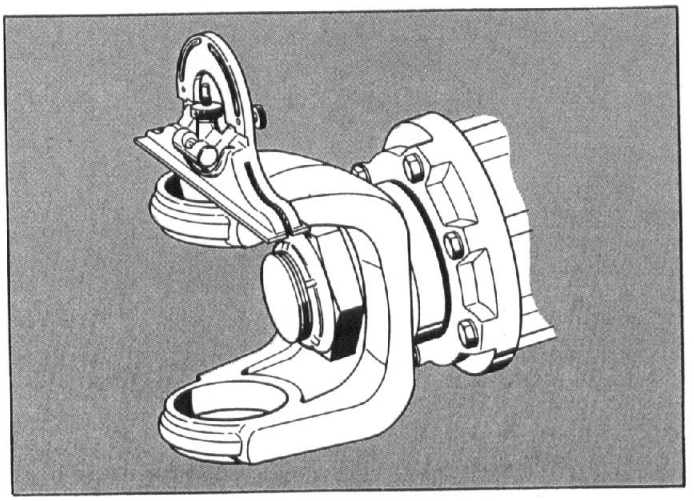


Figure 13. Checking joint for vertical plane.

On plain type joints, it may be necessary to remove the bearing cap. When taking readings, make sure the universal joint is in a vertical plane, Figure 13.

Transmission Alignment (continued)

Taking Readings (continued)

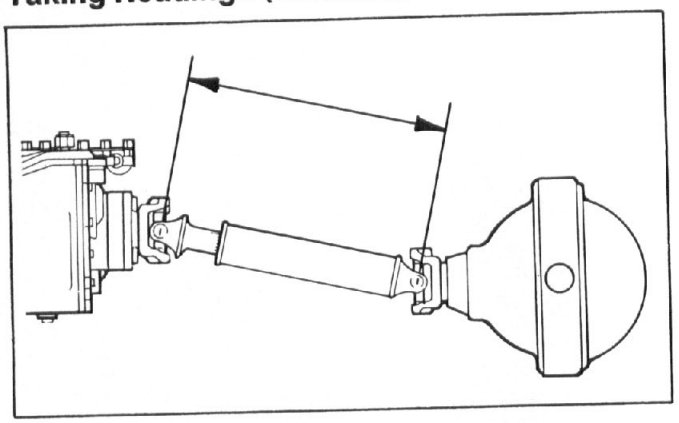


Figure 14. Measure from joint to joint.

At the rear axle, take readings from a machined surface differential carrier that is in the same plane as the axle pinion shaft, or from machined surface that is perpendicular to pinion shaft, whichever is easier.

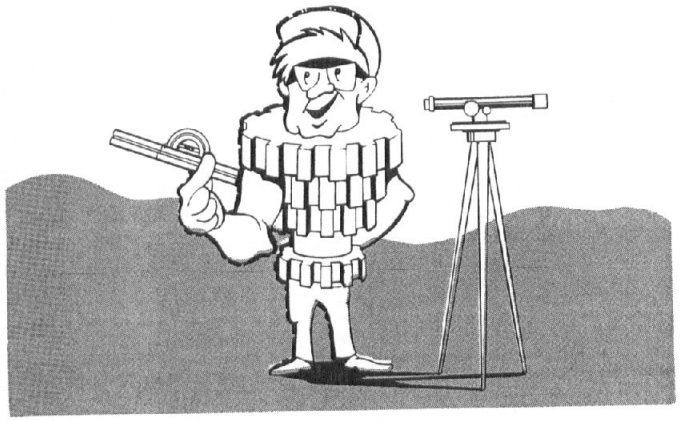
If vibration occurs while operating empty, take readings in empty condition. If it occurs when loaded, take readings when loaded.

When it is necessary to measure drive line lengths, measure from joint center to joint center, Figure 14.

Limits

Manufacturer's specifications should be followed when making initial angularity check. Some manufacturers have found it necessary to vary from the ideal due to geometrical limitations. If vibration persists after adhering to manufacturer's specifications, contact the manufacturer's representative.

Angularity Checks Parallel Flanges or Yokes



1. Single Axle Vehicles
   a. Transmission angle. Take reading of transmission angle. This angle is the angle to which the rear axle joint angle must match. The transmission angle will have a declination reading of from 0 to 5 degrees in most cases.

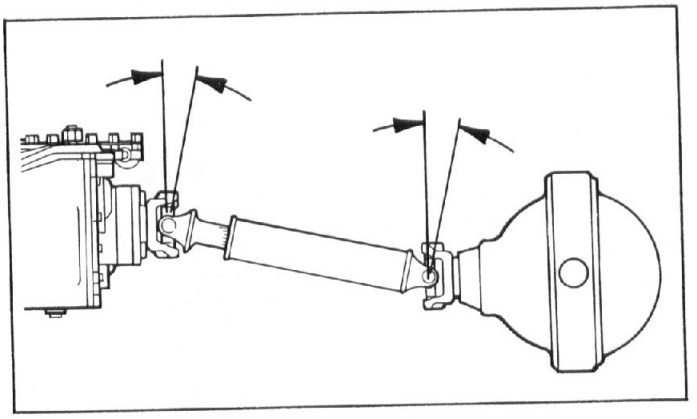


Figure 15. Transmission and rear axle readings should be equal.

   b. Axle angle. Take reading either from machined surface of axle housing or pinion bearing retainer. **This angle must be within one degree of the transmission angle.**
   c. **Example:** If transmission angle reading is 3 degrees down to the rear, the rear axle angle should be 3 degrees up, Figure 15.

2. Tandem Axles or Vehicles with Auxiliary Units
   a. Take transmission angle reading.
   b. Take reading from joint of front tandem axle or auxiliary joint. **This reading should be within one degree of transmission angle. NOTE:** The rear joint of front tandem axle will be the same as the front joint.
   c. Take reading of joint angle at tandem rear axle, or axle to rear of auxiliary. **This angle must be within one degree of transmission angle.**

Joint Working Angle Limits (Parallel)

Universal joints have a maximum working angle, depending on type and manufacture. It is recommended that the joint working angle for parallel joint assembly not exceed 8 degrees for main drive lines over 40" long. For main drive lines under 40" the maximum angle should not exceed Length (L) divided by 5. (This limit does not apply to inter-axle drive lines.) **Example:** For a 35" drive line, the maximum joint working angle would be 35 ÷ 5 or 7°. This working angle must not be exceeded.

Place protractor on drive line to obtain angle of drive line from transmission to axle. The difference between the drive line angle and the joint angle is the joint working angle. For instance, if the transmission is 3 degrees down, and the drive line angle is down 7 degrees, the transmission joint working angle is 7 minus 3 or 4 degrees.

On tandem drive or auxiliary installations, take readings in the same manner, comparing the universal joint angles to the drive line angle to which it is attached.

Angularity Checks — Non-Parallel Compensating Angles of Flanges or Yokes

With short wheel base vehicles which have a minimum drive line length from transmission to axle, the drive line is required to operate through very severe working angles on some installations. This also applies to inter-axle drive lines. These severe joint working angles induce vibration.

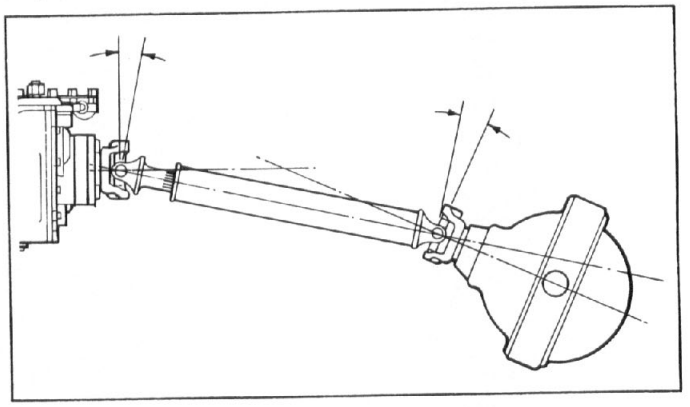


Figure 16. Working angles of non-parallel flange installation.

To decrease working angles, the axle is tilted upward until the pinion shaft centerline and transmission mainshaft centerline intersect midway between the joint centers, Figure 16.

With tandem drive axles, the rearward axle is tilted upward until its pinion shaft centerline and forward axle pinion shaft centerline intersect midway between joint centers.

When figuring non-parallel joint installations, it is necessary to take the drive line angle readings as well as transmission and axle angle readings.

1. Single Axle Vehicles
   a. Take angle reading of transmission.
   b. Take angle reading of drive line.
   c. Take angle reading of axle joint.
   d. To compute for correct angles:
      (1) The difference between the drive line angle and the transmission angle will be the transmission joint working angle.
      (2) The difference between the drive line angle and the axle angle will be the axle joint working angle.
      (3) The two working angles of transmission and axle must be equal.
   e. **Example:**

      Transmission is 3 degrees down.
      Drive line is 7.5 degrees down.
      Rear axle is 12 degrees down.
      Thus 7.5 minus 3 equals 4.5 degrees.
      12 minus 7.5 equals 4.5 degrees
      giving 4.5, equal working angles.

2. Tandem Axles or Vehicles with Auxiliary Units

When taking readings on tandem drive axles or between auxiliary and rear axle, the same principles apply as with single axle vehicles. Take readings between transmission and front tandem axle, or auxiliary. Take readings between axles or between auxiliary and axle. In other words, take angle readings for each set of universal joints.

Joint Working Angle Limits (Non-Parallel)

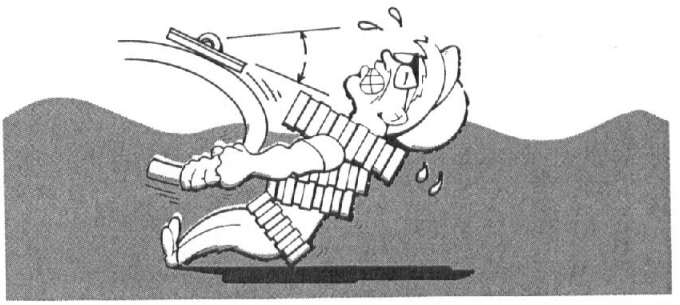
It is recommended that the maximum joint working angle for non-parallel joint assemblies not exceed the main drive line length divided by 10. For example, if the main drive line length is 55", the maximum joint working angle is 55 ÷ 10 or 5-1/2 degrees. (This limit does not apply to interaxle drive lines.)

Axle Adjustments

Axle angles may generally be adjusted by one of the following ways, depending on the type of axle:

1. Adjust torque rods, if adjustable type.
2. Add to or reduce length of non-adjustable torque rods.
3. Add or reduce the number of shims behind torque rod brackets.
4. Use correct amount of wedge shims under spring to axle pad.

Suspensions — Pinion Shaft Angle

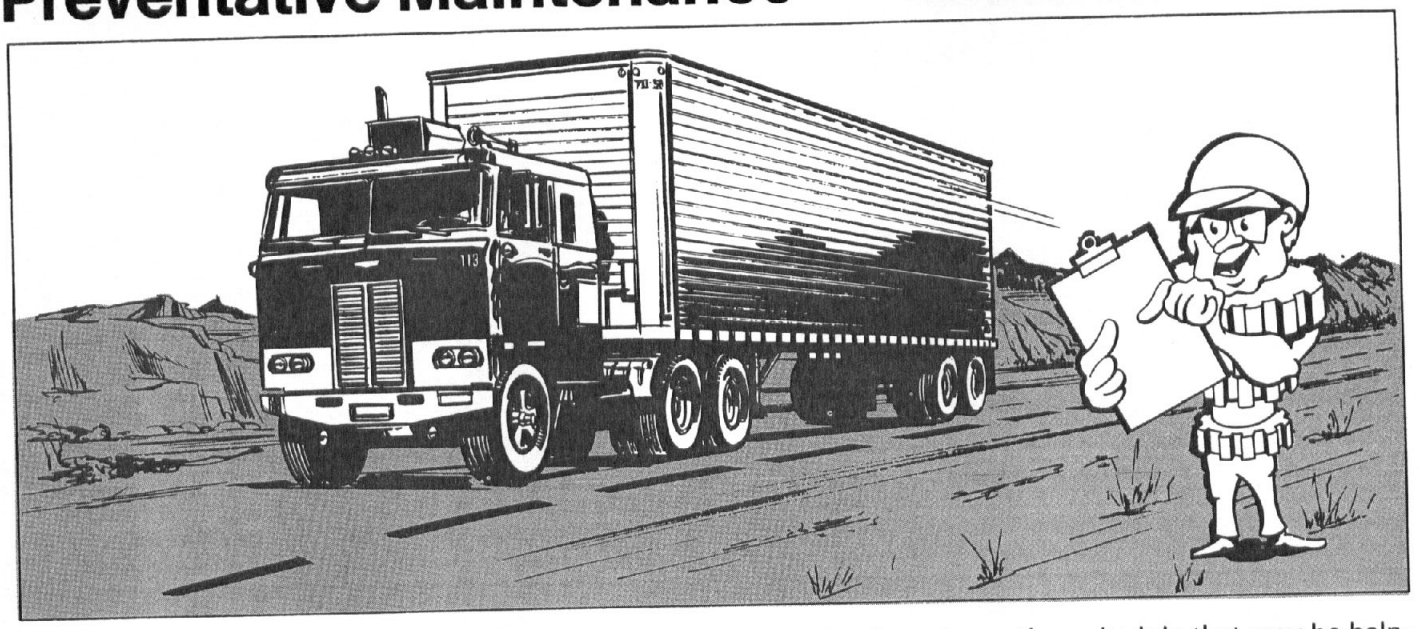


There will be little or no change of axle pinion shaft angle with types of suspensions which have a parallelogram movement. These allow differential housings to move up and down in a straight vertical plane during operation.

Suspensions not having a parallelogram movement will allow axle pinion shaft to oscillate in an arc, thereby constantly changing pinion shaft angle during operation. A varying amount of vibration can occur caused by working angles of the universal joints being momentarily unequal.

Single drive axle vehicles have little or no change of axle pinion angle during operation.

Preventative Maintenance



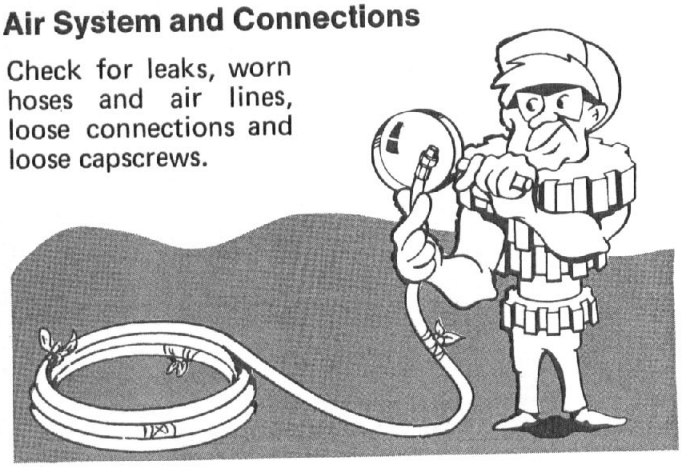
A good preventative maintenance program can avoid breakdowns, or reduce the cost of repairs. Often, transmission problems can be traced directly to poor maintenance.

Following is an inspection schedule that may be helpful in setting up a PM program. This schedule is not all inclusive as inspection intervals will vary depending upon operating conditions.

Inspection to be Made Daily

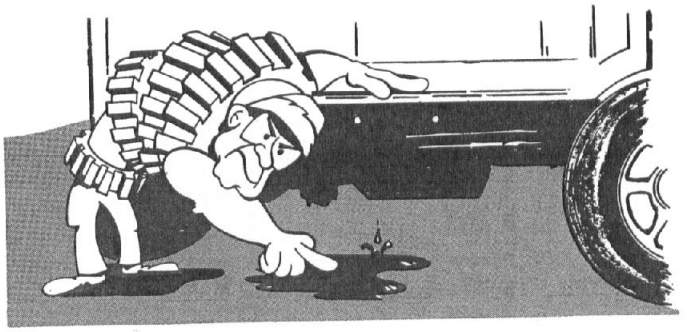
Air System and Connections

Check for leaks, worn hoses and air lines, loose connections and loose capscrews.



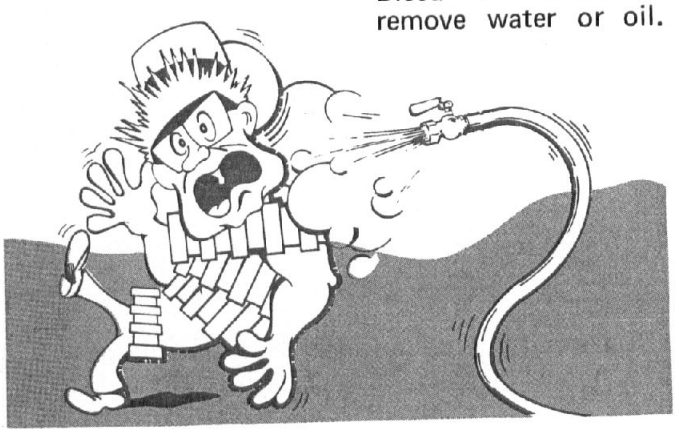
Oil Leaks

Check around bearing covers, PTO covers and other machined surfaces. Also check for leaks on ground before starting truck in the morning.



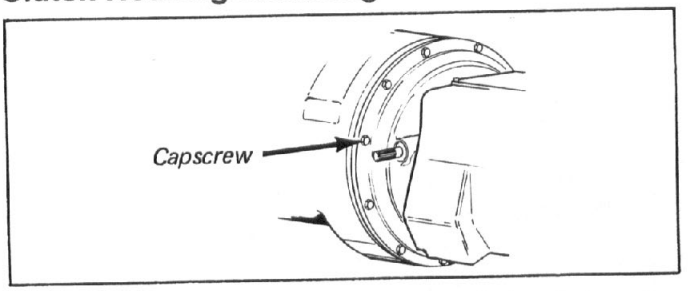
Air Tanks

Bleed air tanks to remove water or oil.



Inspections to be Made Every 5,000 Miles

Clutch Housing Mounting

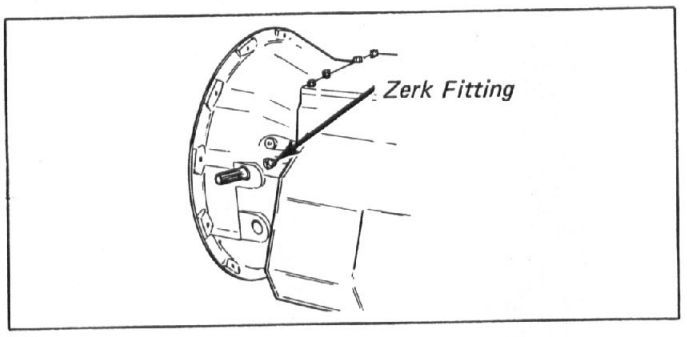


Check all capscrews in bolt circle of clutch housing for looseness.

Clutch Brake

Check to be sure it is operating.

Lubricate Pedal Shafts



Clutch Pedal Shaft and Bores

Pry upward on shafts to check wear.

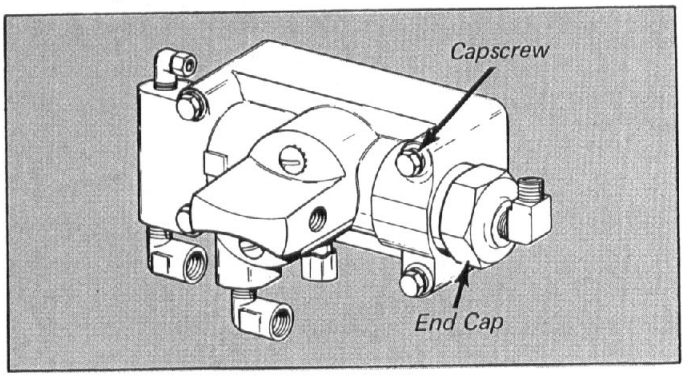
If excessive movement is found, remove clutch release mechanism and check bushings in bores and wear on shafts.

Inspections to be Made Every 10,000 Miles

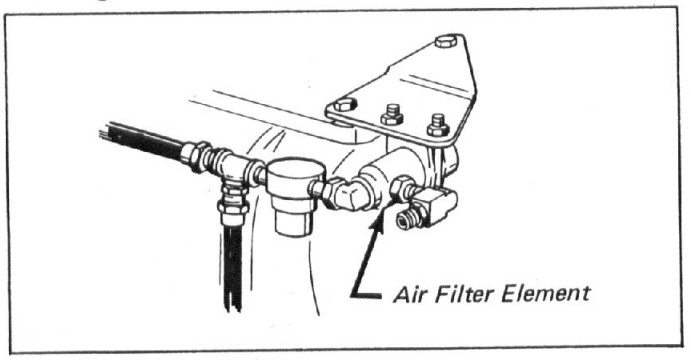
Slave Valve

Remove end cap and check for contamination.

Check capscrews on valve for tightness.



Air Regulator and Air Filter



Check air pressure.

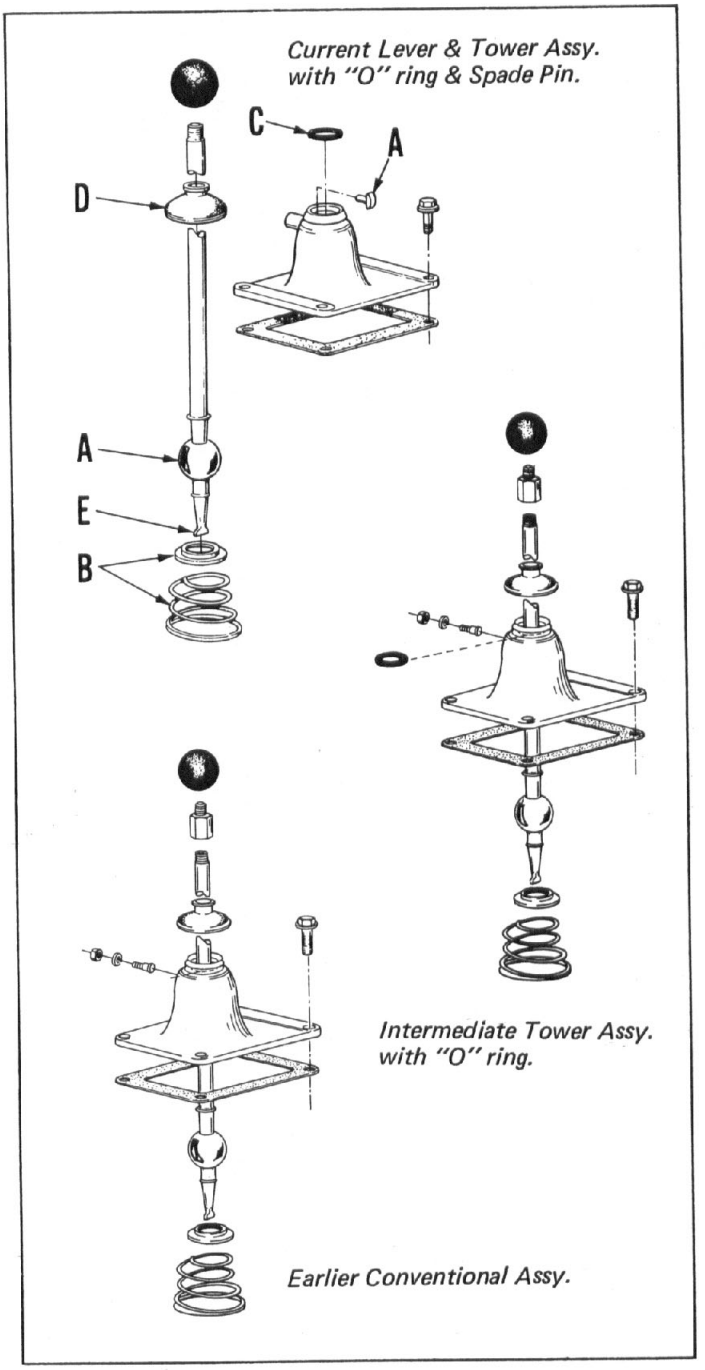
Clean element of air filter, replace if necessary.

Gear Shift Lever

Check for looseness and free play in housing.

If lever is loose in housing, proceed with other shift linkage checks.

Gear Shift Lever Housing Assembly



A. Check spade pin and spade pin slot for wear.

B. Check tension spring and washer for set and wear.

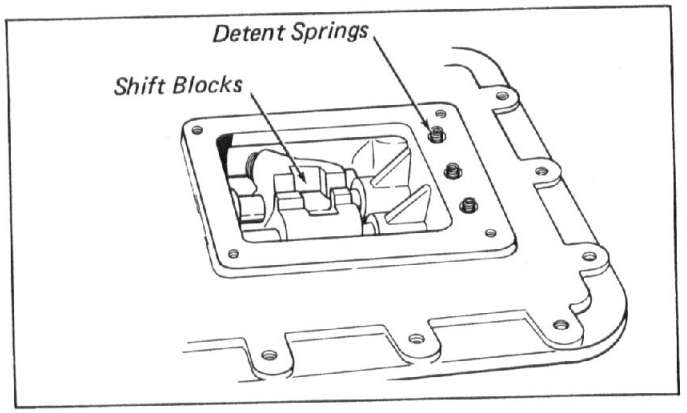
C. Check "O" ring for set and wear.

D. Check dust protector for wear.

E. Check bottom end of gear shift lever for wear.

Preventative Maintenance (continued)

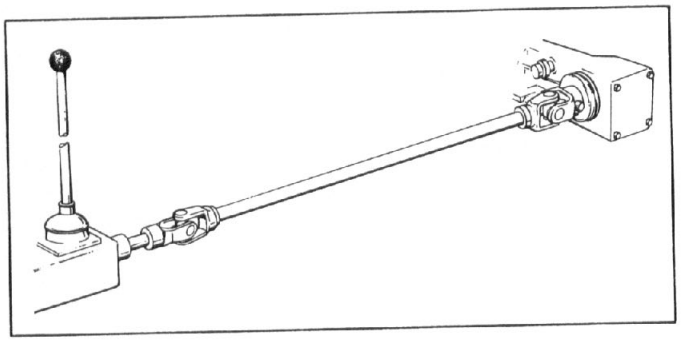
Shift Blocks and Poppet Springs



Check shift block slots for wear.

Check for broken, set or missing detent springs.

Check Remote Control Linkage



Check linkage U-joints for wear.

Check for binding.

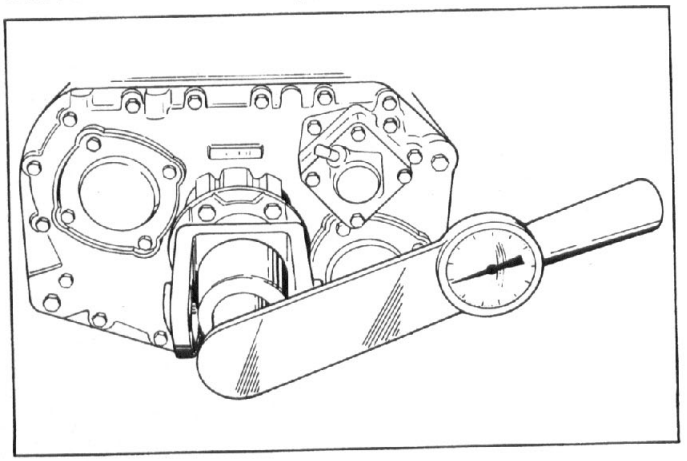
Lubricate U-joints.

Check connections for tightness.

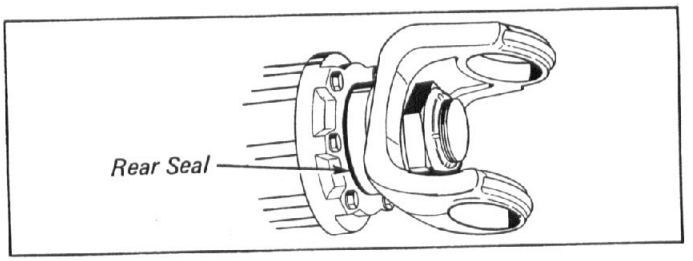
Check for bushing wear.

Inspections to be Made Every 30,000 Miles

Universal Joint Companion Flange



Check for proper torque, 450 to 500 ft. lbs.



Check for rear seal wear.

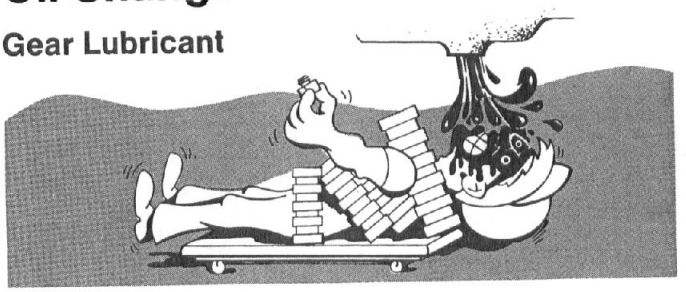
Output Shaft

Pry upward against output shaft to check radial clearance in mainshaft rear bearing.

Check splines for wear from movement and chucking action of the universal joint companion flange.

Inspections to be Made at Each Oil Change

Gear Lubricant



Change at specified intervals. (See "Lubrication" section.)

Use only recommended gear oils. (See "Lubrication" section.)

Inspect oil for excessive contamination. Reduce oil change interval if necessary.

Shift Cylinders

Remove caps and check for contamination.

Inspections to be Made According to Manufacturer's Specifications

Clutch

Check clutch disc faces for wear.

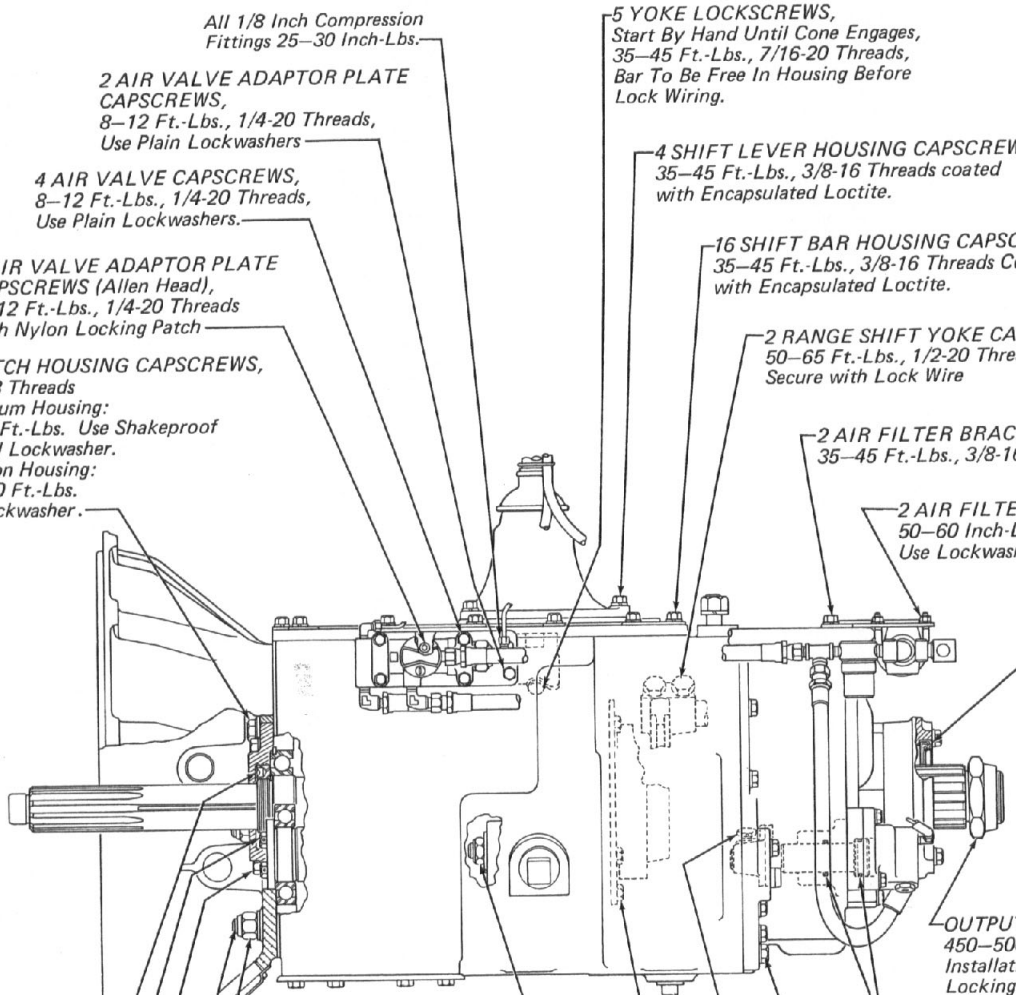
Check dampening action of clutch driven plate.

Release Bearing

Remove hand hole cover and check axial and radial clearance in release bearing.

Check relative position of thrust surface of release bearing with thrust sleeve on push type clutches.

Torque Recommendations



All 1/8 Inch Compression Fittings 25–30 Inch-Lbs.

2 AIR VALVE ADAPTOR PLATE CAPSCREWS, 8–12 Ft.-Lbs., 1/4-20 Threads, Use Plain Lockwashers

4 AIR VALVE CAPSCREWS, 8–12 Ft.-Lbs., 1/4-20 Threads, Use Plain Lockwashers.

2 AIR VALVE ADAPTOR PLATE CAPSCREWS (Allen Head), 8–12 Ft.-Lbs., 1/4-20 Threads with Nylon Locking Patch

4 CLUTCH HOUSING CAPSCREWS, 1/2 - 13 Threads
Aluminum Housing: 70–80 Ft.-Lbs. Use Shakeproof Internal Lockwasher.
Cast Iron Housing: 80–100 Ft.-Lbs.
Use Lockwasher.

5 YOKE LOCKSCREWS, Start By Hand Until Cone Engages, 35–45 Ft.-Lbs., 7/16-20 Threads, Bar To Be Free In Housing Before Lock Wiring.

4 SHIFT LEVER HOUSING CAPSCREWS, 35–45 Ft.-Lbs., 3/8-16 Threads coated with Encapsulated Loctite.

16 SHIFT BAR HOUSING CAPSCREWS, 35–45 Ft.-Lbs., 3/8-16 Threads Coated with Encapsulated Loctite.

2 RANGE SHIFT YOKE CAPSCREWS, 50–65 Ft.-Lbs., 1/2-20 Threads, Secure with Lock Wire

2 AIR FILTER BRACKET CAPSCREWS, 35–45 Ft.-Lbs., 3/8-16 Threads.

2 AIR FILTER BRACKET NUTS, 50–60 Inch-Lbs., 1/4-20 Threads, Use Lockwashers.

Install Seal Flush With Rear Bearing Cover.

