TM 9-1678

WAR DEPARTMENT TECHNICAL MANUAL

ORDNANCE MAINTENANCE

REMOTE CONTROL SYSTEM M15 (FOR 40-MM GUN CARRIAGES M2, M2A1)

RESTRICTED DISSEMINATION OF RESTRICTED MATTER—

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WAR DEPARTMENT • *31 JULY 1944*

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WAR DEPARTMENT

Washington 25, D. C., 31 July 1944

TM 9-1678, Ordnance Maintenance: Remote Control System M15 (For 40-mm Gun Carriages M2, M2A1), is published for the information and guidance of all concerned.

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(For explanation of symbols, see FM 21-6.)

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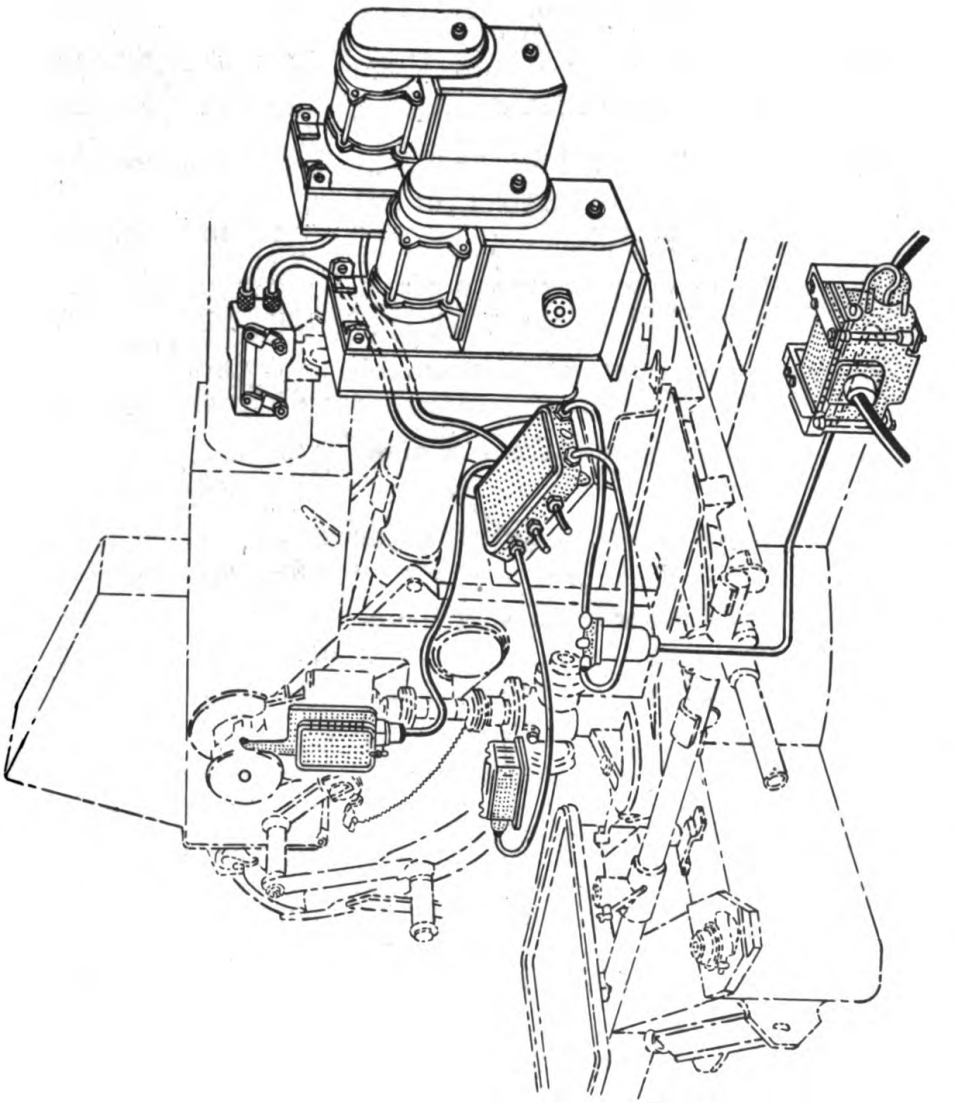
RA PD 31690



Remote Control System M15 With Oil Gear M3

RESTRICTED

Section I

INTRODUCTION

1. SCOPE.*

a. This manual is published for the information and guidance of Ordnance maintenance personnel. It contains detailed instructions for inspection, disassembly, assembly, maintenance, and repair of the Remote Control System M15, supplementary to instructions in the Field Manuals and Technical Manuals prepared for the using arm. This manual does not contain information which is intended primarily for the using arm, since such information is available to Ordnance maintenance personnel in the 100-series Technical Manuals or Field Manuals.

2. CHARACTERISTICS.

a. The Remote Control System M15 is a hydraulic power system, electrically operated by the Director M5, M5A1, or M5A2, with electrical power supplied from the Generator Unit M5. The remote control system continuously points the gun in both azimuth and elevation.

b. The Remote Control System M15 is a modification of the Remote Control System M5. It consists of a gun junction box assembly, a contact ring assembly, a distribution box assembly, an elevation limit switch, an azimuth limit switch, an elevation switch, two Oil Gears M3, and the necessary cable and plug assemblies.

c. The Remote Control System M15 is used with the 40-mm antiaircraft Gun Carriages M2 and M2A1.

d. This system permits continuous tracking in azimuth of 360 degrees in either direction, and tracking in elevation from minus 3 degrees to plus 85 degrees.

e. Operation of the gun may be changed from automatic to hand drive, and vice versa, during firing.

f. What the Oil Gear M3 Is and What it Does.

(1) The Oil Gear M3 is the remote control unit for driving the gun in azimuth or elevation, thus two oil gears are mounted on each gun.

(2) One moves the gun in azimuth (traverses it). It is capable of traversing the gun through 360 degrees in either direction.

*To provide maintenance instructions with the materiel, this Technical Manual has been published in advance of complete technical review. Any errors or omissions will be corrected by changes or, if extensive, by an early revision.

(3) The other moves the gun in elevation between minus 3 degrees and plus 85 degrees. There is an automatic stop at each of these positions. The stop at the lower end of the travel may be set at minus 3, 0, plus 5, plus 10, plus 15, or plus 20 degrees.

(4) The Oil Gear M3 may be used for either azimuth or elevation control by the appropriate positioning of:
The synchro drive change gears.
The limit cam.
The self synchronous toggle switch.
The azimuth-elevation nameplate.

(5) Each oil gear unit employs both electric and hydraulic elements. Each oil gear has a hydraulic pump and a hydraulic motor in a form called a hydraulic transmission, an electric drive motor, a pump stroke control, a data receiving system, and a self-contained limit system.

(6) The azimuth and elevation oil gear units receive electrical data from the director, and electrical power from the generating unit. The director determines the location of the target and the amount the gun should "lead" the target in azimuth and elevation in order that the projectile fired by the gun will meet the target. The oil gear units keep the gun positioned in synchronism with the data they receive from the director.

3 TABULATED DATA.

a. Induction Motor.

Voltage	115-volt, 3-phase, 60-cycle
Horsepower	5/8 hp, continuous
Speed	3,425 rpm

b Data Receiving System.

Voltage	115-volt, 1-phase, 60-cycle

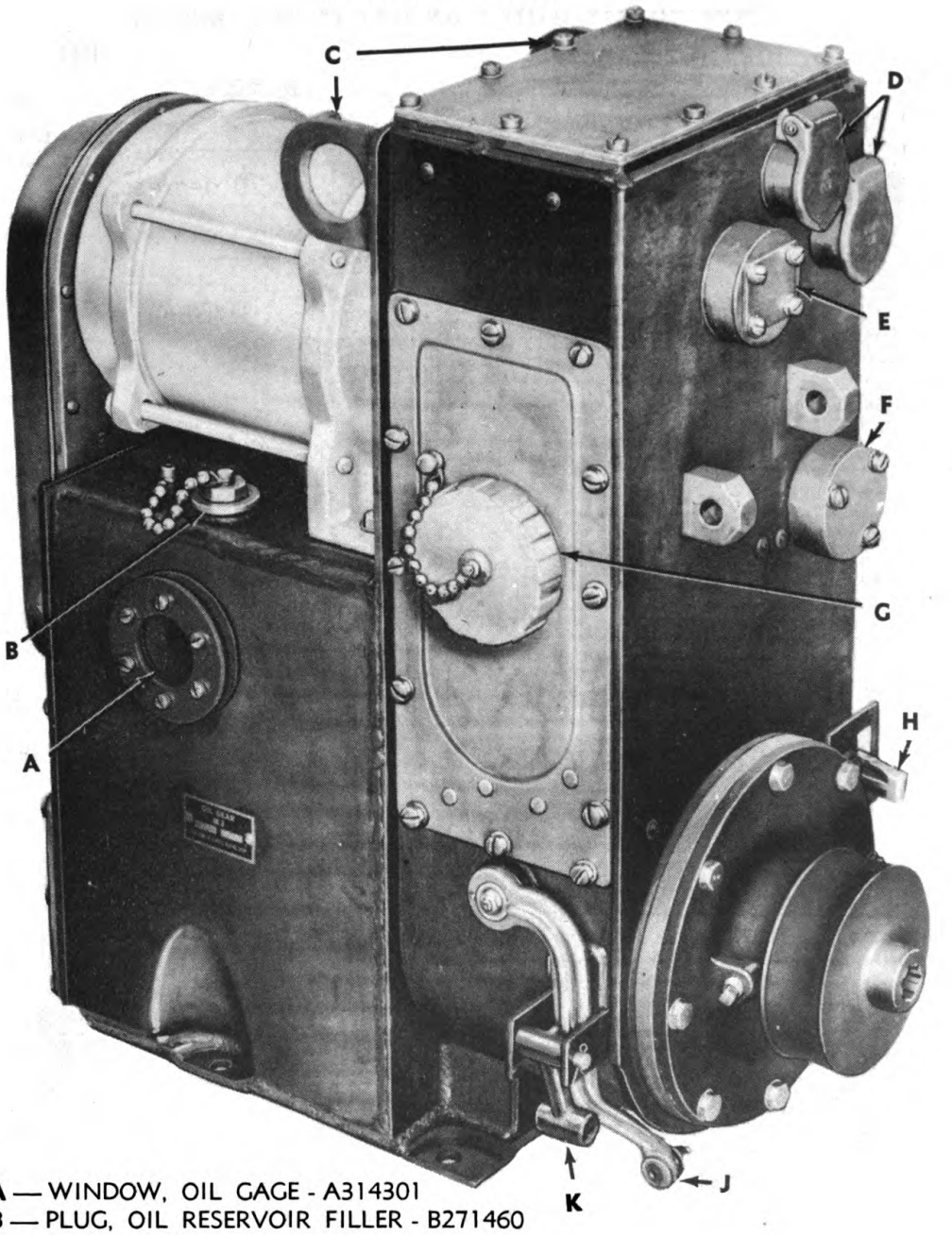
c. Limits of Gun Travel.

Azimuth	No limit
Elevation	Minus 3 deg to 85 deg (lower limit is adjustable)

d. Speeds.

Gun travel in azimuth (max)	Not less than 30 deg per sec
Gun travel in elevation (max)	Not less than 23 deg per sec
Hydraulic transmission pump	2,000 rpm
Hydraulic transmission motor (max)	Not less than 1,800 rpm

INTRODUCTION

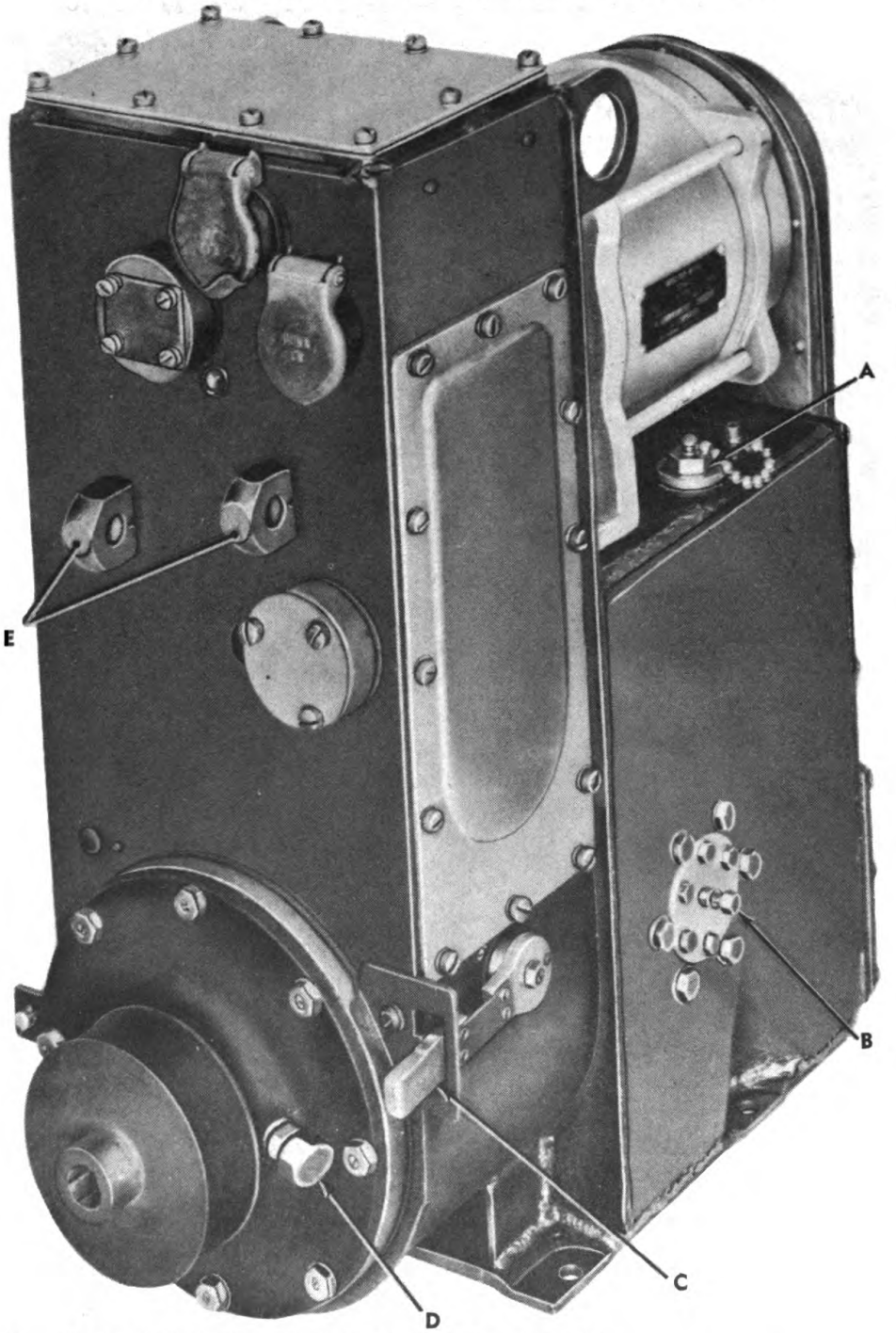


A — WINDOW, OIL GAGE - A314301
B — PLUG, OIL RESERVOIR FILLER - B271460
C — ANGLE, BRACKET, LIFTING - A314334
D — COVERS, PUSH BUTTON SWITCH - B271277
E — FLANGE, POWER LEADS OPENING - A314241
F — FLANGE, DATA LEADS OPENING - A314240
G — COVER, ACCESS, ADJUSTMENT, HYDRAULIC LIMIT SYSTEM LOWER LIMIT - B271884
H — LEVER, BORE SIGHTING CLUTCH - B179460
J — LEVER, SLEWING CLUTCH - B179462
K — LEVER, LOCKING, SLEWING CLUTCH LEVER - A314333

RA PD 21121

Figure 1—Oil Gear M3

ORDNANCE MAINTENANCE—REMOTE CONTROL SYSTEM M15 (FOR 40-MM GUN CARRIAGES M2, M2A1)



A — PLUG, RESERVOIR FILLING, ASSEMBLY - B271460
B — PLUG, OPENING, REPLENISHING OIL PRESSURE GAGE - CPMX1BA
C — LEVER, BORE SIGHTING - B179460
D — FITTING, GREASE, OUTPUT SHAFT BEARING AND COUPLING - CLDX1A
E — EYE, ANCHORING, OIL GEAR - A314238

RA PD 21122

Figure 2—Oil Gear M3

e. Oil for the Hydraulic System.

Type	
Preferred	OIL, hydraulic
Alternate	OIL, recoil
Quantity	(approx) 2 gal
Maximum operating pressure of the transmission	1,500 to 1,800 lb per sq in.
Replenishing pressure for the transmission	150 to 165 lb per sq in.

f. Torques.

Rated torque at output coupling of oil gear	250 lb-in
Maximum torque at output coupling of oil gear	350 lb-in

g. Weights.

Oil gear	250 lb
Oil gear in shipping crate	
Domestic	295 lb
Export	310 lb

h. Outside Dimensions.

Oil gear	21⅝ in. x 10½ in. x 21⅝ in.
Oil gear in shipping crate	
Domestic	26 in. x 14¾ in. x 23⅝ in.
Export	27½ in. x 16 in. x 26 in.

4. CAUTION.

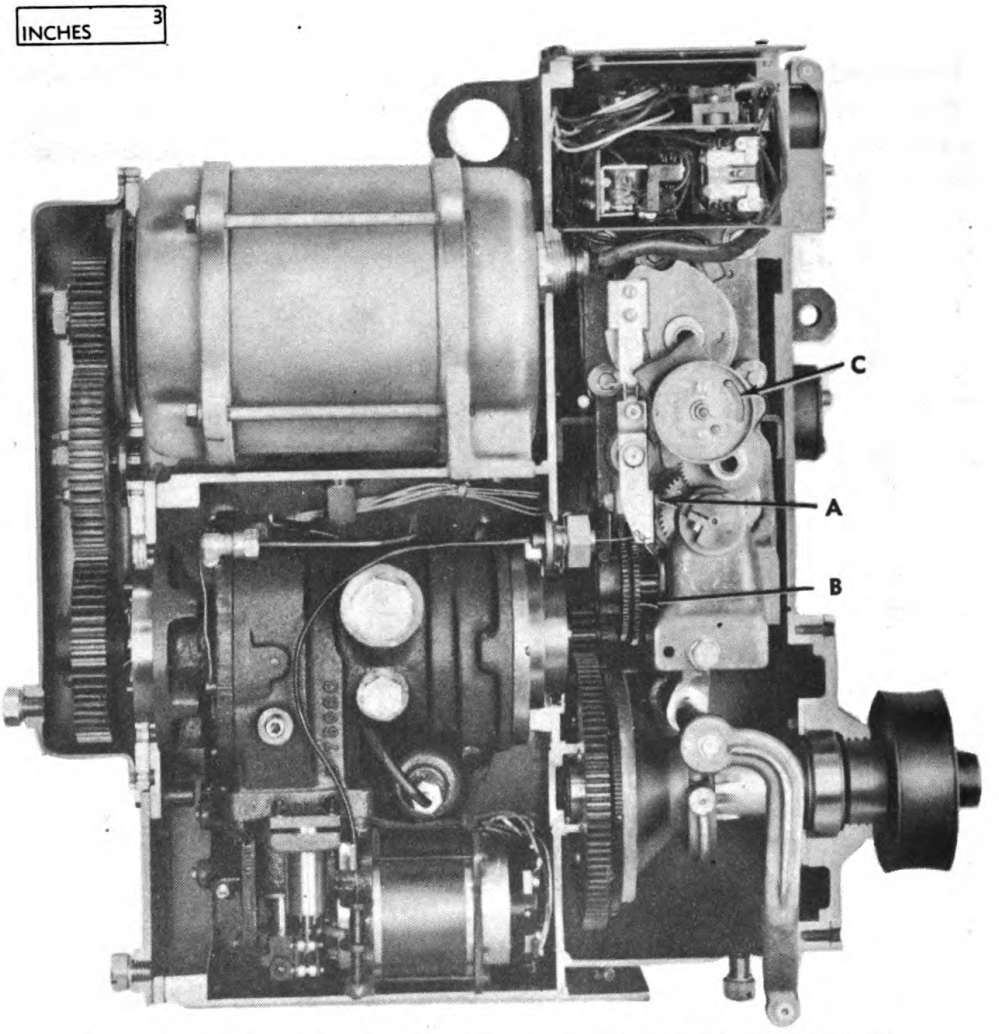
a. Because of the high torque and high speed of operation of the Oil Gear M3, care should be exercised in walking around or working around the gun while the oil gear units are running. It is recommended that metal grilles or wooden boards be placed under the footrests on the 40-mm gun carriage to minimize the likelihood of injury to feet or legs of gun personnel.

Section II

DESCRIPTION OF OIL GEAR M3

5. FUNCTION.

a. The function of the oil gear is to utilize the signal output of the director to position the gun quickly and accurately at all speeds within the rating of the unit.



A — SCREW, ADJUSTING, HYDRAULIC LIMIT SPOOL - BCGX1.1BM
B — GEAR, CHANGE, AZIMUTH-ELEVATION - C82087
C — CAMS, LIMIT

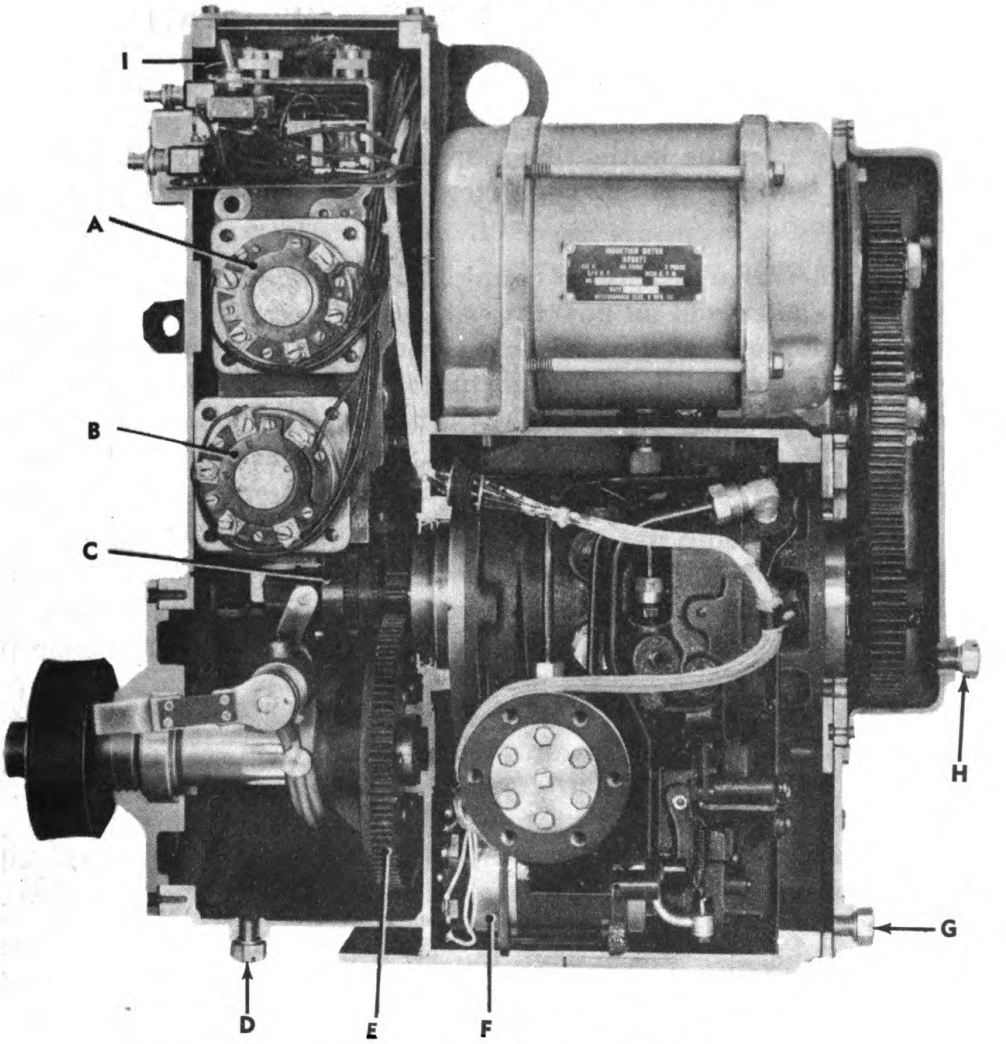
RA PD 21123

Figure 3—Oil Gear M3—Cutaway View

6. PRINCIPAL COMPONENTS.

a. The oil gear unit employs both electric and hydraulic elements. Each oil gear has an electric drive motor (induction motor), a hydraulic pump and a hydraulic motor in a form called a hydraulic transmission, a valve assembly (pump stroke control), a fine data system, a coarse data system, a self-contained limit system, a slewing clutch, a boresighting clutch, and a completely sealed case.

