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TM 9-1727D

RESTRICTED

WAR DEPARTMENT

TECHNICAL MANUAL

of

ORDNANCE MAINTENANCE

TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

APRIL 28, 1943

FOR ORDNANCE PERSONNEL ONLY

RESTRICTED

TECHNICAL MANUAL
No. 9-1727D

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ORDNANCE MAINTENANCE

TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

Prepared under the direction of the
Chief of Ordnance

(with the cooperation of the Cadillac Motor Car Division,
General Motors Corporation)

CONTENTS

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

Section I

INTRODUCTION

1. PURPOSE AND SCOPE.

a. TM 9-1727D is published for the information and guidance of all ordnance personnel charged with the maintenance and overhauling of Light Tanks M5, M5A1, and 75-mm Howitzer Motor Carriage M8. It includes complete maintenance information on the transfer unit. The other technical manuals covering these vehicles are listed in section III.

2. DESCRIPTION OF VEHICLES.

a. The Light Tanks M5 and M5A1 are armored, full-tracklaying combat vehicles, each carrying a crew of four men. They are each powered by two liquid-cooled, 90-degree, V-type, 8-cylinder engines, located in the engine compartment in the rear of the hull. Power is transmitted to the final drives and tracks through two Hydra-Matic transmissions, two propeller shafts, a two-speed, step-down transfer unit, and the controlled differential (fig. 4).

b. The Motor Carriage M8 (fig. 3) is an armored, full-tracklaying, self-propelled mount for a 75-mm howitzer. It carries a crew of four men. It is powered by the same engines, transmissions, and power train as the Light Tank M5.

3. REFERENCES.

a. Section III of this volume lists all technical manuals, standard nomenclature lists, and other publications relative to the materiel described herein.