OUTPUT SHAFT NUT, 450–500 Ft.-Lbs., (Oiled at Vehicle Installation). 2-16 Threads with Nylon Locking Insert.

Lubricate Splitter Cylinder O-Rings with Silicone Lubricant of 30,000 CS. Also Lube Range Shift Cylinder & Splitter Insert Valve O-Rings.

19 AUXILIARY HOUSING CAPSCREWS, 35–45 Ft.-Lbs., 3/8-16 Threads Coated with Encapsulated Loctite. Use Lockwashers on Capscrews Not So Equipped.

SPLITTER YOKE LOCKSCREW, 35–45 Ft.-Lbs., 7/16-20 Threads, Secure with Lock Wire.

OIL DRAIN PLUG, 45–55 Ft.-Lbs., 3/4 Pipe Threads.

6 AUX. DRIVE GEAR BEARING RETAINER CAPSCREWS, 35–45 Ft.-Lbs., 3/8-16 Threads, Secure with Lock Wire.

2 REVERSE IDLER SHAFT NUTS, 50–60 Ft.-Lbs. (Oiled), 5/8-18 Threads with Nylon Locking Insert.

6 CLUTCH HOUSING NUTS, 5/8-18 Threads
Aluminum Housing: 140–150 Ft.-Lbs. (Oiled) With Nylon Locking Insert. Use Plain Flat Washer.
Cast Iron Housing: 180–200 Ft.-Lbs. Standard Nut. Use Lockwasher.

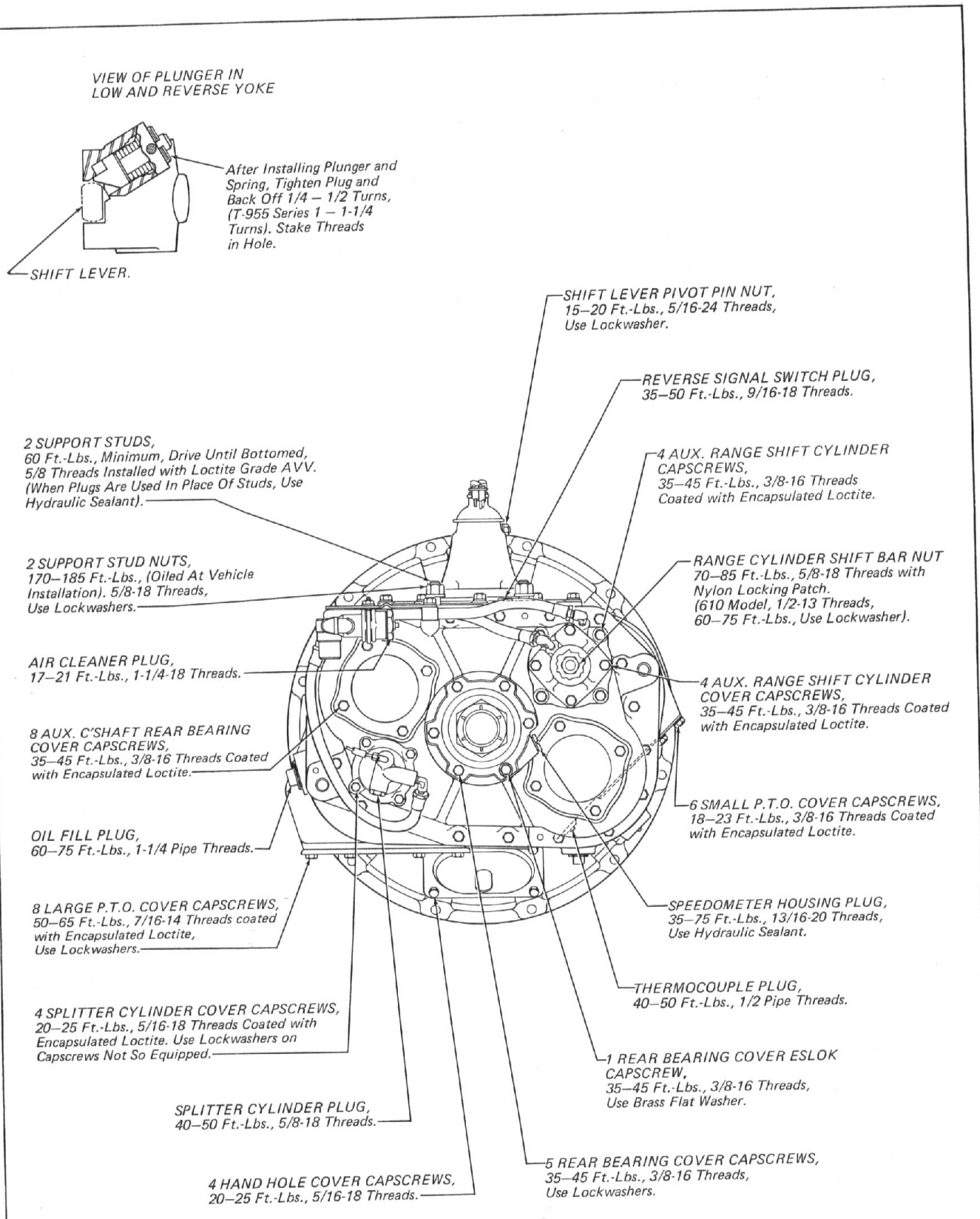
6 STUDS, 60 Ft.-Lbs. Minimum, Driven Until Bottomed, 5/8-11 Thread, Installed with Loctite Grade AVV.

6 FRONT BEARING COVER CAPSCREWS, 35–45 Ft.-Lbs., 3/8-16 Threads Coated with Encapsulated Loctite.

4 C'SHAFT FRONT BEARING RETAINER CAPSCREWS, 35–45 Ft.-Lbs., 3/8-24 or 1/2-20 Thread. Secure with Lockwire.

DRIVE GEAR NUT, 250–300 Ft.-Lbs., 2-1/8-16 L.H. Threads, Clean Threads with Solvasol or Equivalent Before Applying Loctite Grade AVV. Stake 2 Places.

Torque Recommendations (continued)



Conversion Tables

Decimal Equivalents

1/64 — .015625	17/64 — .265625	33/64 — .515625	49/64 — .765625
1/32 — .03125	9/32 — .28125	17/32 — .53125	25/32 — .78125
3/64 — .046875	19/64 — .296875	35/64 — .546875	51/64 — .796875
1/16 — .0625	5/16 — .3125	9/16 — .5625	13/16 — .8125
5/64 — .078125	21/64 — .328125	37/64 — .578125	53/64 — .828125
3/32 — .09375	11/32 — .34375	19/32 — .59375	27/32 — .84375
7/64 — .109375	23/64 — .359375	39/64 — .609375	55/64 — .859375
1/8 — .125	3/8 — .375	5/8 — .625	7/8 — .875
9/64 — .140625	25/64 — .390625	41/64 — .640625	57/64 — .890625
5/32 — .15625	13/32 — .40625	21/32 — .65625	29/32 — .90625
11/64 — .171875	27/64 — .421875	43/64 — .671875	59/64 — .921875
3/16 — .1875	7/16 — .4375	11/16 — .6875	15/16 — .9375
13/64 — .203125	29/64 — .453125	45/64 — .703125	61/64 — .953125
7/32 — .21875	15/32 — .46875	23/32 — .71875	31/32 — .96875
15/64 — .234375	31/64 — .484375	47/64 — .734375	63/64 — .984375
1/4 — .25	1/2 — .5	3/4 — .75	1 — 1.

Metric Conversions

1 mile = 1.609 kilometers (Km)

1 inch = 25.4 millimeters (mm)

1 pound = 0.453 kilograms (Kg)

1 pint = 0.473 liters (l)

1 pounds-feet = 1.356 Newton/Meters (N.m)

Metric Equivalents

MM	In.	MM	In.	MM	In.	MM	In.	MM	In.	MM	In.	MM	In.
1	.0394	21	.8268	41	1.6142	61	2.4016	81	3.1890	105	4.1339	205	8.0709
2	.0787	22	.8661	42	1.6535	62	2.4409	82	3.2283	110	4.3307	210	8.2677
3	.1181	23	.9055	43	1.6929	63	2.4803	83	3.2677	115	4.5276	215	8.4646
4	.1575	24	.9449	44	1.7323	64	2.5197	84	3.3071	120	4.7244	220	8.6614
5	.1969	25	.9843	45	1.7717	65	2.5591	85	3.3465	125	4.9213	225	8.8583
6	.2362	26	1.0236	46	1.8110	66	2.5984	86	3.3858	130	5.1181	230	9.0551
7	.2756	27	1.0630	47	1.8504	67	2.6378	87	3.4252	135	5.3150	235	9.2520
8	.3150	28	1.1024	48	1.8898	68	2.6772	88	3.4646	140	5.5118	240	9.4488
9	.3543	29	1.1417	49	1.9291	69	2.7165	89	3.5039	145	5.7087	245	9.6457
10	.3937	30	1.1811	50	1.9685	70	2.7559	90	3.5433	150	5.9055	250	9.8425
11	.4331	31	1.2205	51	2.0079	71	2.7953	91	3.5827	155	6.1024	255	10.0394
12	.4724	32	1.2598	52	2.0472	72	2.8346	92	3.6220	160	6.2992	260	10.2362
13	.5118	33	1.2992	53	2.0866	73	2.8740	93	3.6614	165	6.4961	265	10.4331
14	.5512	34	1.3386	54	2.1260	74	2.9134	94	3.7008	170	6.6929	270	10.6299
15	.5906	35	1.3780	55	2.1654	75	2.9528	95	3.7402	175	6.8898	275	10.8268
16	.6299	36	1.4173	56	2.2047	76	2.9921	96	3.7795	180	7.0866	280	11.0236
17	.6693	37	1.4567	57	2.2441	77	3.0315	97	3.8189	185	7.2835	285	11.2205
18	.7087	38	1.4961	58	2.2835	78	3.0709	98	3.8583	190	7.4803	290	11.4173
19	.7480	39	1.5354	59	2.3228	79	3.1102	99	3.8976	195	7.6772	295	11.6142
20	.7874	40	1.5748	60	2.3622	80	3.1496	100	3.9370	200	7.8740	300	11.8110

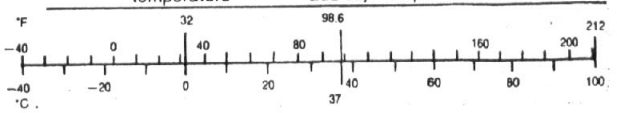
Metric Conversion Factors

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in²	square inches	6.5	square centimeters	cm²
ft²	square feet	0.09	square meters	m²
yd²	square yards	0.8	square meters	m²
mi²	square miles	2.6	square kilometers	km²
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft³	cubic feet	0.03	cubic meters	m³
yd³	cubic yards	0.76	cubic meters	m³
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm²	square centimeters	0.16	square inches	in²
m²	square meters	1.2	square yards	yd²
km²	square kilometers	0.4	square miles	mi²
ha	hectares (10,000 m²)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.46	gallons	gal
m³	cubic meters	35	cubic feet	ft³
m³	cubic meters	1.3	cubic yards	yd³
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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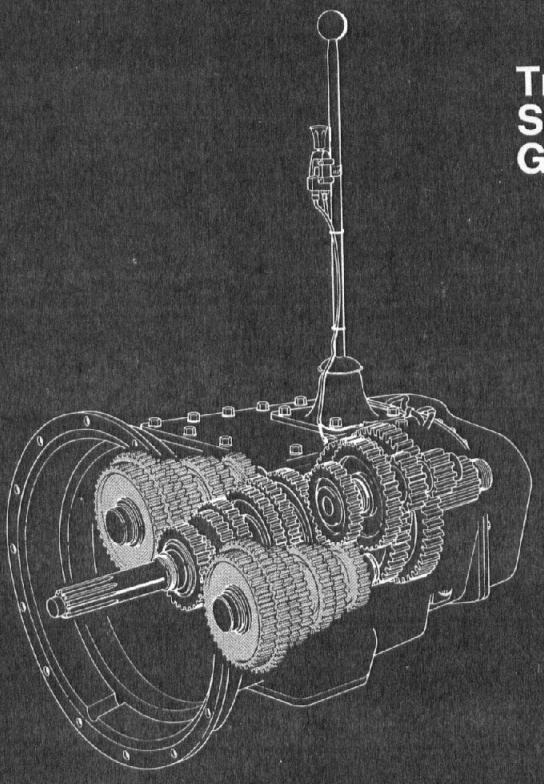


Trouble Shooting Guide

EATON Truck Components

Eaton Corporation
Transmission Division
Kalamazoo, Michigan 49007

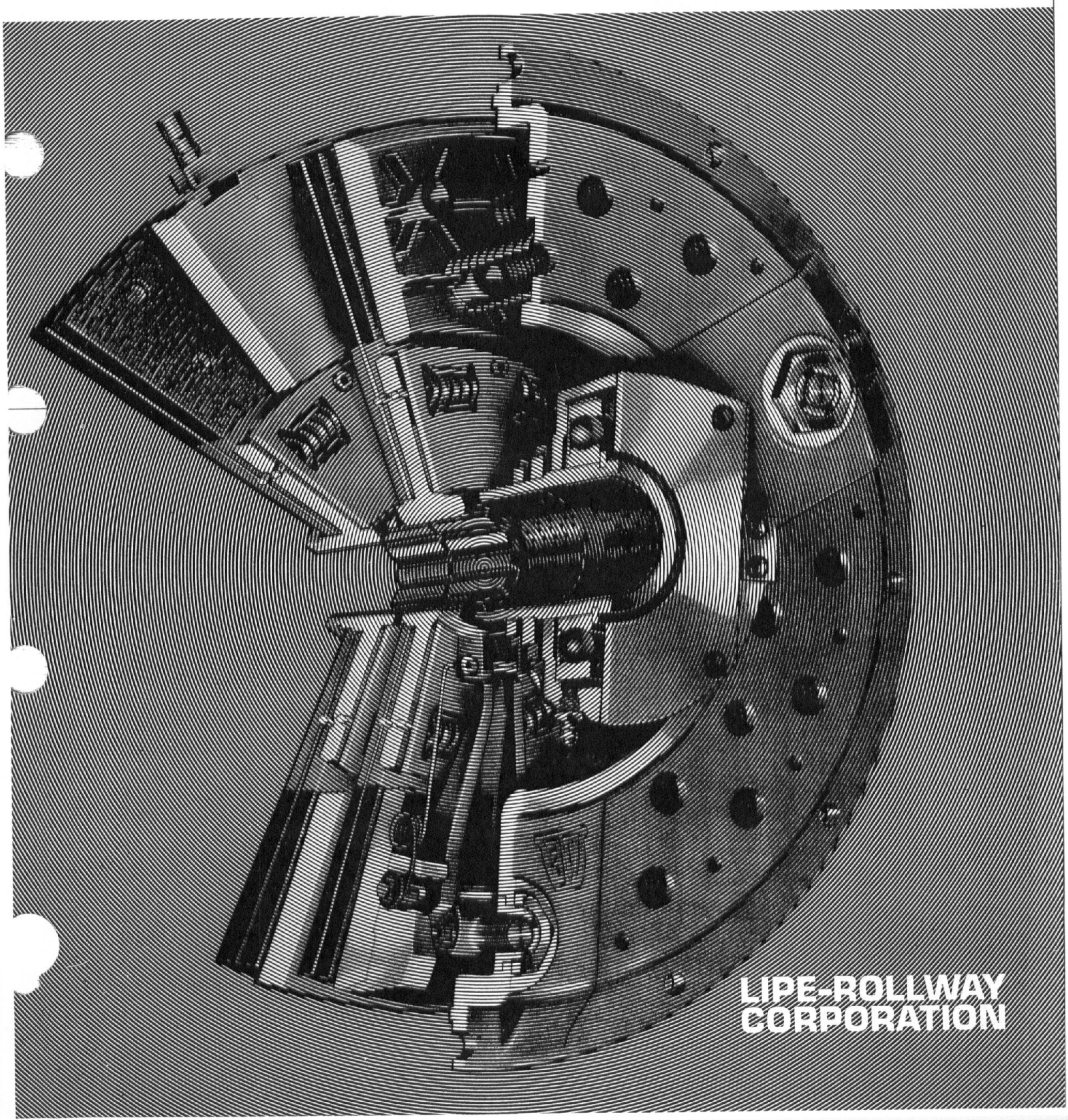
20M/12-75

Printed in U.S.A.

Form No. 102

SERVICE MANUAL

LIPE CLUTCH PRODUCTS



LIPE-ROLLWAY CORPORATION

GENERAL SERVICE MANUAL

Table of Contents

This manual is designed to help you get better results from your Lipe clutches.

It explains, in detail, all the things you need to know about Lipe clutch construction, installation, and adjustment.

Follow carefully the instructions and suggestions given in the manual. Lipe clutches will give excellent service under any circumstances, but you will get even better results if you follow the procedures shown in this manual. If you have any questions about procedure, please feel free to write to our Service Department.

Lipe clutches and parts are the finest that can be made. Their design is simple and practical. They are manufactured by modern, precision methods from materials of the highest quality. This is why you'll find it profitable to use, or continue to use Lipe clutches.

Lipe Clutches are Standard on Heavy Equipment Throughout the World

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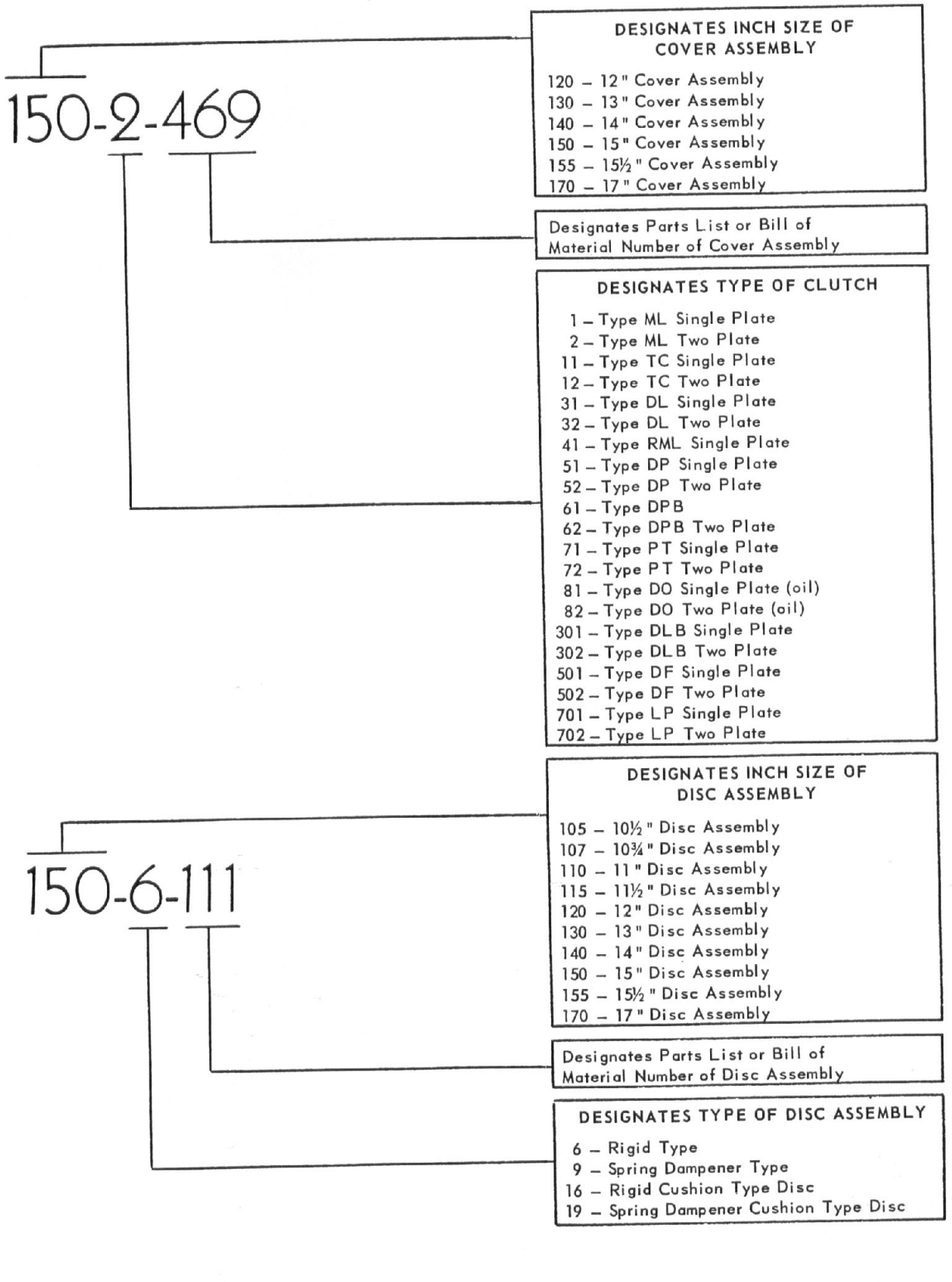
GENERAL SERVICE MANUAL

EXPLANATION OF NUMBERING SYSTEM



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TYPE ML CLUTCHES

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE ML

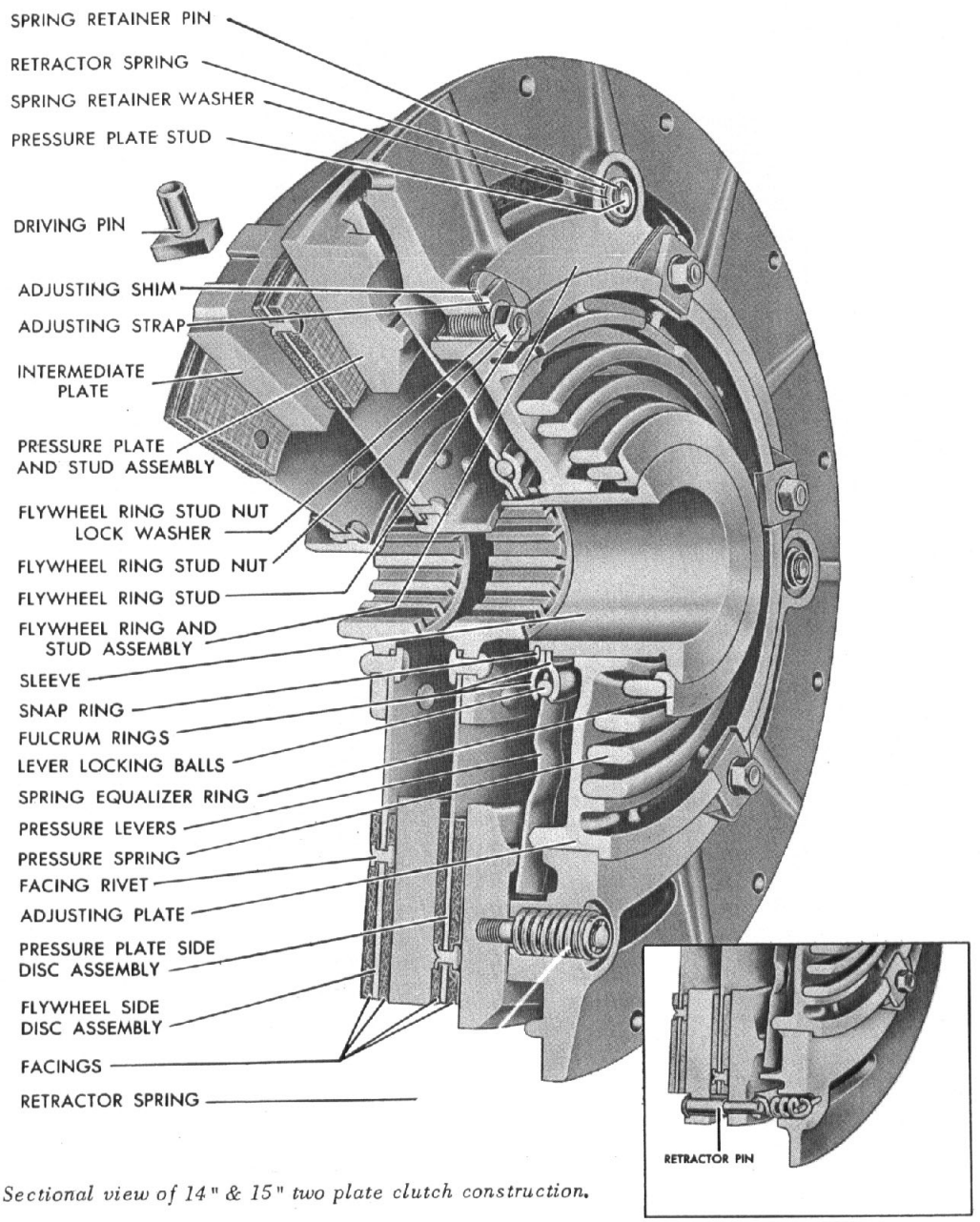

Fig. 1 – Sectional view of 14" & 15" two plate clutch construction.

Fig. 1A – Sectional view showing type of pressure plate retractor spring and pin on 13" two plate clutch.

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GENERAL SERVICE MANUAL

CONSTRUCTION

The Lipe Type ML (multiple lever) clutch is of the adjustable, dry disc, push type construction. It is a simple, precision-built, heavy-duty unit embodying few parts. Maintenance can be accomplished very easily without the use of special tools. Adjustment, to compensate for facing wear, is simple, and is accomplished by removing shims. This simple operation also restores the original spring pressure and does not disturb the running balance of the clutch. Thus long clutch life and smooth operation are maintained.

OPERATION

The operation of the Lipe Type ML clutch is as follows: The clutch flywheel ring is attached to the engine flywheel by means of driving lugs of the pressure plate fitting into mating slots in the flywheel ring.

To disengage this unit, the release sleeve is pushed towards the engine flywheel by the clutch release bearing compressing the pressure spring, thus relieving the twenty pressure levers of spring pressure. The pressure plate is retracted from contact with the driven disc assembly by means of pressure plate retracting springs, thus accomplishing complete clutch release.

During engagement, the clutch release sleeve is allowed to move out away from the engine flywheel at which time the spring pressure is transmitted through the twenty pressure levers which multiply the spring pressure and deliver it to the pressure plate. These twenty pressure levers bear against the continuous fulcrums of both the adjusting plate and the pressure plate which provides for parallel movement of the pressure plate toward the engine flywheel. The basic design of this clutch provides for parallel movement of the pressure plate which allows every square inch of the driven disc facing to be contacted at the same moment, thus providing a smooth clutch engagement. The twenty pressure levers also tend to cushion the engagement of the clutch and make for smooth non-shock loading. These same pressure levers are louvered to provide a fan-like cooling of the clutch.

CLUTCH INSTALLATION

INSPECT ENGINE FLYWHEEL

(1) Check flywheel for correct depth. See chart on pages

(2) Make sure release bearing and flywheel or pilot bearing are in usable condition. Pilot bearing should be a finger press fit in flywheel and on transmission drive shaft.

(3) Friction face of flywheel should be smooth and clean. *CAUTION:* The friction face of the flywheel must be free from heat cracks, score marks, and foreign matter, as the presence of any one of these conditions will cause the facings to quickly disintegrate.

INSTALLING SINGLE-PLATE CLUTCH ASSEMBLY

(1) Try cover plate assembly in flywheel before inserting driven disc assembly, so as to make sure it is a free fit in the flywheel.

(2) Install driven disc assembly in the flywheel. Refer to Fig. 2.

(3) Bolt the clutch assembly to the flywheel and screw in each bolt until it contacts cover plate assembly. Then gradually tighten opposite bolts until assembly is drawn tight to flywheel.

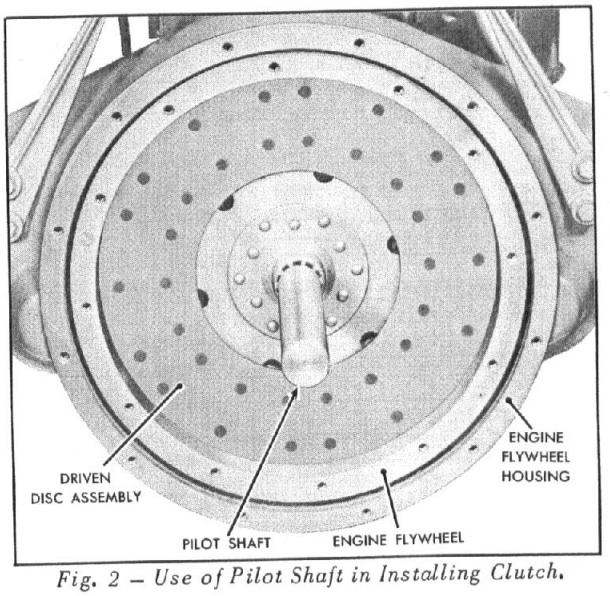

Fig. 2 – Use of Pilot Shaft in Installing Clutch.

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(4) Check for proper Dimension "A". See chart on page 8.

(5) Care should be used in installing the transmission to prevent bending or otherwise impairing the disc assembly which will cause clutch drag.

(6) See Par. 9 and chart on page 6 for release travel requirements.

(7) To facilitate the assembly of the transmission to the engine, the use of a spare splined pilot shaft (Fig. 2) to align the driven disc assembly while bolting the clutch in place is essential. The pressure plate end of the driven disc assembly hub has been chamfered to facilitate the insertion of the drive shaft, whereas the flywheel end of the hub is left plain.

INSTALLING TWO-PLATE CLUTCH ASSEMBLY

(1) Inspect the four intermediate plate driving pins in flywheel. *Make certain that shanks of pins are press fitted into flywheel rim, and that the heads are squarely aligned with the friction face.* *NOTE:* To facilitate the alignment of the driving pins refer to Fig. 3 which illustrates intermediate plate driving pin alignment gauge #T10670A in use.

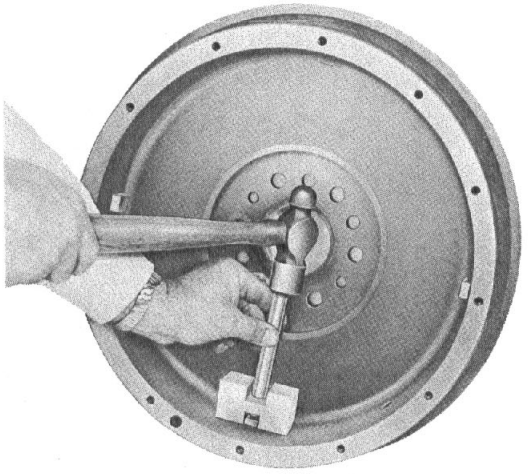

Fig. 3 – Driving Pin Alignment Gauge.

(2) Make sure there is clearance between heads of driving pins and driving slots in intermediate plate by placing intermediate plate over pins. *NOTE:* The intermediate plate should fit over the driving pins with perceptible circumferential lash before the clutch is assembled to the engine flywheel. A clearance of .007" to .011" is required.

(3) The 13" two-plate clutch assembly incorporates retractor spring pins to retract the intermediate plate when clutch is released. This necessitates the driven disc assembly next to the pressure plate being in place before the intermediate plate is assembled to the cover plate assembly. See Fig. 1a.

(4) The two disc assemblies for a two plate clutch may or may not be identical or interchangeable. In most cases they will not be interchangeable and will be marked either flywheel side or pressure plate side. They must be positioned with the side of the disc as marked, next or adjacent to the respective part. In no instance shall the hubs be allowed to approach pilot bearing or come together within 5/32".

(5) Bolt clutch cover plate to flywheel. Screw in each bolt until it contacts the cover plate. Then gradually tighten opposite bolts until assembly is drawn tight to flywheel.

(6) Check for proper Dimension "A." See chart on page 8.

(7) Care should be used in installing the transmission, to prevent bending or otherwise impairing the disc assemblies which will cause clutch drag.

(8) When installing two plate clutches, it is essential that a splined shaft or aligning shaft be used with a key to properly align the two disc assemblies. Otherwise the instruction for installing two plate clutches are the same as for single plate assemblies.

(9) To obtain complete disengagement of Type ML clutch assemblies the sleeve must be moved a specified distance from the engaged position. Assuming the release bearing clearance (distance between the sleeve and the release bearing) to be 1/8" when the clutch is in the engaged position, the release bearing must move forward 1/8" to take up this clearance before it contacts the sleeve and then move the normal amount of travel required to disengage the clutch as shown below.

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ML RELEASE TRAVEL CHART

Clutch Size & Type	Release Bearing Clearance	Normal Sleeve Travel	Total Bearing Travel Required
12" ML Single Plate	1/8"	3/8"	1/2"
13" ML Single Plate	1/8"	7/16"	9/16"
14" ML Single Plate	1/8"	7/16"	9/16"
14" RML Single Plate	1/8"	5/16"	7/16"
15" ML Single Plate	1/8"	1/2"	5/8"
15" RML Single Plate	1/8"	1/2"	5/8"
13" ML Two Plate	1/8"	1/2"	5/8"
14" ML Two Plate	1/8"	1/2"	5/8"
15" ML Two Plate	1/8"	1/2"	5/8"

CLUTCH ADJUSTMENT

PERIODIC INSPECTION

We recommend that the clutch be kept in proper adjustment by periodic inspection of the Dimension "A" which is referred to in Fig. 9 and in the Clutch Adjustment Chart (Page 8) in this manual. By so doing, long and satisfactory clutch life will be obtained. *Never wait for a clutch to slip before adjusting it, as it is then too late to make an adjustment.* Once the facings are burned, through slippage, they quickly disintegrate, and are short-lived thereafter. Do not adjust the clutch pedal to restore the original "free travel" (usually 1-1/2"), but instead, pull shims as directed in the following procedure.

CHECK DIMENSION "A" (Clutch Engaged)

With clutch in engaged position, place gauge (T-2187) between face of clutch release sleeve and clutch release bearing. Turn thumb screw of gauge to just contact the ground surface of clutch cover. Dimension "A" is the distance from underside of gauge to end of thumb screw. NOTE: Obtain Dimension "A" by adding or removing shims as required. Removing one shim from under each adjusting strap reduces Dimension "A" approximately 3/32". Likewise, adding one shim increases Dimension "A" 3/32".