DESCRIPTION OF OIL GEAR M3



A — REPEATER, SYNCHRO, COARSE - C78410
B — TRANSMITTER, OIL GEAR, ASSEMBLY - C78248
C — COLLAR, CLUTCH, SLEWING - B179495
D — PLUG, DRAIN, CLUTCH COMPARTMENT - A182197
E — CLUTCH, BORE SIGHTING - C82056
F — DIFFERENTIAL, SYNCHRO, ASSEMBLY - C78472
G — PLUG, DRAIN, OIL RESERVOIR - A182197
H — PLUG, DRAIN, GEAR COMPARTMENT - A182197
I — SWITCH, TOGGLE

RA PD 21124

Figure 4—Oil Gear M3—Cutaway View

7. OPERATING PRINCIPLE.

a. The power to drive the gun is derived from the induction motor which drives the pump of the hydraulic transmission. The hydraulic transmission consists of a variable displacement oil pump and a fixed displacement oil motor. The induction motor drives the oil pump at a constant speed of 2,000 revolutions per minute.

b. One port of the oil pump connects to one port of the oil motor; the other port of the oil pump connects to the other port of the oil motor. This results in the direction and rate of oil flow through the oil motor being the same as the direction and rate of oil flow through the oil pump.

c. The valve assembly (pump stroke control) determines the direction and rate of oil flow through the oil pump and, consequently, the direction and rate of oil flow through the oil motor. The direction and rate of oil flow through the oil motor determines the direction and speed of rotation of the oil motor. The oil motor is geared to the gun and, consequently, the direction and speed of rotation of the oil motor determines the direction and speed of gun travel.

d. The synchro differential of the fine data system detects error between the director and the gun, and displaces a small pilot piston of the valve assembly (pump stroke control) in accordance with the error. The pilot piston positions the power piston which is connected to the stroke ring of the oil pump. As the stroke of the oil pump is varied in accordance with the position of the pilot piston, oil is pumped through the oil motor. The oil motor then rotates and drives the gun in the direction to correct the error between the synchro transmitter in the director and the synchro transmitter in the oil gear. A means for giving an errorless control for any steady tracking rate is incorporated in the valve assembly (pump stroke control).

e. Oil pressure for actuating the valve assembly (pump stroke control) and for replenishing the leakage oil from the hydraulic transmission is obtained from a small gear-type oil pump (replenishing pump) built integral with the variable-displacement oil pump. A pressure regulator is provided to maintain constant pressure output from the gear pump. The induction motor drives both oil pumps.

8. CASE ASSEMBLY (fig. 48).

a. The case assembly is of welded steel construction, and is divided into two compartments.

b. One compartment contains the transmission and valve assembly. It also contains the filter group assembly and valve B179908 for the gear-type replenishing pump. It has an opening for draining the oil, two openings with filters for oil filling, and an oil level inspection glass window. This compartment serves as an oil reservoir and contains approximately 2 gallons of oil. The induction motor is mounted on top of this compartment.

c. The other compartment of the case assembly contains the slewing clutch, boresighting clutch, receiver assembly, terminal board

assembly, and push button switch assembly. It has an opening for draining any oil which may leak into it.

9. INDUCTION MOTOR.

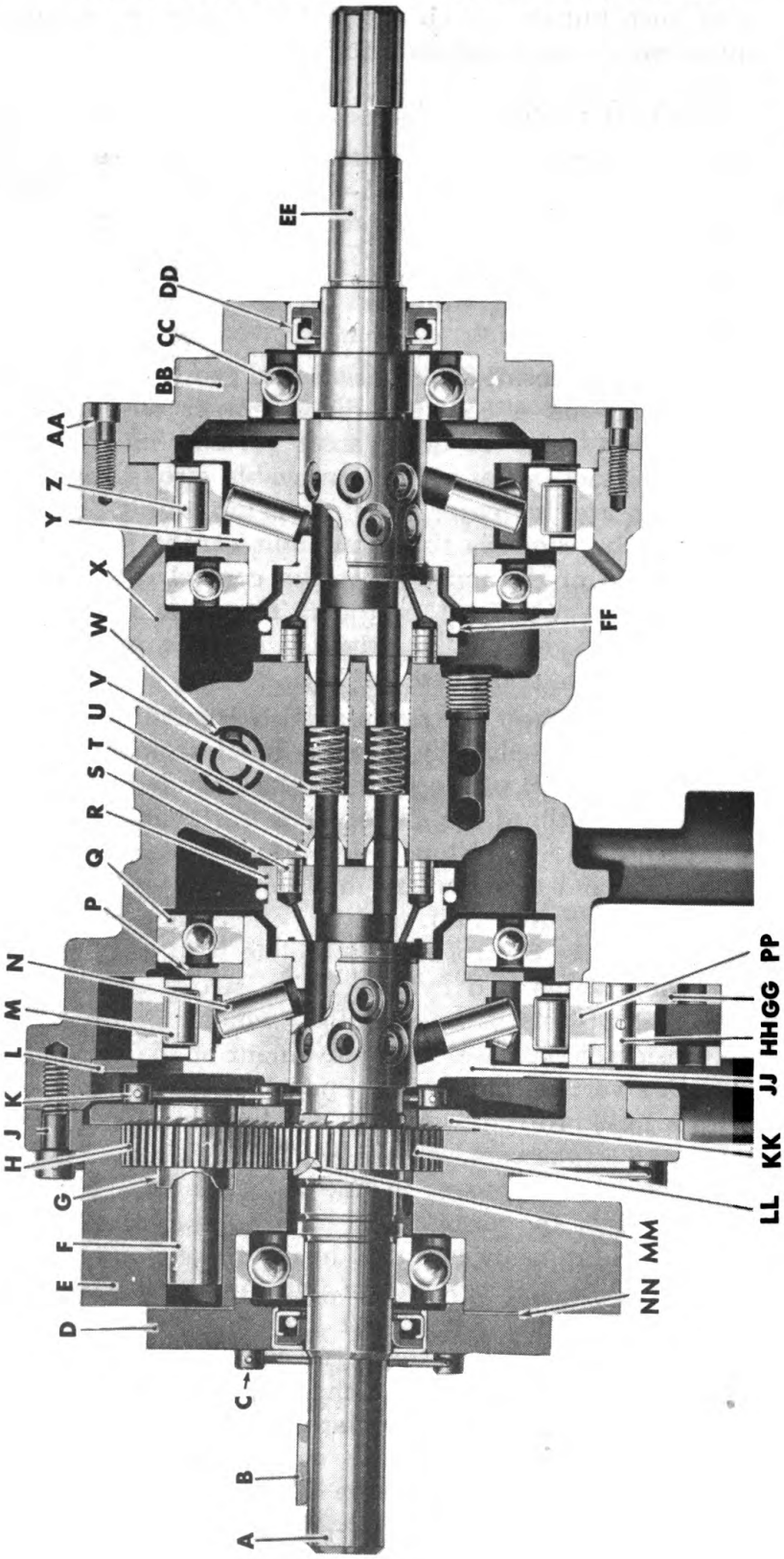
a. The induction motor, used to drive the shaft assembly of the oil pump, is a 3-phase, 60-cycle, 115-volt motor with a rating of ⅝ horsepower and a speed of 3,425 revolutions per minute.

10. HYDRAULIC TRANSMISSION.

a. Construction.

(1) The hydraulic transmission consists of a gear pump, a variable delivery input unit, and a constant displacement output unit, all built into a compact case. A drive shaft pressed into a cylinder having 14 radial pistons, a flat valve, a movable stroke control race, and a roller bearing are the major parts of the input unit. The output unit is essentially the same as the input unit except for the stroke control race. Instead of the movable stroke control race, there is a roller bearing placed in a fixed position. The gear pump consists essentially of a driver gear and a driven gear built into a housing and fitted to the transmission case.

(2) The input drive shaft has seven axial holes drilled in one end, and 14 holes drilled radially. Two radial holes connect with each axial hole. Fourteen radial piston holes in the cylinder coincide with the 14 radial holes in the drive shaft when the cylinder is pressed onto the shaft (fig. 6). A piston is lap-fitted in each hole in the cylinder. The shaft and cylinder are mounted on two ball bearings, one at the front end of the shaft, and the other on the rear end of the cylinder. The stroke control race, complete with a roller bearing, circumscribes the pistons and cylinder. The stroke control race is mounted between two sets of caged rollers which ride on hardened, ground plates inside of the case. The movement of the stroke control race is always in a vertical plane. One end of the stroke control race, equipped with a link, protrudes through the bottom of the body and is connected to the stroke control unit (fig. 6). A balanced flat valve, with two crescent-shaped grooves in line with the axial holes in the shaft, fits flush against the ground end of the input drive shaft and is prevented from rotating by two pins in the transmission body and a retaining spring. The opposite face of flat valve has a large drilled hole which connects with one of the crescents, while two small drilled holes connect with the other crescent. These holes connect with one large and two small holes in the transmission body through closely fitted hollow pistons and associate hollow tumblers. Another flat valve of the same design is flush with the end of the output shaft and connected to the same three holes through closely fitted hollow pistons and associate hollow tumblers. A spring in each hole



RA PD 21125

Figure 5—Hydraulic Variable Speed Transmission—Horizontal Sectionalized View

A — SHAFT, INPUT DRIVE - C82082
B — KEY, SHAFT - BGAX11B
C — SCREW, OIL SEAL HOUSING - A314402
D — COVER, OIL SEAL - A314401
E — HOUSING, GEAR PUMP - D75087
F — SHAFT, GEAR PUMP - A245581
G — BUSHING, GEAR PUMP GEAR - A245577
H — GEAR, DRIVEN - A245575
J — SCREW, GEAR PUMP HOUSING - A314403
K — SCREW, GEAR PUMP COVER - A245585
L — RING, RETAINING - A235553
M — BEARING, ROLLER - A235659
N — PISTON, RADIAL - A195958
P — RING, SPACER - A195976
Q — BEARING, BALL - MRC-110R
R — VALVE, FLAT - C82083
S — PISTON, EQUALIZER - A195979
T — TUMBLER, BACK-UP *(SMALL)* - A195972
U — PISTON, BACK-UP *(SMALL)* - A195980
V — SPRING, BACK-UP *(SMALL)* - A195973
W — PLUNGER, HIGH PRESSURE RELIEF - A244953
X — BODY, TRANSMISSION - D75088
Y — CYLINDER, OUTPUT - B220981
Z — BEARING, ROLLER - A235661
AA — SCREW, BODY COVER - BCWX3AB
BB — COVER, BODY - B179903
CC — BEARING, BALL - .7874 X 2.0472 X .5906
DD — OIL SEAL SHAFT - A195970
EE — SHAFT, OUTPUT DRIVE - C82084
FF — SNAP RING, FLAT VALVE - A314407
GG — LINK, STROKE CONTROL RACE - A314400
HH — PIN, LINK - A314399
JJ — CYLINDER, INPUT - B179900
KK — COVER, GEAR PUMP GEARS - A235582
LL — GEAR, DRIVER - A245574
MM — KEY, DRIVER GEAR - BGAX1
NN — GASKET, OIL SEAL COVER - A318391
PP — RACE, STROKE CONTROL *(SLIDE BLOCK)* - B179902

RA PD 21125A

Legend for Figure 5—Hydraulic Variable Speed Transmission—Horizontal Sectionalized View

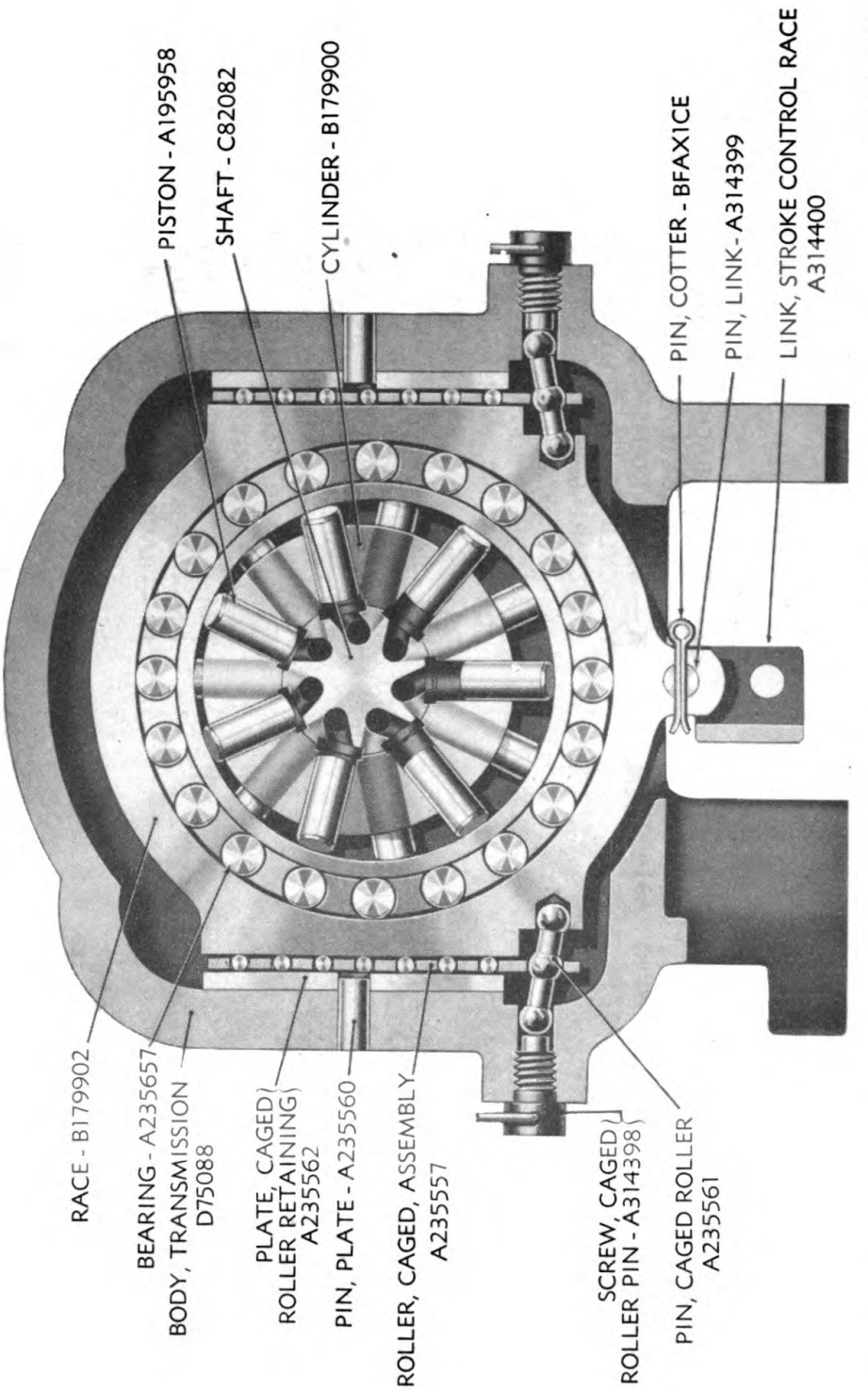


Figure 6—Hydraulic Variable Speed Transmission Input Unit—Vertical Sectionalized View

DESCRIPTION OF OIL GEAR M3

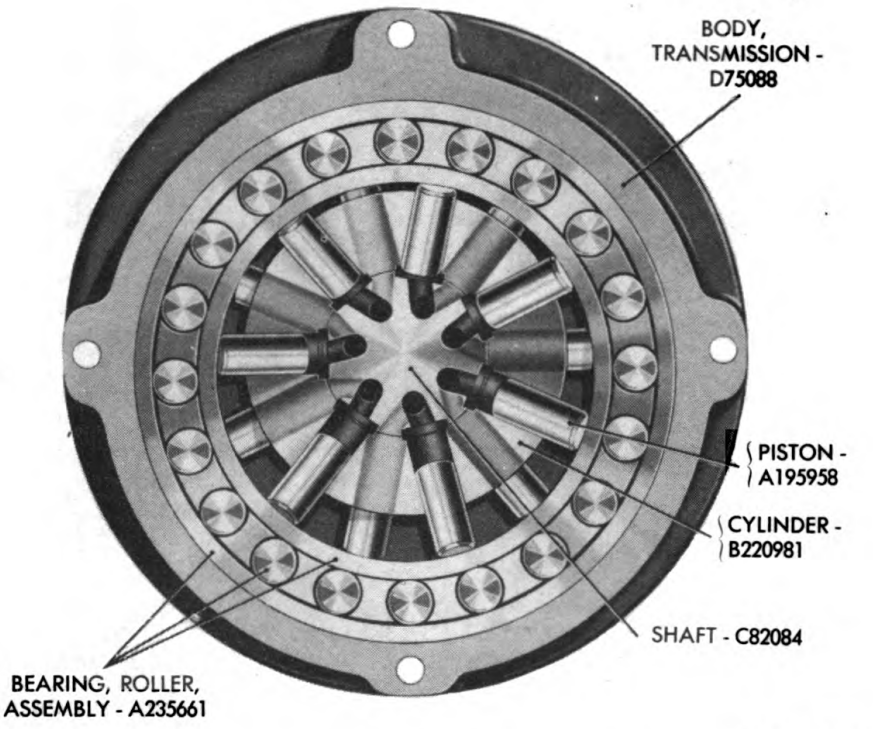


Figure 7—Hydraulic Variable Speed Transmission (Output End)—Vertical Sectionalized View

holds the pistons and tumblers against their respective flat valves and the flat valves against their respective shafts. Two equalizer pistons in each flat valve balance the hydraulic force tending to separate the flat valves from the ends of their respective shafts.

(3) The output shaft, cylinder, pistons, and ball bearing assembly are similar to those of the input assembly (fig. 7). A roller bearing, set at a fixed eccentricity to the shaft centerline, circumscribes the pistons and cylinder. A cover, with shaft seal and outer bearing support, seals the end of the transmission.

(4) A housing, which supports the outer bearing of the input shaft and contains a built-in gear pump, is mounted to the input end of the transmission body. A gear, keyed to the input shaft, drives a smaller gear mounted on an idler shaft. A cover encloses the gears in the housing and provides a close running fit for the gear pump gears.

(5) Two check valves, each consisting of a plunger, spring, and cap are connected through drilled passages to the gear pump discharge and the three axial holes connecting the two flat valves (fig. 9).

(6) A built-in high pressure relief valve, consisting of a seat, plunger, bushing, retainer, spring guide, spring, shims, and cap, is also connected through drilled holes to the three axial passages.

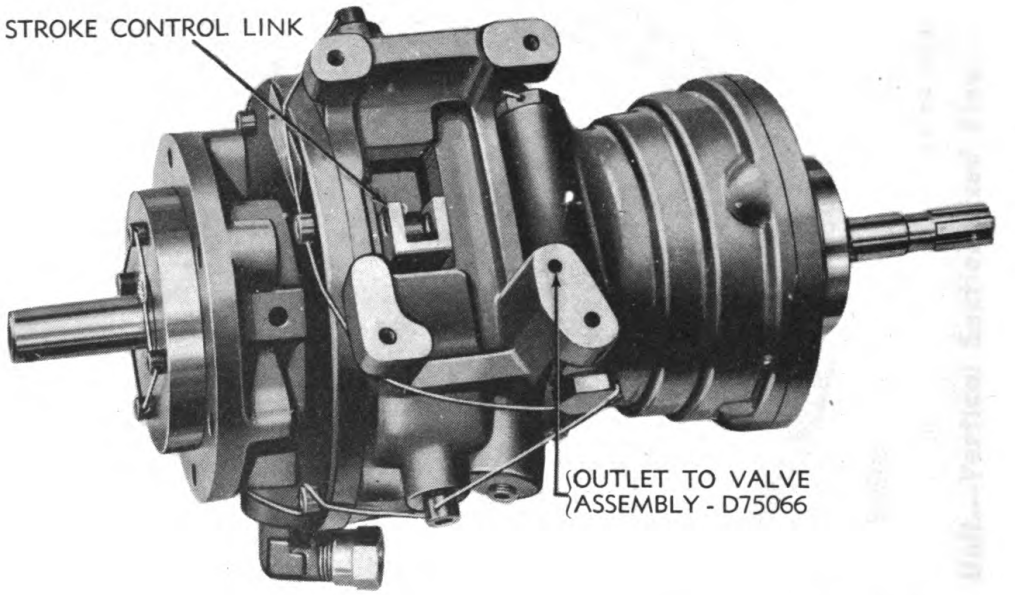


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Figure 8—Hydraulic Variable Speed Transmission—Bottom View

b. Principle of Operation (figs. 10, 11, and 12).

(1) As the input drive shaft is driven counterclockwise by the electric motor, the gear pump gears suck oil from the reservoir and deliver it through drilled passages, past the two check valves, through the back-up pistons, tumblers, flat valves, and drive shafts to the piston bores in the cylinders to fill the system with oil. Centrifugal force, due to the drive shaft rotation, plus oil under gear pump pressure beneath each piston, causes the pistons to ride against the inner surface of the stroke control race assembly at all times. Through contact of the pistons, the roller bearing rotates with the cylinder and input drive shaft.

(2) In neutral position "A" (fig. 10), the stroke control race assembly is concentric with the drive shaft. The pistons are at zero stroke and no oil is delivered by the input unit and, thus, no movement is imparted to the output shaft. The gear pump replenishes all internal leakage and maintains a low supercharging pressure on the system of about 150 pounds per square inch.

(3) As the stroke control race is moved upward from position "A" to position "C" (fig. 11), or any position between "A" and "C," the input drive shaft and the stroke control race assembly are no longer concentric. Thus, as each piston moves counterclockwise through the arc to the right of the vertical centerline, it gradually moves outward as it rides against the inner surface of the stroke control

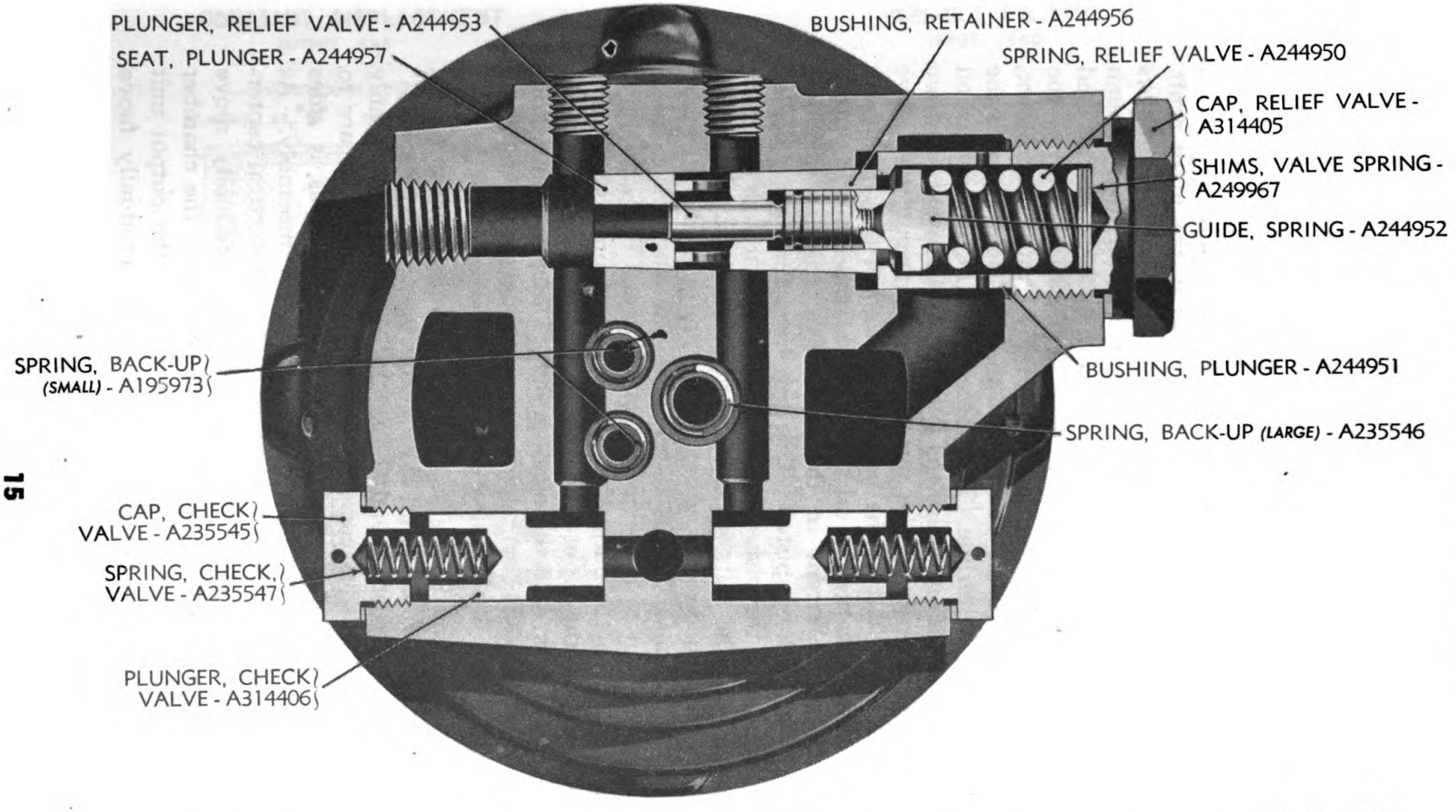

Figure 9—Hydraulic Variable Speed Transmission High Pressure Relief Valve and Check Valves —Vertical Sectionalized View

race assembly. As each piston passes through the arc to the left of the vertical centerline, it gradually moves inward. As the pistons gradually move outward in the arc to the right of the vertical centerline, the chamber beneath each piston is filled with oil returning from the output unit and from the replenishing gear pump. As the pistons gradually move inward while passing through the arc to the left of the vertical centerline, the oil in the chamber beneath each piston is discharged through the axial holes in the input shaft, the left-hand crescent in flat valve, the two small hollow tumblers and the back-up pistons in the input end of case. The oil flows through the passage in the case, the two small hollow back-up pistons and tumblers, the right-hand crescent in the output unit flat valve, the output shaft axial holes that are passing over the right-hand crescent, and into the chamber beneath the pistons that are in the arc to the right of the vertical centerline. The forces resulting from this oil pressure beneath the pistons cause the cylinder and the output drive shaft to rotate clockwise. As the pistons in the output unit move through the arc to the left of the vertical centerline, they gradually move inward and discharge the oil through the axial holes in output shaft, the left-hand crescent in the flat valve, the large hollow tumbler, and the back-up piston. This oil flows through a drilled passage in the case to the pistons of the input unit through a similar piston, tumbler, and the right-hand crescent of the input flat valve. Thus, the oil passes successively from the oil pump to the oil motor and back to the oil pump, and leads to the terminology of a closed-cycle hydraulic system of a specified displacement. The amount of oil which returns from the output unit to the input unit is the same amount delivered by the input unit minus the oil which leaks from the recirculating system into the oil reservoir. The gear pump, however, makes up this loss by supplying an equal amount of oil through a check valve to the input unit.