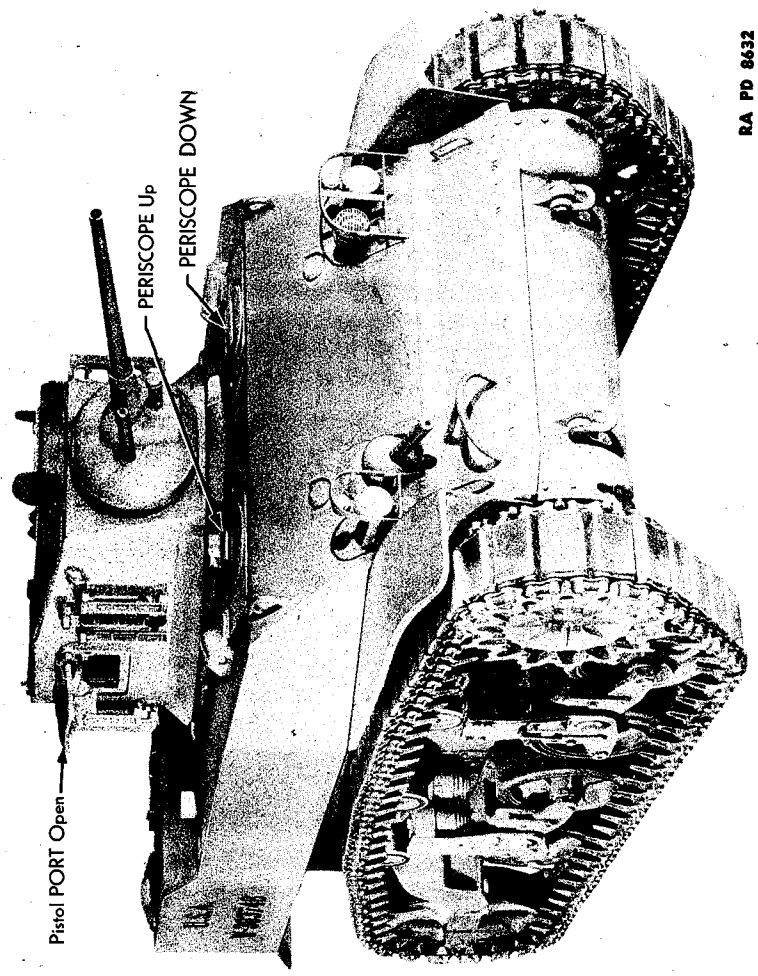

Figure 1 — Light Tank M5 — Right Front View

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

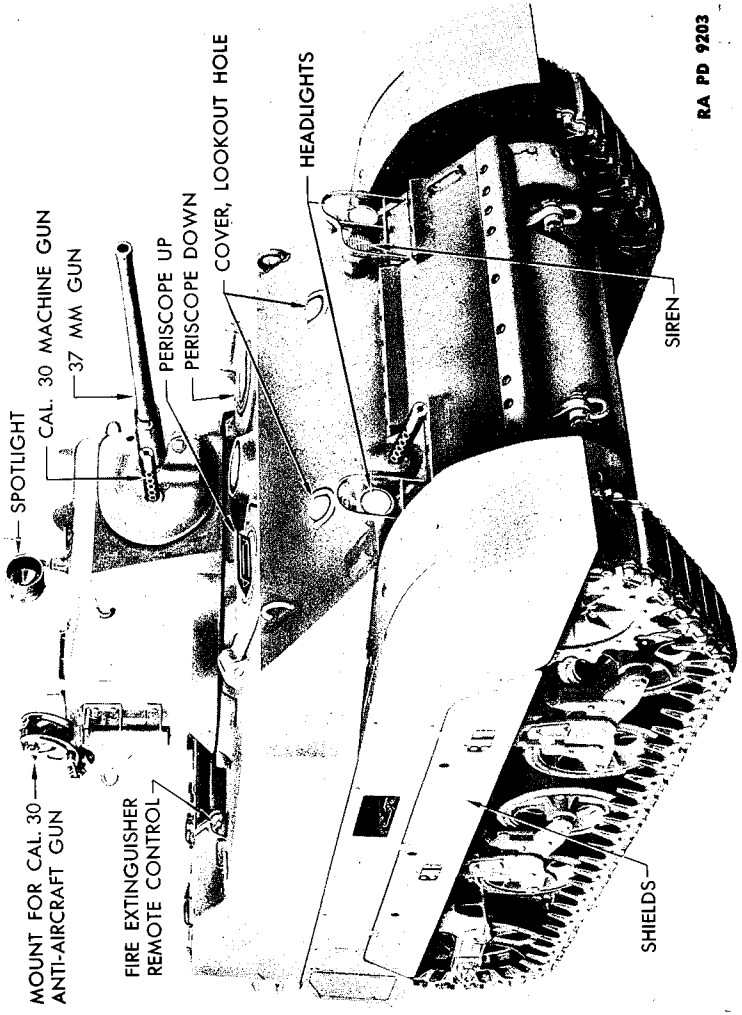

Figure 2 — Light Tank M5A1 — Right Front View

INTRODUCTION

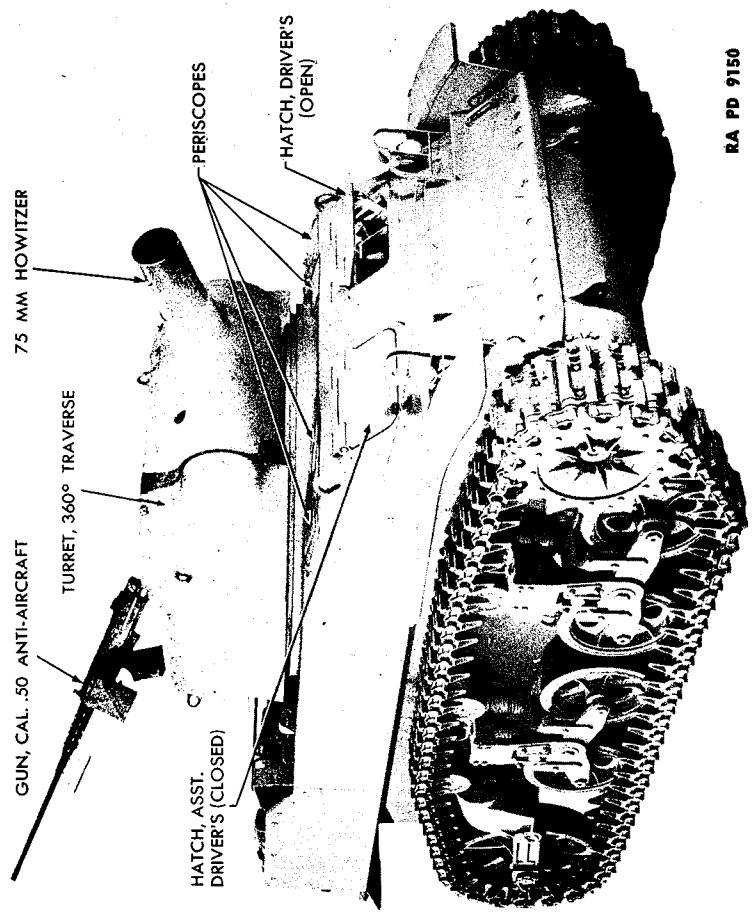

Figure 3 — Motor Carriage M8 — Right Front View

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

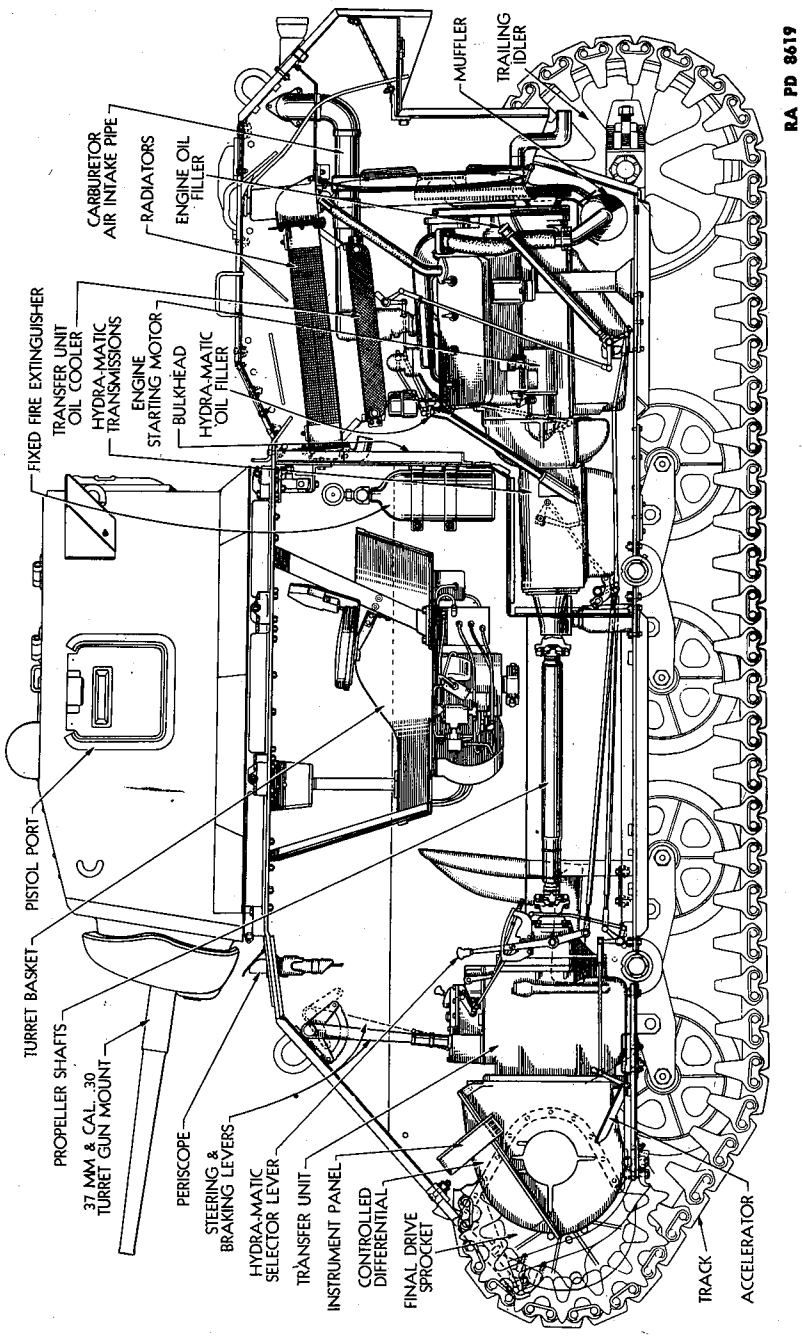

Figure 4 — Light Tank M5 — Longitudinal Cross Section

Section II

TRANSFER UNIT

4. DESCRIPTION.

a. The transfer unit performs two distinct functions. It takes the power of the two engines, delivered to the transfer unit by he propeller shafts, and combines these two power flows into one. It also provides a two-speed, hydraulic-controlled gear reduction which, combined with the reductions in the transmissions, permits a total of six forward speeds and one reverse speed.

b. The transfer unit is located in the front end of the vehicle, mounted on a flange on the rear of the controlled differential housing (fig. 5).

c. The transfer unit case is composed of two sections, a large main case at the front which contains the mechanism for the gear reduction unit and the hydraulic control parts, and a smaller case at the rear which contains the connector unit by means of which the torque from the two propeller shafts is combined into the one transfer unit main shaft.

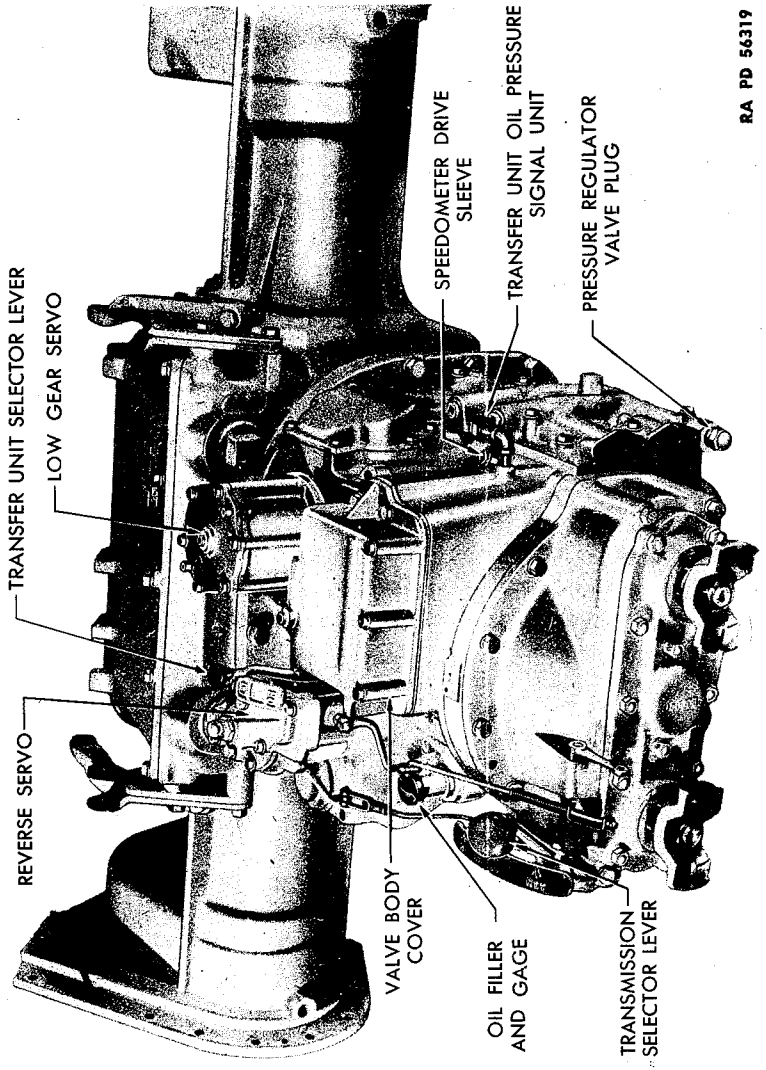

Figure 5 — Transfer Unit and Controlled Differential

d. The connector gears which combine the torque are all of the same diameter and thus do not provide any reduction. The connector gear shafts are mounted in the case in single row ball bearings. The main shaft or input shaft into the transfer unit proper is mounted at its rearward end on a double row ball bearing and on its forward or inner end on a roller pilot bearing (L, fig. 6) in the counterbore of the transfer unit output shaft.

e. The spiral drive pinion for the controlled differential is splined to the transfer unit output shaft and held securely in place by a cottered castle nut. The forward or pinion end of the output shaft is mounted in the transfer case on a large, double-row ball bearing, and the rearward or inner end on a single-row ball bearing.

f. The gear reduction unit is a compound planetary system with the two center gears integral with the main shaft, and the second planet carrier attached to the output shaft. Two bands are used to lock the brake drum and thus provide reduction. The low gear band is self-energizing in forward speeds and the reverse band, in reverse speeds. A multiple disk clutch, engaged by oil pressure, is contained in the clutch drum assembly, and locks the planetary gear train as a unit to provide direct drive.

g. The servos which apply and release the two bands are mounted on the top of the main transfer unit case (figs. 7 and 8). The oil pumps and governor are mounted on a carrier located on the right-hand side of the unit, and the valves which control the shifting are mounted in a valve body on top of the unit.

5. OPERATION.

a. Reduction. When the vehicle is started or operated at low speeds, the transfer unit is in reduction (fig. 10). The low gear band is applied to the drum by spring pressure in the low gear servo, and the clutch is released because there is no oil pressure to the clutch apply pistons. The reverse servo is released by oil pressure applied to the release piston and is held in the released position by a mechanically-operated latch and a ball check valve which prevents air from being drawn into the system. As the main shaft is rotated, the two center gears, being integral with the shaft, also rotate. The internal gear for the first planetary gear train is held from rotating by the low gear band; consequently, the planet gears in this train "walk around" inside the internal gear and carry the planet carrier at a speed less than that of the first center gear. The planet carrier for the first planetary gear train is integral with the internal gear for the second planetary train; consequently, this internal gear rotates