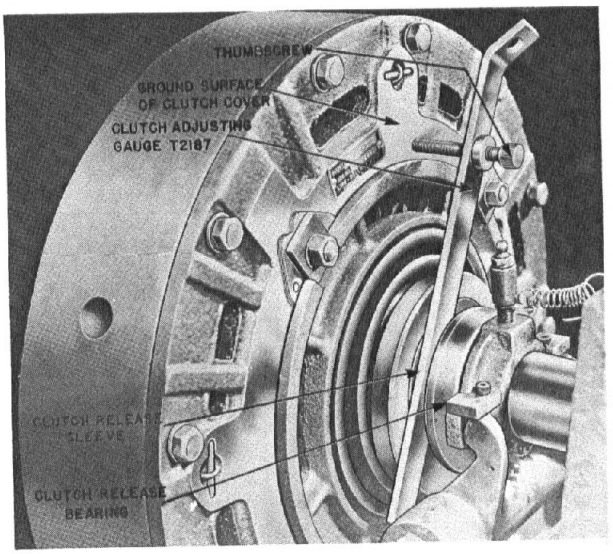

Fig. 4

BLOCK CLUTCH PEDAL (In Released Position)

Block clutch pedal in released position. This prevents bending of the adjusting straps and facilitates loosening of the adjusting nuts.

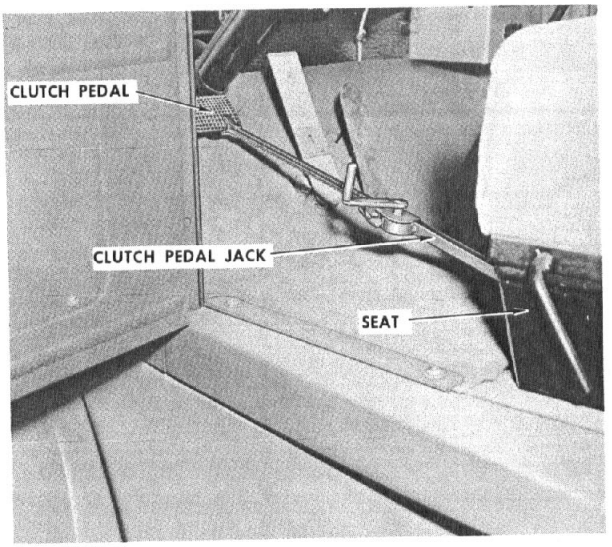

Fig. 5

LOOSEN ADJUSTING NUTS

Loosen adjusting nuts 5 full turns.

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TYPE ML CLUTCHES

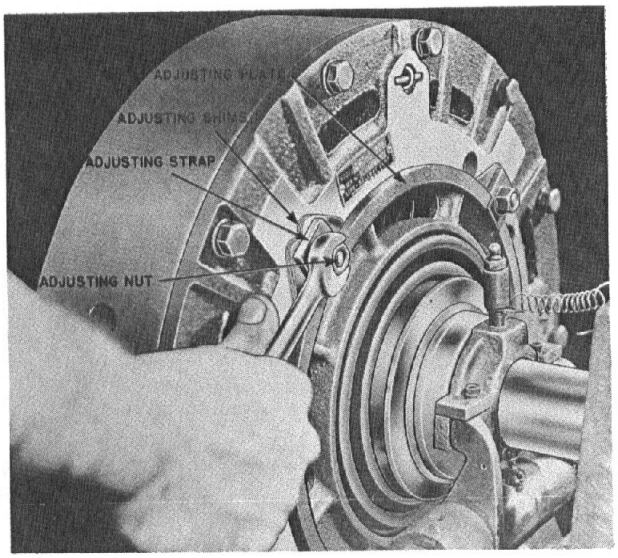

Fig. 6

REMOVE CLUTCH PEDAL JACK
(As shown in Fig. 5)

Clutch pedal jack is shown in Fig. 5. Removing it will allow the adjusting plate to move back for easy removal of shims.

REMOVE SHIMS

(a) To remove shims, use sharp nosed pliers or cotter pin puller.

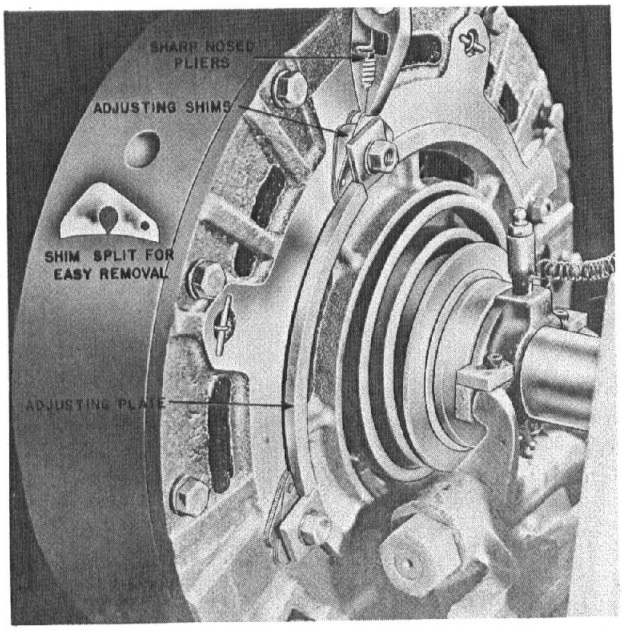

Fig. 7

(b) Removing one shim from each stud reduces Dimension "A" approximately 3/32". Likewise, adding one shim increases Dimension "A" 3/32".

(c) *CAUTION:* Make sure that an equal quantity of shims remains on each stud before proceeding with next step.

REBLOCK CLUTCH PEDAL (As shown in Fig. 5)

This is important because it prevents bending of the adjusting straps. It also facilitates the tightening of adjusting nuts.

TIGHTEN ADJUSTING NUTS FIRMLY

Tighten adjusting nuts, remove pedal jack, and recheck Dimension "A" before proceeding with next step.

CHECK CLEARANCE

Check clearance between clutch release sleeve and clutch release bearing.

(a) If clearance is not 1/8", adjust vehicle clutch pedal linkage to obtain this 1/8" clearance.

(b) This 1/8" clearance normally results in 1-1/2" of clutch pedal "free travel."

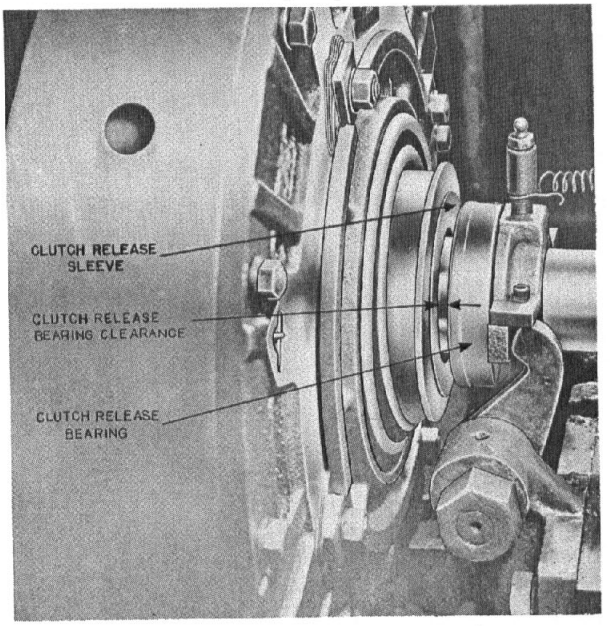

Fig. 8

Important! Use Only GENUINE LIPE PARTS

ML CLUTCH DATA CHART

Model Number	Dimension "A" +1/16"–0"	Quantity of Shims	Flywheel Depth	Facing Thickness
120-1-314	1 1/16"	6	1.920"	5/32"
120-1-361	1 1/8"	8	1.875"	5/32"
130-1-407	1 1/16"	8	1.843"	5/32"
150-1-466	1 3/16"	8	1.812"	5/32"
150-1-468	1 3/16"	7	1.812"	5/32"
150-2-469	1 3/16"	12	2.937"	5/32"
140-2-471	1 1/8"	7	2.937"	9/64"
140-41-483	1 1/4"	8	1.312"	5/32"
150-41-486	1 1/8"	8	1.812"	5/32"
130-41-487	1 1/8"	8	1.500"	5/32"
140-41-495	1 1/4"	9	1.812"	5/32"
140-1-504	1 3/8"	9	1.812"	5/32"
150-2-514	1 3/16"	12	2.937"	5/32"
150-1-516	1 3/16"	8	1.812"	5/32"
140-2-517	1 1/8"	7	2.937"	9/64"
150-1-518	1 3/16"	11	1.750"	5/32"
130-1-540	1 7/16"	9	1.843"	5/32"
140-1-555	1 5/16"	11	1.187"	5/32"
140-1-611	1 1/8"	8	1.812"	5/32"
130-1-621	2 3/16"	9	1.843"	5/32"
150-2-639	1 3/16"	12	2.937"	5/32"
140-2-765	1 1/8"	8	2.937"	5/32"
140-1-822	1 3/8"	9	1.812"	5/32"

Intermediate Plate Thickness
13"–.750 14"–.750 15"–.705

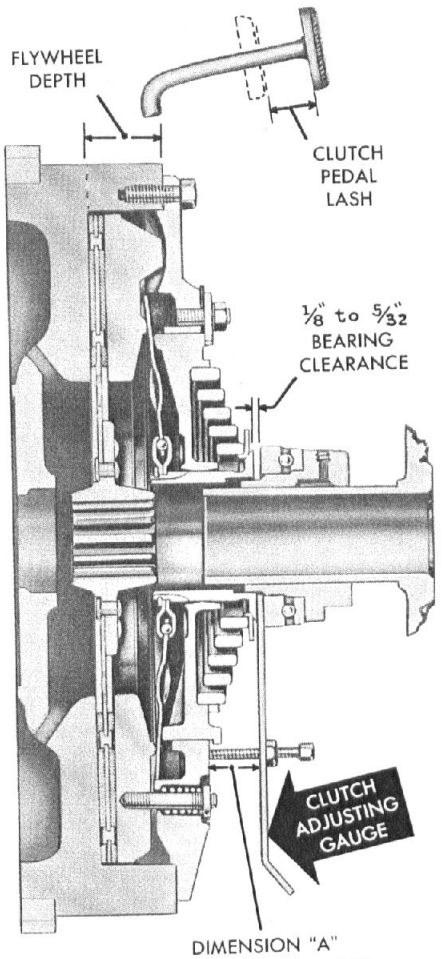

Fig. 9 – Dimension "A".

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TYPE TC CLUTCHES

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE TC

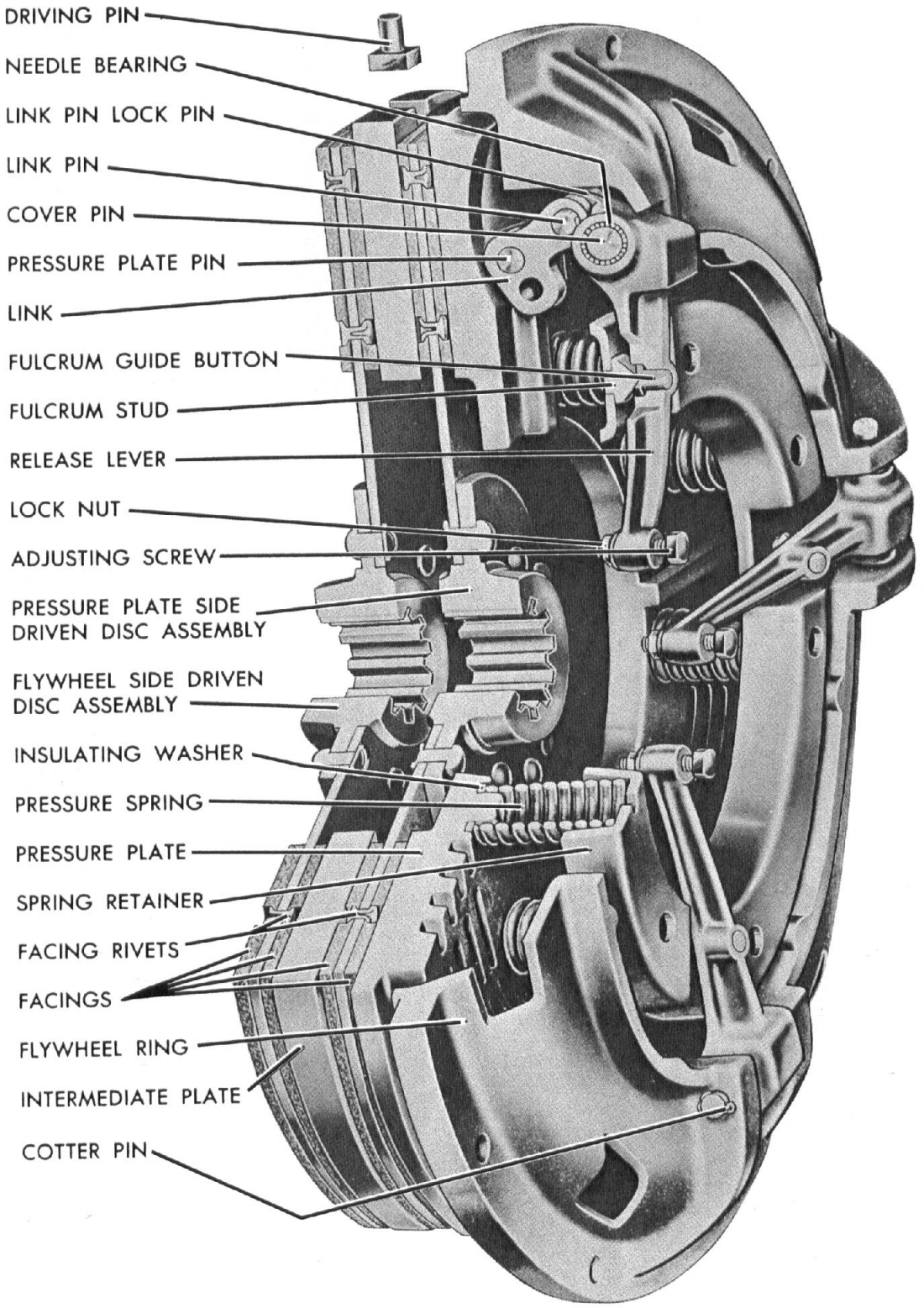

Fig. 10 – Sectional view of Type TC Two-Plate Clutch.

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CLUTCH INSTALLATION

1. *CAUTION:* Be sure hold-down bolts are used to hold the springs compressed and free the release levers before clutch is assembled to the engine flywheel.

2. Make sure the flywheel is the correct depth and the friction face is smooth and clean. (See chart Page 12 on proper flywheel depth.)

3. Inspect the release bearing and flywheel or pilot bearing to make certain they are in usable condition. The pilot bearing should be only a finger press fit in the flywheel and on the transmission shaft.

4. Try the cover plate assembly in the flywheel before inserting the disc assembly so as to make certain the clutch pilot diameter is a free fit in the flywheel.

5. Install driven disc assembly of the correct thickness (see chart page 12) with pressure plate end of hub which has chamfered or pointed ends on splines to assist in the insertion of the transmission drive shaft towards you.

6. Install spare splined shaft or clutch aligning arbor through the disc assembly hub into the flywheel pilot bearing. This will center the disc assembly and facilitate assembling the transmission in place.

7. Install the cover plate assembly in the engine flywheel.

CAUTION: Push inner ends of the release levers in toward the engine flywheel before starting to tighten the opposite cap screws attaching the clutch to the engine flywheel. Screw in each cap screw until it contacts the clutch cover. Then gradually tighten the opposite cap screw until the clutch assembly is drawn tight to the flywheel. *Do not* force the clutch into the engine flywheel with the attaching cap screws as the component parts of the clutch may be damaged.

REMOVE HOLD-DOWN BOLTS

8. Remove hold-down bolts from the clutch.

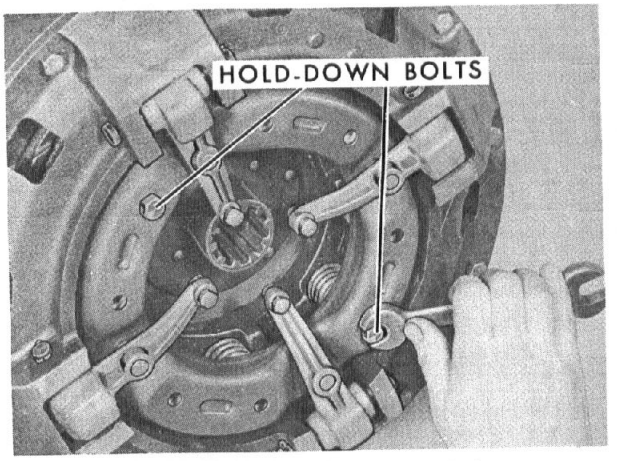

Fig. 11 – Removing Hold-Down Bolts.

ADJUSTING RELEASE LEVERS (Fig. 12)

9. Using straight edge and scale or suitable tool, set adjusting screws in the ends of the release levers to the proper "Dimension A" shown in chart on page 12 with respect to the particular clutch model involved. "Dimension A" is the distance from the ground surface on the raised lever bosses of the clutch flywheel ring (cover) to the heads of the lever adjusting screws when clutch is bolted in engine flywheel and in the engaged position. The contact points of these adjusting screws should be set a uniform distance from the underside of the straight edge. The adjusting screws must be in the same plane within 1/32". To change the position of the screws, loosen the lock nuts and turn the screw as required to obtain "Dimension A." Be sure to tighten locks securely after making screw adjustment.

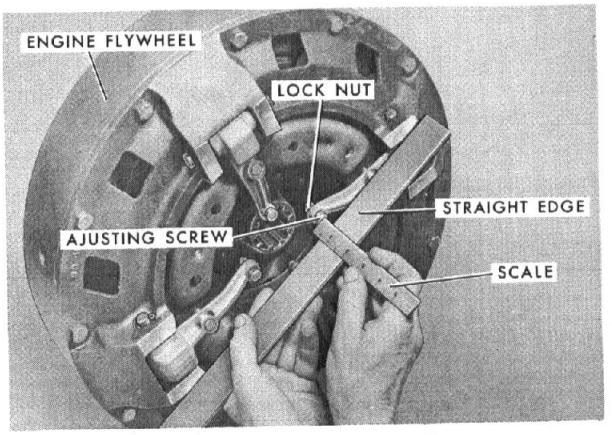

Fig. 12 – Adjusting Release Levers.

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TYPE TC CLUTCHES

VEHICLE CLUTCH LINKAGE

10. Check the vehicle clutch release linkage for excessive wear and resulting lost movement that can cause incomplete release of the clutch (clutch drag) and improper release bearing clearance, which causes clutch slippage. Replace worn parts.

11. *IMPORTANT:* Set the vehicle clutch release linkage so as to provide 1/8" release bearing clearance between the contact face of the bearing and the ends of the clutch release lever adjusting screws. This usually results in 1-1/2" of clutch pedal "free travel" (defined as first easy movement of the clutch pedal). Be sure the 1-1/2" of clutch pedal "free travel" makes approximately 1/8" actual movement of the clutch release bearing and that no lost motion due to worn release linkage is involved.

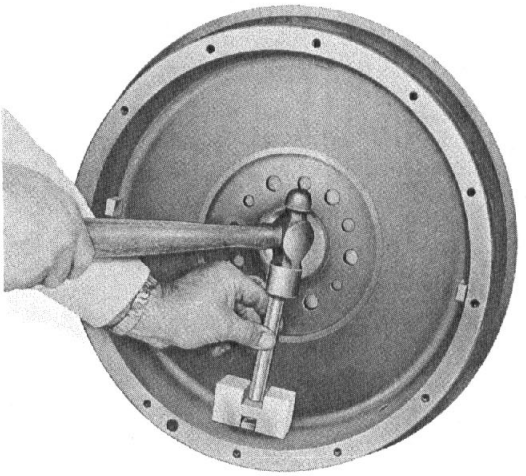

Fig. 13 – Aligning Drive Pins in Flywheel Using Lipe Tool T-10670.

SPECIAL INSTRUCTIONS FOR TWO-PLATE CLUTCHES

1. Check the driving pins and the intermediate plate for wear.

2. The driving pins should be installed in the engine flywheel (press fit) and squarely aligned with the friction face of the flywheel. It is recommended that tool T-10670 Fig. 13 be used. If this tool is not available, place a machinist square firmly against the rim of the flywheel and make sure the contact face of the driving pins have even contact with the square Fig. 14. *NOTE:* Tool #T-10670A is not suitable for Type TC drive pins.

3. Check the clearance between the heads of the driving pins and the driving slots in the mating intermediate plate by placing the intermediate plate over the pins, making certain the plate fits freely before the clutch is assembled to the engine. If excessive clearance between the slots of the intermediate plate and the driving pins exists, new parts should be installed.

4. Try the clutch in the engine flywheel before installing driven discs and intermediate plate to make certain the clutch pilot diameter is a free fit in the bore of the flywheel.

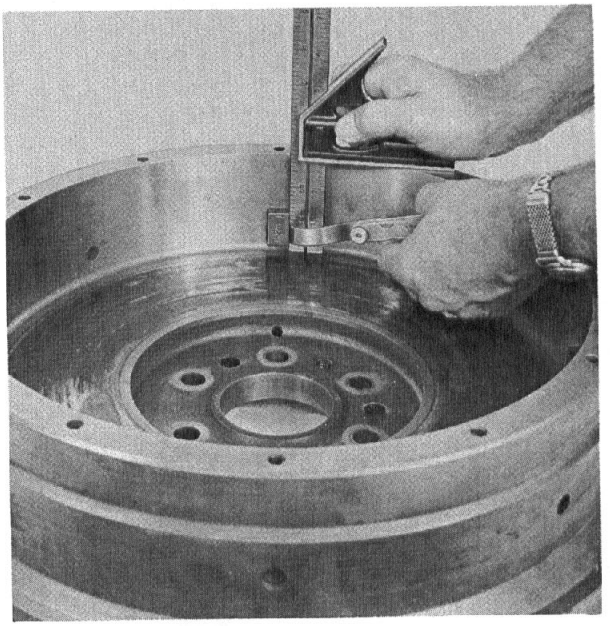

Fig. 14 – Aligning Drive Pins in Flywheel Using Machinist Square and Feeler Gauge.

5. When installing disc assemblies, note that the one marked "Flywheel Side" should be installed with this marking next to the friction face of the flywheel. The disc assembly marked "Pressure Plate Side" should be installed with this marking next to the pressure plate friction surface of the clutch. This is important so as to prevent hub interference. Some discs will be marked intermediate plate side instead of flywheel or pressure plate side.

Important! Use Only GENUINE LIPE PARTS

6. Use spare spline shaft to align disc assemblies so as to make the installation of the transmission possible.

7. The engine flywheel friction face should be clean and smooth. If worn or heat-checked, remachine, maintaining the correct flywheel depth as shown on the chart in this manual with respect to the particular clutch model involved.

8. Check the condition of both the engine flywheel pilot bearing and the clutch release bearing. A damaged or worn-out pilot bearing causes "clutch drag." If adjusting screws in the ends of the clutch release levers are worn, this indicates the release bearing should be replaced as well as adjusting screws.

9. To obtain complete disengagement of type TC clutch assemblies, the release levers must be actuated a specified distance from the engaged position. Assuming the release bearing clearance (distance between the clutch release levers and the release bearing) to be 1/8" when the clutch is in the engaged position, the release bearing must move forward 1/8" to take up this clearance before it contacts the release levers and then move the normal amount of travel required to disengage the clutch as shown on the release travel chart.

TC CLUTCH DATA CHART

Model Number	Dimension "A"	Flywheel Depth +.007" -.000"	Facing Thickness
170-11-355	11/32"	1.218"	3/16"
155-11-377	15/32"	1.781"	5/32"
155-11-379	15/32"	1.781"	5/32"
170-11-452	11/32"	1.218"	3/16"
155-11-457	15/32"	1.781"	5/32"
170-11-458	11/32"	1.218"	3/16"
170-11-523	3/4"	1.218"	3/16"
170-11-527	11/32"	1.218"	3/16"
170-11-664	11/32"	1.218"	3/16"
170-12-690	11/32"	2.321"	5/32"
170-12-715	3/4"	2.321"	5/32"
170-12-722	11/32"	2.321"	5/32"
170-12-733	3/4"	2.321"	5/32"
170-12-737	11/32"	2.321"	9/64"
170-12-744	3/4"	2.321"	5/32"
170-12-777	3/4"	2.321"	5/32"
170-12-799	3/4"	2.321"	5/32"

Intermediate plate thickness .749"

TC RELEASE TRAVEL CHART

Clutch Size & Type	Release Bearing Clearance	Normal Release Bearing Travel	Total Bearing Travel Required
15½ TC Single Plate	1/8"	7/16"	9/16"
17 TC Single Plate	1/8"	7/16"	9/16"
17-2 TC Two Plate	1/8"	1/2"	5/8"

Important! Use Only GENUINE LIPE PARTS

TYPE DP CLUTCHES

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE DP

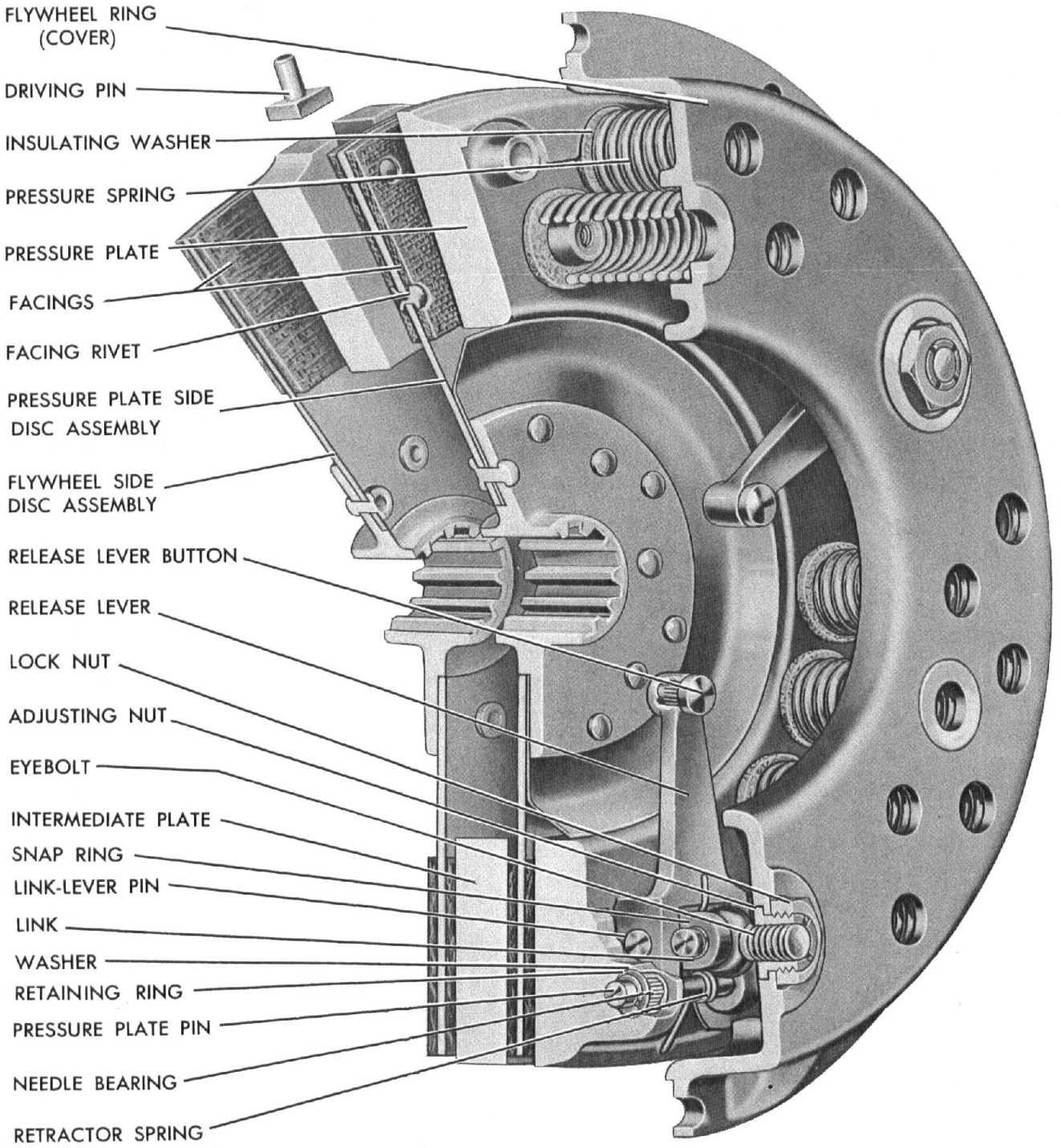

Fig. 15 – Sectional view of Type DP Two-Plate Clutch.

Important! Use Only GENUINE LIPE PARTS

CONSTRUCTION

The Lipe Direct Pressure clutches are simple, precision built, heavy duty units embodying few parts; thus maintenance can be accomplished very easily without the use of special tools. It is of the dry disc, push type construction, with the basic design being that no internal clutch adjustment is required to compensate for wear, as this is accomplished by the conventional and simple method of clutch pedal adjustments.

OPERATION

The operation of the Lipe Direct Pressure clutch is as follows: The clutch flywheel ring (cover) is attached to the engine flywheel and drives the pressure plate by means of driving lugs in the flywheel ring (cover) and mating slots in the pressure plate.

Depressing the clutch pedal disengages the clutch, by allowing the release bearing to contact and move the release levers toward the engine flywheel resulting in the pressure springs being compressed and the pressure plate being retracted away from the disc assembly; thereby disengaging the clutch.

Releasing the clutch pedal engages the clutch by allowing the release bearing and release levers to move away from the engine flywheel and the pressure springs to expand and exert pressure against the pressure plate, resulting in the disc assembly being gripped between friction surfaces of engine flywheel and pressure plate; thereby completely engaging the clutch.

CLUTCH INSTALLATION

INSPECT ENGINE FLYWHEEL

(1) Check flywheel for correct depth. See chart on pages 21 and 22.

(2) Make sure release bearing and flywheel pilot bearing are in useable condition. Pilot bearing should be a finger press fit in flywheel and on transmission drive shaft.

(3) Friction face of flywheel should be smooth and clean. *CAUTION:* The friction face of the flywheel must be free from heat cracks, score marks and foreign matter, as the presence of any one of these conditions will cause the clutch facings to quickly disintegrate.

INSTALLING CLUTCH ASSEMBLY

(1) Try cover assembly in flywheel before inserting driven disc assembly, so as to make sure it is a free fit in the flywheel.

(2) Install driven disc assembly in the engine flywheel making sure long end of hub faces clutch cover assembly. To facilitate the assembly of the transmission to the engine the use of a spare splined pilot shaft (Fig. 16) to align the driven disc assembly while bolting the clutch in place is essential. The side of the clutch driven disc assembly that faces the clutch pressure plate, has a chamfer on the end of the splined hub to facilitate the insertion of the transmission drive shaft.

(3) Bolt the clutch assembly to the flywheel and screw in each bolt until it contacts cover plate assembly. Then gradually tighten opposite bolts until assembly is drawn tight and completely into flywheel.

(4) Remove (3) hold down bolts previously installed.

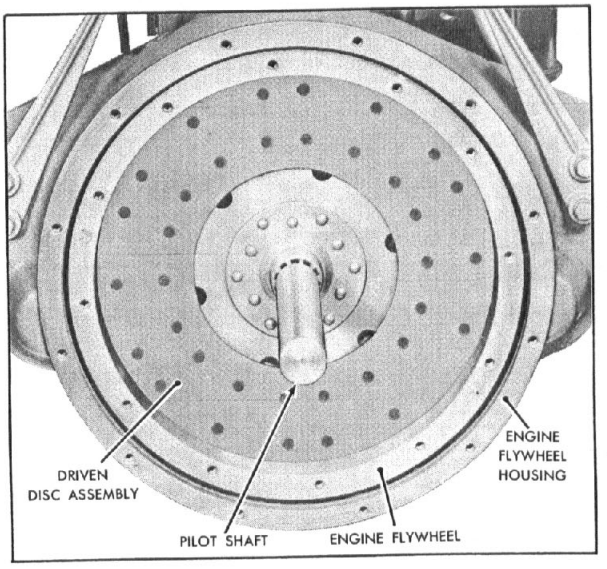

Fig. 16 – Use of Pilot Shaft in Installing Clutch.

Important! Use Only GENUINE LIPE PARTS

(5) *NOTE:* It is very important that the correct cap screws be used when attaching the cover assemblies to flat flywheels. The shank of the attaching cap screws are a close fit to the holes in the cover and the shank extends into a counter bore in the flywheel. If the flywheel has been excessively re-machined, this counter bore may become too shallow which will necessitate replacing the flywheel or deepen the counter bore.

INSTALLING DP TWO PLATE CLUTCH ASSEMBLY

(1) The intermediate plate driving pins must be removed if the flywheel is to be machined. Replace drive pins when replacing clutch.

(2) The driving pins must be installed with the contact face perfectly square to the friction face of the flywheel. To assure perfect alignment, it is recommended that a tool (Lipe T-10670A) be used. (Refer to Fig. 17). If this tool is not available, place a machinist square firmly on the rim of the flywheel and make sure the contact face of the driving pins have even contact with the square (Fig. 19 and 20, page 16).

(3) The 14" two plate type DP clutch driving pins are held in place by lock nuts on the threaded end projecting through the flywheel which must be securely tightened. The 15" two plate driving pins should be locked in place by cup point Allen screws located in the bottom of the tapped holes used for attaching the cover assembly to the flywheel. After the driving pins are properly aligned and secured and a new pilot bearing installed, you are now ready to install the clutch into the flywheel. It is essential that a splined shaft of the correct size for the pilot bearing and driven discs be used to align the driven discs before the cover assembly is attached to the flywheel.

(4) Two-plate driven discs that are identical and interchangeable are marked "intermediate plate side" to indicate their proper positioning. Those driven discs that are not identical and/or interchangeable are marked "Pressure plate side" or "Flywheel side" to indicate proper position.

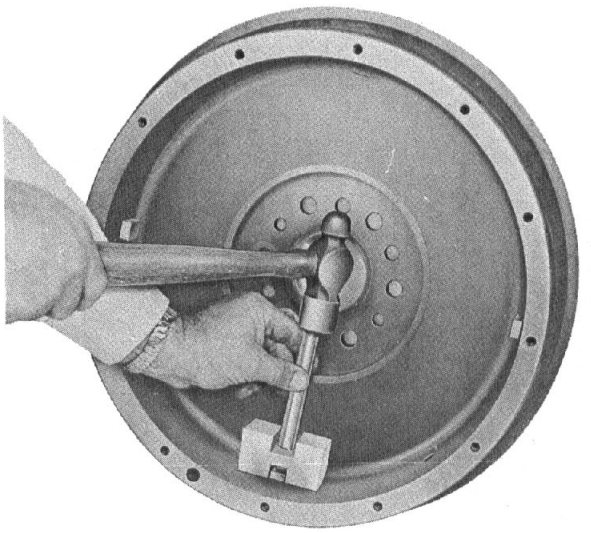

Fig. 17 – Aligning Drive Pins in Flywheel Using Lipe Tool T-10670A.