(4) If the stroke control race assembly is moved downward from position "A" to position "B" (fig. 12), or any position between "A" and "B," the input drive shaft and the stroke control race assembly are not concentric. Thus, as each piston moves through the arc to the left of the centerline it gradually moves outward as it rides against the inner surface of the stroke control race assembly. As each piston moves through the arc to the right of the vertical centerline, it gradually moves inward. As the pistons gradually move outward in the arc to the left of the vertical centerline, the chamber beneath each piston is filled with oil returning from the output unit or with oil from the gear pump. As the pistons gradually move inward in the arc to the right of the vertical centerline, the oil below each piston is discharged through the axial holes in the input shaft,

DESCRIPTION OF OIL GEAR M3

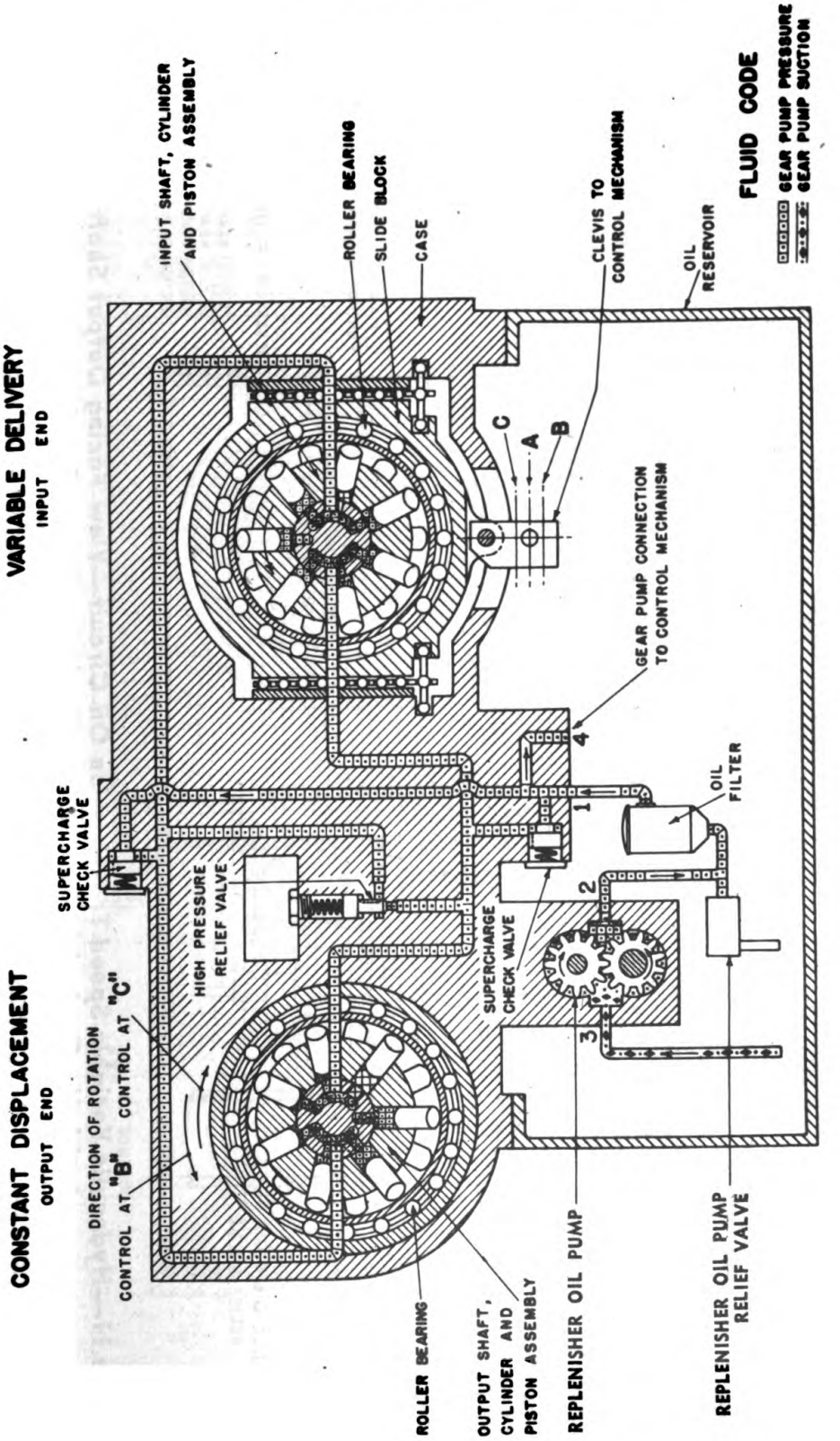

Figure 10—Hydraulic Variable Speed Transmission Oil Circuit—View Facing Output Shaft End With Stroke Control in Neutral Position

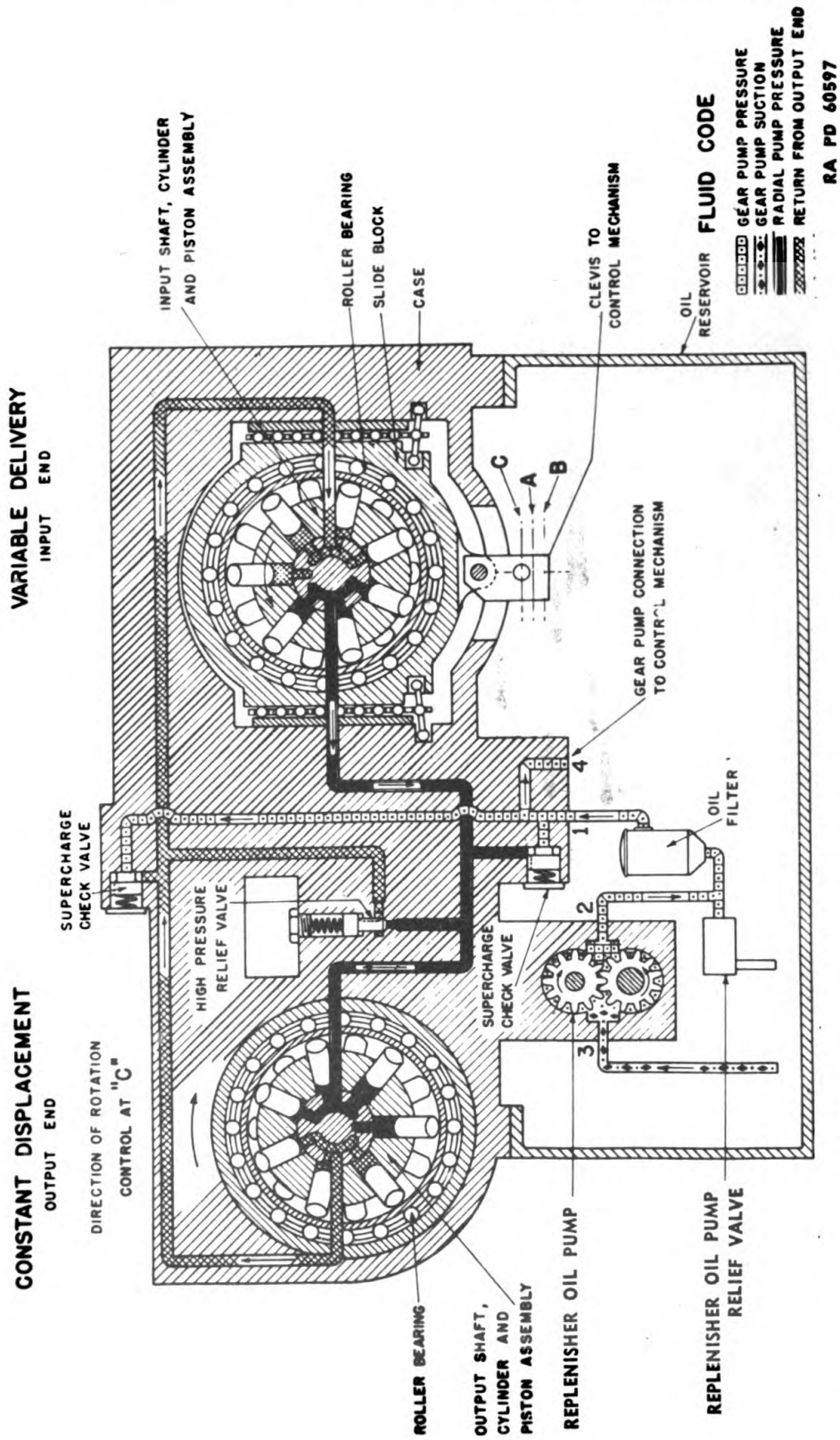

Figure 11—Hydraulic Variable Speed Transmission Oil Circuit—View Facing Output Shaft End With Stroke Control in Position for Clockwise Output Rotation

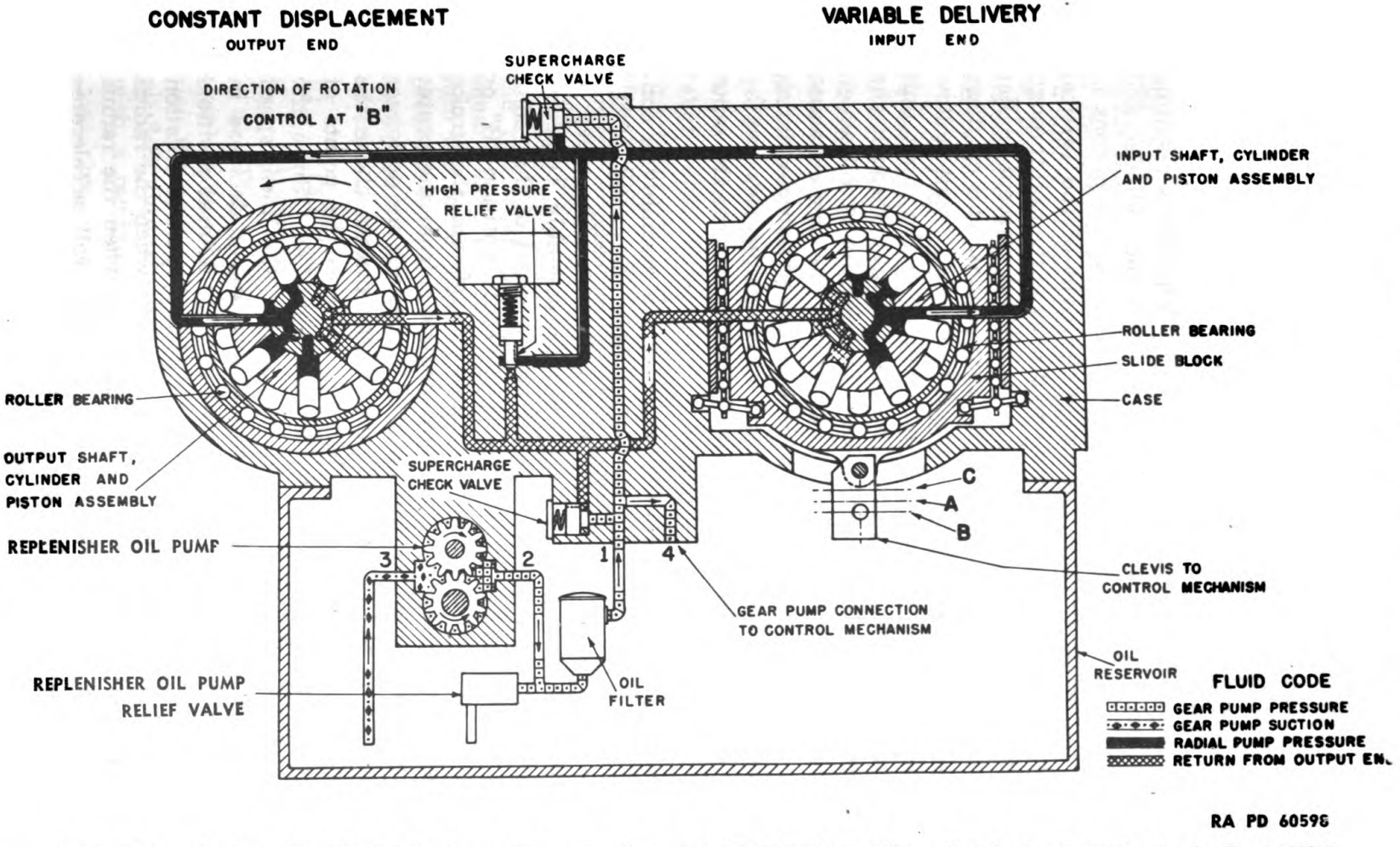

Figure 12—Hydraulic Variable Speed Transmission Oil Circuit—View Facing Output Shaft End With Stroke Control in Position for Counterclockwise Output Rotation

the right-hand crescent in the flat valve, the large hollow tumbler, and back-up piston in the input end of the case. This oil flows through a drilled passage in the case, the large hollow back-up piston and tumbler, the left-hand crescent in output unit flat valve, the output shaft axial holes that are passing over the left-hand crescent, and fills the chambers beneath pistons with oil. The forces resulting from this oil pressure beneath the pistons cause the cylinder and the output drive shaft to rotate counterclockwise. As the pistons in the output unit move through the arc to the right of the vertical centerline, they gradually move inward and discharge their oil through the axial holes in the output shaft, the right-hand crescent in flat valve, two small hollow tumblers, and back-up pistons. This oil flows through a drilled passage in the case through two small hollow back-up pistons, tumblers, and left-hand crescent in the input unit flat valve, to the input unit pistons that are passing through the arc to the left of the vertical centerline. The amount of oil which returns from the output unit to the input unit is the same amount supplied to it, minus the oil which leaks from the recirculating system to the oil reservoir. The gear pump makes up this loss by supplying an equal amount of oil through a check valve to the input unit.

(5) At neutral position, the stroke control race assembly is concentric with the drive shaft, and the radius from the center of the shaft to the contact point of each piston is the same. The speed of the roller bearing in the stroke control race assembly coincides with the input shaft speed because of the point contact of the radial pistons. When the stroke control race is moved to position "B" or "C" (figs. 11 or 12), the centerlines of the drive shaft and the stroke control race do not coincide. Therefore, the radii from the center of the drive shaft to the points of contact of the pistons are no longer equal. The radii to the points of contact of the pistons above the horizontal centerline are different than the radii to the points of contact of the pistons below the horizontal centerline. Since the linear speed of the roller bearing remains constant, the linear speed of the pistons at their contact points must increase or decrease in proportion to the change in radii from the radii at neutral position. This difference in speed is compensated by slow, partial rotation of each piston in its cylinder bore, in one direction when the radius is less than at neutral, and in the other direction when the radius is greater than at neutral. The speed of piston roll accelerates in one direction as the radii become less than at neutral, and then decelerates in the same direction as the radii increase to that at

neutral. The speed of piston roll accelerates in the opposite direction as the radii become greater than at neutral, and then decelerates in the same direction as the radii decrease to that at neutral. Thus, the pistons rotate and reciprocate simultaneously. Since the roller bearing in the output end is not concentric with the shaft centerline, these pistons also rotate and reciprocate simultaneously.

(6) The replenisher oil pump gears suck oil from the reservoir and force it through port number 1, and through the check valves, to fill the system with oil and maintain a minimum low pressure in the system. The replenisher oil pump also supplies oil to port number 4 which is connected to the stroke control unit. When the oil pressure exceeds 150 to 165 pounds per square inch, the oil discharges past the replenisher oil relief valve and returns to the reservoir.

(7) Two spring-loaded check valves, one in each passage between the input and output units, are designed so that the pressure of the oil flowing to the output unit closes the check valve in that passage. This allows the replenishing oil from the gear pump to flow only into the passage that is carrying the discharged oil from the output unit to the input unit.

(8) Overload protection for the input pump, output motor, and drive mechanism, is supplied by the high pressure reverse flow relief valve, built into the transmission case. Normal setting of this relief valve at the factory is approximately 1,600 pounds per square inch. When the oil pressure in the large passage (fig. 9) exceeds approximately 1,600 pounds per square inch, the oil discharges past the relief valve plunger and flows into the two small passages and returns to the input unit. When the oil pressure in the two small passages exceeds approximately 1,600 pounds per square inch, the oil discharges past the relief valve plunger, flows into the large passages, and returns to the input unit. When the pressure is below 1,600 pounds per square inch, the compression spring holds the relief valve closed. Thus, the output shaft can be stalled without overloading the unit.

11. VALVE ASSEMBLY (PUMP STROKE CONTROL) (figs. 13, 14, and 15).

a. The function of the valve assembly (pump stroke control unit) is to take data from the data transmission system and position the race (pump stroke ring) so that the direction and rate of oil flow through the oil motor will cause the gun to be positioned with a minimum of error.

b. The valve assembly (pump stroke control) may be divided into three parts for discussion, namely, the stroke control proper, the error corrector, and the dither mechanism.

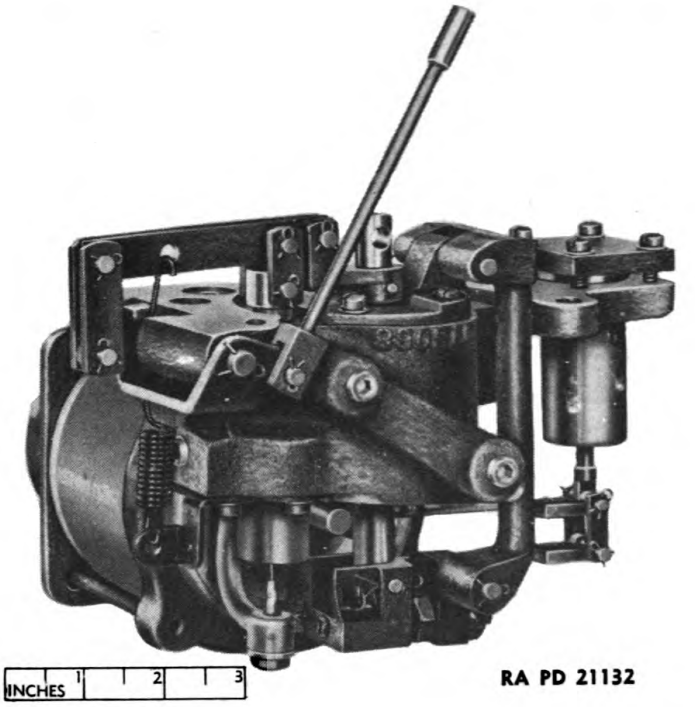

Figure 13—Valve Assembly D75066

c. Stroke Control Proper.

(1) The stroke control proper consists essentially of a power piston assembly and cylinder, a pilot piston assembly, dither sleeve and cylinder, and a synchro differential with lever assembly.

(2) The power piston is a working fit in its cylinder. The upper end of the power piston shaft is fastened to the stroke ring of the oil pump. It is also, through a lever arrangement, connected to the upper end of the dither sleeve.

(3) The position of the power piston directly controls the position of the pump stroke ring. When the power piston is in its neutral position, the pump stroke ring is held concentric to the oil pump shaft assembly.

(4) The dither sleeve has three horizontal rows of holes and is a close working fit in its cylinder. The pilot piston has two circular lands, spaced the same distance, center to center, as the top and bottom horizontal rows of holes through the dither sleeve are spaced. These lands are a close working fit in the dither sleeve.

(5) A drilled passageway leads from the top horizontal row of holes of the dither sleeve to the lower compartment of the power

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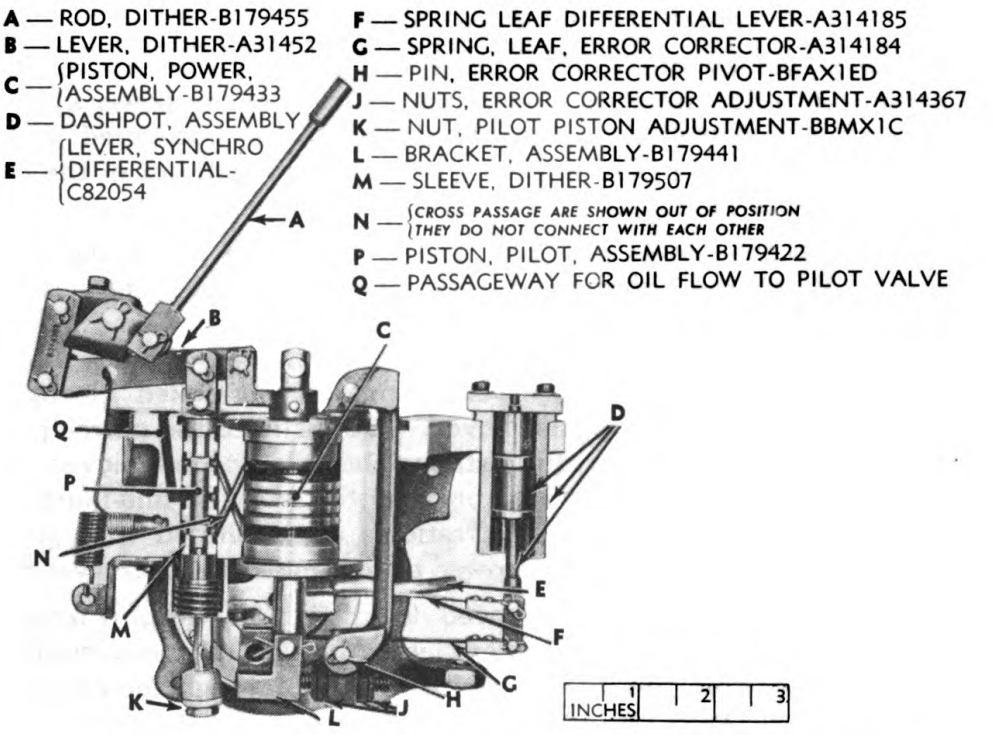

Figure 14—Valve Assembly D75066—Cutaway View

cylinder. Another drilled passageway leads from the bottom horizontal row of holes of the dither sleeve to the upper compartment of the power cylinder. The power piston, and consequently the oil pump stroke ring, are positioned by varying the amounts of oil in the upper and lower compartments of the power cylinder.

(6) Oil under pressure of approximately 150 pounds per square inch is supplied to the center compartment of the dither sleeve (the space inside the dither sleeve between the two circular lands of the pilot piston) whenever the electric motor is in operation. This oil is supplied by the replenishing pump in the hydraulic transmission unit. When the lands of the pilot piston completely cover the top and bottom rows of holes through the dither sleeve, there is no open passageway leading from this center compartment.

(7) If, however, the pilot piston is raised, a portion of the top horizontal row of holes through the dither sleeve will be uncovered by the upper land of the pilot piston, and an equal portion of the bottom horizontal row of holes through the dither sleeve will be uncovered by the lower land of the pilot piston. Oil under 150 pounds per square inch will flow from the center compartment of the dither sleeve through the uncovered portion of the top row of holes, through the associated drilled passageway, and into the lower compartment

of the power cylinder. This forces the power piston upward and causes oil to flow from the upper compartment of the power cylinder through a second drilled pasageway, through the uncovered portion of the bottom row of dither sleeve holes, and to spill out of the open bottom end of the dither sleeve into the oil reservoir.

(8) As the power piston is moved upward it raises the dither sleeve. When the power piston has moved far enough to raise the dither sleeve the distance the pilot piston was moved, the lands of the pilot piston will cover the top and bottom rows of holes through the dither sleeve, and the power piston will be locked in position until the pilot piston is again moved. The distance the power piston moves is determined by the distance the pilot piston moves. The travel of the power piston is approximately one and one-fourth the travel of the pilot piston. This ratio is accomplished through the leverage linkage between the power piston and the dither sleeve.

(9) If the pilot piston is moved downward, oil will flow from the center compartment of the dither sleeve through the uncovered portion of the bottom row of dither sleeve holes, through the associated drilled passageways into the upper compartment of the power cylinder. This forces the power piston downward and causes oil to flow from the lower compartment of the power cylinder through the other drilled passageway, through the uncovered portion of the top row of dither sleeve holes, and to spill out of the top open end of the dither sleeve into the oil reservoir.

(10) And again, as the power piston moves, it moves the dither sleeve in the same direction the pilot piston was moved. When the power piston has moved far enough to move the dither sleeve the distance the pilot piston was moved, the lands of the pilot piston will cover the top and bottom rows of dither sleeve holes, and the power piston will be locked in position until the pilot piston is again moved.

(11) The synchro differential lever positions the pilot piston; the pilot piston positions the power piston; the power piston positions the oil pump stroke ring of the hydraulic transmission; the position of the oil pump stroke ring controls the direction and rate of oil flow through the oil pump and oil motor; and the direction and rate of oil flow through the oil motor controls the direction and speed of rotation of the oil motor. The oil motor is geared to the gun; consequently, the direction and speed of rotation of the oil motor determines the direction and speed of gun travel.

(12) The position of the pilot piston in relation to the position of the synchro differential lever is adjustable. The adjustment must be made according to instructions in paragraph 44.