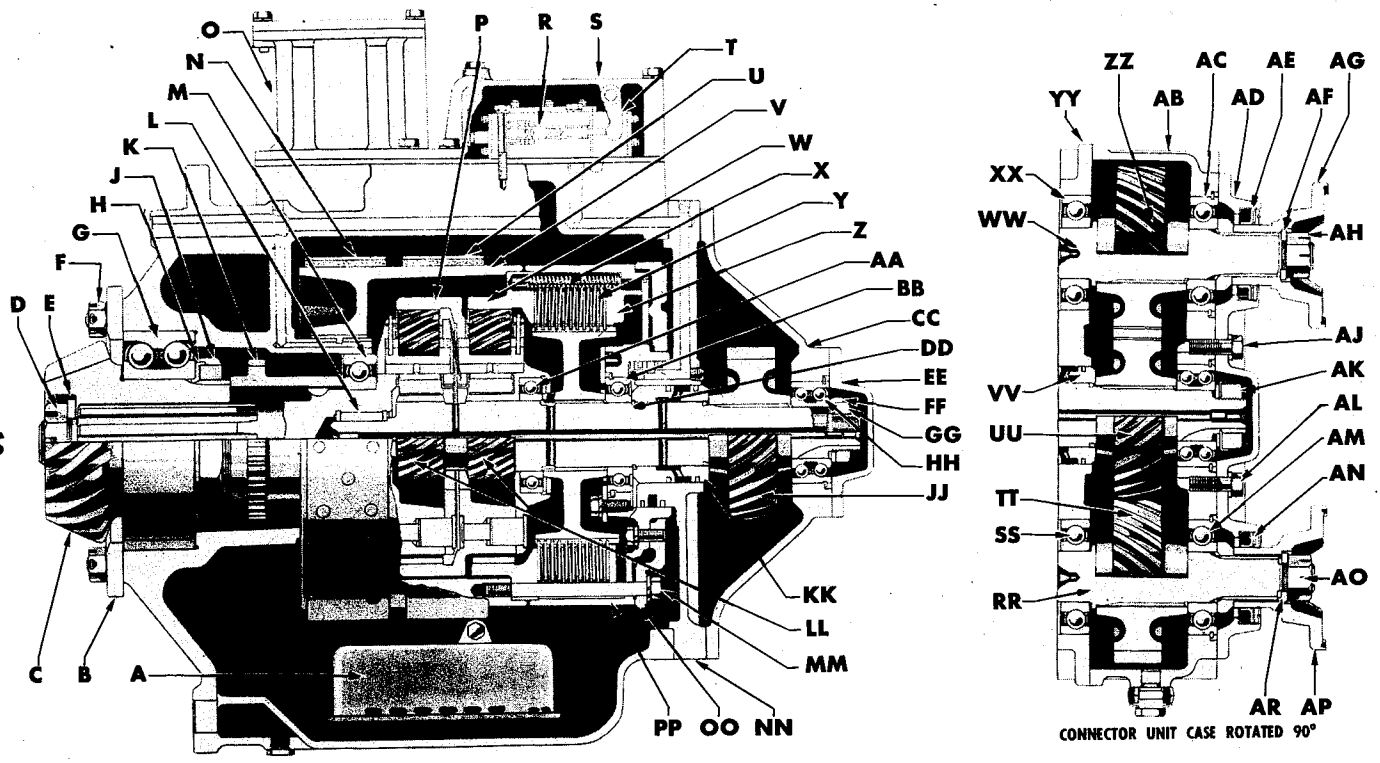

Figure 6 — Transfer Unit — Longitudinal Section

A—STRAINER, OIL

B—RETAINER, DRIVE PINION BEARING

C—PINION, SPIRAL DRIVE

D—NUT, SPIRAL DRIVE PINION

E—WASHER, SPIRAL DRIVE PINION NUT

F—NUT, BEARING RETAINER

G—BEARING, OUTPUT SHAFT, FRONT

H—WASHER, LOCK, BEARING, RETAINER NUT

J—NUT, BEARING RETAINER

K—GEAR, DRIVE, OIL PUMP AND GOVERNOR

L—BEARING, MAIN SHAFT PILOT

M—BEARING, OUTPUT SHAFT, REAR

N—BAND, LOW GEAR

O—SERVO, LOW GEAR

P—CARRIER, DIRECT DRIVE

R—BODY, VALVE AND ACCUMULATOR

S—COVER, VALVE, BODY

T—LEVER, THROTTLE VALVE CONTROL, INNER

U—BAND, REVERSE

V—DRUM, BRAKE

W—GEAR, INTERNAL, LOW GEAR CLUTCH DRUM

X—SPRING, CLUTCH RELEASE

Y—PLATE, CLUTCH, DRIVE

Z—PLATE, CLUTCH, PRESSURE

AA—BEARING, MAIN SHAFT

BB—BEARING, CLUTCH DRUM

CC—CASE, CONNECTOR UNIT

DD—SHAFT, MAIN

EE—COVER, CONNECTOR UNIT CASE

FF—WASHER, LOCK, MAIN SHAFT NUT

GG—NUT, MAIN SHAFT

HH—BEARING, MAIN SHAFT, REAR

JJ—GEAR, DRIVEN, CONNECTOR UNIT

KK—SPACER, MAIN SHAFT

LL—PINION, PLANETARY, DIRECT DRIVE CARRIER AND OUTPUT SHAFT

MM—BOLT, CLUTCH DRUM TO BRAKE DRUM

NN—COVER, TRANSFER UNIT CASE, REAR

OO—COVER, CLUTCH DRUM

PP—DRUM, CLUTCH

RR—SHAFT, CONNECTOR UNIT DRIVE GEAR

SS—BEARING, CONNECTOR DRIVE GEAR

TT—GEAR, DRIVE, CONNECTOR

UU—GEAR, DRIVEN, CONNECTOR UNIT

VV—SPACER, MAIN SHAFT

WW—SHAFT, CONNECTOR UNIT DRIVE GEAR

XX—BEARING, CONNECTOR DRIVE GEAR, FRONT

YY—COVER, TRANSFER UNIT CASE, REAR

ZZ—GEAR, DRIVE, CONNECTOR

AB—CASE, ASSEMBLY, CONNECTOR UNIT

AC—BEARING, CONNECTOR DRIVE GEAR, REAR

AD—COVER, CONNECTOR UNIT CASE

AE—OIL SEAL, CONNECTOR UNIT UNIVERSAL JOINT YOKE

AF—WASHER, YOKE

AG—YOKE, UNIVERSAL JOINT

AH—NUT, UNIVERSAL JOINT YOKE

AJ—SCREW, CONNECTOR COVER TO CASE

AK—NUT, MAIN SHAFT

AL—SCREW, CONNECTOR COVER TO CASE

AM—BEARING, CONNECTOR DRIVE GEAR, REAR

AN—OIL SEAL, CONNECTOR UNIT UNIVERSAL JOINT YOKE

AO—NUT, UNIVERSAL JOINT YOKE

AP—YOKE, UNIVERSAL JOINT

AR—WASHER, UNIVERSAL JOINT

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Legend for Figure 6 — Transfer Unit — Longitudinal Section

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

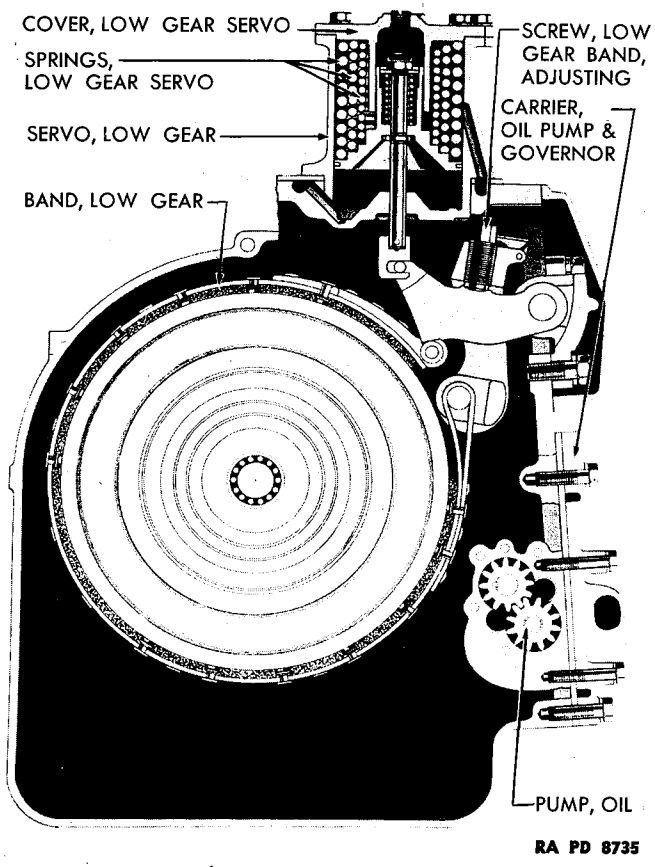

Figure 7 — Transfer Unit — Cross Section at Low Gear Servo

at a speed less than that of the second center gear. The planet gears of the second planetary train accordingly rotate with these gears and at the same time "walk around" the second center gear at an over-all gear reduction of 2.37 to 1. Since the output shaft is attached to the planet carrier of the second planetary gear train, this is the gear reduction of the transfer unit.

b. Upshift. When the vehicle speed is such that the transfer unit upshifts, oil pressure is applied to the release side of the low gear servo. This oil pressure overcomes the apply pressure of the springs and assures the gradual release of the low gear band from the brake drum. At the same time that this occurs, oil pressure is also delivered to the clutch apply pistons and the clutch is applied (fig. 11). Details of the hydraulic mechanism whereby this is accomplished are given in paragraph 5 j.

TRANSFER UNIT

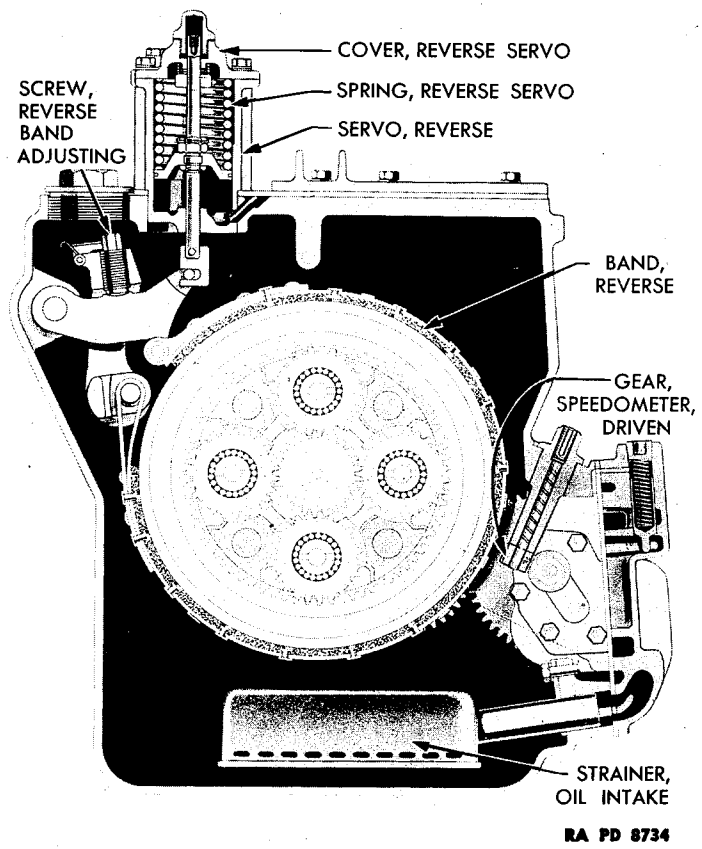

Figure 8 — Transfer Unit — Cross Section at Reverse Servo

c. Direct Drive. When the above action has taken place, the entire planetary gear train revolves as a unit and the rotation of the propeller shafts is transmitted without reduction to the pinion on the output shaft.

d. Reverse. When the selector lever for the Hydra-Matic transmissions is moved into the reverse position, a connection from this lever to the transfer unit releases a mechanical latch holding the reverse servo apply spring in the released position. This spring, being freed, applies the reverse servo. At the same time, a valve is repositioned to relieve the oil pressure that also holds the reverse servo in the released position. The flow of power to the transfer unit is exactly the same as previously described except that the direction of rotation is reversed. The reverse band application is necessary to provide self-energizing action with this direction of rotation, and both bands act to hold the drum from slipping (fig. 12).