(5) Install the flywheel side disc in the flywheel and then place the intermediate plate on the driving pins and check for lash or free play at the driving slots. The intermediate plate should fit over the driving pins with a clearance of not less than .007" at the contact faces which will permit free movement of the intermediate plate. If the clearance exceeds .012", the intermediate plate may cause some noise when the clutch is disengaged.

(6) With the splined alignment shaft holding the driven discs in position the cover assembly can now be attached to the flywheel. Attaching cap screws should be evenly tightened until the cover is drawn tight to the flywheel. New cover assemblies have either wooden blocks positioned between the release levers and the cover or hold down bolts which facilitate assembly to the flywheel. Make sure these blocks or hold down bolts are removed after installation of cover assembly.

(7) After the wood blocks or hold down bolts and splined alignment shaft have been removed, the "A" dimension should be checked to assure the proper seating of the cover assembly to the flywheel. See Fig. 19 and 20 on page 16 and chart on pages 26–28.

(8) Care should be used in installing the transmission to prevent bending or otherwise impairing the disc assembly which will cause clutch drag.

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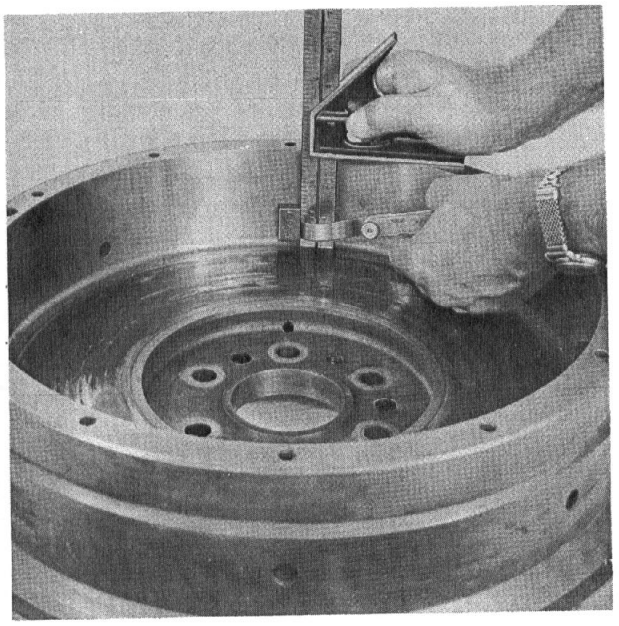

Fig. 18 – Aligning Drive Pins in Flywheel Using Machinist Square and Feeler Gauge.

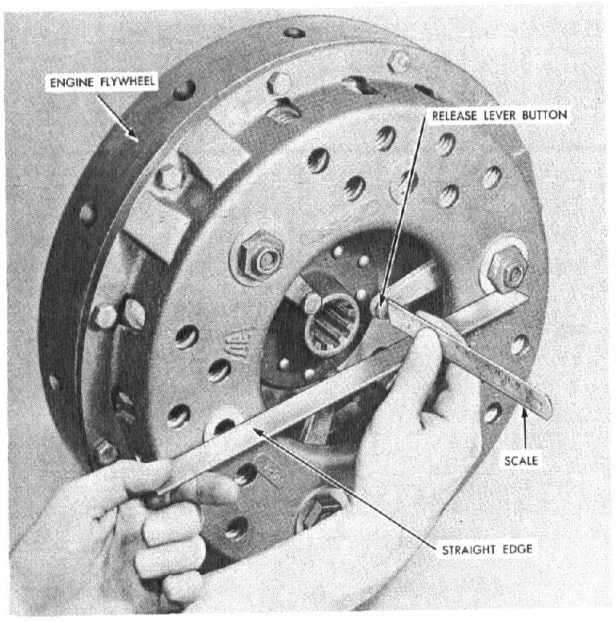

Fig. 19 – Checking Dimension "A".

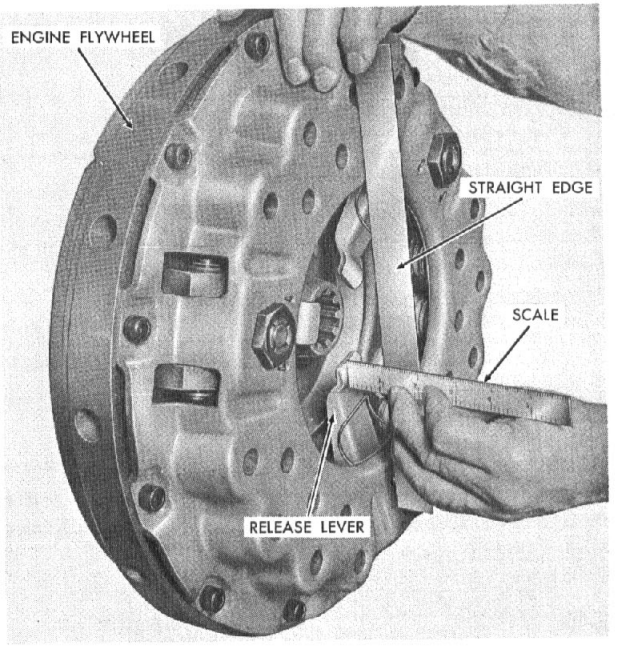

Fig. 20 – Checking Dimension "A".

CLUTCH PEDAL ADJUSTMENT

(1) The clutch pedal must be kept in proper adjustment by frequent inspection of the clutch pedal "free travel" which is the first easy movement of the clutch pedal.

(2) Check clutch pedal "free travel" with hand, rather than with foot, and make sure the release bearing has 1/8" clearance.

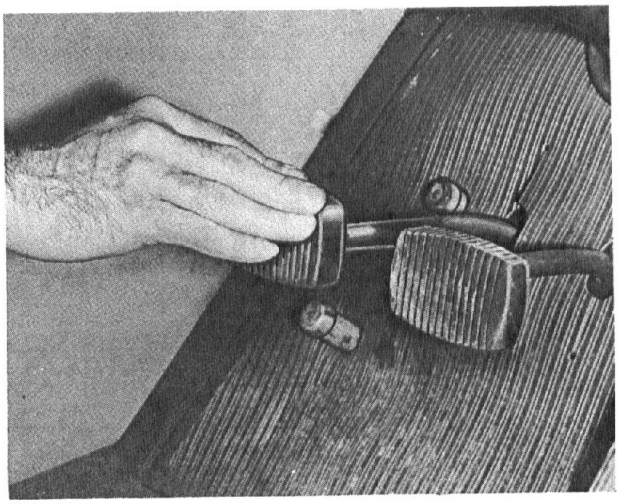

Fig. 21 – Checking Clutch Pedal 'Free Travel'.

(3) Proper clutch pedal "free travel" is approximately 1-1/2". The gradual reduction from this amount is a normal condition caused by wearing of the facings.

(4) If inspection indicates clutch pedal "free travel" is less than 1/2", immediate adjustment of the clutch pedal linkage should be made to restore proper 1-1/2" free travel, (Fig. 22). This 1-1/2" pedal free travel normally results in 1/8" clearance between the clutch release levers and release bearing.

(5) If excessive free play is present in the clutch pedal linkage due to worn parts, the worn parts should be replaced. Excessive wear of the release linkage may give a false impression of the actual amount of release bearing clearance. *CAUTION:* Excessive clutch pedal "free travel" may prevent complete clutch disengagement while insufficient clutch pedal "free travel" will cause slippage, and short clutch life.

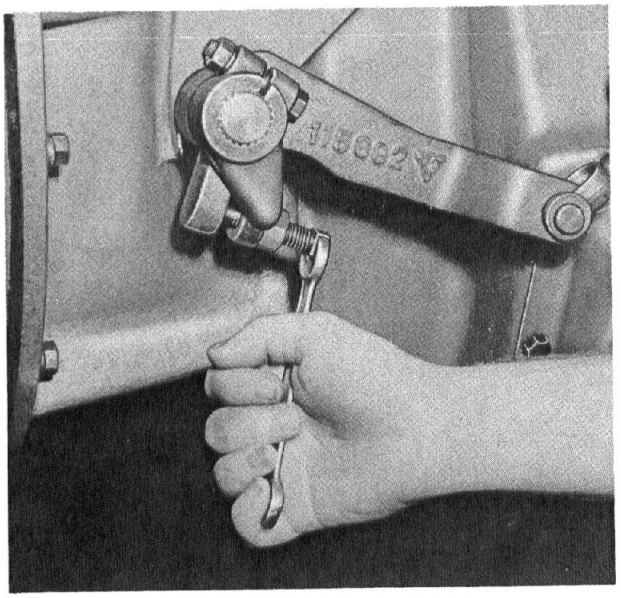

Fig. 22 – Adjusting Clutch Pedal Linkage.

DP RELEASE TRAVEL CHART

Clutch Size & Type	Release Bearing Clearance	Normal Release Bearing Travel	Total Bearing Travel Required
13" Single Plate	1/8"	7/16"	9/16"
14" Single Plate	1/8"	7/16"	9/16"
15" Single Plate	1/8"	7/16"	9/16"
13" Two Plate	1/8"	1/2"	5/8"
14" Two Plate	1/8"	1/2"	5/8"
15" Two Plate	1/8"	1/2"	5/8"

Important! Use Only GENUINE LIPE PARTS

GENERAL SERVICE MANUAL

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE DPB

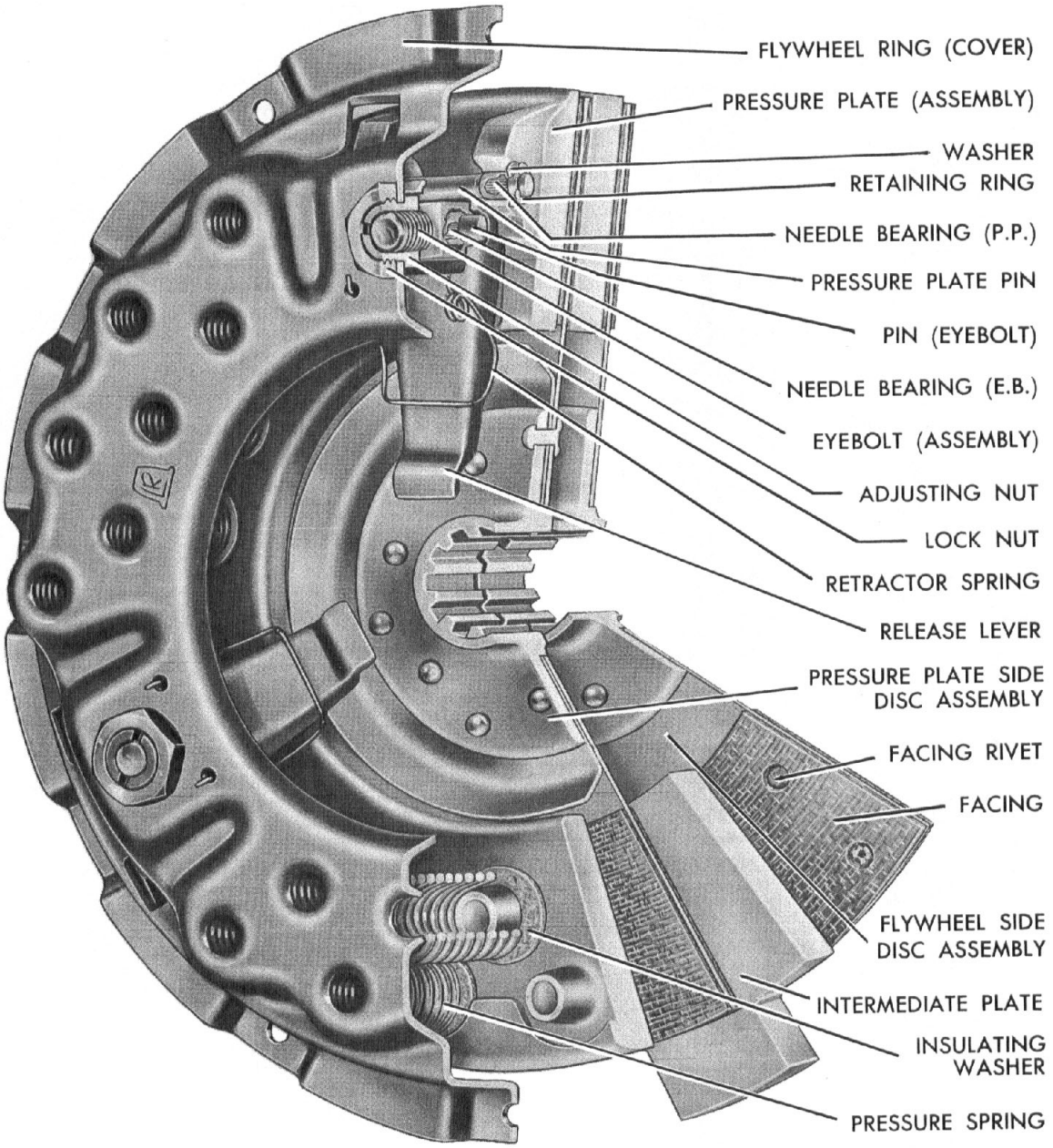

Fig. 23 – Sectional view of Type DPB Two-Plate Clutch.

Important! Use Only GENUINE LIPE PARTS

— TYPE DPB, DL, DLB, DO, DF CLUTCHES —

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE DL

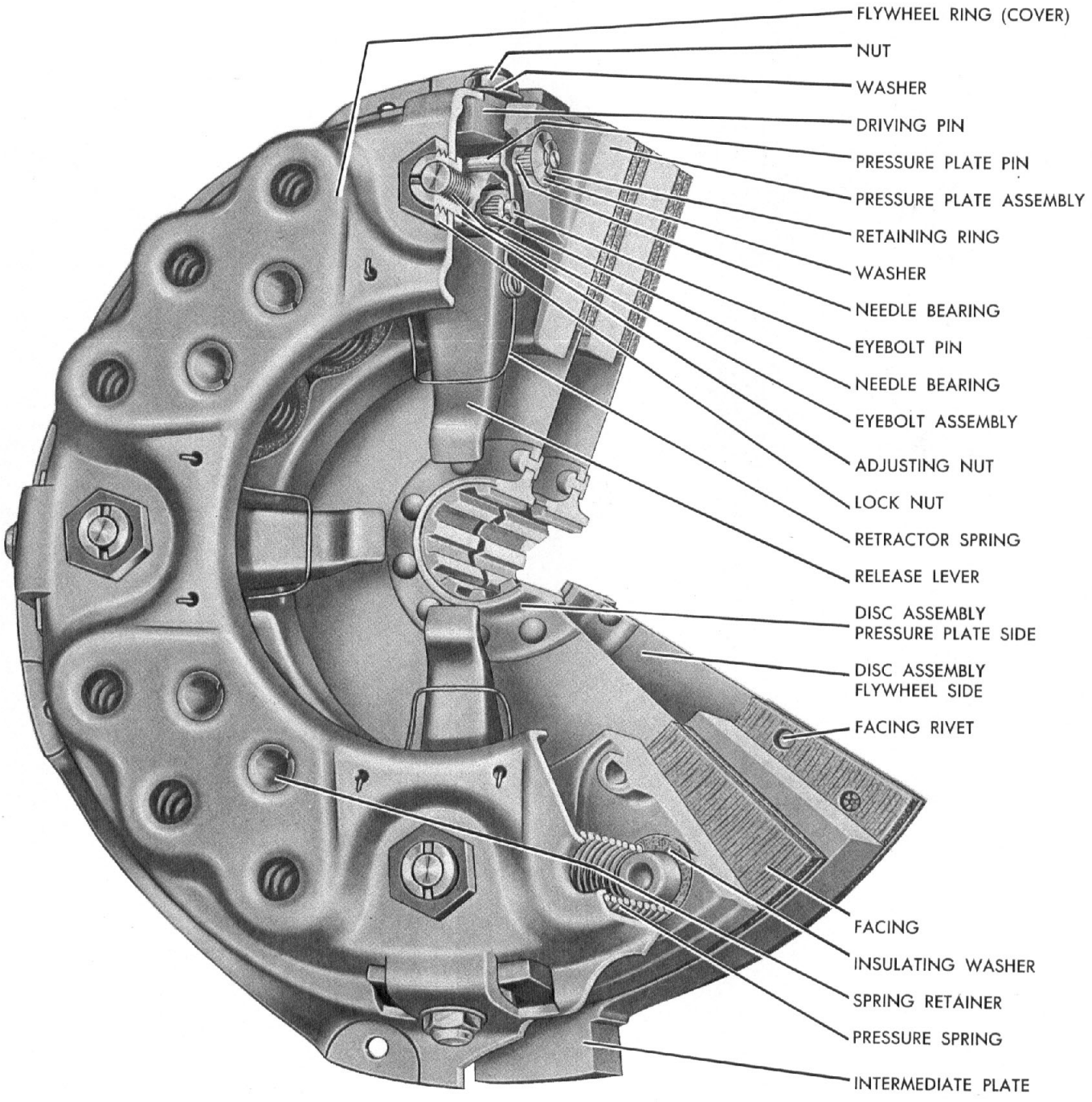

Fig. 24 – Sectional view of Type DL Two-Plate Clutch.

Important! Use Only GENUINE LIPE PARTS

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE DLB

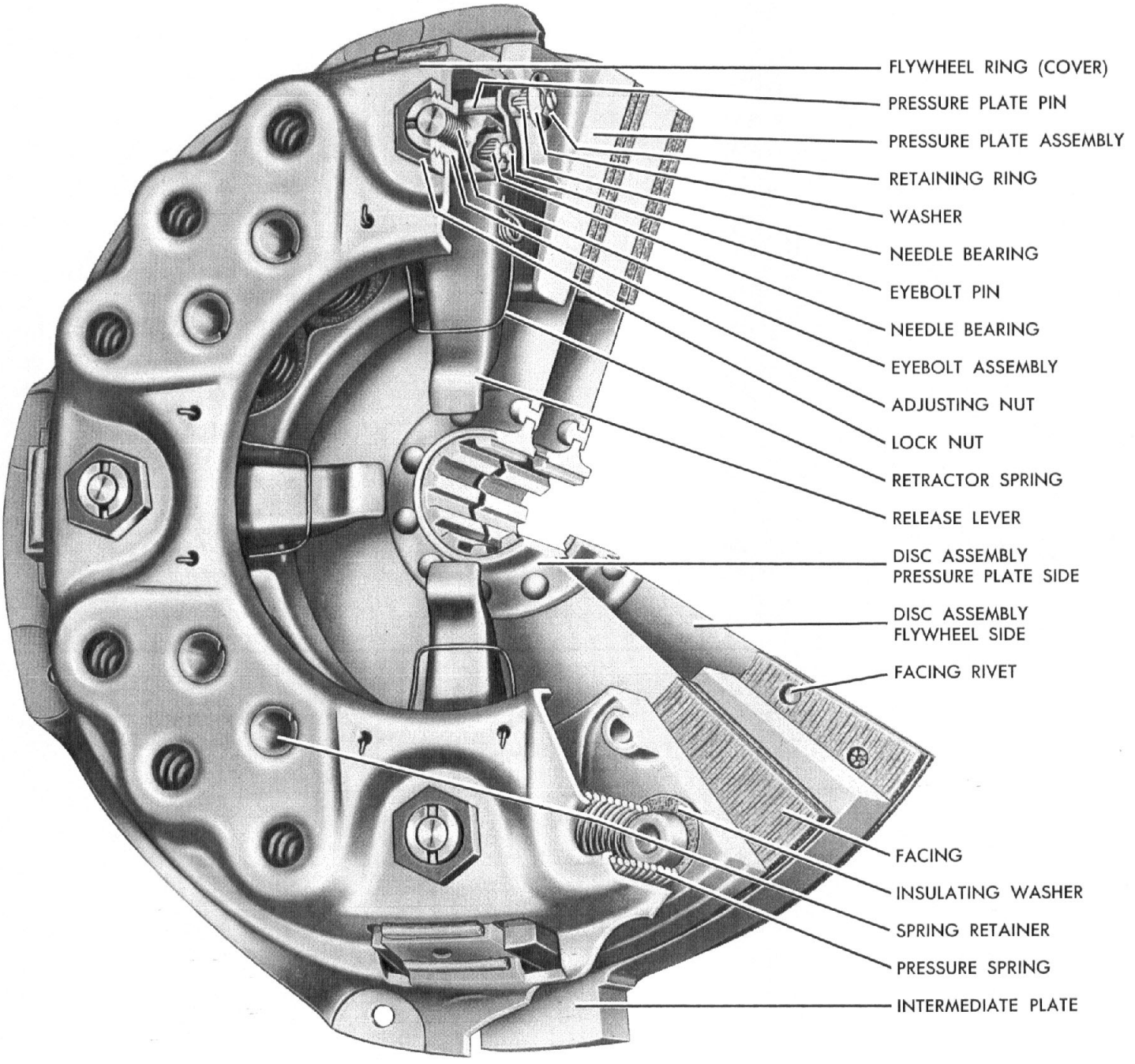

Fig. 25 – Sectional view of Type DLB Two-Plate Clutch.

Important! Use Only GENUINE LIPE PARTS

— TYPE DPB, DL, DLB, DO, DF CLUTCHES —

CUTAWAY DETAIL - TYPICAL 2 PLATE TYPE DO

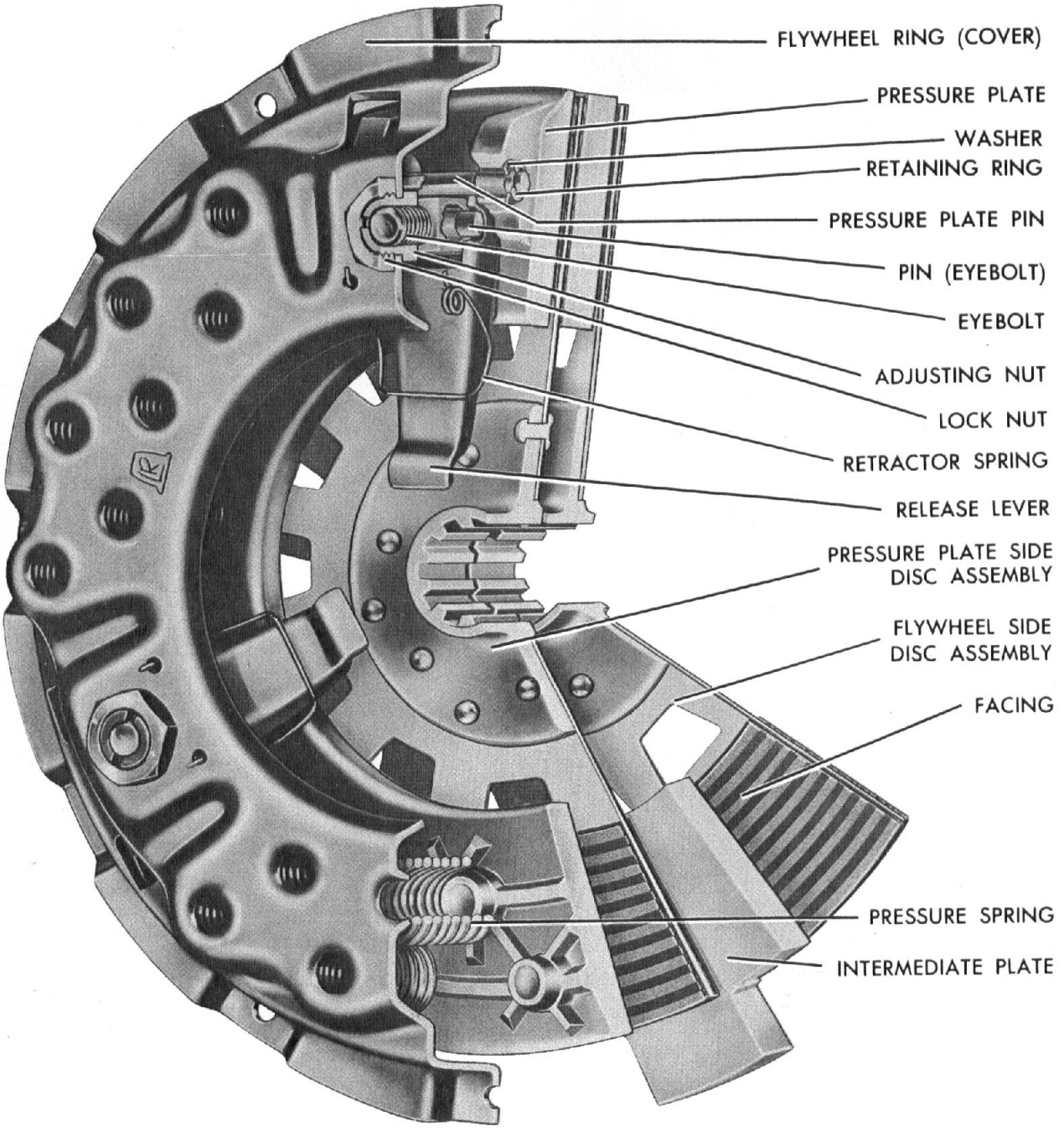

Fig. 26 – Sectional view of Type DO Two-Plate Clutch.

Important! Use Only GENUINE LIPE PARTS

GENERAL SERVICE MANUAL

SECTIONAL DETAIL - TYPICAL 2 PLATE TYPE DF

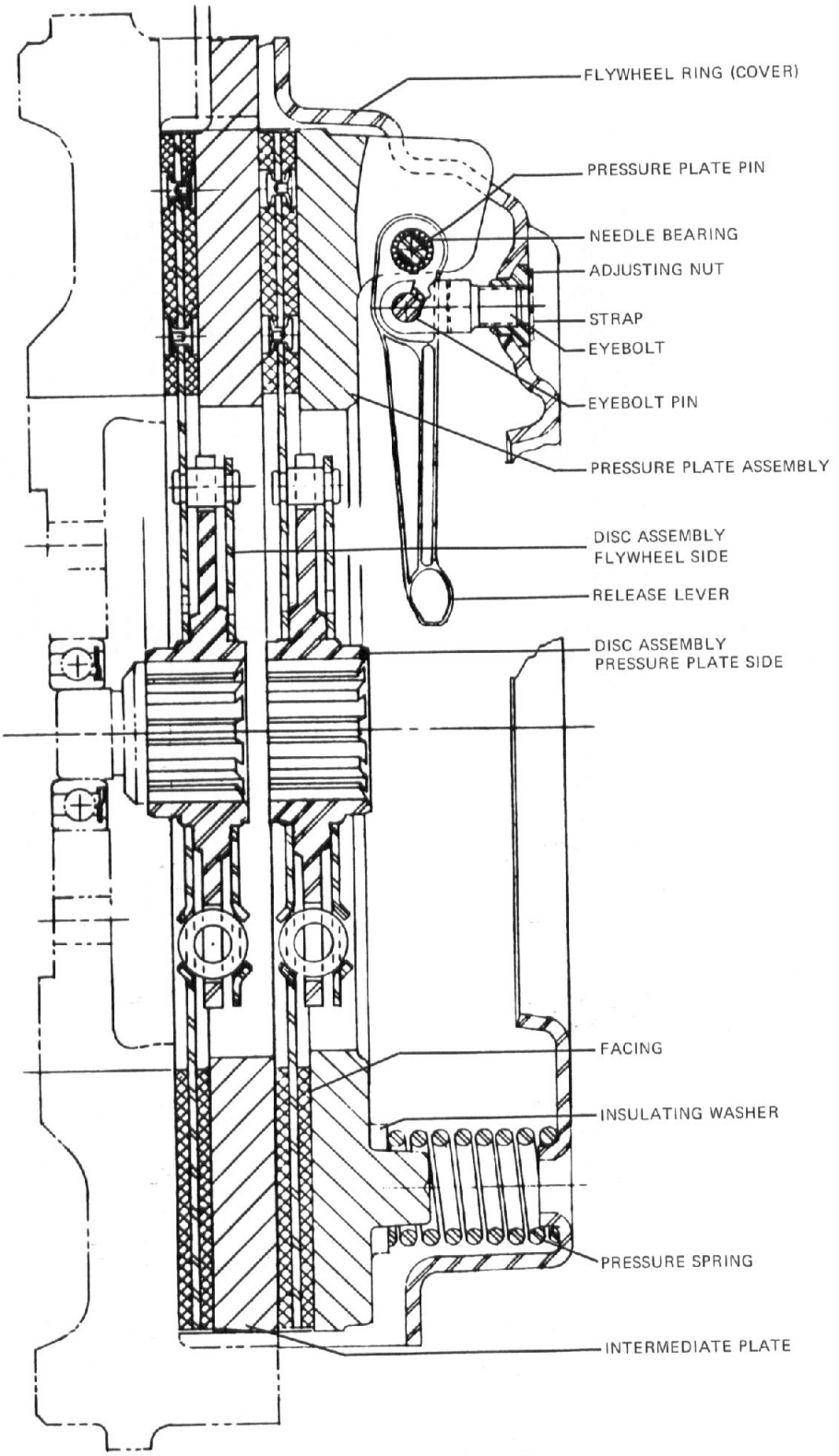

Fig. 27 – Sectional view of Type DF Two-Plate Clutch.

Important! Use Only GENUINE LIPE PARTS

— TYPE DPB, DL, DLB, DO, DF CLUTCHES —

CONSTRUCTION

The Lipe DPB, DL, DLB, DO, and DF type (direct pressure) clutches are precision built heavy duty units incorporating few parts. These clutch assemblies require no maintenance other than maintaining release bearing clearance which is accomplished by normal linkage adjustment.

The DO clutch is similar to the DPB type clutch and differs only in that it does not incorporate either insulating washers or needle bearings as it operates in oil. The DO is manufactured in 12", 13" and 14" single plate, 13" and 14" two plate sizes.

The DL and DLB clutches are also similar to the DPB type clutch and differ only in that the DL and DLB are equipped with hardened steel drive lugs to afford the maximum amount of area to drive the pressure plate. The DLB also incorporates spring retainers. The DL and DLB type are manufactured in 13" and 14" single and two plate sizes.

The DF clutch is also similar to the DPB type clutch and differs only in that the DF is equipped with forged levers and some have a convex configurated pressure plate friction face. The DF type is manufactured in 12" and 13" single and two plate sizes.

OPERATION

The operation of the Lipe Direct Pressure clutch is as follows: The clutch flywheel ring (cover) is attached to the engine flywheel and drives the pressure plate by means of driving lugs in the flywheel ring (cover) and mating slots in the pressure plate.

Depressing the clutch pedal disengages the clutch, by allowing the release bearing to contact and move the release levers toward the engine flywheel resulting in the pressure springs being compressed and the pressure plate being retracted away from the disc assembly; thereby disengaging the clutch.

Releasing the clutch pedal engages the clutch by allowing the release bearing and release levers to move away from the engine flywheel and the pressure springs to expand and exert pressure against the pressure plate, resulting in the disc assembly being gripped between friction surfaces of engine flywheel and pressure plate; thereby completely engaging the clutch.

CLUTCH INSTALLATION

INSPECT ENGINE FLYWHEEL

(1) Check recessed type flywheels for correct depth. See Chart on pages 26–28.

(2) Replace release bearing and carrier, and flywheel pilot bearing. Pilot bearing should be a hand press fit in the flywheel recess and on the transmission drive gear. The release yoke or fork should contact the release bearing carrier pads evenly to prevent a bind on the front bearing cap extension.

(3) The friction face of the flywheel must be free from heat cracks, score marks and taper. The presence of any of these conditions will have an adverse effect on clutch function and life.

INSTALLING CLUTCH ASSEMBLY

(1) It is a good idea to try the cover assembly on the flywheel without the disc assembly to check fit where cover is piloted at O.D.

(2) Install driven disc, making sure that it is properly positioned and insert an aligning shaft. Normally the long end of the driven disc hub extends toward the transmission, but in a few instances the long end may face toward the engine. Make sure that the driven disc hub does not come within 5/32" of the pilot bearing.

(3) Bolt the cover assembly to the flywheel, tightening each cap screw gradually until the cover is drawn up tight. Extreme care must be exercised to make sure flywheel ring or cover is seated in piloting rim on recessed type flywheels.

Special Cap Screws

(4) Some cover assemblies are piloted to the flywheel by cap screws with a ground shank which fits the reamed holes in the cover. The machined shank extends through the cover into a recessed or counterbored hole in the flywheel. If a flywheel

has been reground there is a chance that the counter bores could be too shallow and may require deepening. If the flywheel has been remachined several times to remove heat cracks or scores, the counterbored holes may not be deep enough to allow complete tightening of the cap screws. This will necessitate replacing the flywheel.

INSTALLING TWO PLATE CLUTCH ASSEMBLY

(1) The DPB, DL, DLB, DO, DF two plate assemblies have an intermediate plate with driving lugs which fit into mating slots of the flywheel.

(2) Before installing a two plate assembly, the intermediate plate should be set into the driving slots of the flywheel and clearances checked. A minimum of .006" is recommended to allow for free movement of the intermediate plate.

(3) The two disc assemblies for a two plate clutch may or may not be identical or interchangeable. In most cases they will not be interchangeable and will be marked either flywheel side or pressure plate side. They must be positioned with the side of the disc as marked, next or adjacent to the respective part. In no instance shall the hubs be allowed to approach pilot bearing or come together within 5/32".

(4) When installing two plate clutches, it is essential that a splined shaft or aligning shaft be used with a key to properly align the two disc assemblies. Otherwise the instructions for installing two plate clutches are the same as for single plate assemblies.

(5) To obtain complete disengagement of Type DPB, DL, DLB, DO, DF clutch assemblies, the release levers must be actuated a specified distance from the engaged position. Assuming the release bearing clearance (distance between the clutch release levers and release bearing) to be 1/8" when the clutch is in the engaged position, the release bearing must move forward 1/8" to take up this clearance before it contacts the release levers and then move the normal amount of travel required to disengage the clutch as shown below.

Note: If release levers are not in plane, it is an indication that cover is not properly seated in flywheel. Check "A" dimension, Fig. 28 and chart on pages 26–28.

DIMENSION 'A'

(1) Dimension 'A' is the distance from the top of the clutch flywheel ring (cover) to ends of release levers. See Fig. 28.

(2) Check chart on pages 26–28 for correct 'A' Dimension. Satisfactory operation of the clutch depends greatly upon the accuracy of the lever setting, as this controls the parallel movement of the pressure plate.