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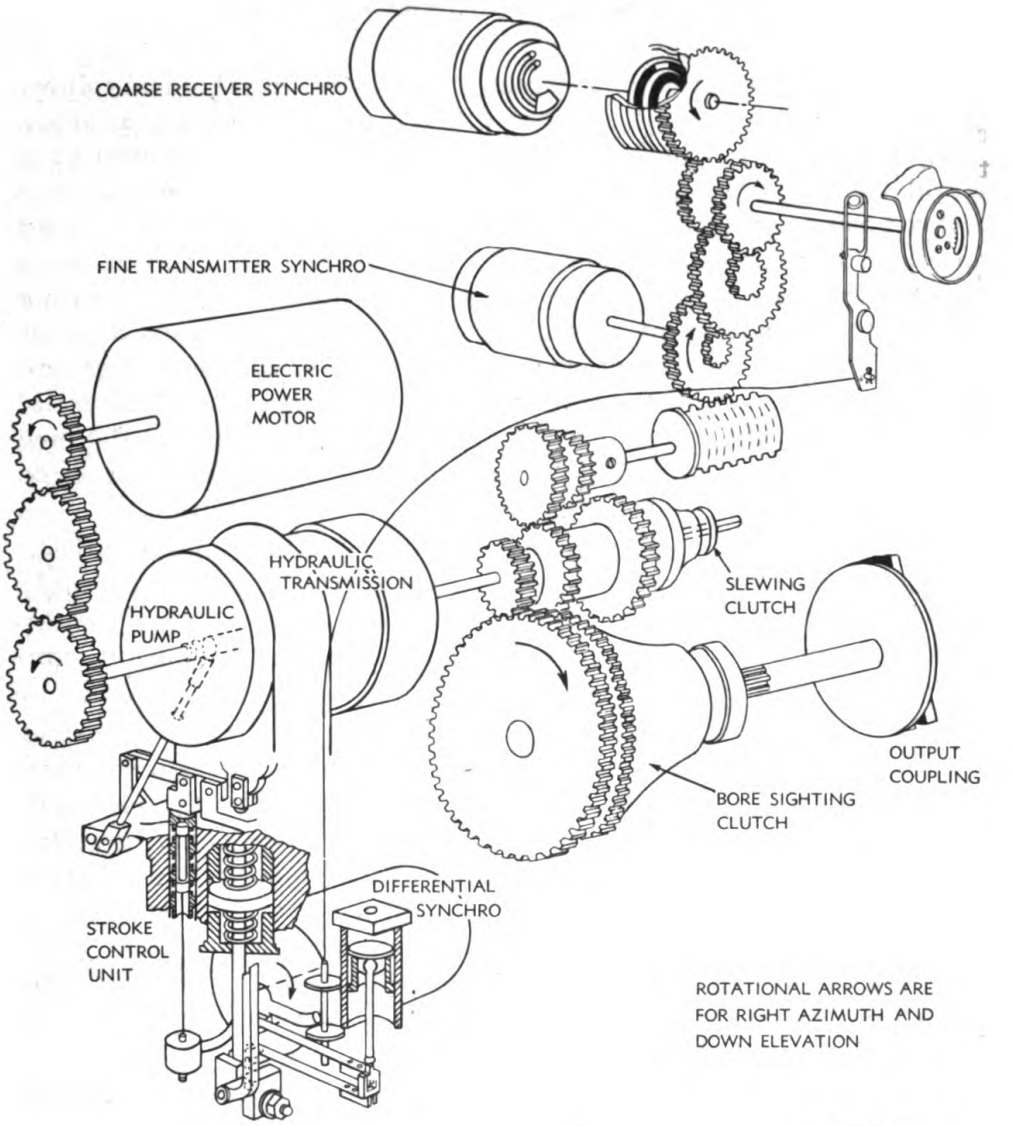

Figure 15—Oil Gear M3—Schematic

d. The Error Corrector (figs. 14 and 15).

(1) The operation of the stroke control proper is such that, for a given speed of gun travel, there must be a corresponding length of oil pumping stroke; and, consequently, a corresponding displacement of the power piston, the pilot piston, and the synchro differential lever. The displacement of the synchro differential lever is caused by the director synchro fine transmitter leading the oil gear synchro fine transmitter and is proportionate to this lead. Without a correcting system, this differential lever displacement could be maintained only by the continued lead of the director transmitter over the oil gear transmitter.

(2) The error corrector mechanism supplies a mechanical follow-up power for holding the synchro differential lever in any position it has been put in by the lead of the director synchro transmitter over the oil gear synchro transmitter. It will hold the differential lever in this position without the director transmitter continuing to lead the oil gear transmitter. This quickly eliminates the error between the director transmitter and the oil gear transmitter during the time the director is moving at a constant speed. Any change in director speed will again create an error between the director transmitter and the oil gear transmitter, electrically repositioning the differential lever; and again the error corrector will function to maintain the new position of the differential lever without the continuance of error between the director transmitter and the oil gear transmitter.

(3) The error corrector mechanism consists essentially of a dash-pot assembly, dash, error corrector leaf spring, bracket assembly B179441, and a pivot (the position of which is adjustable) for the bracket assembly. The dashpot assembly consists of a piston, connecting rod, cylinder, and orifice assembly.

(4) The bracket assembly is hinge-pinned to the lower end of the power piston shaft; it is also attached to the adjustable pivot and to one end of the error corrector leaf spring. The dashpot connecting rod is hinge-pinned to the other end of the error corrector leaf spring. It is also hinge-pinned to one end of the synchro differential lever leaf spring. The synchro differential lever leaf spring supplies the restraint the synchro differential electrical torque must overcome in moving the synchro differential lever. The other end of the dashpot connecting rod is attached to the dashpot piston by means of a ball socket.

(5) As the director telescopes are moved, the director synchro fine transmitter begins to lead the oil gear synchro fine transmitter (there is one set of synchro fine transmitters for azimuth and a similar set for elevation). This lead of the director transmitter powers the synchro differential to overcome the restraint of the differential lever leaf spring, thereby displacing the differential lever and pilot piston. This displacement moves the power piston and the stroke ring to the position which results in the oil motor moving the gun and the oil gear synchro transmitter in the same direction, and at the same rate of speed, as the telescopes and director transmitter, respectively, are moving. In order for the differential to main this lever and pilot piston displacement, without an error corrector, the director transmitter would have to continually lead the oil gear transmitter, constituting an error which would vary in size with varying speeds of gun motion.

(6) As the power piston moves to its called-for position, it

changes both the position and the angle of the bracket assembly. This change, through the error corrector leaf spring, displaces the dashpot connecting rod and piston and one end of the differential lever leaf spring. This displacement positions the differential lever leaf spring mechanically, rather than electrically, thus maintaining the displacement of the differential lever and pilot piston with a minimum of error between the oil gear transmitter and the director transmitter. At any steady rate of gun travel of not more than 30 degrees per second in azimuth, and 23 degrees per second in elevation, the error between the gun and the director data will be less than 1.5 mils.

(7) The ratio of angular change of the bracket assembly to power piston travel determines the degree of correcting that is accomplished. This is adjustable by moving the pivot point of the bracket assembly. The two nuts A314367 (fig. 14) do this positioning. Move them toward the dashpot connecting rod to decrease the degree of correction. Move them toward the power piston shaft to increase the degree of correction.

(8) The desire is to eliminate the error as soon as possible following acceleration. The error corrector leaf spring, with no damping, would very quickly move to its called-for position; but it would overrun and vibrate. The oil dashpot supplies the damping action whereby the error corrector leaf spring moves as quickly as possible without overrun and vibration.

(9) The inherent error that the error corrector is designed to eliminate is a lag of the oil gear transmitter behind director transmitter—the gun behind the director data. It is possible, however, to adjust the error corrector so it will overcorrect, putting the gun ahead of the director data. The amount of error, whether it is a lead error or a lag error, must not exceed 1 mil for gun travel speeds under 20 degrees per second, and 1½ mils for gun travel speeds of 30 degrees per second. NOTE: *These speeds are for azimuth travel. Speeds for elevation travel are 14 and 23 degrees per second, respectively.*

(10) For adjustment of the two nuts A314367, see paragraph 46.

e. Dither Mechanism (figs. 14 and 15).

(1) The function of the dither mechanism is to:

(a) Reduce the force required to move the pilot piston by approximately 10 times.

(b) Allow the use of manufacturing tolerances on the pilot piston and dither sleeve.

(c) Replenish any oil leakage from the power cylinder of the stroke control.

(d) Reduce effect of friction in oil motor, enabling the oil motor to rotate smoothly at low speeds.

(2) The dither mechanism consists essentially of a dither cam, dither rod, dither sleeve, and a tension coil spring-loaded lever linkage between the dither rod and the dither sleeve.

(3) The dither cam is a hardened eccentric surface on the oil pump shaft of the hydraulic transmission. It is turned at a speed of approximately 2,000 revolutions per minute and gives a dither frequency of about 33 cycles per second.

(4) The dither rod is a small-diameter hardened steel rod, one end of which is linked to the top end of the dither sleeve by means of the coil spring-loaded lever. This spring loading thrusts the other end of the dither rod against the dither cam.

(5) Rotation of dither cam gives a reciprocating motion to the dither rod which transfers the reciprocating motion of the dither sleeve. The dither rod travel is approximately 0.080 inch; and sleeve travel is approximately 0.023 inch. The length of the stroke is determined by the eccentricity of the dither cam, and cannot be adjusted. The length of the dither stroke remains constant, regardless of the positioning of the dither sleeve by the power piston.

(6) In dithering, the dither sleeve will travel the same distance each way from the position of being neutral in relation to the position of the pilot piston. (The dither sleeve is in a neutral position in relation to the position of the pilot piston when a center line through the lower land of the pilot piston and a center line through the upper land of the pilot piston coincide, respectively, with the center line through the bottom row of dither sleeve holes and the center line through the rop row of dither sleeve holes.)

(7) The dither stroke establishes passageways for oil to reposition the power piston, in the same manner in which the pilot piston establishes these passageways. The oil passageways established by the dither stroke alternate at the frequency of the dither stroke, causing the power piston to vibrate at the frequency of the dither stroke. This produces a pulsation of oil pumped by the oil pump, and when the power piston is in its neutral position, the oil motor will vibrate at dither frequency.

12. FINE DATA SYSTEM (figs. 15 and 16).

a. There is a fine data system for azimuth and fine data system for elevation. They are essentially the same.

b. Each fine data system consists of two synchro transmitters and a synchro differential.

c. One transmitter is in the director and is called the director transmitter. The other transmitter is in the oil gear (fig. 41) and is called the oil gear transmitter. The differential is also in the oil gear (fig. 67).

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d. Each transmitter has a two-pole (single-winding) rotor and a three-winding stator. The director transmitter rotor is geared to a driving mechanism in the director. The oil gear transmitter rotor is geared to the gun and to the oil motor of the hydraulic transmission. The rotor of each transmitter turns one revolution for each 20 degrees of gun travel.

e. The differential has a three-winding stator and a three-winding rotor. Stop assembly B179420 and the differential lever assembly are anchored to the differential rotor shaft. The differential lever assembly is connected to the pilot piston of the pump stroke control, and to a leaf spring, the other end of which is hinge-pinned to the dashpot connecting rod. The differential rotor can turn within the limits established by the stop springs and the stop post. This possible travel is approximately 16 degrees.

f. The rotor of the director transmitter is rotated as the director follows a target. The rotor of the oil gear transmitter is rotated as the gun is moved. Speed of rotation and direction of rotation in each case depends upon speed of travel and direction of travel of the director and the gun.

g. The rotor of each transmitter (one in the director and one in the oil gear) receives a single-phase voltage from the generator unit. Since this is alternating current, voltages will be induced in the windings of each transmitter stator. The voltage distribution in the stator windings will be determined by the angular position of the rotor. The windings of the director transmitter stator are wired to corresponding windings of the differential rotor. By means of this hook-up the voltages induced in the director transmitter stator windings are transferred to the corresponding differential rotor windings. The windings of the oil gear transmission stator are wired to corresponding windings in the differential stator, and the voltages induced in the oil gear transmitter stator windings are transferred to the corresponding differential stator windings.

h. When both transmitter rotors have the same angular position, there is a voltage balance between the differential rotor windings and the differential stator windings. This, together with the differential lever leaf spring, holds the differential rotor in its neutral position, and the gun remains stationary. When the director starts tracking a target, the director transmitter rotor rotates, causing the director transmitter rotor to lead the oil gear transmitter rotor. This destroys the voltage balance between the differential rotor and the differential stator, and moves the differential rotor from its neutral position toward the position which would restore the voltage balance. The differential rotor, through the differential lever, moves the pilot piston of the pump stroke control, causing the oil motor to turn the gun and the oil gear transmitter.

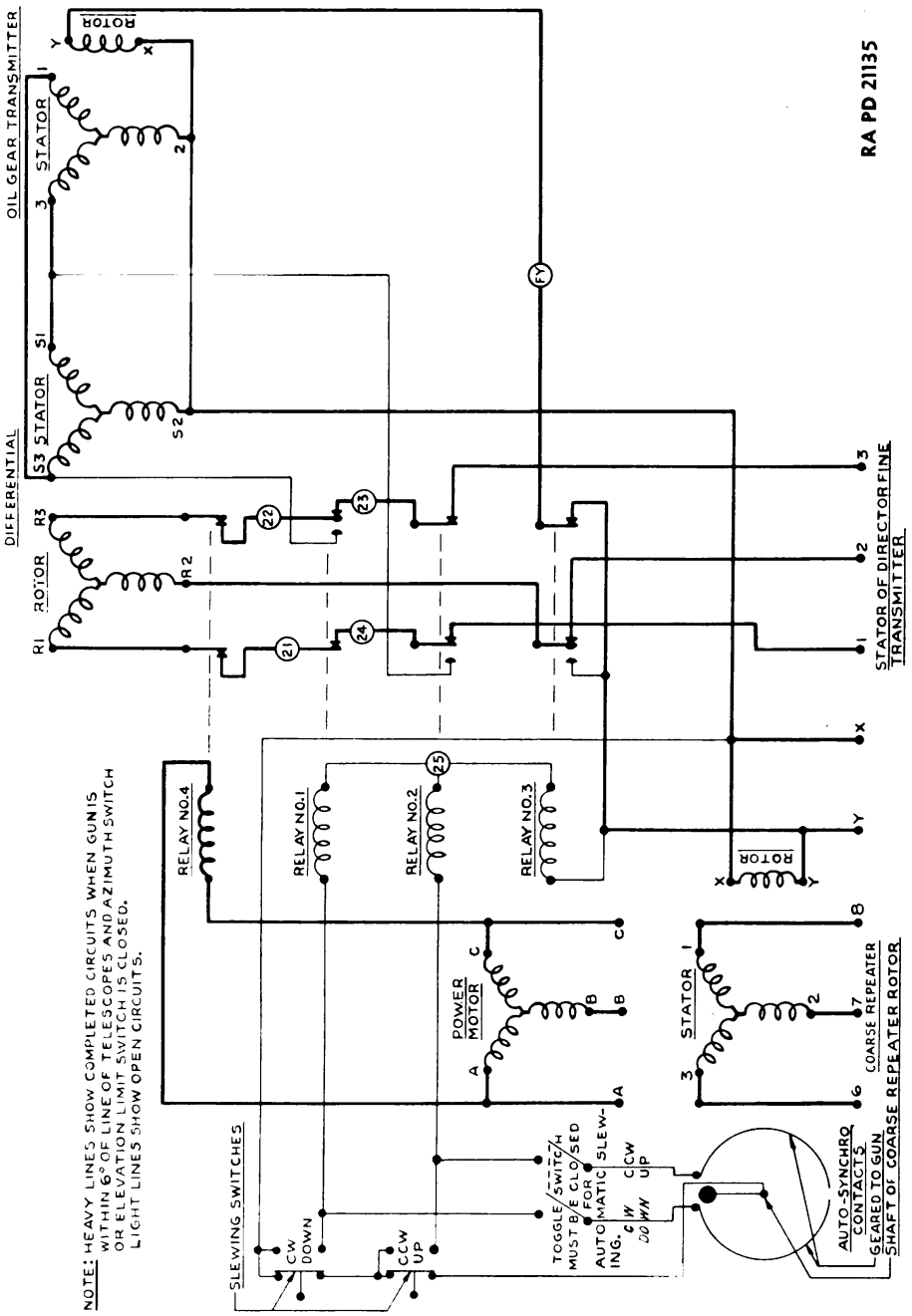

Figure 16—Oil Gear M3—Wiring Schematic

i. The *amount* of lead the director transmitter rotor has over the oil gear transmitter rotor determines the tendency for the differential rotor to move. The *direction* of lead determines the *direction* the differential rotor moves. This differential rotor movement, since the differential lever is connected to the pilot piston, directly controls the speed and direction of gun travel.

j. The differential rotor may also be turned by the application of mechanical torque to its shaft, despite the angular position of the director transmitter rotor and of the oil gear transmitter rotor. The error corrector supplies this mechanical torque which maintains the displacement of the differential rotor without the director transmitter rotor continuing to lead the oil gear transmitter rotor, when the director transmitter rotor is rotated at a constant speed. NOTE: *Lead is required only for gun acceleration. The error corrector maintains position of the differential rotor for steady velocity. Data transmission maintains the differential rotor position only during changes of velocity.*

k. Any change in the director speed will create an error between the director transmitter and the oil gear transmitter, electrically repositioning the differential lever. Consequently, as the director stops tracking, the differential lever will be electrically returned to its neutral position and the gun will stop.

l. If the cable between the gun junction box and the director is disconnected, the differential will not be energized to hold its rotor in a neutral position. If the oil gear electric motor is energized under this condition, the pump stroke control may drift off its neutral position and gradually bring the oil motor up to full speed. The elevation unit will run into the limit and come smoothly to rest. The azimuth unit will continue to rotate the gun.

m. A relay, located on the terminal board assembly (figs. 85 and 89), is used to protect the fine data system from overheating in case the director is operated with no electric current supplied to the oil gear induction motor. This condition would occur if the director were operated while the elevation limit switch or azimuth switch was disengaged. Under this condition, the relay is open. When the relay is closed, as it is in normal operation, it completes the connections between the director transmitter stator and the differential rotor. It receives its actuating current through the elevation limit switch or azimuth switch since the electromagnetic coil of the relay is wired in parallel to the induction motor of the oil gear unit concerned.

13. COARSE DATA SYSTEM (figs. 15, 17, and 18).

a. A coarse data system is used to select the proper synchronous position out of the 18 possible positions provided by the fine data system. (The fine transmitters are geared to turn one revolution per

20 degrees of gun travel, consequently the gun can be in any one of 18 positions in azimuth and still be in synchronism with the fine data system (18 x 20 degrees = 360 degrees). NOTE: *This self-synchronous feature is not used on the elevation unit with an M5 Director because the M5 Director has no coarse transmitter for elevation. It is made inoperative by snapping the toggle switch which is a part of the terminal board assembly to the off position. The cover over the terminal board compartment must be removed to operate this switch.*

b. The coarse data system consists of a synchro transmitter, a synchro repeater, contact assembly, contact ring, and three relays.

c. The synchro transmitter is located in the director, and is called director coarse transmitter. The synchro repeater, contact assembly, and contact ring are located in the oil gear receiver assembly (fig. 41). The three relays are also located in the oil gear, and are a part of the terminal board assembly (figs. 85 and 89).

d. The director coarse transmitter and the synchro repeater are similar in construction, each having a two-pole rotor and a three-winding stator. Both rotors receive single-phase alternating current from the generator unit. The two stators connect with each other. With this hook-up the synchro repeater rotor turns in synchronism with the director coarse transmitter rotor. The director coarse transmitter rotor is geared to a driving mechanism in the director, and turns 1 degree for 1 degree of desired gun travel. Consequently, the synchro repeater rotor provides an indication at the oil gear of the gun position desired by the director.

e. The contact assembly is anchored to the rotor shaft of the synchro repeater (figs. 51 and 52) and, consequently, its contacts are positioned by desired gun position. The contact ring is geared to the gun and to the oil motor of the hydraulic transmission. It turns 1 degree for 1 degree of gun travel and, consequently, provides an indication of actual gun position. Its contacts are positioned by actual gun position. The contacts of the contact assembly are spring-loaded to ride against the contact ring.

f. If the difference between the desired gun position and the actual gun position becomes greater than 6 degrees, the spring contacts touch the contact ring contacts. This completes a circuit for energizing two of the three relays. The direction of difference between desired gun position and actual gun position determines which two relays are energized. Relays number 3 and number 2 are energized (in series) for counterclockwise gun travel in azimuth, or up travel in elevation. Relays number 3 and number 1 are energized (in series) for clockwise travel in azimuth or down travel in elevation.

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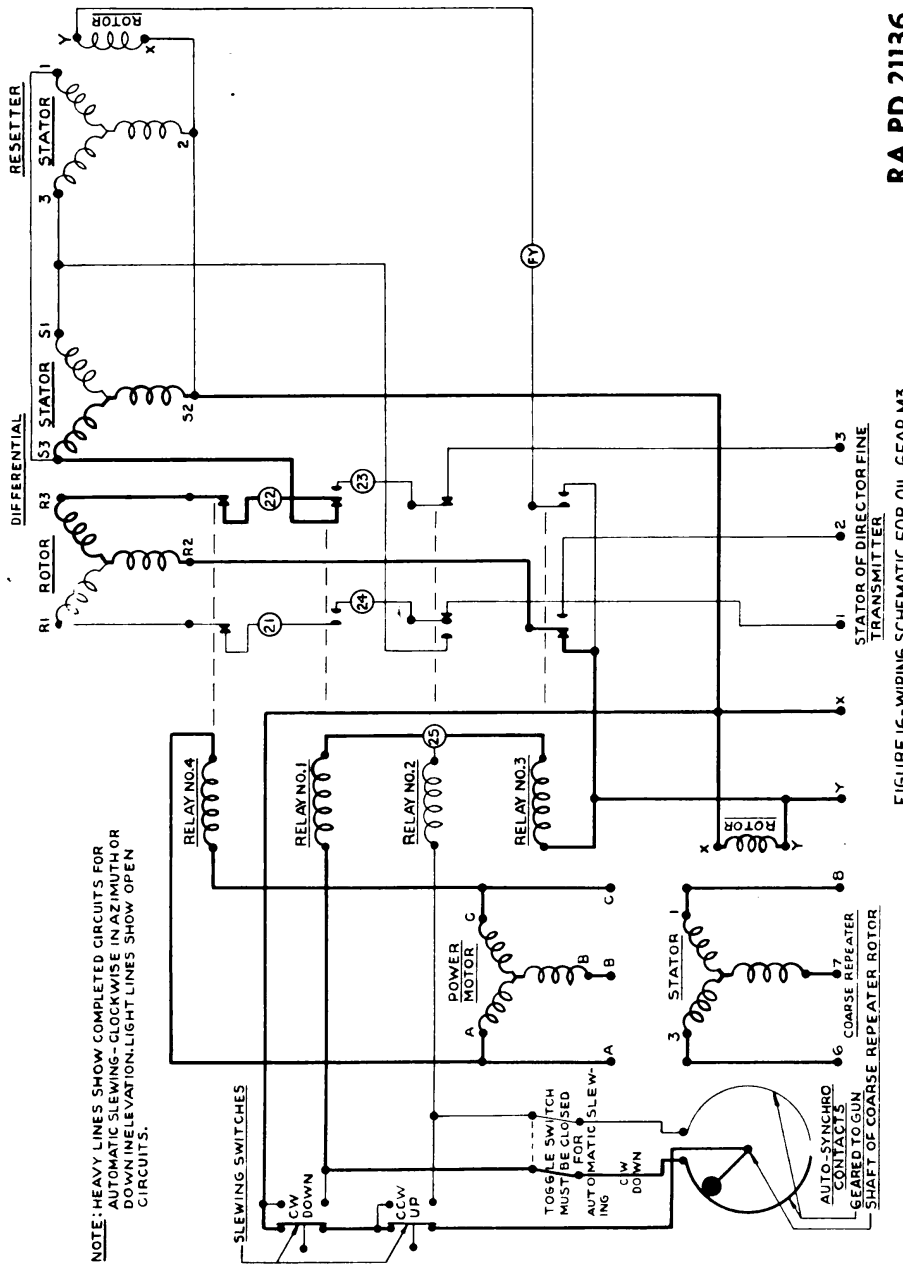

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FIGURE 16-WIRING SCHEMATIC FOR OIL GEAR M3

Figure 17—Oil Gear M3—Wiring Schematic

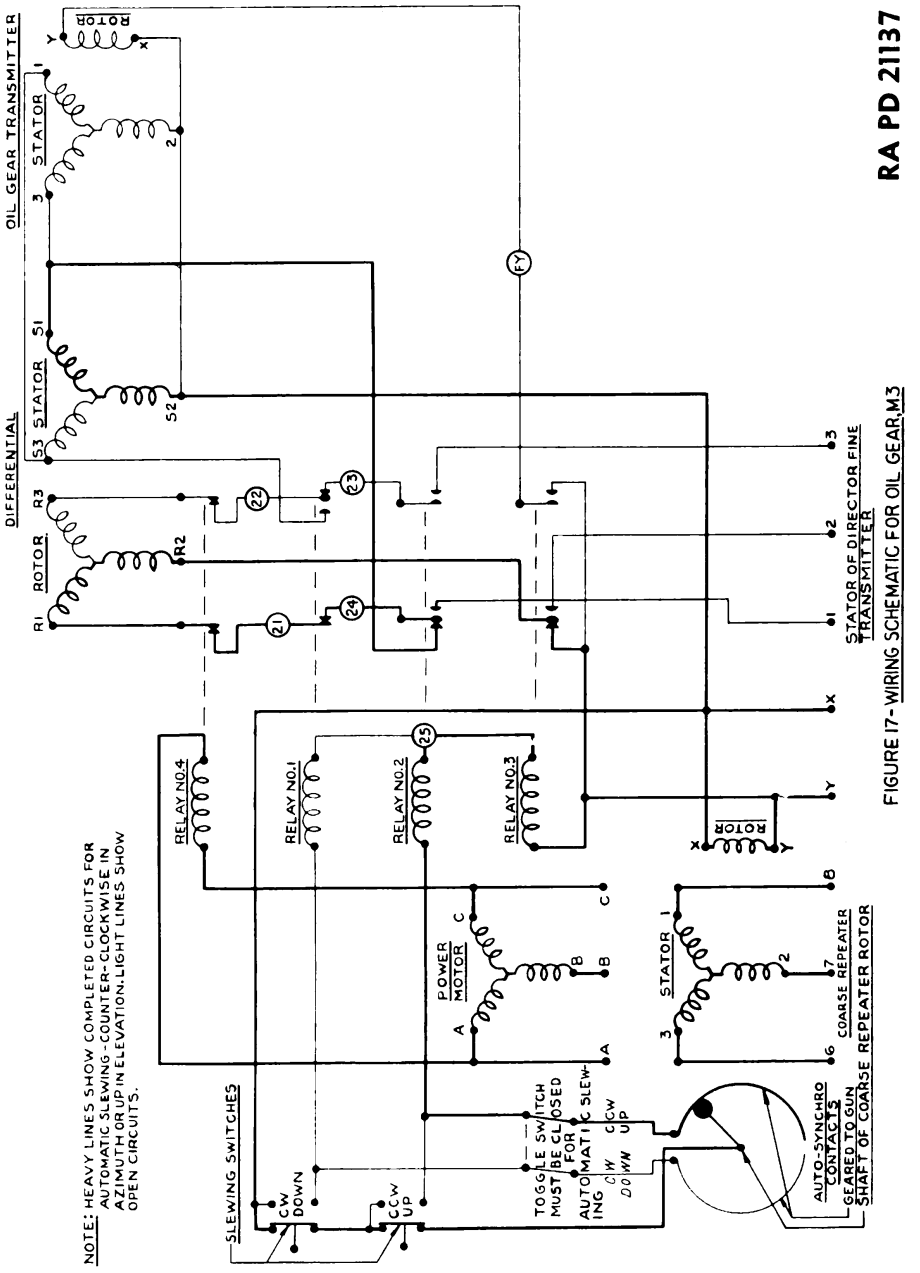

FIGURE 17-WIRING SCHEMATIC FOR OIL GEAR M3

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Figure 18—Oil Gear M3—Wiring Schematic

g. The function of the relays is to disconnect the fine data transmitters from the differential and to connect single-phase voltage to selected windings of the differential stator and rotor. The disconnecting breaks the three lines between the director fine transmitter stator and the differential rotor, and breaks one line of the circuit to the oil gear transmitter rotor. The connecting of single-phase voltage to the differential puts windings of the differential stator in series with windings of the differential rotor. The connected windings of the stator are 120 degrees from the connected windings of the rotor, when the differential rotor is in its neutral position. This provides the differential with power to quickly displace the pilot piston of the pump stroke control to the position giving maximum oil motor velocity in the direction to make the gun regain synchronism with the director.

h. The relays are of a type that can withstand the vibration encountered in this application without false operation. The connections to the various contacts are such that a false closure of any contact will not damage equipment.

i. When the gun has regained to within 6 degrees of synchronism the relays are de-energized, and the fine data system regains control.

j. The oil gear may be controlled by the coarse data system during much of the slewing period to change targets. At such times it is inaccurate.

k. Push Button Slewing. Power slewing by push button is provided as an aid in servicing, and for hand-operated slewing when the mount is run without self-synchronous operation. If the gun is out of synchronism with the director by one or more of the 20-degree steps, a push button can be pushed to move the gun in the desired direction. The push button must be released as the proper synchronous position is reached so the gun can synchronize on the fine data system. There are two push buttons (fig. 1), and they are located under spring-loaded flapper-type covers on the output coupling end of the oil gear. The upper left push button gives up elevation or counterclockwise azimuth. The lower right push button gives down elevation or clockwise azimuth. The push button switches energize the same relays that the coarse data system energizes.