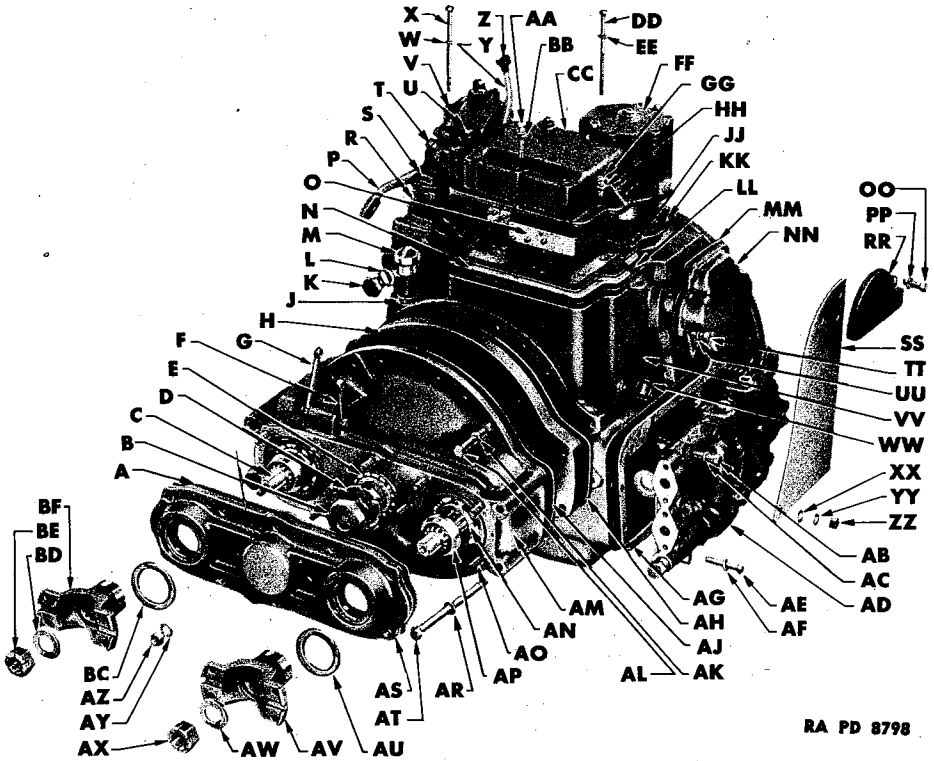

PLATE 9B-2—TRANSFER UNIT ASSEMBLY—EXPLODED VIEW

Figure 9 — Transfer Unit Assembly — Disassembled

A—GASKET, CONNECTOR UNIT CASE COVER
B—NUT, MAIN SHAFT
C—SHAFT, CONNECTOR UNIT DRIVE GEAR
D—WASHER, LOCK, MAIN SHAFT NUT
E—BEARING, MAIN SHAFT, REAR
F—LEVER, THROTTLE VALVE RELAY SHAFT, SHORT
G—LEVER, THROTTLE VALVE RELAY SHAFT, LONG
H—COVER, TRANSFER UNIT CASE, REAR
J—SLEEVE, OIL FILLER
K—PLUG, REVERSE BAND LEVER SHAFT
L—GASKET, REVERSE BAND LEVER SHAFT PLUG
M—INDICATOR, OIL LEVEL
N—PLATE, SPACER, TRANSFER UNIT CASE, TOP
O—BODY, VALVE AND ACCUMULATOR
P—LEVER, REVERSE BRAKE SERVO EXHAUST VALVE, OUTER
R—GASKET, REVERSE BRAKE ADJUSTMENT HOLE PLUG
S—PLUG, REVERSE BRAKE ADJUSTMENT HOLE
T—SCREW, CAP, HEX. HEAD
U—SCREW, CAP, HEX. HEAD
V—SERVO, REVERSE
W—WASHER, LOCK
X—SCREW, CAP, SERVO BODY TO CASE
Y—LEVER, MANUAL VALVE CONTROL, OUTER
Z—KNOB, MANUAL CONTROL VALVE OUTER LEVER
AA—SCREW, CAP, VALVE BODY COVER
BB—WASHER, LOCK
CC—COVER, VALVE BODY
DD—SCREW, SERVO BODY TO CASE
EE—WASHER, LOCK
FF—SERVO, LOW GEAR
GG—SCREW, VALVE BODY COVER
HH—WASHER, LOCK
JJ—GASKET, VALVE BODY COVER
KK—GASKET, LOW GEAR SERVO BODY
LL—GASKET, TRANSFER UNIT CASE, TOP
MM—GASKET, LOW GEAR BRAKE ADJUSTMENT HOLE COVER
NN—COVER, LOW GEAR BRAKE ADJUSTMENT HOLE
OO—SCREW, CAP
PP—WASHER, LOCK
RR—EXTENSION, LEG GUARD
SS—SHIELD, LEG GUARD
TT—SCREW, LOW GEAR, ADJUSTING COVER
UU—WASHER, LOCK
VV—CASE, TRANSFER UNIT
WW—SLEEVE, SPEEDOMETER DRIVE SHAFT
XX—WASHER, PLAIN, S., U.S. STD.
YY—WASHER, LOCK
ZZ—NUT, LEG GUARD, SHIELD
AB—SCREW, CARRIER
AC—WASHER, LOCK
AD—CARRIER, OIL PUMP AND GOVERNOR
AE—SCREW, CARRIER
AF—WASHER, LOCK
AG—GASKET, OIL PUMP AND GOVERNOR CARRIER
AH—GASKET, CASE, COVER
AJ—GASKET, CONNECTOR UNIT CASE
AK—WASHER, LOCK
AL—SCREW, CAP, CONNECTOR UNIT CASE TO TRANSFER UNIT CASE
AM—CASE, CONNECTOR UNIT
AN—BEARING, CONNECTOR DRIVE GEAR, REAR
AO—STUD, CONNECTOR UNIT CASE COVER
AP—SPACER, CONNECTOR UNIT DRIVE GEAR SHAFT
AR—WASHER, LOCK
AS—COVER, CONNECTOR UNIT CASE
AT—SCREW, CONNECTOR UNIT CASE TO TRANSFER UNIT CASE
AU—OIL SEAL, UNIVERSAL JOINT YOKE
AV—YOKE, UNIVERSAL JOINT
AW—WASHER, UNIVERSAL JOINT YOKE
AX—NUT, UNIVERSAL JOINT YOKE
AY—WASHER, LOCK
AZ—NUT
BC—OIL SEAL, UNIVERSAL JOINT YOKE
BD—WASHER, UNIVERSAL JOINT YOKE
BE—NUT, UNIVERSAL JOINT YOKE
BF—YOKE, UNIVERSAL JOINT

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Legend for Figure 9 — Transfer Unit Assembly — Disassembled

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

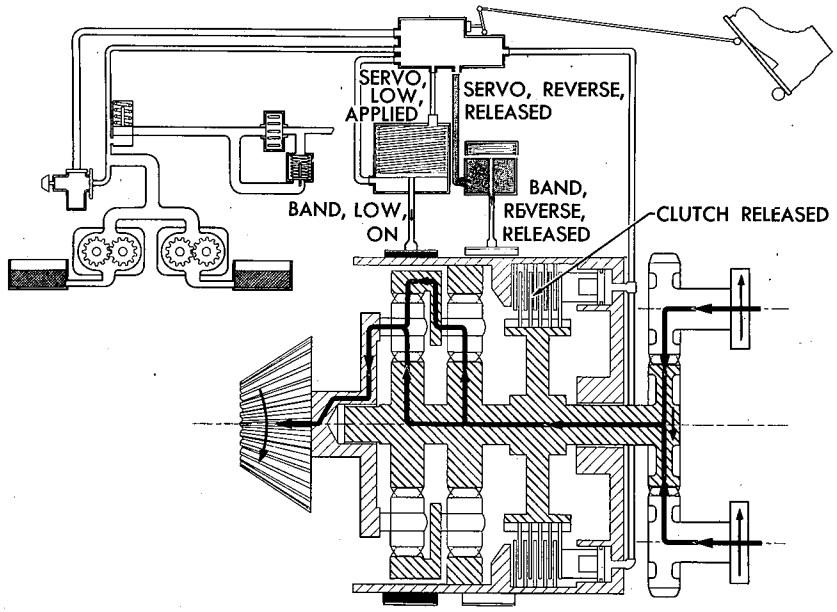

Figure 10—Transfer Unit in Reduction

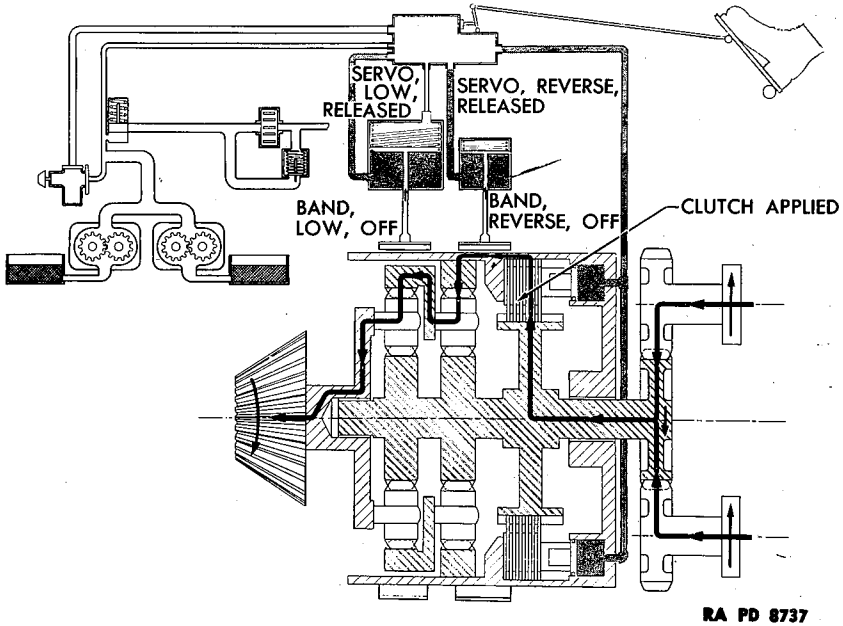

Figure 11—Transfer Unit in Direct Drive

TRANSFER UNIT

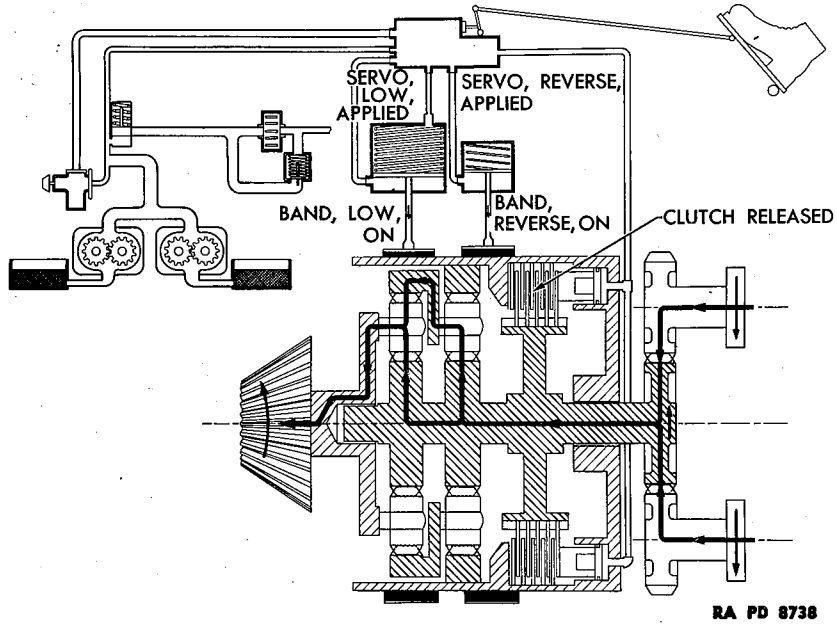

Figure 12—Transfer Unit in Reverse

e. Hydraulic Control System. The timing of the changes in gear ratios, either upshifting or downshifting, is the function of the hydraulic control system. This system is basically one of carefully balanced valves to provide a precise relationship between the velocity of the vehicle and the performance demands of the driver as expressed by the pressure on the accelerator. The hydraulic control units, illustrated in diagrammatic form in figure 13, consist of the following: a compound oil pump connected to an oil pressure regulator, a centrifugal-type governor, a control valve body containing the control valves and shift valves, and the necessary connecting passages.