(3) A straight edge and scale will provide a means of checking the 'A' Dimension as shown in Fig. 28.

(4) See Chart on page 25 for release lever travel requirements.

(5) New or genuine Lipe-Rollway exchange cover assemblies are pre-adjusted at the factory and the lever settings shall not be altered. If the 'A' dimension does not check out according to the chart on pages 26–28 within 1/32" recheck the complete installation and, if necessary, remove the cover.

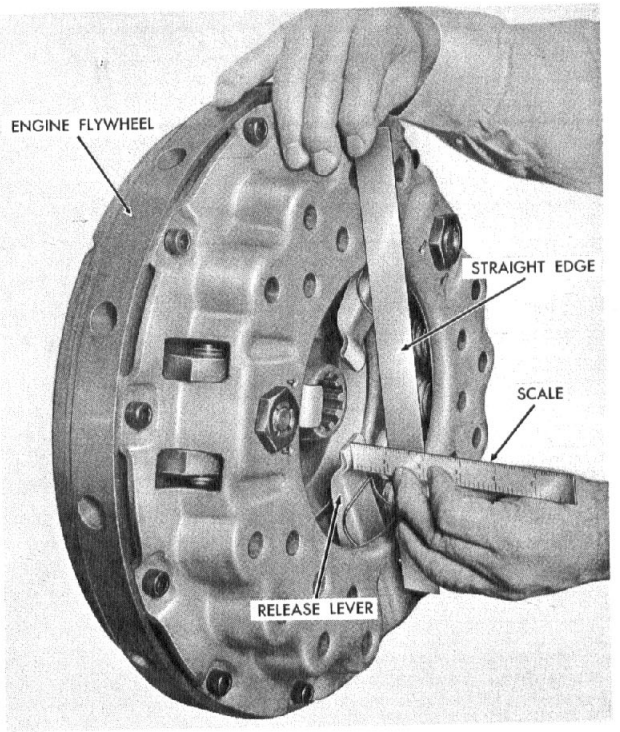

Fig. 28 – Checking Dimension 'A'.

Important! Use Only GENUINE LIPE PARTS

DPB, DL, DLB, DO, DF
RELEASE TRAVEL CHART

Clutch Size & Type	Release Bearing Clearance	Normal Release Bearing Travel	Total Bearing Travel Required
12" Single Plate	1/8"	11/32"	15/32"
13" Single Plate	1/8"	7/16"	9/16"
14" Single Plate	1/8"	7/16"	9/16"
15" Single Plate	1/8"	7/16"	9/16"
17" Single Plate	1/8"	7/16"	9/16"
12" Two Plate	1/8"	1/2"	5/8"
13" Two Plate	1/8"	1/2"	5/8"
14" Two Plate	1/8"	1/2"	5/8"
15" Two Plate	1/8"	1/2"	5/8"
17" Two Plate	1/8"	1/2"	5/8"

CLUTCH PEDAL ADJUSTMENT

Never wait for the clutch to slip before making a pedal adjustment.

(1) We recommend that the clutch pedal be kept in proper adjustment by frequent inspection of the clutch pedal 'free travel' which is the first easy movement of the clutch pedal.

(2) Check clutch pedal 'free travel' with hand to be positive that 'free travel' is a result of actual release bearing clearance and not caused by worn linkage.

(3) Proper clutch pedal 'free travel' is approximately 1½". The gradual reduction from this amount is a normal condition caused by wearing of the facings.

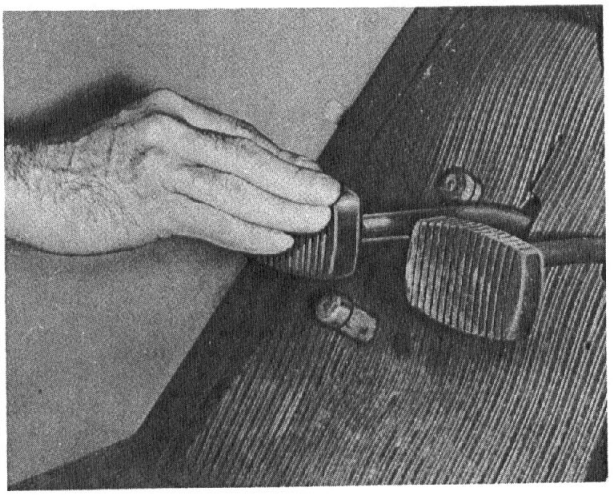

Fig. 29 – Checking Clutch Pedal 'Free Travel'.

(4) If inspection indicates clutch pedal 'free travel' is less than ½", immediate adjustment of the clutch pedal linkage should be made to restore proper 1½" 'free travel,' Fig. 30. This 1½" pedal 'free travel' normally results in 1/8" clearance between the clutch release levers and release bearing.

(5) If excessive free play is present in the clutch pedal linkage due to worn parts, the worn parts must be replaced. Excessive wear of the release linkage may give a false impression of the actual amount of release bearing clearance.
CAUTION: Excessive clutch pedal 'free travel' may prevent complete clutch disengagement while insufficient clutch pedal 'free travel' will cause slippage, and short clutch life.

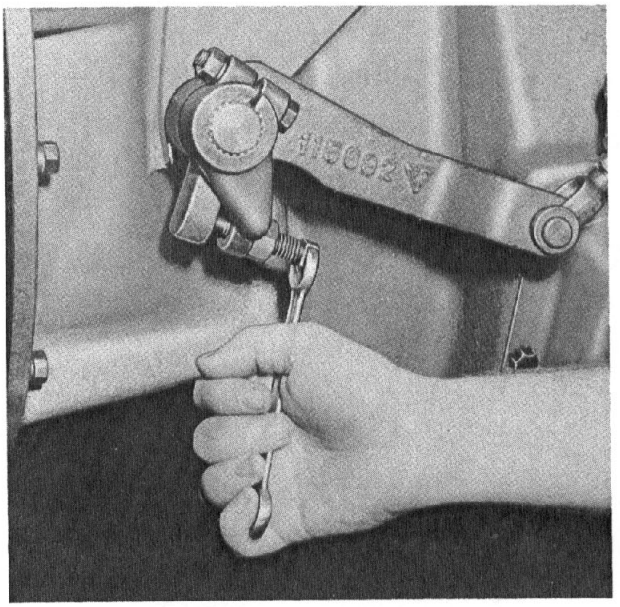

Fig. 30 – Adjusting Clutch Pedal Linkage.

Important! Use Only GENUINE LIPE PARTS

GENERAL SERVICE MANUAL

CLUTCH DATA CHART TYPES DP, DPB, DL, DLB, DO, DF

Model Number	Dimension 'A'	Flywheel Depth +.005" -.005"	Facing Thick-ness
140-51-519	1"	1.187"	7/32"
140-51-535	1"	1.187"	3/16"
140-51-537	1"	1.187"	3/16"
140-51-538	1"	1.187"	3/16"
140-51-539	1"	1.187"	3/16"
140-51-549	1 1/4"#	1.594"	3/16"
140-52-581†	1"	1.406"	5/32"
140-51-583	1 1/4"#	1.594"	3/16"
130-51-588	31/32"	Flat	5/32"
140-52-589†	1"	1.406"	5/32"
120-61-615	1 3/16"	Flat	5/32"
140-61-623	29/32"	Flat	3/16"
130-62-625**	1 1/16"	1.062"	5/32"
120-61-627	1 3/16"	Flat	5/32"
120-61-628	1 1/16"	Flat	5/32"
120-61-633	1 3/16"	Flat	5/32"
150-51-634**	1 1/8"	1.750"	3/16"
140-61-635	29/32"	Flat	3/16"
130-61-642	1 1/16"	Flat	5/32"
130-61-647	1 1/16"	Flat	5/32"
140-61-648	29/32"	1.187"	3/16"
140-62-650†	29/32"	1.093"	5/32"
140-61-651	29/32"	1.187"	3/16"
140-61-652	29/32"	Flat	3/16"
140-61-653	29/32"	1.187"	3/16"
150-51-654**	5/16"	1.750"	3/16"
150-51-655	1 1/8"*	1.594"	3/16"
150-51-656A	1 1/8"*	1.594"	3/16"
150-51-657**	5/16"	1.750"	3/16"
150-51-658**	1 1/8"	1.750"	3/16"
150-51-659	1 1/8"	1.750"	3/16"
150-51-660**	1 1/8"	1.750"	3/16"
150-51-661**	1 1/8"	1.750"	3/16"
150-51-662**	5/16"	1.750"	3/16"
140-62-665†	29/32"	1.093"	5/32"
120-61-667	1 3/16"	Flat	5/32"
140-61-684	27/32"	1.187"	7/32"
150-51-685**	5/16"	1.750"	3/16"
140-61-689	29/32"	Flat	3/16"
150-52-696□	25/32"	2.796"	5/32"
150-61-697	1"	1.750"	3/16"
130-62-699**	1 1/16"	1.062"	5/32"
130-62-700**	1 1/16"	1.062"	5/32"
140-62-701†	29/32"	1.093"	5/32"
130-62-702**	1 1/16"	1.062"	5/32"
140-61-703	29/32"	1.187"	7/32"
140-62-704†	29/32"	1.093"	5/32"
140-61-706	29/32"	Flat	3/16"
140-61-707	29/32"	1.187"	3/16"
140-61-713	29/32"	Flat	3/16"
150-51-714	1 1/8"	1.750"	3/16"
130-302-716♦	15/16"	1.062"	5/32"
140-61-718	29/32"	1.187"	3/16"
150-62-719□	1"	1.093"	5/32"
140-61-720	29/32"	1.187"	3/16"

Model Number	Dimension 'A'	Flywheel Depth +.005" -.005"	Facing Thick-ness
140-61-721	29/32"	Flat	3/16"
140-61-723	29/32"	1.187"	3/16"
130-61-725	5/8"‡	Flat	5/32"
120-61-726	1 1/16"	Flat	5/32"
155-51-728	1 3/8"	1.312"	7/32"
150-61-731	1"	1.750"	3/16"
130-61-734	1 1/8"	Flat	5/32"
140-62-735†	29/32"	1.093"	5/32"
130-62-736%	29/32"●	1.477"	5/32"
150-61-738	1"	1.750"	3/16"
150-52-739††	1 1/8"	2.937"	5/32"
150-62-743□	1"	1.093"	5/32"
150-52-747□	25/32"	2.796"	5/32"
140-61-761	29/32"	1.187"	3/16"
155-51-766	1 3/8"	1.312"	7/32"
155-51-767	1 3/8"	1.312"	7/32"
150-61-776	1"	1.750"	3/16"
140-32-778†	29/32"	1.093"	5/32"
140-32-779†	29/32"	1.093"	5/32"
140-32-780†	29/32"	1.093"	5/32"
140-32-781†	29/32"	1.093"	5/32"
140-61-785	29/32"	Flat	3/16"
170-62-789♦	1 3/32"■	1.562"	5/32"
140-32-796†	29/32"	1.093"	5/32"
140-32-797†	29/32"	1.093"	5/32"
130-62-798%	29/32"	1.477"	5/32"
140-31-803	29/32"	1.187"	3/16"
140-61-805	23/32"	.976"	3/32"
120-61-813	1 3/16"	Flat	9/64"
130-31-817	1 1/16"	Flat	9/64"
140-31-818	29/32"	Flat	3/16"
140-31-819	29/32"	Flat	3/16"
170-61-821	31/32"■	.396"	5/32"
130-32-823♦	1 1/16"	1.062"	5/32"
130-32-824♦	1 1/16"	1.062"	5/32"
140-31-825	29/32"	1.187"	3/16"
140-31-826	29/32"	1.187"	3/16"
140-31-827	29/32"	1.187"	3/16"
140-31-831	29/32"	1.187"	3/16"
140-31-832	29/32"	Flat	3/16"
140-31-833	29/32"	Flat	3/16"
140-31-834	29/32"	Flat	3/16"
120-81-836	1 1/8"	Flat	3/32"
130-81-837	1 1/16"	Flat	3/32"
130-81-842	1 1/16"	Flat	3/32"
150-61-843	1"	1.750"	3/16"
130-61-851	1 3/16"	Flat	9/64"
130-81-863	1 1/16"	Flat	3/32"
120-61-864	1 3/16"	Flat	9/64"
130-61-865	1 3/16"	Flat	9/64"
130-61-866	1 3/16"	Flat	9/64"
130-62-872♦	31/32"#	.790"	3/32"
140-61-874	29/32"	Flat	3/16"
140-61-881	29/32"	1.187"	7/32"
130-32-882♦	1 1/16"	1.062"	5/32"

**Also applicable to engine flywheel depth of 1.812" with 7/32" facing thickness. * was 15/16". ‡ 'A' Dimension was 29/32".

Intermediate Plate Thickness: %13" .874 + .000 - .003 †14" .754 + .000 - .003 ††15" .832 + .000 - .003 □15" .705 + .000 - .003 ♦17" .749 + .000 - .003

♦13" .676 + .000 - .003 ■ From top of machined boss beside locknut ●'A' Dimension was 5/8". #was 1".

Important! Use Only GENUINE LIPE PARTS

— TYPE DP, DPB, DL, DLB, DO, DF CLUTCH —

CLUTCH DATA CHART TYPES DP, DPB, DL, DLB, DO, DF (Cont.)

Model Number	Dimension 'A'	Flywheel Depth +.005" -.005"	Facing Thickness
140-61-884	29/32"	1.187"	7/32"
130-62-885**	1 1/16"	1.062"	5/32"
130-62-886**	1 1/16"	1.062"	5/32"
170-61-887	1 5/16"	1.218"	3/16"
140-61-888 †	29/32"	.976"	3/32"
140-62-893 †	29/32"	1.093"	5/32"
130-32-894**	1 1/16"	1.062"	5/32"
150-62-897 □	1"	1.093"	5/32"
130-61-898	1 3/16"	Flat	9/64"
140-62-902 †	25/32"	.795"	3/32"
140-62-903 †	25/32" #	.795"	3/32"
140-61-906	29/32"	1.187"	3/16"
140-61-907	29/32"	1.187"	3/16"
140-61-908	29/32"	1.187"	3/16"
140-61-909	29/32"	1.187"	3/16"
140-61-911	29/32"	1.187"	7/32"
120-501-914	1 3/16"	Flat	5/32"
140-61-916	29/32"	Flat	3/16"
140-61-918	29/32"	Flat	3/16"
140-61-921	29/32"	Flat	3/16"
140-62-922 †	29/32"	1.093"	5/32"
130-501-924	1 3/16"	Flat	5/32"
130-501-926	1 3/16"	Flat	5/32"
130-502-927**	1 3/16"	1.062"	5/32"
130-501-928	1 3/16"	Flat	5/32"
130-62-929**	1 1/16"	1.062"	5/32"
130-81-930	1 1/16"	Flat	3/32"
140-81-931	23/32"	.976"	3/32"
170-62-934 ♦	1 5/16"	2.321"	5/32"
140-81-940	23/32"	.976"	3/32"
140-81-942	23/32"	.976"	3/32"
140-81-943	23/32"	.976"	3/32"
120-61-945	1 3/16"	Flat	5/32"
130-61-946	1 3/16"	Flat	5/32"
130-62-949**	1 3/16"	Flat	5/32"
130-61-950	1 3/16"	Flat	5/32"
120-81-952	1 1/8"	Flat	3/32"
130-501-953	1 3/16"	Flat	5/32"
130-501-954	1 3/16"	Flat	5/32"
140-62-959 †	29/32"	1.093"	5/32"
140-302-962 †	1 3/32"	1.065"	5/32"
130-502-963**	1 3/16"	1.062"	5/32"
120-81-976	1 1/8"	Flat	3/32"
130-301-977	15/16"	Flat	9/64"
140-301-978	1 3/32"	Flat	.172"
140-81-983	23/32"	.976"	3/32"
140-32-985 †	29/32"	1.093"	5/32"
130-62-987**	1 1/16"	1.062"	5/32"
130-61-989	1 1/16"	Flat	5/32"
130-31-990	1 1/16"	Flat	5/32"
150-52-1003 ††	1 1/8"	2.937"	5/32"
150-62-1004 □	23/32"	.785"	3/32"
140-61-1006	29/32"	Flat	3/16"
130-302-1011**	1 1/16"	Flat	5/32"
120-501-1013	1 3/16"	Flat	5/32"

Model Number	Dimension 'A'	Flywheel Depth +.005" -.005"	Facing Thickness
140-82-1014 †	25/32"	.795"	3/32"
150-52-1019 §	1 3/8"	2.582"	3/16"
140-82-1020 †	25/32"	.795"	3/32"
130-61-1022	1 1/16"	Flat	5/32"
130-32-1023**	15/16"	1.062"	5/32"
130-502-1026**	1 3/16"	Flat	5/32"
120-501-1030	1 3/16"	Flat	5/32"
130-501-1031	1 3/16"	Flat	5/32"
130-502-1032**	1 3/16"	Flat	5/32"
140-61-1033	29/32"	Flat	3/16"
140-62-1034 †	29/32"	Flat	5/32"
130-501-1035	1 3/16"	Flat	5/32"
140-61-1040	29/32"	Flat	3/16"
140-301-1045	29/32"	Flat	3/16"
140-301-1046	29/32"	1.187"	3/16"
140-301-1047	29/32"	Flat	3/16"
120-81-1048	1 1/8"	Flat	3/32"
140-81-1049	23/32"	.976"	3/32"
130-301-1055	1 1/16"	Flat	9/64"
130-302-1056**	1 1/16"	1.062"	5/32"
120-81-1057	7/8"	Flat	3/32"
140-301-1058	29/32"	1.187"	3/16"
130-301-1060	1 1/16"	Flat	5/32"
130-302-1061**	15/16"	1.062"	5/32"
140-302-1063 †	15/16"	1.093"	5/32"
140-302-1064 †	15/16"	1.093"	5/32"
140-302-1065 †	15/16"	1.093"	5/32"
140-302-1066 †	15/16"	1.093"	5/32"
140-302-1067 †	15/16"	1.093"	5/32"
140-301-1068	29/32"	Flat	3/16"
140-81-1069	23/32"	.976"	3/32"
130-302-1070**	15/16"	1.062"	5/32"
130-301-1071	15/16"	Flat	9/64"
140-302-1072 ⊕	1 3/32"	1.062"	5/32"
140-301-1073	1 3/32"	Flat	3/16"
140-301-1076	29/32"	1.187"	3/16"
130-61-1080	1 3/16"	Flat	5/32"
130-302-1081**	1 1/16"	1.062"	5/32"
130-302-1084**	15/16"	1.062"	5/32"
140-302-1085 †	29/32"	1.093"	5/32"
140-301-1086	29/32"	Flat	3/16"
140-302-1087 ⊕	29/32"	1.065"	5/32"
140-301-1095	29/32"	Flat	3/16"
140-301-1097	29/32"	Flat	3/16"
140-301-1098	29/32"	1.187"	7/32"
140-301-1099	29/32"	1.187"	3/16"
140-301-1101	29/32"	1.187"	3/16"
140-301-1102	29/32"	1.187"	3/16"
140-301-1105	29/32"	1.187"	7/32"
140-301-1106	29/32"	1.187"	3/16"
140-301-1107	29/32"	Flat	3/16"
140-301-1111	29/32"	Flat	3/16"
140-301-1112	29/32"	Flat	3/16"
140-302-1113 †	29/32"	1.093"	5/32"
130-302-1140**	1 1/16"	1.062"	5/32"

Intermediate Plate Thickness: **13" .676 + .000 - .003 ≈13" .874 + .000 - .003 †14" .754 + .000 - .003 ⊕14" .732 + .000 - .003

□15" .738 + .000 - .003 §15" .898 + .000 - .003 ♦17" .749 + .000 - .003

Tolerance of – 5/32" to + 1/32". Maximum variation between levers 1/16".

Important! Use Only GENUINE LIPE PARTS

CLUTCH DATA CHART TYPES DP, DPB, DL, DLB, DO, DF (Cont.)

Model Number	Dimension 'A'	Flywheel Depth +.005" -.005"	Facing Thick-ness
130-302-1141**	15/16"	1.062"	5/32"
140-301-1142	1 3/32"	Flat	3/16"
140-301-1505	29/32"	Flat	3/16"
130-302-1507**	1 1/16"	1.062"	5/32"
130-302-1508**	1 1/16"	1.062"	5/32"
140-301-1509	29/32"	Flat	3/16"
130-301-1511	5/8"	Flat	5/32"
130-301-1513	5/8"	Flat	5/32"
140-302-1521†	29/32"	1.093"	5/32"
140-302-1522†	29/32"	1.093"	5/32"
140-302-1523†	29/32"	1.093"	5/32"
130-301-1524	1 3/16"	Flat	9/64"
130-301-1525	1 3/16"	Flat	9/64"
130-302-1526**	1 1/16"	1.062"	5/32"
140-301-1527	29/32"	Flat	3/16"
140-52-1528▲	25/32"	2.796"	5/32"
130-301-1540	1 1/16"	Flat	5/32"
130-302-1541≈	15/16"	1.477"	5/32"
130-302-1542≈	15/16"	1.477"	5/32"
130-302-1543**	1 1/16"	1.062"	5/32"
130-302-1544**	1 1/16"	1.062"	5/32"
130-301-1545	1 3/16"	Flat	5/32"
130-302-1546**	1 3/16"	1.062"	5/32"
140-61-1547	29/32"	Flat	3/16"
130-301-1555	1 3/16"	Flat	9/64"
140-301-1558	29/32"	Flat	3/16"
140-52-1566▲	25/32"	2.796	5/32"
140-302-1573†	29/32"	Flat	5/32"
140-81-1587	23/32"	.976"	3/32"
120-501-1588	1 3/16"	Flat	5/32"

Intermediate Plate Thickness: **13" .676 + .000 - .003 †14" .754 + .000 - .003 ▲14" .705 + .000 - .003 ≈13" .874 + .000 - .003

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TYPE PT, LP CLUTCHES

CUTAWAY DETAIL - TYPE 14" - 2 PLATE PT, LP

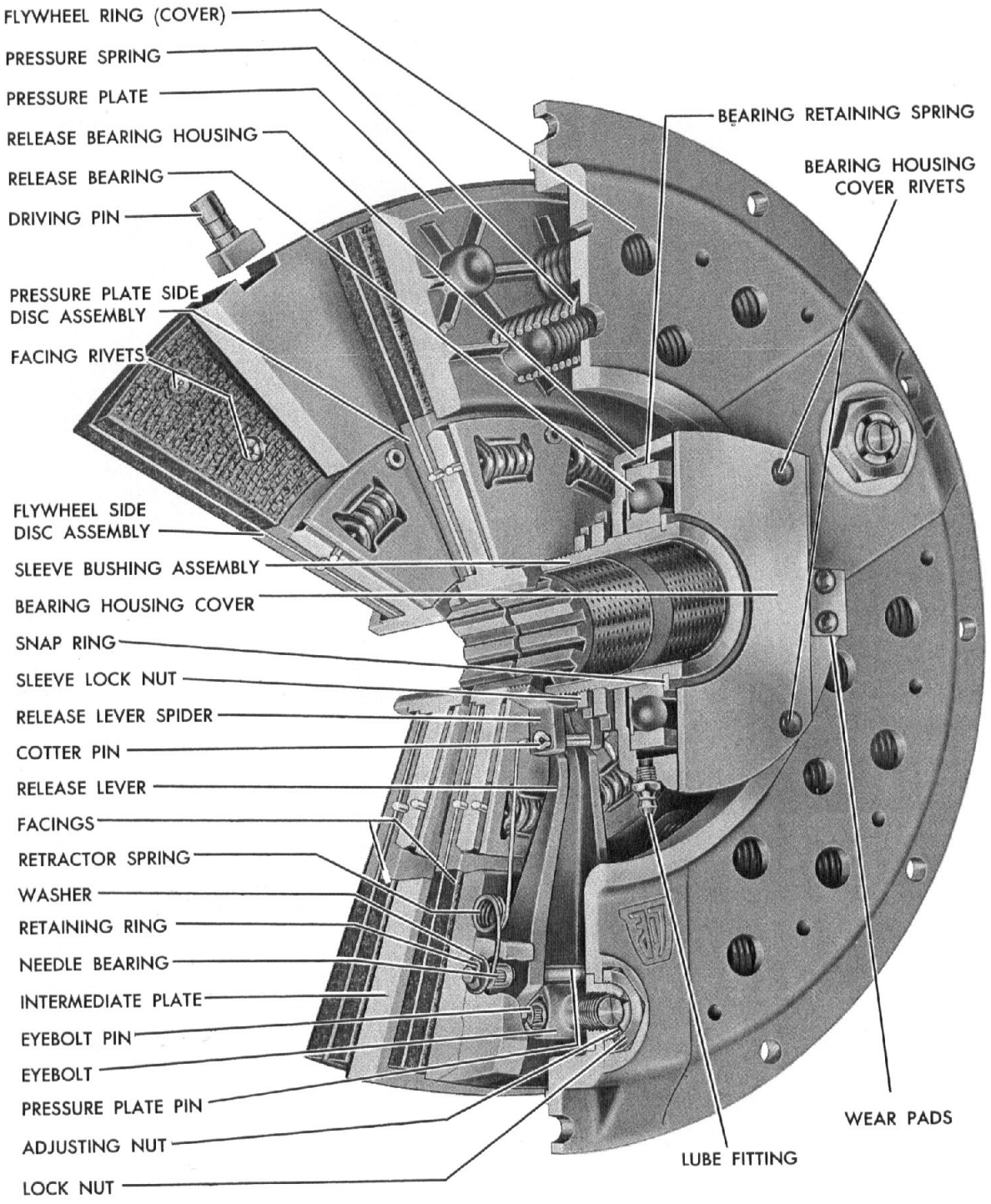

Fig. 31 – Sectional view of Type PT, LP 14" Two-Plate Clutch.

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GENERAL SERVICE MANUAL

CUTAWAY DETAIL - TYPE 15 1/2" - 2 PLATE PT, LP

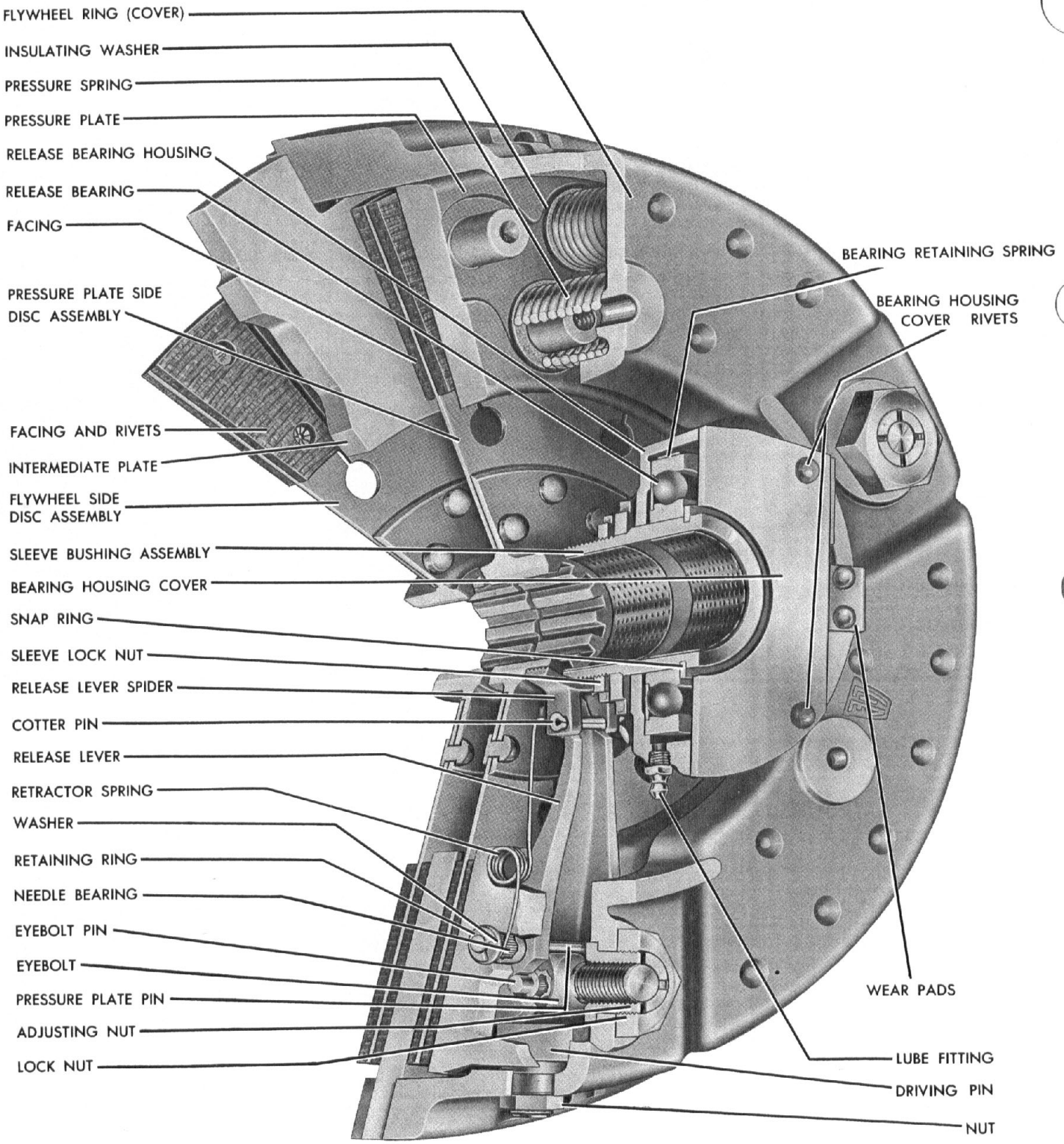

Fig. 32 – Sectional view of Type PT, LP 15½" Two-Plate Clutch.

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TYPE PT, LP CLUTCHES

CONSTRUCTION

The Lipe-Rollway type PT and LP clutches are a pull type, dry disc, non-adjustable design, incorporating an adjustable sleeve connecting the release levers to the release bearing. Adjustment of this sleeve compensates for facing wear, maintains pedal lash and provides operating clearance for the clutch brake.

Anti-friction bearings are supplied in the release lever system resulting in low release load at the pedal.

OPERATION

The operation of the Lipe PT and LP (pull type) clutches is as follows:

The 14"-1 and 14"-2 clutch flywheel ring (cover) is attached to the engine flywheel by twelve 3/8" cap screws. 7/16" cap screws are used for 15½"-2 applications.

The 14"-1 and 14"-2 pressure plate is driven by means of driving lugs extending into mating slots of the flywheel ring (cover). The intermediate plate is driven by drive pins located in the engine flywheel. The 15½"-2 pressure plate is driven by drive pins attached to the flywheel ring (cover) that engages the drive lugs of the pressure plate. The intermediate plate is driven by extended lugs that engage matching slots in the flywheel ring.

Depressing the clutch pedal pulls the release bearing toward the transmission. The release bearing being connected to the release levers thus retracts the pressure plate from contact with the driven disc assembly, thereby relieving the pressure on the intermediate plate and the forward driven disc assembly which disengages the clutch.

Releasing the clutch pedal allows the release bearing assembly to move toward the engine permitting the pressure plate to move toward the flywheel gripping the discs, causing engagement.

CLUTCH INSTALLATION

(1) Before installing the clutch on the flywheel, check for free fit of cover assembly to flywheel before proceeding with installation.

(2) 14"-2 – Be sure that intermediate drive pins are a press fit in holes in flywheel rim and that the heads are perfectly square to the friction surface. Lipe-Rollway tool T-10670A will assist in installnew pins and assure that they are properly aligned. See Fig. 33. Drive pins must be square to provide proper clearance for the drive slots in the intermediate plate. If the Lipe tool T-10670A is not available, a machinist's square and feeler gage may be used to check for squareness.

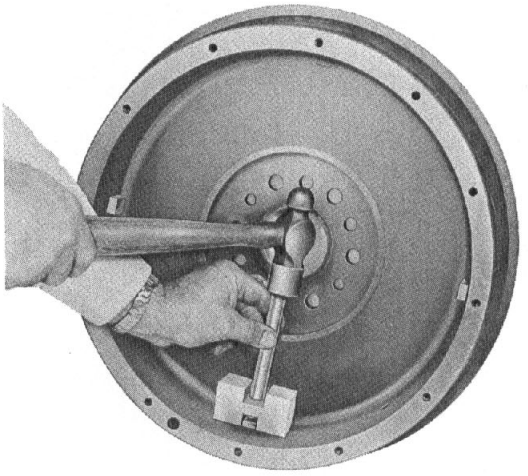

Fig. 33 – Driving Pin Alignment Gauge T-10670A.

(3) 14"-2 – After the pins are installed and properly squared, try the intermediate plate for fit over the pins. With new pins and a new intermediate plate, there should be from .006" to .014" clearance. Try the plate in different positions and select the position which provides the greatest freedom of movement. Mark the plate for location to the flywheel. Lock the drive pins in place with the socket head or Allen set screws.

(4) 15½"-2 – Before installing a two plate assembly, the intermediate plate should be set into the driving slots of the flywheel ring (cover) and clearances checked. A minimum of .006" is recommended to allow for free movement of the intermediate plate.

(5) Driven discs are marked, "Pressure Plate side" and "Flywheel side," to indicate their proper positions. Install as indicated.

(6) The cover assembly may now be installed on the flywheel but, before tightening cap screws, install an aligning shaft through the two hubs and into pilot bearing.

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(7) Cover cap screws may now be tightened progressively around the flywheel using 35 to 40 ft. lbs. of torque.

(8) Remove the three hold down bolts from cover before removing splined aligning shaft or disc assemblies may fall out of position.

CLUTCH ADJUSTMENT

(1) Unlock sleeve locknut "D".

(2) Turn slotted spanner adjusting nut "E" for proper clearance.

3/8" for 14"-1LP
1/2" for 14"-2PT - LP
1/2" for 15½"-2PT - LP

(3) Lock sleeve locknut "D".

NOTE: Keep light tension on Release Yoke (to remove play in linkage) while turning slotted spanner adjusting nut "E". See Fig. 34.

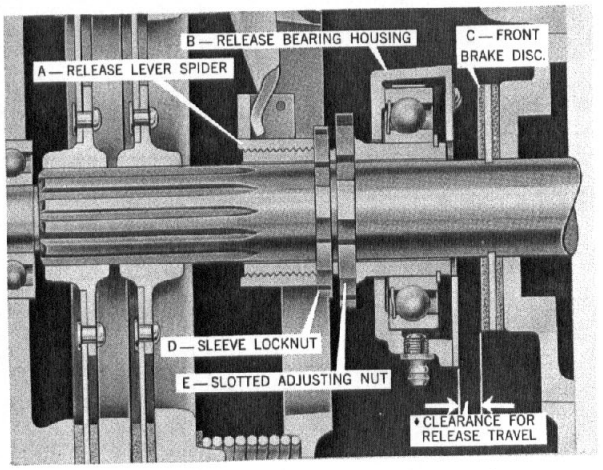

Fig. 34 – Sectional view of Release Bearing Assembly.