14. HYDRAULIC LIMIT SYSTEM (fig. 15).

a. The travel of the gun in elevation is mechanically limited to minus 5 degrees and plus 90 degrees. In addition to the mechanical limits, a hydraulic limit system, supplied as part of the oil gear, is made operative when the unit is used for elevation drive. It serves automatically to stop the hydraulic transmission before the mechanical limits are attained. It does this by returning the pump stroke ring of the hydraulic transmission to its neutral position.

b. The hydraulic limit system consists essentially of a cam assembly, lever mechanism, a push-pull wire, and a limit spool.

c. The cam assembly is geared to the gun and to the oil motor of the hydraulic transmission. It turns 2½ degrees for each degree of gun travel.

d. The lever mechanism is spring-loaded to return to its neutral position.

e. The limit spool has a flange at each end. These flanges straddle the synchro differential lever, but are spaced far enough apart to permit maximum displacement of the differential lever.

f. The push-pull wire connects the spool to the lever mechanism. When the lever mechanism is in its neutral position, the spool flanges do not touch the differential lever. A screw adjustment (figs. 3 and 98), which is a part of the lever mechanism, provides a means for so positioning the spool.

g. Approximately 5 degrees before either limit of gun travel has been reached, the cam contacts a roller on the lever mechanism. As the cam continues to rotate, the lever mechanism displaces the push-pull wire and consequently the spool. One flange of the spool eventually contacts the differential lever, and returns it to its neutral position. This action returns the pilot piston, power piston, and stroke ring of the hydraulic transmission to the neutral position, thereby stopping the gun.

h. If the gun is approaching a limit at maximum velocity, synchronism begins to be lost 5 degrees before the limit. For less than maximum velocity, the fraction of this 5-degree zone in which synchronism is lost, is proportional to the fraction of full velocity at which the gun is moving. If the gun is approaching a limit at a creeping rate, synchronism will not be lost until the limit is reached.

i. The gun will move away from the limit smoothly, without any switching operation, when the direction of the director synchro fine transmitter is reversed.

j. This system of limit stops will operate regardless of failure of the electrical data system.

k. The upper hydraulic stop limit is set at plus 85 degrees. The lower hydraulic stop limit may be set for plus 20, plus 15, plus 10, plus 5, 0, or minus 3 degrees. The procedure for the setting of the cam is described in paragraph 42.

15. SLEWING CLUTCH.

a. The slewing clutch is of the gear type, and is assembled on the shaft extension from the oil motor end of the hydraulic trans-

mission (fig. 99). Its function is to disengage the hydraulic transmission oil motor from the gun and data system. It does not disengage the gun from the data systems. It is equipped with a lever and locking device for locking it in either the engaged or disengaged position (fig. 1).

b. The locking device feature is no longer used. It is made inoperative by assembly with the locking device lug turned outward. The gun slewing handle fastens to the slewing clutch lever on the azimuth oil gear and provides a locking device. The elevation switch lever is linked to the slewing clutch lever on the elevation oil gear and provides a locking device.

c. When the system is operated as a self-synchronous system, power slewing will occur automatically at 30 degrees per second in azimuth, which is as fast as the gun can be manually slewed. The gun slewing handle is used primarily to connect or disconnect the power to the azimuth oil gear, as this handle operates the power switch (azimuth switch) as well as the clutch lever.

d. The slewing clutch is ordinarily engaged except when the gun is being serviced or manually operated. Manual operation of the gun is much easier with the slewing clutch disengaged, as the hydraulic transmission does not then have to be turned.

16. BORESIGHTING CLUTCH.

a. The boresighting clutch is of the gear type, and is assembled on the oil gear output shaft (fig. 99). Its function is to disengage the gun from the data systems and from the oil motor of the hydraulic transmission. It does not disengage the oil motor from the data systems. Its use simplifies the boresighting operation.

b. It is equipped with a lever which is located on the right-hand side of the oil gear, when viewed from the output coupling end (fig. 2). The lever is approximately horizontal and can be latched securely in the detent provided for either the engaged or disengaged position.

c. When the boresighting clutch is disengaged, the oil gear units of the data systems will synchronize with the director units of the data systems. With the director sighted on a target and the boresighting clutch disengaged, the gun may be manually pointed to boresight on the same target. The boresighting clutch may then be re-engaged, locking the gun relative to the oil gear in the boresighted position. This puts the gun in synchronism with the data systems (par. 39 for detailed instructions).

d. Re-engagement of the boresighting clutch causes gun displacement of not more than one-third mil in azimuth and not more than than one-fourth mil in elevation.

17. OUTPUT COUPLING (fig. 99).

a. The output coupling is the connecting link between the oil gear and the mechanism that turns the gun. It is of semiuniversal design, and allows for some misalinement between the oil gear and the drive shaft.

Section III

DESCRIPTION OF WIRING SET M12 AND CABLE SYSTEM M8

18. GENERAL.

a. The Wiring Set M12 consists of a gun junction box assembly, a contact ring assembly, a distribution box assembly, an elevation limit switch, an azimuth switch, an elevation switch, and the necessary cable and plug assemblies.

b. The Cable System M8 consists of a 3-conductor cable with plugs and a 15-conductor cable with plugs. The Generating Unit M5 is connected to the gun junction box by the 3-conductor cable, 225 feet long, thus permitting the generating unit to be placed at a distance from the gun carriage. The director is connected to the gun junction box by a 30- or 60-foot, 15-conductor cable.

19. GUN JUNCTION BOX ASSEMBLY.

a. The gun junction box (figs. 19 and 20) is a rectangular bronze casting containing a 15-pole receptacle assembly and a 3-pole receptacle assembly. The box is fastened to the front right-hand side of the gun mount chassis frame, to receive the plug on the 15-conductor cable from the director, and the plug on the 3-conductor power cable from the generating unit.

b. The 3-pole receptacle assembly is bolted to the side of the casting about midway. The terminals in the 3-pole receptacle are connected to terminals 1, 8, and 15 of the 15-pole receptacle within the body, by three short lengths of number 12 wire. The connections are: A to 1, B to 8, and C to 15.

c. The 15-pole receptacle assembly is fastened inside the body, to receive the D-shaped plug of the 15-conductor cable from the director, and to connect the conductors of the cable running to the contact ring. The junction box cover assembly carries on its bottom a connection table showing the correct wiring of the box for Remote

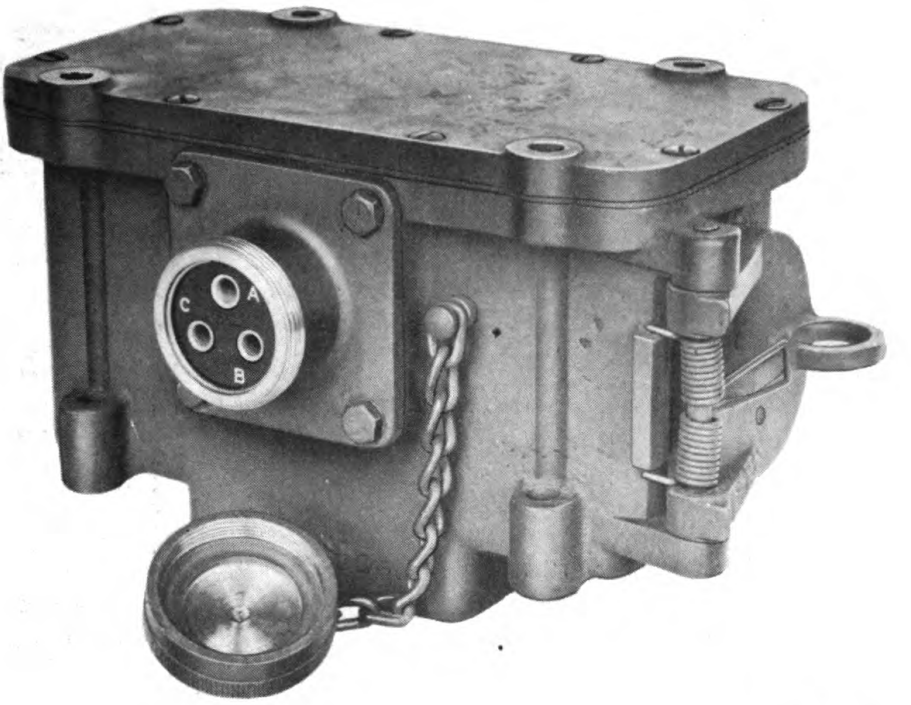

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Figure 19—Gun Junction Box

Control System M5 (fig. 108). For Remote Control System M15, the box should be wired according to wiring diagram in figure 36.

d. The cable to the contact ring is inserted through the gland assembly in the bottom rear of the body. This assembly consists of glands, wedges, gasket, and follower. The wooden plug is inserted to seal the opening during shipment and storage.

e. The 15-pole receptacle cover assembly is forced closed by a spring when the D-shaped plug is withdrawn, to prevent the entry of foreign matter.

20. CONTACT RING ASSEMBLY.

a. The contact ring assembly maintains uninterrupted circuits during rotation of the gun in azimuth. Its major units are the plug assembly (fig. 22) and the receptacle assembly.

b. Plug Assembly. The plug assembly, the stationary part of the contact, is secured to the adapter B173231. A lug protruding from the adapter fits in a slot in the undercarriage, thus locking the plug to the fixed part of the carriage. The circuit through the plug is as follows:

(1) Each conductor terminal in the cable from the gun junction box is attached by a screw to a block at the lower end of the plug

21. DISTRIBUTION BOX ASSEMBLY.

a. The distribution box (figs. 23 and 24) is a rectangular aluminum casting which receives the two cables from the contact ring and distributes the data and power to the various units through seven cables. It is mounted on a bracket in the front of the gun carriage, between the two oil gears.

b. Three terminal block assemblies are mounted on pads on the bottom of the box to connect the various conductors. The middle terminal block assembly C78562 is typical of the construction of the three.

(1) It is made up of eight contact blocks, each insulated from the other and from the metal part of the rod that holds them together. The rod is supported by brackets, one fastened to each end of the rod by a bolt.

(2) The blocks are provided with contact strips and contact screws. The tinned end of a conductor is inserted under the strip and the screw tightened to secure the contact. The end of the strip is turned up so that the strip will not slide in the block.

(3) Identification strips over the top of each terminal block assembly facilitates the wiring of the box. These strips are inserted in holders which bridge the terminal blocks, each holder being fastened to the brackets at each end.

c. The box is provided with nine cable gland assemblies (fig. 24). These assemblies consist of a gasket, wedges, glands, and follower. They fit tightly around the cable when the follower is tightened, excluding moisture or foreign matter. The wooden plugs are removed when the box is assembled, being inserted to seal the openings during storage and shipment.

d. The detachable cover assembly contains a wiring panel showing the correct wiring of the box for Remote Control System M5. For Remote Control System M15 the box should be wired according to wiring diagram in figures 36 and 37. When replacing the cover, be sure to bring the bolts up tight and exercise care not to damage the gasket in the cover.

e. The cables are connected to the terminal blocks in accordance with the wiring diagram and color codings of the cables (fig. 36).

DESCRIPTION OF WIRING SET M12 AND CABLE SYSTEM M8

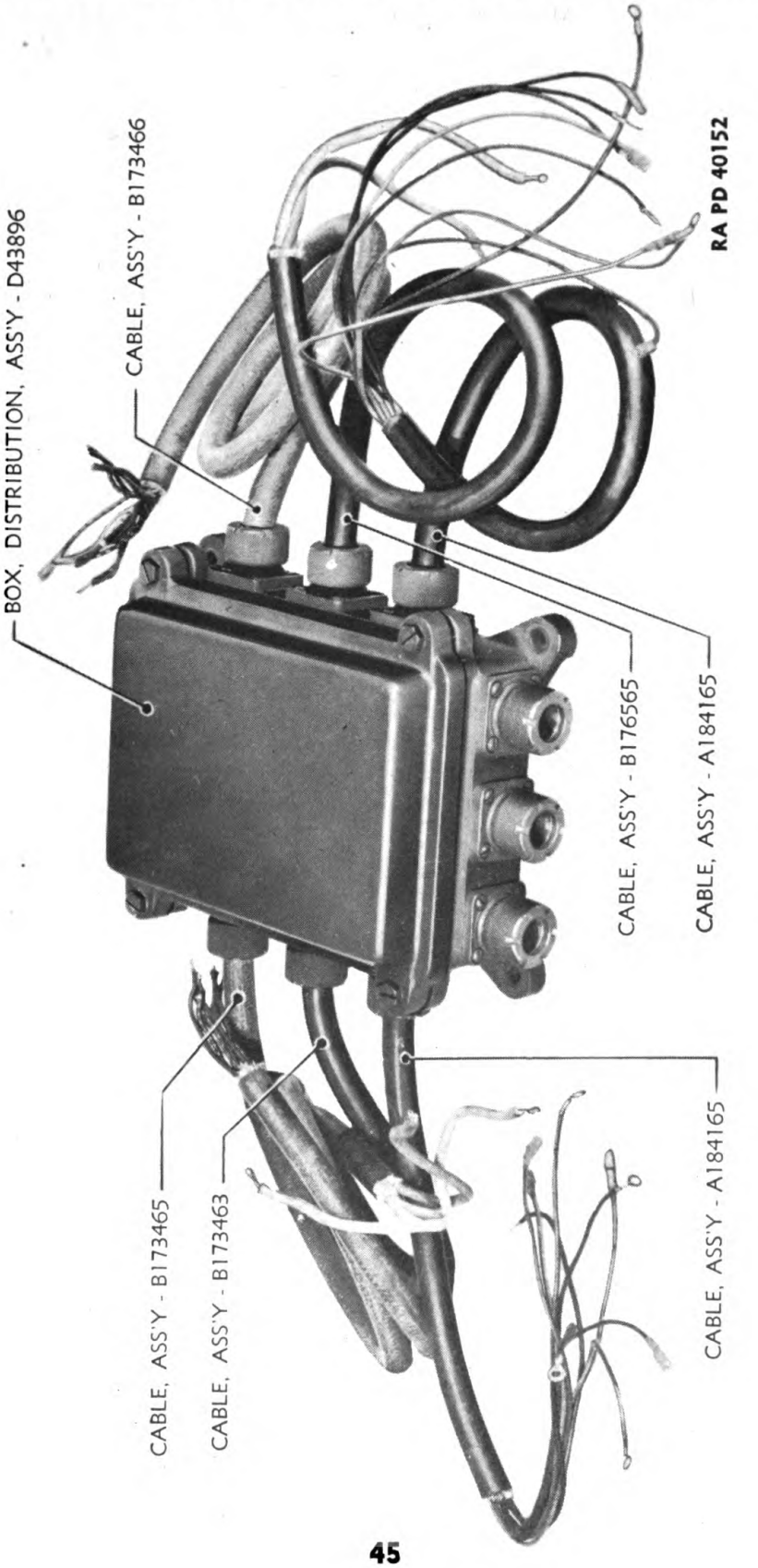


Figure 23—Distribution Box Assembly With Cables

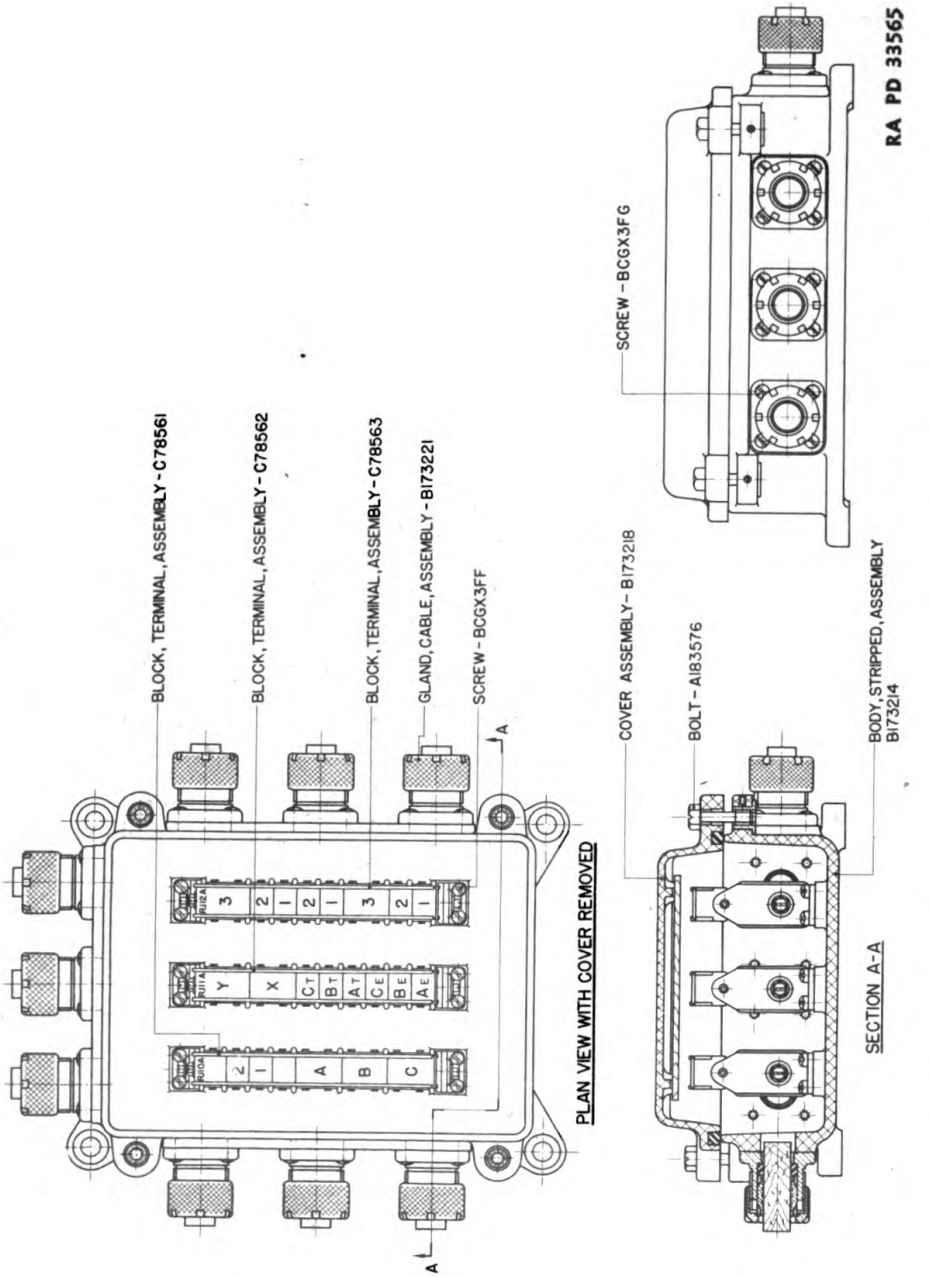


Figure 24—Distribution Box Assembly—Assembled and Sectional Views

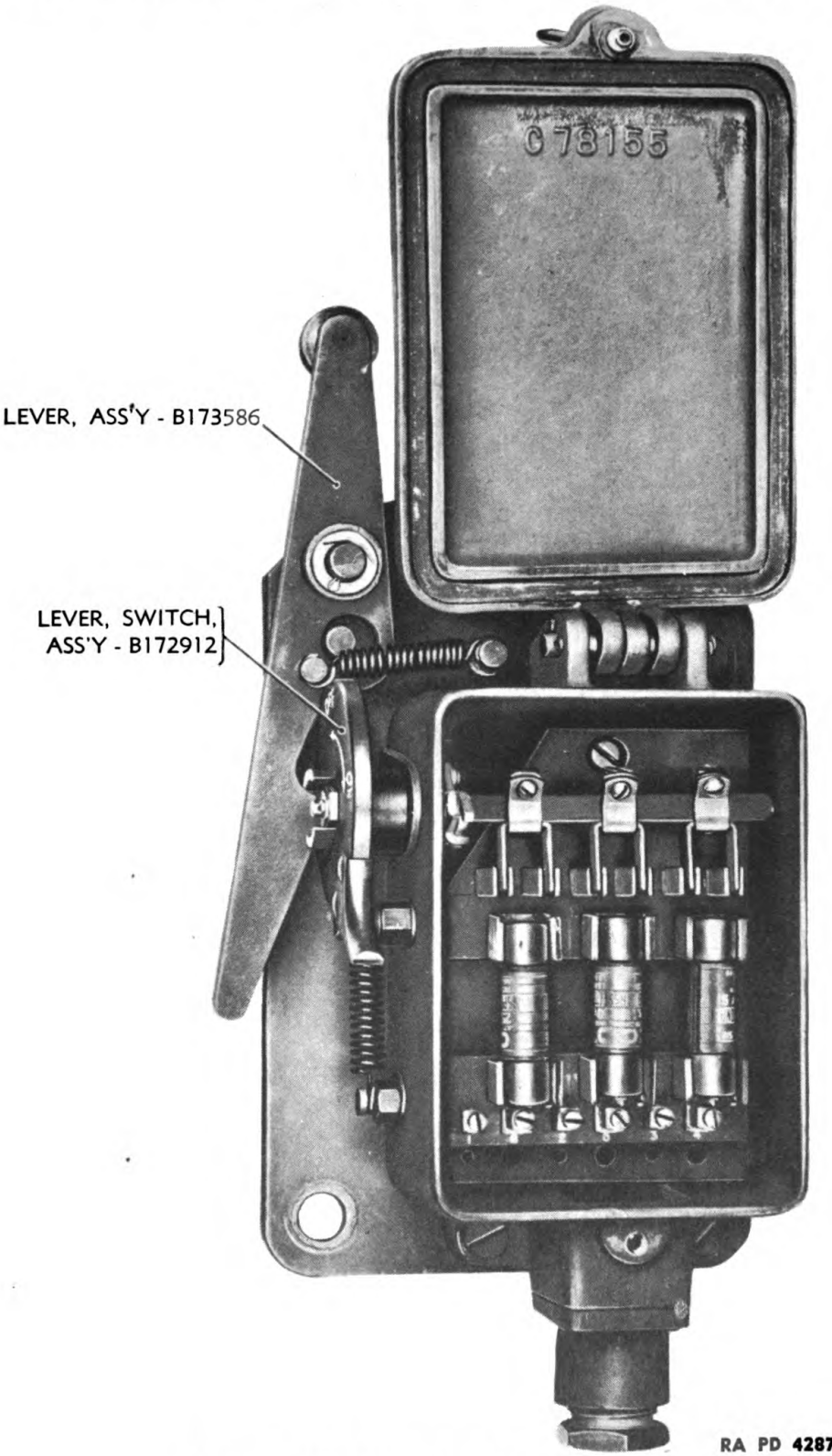


Figure 25—Elevation Limit Switch

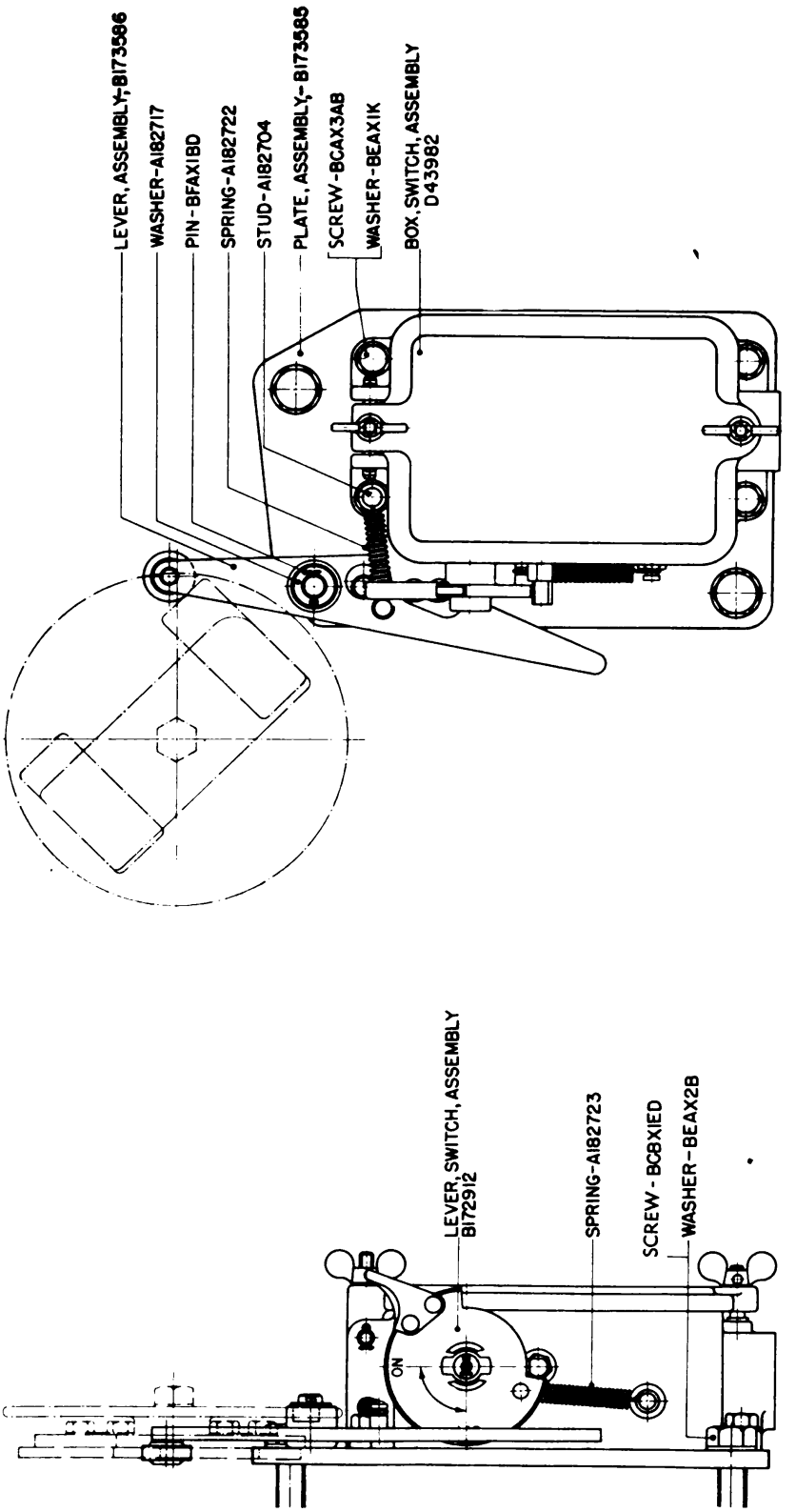


Figure 26—Limit Switch (Elevation) Assembly—Assembled Views

22. ELEVATION LIMIT SWITCH ASSEMBLY.

a. The elevation limit switch assembly (figs. 25 and 26) is attached to the right side of the top carriage, in front of and a little below the gun trunnion. It is actuated by a circular disk attached to the gun trunnion and is automatically thrown to "OFF" at elevations of plus 87 degrees and minus 4 degrees. The switch is connected into the power circuit of the elevation oil gear motor and automatically shuts off the power when the gun approaches the limits of its travel.

b. The limit switch assembly consists principally of the switch box assembly, the trip lever assembly, and the switch lever assembly.

c. The switch box assembly consists of the switch box, the terminal board, the contacts, and the fuse clips. The fuses are not a part of the assembly.

d. When the switch lever is pressed down to the on position, it is caught and held by the trip lever. As the gun is elevated, the disk rotates with the trunnion until at an elevation of 85 degrees, one of the projecting lugs attached to the disk contacts the roller on the trip lever, forcing the lever to rotate and release the switch lever.