f. The governor and oil pump are mounted on a carrier on the right-hand side of the transfer unit case and are driven by the same shaft, which in turn is geared to the output shaft. With this arrangement, the oil pump delivers oil only when the vehicle is in motion, at which time it provides both the oil pressure for operating the control mechanism and the oil for lubricating the gears and bearings of the transfer unit and the controlled differential.

g. The oil pressure supplied by the pump for the control mechanism is maintained between 85 and 90 pounds by means of the oil pressure regulator. This pressure is directed through control valves to apply or

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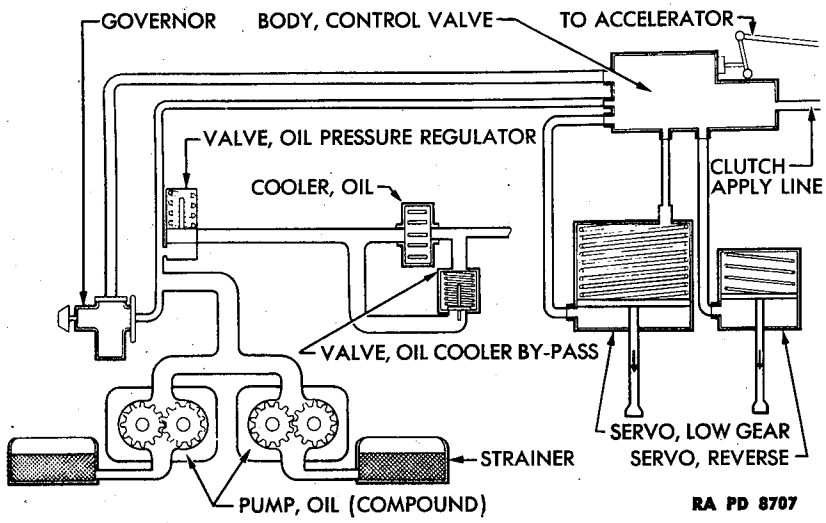

Figure 13 — Hydraulic Control System

release the bands and apply the clutch as required by the various operating conditions.

h. Reductions. As soon as the vehicle starts to move forward, oil under pressure is delivered to the control valve body. At the same time, this oil under pressure is directed to the governor in such a way that pressure is built up and applied to oppose the centrifugal force acting on the governor weight.

i. As the vehicle speed increases, the centrifugal force acting on the governor weight also increases and repositions the governor valve, so that a variable pressure from the governor is fed back to the control valve body. This pressure is directed to one end of the shift valve, tending to force it to the open position and upshift the transfer unit from reduction to direct drive. Spring pressure and throttle pressure on the opposite end of the valve act against the governor pressure and tend to oppose the upshift. Thus, the speed at which the upshift occurs is determined by the relation between throttle pressure and governor pressure (fig. 14).

j. Upshift. As the speed of the vehicle increases further, the oil pressure from the governor becomes great enough to overcome the opposing spring and throttle pressure on the shift valve, causing it to move to its open position. The movement of the shift valve causes oil to be directed

TRANSFER UNIT

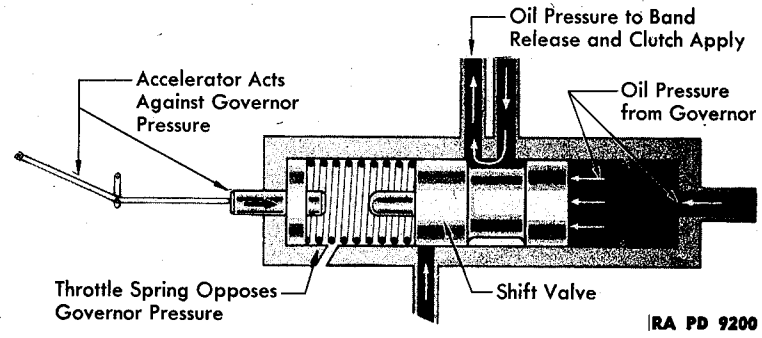

Figure 14 — Opposing Forces on Shift Valve

to the clutch apply pistons and also to the release side of the low gear servo, thus applying the clutch and releasing the low gear band. This arrangement causes the planetary gear system to rotate as a unit and the shift to direct drive is completed.

k. Downshift. When the speed of the vehicle is reduced to a point where the spring and throttle valve pressure against the shift valve in the valve body overcomes the oil pressure directed against it by the centrifugal governor, the shift valve moves back to the closed position. This action cuts off oil pressure to the release section of the low gear servo, allowing the springs in the servo to reapply the low gear band. At the same time, the oil pressure against the clutch relay valve in the valve body is cut off, which in turn permits release of the pressure applying the clutch. The clutch release springs then release the clutch at the same time as the band is being reapplied, thus putting the transfer unit again in reduction.

l. "LO" Range. When the control lever on the transfer unit is moved to the "LO" position, a valve in the control valve body is manually moved into a position where the full pressure from the oil pump is directed against the shift valve. This force, together with the spring pressure against the shift valve, is great enough so that the pressure from the governor cannot move the valve to its open position. Thus, no upshift can take place. Oil pressure is also directed to the low gear servo in such a manner as to assist the springs in holding the band tight on the drum.

m. If the transfer unit control lever should be moved to the "LO" position while the vehicle is being driven at high speed, the governor pressure existing at these high speeds will be high enough to oppose a downshift until the speed of the vehicle has been reduced to a point where the downshift can be made without damage to the mechanism.

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

6. TABULATED DATA AND SPECIFICATIONS.

Connector gear ratio ..... 1 to 1
Connector gear type ..... Helical
Gear ration in reduction ..... 2.37 to 1
Lubrication ..... Oil under pressure
Number of speeds forward 2
Number of speeds reverse 1
Shift control ..... Hydraulic
Type of gearing ..... Compound planetary
Serial number ..... 1GT1 and up
(Located on the flat machined surface between the low gear and reverse servos)

7. ALLOCATION OF MAINTENANCE DUTIES BY ECHELONS.

a. Definitions. Echelons and words as used in this list of maintenance allocations are defined as follows:

SECOND ECHELON: Line organization regiments, battalions, companies (first and second echelons).

THIRD ECHELON: Ordnance light maintenance companies, ordnance medium maintenance companies, ordnance divisional maintenance battalions, and post ordnance shops.

FOURTH ECHELON: Ordnance heavy maintenance companies and service command shops.

FIFTH ECHELON: Ordnance base regiments, ordnance bases, arsenals, manufacturers' plants.

SERVICE:

(Including preventive maintenance) (par. 23 a (1) and (2) AR 850-15 (10-6-42)) — Consists of servicing, cleaning, lubricating, tightening bolts and nuts, and making external adjustments of subassemblies or assemblies and controls.

REPLACE:

(par. 23 a (4) AR 850-15 (10-6-42)) — Consists of removing the part, subassembly or assembly from the vehicles and replacing it with a new or reconditioned or rebuilt part, subassembly or assembly, whichever the case may be.

REPAIR:

(par. 23 a (3) and (5), in part, AR 850-15 (10-6-42)) — Consists of making repairs to, or replacement of the part, subassembly or assembly that can be accomplished without completely disassembling the subassembly or assemblies, and does not require heavy welding, or riveting, machining, fitting and/or alining or balancing.

TRANSFER UNIT

REBUILD:

(par. 23 a (5), in part, and (6), AR 850-15 (10-6-42)) — Consists of completely reconditioning and replacing in serviceable condition any unserviceable part, subassembly or assembly of the vehicle, including welding, riveting, machining, fitting, alining, balancing, assembling, and testing.

b. Maintenance Allocations.

NOTE: Operations allocated will normally be performed in the echelon indicated by "X". Operations allocated to the echelons as indicated by "E" may be accomplished by the respective echelons in emergencies only.

UNIT, TRANSFER, ASSEMBLY	ECHELONS 2nd	3rd	4th	5th
Bands, transfer unit—adjust	X			
Bands, transfer unit—replace or repair (reline)			E	X
Body, control valve—replace	X			
Body, control valve—repair		X		
Body, control valve—rebuild			E	X
Unit, transfer, assembly—replace		X		
Unit, transfer, assembly—repair		E	X	
Unit, transfer, assembly—rebuild			E	X

8. INSPECTION IN VEHICLE.

a. Purpose. Inspections by ordnance personnel are a follow-up and check on organizational maintenance inspections and servicing. These inspections determine whether or not the vehicle should be continued in service or withdrawn from operation for overhaul.

b. Inspection Form. War Department O.O. Form No. 7351 "Preventive Maintenance Operation and Technical Inspection Form for Full-Track Vehicles," is the standard and official form for recording the inspection of all motor vehicles, including combat vehicles of the Ordnance Department. The extent to which use is made of this form or modification thereof depends entirely on the technical ability of available personnel, the time factor, and the test shop equipment available.

c. Equipment Required.

CLEAN RAGS
FLASHLIGHT
GAGE, pressure, 0 to 100-lb

d. Visual Inspection Procedure. The following periodic inspections of the transfer unit in the vehicle are prescribed.

(1) DAILY

(a) Check oil level. NOTE: Whenever checking oil level, vehicle should be on level ground.

ORDNANCE MAINTENANCE—TRANSFER UNIT FOR LIGHT TANKS M5, M5A1, AND 75-MM HOWITZER MOTOR CARRIAGE M8

(2) AFTER 250 MILES OF OPERATION.

(a) Check oil level.

(b) Check oil cooler connections for leaks.

(c) Check entire transfer unit for leaks at any possible point.

(3) AFTER 3,000 MILES OF OPERATION.

(a) Drain oil in transfer unit, flush and refill (par. 10 b).

(b) Check and adjust bands (par. 10 c).

e. Operating Inspection. Check the transfer unit under actual operating conditions and notice whether it is functioning properly, at the various shift speeds.

(1) SHIFT SPEEDS. Check to make sure the transfer unit upshifts and downshifts in the proper speed ranges, as follows:

(a) Selector Lever in "DR".

Upshift	Light Throttle	Full Throttle
4th to 6th	1,600 to 2,000 rpm	3,400 to 3,900 rpm
Downshift		
6th to 4th	460 to 650 rpm	925 to 1,125 rpm
6th to 5th	——	2,100 to 2,400 rpm

(b) Selector Lever Moved to "LO".