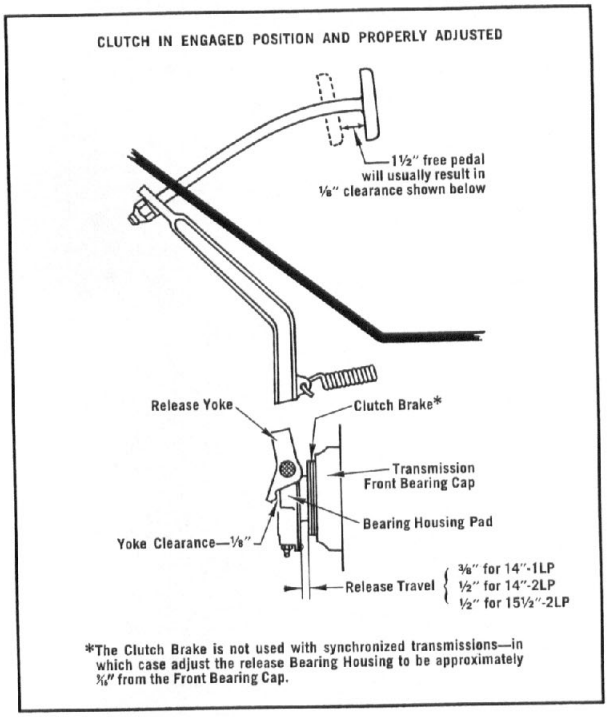

Fig. 35

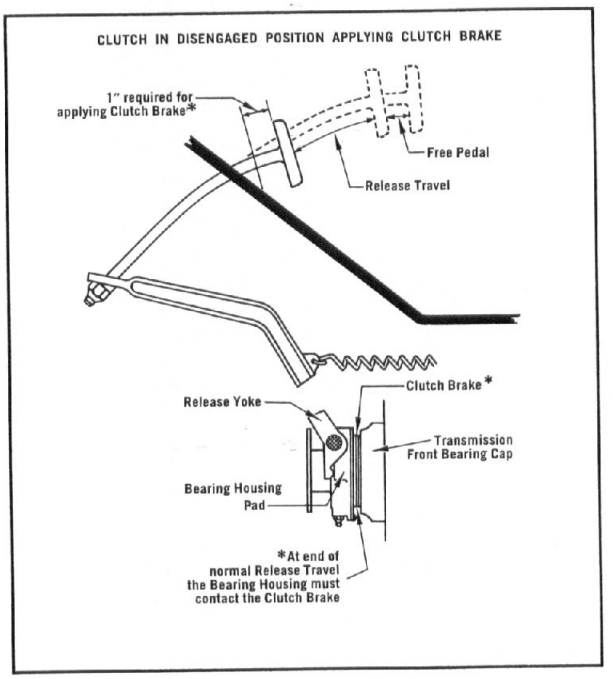

Fig. 36

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CLUTCH PEDAL ADJUSTMENT

(1) The clutch must be kept in proper adjustment by frequent inspection of the "free travel," which is the first easy movement of the clutch pedal.

(2) Check the clutch pedal, "free travel," with the hand (Fig. 37) and be positive that "free travel" is a result of actual release bearing clearance and not caused by worn linkage, or faulty hydraulic cylinders.

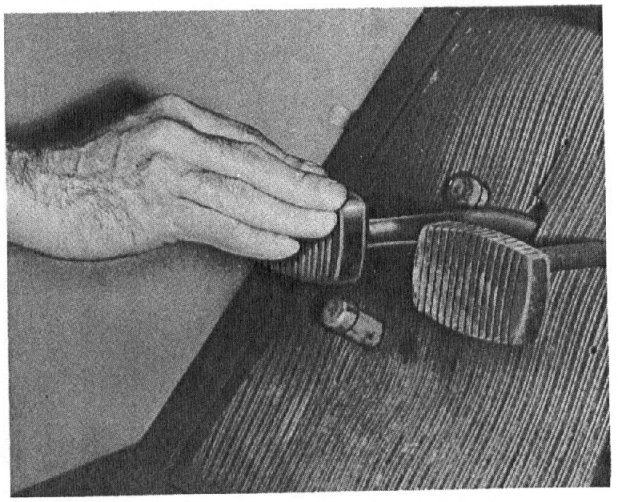

Fig. 37 – Checking Clutch Pedal 'Free Travel'.

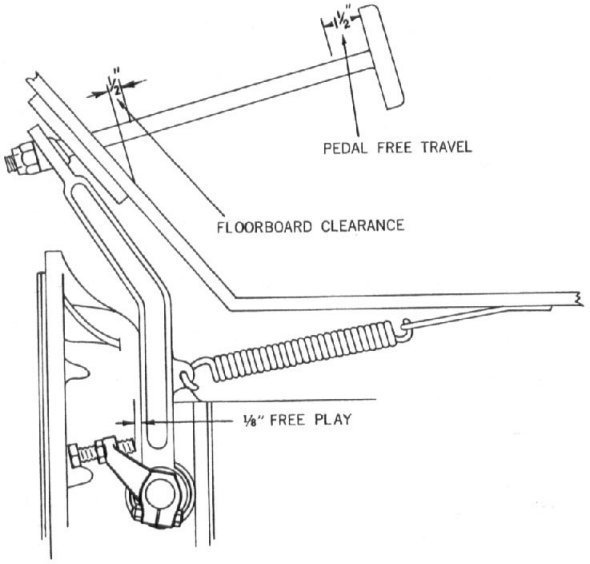

Fig. 38 – Adjusting Clutch Pedal Linkage.

(3) The proper clutch pedal "free travel" is approximately 1½". The gradual reduction from this amount is a normal condition caused by facing wear.

(4) If inspection indicates clutch pedal "free travel" is less than ½", immediate adjustment of the release sleeve should be made to restore the proper 1½", "free travel," see Fig. 38. This 1½" of "free travel" normally results in 1/8" clearance between the release yoke and the bearing carrier wear pads or at the cross shaft adjustment.

LINKAGE ADJUSTMENT

(1) Be sure release bearing sleeve is properly adjusted and locked before attempting to adjust the external linkage to set the pedal lash.

(2) In vehicles equipped with a hydraulic release refer to the vehicle manufacturer's maintenance manual for specifications relating to master and slave cylinder adjustments.

(3) The following items should be checked on vehicles equipped with hydraulic clutch release.

(a) Master cylinder operating lever must be adjusted so that the piston can retract fully and uncover the compensating port.

(b) The cross shaft lever should travel the same distance on each side of the vertical centerline of the cross shaft. See Fig. 39.

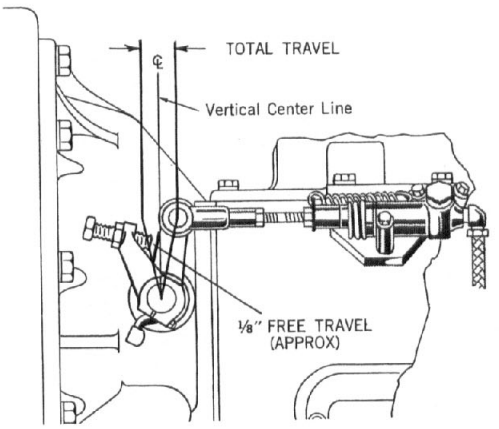

Fig. 39 – Typical Hydraulic Release Linkage.

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TRANSMISSION INSTALLATION

(1) Place the two brake friction discs on the transmission clutch shaft with the keyed steel disc between the friction discs. *NOTE:* These parts are not used with a synchronized transmission.

(2) Raise the transmission and enter spline shaft into the release sleeve assembly. Square up the transmission and move it forward to enter the driven disc hubs, at the same time allow the release yoke to pass over the top of the release bearing housing and fall into its normal operating position on the bearing housing wear pads. It is extremely important that the transmission be adequately supported in line with the crank shaft of the engine to facilitate entering the driven disc splines without damaging the splines or distorting the disc assembly.

(3) The following method of assembling the transmission to the engine is possible with the PT and LP clutches.

The release sleeve and bearing assembly may be placed on the transmission with the release yoke in its operating position. Then after the transmission has been raised into position and started forward, the adjusting sleeve must be threaded into the release lever spider. If this method is used, care must be taken that the transmission is not moved up to the engine faster than the sleeve and spider are threaded together or cotter pins may be damaged.

RELEASE BEARING ADJUSTMENT

(1) The release levers of new or genuine factory exchange cover assemblies are properly adjusted and locked at assembly and will not require further adjustment.

(2) After the transmission has been securely attached to the engine, the release sleeve must be adjusted until there is 3/8" for 14"-1, 1/2" for 14"-2, and 1/2" for 15½"-2, between the contact surface of the release bearing housing and the front brake disc. *IMPORTANT:* Keep tension on release yoke while turning adjusting nut. Do not attempt to lock the sleeve lock-nut to the release lever spider until the pedal linkage has been connected and adjusted for "free travel."

(3) As synchronized transmissions do not require the use of brake discs the gap between the release bearing housing and the transmission bearing cap should be maintained from 1/2" to 9/16". The method of obtaining this gap is the same as when brake discs are used.

(4) Following the preliminary adjustment of the pedal linkage, check the release bearing travel by pressing down on the clutch pedal. The release bearing housing should contact the transmission brake disc just before the clutch pedal makes contact with the floor board. Depress the pedal a few times and recheck the clearance stated in paragraph (2).

(5) Hold or block the clutch pedal down while the locknut is turned up to the release lever spider and securely tightened. *CAUTION:* Always disengage the clutch while the locknut is being locked or unlocked but have the clutch engaged while turning the release sleeve to obtain the proper clearance which must be rechecked and adjusted as facing wear occurs.

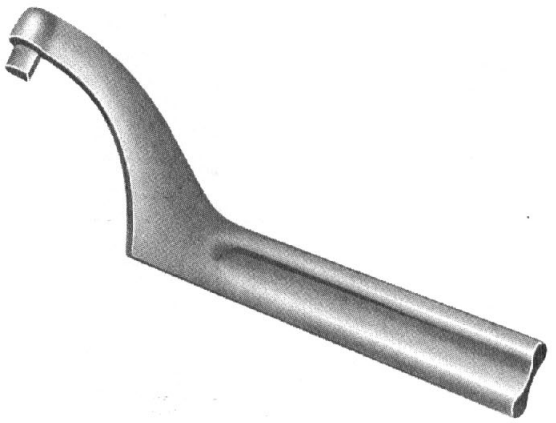

Fig. 40 – Lipe Spanner Wrench T-10970.

(6) "Free travel" of the pedal will diminish as the facings wear and must be re-established by adjustment of the release sleeve. If the pedal linkage is properly adjusted at the time of assembly, it should only require further adjustment as wear takes place in the linkage or at the two fiber brake discs.

NOTE: A spanner wrench Lipe Tool #T-10970 is available for turning the notched adjusting wheel and locknut on the release sleeve. If this tool is not available a brass drift and hammer may be used. See Fig. 40.

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TYPE PT, LP CLUTCHES

LUBRICATION OF RELEASE BEARING

(1) The release bearing rotates with the engine consequently small amounts of high temperature lubricant should be applied at frequent intervals, preferably with engine idling. Suggested high temperature lubricants are "Alert #275", Andok "C", Keystone #44, Lubrico M-31, Arm-Vac #781, Lidok #1 or #2, Nebula #1, Amdex #1 EP, Citco Premium Lithium #1, Gulf Crown Grease #1 EP, Mobilgrease #77, Alvania #1, Multifax #1 or #2, or equivalent.

TYPE LP, PT CLUTCH CHART

Model Number	Dimension "A"	Flywheel Depth +.005" -.005"	Facing Thickness
*140-72-760	1 9/32"	2.937	3/16"
*140-72-786	1 9/32"	2.937	3/16"
*140-72-787	1 9/32"	2.937	3/16"
*140-72-788	1 9/32"	2.937	3/16"
*140-72-816	1 9/32"	2.937	3/16"
*140-72-901	1 9/32"	2.937	3/16"
*140-72-917	1 9/32"	2.937	3/16"
*‡140-72-919	1 9/32"	2.937	3/16"
*‡140-72-920	1 9/32"	2.937	3/16"
#♦‡155-72-935	1 15/32"	Flat	3/16"
#♦155-72-936	1 15/32"	Flat	3/16"
#♦155-72-970	1 15/32"	Flat	3/16"
#♦155-72-971	1 15/32"	Flat	3/16"
#♦‡155-72-972	1 15/32"	Flat	3/16"
#♦‡155-72-973	1 15/32"	Flat	3/16"
*140-72-975	1 9/32"	2.937	3/16"
#♦155-72-1021	1 15/32"	Flat	3/16"
*‡140-72-1029	1 9/32"	2.937	3/16"
*140-72-1041	1 9/32"	2.937	3/16"
%140-72-1052	1 9/32"	2.937	3/16"
%‡140-72-1053	1 9/32"	2.937	3/16"
#♦‡155-72-1054	1 15/32"	Flat	3/16"
*140-702-1082	1 1/8"	2.937	3/16"
*140-702-1083	1 1/8"	2.937	3/16"
%‡140-702-1091	1 1/8"	2.937	3/16"
*‡140-702-1115	1 1/8"	2.937	3/16"
*‡140-702-1116	1 1/8"	2.937	3/16"
‡140-71-1124	1 19/64"	1.875	3/16"
†140-701-1131	1 9/64"	1.860	3/16"
#♦155-702-1132	1 15/32"	Flat	.184" FWS .169" PPS
#♦155-702-1133	1 15/32"	Flat	.184" FWS .169" PPS
#♦‡155-702-1135	1 15/32"	Flat	.184" FWS .169" PPS
#♦‡155-702-1136	1 15/32"	Flat	.184" FWS .169" PPS
*140-702-1138	1 1/8"	2.937	3/16"
*‡140-702-1139	1 1/8"	2.937	3/16"
#♦155-702-1495	1 15/32"	Flat	.184" FWS .169" PPS
#♦155-702-1496	1 15/32"	Flat	.184" FWS .169" PPS
#♦‡155-702-1497	1 15/32"	Flat	.184" FWS .169" PPS
#♦‡155-702-1498	1 15/32"	Flat	.184" FWS .169" PPS
‡140-701-1506	1 9/64"	1.875	3/16"
140-701-1514	1 9/64"	1.860	3/16"
%140-702-1529	1 1/8"	2.937	3/16"
140-701-1532	1 9/64"	1.860	3/16"
140-701-1550	1 9/64"	1.860	3/16"
†140-701-1552	1 9/64"	1.860	3/16"
*140-702-1570	1 1/8"	2.937	3/16"

Intermediate Plate Thickness 14"-2 .630 +.000" -.005" 15½"-2 .750 +.000" -.003"

* (1) C25-70 Intermediate Plate, (6) C26-32 Drive Pins only included.
‡ Equipped for 2"-10 spline. All others 1¾"-10 spline.
♦ (1) C25-67 Intermediate Plate included.
(12) C78-30 Cap Screws available when desired.
% (1) C25-70 Intermediate Plate, (6) C26-52 Drive Pins not included.
† Equipped for 1½"-10 spline.

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GENERAL MAINTENANCE

CLUTCH INSTALLATION CHECK LIST

I. Flywheel (Pot and Flat)

(a) Check for scoring, heat check and taper

(b) Check manufacturers' manual for minimum allowable thickness

(c) Resurface if sufficient stock is available

(d) Replace pilot bearing

(e) Check bolt hole counterbores

(f) Check clutch pilot rim

(g) Check drive pin condition and alignment with tool

(h) Check flywheel alignment with housing and vice-versa. See chart page 37.

II. Clutch Cover, Disc and Intermediate Plate

(a) Check for correct size

(b) Install disc assembly using pilot shaft

(c) Install cover assembly – Check pilot seating, remove hold down bolts or blocks

(d) Check with feeler gage – Bolt pilot

(e) Check "A" Dimension

1. Levers too high – too low – flywheel depth wrong, wrong disc thickness

2. Lever heights uneven – cover not seated properly.

III. Linkage

(a) Hydraulic or mechanical

1. Check for worn, loose or broken parts

(b) Check pedal return of hydraulic master cylinder

IV. Transmission

(a) Check release bearing carrier wear pads

(b) Check release yoke contact with release bearing carrier

(c) Check cross shaft for wear and housing bushings

(d) Check release bearing carrier travel

(e) Check bearing lubrication fitting and tube

(f) Replace bearing and lubricate

(g) Check stem gear – wear, chipping, rust, scoring, etc. and lubricate lightly

(h) Install transmission carefully – do not damage disc(s)

V. Completion

(a) Connect clutch pedal linkage

(b) Adjust release bearing carrier clearance

(c) Check clearance after 5,000 miles and before 10,000 miles

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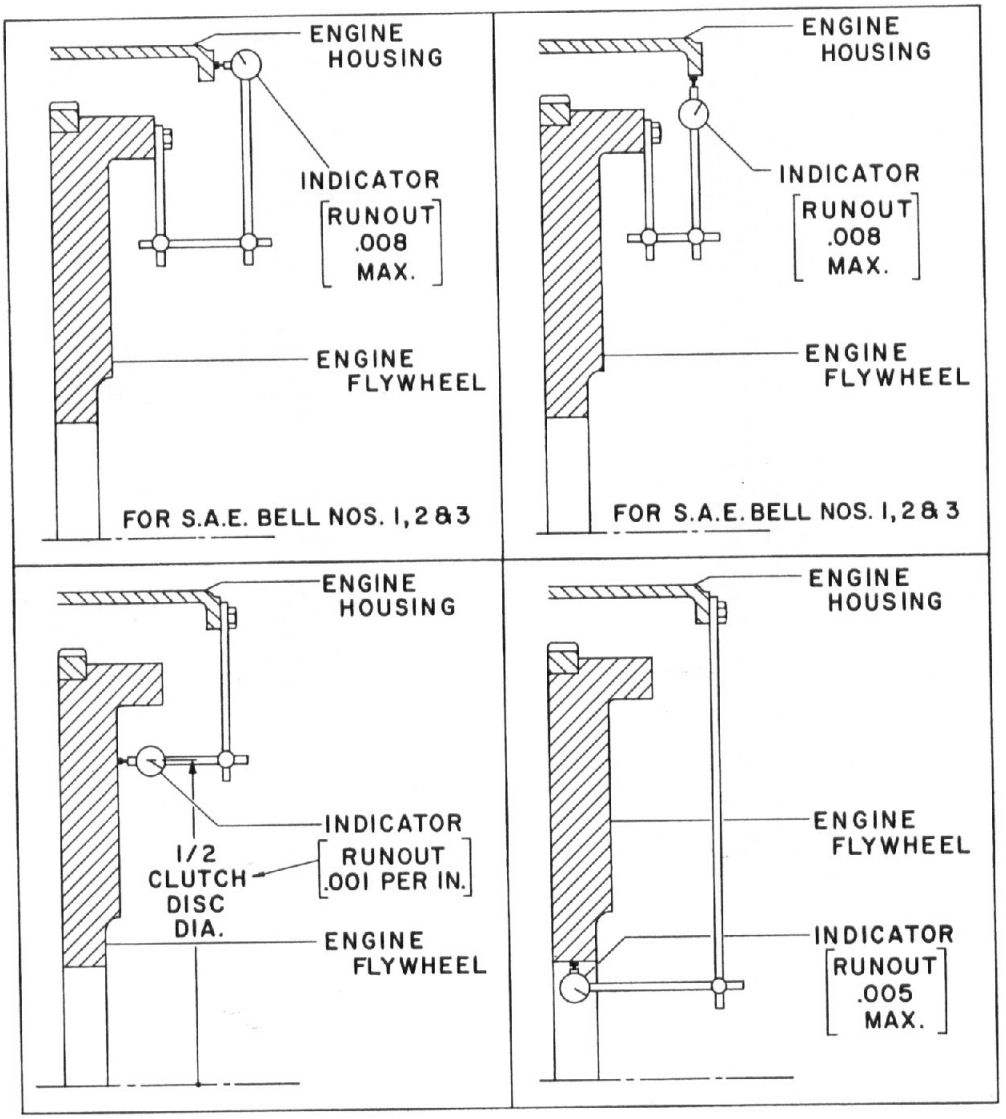
GENERAL MAINTENANCE

CHECKING FOR MISALIGNMENT



The center line or axis of the engine, crankshaft, flywheel, clutch, and transmission shall be common to these units with a permissable variation of not to exceed .005" between any or all of these members.

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GENERAL MAINTENANCE

CLUTCH OPERATION & MAINTENANCE

There are many things that have a great deal to do with satisfactory clutch life. These are not actually a part of what we normally think of as being of a maintenance nature. Let us start with the driver; he can be your best friend or your worst enemy depending on how he handles the vehicle. A great deal can be accomplished by driver training and in some cases we might go so far as to make an attempt to educate the dispatcher and loading foreman. The driver should not be held responsible for poor clutch life when vehicles are consistently overloaded and trip schedules are faster than traffic laws will allow.

We know of no formula for estimating clutch life expectancy on any given vehicle. We usually talk in terms of so many thousand miles for highway service or in the case of off highway vehicles we quote hours of operation. Neither of these ways of quoting clutch life are very accurate, except for comparison purposes on a certain run. Instead of using the term miles with respect to clutch life we should consider it in terms of ton miles and to our formula add a factor for number of starts per mile and also a time element.

We are all familiar with the fact that a certain driver on a certain run will obtain very satisfactory clutch life with a given vehicle, while another driver with the same vehicle on the same run will obtain very short clutch life. This is where driver training can be of considerable help. Education on the proper starting and gear shifting techniques should definitely be a part of basic clutch maintenance requirements. The vehicle manufacturer uses a transmission having various gear ratios but, if starts are repeatedly made in the higher gears, clutch life is bound to suffer. Clutches are not the only part of the vehicle that may suffer, but they are our chief interest at the moment. If the vehicle is equipped with a two speed rear axle or auxiliary transmission, the proper use of these ratios should be stressed. We know of many city operated vehicles where the high speed range of the two speed rear axle had to be blocked out in the interest of both clutches and engines. This clearly indicates the vehicle purchased was not geared or suitable for the job and such instances can result in very costly maintenance. It has been our experience that all together too many drivers shift into the higher gears before the vehicle has reached a speed where the engine does not labor. This driver practice causes impact or shock loading of the drive line component parts from the clutch on through to the rear wheels. In some instances severe torsional vibration is set up by this practice and it is a proven fact that engine life suffers from this type of operation. We cannot over stress the importance of starting in the correct gear ratios because actual clutch life is dependent on the amount of heat generated and how much the clutch is forced to act as a dry torque converter. We are all familiar with the fact that when a clutch is fully engaged or in a static state, heat or wear is practically non-existent, but that during the moment of engagement when the clutch is picking up its burden or load, it generates considerable heat through the expenditure of kinetic energy. It then is evident, that the problem is to operate the vehicle in a manner that will allow the shortest possible kinetic moment or slip period. This is done by mating the torque demand at the rear wheels with a suitable transmission ratio. The engine throttle should be opened just enough, to prevent stalling until the clutch has become statically engaged. The critical period of any clutch is during the moment of engagement, for it is a very weak clutch indeed that will slip after it once becomes statically engaged, assuming of course, that it is in proper adjustment and release bearing clearance is being maintained. This is true because practically all clutches have a static capacity far greater than their kinetic capacity. In general, clutches are mated to an engine based on their kinetic capacity rather than on their static capacity, hence, if satisfactory starts are made, clutch life is bound to be satisfactory.

Important starting of the vehicle effects clutch life – for example, a vehicle equipped with a 15" clutch and the engine running at 2,000 RPM, the clutch would, if engaged at this speed, have a slip speed of approximately 7,853 feet per minute at the outer edge or nearly 1-1/2 miles per minute. A 17" clutch engaged at the same speed will have a slip speed of 8,835 feet per minute or an increase of nearly 1,000 feet per minute for a 2" difference in clutch diameter. Film temperature under such conditions is high enough to cause metal to flow on the friction surfaces of the pressure plate and flywheel, not to mention what it does to the clutch facing friction material. Heat is generated much faster than it can be dissipated and, if starts are very frequent so that the unit as a whole has no chance to cool, the resulting very high temperature will cause pressure plates to warp, heat check and even break. The flywheel will become heat checked and the components in the clutch facing material will bleed out, causing further slippage and heat, to

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the point where the facings rapidly start to disintegrate. It is a vicious cycle once it is started. Slip or friction generates heat and once the critical temperature of the friction material is reached, its friction value rapidly decreases and this results in more slippage and heat and so on, to quick destruction.

The general complaints or troubles attributed to the clutch are usually classified as:

1. Failure to transmit power, slips, short life
2. Does not release properly – gears clash
3. Chatter
4. Grabs
5. Vibration

SLIPPAGE – FAILURE TO TRANSMIT FULL POWER

The first and most important item for discussion is clutch slippage or failure to transmit full power developed by the engine into the transmission and back to the rear wheels. The first thing probably any of us would check would be to look for pedal lash or floor board clearance. We should go a little farther than this, however, as vehicles have been found with pedal lash yet the clutch release bearing was in heavy contact with the clutch release sleeve or fingers causing a partial clutch disengagement. This is not generally true but it is possible due to the way some vehicle clutch release linkage is constructed or worn. Riding of the clutch pedal can be a serious threat to clutch life and clutch release bearings as this driver habit causes partial disengagement of the clutch resulting in slippage.

The next step should be to check the adjustment of the clutch cover assembly itself. Clutches may be divided into two very simple classifications. They are either of the adjustable or non-adjustable type. When the terms adjustable or non-adjustable are used they mean service adjustments in the vehicle to compensate for facing wear. A so-called non-adjustable clutch has definite settings which should be made on a bench fixture before assembling to the engine as no provision is made for internal clutch adjustments. This type of clutch has no provision for restoring full plate pressure and therefor is subject to fade in torque capacity. In the use of adjustable type clutches we do not rely on pedal lash or even bearing clearance as an indication that satisfactory performance can be expected but rather rely on internal clutch adjustments.

A typical example of the non-adjustable type clutches are those used in passenger cars. An example of the adjustable type clutches is that made by the Lipe-Rollway Corporation. Internal clutch adjustment is provided by means of shims. Removal of these shims is readily accomplished and the cover assembly is thereby restored to the original factory setting without the use of special tools. Removal of the shims does not affect the dynamic balance of the clutch, yet compensates for facing wear and at the same time restores full spring pressure. All clutch manufacturers furnish service manuals that provide service dimensions and adjustment procedures for their various clutches. It is important to have such information available in your service file so that the best possible clutch performance can be obtained. In the case of the Lipe type ML clutch we stress the importance of maintaining the Dimension "A" by periodic inspection; Dimension "A" being a service dimension that when maintained will provide maximum clutch efficiency. In the way of explanation the Dimension "A" is the distance that the face of the clutch release sleeve extends beyond the machined surface of the flywheel ring on which the shims are located. As the clutch facings wear the release sleeve moves out from the assembly toward the release bearing, thus reducing the bearing clearance or pedal lash and results in lengthening the "A" Dimension. Removing a set of shims – one from each stud – from under the adjusting plate allows the adjusting plate to be pulled farther into the flywheel ring which in turn pulls the release sleeve back with it and results in shortening up the "A" Dimension. We highly recommend the use of a scale or suitable gauge for measuring the "A" Dimension and by referring to charts or service manuals published, the cover assemblies can be kept in good adjustment and maximum service obtained. We only adjust the pedal linkage to compensate for wear in the linkage itself or to correct a previous faulty adjustment. For instance some one may have adjusted the pedal rather than remove shims until it would become necessary to remove two or even three shims to obtain the correct "A" Dimension. By removal of two or three shims at one time, the sleeve will be pulled in so far that an excessive

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amount of bearing clearance or pedal lash will be present and the pedal linkage must then be adjusted or the clutch cannot be fully disengaged. There are several reasons, other than maladjustment, that can cause clutch slippage; oil or grease on the facings, binding at the driving lugs and broken or weakened pressure springs. There is very little that can be done about any of these conditions except to remove the clutch. Some mechanics have washed the clutch with Pyrene or gasoline to remove oil or grease as a means of obtaining a few days more service but the job will very likely require a good cleaning and overhauling before much additional satisfactory service can be had.

FAILURE TO RELEASE

Number two on the list of common complaints is failure to release properly and there are a great many reasons why a clutch may not release completely. Probably the most common cause of poor release is wear in the release linkage and in some cases we find the release linkage in new vehicles improperly adjusted or designed to give full release of the clutch. Before a clutch is condemned for not releasing, it would be well to check the actual release bearing travel and make certain that maximum travel is available. It is often the last 1/16" of release travel that is the critical portion and may be very essential to easy gear shifting. It may be possible to make some changes or adjustments in the linkage to obtain a little more release travel which will eliminate the necessity of dropping the transmission and removing the clutch. In this same connection, check for loose motor supports and loose or cracked bell housings. In most vehicles the clutch pedal is mounted on a bracket which is attached to the frame. A connecting rod or link runs from the pedal shaft arm to the transmission cross or release shaft so that any perceptible movement of the engine will detract from the movement of the release bearing and poor clutch disengagement will result.

Clutch pressure plate retraction springs must also be considered in certain types of clutches. If they are weak or stretched out, they cause clutch drag. In the case of two plate clutches the driving pins should be squarely aligned with the flywheel friction face and the intermediate plate should have a free fit over the pins.

Another common cause for dragging clutches is the pilot bearing in the flywheel. In most cases the pilot bearing can only be lubricated at assembly and it is very important that a high melting point type of grease be used. The fit of the pilot bearing in the flywheel and on the stem gear is important. A push fit is recommended in both instances so there will be some room for heat expansion without obstructing the free rolling of the balls. Some manufacturers of trucks and buses have tried various means of lubricating the pilot bearings but this has been abandoned because the tendency was to over lubricate which caused an even worse condition.

Grease on the facings can also cause clutch drag as well as create excessive slippage. One of the reasons for clutch drag in a vehicle, which has been in service for some time, is the accumulation or spent or worn off facing material around the inside of a cupped type of flywheel. Clutches which are attached to flat flywheels are not confronted greatly with this problem but clutches which work in a recessed or cupped type flywheel are often accused of malfunction, when actually it is this accumulation of dirt and facing dust inside the flywheel which prevented complete disengagement and created what we are referring to as clutch drag. This is especially true if there is any oil or oil vapor present in the clutch and flywheel housing. The oil collects and mixes with the accumulated dust and dirt and is then packed on the inside of the flywheel rim until the driven member is running in a groove or trough. Obviously, this can create considerable clutch drag and the only solution is to remove and thoroughly clean the units and locate and stop the oil leaks. At this point, let us mention that the release bearing and carrier assembly can be over lubricated also. The clutch release bearing also requires a high melting point type of grease but usually the transmission will have a pressure lubrication fitting connected to the release bearing carrier, with the result that the lubrication man applies his pressure gun filled with chassis grease and loads it excessively with improper lubricant. It is not uncommon to find an excessive amount of grease inside the clutch transmission housing after just three or four lubrication jobs, resulting in the grease getting on the clutch facings causing drag, slippage and chatter.

Another reason for clutch drag and hard shifting is a bent or sprung driven disc. This is usually caused by faulty installation where the transmission stem gear is entered into the driven disc splines out of proper alignment or the transmission

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is allowed to drop and hang unsupported in the splined hub of the clutch disc. Disc assemblies are not sprung in service but rather during installation or removal. Ideal inspection of driven discs is to first mount them on an expanding arbor and rotate the disc against a dial indicator. The dial indicator contacts the facing just inside the outer facing rivet circle and a total indicated run out of .015" is the maximum allowed. The disc is then placed on a splined arbor having a fit similar to that of the transmission stem gear and rotated between two flat and parallel platens. This simulates the position of the disc between the flywheel and pressure plate in a vehicle. These platens are set to allow .025" clearance over the nominal thickness of the complete driven member and the driven member must rotate freely without drag to pass this inspection station. This latter procedure is termed checking for flatness, as a dial indicator checks for run out, but cannot detect a concave or dished disc assembly. Before relining a driven disc, a check should be made for run out with a dial indicator, and a square or straight edge can be used as a flatness checker.

Misalignment between transmission and engine is also a common cause of clutch drag. It also will result in rapid wear of the splines and very frequently results in fatigue of the steel disc to the point where it fractures and breaks away from the hub. Misalignment can also cause chatter and grab, since it will hinder parallel engagement of the friction surfaces. It is comparatively simple to attach a dial indicator to the flywheel and check the concentricity of the flywheel housing to the crankshaft and also the rear face of the engine housing to which the transmission is attached. A maximum indicator reading of .010" is allowed on the I.D. of the housing while the bolting face should not exceed .006" total indicator reading. After making and recording these two checks, the indicator should be attached to the housing and similar readings taken of the flywheel. It is essential that the engine be rotated by hand while making these checks in order to obtain accurate readings. If the flywheel has a high run out, you are very apt to have another undesirable feature and that is vibration. There are four (4) checks or readings to be taken on the flywheel if it is of the cupped or recessed type. See "Checking for Misalignment," page 37.

No. 1 is at the bolting surface.

No. 2 is at the clutch pilot diameter. This pilot diameter of the flywheel and also the pilot diameter of the clutch cover assembly, have to be very accurately machined, to assure centering the clutch.

No. 3 is to check the run out at the flywheel friction surface. This usually will show good relationship to the bolting face but, if a flywheel has been re-machined and was improperly set up, a variation is possible. These three checks should not show a total indicator reading of over .005" to be acceptable.

No. 4 is to check the pilot bearing bore.

A maximum reading of .003" is all that is allowed at this point. What we are trying to do here, is make sure that the engine crankshaft, flywheel, clutch and transmission are all turning on a common axis with a permissible variation of not to exceed .005" between any or all of these members.