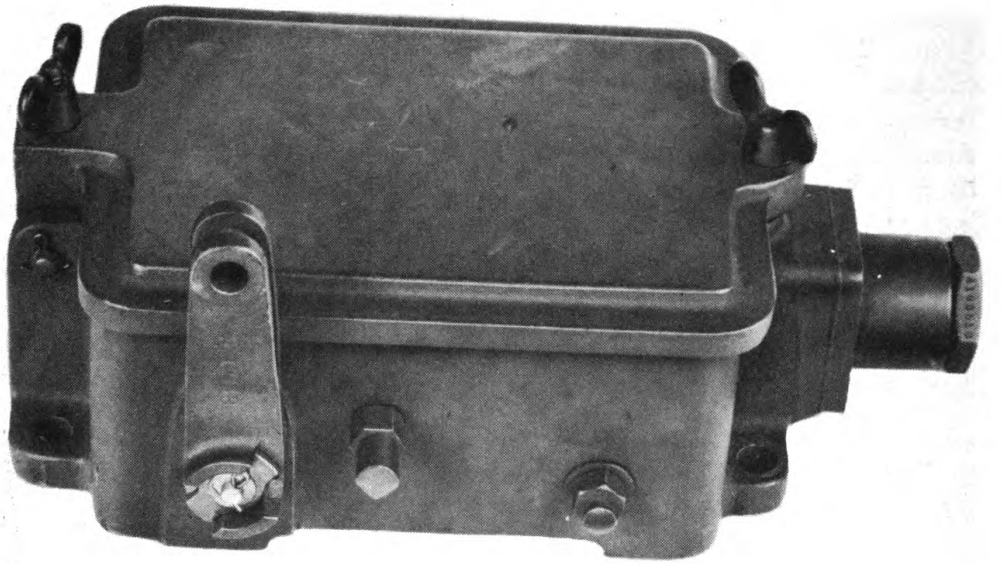
(1) To reset the switch, depress the gun manually to within 85 degrees and press the switch lever down to the on position. The gun will then follow the direction in elevation until it reaches minus 5 degrees, when the other lug will trip the lever and throw the switch to the off position.

(2) The switch lever spring pulls the switch lever up when the trip lever is released. The trip lever spring pulls the trip lever in, to hold the switch lever in the on position, until the trip lever is forced out by the lugs on the disk.

23. AZIMUTH SWITCH ASSEMBLY.

a. The azimuth switch (figs. 27 and 28) is a box switch consisting of the switch box assembly and a lever. The switch box assembly is identical to the corresponding assembly in the elevation limit switch, and is made up of the body, cover assembly, terminal board assembly, and a toggle switch with three forked contacts. The lever is attached to the switch shaft and is connected to the slewing clutch on the gun carriage, so that when the clutch is disengaged, the switch is thrown to the off position. The switch box is mounted on the right rear of the carriage, just in front of the azimuth indicator.

b. The terminal board assembly contains six clips that hold three 15-ampere fuses, six contact clips and six terminal posts marked



RA PD 40153

Figure 27—Switch (Azimuth) Assembly

1, 6, 2, 5, 3, and 4, in that order, from left to right. Three of the posts are connected by strips to one set of fuse clips, and the other three posts are connected to three of the contact clips by metal strips underneath the board. Six pairs of conductors of the 13-conductor cable from the distribution box are connected to these posts.

c. There is no automatic throw-off for the azimuth switch, as the gun can be traversed through 360 degrees in either direction.

24. ELEVATION SWITCH ASSEMBLY.

a. The elevation switch (figs. 29 and 30) is attached to the left side of the top carriage, in front of the coupling end of the elevation oil gear. It consists of a switch box assembly and a lever. The lever is attached to the switch shaft and is connected to the slewing clutch lever of the elevation oil gear. When the lever is in one position, the switch is in the off position and the clutch is disengaged. When the clutch is in the other position, the switch is in the on position and the clutch is engaged.

b. The switch is connected into the power circuit of the elevation oil gear.

c. The purpose of the elevation switch assembly is to facilitate change from manual to director-controlled operation of the gun carriage. The lever is within easy reach of the operator.

DESCRIPTION OF WIRING SET M12 AND CABLE SYSTEM M8

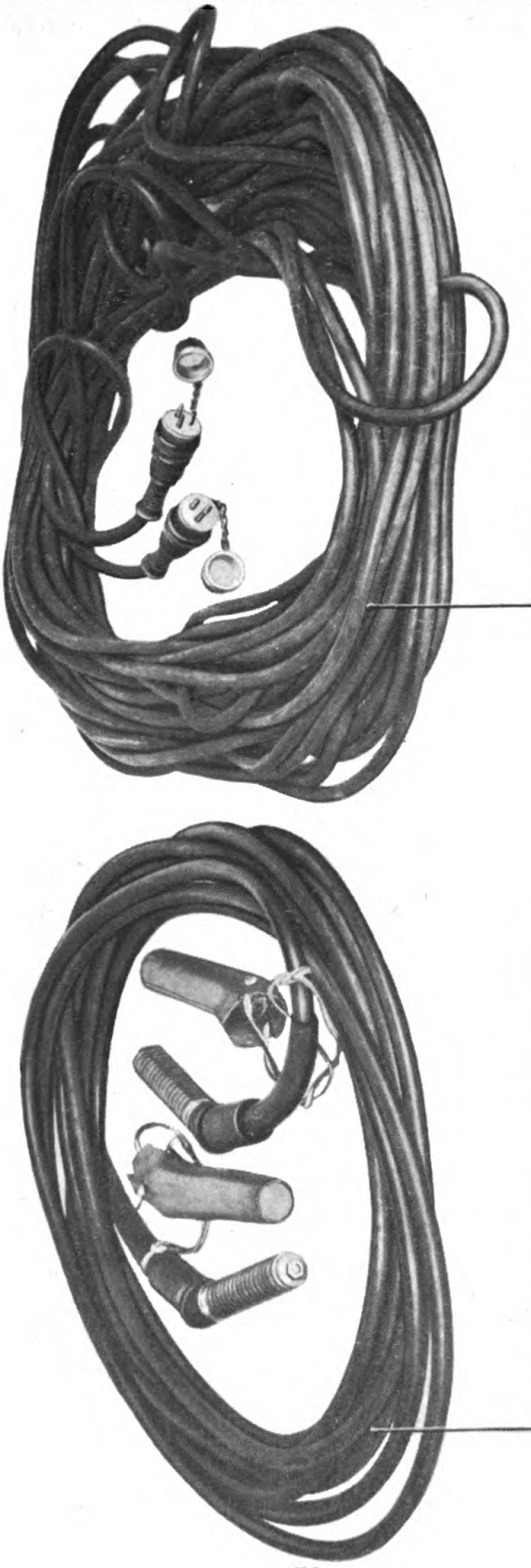


Figure 31—Cable System M8

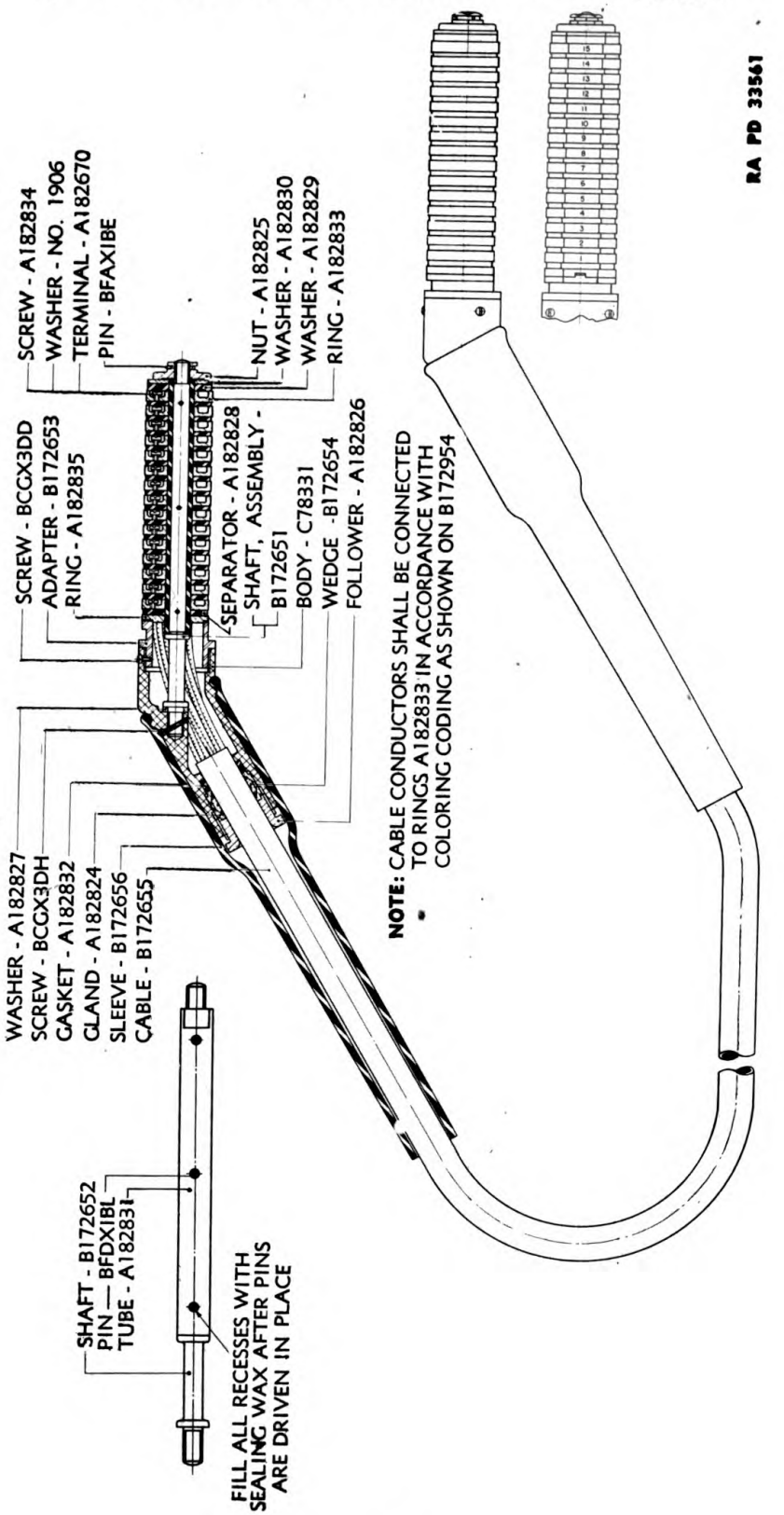


Figure 32—15-conductor Cable Assembly for Cable System M8

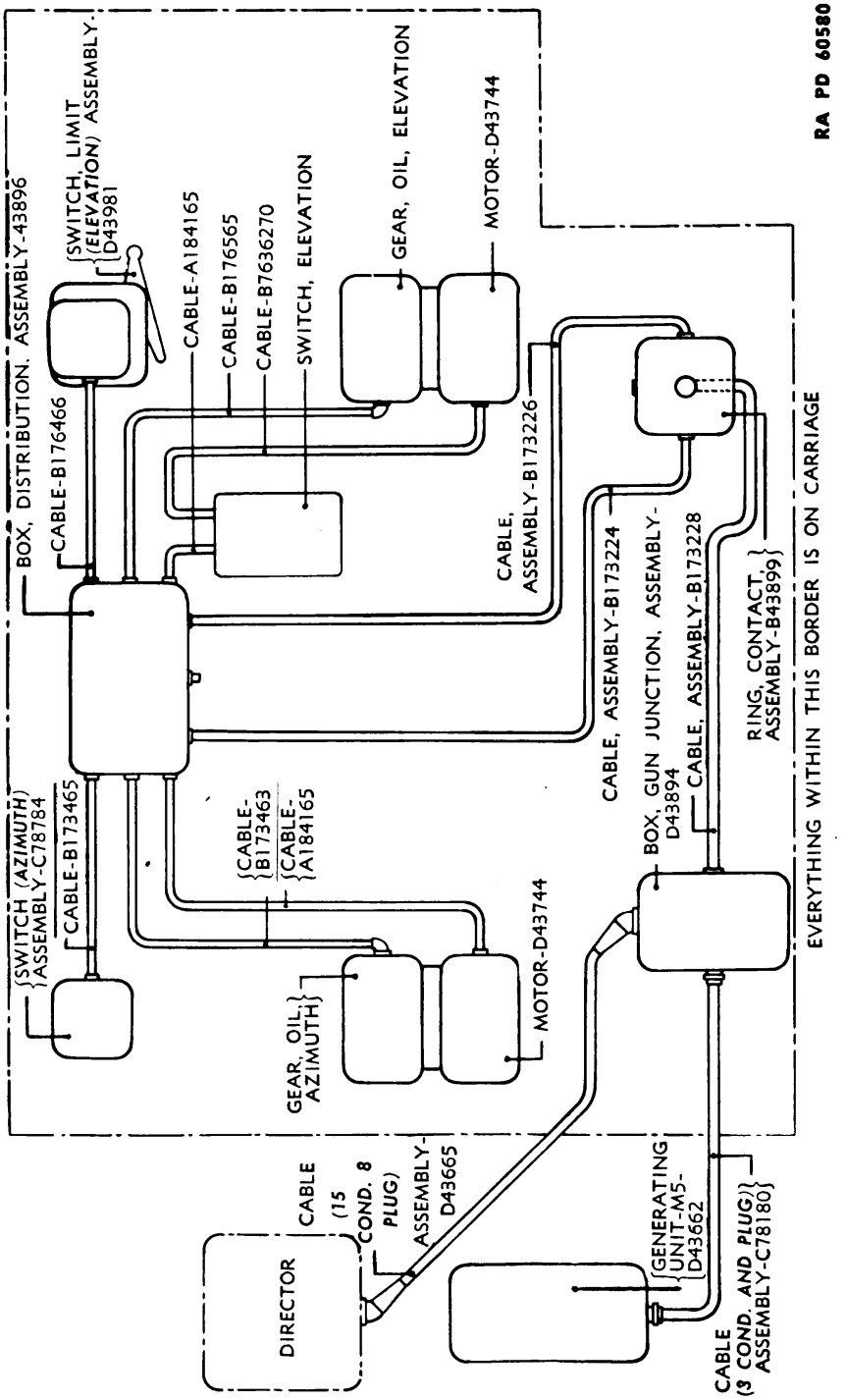


Figure 33—Remote Control System M15—Schematic Arrangement

the director to the remote control system. The assembly consists of the 15-conductor cable and two D-shaped, built-up plugs. Each plug contains 15 D-shaped rings.

(1) The contact rings are built up on the shaft assembly. The rings are insulated from each other by the separators. A nut secures the assembly of the plug parts.

(2) The cable conductors are connected to the rings in accordance with the color coding, as shown on figure 138.

(3) The adapter B172653 is provided in the assembly, so that by turning the plug after it is inserted in the receptacle, it will be locked in place by its mating part in the receptacle of either the gun junction box or the director.

26. COMPONENTS OF WIRING SET M12.

a. A 15-conductor cable assembly B173228, 56½ inches long, extends from the gun junction box to the contact ring.

b. A 3-conductor cable assembly B173224, 52½ inches long, extends from the contact ring to the distribution box, to carry power. The eyelet terminal end is fastened to the contact ring.

c. A 13-conductor cable assembly B173226, 51¾ inches long, also extends from the contact ring to the distribution box. The eyelet terminal end is fastened to the contact ring.

d. A 13-conductor cable assembly B173466, 56½ inches long, extends from the distribution box to the elevation limit switch. Twelve of the conductors are twisted in pairs. The odd conductor is a spare and is taped at both ends.

e. A 13-conductor cable assembly B173465, 61 inches long, extends from the distribution box to the azimuth switch. Twelve of the conductors are twisted in pairs. The odd conductor is a spare and is taped at both ends.

f. Two 3-conductor cable assemblies A184165, 39 inches long, are used: one extending from the distribution box to the azimuth induction motor; the other, from the distribution box to the elevation switch.

g. A 9-conductor cable assembly B176565, 34 inches long, extends from the distribution box to the elevation oil gear assembly. One taped conductor is a spare.

h. A 9-conductor cable assembly B173463, 41 inches long, extends from the distribution box to the azimuth oil gear assembly. One taped conductor is a spare.

Section IV

INSPECTION

27. GENERAL.

a. The over-all inspection on carriage is for the purpose of determining the functional condition of the remote control system when it is connected to the gun carriage, director, and generator unit. This inspection should be made if the operation of the control system is questionable.

b. The unit inspection of Oil Gear M3 is for the purpose of determining the condition of any questionable Oil Gear M3 when it is off the gun carriage. This inspection should be used for locating trouble in a unit that needs repair. It should also be used as a test of a unit that has been repaired.

c. Inspection of wiring set components is for the purpose of determining the condition of any questionable component of the wiring set when it is off the gun carriage. This inspection should be used for locating trouble in a unit that needs repair. It should also be used as a test of a unit that has been repaired.

28. OVER-ALL INSPECTION ON CARRIAGE.

a. Outline of Procedure.

(1) Check gun carriage and director for level.
(2) Check oil gear settings for azimuth and elevation.
(3) Check level of oil in main case of each oil gear.
(4) Check generator voltage.
(5) Check replenishing oil pressure of each oil gear.
(6) Check for synchronism of gun with director.
(7) Check gun response to director data.
(8) Check hydraulic limit stops.
(9) Check elevation limit switch.
(10) Check azimuth limit switch.
(11) Check rate of push button slewing.
(12) Check rate of automatic slewing.

b. Detailed Description of Procedure.

(1) CHECK GUN CARRIAGE AND DIRECTOR FOR LEVEL. For proper orientation of the remote control system, the director and the gun carriage must be level. Refer to TM 9-252 for procedure.

(2) CHECK OIL GEAR SETTINGS FOR AZIMUTH AND ELEVATION. Check the oil gear which is being used for azimuth, making sure of the following points: nameplate reads azimuth; toggle switch (fig. 4)

is in on position; the smaller gear of the sliding pair (fig. 3) is meshing with the right-hand gear on the oil motor shaft; the cams (fig. 3) are turned so that their flanges face the outside of the case; and the locking lever (fig. 1) in the down position does not lock the slewing clutch lever. Check the oil gear which is being used for elevation, making sure of the following points: nameplate reads elevation; toggle switch is in the off position if used with Director M5—in the on position if used with Director M5A1 or M5A2; the larger gear of the sliding pair is meshing with the middle gear on the oil motor shaft; the cams are turned so that their flanges are facing inward and will contact the roller of the hydraulic limit mechanism; and the locking lever in the down position does not lock the slewing clutch lever.

(3) CHECK LEVEL OF OIL IN EACH OIL GEAR. The oil should cover half of the inspection window (fig. 1) in the main case of each oil gear. Make sure it does before proceeding with inspection.

(4) CHECK GENERATOR VOLTAGE. The generator voltage should be adjusted to give 115 volts at the gun carriage. If the generator is adjusted to give 125 volts under, there will be approximately 115 volts at the gun.

(5) CHECK REPLENISHING OIL PRESSURE OF EACH OIL GEAR. Remove the ⅛-inch pipe plug (fig. 2) from filter head and install a pressure gage in the opening so provided. Supply current to the induction motor of the oil gear and the gage will show the replenishing oil pressure. This pressure should be between 150 and 165 pounds per square inch when the oil gear has a temperature between 100 degrees Fahrenheit and 120 degrees Fahrenheit. Make this test on each oil gear.

(6) CHECK FOR SYNCHRONISM OF GUN WITH DIRECTOR. Aline deflection marks and pull out rate setting clutches. Turn on the power. Sight the director on a stationary target, approximately 1,500 yards from the director. The gun should boresight on the same target to within one-third mil in azimuth and one-quarter mil in elevation (see paragraph 39 for correction).

(7) CHECK GUN RESPONSE TO DIRECTOR DATA. Slowly rotate the director through 360 degrees in azimuth. Do this in each direction of rotation. Gun must move smoothly throughout the travel called for by the director. Slowly move the director telescopes through their entire elevation travel. Do this in both directions. Gun must move smoothly throughout its entire travel between hydraulic limit stops. NOTE: *If the director dials do not move smoothly, the trouble is in the director.*

INSPECTION

(8) CHECK HYDRAULIC LIMIT STOPS. Look through opening provided by the removal of cover assembly (G, fig. 1) and note the cam setting for the lower limit. Use director to slowly lead the gun into each stop. Gun must stop at 85 ±1 degree at the upper limit without opening the limit switch. Gun must stop at the position called for by the cam setting ±0.5 degree at the lower limit without opening the limit switch (see paragraphs 39 and 41 for correction).

(9) CHECK ELEVATION LIMIT SWITCH. Set the director telescopes at 45 degrees of elevation. Disengage the slewing clutch of the elevation oil gear. Manually elevate the gun to 87 degrees. If elevation limit switch (par. 22) does not open at this position, adjust the limit switch cam on the gun trunnion so it will. Manually depress the gun to minus 4 degrees. If elevation limit switch does not open at this position, adjust the limit switch cam on the gun trunnion so that it will. Manually elevate the gun to 45 degrees. Re-engage the slewing clutch. NOTE: *The elevation limit switch should make and break contact rapidly with a sharp snap action.*

(10) CHECK AZIMUTH SWITCH. The azimuth switch (par. 23) should snap on just after the azimuth oil gear slewing clutch is engaged by throwing the slewing handle to the on position. It should snap off and the oil gear clutch disengage when the slewing handle is thrown to the off position. The azimuth switch should make or break contact rapidly with a sharp snap action.