Transfer unit should downshift 6th to 4th, no higher than 1,600 to 1,800 rpm.

f. Checking Transfer Unit Oil Pressure. Five oil pressures in the transfer unit hydraulic control system may be checked without removing the transfer unit from the vehicle. These are pump pressure, lubrication pressure, clutch apply pressure, governor pressure (except on early transfer units) and low servo apply pressure in low. Whenever the transfer unit is not operating properly, these oil pressures should be checked in accordance with the trouble-shooting outline in paragraph 9. The pressures are checked as follows:

(1) EQUIPMENT.

ADAPTER, pipe plug, ⅛-in.
ADAPTER, pipe plug, ¼-in.
GAGE, pressure, 0 to 100-lb
SCREWDRIVER
WRENCH, open-end, ⅜-in.
WRENCH, open-end, 1-in.
WRENCH, socket-head set screw, 3/16-in.
WRENCH, socket-head set screw, ¼-in.

(2) CHECK PUMP PRESSURE.

ADAPTER, pipe plug, ⅛-in.
GAGE, pressure, 0 to 100-lb
WRENCH, socket-head set screw, 3/16-in.
WRENCH, open-end, 1-in.

On early transfer units, remove ⅛-inch pipe plug on right side of case just behind speedometer driven gear adapter, using 3/16-inch socket-head

TRANSFER UNIT

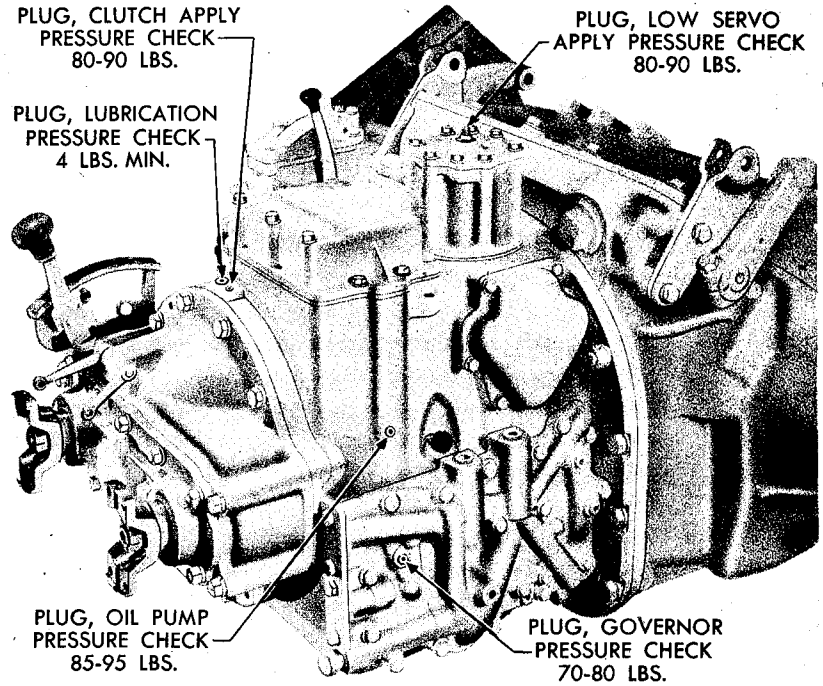

Figure 15 — Plugs for Oil Pressure Checks

set screw wrench (fig. 15). On later type units, remove the oil pressure gage unit which is installed at this point (1-in. open-end wrench). Connect pressure gage and adapter at opening from which plug or gage unit was removed. Start vehicle and drive at any speed above two miles per hour. The pump pressure should be from 85 to 95 pounds at these speeds in any gear. If pressure is less than this amount, check for cause of condition, as outlined in paragraph 9. Remove pressure gage and adapter and install plug or gage unit.

(3) CHECK LUBRICATION PRESSURE.

ADAPTER, pipe plug, ¼-in.
GAGE, pressure, 0 to 100-lb
SCREWDRIVER
WRENCH, socket-head set screw, ¼-in.

Remove ¼-inch pipe plug (large plug) at top of transfer unit rear cover (fig. 15). Connect pressure gage and adapter to transfer case rear cover where plug was removed. Start vehicle and drive at approximately 10 miles per hour. The lubrication pressure should be four pounds minimum at this speed in any gear. NOTE: The transfer unit should be

thoroughly warmed up to normal operating temperature when this check is made. If pressure is less than this amount, check for cause of condition as outlined in paragraph 9. Remove pressure gage and adapter, and install ¼-inch pipe plug.

(4) CHECK CLUTCH APPLY PRESSURE.

ADAPTER, pipe plug, ⅛-in.	SCREWDRIVER
GAGE, pressure, 0 to 100-lb	WRENCH, socket-head set screw, 3/16-in.

Remove ⅛-inch pipe plug (small plug) at top of transfer unit rear cover (fig. 15). Connect pressure gage and adapter to transfer unit rear cover where plug was removed. Start vehicle and increase speed until transfer unit shifts from reduction to direct drive. When the shift is made, the clutch apply pressure should be not more than five pounds less than the pump pressure. If pressure is less, check for cause of condition, as outlined in paragraph 9. Remove pressure gage and adapter, and install plug in transfer unit rear cover.

(5) CHECK GOVERNOR PRESSURE.

ADAPTER, pipe plug, ⅛-in.	WRENCH, socket-head set screw, 3/16-in.
GAGE, pressure, 0 to 100-lb	

Transfer units of early production did not have provision for making this check. On later transfer units, proceed as follows: remove the socket-head set screw wrench located toward the rear of the center of the oil pump and governor carrier (fig. 15), and connect pressure gage and adapter at opening. Drive vehicle with transmission and transfer unit selector levers in "DR" position. At 1,700 revolutions per minute, pressure should be 25 to 30 pounds; at 3,400 revolutions per minute, it should be 70 to 80 pounds. Reduce vehicle speed, shift transfer unit to "LO" range, and increase speed to 3,000 revolutions per minute. Pressure should then be between 50 and 60 pounds. If pressure is less than these amounts, check for causes of conditions as outlined in paragraph 9. Remove pressure gage and install plug.

(6) CHECK LOW SERVO APPLY PRESSURE.

ADAPTER, pipe plug, ¼-in.	WRENCH, socket-head set screw, ¼-in.
SCREWDRIVER	WRENCH, open-end, ⅜-in.

Remove adjusting plug from low gear servo cover, using screwdriver or socket-head set screw wrench. Connect gage and adapter to plug opening. Drive vehicle with transmission and transfer unit levers in "DR" position at a speed above 22 miles per hour. Move transfer unit lever to "LO" position, release accelerator, and let vehicle slow down. Transmission will downshift to 5th at about 22 miles per hour; transfer unit will downshift to 4th at about 20. After transfer unit downshifts,

accelerate engines to 2,200 revolutions per minute and check pressure on gage, which should be 85 to 95 pounds. If pressure is low, check for cause of condition as outlined in paragraph 9. Remove pressure gage and install plug.

(7) RELATION TO TROUBLE SHOOTING. The Trouble Shooting section (par. 9) of this manual should be studied closely in order that various trouble symptoms may be recognized during the operating inspection.

9. TROUBLE SHOOTING.

a. When checking the transfer unit for possible malfunctioning, the first job is to determine definitely that the condition at hand is due to the transfer unit and not to other related units. The transmissions, for example, are so closely related to the transfer unit that often when the transfer unit is suspected of not operating properly, the original cause may lie in the transmissions. After the vehicle has been checked under actual operating conditions and the fault determined, compare the condition with those listed in the chart below. When a comparable condition is found, repeat the test at least two more times to make sure that all symptoms agree with the condition on the chart. NOTE: Do not remove the transfer unit until the condition is definitely determined.

b. Transfer Unit Does Not Respond to Selector Lever Position (will not upshift in "DR" position or downshift in "LO" position).

Possible Cause	Possible Remedy
Manual control valve in valve body not engaged with button on control lever.	Remove valve body cover and engage manual control valve with lever.

c. Transfer Unit Slips in 1st, 2nd, 3rd and 4th Speeds, but Operates Satisfactorily in 5th and 6th Speeds.

Low gear band not holding due to improper adjustment.	Adjust band.

d. Transfer Unit Drives Vehicle in 1st, 2nd, 3rd, and 4th Speeds, but Both Engines Race in 5th and 6th Speeds Due to Clutch Slipping.

No oil pressure to clutch pistons.	Check oil pressure as explained in paragraph 8 and repair or replace units as required.
Mainshaft spacer oil seal rings in clutch drum broken or sticking.	Clean, repair, or replace.
Clutch piston rings broken or sticking.	Clean, repair, or replace.
Low pump pressure.	Clean, repair, or replace.

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Possible Cause	Possible Remedy
Oil passages to clutch plugged.	Clean, repair, or replace.
Oil leaks in oil passages to clutch.	Clean, repair, or replace.
Oil leaks between valve body and spacer plate.	Clean, repair, or replace.
Clutch plates scored or burned.	Replace plates.

e. Transfer Unit Slips in Reverse.

Reverse band not holding.	Check reverse band adjustment.
Reverse band released due to release pressure or release latch not being tripped.	Check adjustment of control linkage to reverse servo. Remove reverse servo and check operation of release mechanism. Replace reverse servo.

f. Transfer Unit Starts in Reduction but Shifts to Direct Drive Immediately After Vehicle is Put in Motion.

Governor valve sticking in *"open"* position.	Clean, repair, or replace governor.
Clutch relay valve sticking in *"open"* position.	Clean, repair, or replace valve body assembly.
Shift valve sticking in *"open"* position.	Clean, repair, or replace valve body assembly.

g. Transfer Unit Will Not Upshift into Direct Drive for 5th or 6th Speeds.

Manual control valve not engaged with lever.	Clean, repair, or replace valve body assembly.
Governor valve sticking in *"closed"* position.	Clean, repair, or replace governor.
Oil pressure leak in passages between governor and valve body assembly.	Clean, repair, or replace valve body assembly.
Governor plug or shift valve sticking in *"closed"* position.	Clean, repair, or replace valve body assembly.
Clutch relay valve sticking.	Clean, repair, or replace valve body assembly.
Exhaust downshift valve sticking in *"open"* position.	Clean, repair, or replace valve body assembly.
Low oil pressure.	Check oil pressures as explained in paragraph 8 and repair or replace units as required.

TRANSFER UNIT

Possible Cause	Possible Remedy

h. Transfer Unit Shifts into Direct Drive at Lower Vehicle Speeds Than is Desirable.