At this point we would like to discuss inertia and how it relates to clutch drag. The dictionary defines inertia as the inability of matter to change its state of rest or motion. A vehicle at rest has inertia and that is one of the reasons why we have clutches so as to make possible a gradual change from its state of rest to a state of motion. Inertia also has its effects on gear shifting although we may seldom think of inertia as being the guilty party. As an example, let us assume that we are operating a vehicle equipped with a 165 H.P. Diesel engine and a 15" single plate clutch. This vehicle will have a fairly large transmission which will probably be of the constant mesh type. The job has been operated perhaps a couple of hours so the oil in the transmission is well warmed up and everything seems to be working fine, except that the driver complains that the clutch drags and he can't get the transmission into gear from neutral without clashing gears. The engine in this vehicle may be idling between 450 and 500 RPM and, due to the weight of the rotating parts in the transmission and the driven member of the clutch all of which are rotating at engine speed, we may find it necessary to wait as much as four seconds after depressing the clutch pedal, before we can put the transmission into a starting gear without clashing. This is a result of inertia and the complaint is not uncommon, especially in later years with the increased popularity of larger engines and transmissions and also the frequent use of a lighter weight transmission oil. It is especially true when a

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driver becomes promoted from a light vehicle to a heavier one or from gas to Diesel operation. Aside from explaining the phenomena of this inertia to the driver, attention should be given to engine idling speed and lubricant in the transmission. A very convincing demonstration which has been used many times to prove that the clutch does disengage completely and that the trouble is not clutch drag, but rather inertia, is to put the transmission into gear and then with the clutch pedal still fully depressed put the transmission into neutral and accelerate the engine to about 1200 RPM. Then the shifting lever is quickly moved back into gear; if the clutch has any perceptable drag, the driven member will again have started to rotate and it will be impossible to put the transmission into gear without clashing.

CLUTCH CHATTER AND GRAB

There are a multitude of things that can cause chatter and grab and they are usually attributed to the clutch, however, in the majority of cases the trouble lies elsewhere. Any looseness along the power line from the tires to the engine flywheel can cause chatter. Broken rear springs, loose motor mounts and spring shackles can aggravate the condition. This excess play or lost motion causes the transfer of power with impact and continued operation is very apt to show up in badly hammered splines of the clutch disc assembly or transmission stem gear. Misalignment as previously mentioned attributes to clutch chatter and grabbing clutches in that the entire friction surface of the clutch is not being engaged at the same moment and spotty contact results. To these conditions we can add oil soaked or greasy clutch facings. An oil soaked facing has little friction value until high unit pressure is applied, hence the sudden grab. Oil soaked facings reduce the coefficient of friction value and as heat is generated due to excessive slippage the oil film is burned away and causes the coefficient of friction to quickly rise and cause a grabbing or aggressive engagement.

Another common cause of clutch grab can be found in the release linkage. Linkage that binds or otherwise does not operate smoothly will cause erratic engagement of the clutch. This is particularly true of the release bearing carrier. If this is allowed to become dry or sticky, pedal pressures will go up and engagement may be erratic. Here again, motor mounts should be inspected. An engine that rocks around on the frame can also cause erratic or aggressive engagement.

VIBRATION

Vibration is usually caused by rotating parts being out of balance and while the clutch is sometimes blamed for vibration, there are many other things that can contribute to vibration such as main bearings, loose flywheel bolts, worn transmission bearings, loose engine frame, inoperative engine vibration dampeners, bent propeller shafts and worn universal joints.

Today's high speed engines demand balanced clutches in order to obtain smooth, vibration free operation which eliminates wear and therefore reduces maintenance costs. We would like to point out that centrifugal force due to unbalance increases as the square of the speed, double the speed increases the force four times, whereas tripling the speed increases the force nine times. Take, for example, if a repaired clutch is out of balance 3 inch ounces which is not uncommon to encounter at 1000 RPM, this equals 5½ pounds force. At 3000 RPM this centrifugal force rises to 48 pounds. When you consider that the average weight of our cover plate assembly is approximately 48 pounds, this force would be equivalent to lifting the clutch and dropping it down again 3000 times per minute. This great centrifugal force, of course, causes severe vibration and accelerates wear of the engine and drive line component parts and makes them short lived thus attributing greatly to maintenance costs.

In maintenance work on clutches, we have found the condition of the flywheel is very frequently overlooked. Even though a flywheel may not show heat cracks or scoring that would seem to warrant replacement or reconditioning, it still may be worn to a very definite taper. The slip speed being much greater at the outer edge, this is where the greatest wear occurs. At the same time, if the pressure plate is warped or dished, it will have further increased the unit pressure at the outer edge and further aggravated the wear at this diameter. The net result is that a flywheel may be .010" to .015" deeper at the outer diameter than it is toward the center. Therefore it is possible to install a 15" clutch but only have a friction area contact and tact the flywheel at the highest point which is near the center. It thus is possible to install a 15" clutch but only have a friction area contact and torque capacity of a 12" clutch and slippage is bound to occur until the facings wear down or the pressure plate has again warped enough to obtain full contact area. When a clutch is removed from

GENERAL MAINTENANCE

an old vehicle, the chances are it needs a new starter ring gear, so it is money and time saved in the long run, to remove the flywheel and have it properly reconditioned by a competent machine shop. Always insist that the friction surface be finished perfectly square to the axis and the final depth is brought back to original factory specifications. This of course applies to cupped type flywheels only and the specifications on these depths are available from the clutch manufacturer as well as included in most of the vehicle builders service manuals. Flywheels that are severly heat cracked should be replaced since the flywheel may have become weakened and unsafe for further service. *CAUTION:* When refacing friction face of flywheel do not remove material to a point that the hub of the disc assembly will interfere with the pilot bearing.

Reconditioning or rebuilding of the cover assembly is best done by the original manufacturer who has the necessary knowledge and equipment to properly adjust and re-balance each specific assembly. There are many automotive parts jobbers who carry service parts in stock and can do a fair job in rebuilding cover assemblies and relining driven members, but in very few places do they have the equipment for rebalancing the assembly after it is rebuilt. Many parts jobbers do not carry service parts or assemblies made by the original manufacturer and the quality of this replacement material is questionable. Authorized jobbers and distributors representing the clutch manufacturers as well as the vehicle manufacturers' dealers carry the genuine part and is the place to procure service parts as they are obviously in the best position to render genuine service. These authorized outlets are on the direct pipe line carrying vital information concerning the clutch products they represent and are in the best position to pass on important service information as well as information concerning improvements and supersessions that may have taken place.

Use of inferior linings or substandard parts, is not economical when tear down and overhaul time is considered. For this reason the clutch facing, pressure plate assembly and all service parts should be of the best material available. Used parts that are of a border line condition should be replaced with new parts. Pressure springs should be checked for weight and, if there is the slightest doubt, install new springs as the spring is the very heart of the clutch. Reconditioning of cover assemblies may be done in your own shop, if you have the necessary equipment and competent mechanics, but the economy of this procedure is questionable. Genuine clutch exchange assemblies are available at leading authorized parts jobbers, which were rebuilt by the original clutch manufacturer and have been adjusted and balanced to the original factory specifications. These units carry the same warranty policy as a brand new unit at about 25% savings over the cost of a new unit.

Driven members are not generally sold on an exchange basis, at least not by the original manufacturer or his jobbing outlets. The cost of returning these units to the factory with the labor and parts involved to put a driven member in new condition does not make this practice economical. However, facings are available and considerable relining is done in the field. We mentioned before how to check a driven member for run out and dish before relining and you should also check for excessive spline wear. There are several makes of high quality clutch facings on the market and we highly recommend the use of the original equipment top quality woven type of facing of the correct thickness, to be assured of getting the proper frictional values for best performance and long life. It is also important that the correct size of rivet be used as well as the type of set. The rivet must have a body diameter the same as the hole in the steel disc and the head should be approximately the same size as the counter bore in the facing. The rivet should be just long enough so that when set with a star or split type set, the ends will reach to the edge of the counter bore of the facing. A roll or eyelet type of rivet clinch is not recommended for use with fabric facings. The rivet shank should also be bored deep enough so they can be split far enough to securely tighten the facings to the steel disc. *CAUTION:* Do not over set the rivets so as to damage and weaken the facing rivet counterbore.

The clutch is engineered to last many thousands of miles under normal operating conditions and, properly installed, used and maintained, should give many hours of satisfactory service. The clutch is mated to the power train at the factory and is rated to specifications consistant with engine power and gross vehicle weight. In cases where overloads or extremely rugged operations prevail, a heavier pressure assembly may be available. However, a larger or heavier assembly is not a cure all for overloads, and a 15" clutch for example in place of a 13" clutch will not rectify or justify loading abuses.

Important! Use Only GENUINE LIPE PARTS

GENERAL MAINTENANCE

SUMMARY

To summarize briefly this dissertation on clutch maintenance, we would like to mention the following points.

1. Drivers should be trained in driving techniques that will help to eliminate breakdowns and prolong clutch life.

2. Don't overload. Loads should be adjusted to the capacity of the vehicle, as clutches are not designed and recommended for overloaded conditions.

3. Mechanics should be trained in the proper methods of installing and adjusting clutches.

4. A preventative maintenance program should be devised so that impending troubles can be caught before serious breakdowns and road failures occur.

5. It is false economy to use any clutch material but the best since labor involved in removing the clutches, plus the loss of vehicle revenue, is more costly than the clutch repair parts involved.

6. Be sure the vehicle being used is engineered for the job.

FLYWHEEL - CAUSE OF MANY COMPLAINTS

The importance of the flywheel to smooth, satisfactory clutch performance is often overlooked. The flywheel does half the work, and, if it's warped or distorted, no clutch will give good service. On all clutch jobs, the flywheel should get the same careful inspection that brake drums get on a brake job.

When a clutch burns out, there's usually enough heat generated to cook everything, and the flywheel with a clutch bolted on it, is very apt to warp and distort as it cools off.

THE FLYWHEEL MUST BE CAREFULLY CHECKED AND RESURFACED, IF NECESSARY, TO PROVIDE A SMOOTH, FLAT SURFACE! No trouble should be experienced in refacing a flat flywheel, but a "pot" or "recessed" flywheel requires that extreme care be taken to make sure that the exact depth is maintained from the friction face of the flywheel to the bolting surface, otherwise trouble will be encountered. On a clutch job, treat the flywheel with the same respect you give to a brake drum on a reline job. Never – *NEVER* – install a clutch without first making sure the flywheel is O.K.

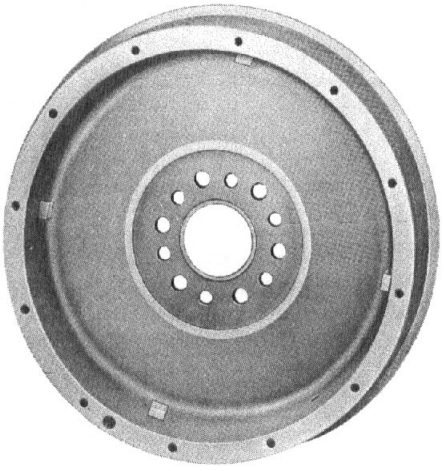


Fig. 41 – Properly reconditioned flywheel

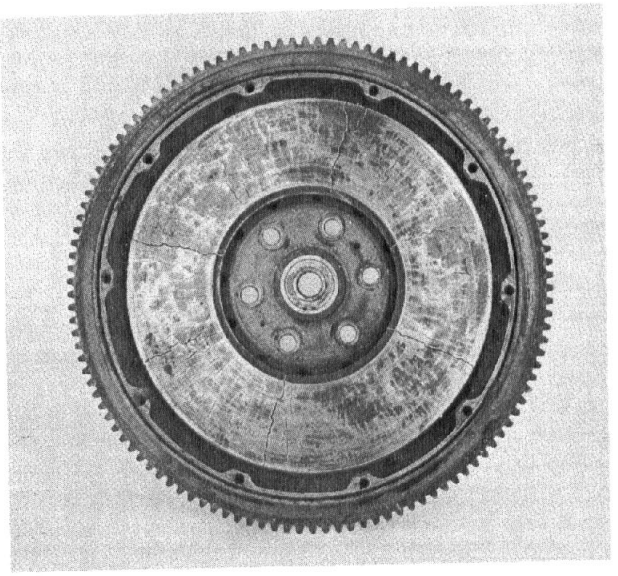


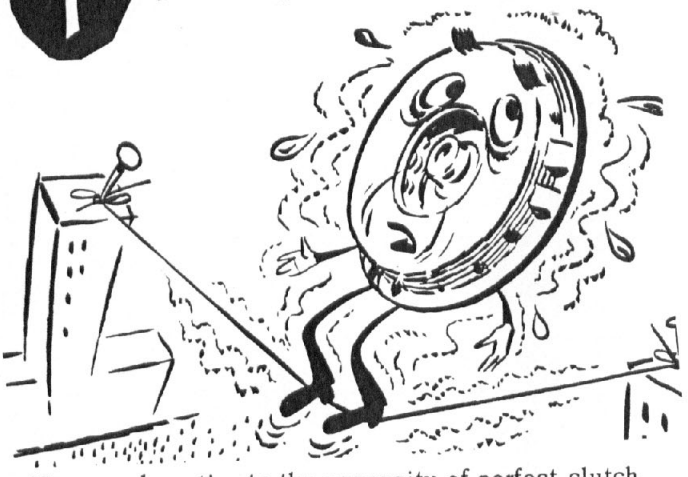
Fig. 42 – Scrap

Important! Use Only GENUINE LIPE PARTS

GENERAL MAINTENANCE

PLAIN TALK

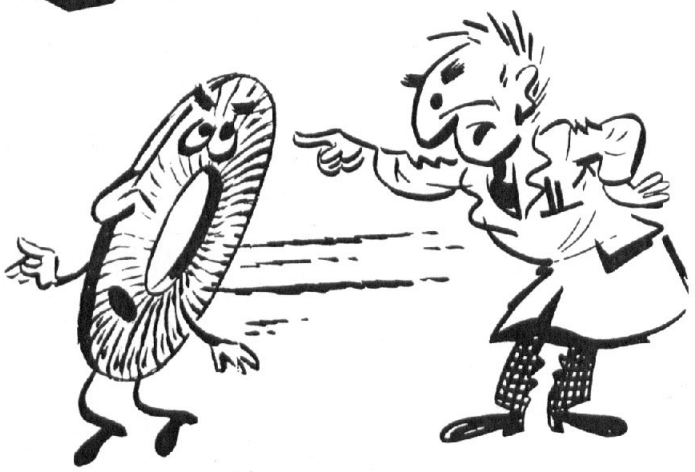
1 IT'S A FACT!



Never underestimate the necessity of perfect clutch balance. For example, just 3 inch ounces of clutch unbalance at 3000 RPM is enough to fracture a crankshaft!

Every Lipe clutch is balanced on special equipment... in rotation, just as it would be in the vehicle. Few field rebuilders are equipped to do this.

2 IT'S A FACT!



Pressure plates dished as much as .060" are reground by some rebuilders! Not enough metal remains to dissipate heat. That means quick failure.

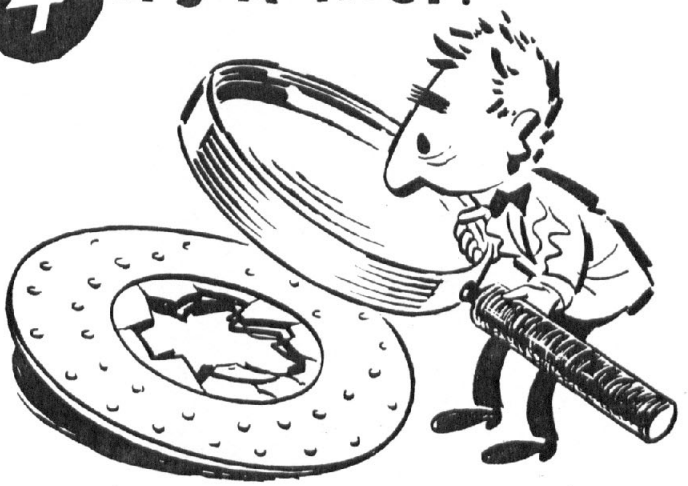
Pressure plates that are dished beyond original specifications are scrapped by Lipe.

3 IT'S A FACT!

You should never wait for a clutch to slip before adjusting! Regular inspection of the release bearing clearance insures proper adjustment.

Lipe furnishes its distributors detailed service manuals... available to the fleet owner at no charge.

4 IT'S A FACT!



Misalignment will cause chatter, grab, drag or vibration... or all four! Alignment of clutch and all other drive-line parts should be checked before taking vehicle off dead-line.

A Lipe Guaranteed Clutch is built to give you long clutch life. Don't let misalignment of other drive-line components steal it from you!

Important! Use Only GENUINE LIPE PARTS

GENERAL MAINTENANCE

TEN TIPS ON HEAVY DUTY CLUTCH OPERATION

1. Don't ride the clutch. It partially disengages the clutch at a time when it should be fully engaged.

2. Don't shift into higher gears before the engine reaches governed R.P.M. A lugging engine shock loads the driveline from the clutch on through to the rear wheels causing harmful torsional vibration.

3. Don't make a practice of skipping gears when upshifting with a heavy load. It can save the driver work, but costs money.

4. Don't forget vehicle weight when shifting. The fact that a vehicle is empty doesn't mean the clutch hasn't plenty of weight with which to contend.

5. Don't overload. The vehicle and its components, purchased for specific loads will rebel at excessive loads.

6. Don't speed. Excessive R.P.M. is as detrimental to the clutch as overloading.

7. Don't coast with the clutch disengaged. The centrifugal force extertion on a clutch running rampart can literally cause the driven disc to explode.

8. Don't hold the vehicle on a hill by slipping the clutch. Nothing wears out a clutch faster.

9. Do select the correct gear. The gear that will safely move any empty vehicle obviously can't cope with a loaded vehicle.

10. Do submit a driver report at the end of each day or trip, paying particular attention to clutch chatter, vibration, grabbing, slippage or failure to release. Be sure there is proper floor board clearance.

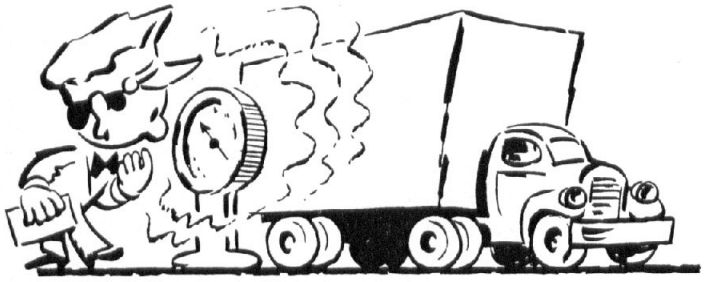
GENERAL MAINTENANCE

To get the most from your heavy-duty clutches

. . . Observe These Standard Procedures:

1. Driver training – Promote the use of driving techniques that will help eliminate breakdowns, prolong clutch life. Insist on reports of minor maladjustments . . . before they become major troubles.

2. Beware of overloading – Loads should be adjusted to the capacity of the vehicle. No clutch is designed or recommended for overloaded conditions.



3. Preventive maintenance – Regular inspection of clutches should be made to check critical dimensions and adjustments, uncover impending troubles. Mechanics should be trained in proper methods of installing, adjusting, maintenance.

4. Use only the best materials – Anything less is false economy. The labor involved in removing clutches – plus the loss of vehicle revenue – is far more costly than the repair parts involved: Heat will cause cheap facings to prematurely wear out and/or burst. High-fade pressure springs lower torque capacity, cause slippage, burn-out. Low-tensile pressure plates warp, chatter, vibrate, cause the ruin of other vehicle parts.

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GENERAL MAINTENANCE

COMMON SERVICE PROBLEMS

Problem	Remedy
CHATTER	
1. Loose, broken or worn engine mounts.	1. Tighten or replace.
2. Pedal linkage worn.	2. Replace linkage.
3. Loose or cracked clutch housing.	3. Tighten or replace.
4. Spring shackles and mountings loose, worn or broken.	4. Tighten or replace.
5. Misalignment.	5. Realign. See service bulletin #2A.
6. Oil or grease on facings.	6. Install new facings or disc ass'y.
7. Warped or bent driven disc ass'y.	7. Install driven disc ass'y.
8. Improper disc facing thickness.	8. Install proper disc ass'y.
9. Worn pilot bearing.	9. Replace.
10. Wrong spring pressure in cover ass'y.	10. Replace with proper cover ass'y.
11. Improper "A" dimension (Type ML only).	11. Adjust for "A" dimension according to ML charts.
12. Unequal quantity of shims under straps of ML clutch.	12. Use same quantity of shims under each strap.
13. Release levers not parallel.	13. Recheck installation.
AGGRESSIVE	
1. Release sleeve dry (Type ML only).	1. Lubricate release sleeve.
2. Worn or loose pedal linkage.	2. Replace or tighten.
3. Excessive backlash in power train.	3. Adjust or replace worn parts.
4. Warped driven disc.	4. Install new disc ass'y.
5. Worn hub splines.	5. Install new disc ass'y.
6. Worn splines on splined shaft.	6. Replace shaft.
7. Improper facing material	7. Install proper driven disc ass'y.
INSUFFICIENT RELEASE	
1. Broken or loose motor mounts.	1. Replace or tighten.
2. Worn or loose pedal linkage.	2. Replace or tighten.
3. Excessive idling speed.	3. Adjust to factory specs.
4. Loose or worn facings.	4. Replace facings or install new driven disc ass'y.
5. Improper facing thickness.	5. Install proper driven disc ass'y(s).
6. Warped or bent driven disc ass'y.	6. Install recommended driven disc ass'y properly.
7. Lever settings wrong.	7. Refer to "A" dimension chark and recheck installation.
8. Worn splines.	8. Replace with new driven disc ass'y.
9. Worn or rusty splines on splined shaft.	9. Repair or replace.
10. Worn pilot bearing.	10. Replace.

Important! Use Only GENUINE LIPE PARTS

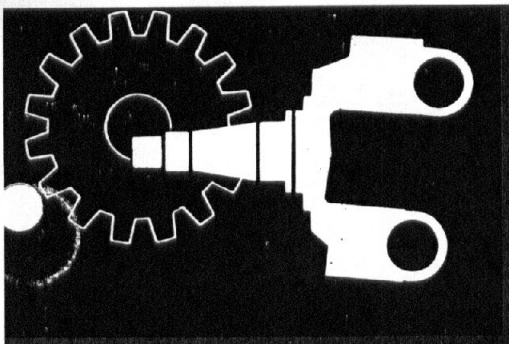
GENERAL MAINTENANCE

COMMON SERVICE PROBLEMS (Cont.)

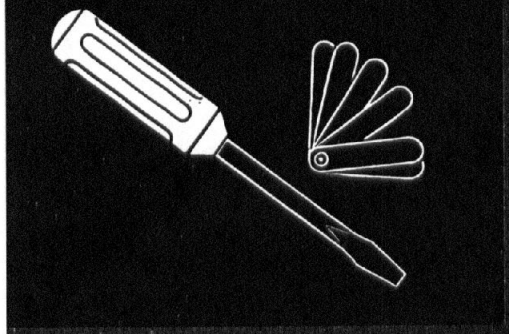
Problem	Remedy
HARD PEDAL	
1. Worn pedal linkage.	1. Replace with new linkage.
2. Binding in pedal linkage.	2. Lubricate and adjust.
3. Excessive spring pressure in cover ass'y.	3. Install proper cover ass'y.
4. Contact pad of release bearing carrier worn by shifter yoke.	4. Replace carrier and shifter yoke. Also check for proper hook-up to provide best linkage operating positions.
SLIPPAGE	
1. Oil or grease on facing.	1. Replace facing or install new driven disc ass'y. and correct oil leak.
2. Loose or worn facings.	2. Replace facings or install new driven disc ass'y.
3. Flywheel burned, checked or cracked.	3. Replace or regrind.
4. Insufficient plate pressure.	4. Install new cover assembly.
5. Improper "A" dimension (Type ML only).	5. Refer to "A" dimension chart for Type ML. Adjust to correct setting.
6. Binding in pedal linkage.	6. Lubricate and adjust.
7. Improper facing material.	7. Use correct facing or replace disc ass'y.
VIBRATION	
1. All or part of power train out of balance.	1. Check each unit individually and recheck as a complete ass'y.
2. One or more units in power train out of alignment.	2. Check and align (replace faulty component).
3. Worn splined shaft.	3. Replace.
4. Worn crankshaft bearings.	4. Replace.
5. Worn or loose engine mounts.	5. Replace or tighten.
6. Loose or out of balance universal joint.	6. Tighten or replace – check for balance.
7. Clutch out of balance	7. Install balance unit.
8. Worn disc splines.	8. Replace disc.

SUMMARY OF PROBLEMS AND SOLUTIONS – *Generally if the flywheel, engine mounts, transmission shaft, and power train are all installed properly and operating correctly, then the correct clutch, properly installed, will do the job in the vehicle.*

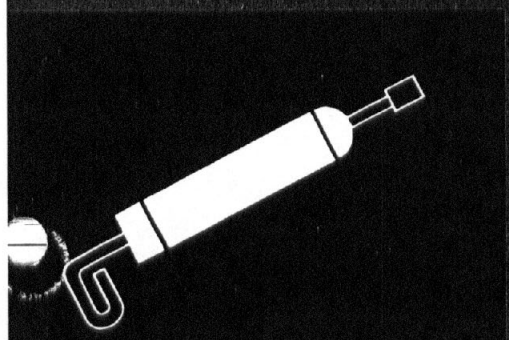
Important! Use Only GENUINE LIPE PARTS



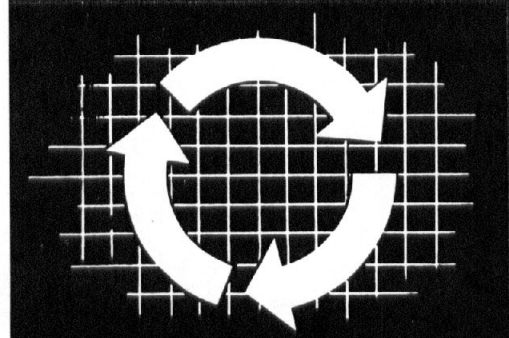
Disassembly & Reassembly



Cleaning, Inspection, Repairs & Adjustment



Lubrication



Torque Values

Field Maintenance Manual for Rockwell-Standard® Highway Truck & Tractor Axles

Rockwell International

2135 West Maple Road, Troy, Michigan 48084

Field Maintenance Manual For Rockwell-Standard® Highway Truck and Tractor Axles

The Rockwell-Standard Group of the Rockwell International Corporation has prepared this Field Maintenance Manual as an aid to the efficient service and maintenance of Rockwell-Standard Axles. This manual is a consolidation of all the material previously published in the following Field Maintenance Manuals:

FMM #1	Lubrication
FMM #2	Non-Driving Front Axle with Conventional Knuckle Pins
FMM #2A	Non-Driving Front Axles with Sealed Knuckle Pins (Supersedes Adv. FMM on this subject)
FMM #5	Single Reduction Drive Unit — Single Axles
FMM #5B	Single Reduction Forward Rear Drive Units — 2 Gear Transfer Train
FMM #5C	Single Reduction Forward Rear Drive Units — 3 Gear Transfer Train

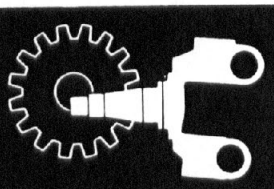
This manual is divided into sections pertaining to the specific operations to be performed. The Table of Contents will quickly show you the section(s) which detail the information you require. The pages are identified by page numbers at the lower outside corners and by section description in the upper outside corners.

Every effort has been extended to make this manual complete and easy to understand. If isolated questions arise which are not covered by this manual or by previously published material, contact the end product manufacturer or, if this is not possible, the Service Engineering Department of the Rockwell-Standard Group, Rockwell International Corporation, Troy, Michigan.

Use only Genuine Rockwell-Standard® Parts

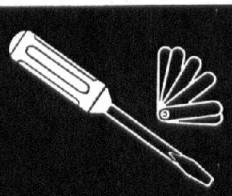
$1.00 per copy

section 1



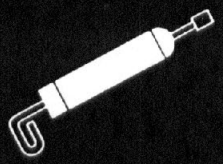
DISASSEMBLY AND REASSEMBLY

section 2



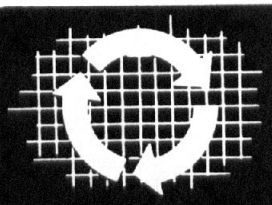
CLEANING, INSPECTION, REPAIRS AND ADJUSTMENT

section 3



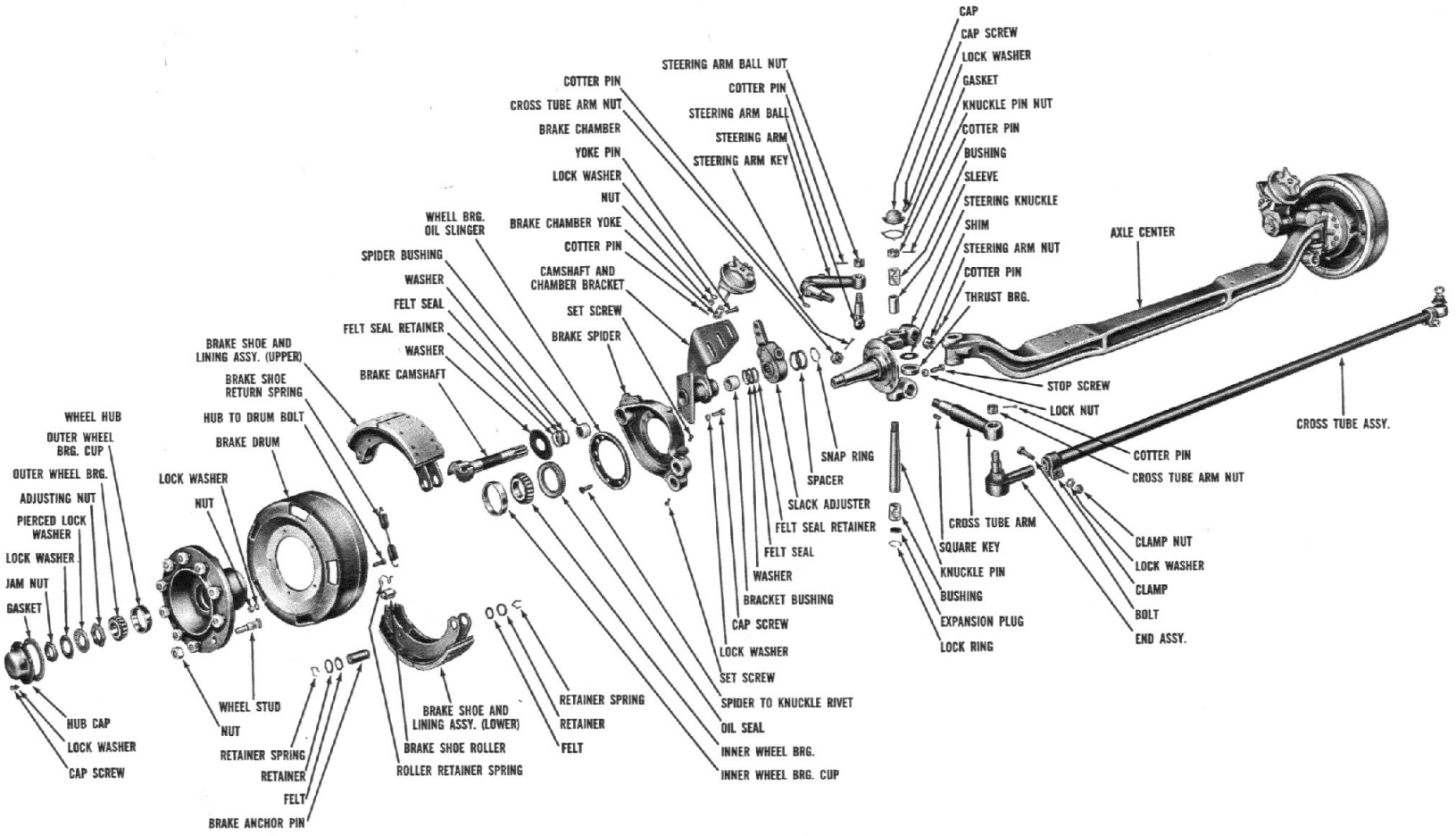
LUBRICATION

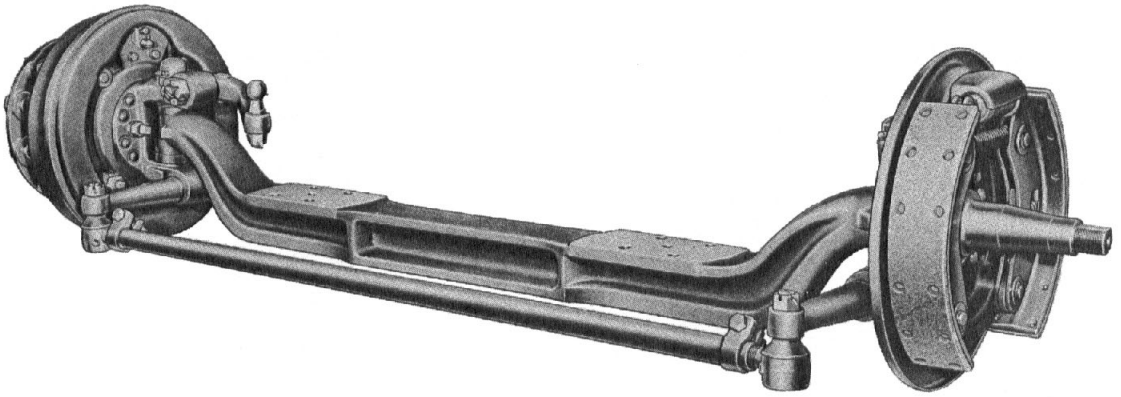
section 4



TORQUE VALUES

FRONT AXLE EXPLODED VIEW
(TAPERED KNUCKLE PIN DESIGN)





NON-DRIVING FRONT AXLES

Component Description

AXLE CENTERS

All "I-beam" type non-driving front axle centers, though varying in size, are machined from heat-treated steel forgings with "I-beam" section and spring pads integral.

All tubular type non-driving front axle centers are built of tempered seamless steel tube center sections with heat-treated steel forged knuckle pin ends. The knuckle pin ends and spring pads are electrically welded in position on the tube and become integral parts of the axle center.

Both the "I-beam" and the tubular type are of the "Reversed Elliot" design.

STEERING KNUCKLE PINS

Rockwell-Standard non-driving front axles may be equipped with tapered knuckle pins or straight knuckle pins, depending on model. Tapered knuckle pins are drawn into the axle center by tightening the nut at the upper end of pin, while the straight pins may employ one or two flats and are held in the axle center by means of tapered dowel keys. Both the tapered pins and the straight pins effectively become an integral or rigid part of the axle center.