(11) CHECK RATE OF PUSH BUTTON SLEWING. Use push button switch (fig. 1) to slew the gun (par. 13) through 360 degrees of azimuth travel clockwise. Time it with stop watch during this travel. Slewing speed must be not less than 30 degrees per second. Make the same test for counterclockwise travel. Use push buttons to slew the gun from 80 degrees of elevation to 20 degrees of elevation. Time it with stop watch during this travel. Slewing speed must be not less than 23 degrees per second. Make the same test from 20 degrees to 80 degrees. NOTE: *Make sure the gun is positioned in elevation in synchronism with the director when you finish the elevation slewing test if using a Director M5.*

(12) CHECK RATE OF AUTOMATIC SLEWING. Quickly slew the director 180 degrees in azimuth and use stop watch to check the rate of gun travel through this 180 degrees (par. 13). Gun travel in azimuth should be not less than 30 degrees per second. NOTE: *If director is slewed more than 180 degrees ahead of gun, the gun will travel in the opposite direction. If the director is an M5A1 or an M5A2, check the rate of automatic slewing in elevation. It should be not less than 23 degrees per second.*

29. UNIT INSPECTION OF OIL GEAR M3.

a. Purpose of Inspection. The purpose of this inspection is to determine the condition of any questionable Oil Gear M3 when it is off the carriage. Make the inspection before disassembling a unit for repair. Malfunctions disclosed by the inspection will usually indicate the assembly or assemblies causing trouble. Make the inspection again after repair in order to make sure the repaired unit will operate satisfactorily.

b. Outline of Procedure.

(1) Check level of oil in main case.
(2) Check replenishing oil pressure.
(3) Check power input.
(4) Check slewing speed.
(5) Check self-synchronous operation.
(6) Check fine data system.
(7) Check coarse data system.
(8) Check error with field test set.
(9) Check static repeat.
(10) Check torque.

c. Check Level of Oil in Main Case. The oil should cover half of the inspection window (fig. 1) in the main case of the oil gear. Make sure it does before proceeding with inspection.

d. Check Replenishing Oil Pressure. Connect the unit with the azimuth data system of a Director M5, M5A1, or M5A2. Remove the ⅛-inch pipe plug from filter head (fig. 2) and install a pressure gage in the opening so provided. Supply current to the induction motor of the oil gear and the gage will show the replenishing oil pressure. This pressure should be between 150 and 165 pounds per square inch when the oil gear has a temperature between 100 degrees Fahrenheit and 120 degrees Fahrenheit. NOTE: *If the gage shows no pressure, the direction of induction motor rotation is probably wrong. Motor rotation should be correct when A, B, and C leads of the M5 Generator are connected to motor leads A, B, and C, respectively (fig.* 101).

e. Check Slewing Speeds. Set limit cam (fig. 3) and the change gears (fig. 3) for *azimuth* operation (par. 41). Turn the toggle switch (fig. 4) to the off position. Check slewing speeds by operating push buttons and measuring output shaft speeds. The speed at the output coupling should be at least 300 revolutions per minute in each direc-

tion. Adjust the hydraulic limit stop adjusting screw if speed is limited in either direction (par. 42). (If the speed is limited in the clockwise direction, turn the adjusting screw clockwise.) NOTE: *If no tachometer or revolutions recorder is available, put a mark on the collar A314290 (fig. 48) of the oil gear transmitter and count the revolutions per minute of the collar. When geared for azimuth, the oil gear transmitter and collar A314290 will turn at three-tenths the speed of the output coupling.*

f. Check Self-synchronous Operation. Check self-synchronous operation by turning the toggle switch (fig. 4) to the on position and allowing the unit to synchronize. Slew the unit in each direction by means of the push buttons, and observe synchronization. Relays should not chatter when resynchronizing. NOTE: *Voltage of less than 100 may cause relay chatter.*

g. Check Fine Data System.

(1) Make certain that zero deflection is set into the director and that the rate setting clutches are disengaged.

(2) Electrically zero the director synchro transmitters (see paragraph 39 for detailed instructions).

(3) Turn toggle switch to off position.

(4) Disengage the boresighting clutch.

(5) Remove the hydraulic limit cam.

(6) Turn change gear until both the white dot on the limit cam gear and the white dot on the synchronous switch gear are visible (fig. 98).

(7) Replace the limit cam for elevation with the lower stop set for zero.

(8) Set the change gears for elevation.

(9) Set the director for plus 5 degrees and connect it in elevation to the oil gear.

(10) Turn on the power.

(11) Push-button slew the unit into the lower limit and release the push button. It will return to fine data synchronization.

(12) Rotate stator of oil gear transmitter until limit cam just makes contact with roller.

(13) Run director down steadily and limit cam should come to rest at zero degrees plus or minus one-half degree. Make correction if necessary by rotating stator of oil gear transmitter. Run director up steadily and limit cam should come to rest at 85 degrees plus or minus 1 degree (par. 42).

h. Check Coarse Data System.

(1) If director has no coarse synchro transmitter for elevation, the coarse data system (par. 13) of any Oil Gear M3 can be tested by

setting the change gears and the limit cam for azimuth (par. 41) and connecting it to the director azimuth data system.

(2) Disconnect the motor leads from the terminal board assembly.

(3) Turn toggle switch to on position.

(4) Rotate stator of coarse repeater until contacts are midway between the points where relays click.

(5) Check to see that pushing each push button causes relay click.

(6) Turn director in each direction and note where relays click. The travel from original director setting to each position of relay click should be within 1 degree of half the travel between clicks. The travel between clicks is approximately 12 degrees.

(7) Make sure relays don't chatter.

i. Check Drift.

(1) Turn toggle switch to off position.

(2) Connect oil gear to a director and energize the fine data system (par. 12) for at least 3 seconds with the director stationary.

(3) De-energize both the director transmitter and the oil gear transmitter and check length of time required to drift up to full speed. (Some type of switch arrangement must be used so both the oil gear transmitter and the director transmitter can be de-energized simultaneously.) This time must be not less than 6 seconds. Make correction by turning the oil gear on its coupling end and, with oil reservoir access cover removed, adjust the pilot piston (par. 11). Turn it clockwise if output coupling drift is too soon clockwise. Cover must be replaced and unit returned to upright position for again checking drift. It may be necessary to make several settings and tests until you become familiar with this adjustment.

j. Check Error With Field Test Set. The error corrector adjusting nuts should not be disturbed even in disassembly unless absolutely necessary. The error corrector adjustment is correctly made by the manufacturer. This adjustment will remain correct except for the replacement of leaf springs in the stroke control or disturbance in disassembly. A reasonably accurate adjustment may be made by positioning the nuts as shown in figure 64.

k. Check Static Repeat.

(1) Attach a stationary marker to the oil gear so that it will just clear the rim of the front face of the output coupling.

(2) Put two radial marks on the front face of the output coupling so they are one-sixteenth inch apart at the coupling rim.

(3) Set the change gears for azimuth (par. 41) and connect the oil gear to the director in azimuth.

(4) Turn toggle switch to on position.

(5) Move the director until the stationary marker is centered between the two lines on the coupling face.

(6) Push-button slew the unit and release. Output coupling should return to the position of marker, being within the two lines. Make this test in both directions (see paragraph 38 for correction).

l. Check Torque.

(1) The torque at the output coupling must be not less than 250 pound-inches (each direction) with not more than a 5-mil lag of gun behind the director when turning at creep speed.

(2) A pulley, strap, and weights should be used for creating the load. Radius of the pulley in inches x weight-pounds lifted = pound-inches.

(3) The torque testing equipment used for testing the torque of the Oil Gear M1 can be used for testing the Oil Gear M3. The lag limit when testing the Oil Gear M3 is one-third of the lag limit when testing an Oil Gear M1.

(4) CHECK FOR OIL LEAKS. Examine the unit carefully for oil leakage.

m. Make sure the unit is set entirely for elevation or entirely for azimuth upon completion of inspection (par. 41).

30. INSPECTION OF WIRING SET COMPONENTS.

a. Inspection of Gun Junction Box Assembly. The insulation must be clean and dry, and must have no charred spots. Check the spring tension of each contact by flipping with fingernail. Replace any springs that are weak. Remove each contact and examine for burnt spots. Replace any damaged contacts.

b. Inspection of Contact Ring Assembly. Mount the contact ring assembly (par. 20) on the gun carriage and use the director to slowly turn the gun through 360 degrees of azimuth. Failure of the gun to make this entire travel is an indication of poor contacts in the contact ring assembly.

c. Inspection of Distribution Box Assembly. The insulation must be clean and dry, and must have no charred spots. Check that wires are attached to the terminals in accordance with wiring diagram (fig. 36).

d. Inspection of Elevation Limit Switch Assembly. Check the operation of the elevation limit switch (par. 22). It should make or

break contact rapidly with a clean snap action. Examine the contacts for burnt spots. Test the fuses.

e. Inspection of Azimuth Switch Assembly. Check the operation of the azimuth switch (par. 23). It should make or break contact rapidly with a clean snap action. Examine the contacts for burnt spots. Test the fuses.

f. Inspection of Cable and Plug Assemblies. Check all conductors for continuity by means of a continuity indicator. Check for shorts by means of an ohmmeter. CAUTION: *Make certain power is turned off before using ohmmeter.*

31. ACTION TO BE TAKEN.

a. Units found defective must be repaired or adjusted to render them serviceable. The action to be taken will be governed by the facilities available. If the facilities of the section do not permit satisfactory accomplishment of the repair or adjustment, the unserviceable unit will be passed on to a higher maintenance echelon; a replacement unit should then be issued to the using arm.

Section V

GENERAL MAINTENANCE

32. TOOLS.

a. Instruments required for maintenance of Remote Control System M15 are shown in figure 34. These instruments are listed as available for issue in SNL F-272. The indicator is used as a revolution-counter in measuring the oil gear speed as required in paragraph 29f and 42b. The gage is required in paragraphs 28b, 29d, 37, and 47 for measuring replenisher oil pressure. The ohmmeter is for measuring electrical resistances and checking continuity of wiring and may be used under paragraphs 37 and 39. The voltmeter can be used for measuring voltages anywhere in the system and is needed to determine electrical zero of transmitters as in paragraph 39e.

33. LUBRICATION.

a. Lubrication of Oil Gear.

(1) The oil in the reservoir of the main case serves as a hydraulic oil and as a lubricant for the transmission and valve assembly. The oil should cover half of the inspection window (fig. 1). Use

GENERAL MAINTENANCE

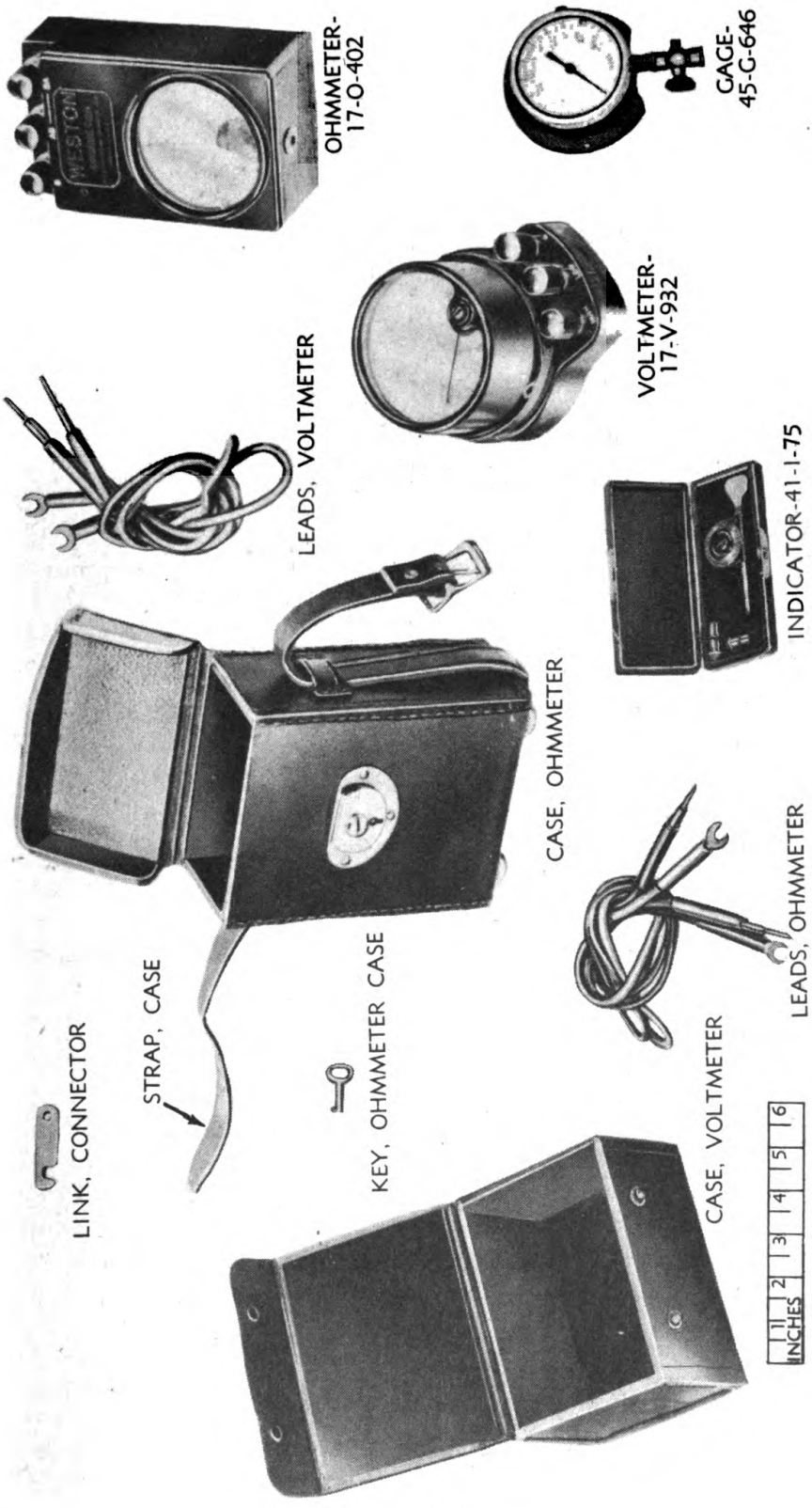


Figure 34—Tools for Maintenance

hydraulic oil if atmospheric temperatures will be in excess of 0°F, or special recoil oil if below 0°F.

(2) Cleanliness is of extreme importance in handling the oil for the oil gears. Dust or moisture should not be allowed to get into the oil while refilling main case to proper level. A filter-protected opening is provided at each side of the top of the oil reservoir for filling.

(3) The oil in the reservoir is being constantly filtered while the oil gear is in operation.

(4) Wipe the gear train and clutch mechanism (figs. 4 and 41). Clean and apply a film of special lubricating grease to the gear teeth. Any oil leakage from the oil reservoir into the synchro and clutch compartment should be drained by removing the drain plug.

(5) Lubricate the gear train between the electric motor and the hydraulic pump by keeping the electric motor gear case full to the drain plug level with the same oil as used in the main case reservoir.

b. Lubrication of Wiring Set.

(1) AZIMUTH SWITCH. The cover and clamp hinges should be oiled sparingly. The shaft spindle requires a thin film of special lubricating grease at time of overhaul.

(2) ELEVATION LIMIT SWITCH. The cover and clamp hinges should be oiled sparingly. The shaft spindle requires a thin film of special lubricating grease at time of overhaul. The lever bearing and lever roller should also be lightly oiled.

(3) CONTACT RING. The contact ring is lubricated at assembly at points indicated in figure 22.

34. CLEANING THE FILTER.

a. The filter inserted in the discharge line from the gear pump (replenishing pump) should be removed and cleaned (fig. 45). This cleaning can be accomplished without draining the oil. Remove the six bolts and tooth-type lock washers holding the filter head to the filter housing and withdraw the filter cartridge as shown in figure 45. A small quantity of oil will be lost from the filter housing.

b. The filter cartridge is metallic and should be washed free of dirt, lint, and other foreign particles. Use dry-cleaning solvent and allow to dry before inserting. The bolts should be kept tight and the gasket free from damage to prevent leakage of oil at the replenishing pressure.

35. CARE OF CABLES AND COMPONENT PARTS.

a. The portable cables supplied are of the highest grade obtainable. The importance of giving the cables the best of care cannot be overemphasized.

b. No cable of this size will withstand repeated kinking or twisting. Avoid bending the cable on a short radius or allowing it to chafe against a moving object.

c. Do not allow vehicles to run over unprotected cables.

d. Keep lugs and receptacles clean; accumulated dirt will cause faulty connections.

e. When the cables are not connected, all plugs must be kept closed with the covers provided, to exclude dirt and moisture. The D-shaped plugs (fig. 31) of the director cable are furnished with leather covers that should be pulled over the plugs when not connected.

f. When disconnecting a cable, pull on the body of the plug. Never pull on the cable or spring. The D-shaped plugs have to be turned to unlock them before they can be disconnected.

g. In case it becomes necessary to tape the ends of any flexible cables, use rubber insulating tape and bind with black friction tape.

h. Oil and grease are detrimental to rubber; keep the cables free of these materials. If oil or grease does get on the cable, wipe it off and wash the place with soapy water, rinse with clean water, and wipe dry.

i. Protect the cable receptacles in the gun junction box when the cables are not plugged in, by means of the covers provided for that purpose.

Section VI

MALFUNCTIONS AND CORRECTIONS

36. ISOLATION OF ELECTRICAL TROUBLE FROM HYDRAULIC TROUBLE.

a. Failure of the Oil Gear M3 to turn the gun is no indication of trouble in the hydraulic components. The trouble will nearly always be electrical. Never go into the hydraulic part of the Oil Gear M3 without having proved definitely that the trouble is not somewhere else.

b. If an Oil Gear M3 is on the gun carriage and its operation is faulty:

(1) Disconnect the coarse system by turning the self-synchronous toggle switch to the off position.

(2) Clean the replenishing filter (par. 34).

(3) Close the power switch. If the unit will move the gun at all, the trouble should be electrical.

(4) If the unit will not move the gun, try operating the push buttons. If the unit can be made to run by operating the push buttons, the trouble is not hydraulic. If unit will not run by operating the push buttons, *and the electric motor is turning in the right direction,* measure the replenishing pressure (par. 28). If the replenishing pressure is zero or very low, fill the oil reservoir above the top of the sight gage (fig. 1). This will be a check on the replenishing pump suction line for tightness.

(5) If the unit still fails to run, the trouble is hydraulic (pars. 10 and 11). In most cases the tests will have located the trouble as electrical.

c. If previous tests have shown the trouble to be electrical, perform the following sequence of tests on the electrical system:

(1) Measure the resistance across the terminals of the differential cable. These values should be between 35 and 40 ohms and some two-thirds of this value if the differential is still connected to the resetter and transmitter synchros (par. 12).

(2) If the resistance is correct, check resistance to ground to locate a differential cable that may have shorted to the case.

(3) If the differential circuits check satisfactorily, the trouble is in the resetter synchros assembly or in the relays. Test for a faulty synchro resetter by applying voltage to X and Y, rotating the synchros by hand, and seeing whether the secondary voltages vary from 0 to 105 volts as the synchro is turned.

(4) If the synchro checks satisfactorily, lift the relays out of the terminal compartment (figs. 46 and 85) and examine the contacts. If the contacts are clean and actuation of the push buttons gives positive action of the relays, the fault lies in the wiring of the relays, the synchro circuits, or the on-carriage circuits.

(5) If the trouble appears to be in the relays, connect jumpers from the director fine transmitter stator leads (fig. 101) (on terminal board of oil gear) to the R leads of the differential. This will bypass the relay contacts. Automatic slewing and the self-synchronous feature will be lost, but the oil gear will point the gun just as the Oil Gear M1, but with the added features of error correction and high speed.

d. If the Oil Gear M3 has been removed from the carriage and can be placed on its output coupling end (coupling must be free to

turn), apply power to the terminals of the electric motor. Remove the oil reservoir access cover and move the pilot piston by hand (par. 11). If the power piston assembly follows the pilot piston motion faithfully, and if the output coupling of the oil gear rotates with good response, the fault is not with the hydraulic components.

37. TROUBLE SHOOTING CHART (ON CARRIAGE).

a. Oil Gear Induction Motor Will Not Run.

Cause	Remedy
Blown fuse in limit switch.	Replace with new fuse.
Broken wire or damaged contact in wiring set.	Locate the break or faulty contact by checking motor circuit for continuity (fig. 101). Make necessary repair or replacement.
Excessive friction in driven mechanism.	If the excess friction is in the oil gear, the oil gear must be removed from gun carriage and overhauled.
Defective motor.	Replace with new one.

b. No Response to Director Data.

Induction motor turning in wrong direction.	Check wiring against wiring diagram and make necessary changes (figs. 36, 37, and 101).
Boresighting clutch disengaged.	Engage it (fig. 2).
Slewing clutch disengaged.	Engage it (fig. 1).
Incorrect or defective wiring of fine data system.	Check wiring, using wiring diagram (fig. 36), and make any necessary changes or repairs.
Dirty contacts in number 4 relay.	Clean them. Make sure they close (fig. 85).
Replenishing oil filter plugged.	Wash filter in dry-cleaning solvent or replace with new one if damaged (par. 34).
No oil in oil reservoir.	Fill with oil to halfway point of inspection window (fig. 1). Run unit a couple of minutes and add more oil if level has dropped.

c. Gun Travel Reverse From Director Data.

Incorrect or faulty wiring of fine data system.	Check wiring, using wiring diagram (figs. 36 and 37), and make necessary changes.

d. Sluggish Response to Director Data.

Cause	Remedy
Low pressure in replenishing line.	Clean the filter (par. 34). If this fails to raise the pressure, the oil gear must come off for repair.
Broken wire in fine data system.	Locate break by continuity test (figs. 36, 37, and 101), and make necessary repair.
Faulty synchro unit in fine data system.	If the faulty synchro unit (par. 12) is in the oil gear, the oil gear must come off for repair.

e. Gun Starts Slowly and in One Direction Only and Accelerates Regardless of Director Data.

Incorrect or defective wiring of fine data system.	Check wiring, using wiring diagram (figs. 36 and 37), and make any necessary changes. Locate break by continuity test and make necessary repair.
Number 4 relay not closing (fig. 85).	Set generator voltage for 125. Test relay.
Faulty synchro unit in fine data system.	If the faulty synchro unit (par. 12) is in the oil gear, the oil gear must come off for repair.

f. Gun Jerks Back and Forth With Large Amplitude (Hunts).

Incorrect wiring of data system.	Check wiring of fine and coarse data systems, using wiring diagram (figs. 36, 37, and 101). Make any necessary changes.
Director synchros are not set accurately at electrical zero.	The procedure given in paragraph 39 should be followed.
Oil gear synchros are not set accurately.	Follow procedure given in paragraphs 42 and 43.
Extremely low oil in oil reservoir.	Add oil until it covers half of sight gage (fig. 1).
Defective synchro in coarse data system.	If the defective synchro (par. 13) is in the oil gear, the oil gear must come off for repair, or operated with toggle switch in off position.

MALFUNCTIONS AND CORRECTIONS

g. Gun Travel Trips Elevation Limit Switch.

Cause	Remedy
Limit switch cam on the gun set to trip too soon.	Reset the cam for minus 4 degrees and plus 87 degrees (par. 40).
Hydraulic limit system not set for elevation.	Set it according to instructions given in paragraph 40.
Replenishing oil filter dirty.	Clean the filter with dry-cleaning solvent (par. 34).
Stop assembly broken or damaged (fig. 61).	Oil gear must come off for repair.

h. Gun Runs to One of the Elevation Limit Settings and Stops.

Toggle switch closed on elevation unit when operated with a Director M5.	Turn toggle switch to off position.
Jammed push-pull wire (fig. 61).	Unit must come off for repair (par. 14).
Push-button switch shorted.	Repair or replace.
Toggle switch shorted.	Repair or replace.
White dots are not visible at same time.	See paragraph 39 c (3).

i. Gun Will Follow Director in Azimuth But Not Through 360 Degrees.

Faulty contacts in contact ring of wiring set.	Contact ring must come off for repair (par. 20).
Cam set for elevation.	Reverse cam.

j. Lack of Speed of Gun Travel in One Direction Only.

Stop spool of hydraulic limit system incorrectly set.	Turn adjusting screw BCGX1.1BM (fig. 98) clockwise to increase clockwise speed of oil gear output coupling. Turn it counterclockwise to increase counterclockwise speed of oil gear output coupling. NOTE: *If this is done on elevation oil gear, it will change the positions at which the hydraulic limit system will stop the gun* (par. 40).
Differential stator incorrectly positioned.	Oil gear must come off for repair.

k. Lack of Gun Travel Speed in Both Directions.

Cause	Remedy
Temperature too low.	During extremely cold weather the oil gears need to be run at frequent intervals.
Gun too hard to turn.	This can be determined by cranking the gun. Make necessary repair of gun carriage.
Defective oil gear.	Oil gear must come off for repair (pars. 10 and 11).

l. Lack of Power.

Replenishing oil filter dirty.	Clean filter with dry-cleaning solvent (par. 34).
Defective oil gear.	Oil gear must come off for repair. NOTE: *Make sure the condition is not caused by extremely low temperature or gun being hard to turn.*

m. Jerky Gun Travel at Low Speeds.

NOTE: *Make sure director dials are moving smoothly.*

Poor gun equilibration.	Adjust equilibrators.
Gun too hard to turn.	Determine this by cranking the gun. Make necessary repair of gun carriage.
Gun backlash.	Make necessary repair of gun carriage.
Defective oil gear (tight pins).	Oil gear must come off for repair if the gun travel is jerky enough to cause inaccuracy (pars. 10 and 11).

n. Gun Will Not Automatically Slew.

Incorrect or defective wiring of coarse data system.	Check wiring, using wiring diagram (fig. 36), and make necessary changes or repairs.
Damaged contacts in coarse data system (between receiver contact and contact ring assembly (fig. 51)).	Oil gear must come off for repair.
Dirty relay contacts.	Clean the contacts (figs. 46 and 85).
Defective relay or relays.	Replace with new ones.
Poor contact between contact brush and contact ring assembly (fig. 51).	Clean contacts.

MALFUNCTIONS AND CORRECTIONS

o. Gun Whips at End of Automatic Slewing.

Cause	Remedy
Coarse and fine synchros not alined.	Reset them according to instructions given in paragraphs 42 and 43.
Low line voltage.	Set generator for 125 volts.
Low oil level in oil reservoir.	Add oil until half of sight gage is covered (fig. 1).

38. TROUBLE SHOOTING CHART FOR OIL GEAR M3 (OFF CARRIAGE).

a. Induction Motor Will Not Come Up to Speed.

Voltage too low.	Raise to 125 at generator.
Frequency too low.	Raise to 60.
Defective induction motor.	Replace with new one.

b. No Response to Director Data.