Improperly adjusted throttle valve linkage between front throttle relay and transfer unit valve body.	Adjust throttle linkage.
Governor valve sticking.	Clean, repair, or replace valve body assembly.
Regulator plug in valve body sticking.	Clean, repair, or replace valve body assembly.
Throttle valve in valve body sticking.	Clean, repair, or replace valve body assembly.
Low oil pressure.	Check oil pressures (par. 8). Repair or replace units as required.

i. Transfer Unit Shifts into Direct Drive at Higher Vehicle Speeds than Desirable.

Improperly adjusted throttle valve linkage.	Adjust throttle linkage.
Sluggish or sticking governor valve.	Clean, repair, or replace governor.
Regulator plug in valve body sticking.	Clean, repair, or replace valve body.
Sluggish or sticking governor plug or shift valve in valve body.	Clean, repair, or replace valve body.
Throttle valve sticking in *"open"* position.	Clean, repair, or replace valve body.
Sluggish or sticking clutch relay valve in valve body.	Clean, repair, or replace valve body.
High oil pressure.	Check oil pressure as explained in paragraph 8 and repair or replace units as required.

j. Transfer Unit Slips in Low Range When Using Engine as Brake, but Operates Satisfactorily on Pull.

Low gear servo valve sticking in *"closed"* position.	Clean, repair, or replace valve body.

k. Transfer Unit Downshift from Direct Drive to Reduction with Wide Open Throttle Very Severe, or Engines Race Momentarily When Shift Occurs.

Accumulator valve or throttle downshift valve in valve body sticking.	Clean, repair, or replace valve body.

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Possible Cause	Possible Remedy
Low oil pressure.	Check oil pressure as explained in paragraph 8 and inspect for cause of condition until source is located. Repair or replace units as required.
Weak or broken oil pressure regulator spring.	Repair or replace.
Oil pressure regulator valve in governor and oil pump carrier sticking.	Repair or replace.
Oil pump loose on carrier.	Tighten.
Defective gasket between oil pump carrier and spacer plate.	Replace.
Worn oil pump gears.	Replace.
Defective gasket between top spacer plate and transfer unit case.	Replace.
Plugged oil lines in transfer unit case.	Clean, repair, or replace.

10. SERVICE IN VEHICLE.

a. Check Oil Level.

CLEAN RAGS

Make sure vehicle is on level ground. Clean area around transfer unit oil filler pipe. Remove gage indicator assembly and wipe plunger clean. Then return to filler pipe and push down until cap on indicator seats on filler pipe opening. Remove to check oil level. If necessary, add OIL, engine (seasonal grade).

b. Change Oil. When changing oil in the transfer unit, it is necessary to also change oil in the controlled differential.

(1) DRAIN OIL FROM TRANSFER UNIT AND CONTROLLED DIFFERENTIAL.

CLEAN RAGS
DRAIN PAN, 10-gal capacity
WRENCH, socket, 9/16-in.
WRENCH, socket-head set screw, 9/16-in.
WRENCH, socket-head set screw, 3/4-in.

Remove cover plates on bottom of hull under transfer unit and controlled differential (9/16-in. socket wrench), and clean area around drain

TRANSFER UNIT

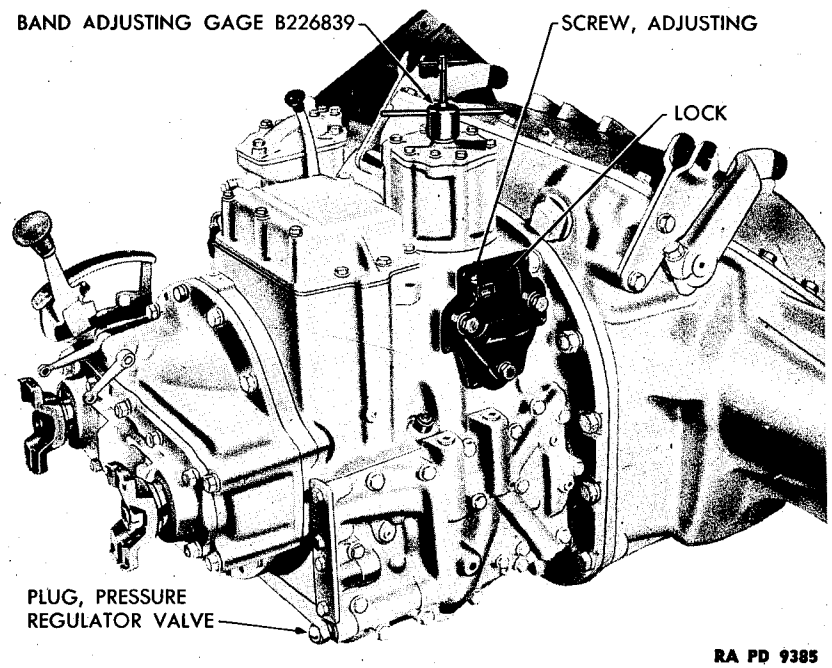

Figure 16 — Adjusting Low Gear Band

plugs. Place drain pan under three openings. Remove one drain plug from transfer unit (9/16-in. socket-head set screw wrench), and two plugs from controlled differential (3/4-in. socket-head set screw wrench) and allow oil to drain into the drain pan. Clean magnetic drain plugs, and if excessive metal particles are present, investigate condition of units.

(2) REFILL TRANSFER UNIT AND CONTROLLED DIFFERENTIAL.

WRENCH, socket, 9/16-in.
WRENCH, socket-head set screw, 9/16-in.
WRENCH, socket-head set screw, 3/4-in.

Position three drain plugs in bottom of transfer unit (9/16-in. socket-head set screw wrench) and controlled differential (3/4-in. socket-head set screw wrench) and tighten in place. Position three cover plates on bottom of hull and tighten in place (9/16-in. socket wrench). Fill transfer unit with 28 quarts of OIL, engine (seasonal grade).

c. Band Adjustments in Vehicle. Two bands are used in the transfer unit: a low gear band (toward front of vehicle) and a reverse band

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(toward rear of vehicle). The bands can be adjusted while the transfer unit is in the vehicle. Both bands should always be adjusted whenever it becomes necessary to adjust one or the other. The low gear band should always be adjusted before the reverse band is adjusted.

(1) EQUIPMENT.

GAGE, feeler
GAGE, low and reverse transit band adjusting, B226839
SCALE, 6-in.
SCREWDRIVER
WRENCH, 3/8-in.
WRENCH, 1/2-in.
WRENCH, 1 1/2-in.
WRENCH, deep socket, 9/16-in.
WRENCH, deep socket, 1 1/16-in.
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 1 1/2-in.
WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 5/8-in.
WRENCH, socket-head set screw, 1/4-in.

(2) LOW GEAR BAND ADJUSTMENT.

(a) *Check Position of Reverse Servo Piston.*

GAGE, low and reverse transit band adjusting, B226839
SCALE, 6-in.
WRENCH, open-end, 1 1/16-in.

Before any adjustments are made, it is important to check the position of the reverse servo piston. To do this, remove the acorn plug on the top of the reverse servo cover with a 1 1/16-inch open-end wrench. The piston rod must be at least 1/2-inch above the top of the boss on the servo cover. This is the released position. If the piston rod is in this position, proceed with step (*b*) below; if not, release the band either by installing band adjusting gage B226839 in top of rod and tightening pressure nut until piston rod is pulled up to at least 1/2-inch above top of boss, or by driving vehicle forward a few feet. Place the selector lever in any position other than "REV"; this will hold the piston rod in the proper position for adjustment procedure.

(b) *Install Adjusting Tool in Low Gear Servo.*

GAGE, low and reverse transit band adjusting, B226839
WRENCH, 3/8-in. or
WRENCH, socket-head set screw, 1/4-in.

Remove plug from low gear servo cover, and screw in gage until it bottoms in tapped hole in upper end of low gear servo piston rod. Tighten pressure nut on band adjusting gage until "LO" marke on gage is flush with top of pressure nut (fig. 16).

(c) *Check Low Gear Band Adjustment.*

GAGE, feeler
GAGE, low and reverse transit band adjusting, B226839
SCALE, 6-in.

Note position of pressure nut. It should be just clear of servo cover if the low gear band is adjusted properly. There should be from 0.002-inch to 0.005-inch clearance between pressure nut and servo cover. If pressure nut is tight against servo cover, low gear band is too loose. **NOTE:** If band adjusting gage is not available, adjustment can be checked by measuring distance from boss on servo cover to upper end of piston rod. This distance should be 1 1/4 inches (plus or minus 1/32 in.).

(d) *Remove Leg Guard and Adjusting Hole Cover.*

WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 5/8-in.

Remove assistant driver's leg guard by removing two mounting screws (9/16-in. and 5/8-in. wrenches). Remove six screws and lock washers (1/2-in. socket wrench) holding low gear band adjusting hole cover on right side of transfer unit case, and remove cover and gasket.

(e) *Adjust Low Gear Band.*

GAGE, low and reverse transit band adjusting, B226839
SCREWDRIVER
WRENCH, 9/16-in.

Swing back lock plate (fig. 16) which keeps the low gear band adjusting screw from turning, and tighten adjusting screw (9/16-in. wrench). Continue tightening adjusting screw until pressure nut on the band adjusting gage is just lifting off low gear servo cover, or until rod end is 1 1/4 inches below boss on servo cover, as explained in step (2) (*a*) above.

(f) *Install Adjusting Hole Cover and Leg Guard.*

WRENCH, socket, 1/2-in.
WRENCH, socket, 9/16-in.
WRENCH, socket, 5/8-in.

Position low gear band adjusting hole cover and a *new* gasket on side of screws and lock washers (9/16-in. and 5/8-in. socket wrenches). **NOTE:** Do not remove band adjusting gage from low gear servo until reverse band is adjusted.

(3) REVERSE BAND ADJUSTMENT.

(a) *Remove Plug in Reverse Servo Cover.*

GAGE, low and reverse transit band adjusting, B226839
WRENCH, deep socket, 1 1/16-in.