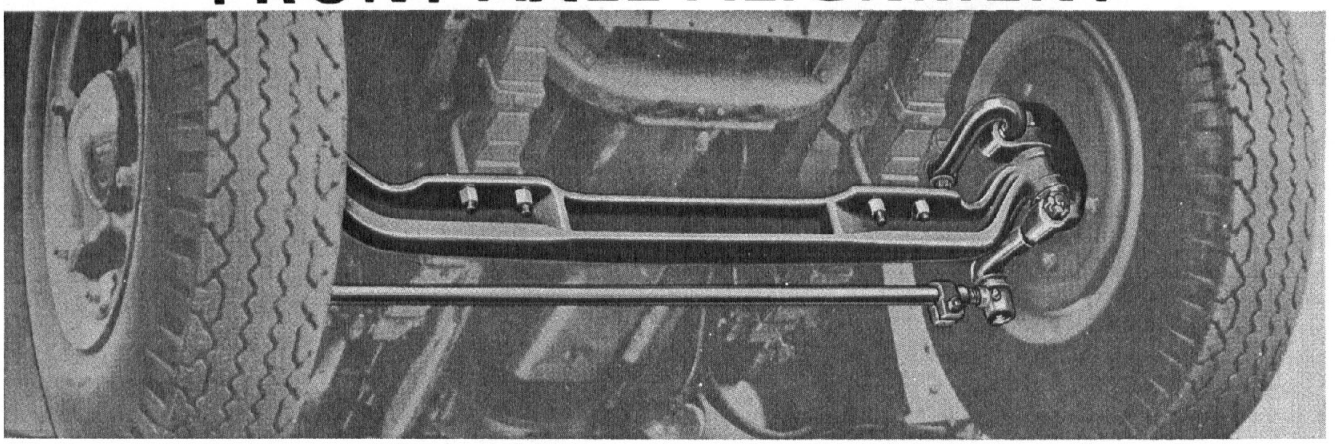
STEERING KNUCKLE AND BUSHING ASSEMBLY

Steering knuckles are bushed in the upper and lower pin bosses so that they may turn freely about the pins. Bushings, depending on model, may be bronze, steel backed bronze, or plastic material, all of which contain grooves to allow grease to flow uniformly to the high-pressure areas. Grease fittings are installed in both upper and lower knuckle pin bosses.

TIE ROD

The two steering knuckle assemblies are connected to each other by a tie rod. The tie rod is threaded at each end and held securely in position by clamp bolts. Right and left hand or "differential" threads are provided on the tie rod to facilitate toe-in adjustment.

FRONT AXLE ALIGNMENT



Front wheels must be properly aligned to assure efficient steering and optimum tire life. Recommendations for proper alignment of front axles, as furnished by the various vehicle manufacturers, should be carefully followed.

DISASSEMBLE FRONT AXLE

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: Do not attempt to dissemble or perform knuckle repair with vehicle supported by jacks only.

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.

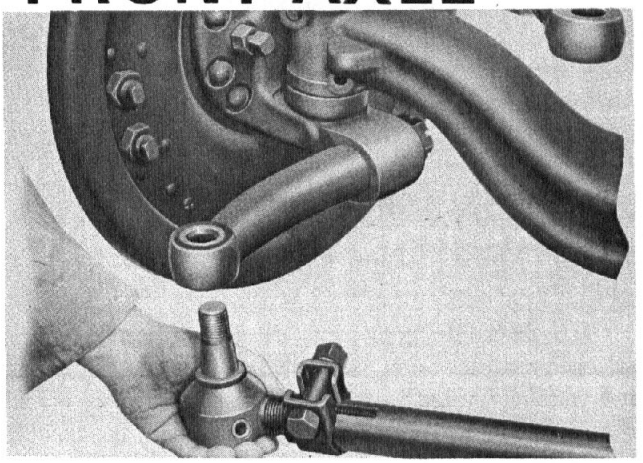
D. Remove wheel and hub assembly.

E. Remove brake air chambers on units equipped with air brakes, or hydraulic lines on units equipped with hydraulic brakes.

F. Remove brake assembly from steering knuckle.

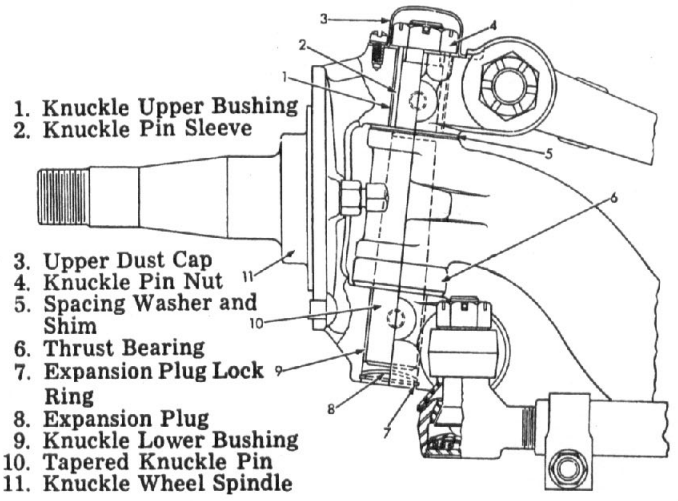
G. Remove tie rod end nut and disassemble cross tube assembly from cross tube arm.

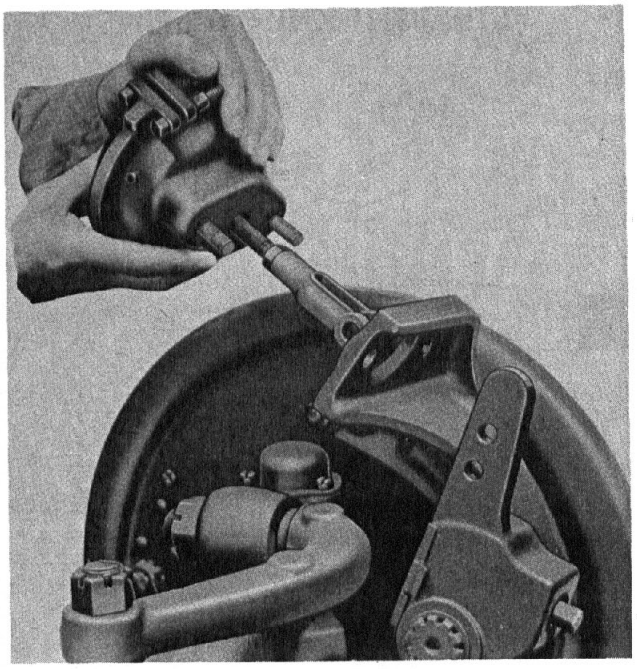
H. Remove cross tube arm nut, and steering arm nut and disassemble cross tube arm and steering arm from knuckle.



NOTE: It is not necessary to remove cross tube arm or steering arm from knuckle unless service is necessary.

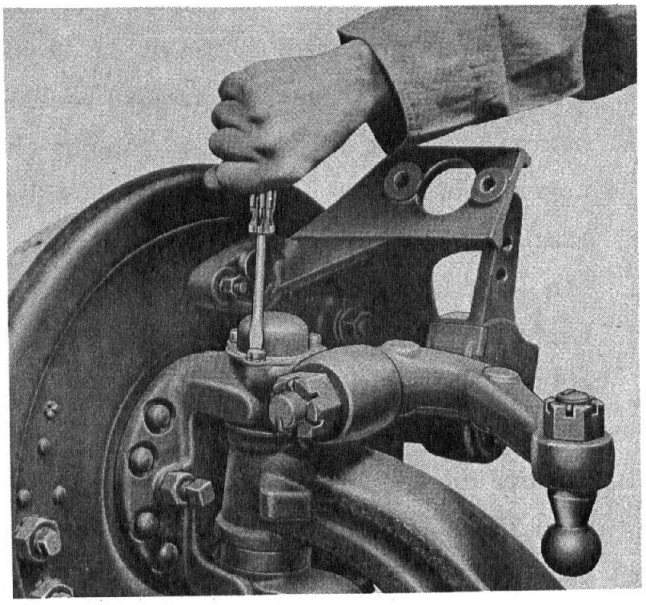
TAPERED KNUCKLE PIN UNITS



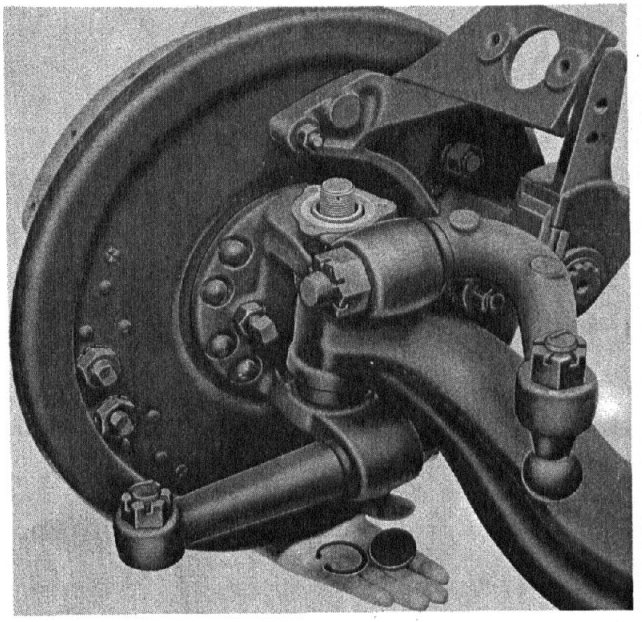


A. Tapered knuckle pins must be removed from the bottom side of the knuckle.

1. Disconnect push rod and remove brake chamber on units equipped with air brakes where clearance is needed for knuckle pin removal.
2. Remove cylinder brake fluid adapter fitting on units equipped with hydraulic brakes where clearance is needed for knuckle pin removal.



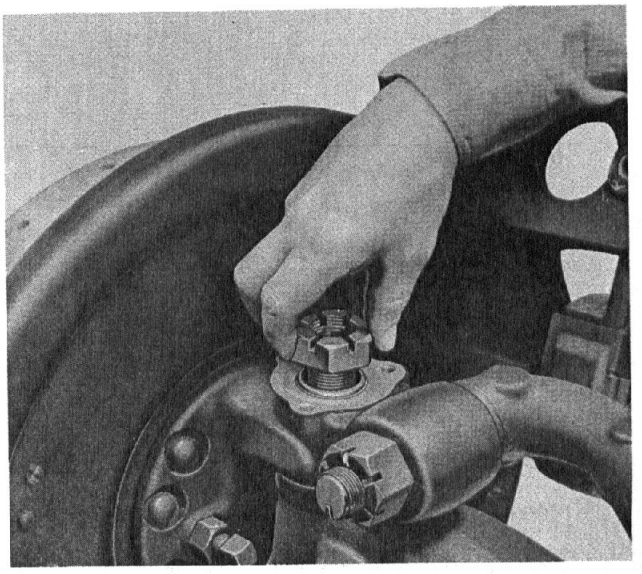
3. On some models it will be necessary to remove the brake shoe assembly and backing plate to provide clearance for knuckle pin removal.



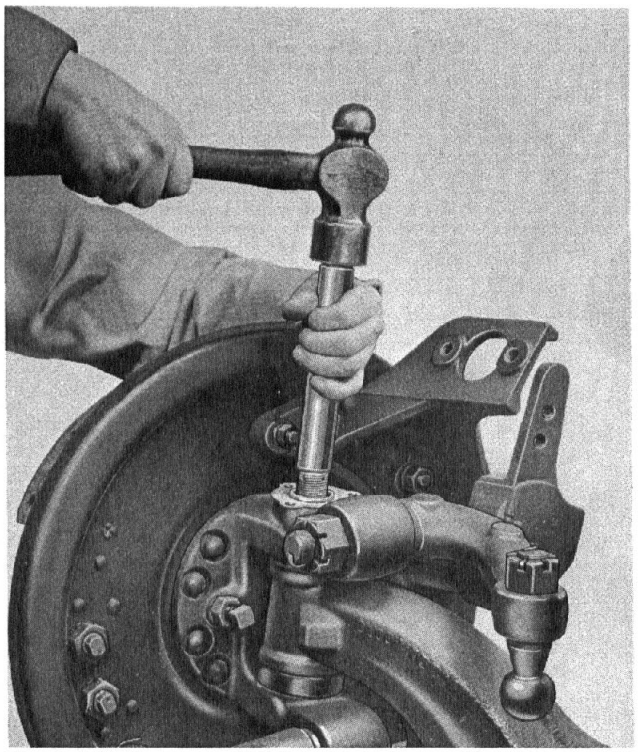
B. Remove the knuckle pin cover cap screws, cover and cover gasket.

C. Knuckles employing 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.

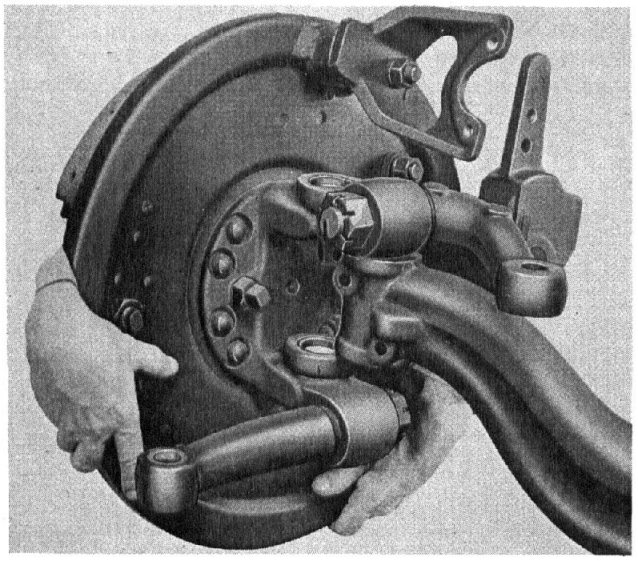


D. Remove knuckle pin cotter key and nut.



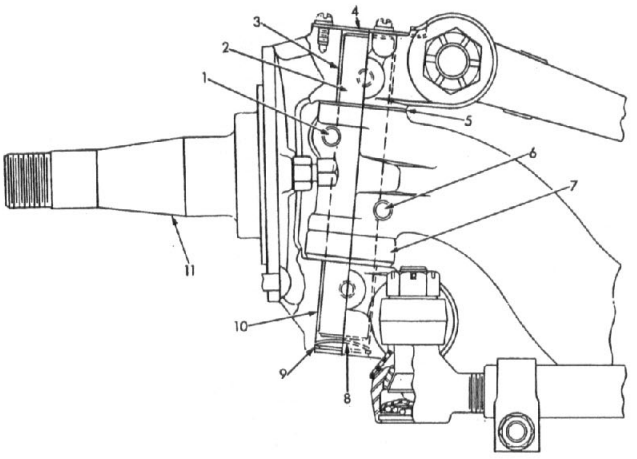
E. Drive knuckle pin out by use of drift on upper end. Bronze drift should be used to avoid any damage to threads.

CAUTION: Do not strike these hardened steel pieces directly with a steel hammer.



F. Remove the knuckle pin sleeve and lift off steering knuckle, thrust bearing and spacing washers.

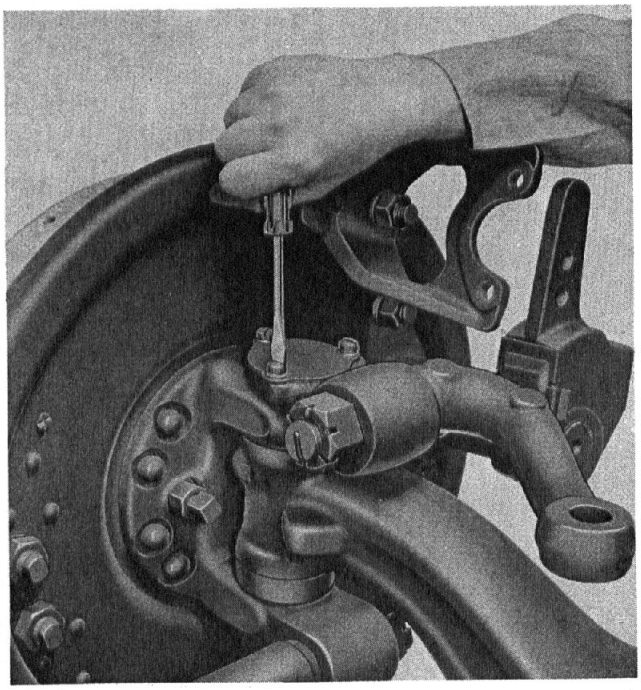
STRAIGHT KNUCKLE PINS



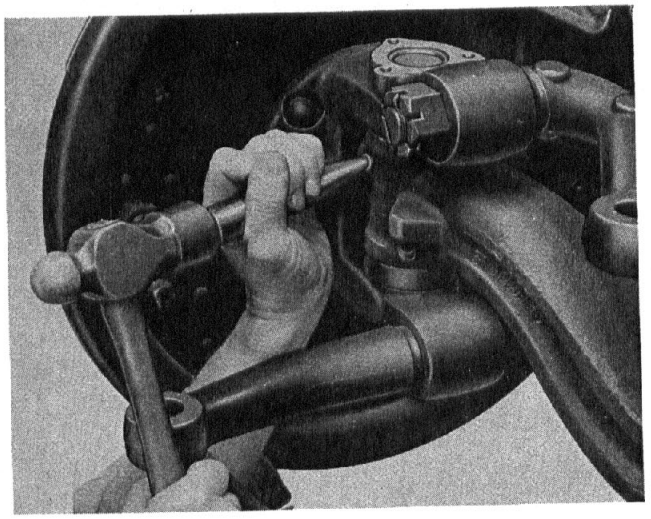
1. Draw Key—Upper
2. Knuckle Pin
3. Knuckle Bushing—Upper
4. Dust Cover
5. Spacing Washer and Shim
6. Draw Key—Lower
7. Thrust Bearing
8. Expansion Plug
9. Expansion Plug Lock Ring
10. Knuckle Bushing—Lower
11. Knuckle Wheel Spindle

A. 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.

B. Remove the snap rings and expansion plug from the bottom of the knuckle where employed. If plug employs no snap ring and is expanded and staked, remove plug by use of a cape chisel and discard.



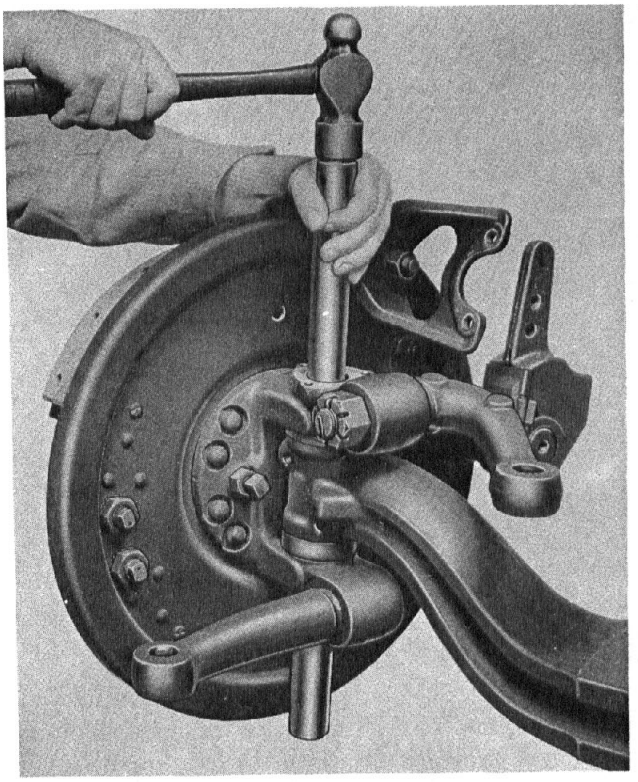
C. Remove the cap screws, cover plate and gasket from top of knuckle or remove lock ring retainer and seal, depending on model.



D. Tap out the knuckle pin draw key (or keys) from the small end using a suitable small slender drift.

CAUTION: Do not strike these hardened steel pieces directly with a steel hammer.

(Older models may employ tapered draw keys that are threaded on the small end and drawn into place by a nut. On these models, remove the nut and lock washer. Drive the draw key out by use of brass hammer on threaded end.)



E. Tap out the knuckle pin by use of a bronze drift.

CAUTION: Do not strike these hardened steel pieces directly with a steel hammer.

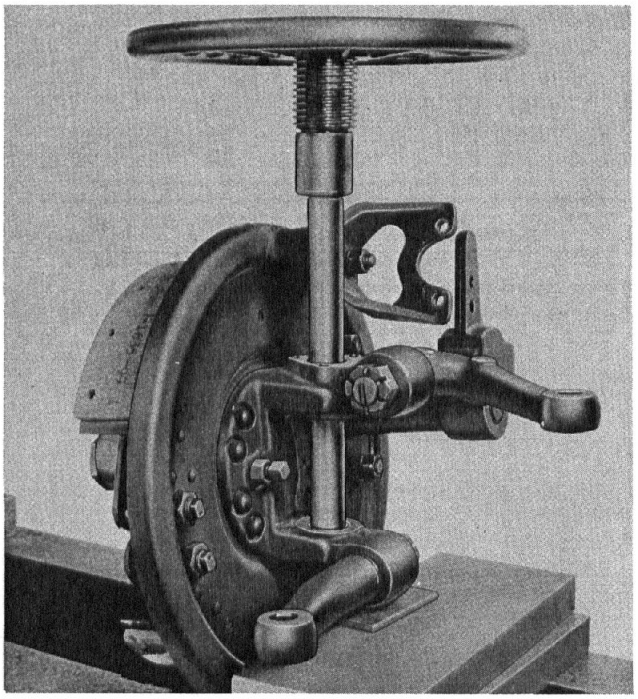
F. Lift off the knuckle assembly, thrust bearing and spacing washers. Retain shim, thrust bearing and seal for reassembly.

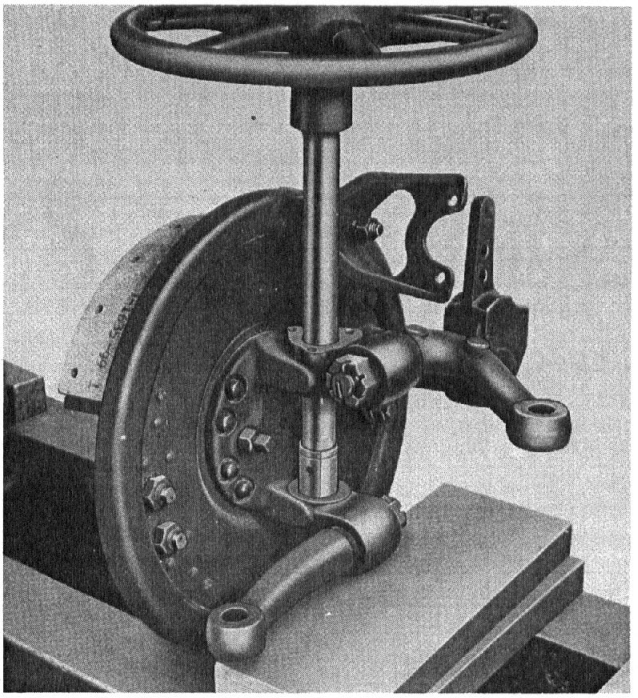
G. Refer to Section 2 for cleaning, inspection and component repairs.

REPLACEMENT OF BRONZE OR STEEL BACKED BRONZE STEERING KNUCKLE BUSHINGS

When it is desirable to service the steering knuckle bushings the following procedure is recommended and the tools shown in the sketches will facilitate this operation.

The tool utilized for removal of old and installation of new steering knuckle bushings is shown on the following page. The tool can be made from a piece of round bar stock which is ground with a step to serve as a pilot.





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

B. The new bushings should be installed with the same tool. The pilot of this tool prevents collapse or distortion of bushing during installation. The bushing should be pressed into the knuckle in three or more steps to allow it to align itself with the bore. Oil hole in bushing must line up with oil hole in knuckle.

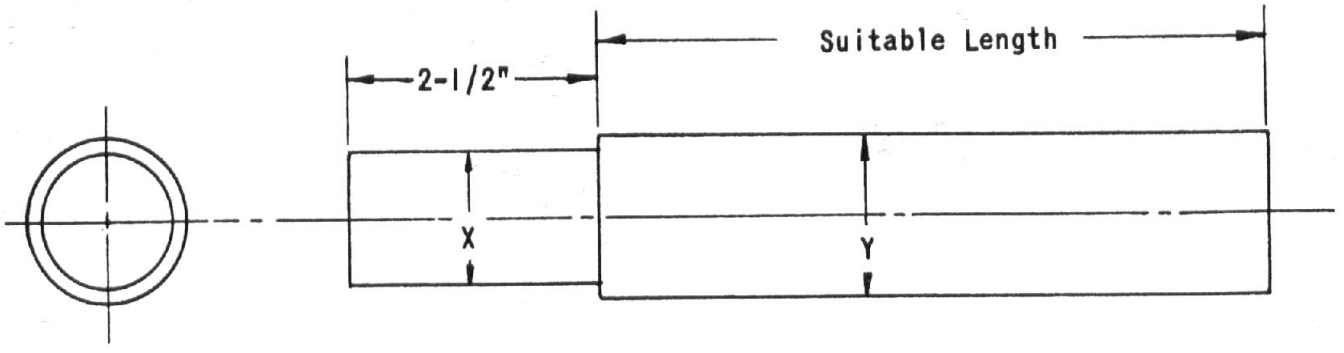
First press bushing into knuckle approximately ⅛" and relieve press pressure, press bushing in another ½" and relieve press pressure. The bushing can now be pressed in until it is flush with the inner machined surface of the knuckle.

This applies to both upper and lower bushings.

C. To finish a bushing, either a burnishing bar or reamer must be employed. The dimensional limits of these tools at finishing surfaces should correspond to those listed in columns "B" and "C" for the desired axle. (See table, page 11.)

Utilization of burnishing ball for this operation must be avoided, as it does not insure a true alignment between the two bushings.

BUSHING REMOVAL AND INSTALLATION TOOL



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

See table on following page

TABLE OF REAMER DIMENSIONS

Axle No.	A	B and C	D	E	Bushing	Knuckle Pin	X	Y
26000 27000	1.600 1.602	1.6095 1.6105	7.8125	6.9375	1225-R-278	3101-G-59	1.590 1.592	1.723 1.725
27460	1.787 1.789	1.7965 1.7975	8.125	7.250	1225-G-345	3101-F-84	1.777 1.779	1.909 1.911
30000 31000	1.100 1.102	1.1095 1.1105	5.750	4.875	1225-N-248	3101-B-54	1.090 1.092	1.223 1.225
32000 33000	1.225 1.227	1.2345 1.2355	6.375	5.500	1225-Z-234	3101-H-60	1.215 1.217	1.348 1.350
35000	1.349 1.351	1.3595 1.3605	6.6875	5.8125	1225-R-252	3101-C-55	1.339 1.341	1.473 1.475
36000	1.474 1.476	1.4845 1.4855	7.8125	6.9375	1225-Z-260	3101-F-58	1.464 1.466	1.598 1.600
FC-900	1.225 1.227	1.2345 1.2355	6.500	5.750	1225-B-366	3101-L-90	1.215 1.217	1.348 1.350
FC-901	1.225 1.227	1.2345 1.2355	6.900	9.750	1225-B-366	3101-N-92	1.215 1.217	1.348 1.350
FD-900	1.427 1.429	1.4365 1.4375	8.000	7.125	1225-J-348	3101-G-85	1.417 1.419	1.550 1.552
FD-901	1.427 1.429	1.4365 1.4375	8.000	7.125	1225-G-761	3101-M-91	1.417 1.419	1.550 1.552
FE-900	1.600 1.602	1.6095 1.6105	8.500	7.625	1225-Y-337	3101-B-80	1.590 1.592	1.723 1.725
FE-970	1.600 1.602	1.6095 1.6105	8.312	7.437	1225-Y-337	3101-X-102	1.590 1.592	1.723 1.725
FF-901	1.789 1.787	1.7975 1.7965	8.625	7.750	1225-V-750	3101-E-109	1.779 1.777	1.692 1.694
FF-921	1.789 1.787	1.7975 1.7965	10.00	9.125	1225-Z-650	3101-P-146	1.779 1.777	1.909 1.911
FG-900	1.787 1.789	1.7965 1.7975	8.875	8.000	1225-A-417	3101-Q-95	1.777 1.779	1.909 1.911
FH/FL-901	1.992 1.994	2.0015 2.0025	10.50	9.625	1225-C-523	3101-A-105	1.982 1.984	1.993 1.991
FQ-901	2.0545 2.0565	2.0640 2.0650	12.19	11.315	1225-F-760	3101-Q-173	2.0445 2.0465	2.1765 2.1785
FQ-921	2.0545 2.0565	2.0640 2.0650	12.19	11.315	1225-F-760	3101-U-177	2.0445 2.0465	2.1765 2.1785
FU-900	2.054 2.056	2.0635 2.0645	12.375	11.490	1225-F-318	3101-Y-77	2.044 2.046	2.177 2.179
FU-901	2.054 2.056	2.0635 2.0645	12.626	11.751	1225-F-318	3101-S-175	2.044 2.046	2.177 2.179
FU-910/915/935	2.054 2.056	2.0635 2.0645	12.75	11.875	1225-F-318	3101-R-174	2.044 2.046	2.177 2.179
FU-930	2.054 2.056	2.0635 2.0645	12.626	11.751	1225-F-318	3101-S-175	2.044 2.046	2.177 2.179
2661 2770	1.710 1.712	1.717 1.718	8.500	7.625	1225-A-157	3101-Q-43	1.700 1.702	2.083 2.085

Two sets of reamers, shown on next page, are designed to permit line reaming of the bushings without removing the dust shields. Reamers "Nos. 1 and 1A" comprise one set while the second set, "No. 2," consists of a reamer and pilot.

When using the "Nos. 1 and 1A" reamer set to ream the bushings, use reamer "No. 1" first to ream the upper bushing, then "No. 1A" to ream the lower bushing.

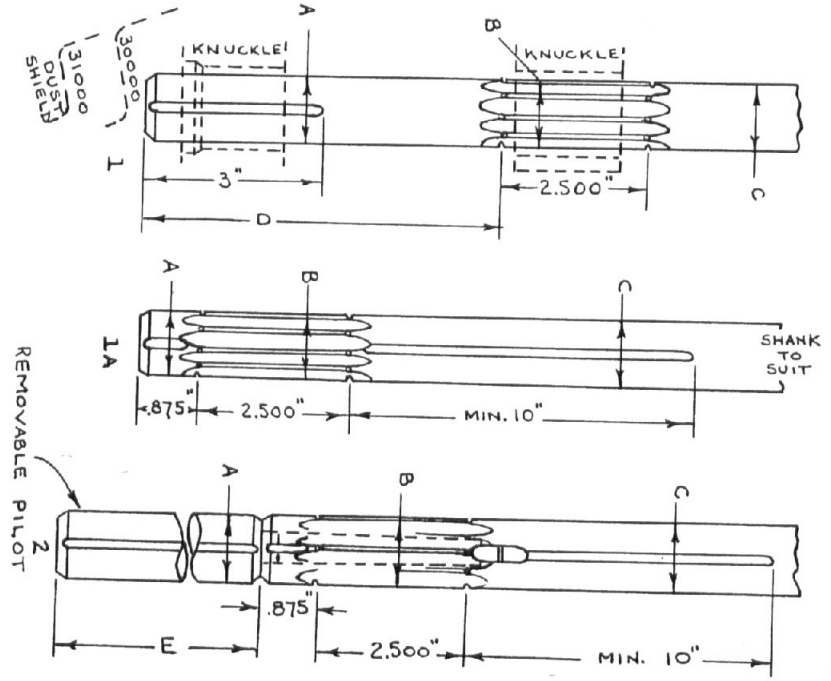
To use reamer "No. 2," first insert the pilot into the reamer to ream upper bushing, then remove the pilot to ream the lower bushing. Length of "D" dimension is dependent on model.

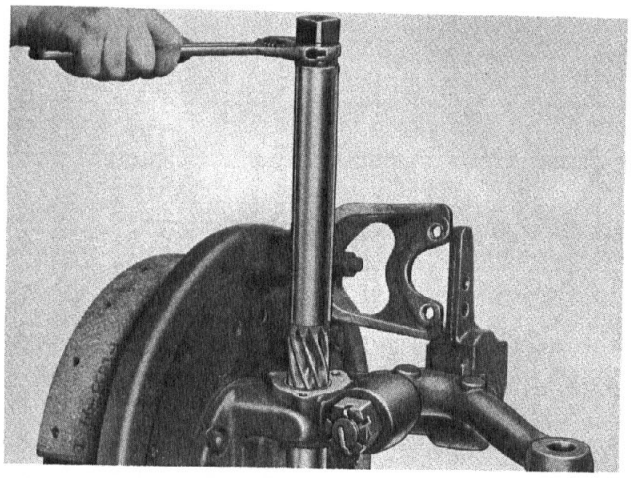
Avoid the possibility of tapering or enlarging the upper bushing while inserting the tool to ream the lower bushing. To do this, the reamer should be turned slightly in the non-cutting direction. Do not turn it in excess of 90 degrees as this may damage the cutting edges of the reamer.

Both the "Nos. 1 and 1A" reamer set and the "No.2" reamer and pilot can be made by a reliable tool source from the specifications on this page.

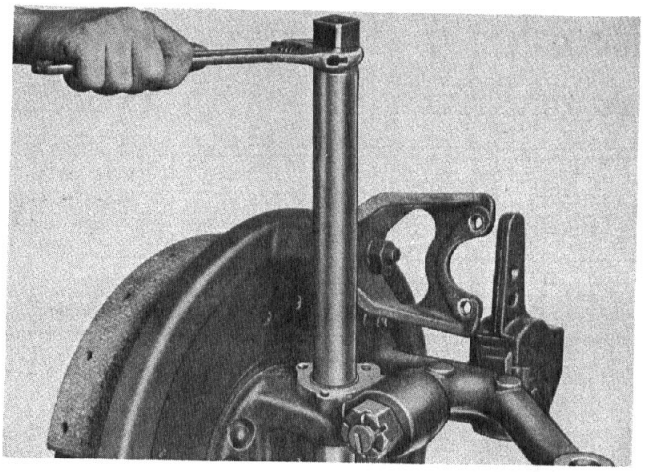
Reamers "Nos. 1 and 1A," which make a set, may be purchased from Red Arrow Tool Company, 26531 King Road, Romulus, Michigan, or from L. O. Beard Company, Lancaster, Pennsylvania.

REAMERS





USING "NO. 1" REAMER FIRST TO REAM UPPER BUSHING



USING "NO. 2" REAMER TO REAM LOWER BUSHING