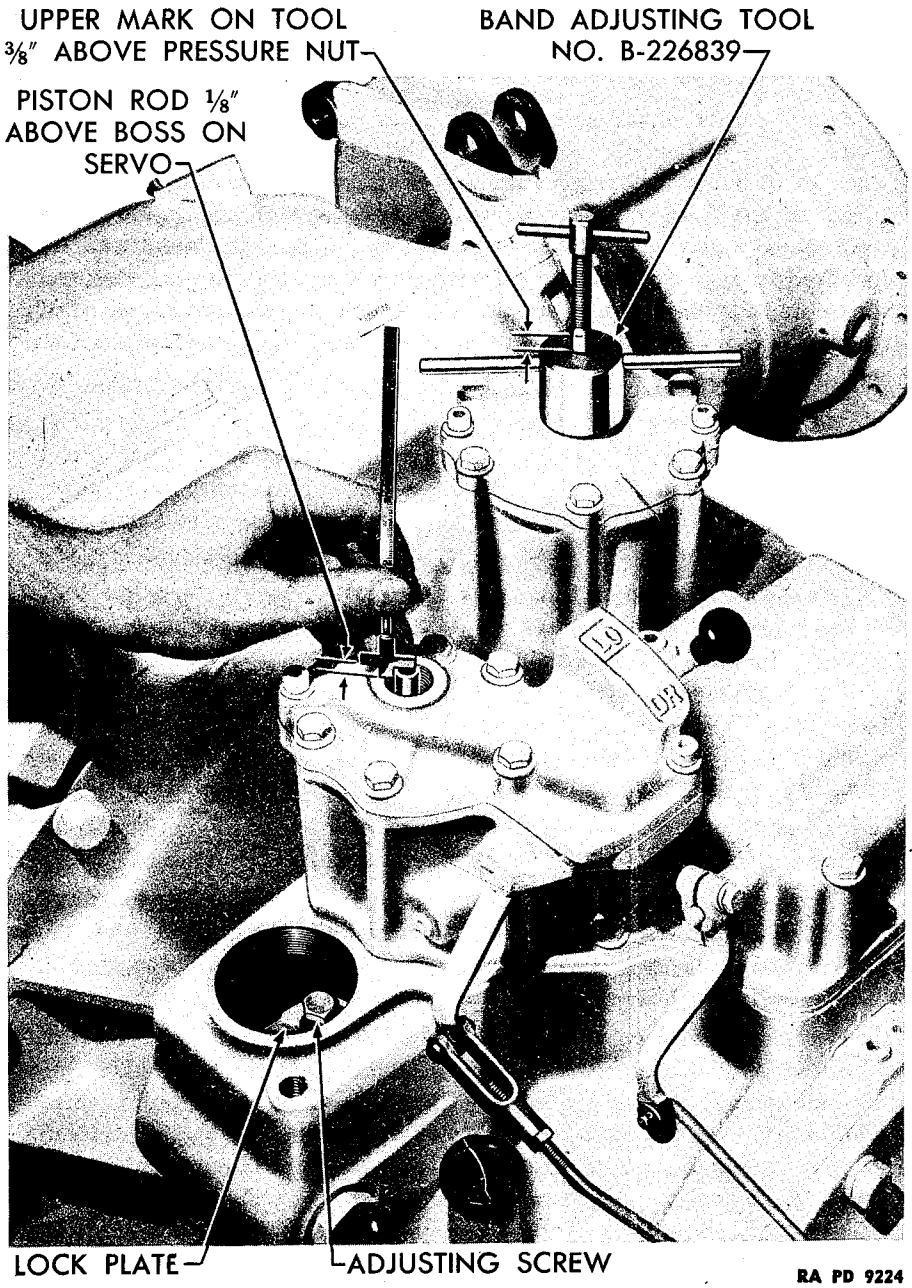

Figure 17 — Adjusting Reverse Band

TRANSFER UNIT

Be sure to check low gear band adjustment before proceeding with reverse band adjustment. Tighten pressure nut on band adjusting gage on low gear servo (installed in step c (2) above) until "LO" mark on gage is 3/8 inch above pressure nut. Place the transmission selector lever in the "REV." (reverse) position. Remove acorn plug and gasket from reverse servo cover (1 1/16-in. deep socket wrench).

(*b*) *Check Band Adjustment.*

SCALE, 6-in.
WRENCH, 1½-in.

Apply both steering brakes and lock with ratchets. Start both engines and accelerate to 800 revolutions per minute with selector lever in reverse. Shut off engines. Check position of reverse servo piston rod. Upper end of rod should be 1/8 inch plus or minus 1/32 inch *above* top of the boss on servo cover when reverse band is adjusted properly.

(*c*) *Adjust Reverse Band and Install Plug.*

GAGE, low and reverse transit band adjusting, B226839
SCREWDRIVER
WRENCH, deep socket, 9/16-in.
WRENCH, open-end, 1½-in.

If reverse band requires adjustment, remove reverse band adjusting plug (1½-in. open-end wrench) and copper gasket from top of transfer unit case (fig. 17). Lift up lock plate that keeps reverse band adjusting screw from turning, and tighten adjusting screw (9/16-in. deep socket wrench) until servo piston rod is 1/8 inch above boss on cover. NOTE: If band adjusting gage is not available to release low gear band, as explained in step (3) (*a*) above, it will be necessary to back off low gear band adjustment and readjust low gear band after reverse band adjustment is complete.

(*d*) *Remove Band Adjusting Gage, and Install Plugs on Low Gear and Reverse Servos.*

GAGE, low and reverse transit band adjusting, B226839
SCREWDRIVER
WRENCH, open-end, 1 1/16-in.
WRENCH, open-end, 1½-in.
WRENCH, socket-head set screw, ¼-in.

Install reverse band adjusting plug and a *new* copper gasket on transfer unit case (1½-in. open-end wrench). Install acorn plug and a new gasket on reverse servo cover (1 1/16-in. open-end wrench). Loosen pressure nut on band adjusting gage; then unscrew gage from low gear servo piston rod. Install plug in low gear servo cover (screwdriver or ¼-in. socket-head set screw wrench).

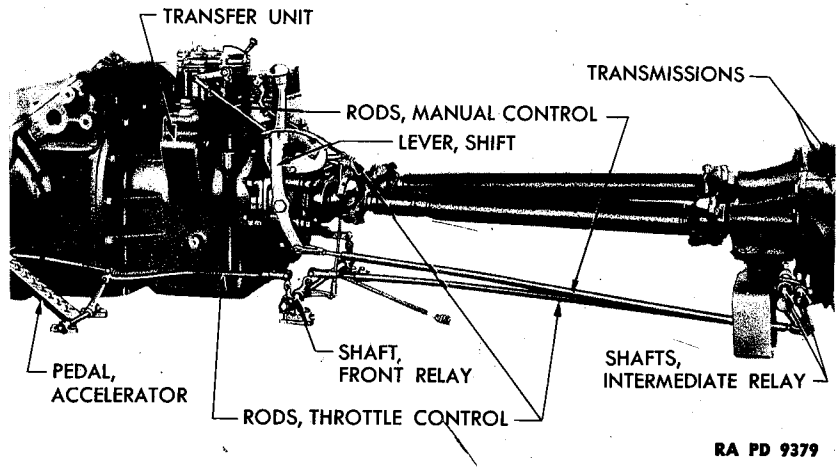

Figure 18 — Transfer Unit and Transmission Control Linkage

d. Linkage Adjustments.

(1) DISCONNECT RODS AT SHIFT LEVER.

PLIERS

Disconnect rod between shift lever and transfer unit reverse servo release lever at shift lever end (fig. 18). Place shift lever in "REV" position (make sure that it is in detent position shown on quadrant by the arrow), and disconnect rod at lower end of shift lever.

(2) INSTALL INTERMEDIATE RELAY GAGE PLATE.

GAGE, pin, throttle controls, adjusting, set, A266522

GAGE, throttle, intermediate relay, A266521

Install intermediate relay gage plate A266521 next to manual lever and throttle lever on left ends of intermediate relay cross shafts. Install 2 gage pins A266522 (long), through pinholes on intermediate relay throttle and manual levers, and into holes in gage plate to lock levers in a fixed position (fig. 19).

(3) ADJUST ROD AT SHIFT LEVER AND REMOVE INTERMEDIATE RELAY GAGE PLATE.

GAGE, pin, throttle controls adjusting, set, A266522

GAGE, throttle, intermediate relay, A266521

PLIERS

WRENCH, open-end, 9/16-in.

Adjust length of rod disconnected from lower end of shift lever by loosening clevis lock nut (9/16-in. open-end wrench), and rotating clevis with a pair of pliers until clevis pin slips into selector lever. **CAUTION:** Shift lever must be in "REVERSE" position. Install clevis pin and cotter

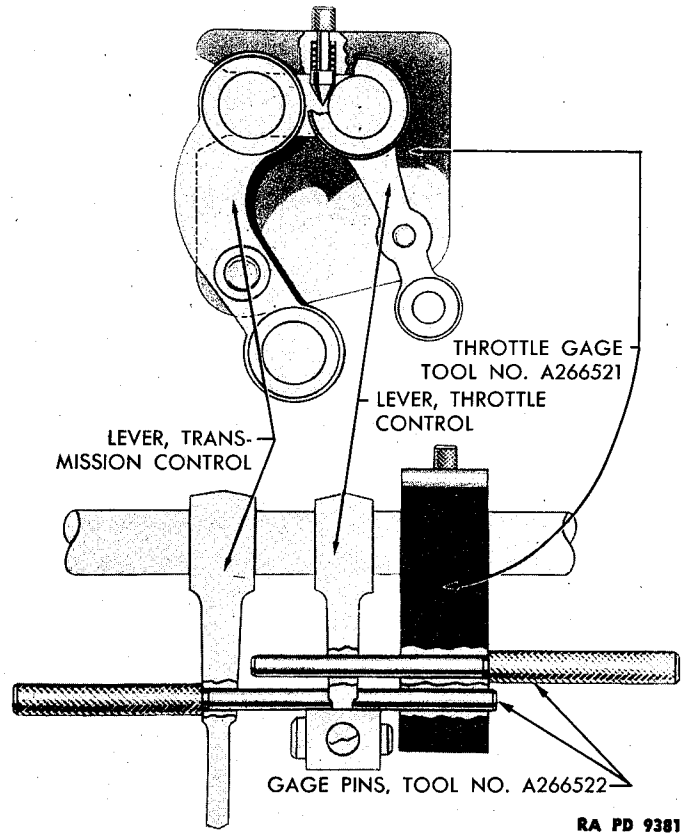

Figure 19 — Gage at Intermediate Relay

key, and tighten clevis lock nut. Remove gage pins and gage plate from intermediate relay.

(4) ADJUST MANUAL ROD TO TRANSFER UNIT REVERSE SERVO.

PLIERS

WRENCH, open-end, 7/16-in.

While working in fighting compartment, move transmission and transfer unit shift lever past "REVERSE" position (toward rear of vehicle) as far as it will go. Hold shift lever in that position while adjusting length of rod from shift lever to reverse servo release lever. When clevis pin is inserted, the stop on reverse servo release lever should just contact stop on servo body if rod is adjusted properly. Release shift lever, install clevis pin and cotter key, and tighten clevis lock nut (7/16-in. open-end wrench).