Leak in suction lines to replenishing pump.	Dismantle and make fittings tight (fig. 60). If unit runs satisfactorily with oil above top of sight gage and not at normal level, suction line leaks.
Induction motor turning in wrong direction.	Check wiring against wiring diagram (figs. 36, 37, and 101) and make proper connections.
Replenishing oil filter plugged.	Wash filter in dry-cleaning solvent or replace with new one if damaged (par. 34).
No oil in oil reservoir.	Fill with oil to halfway point of inspection window (fig. 1). Run unit a couple of minutes and add more oil if level has dropped.
Incorrect or defective wiring of fine data system.	Check wiring, using wiring diagram (figs. 36 and 101), and make any necessary changes or repairs.
Defective synchro in fine data system.	Replace oil gear transmitter. If trouble continues, replace synchro differential. Try using original oil gear transmitter after changing differential.
Dirty points on number 4 relay or relay not closing (fig. 85).	Set generator voltage for 125. If relay closes, clean points. If it does not, test it.

c. Output Coupling Oscillates With Large Amplitude.

NOTE: *Make sure transmitters of test directors are set at electrical zero* (par. 38).

Cause	Remedy
Extremely low oil level in main case.	Fill with oil to halfway point of inspection window (fig. 1). Run unit a couple of minutes and add more oil if level has dropped.
Incorrect wiring of data system.	Check wiring, using wiring diagram (figs. 36 and 101).
Coarse receiver or oil gear transmitter not set correctly.	Check and reset according to instructions in paragraphs 42 and 43.

d. Output Coupling Rotates in Direction Opposite Director Data.

Incorrect wiring of fine data system.	Check wiring, using wiring diagram (figs. 36 and 101).
Defective wiring of fine data system.	Check continuity.

e. Sluggish Response to Director Data.

Replenishing oil pressure too low.	Make sure oil is to proper level in oil reservoir. Inspect replenishing oil filter. Wash filter with solvent or replace if damaged. Check constant pressure valve (fig. 61). Paragraph 47 tells how to adjust this valve.
Broken wire or poor connection in fine data system.	Check wiring, using wiring diagram (figs. 36, 37, and 101), and make any necessary repairs.
Low line voltage.	Set generator for 125 volts.

f. Hydraulic Limit System Will Not Work (Elevation Unit).

Replenishing oil pressure too low.	Remedy is the same as given in subparagraph e, above.
Hydraulic limit cam not set for elevation.	Reset according to instructions in paragraph 41.
Stop assembly B179427 (fig. 61) broken or damaged.	Replace with new assembly and adjust according to instructions in paragraph 42.

MALFUNCTIONS AND CORRECTIONS

g. Unit Will Not Automatically Slew.

Cause	Remedy
Incorrect or defective wiring of coarse data system.	Check wiring, using wiring diagram (figs. 36, 37, and 101), and make any necessary repairs.
Poor connection between contact assembly and contact ring (fig. 51).	Replace damaged contacts with new ones.
Relays will not close.	Make sure voltage is 125 at the generator. Test relay and replace if defective (par. 12).
Dirty relay points.	Clean the relay points (fig. 85).

h. Output Coupling Oscillates at End of Slewing.

Coarse and fine synchros not alined.	Reset them according to instructions given in paragraphs 42 and 43.
Low line voltage.	Set generator for 125 volts.
Low oil level in oil reservoir.	Add oil until half the sight gage is covered.

i. No Dither Action at Output Coupling.

Replenishing oil pressure too low.	Remedy is same as in subparagraph e, above.
Binding of dither rod.	Aline dither rod for smooth operation.
C spring has been left out or is out of place.	Place C spring in position as shown in figure 97.

j. Lack of Speed in One Direction Only.

Stop assembly B179427 (fig. 61) incorrectly positioned.	Reposition by turning screw BC-GX1.1BM. Turn screw clockwise to increase speed of output coupling in clockwise direction. Turn screw counterclockwise to increase speed of output coupling in counterclockwise direction (par. 42).
C spring out of position.	Place C spring in position as shown in figure 97.
Synchro differential springs A314162 hitting post A314153 (fig. 67) too soon.	Reposition differential stator (par. 45).

k. Lack of Speed in Both Directions.

Cause	Remedy
Low replenishing pressure.	Clean oil filter (par. 34).

l. Excessive Input Torque.

Replenishing pump gears A245574 and A245575 fitted too tightly between housing D75087 and cover A245582 (fig. 94).	Replace gears with new ones carefully selected for correct thickness, or lap gears against lapping block. Gears should be 0.001 to 0.002 inch thinner than depth of recess that receives them.
Damaged bearing or bearings in hydraulic transmission.	Replace any bearing that does not turn freely. There are two ball bearings and one roller bearing in the oil motor, and two ball bearings and one roller bearing in the oil pump (par. 10).
Pistons A195976 (fig. 94) fitting too tightly in their cylinders.	Each piston must turn in its cylinder so the piston end will roll on the race it thrusts against. Replace any sticky piston with one carefully selected for size. Each piston is lapped to a fit of 0.0003 inch in its cylinder.

m. Insufficient Power.

High pressure relief valve (fig. 93) opening at too low pressure.	Replace any damaged parts. Add shims A244967 (fig. 93) to increase the pressure at which valve will open. Valve should open at between 1,500 and 1,800 pounds per square inch (par. 10).

n. Excessive Leakage at Oil Motor Shaft or Oil Pump Shaft of Hydraulic Transmission.

Damaged seal A195970 (fig. 5).	Replace with new seal.
Groove worn in shaft of oil pump or oil motor (fig. 5).	Replace shaft assembly.

Section VII

ADJUSTMENT AND REPAIR OF OIL GEAR M3

39. ALINEMENT PROCEDURE.

a. General. The Oil Gears M3, because of their additional features of self-synchronous operation and the self-contained limits for elevation, are more difficult to get into initial alinement than the Oil Gears M1. The procedure outlined below should be followed carefully to avoid faulty operation. If the gun at some later date fails to operate properly, the initial alinement procedure should again be followed to make sure that the unit is properly alined. Boresighting has been made much easier with the Oil Gears M3 by the inclusion of a boresighting clutch.

b. Azimuth. Initial alinement of the azimuth oil gear can be obtained by the following procedure:

(1) Open the azimuth boresighting clutch (fig. 2) by moving the lever to the up position. The lever can be moved only when it is forced away from the notched detent.

(2) Close the azimuth power switch (fig. 27). The oil gear should start and its mechanism should synchronize with the director without driving the gun. A test to see that the oil gear is operating properly consists of pushing either push button (fig. 1) which should cause the mechanism to run at full speed. When the button is released, the mechanism should return to its former position and come to rest. This performance can be observed by watching the gearing through the opening provided by removing cover C82079 (fig. 38).

(3) Hand-operate the gun into approximate boresight with the director, and close the boresighting clutch by moving the boresight lever to the down position.

(4) The gun should now follow slow rates of the director and, when the director is suddenly slewed approximately one-third revolution in either direction, the gun should follow at its maximum rate and resynchronize.

(5) If under step (2) above, the oil gear mechanism does not rotate even when the push buttons are operated, it is likely that the power motor phase rotation is reversed. These leads should be checked for continuity and two of them will have to be reversed (figs. 36, 37, and 101). If under step (2), above, the output gearing oscillated back and forth with a continual clicking of the oil gear relays, it is likely that the director is not properly electrically zeroed. If under step (4), above, the gun synchronizes smoothly in one direction, but synchronizes with a chatter in the other direction, it is also likely that the director is not accurately set at electrical zero. If there is a question of coarse and fine synchro alinement as opposed to improper operation of the oil gear mech-

anism, turn the self-synchronous toggle switch in the oil gear terminal compartment to the off position after which the oil gear should operate normally on fine data only.

c. **Elevation.** Initial alinement of the elevation oil gear can be obtained by the following procedure:

(1) Remove the oil gear side cover having a screw cap (fig. 1).

(2) Open the elevation boresighting clutch (fig. 2) by moving the lever to the up position.

(3) Rotate the synchro gearing until a white dot is visible on the gear behind the limit cam and, at the same time, a white dot is visible on the large gear above the cam (fig. 98). It should be easy to rotate this gearing by hand when both the boresighting and the slewing clutches are open. The slewing clutch is open when the lever is forward.

(4) Put elevation limit cam (fig. 3) in the minus-3-degree detent (red number) by loosening the two clamp screws and moving the lower lobe of the cam until the pin is opposite the minus 3 mark. The clamp screws should then be tightened.

(5) Run the director to zero elevation as shown by the elevation dials and the telescope.

(6) Close slewing clutch (fig. 1) by moving lever to rear position.

(7) Check to be sure that the boresighting clutch is open, then close elevation limit switch. The oil gear mechanism should run and synchronize with the director position. This can be determined by observing the rotation of the synchro gearing and the position of the cam (fig. 3).

(8) When operating with a Director M5, the self-synchronous toggle switch in the elevation oil gear terminal compartment should be turned to the off position. When operating with either a Director M5A1 or M5A2, the self-synchronous toggle switch should be in the on position.

(9) Push the "UP" push button which should cause the mechanism to rotate until stopped by the large lobe of the cam.

(10) Release the push button and if operating from a Director M5, the mechanism will move only a small amount. If operating from a Director M5A1 or M5A2, the mechanism should return to the small lobe of the cam.

(11) Push the "DOWN" push button, which should cause the mechanism to rotate until stopped by the small lobe of the cam.

(12) Release the "DOWN" push button and the mechanism should move only slightly and the roller should still be in contact with the small lobe of the cam.

(13) Hand crank the gun to zero elevation and close the boresighting clutch by moving the lever to the down position.

(14) Operate the director slowly to approximately 90 degrees elevation. The gun should be stopped by the limit cam when its elevation reaches 85 degrees (plus or minus 1 degree) without tripping the electrical limit switch. Operate the director slowly to minus 5 degrees elevation and the gun should be brought to rest at minus 3 degrees (plus or minus one-half degree) without tripping the electrical limit switch. If this operation has been satisfactory, the gun can be slewed into the upper and lower limits by the push buttons with the gun being brought smoothly to rest by the limit mechanism.

(15) As a precaution, open the boresighting clutch only for small corrections of boresighting and immediately reclose it. If the boresighting clutch is found open at any time, recheck the initial alinement as described above, including the check for the white dots.

(16) If under step (7), above, there is no rotation of the oil gear mechanism even when the push buttons are operated, it is likely that the power motor is running in the wrong direction. The wiring continuity should be checked and two of the power leads will have to be reversed (figs. 36 and 37). If the mechanism oscillates with a continuous clicking of the oil gear relays, it is likely that the director is not set at electrical zero (subpar. e, below). If the gun synchronizes, it is likely that the director synchros are accurately set at electrical zero. Any error in the data wiring (figs. 36, 37, and 101) may cause the same performance as improper electrical zero setting of the director.

d. Accurate Boresighting Alinement. When it is known that the oil gears and the director are in initial alinement, the following procedure can be followed to obtain accurate boresighting alinement. The procedure is applicable to either elevation or azimuth.

(1) Level the gun and director. Make certain that zero deflection is set into the director and that the rate setting clutches are disengaged.

(2) Energize both oil gears and let them synchronize with the director. To lift the shell deflector for boresighting, turn off elevation power motor at limit switch, depress gun by hand crank, lift deflector, elevate gun by hand, and turn on elevation power.

(3) Sight the director on the selected boresighting point allowing the oil gears to drive the gun. Make sure that the elevation oil gear is following the director and is not being restrained by the lower limit. The oil gear should be able to drive the gun at least 1 degree below the boresighting point.

(4) Disengage the boresighting clutches of both units by raising the clutch handles.

(5) Crank the gun by hand to the position where it is sighted on the boresighting point, making sure that the director is kept sighted on the boresighting point. The gun should not have to be cranked more than a degree in elevation, but the gun may have to be cranked as much as 180 degrees in azimuth.

(6) Re-engage the boresighting clutches. Run the director off to one side. The motion should be followed by the gun. Bring the director back to the boresighting point. The gun should still be in alinement with the director. The boresighting clutches are positive dog-type clutches (fig. 42) and allow boresighting within one-third mil in azimuth and one-quarter mil in elevation.

(7) If the electrical zeros of all the synchros in all the directors are properly set, and if the above procedure for initial alinement has been followed, it will be found that any director can be used with any gun and boresighted by the simple procedure outlined in this subparagraph d. The self-contained limit stops and the self-synchronous circuits will automatically operate correctly. When changing from one director to another, or from one gun to another, it will only be necessary to make a correction of a few mils in elevation when boresighting accurately.

e. Checking Electrical Zeros of the Synchros in the Director. The proper zeroing of the synchros in the director can be checked at the oil gear terminals (fig. 101) with the remote control system energized but with both oil gear motors shut off. Proceed in the following manner:

(1) Run the director to zero elevation as shown by the elevation dials and the telescope dial, and to zero azimuth as indicated by the azimuth dials, *making sure that zero deflection is set into the director and that the rate setting clutches are disengaged.*

(2) Check elevation fine data zeroing by the following steps:

(a) Connect a jumper from 2 to X on the oil gear terminal strip.

(b) The voltage between 1 and Y should be approximately 25 volts.

(c) The voltage between 1 and 3 should be 1 volt or less.

(3) Check elevation in coarse data zeroing by the following steps:

(a) Connect a jumper between 7 and X.

(b) The voltage between 6 and Y should be approximately 25 volts.

(c) The voltage between 6 and 8 should be 1 volt or less.

(4) Check fine azimuth data zeroing by the following steps:

(a) The voltage between 2 and X should be approximately 80 volts.

(b) The voltage between 1 and 3 should be one volt or less.

(5) Check coarse azimuth data zeroing by the following steps:

(a) The voltage between 7 and X should be approximately 80 volts.

(b) The voltage between 6 and 8 should be 1 volt or less.

(6) If it is found by the above voltage measurements that the director is not properly zeroed, the director can be zeroed either by the standard Ordnance procedure, or by adjusting the director synchros until all of the above voltage conditions are met.

40. ADJUSTMENT OF HYDRAULIC LIMIT SYSTEM.

a. The hydraulic limit system (par. 14) is made inoperative on the azimuth unit. This is done by turning the cams (fig. 3) so they do not contact the roller. However, the flanges of limit spool straddle the synchro differential lever (fig. 15). The limit spool must be positioned so it will not interfere with maximum travel of the synchro differential lever. Lack of slewing speed in one direction only, indicates that the limit spool is incorrectly set. Make correction by turning adjusting screw BCGX1.1BM (figs. 3 and 98). Turn it clockwise to increase oil gear output coupling clockwise speed. Turn it counterclockwise to increase oil gear output coupling counterclockwise speed.

b. The same adjustment as given in subparagraph **a**, above, can be made on an elevation unit; however, it will change the locations at which the hydraulic limit system will stop the gun. Any change in the setting of screw BCGX1.1BM necessitates a check of the position of the oil gear transmitter stator (par. 42).

c. Changing Location of Lower Stop. Cam assembly B271811 (figs. 3 and 98) controls the lower limit of gun travel in elevation. It may be set in any one of six positions. These positions, ranging from minus 3 degrees to plus 20 degrees, are marked on the inside of the cup. To change setting, loosen the two screws that are holding the cup and cams to adapter assembly B271262. Reposition cam assembly B271811 for the desired stop. Tighten the two screws.

41. SETTING UNIT FOR AZIMUTH OR ELEVATION.

a. All Oil Gear M3 units are adaptable to azimuth drive or elevation drive. As they leave the factory, they are set up one way or the other as indicated by the small nameplate (fig. 38) on cover

C82051. Any unit can be be reversed in the field by performing the following operations:

b. Making an Azimuth Unit (figs. 1 and 3).

(1) Remove cover assembly C82079 (fig. 38).

(2) Loosen the Allen-type lock screw in the hub of the change gear pair (fig. 3).

(3) Slide the gear pair to the right-hand position. The smaller gear of the sliding pair will then mesh with the right-hand gear on the oil motor shaft.

(4) Check to be sure there is no interference from the other gear in the pair, and tighten the lock screw securely.

(5) Remove the two screws that are anchoring the cup and cams (fig. 3) to the adapter assembly. Remove the cup and cams and replace them with the cams turned so that their flanges face the outside of the case. Replace the two screws. The cams are now positioned so they will not contact the hydraulic limit mechanism.

(6) Replace cover assembly.

(7) Remove the terminal compartment cover assembly (fig. 38) and put toggle switch in on position. Replace cover assembly.

(8) Remove the pin through the slewing clutch locking lever and replace with the lever turned so that in the down position it does not lock the slewing clutch lever. NOTE: *Locking lever will probably already be in the called-for position.*

(9) Change the small nameplate on the gear cover (fig. 38) by reversal, so that it reads "Azimuth."

c. Making an Elevation Unit (figs. 1 and 3).

(1) Remove cover assembly C82079 (fig. 38).

(2) Loosen the Allen-type lock screw in the hub of the change gear pair C82087 (fig. 3).

(3) Slide the gear pair to the left so the larger gear of the pair meshes with the middle gear on the oil motor shaft.

(4) Check to be sure the proper mesh is obtained and tighten the lock screw securely.

(5) Remove the two screws that are anchoring the cup and cams (fig. 3) to the adapter assembly. Remove the cup and cams. Turn output coupling (disengage the slewing clutch to make this easier) until the white dot on gear B179413 and the white dot on gear B271259 (fig. 98) are both showing. Replace the cams and cup with the cam flanges facing inward so that they will contact the roller of the hydraulic limit mechanism. Cam assembly B271811 (fig. 52) controls the lower limit of gun travel in elevation. It may be set in

any one of six positions. These positions, ranging from minus 3 degrees to plus 20 degrees, are marked on the inside of the cup. Use the zero-degree position for ordinary setting. Replace the two screws. Re-engage the slewing clutch.

(6) Replace cover assembly.

(7) Remove the terminal compartment cover assembly and put toggle switch in off position if Director M5 is used. Put it in on position for Director M5A1 or M5A2.

(8) Note that the locking lever on elevation unit is to remain positioned so that it will not lock the slewing clutch lever.

(9) Change the small nameplate on the gear cover (fig. 38) by reversal, so that it reads "Elevation."

42. ADJUSTMENT OF HYDRAULIC LIMIT SYSTEM AND OIL GEAR TRANSMITTER (OFF CARRIAGE).

a. The flanges of the limit spool (fig. 15) straddle the synchro differential lever. The limit spool must be positioned so that it will not interfere with maximum travel of the synchro differential lever when the limit cam is not contacting the roller. It must also be positioned so that the limit cam can cause it to return the synchro differential lever to neutral at exact positions of gun travel in elevation. The hydraulic limit system is adjusted correctly at the factory and the following procedure will be required only on units that have been put out of adjustment.

b. Check Position of Limit Spool. Remove the limit cam (fig. 3) and set the gear pin (fig. 3) for azimuth (par. 41). Check slewing speeds by operating slewing push buttons. (The self-synchronous toggle switch (fig. 85) should be in the off position during this test.) The speed at the output coupling should be not less than 300 revolutions per minute in each direction. Make correction, if necessary, by turning adjustment screw BCGX1.1BM (figs. 3 and 103). Turn it clockwise to increase clockwise speed. NOTE: *If no tachometer or revolutions recorder is available, put a mark on the collar A314290 (fig. 51), and count the revolutions per minute of the collar.* When geared for azimuth, the oil gear transmitter and collar A314290 will turn at three-tenths speed of the output coupling. When geared for elevation, it would turn at seven-thirtieths the speed of the output coupling.

c. Check Position of Oil Gear Transmitter Stator.

(1) Set the change gear for elevation (par. 41) and have the limit cam off (fig. 3).

(2) Turn toggle switch (fig. 85) to off position.

(3) Disengage the boresighting clutch (fig. 2).

(4) Turn change gear until both the white dot on the limit cam and the white dot on the synchronous switch gear are visible (fig. 98).

(5) Replace the limit cam for elevation with the lower stop set for zero.

(6) Set the director for plus 5 degrees and connect it in elevation to the oil gear. NOTE: *Director can be M5, M5A1, or M5A2.* Set zero deflection into the director and make sure its transmitters are electrically zeroed (see paragraph 39 for instructions for electrically zeroing director synchros).

(7) Turn on the power.

(8) Push-button slew the unit into the lower limit and release the push button. It will return to fine data synchronization unless it is in fine data synchronization.

(9) Rotate stator of oil gear transmitter (fine data transmitter) until limit cam just makes contact with roller.

(10) Run director down steadily and limit cam should come to rest at zero degrees plus or minus one-half degree. Make correction if necessary by rotating stator of oil gear transmitter. Run director up steadily and limit cam should come to rest at 85 degrees plus or minus 1 degree.

43. ADJUSTMENT OF COARSE DATA SYSTEM.

NOTE: *Adjustment of oil gear transmitter (par. 42) must be made before adjustment of coarse data system is made.*

a. If the director has no coarse synchro transmitter for elevation, the coarse data system of any Oil Gear M3 can be adjusted by setting the change gears and the limit cam for azimuth (par. 41) and connecting it to the director azimuth data system.

b. Details of Adjustment.

(1) Disconnect the motor leads from the terminal board assembly (fig. 101).

(2) Turn toggle switch (fig. 85) to on position.

(3) Rotate stator of coarse repeater until contacts are midway between the points where relays click.

(4) Check to see that pushing each push button causes relay click.

(5) Turn director in each direction and note where relays click. The travel from original director setting to each position of relay click should be within 1 degree of half the travel between clicks. The travel between clicks is approximately 12 degrees.

(6) Make sure relays do not chatter.

ADJUSTMENT AND REPAIR OF OIL GEAR M3

44. ADJUSTMENT OF PILOT PISTON.

a. The pilot piston (fig. 14) is correctly adjusted at the factory and should require no readjusting except from disassembly or the replacement of stroke control parts.

b. The adjustment of the pilot piston can be changed with the hydraulic transmission and valve assembly in the main case. The oil gear must be on its coupling end and the oil reservoir access cover must be removed when this is being done.

c. Details of Making Adjustments.

(1) Have oil gear in upright position.

(2) Turn toggle switch (fig. 85) to off position.

(3) Connect oil gear to a director and energize the fine data system (par. 12) for at least 3 seconds with the director stationary.

(4) De-energize both the director transmitter and the oil gear transmitter, and check the length of time required to drift up to full speed. This time must not be less than 6 seconds. NOTE: *Some type of switch arrangement must be used so that both the director transmitter and the oil gear transmitter can be de-energized simultaneously.*

(5) Make correction by turning oil gear on its coupling end and, with oil reservoir access cover removed, adjust the pilot piston. Turn it clockwise if output coupling drift is too soon clockwise. Cover must be replaced and unit returned to upright position for again checking drift. It may be necessary to make several settings and tests until you become familiar with this adjustment.

(6) To eliminate much of the trial and error procedure necessary in the above paragraph, the following method may be used if a test stand is available which will permit operation of the unit with the output coupling down. Determine which direction the pilot piston must be moved to obtain a neutral setting, and adjust the pilot piston until the output coupling requires 12 to 15 seconds to drift into full speed. To compensate for the displacement from neutral of the dashpot piston which will be evidenced when the unit is turned upright, turn the pilot valve adjusting screw approximately 25 degrees in a counterclockwise direction. Replace the oil reservoir cover plate and return the unit to upright position and recheck drift as in step (4) above.

45. ADJUSTMENT OF SYNCHRO DIFFERENTIAL.

a. The position of the differential stator is correctly adjusted at the factory and should remain correct except from disassembly or the replacement of stroke control parts. Reasonable accuracy however, may be obtained by positioning the differential stator so that the spring stops of the differential stop assembly are equidistant from the stop pin. NOTE: *The transmission and valve assembly must be out of the case when this is being done.*

46. ADJUSTMENT OF ERROR CORRECTOR.

a. Field test equipment for measuring error is not available for other than base shops. The error corrector adjusting nuts (figs. 14 and 66) should not be disturbed even in disassembly unless error measuring test equipment is available. The error corrector adjustment is correctly made by the manufacturer. This adjustment will remain correct except for the replacement of leaf springs in the stroke control, or disturbance in disassembly. A reasonably accurate adjustment may be made by positioning the nuts as shown in figure 64.

47. ADJUSTMENT OF REPLENISHER OIL RELIEF VALVE.

a. Replenishing oil pressure should be between 150 pounds per square inch and 165 pounds per square inch with oil temperature between 100 and 140 degrees Fahrenheit. The replenishing oil relief valve (figs. 60 and 61) is correctly set by the manufacturer and should require no changing.

b. A dirty filter will cause the replenishing oil pressure to be low. Make sure the filter is clean (par. 34) before blaming the valve adjustment.

c. The replenishing oil relief valve may be adjusted by removing the oil reservoir access cover plate while the unit is turned so that the coupling is down. NOTE: *On some units, it may be necessary to bend slightly the suction line for the replenishing oil pump in order to remove the two fillister-head screws securing the cap to the oil replenishing valve body.* Add shims A314420 to increase the pressure. Subtract shims to decrease the pressure (fig. 62). NOTE: *Readjustment of the replenisher oil relief valve should not be necessary.*

48. ADJUSTMENT OF HIGH PRESSURE RELIEF VALVE.

a. The high pressure relief valve (figs. 9 and 84) should open for both directions of rotation at pressure of 1,500 pounds per square inch to 1,800 pounds per square inch. This valve is correctly set by the manufacturer and should require no changing.

49. REPAIR.

a. The Oil Gear M3 is a carefully machined precision mechanism. The fit of all moving parts is extremely close, and cleanliness is of the utmost importance. Repair will consist essentially of cleaning, and replacing worn or defective parts.

b. A careful analysis of the operation during inspection of the complete unit before disassembly, and of the various subassemblies before they are disassembled, will assist greatly in locating parts causing malfunction. Make the complete inspection and use the trouble shooting chart (pars. 36, 37, and 38) before attempting repair.

Section VIII

ADJUSTMENT AND REPAIR OF WIRING SET M12

50. SETTING OF LIMIT SWITCHES.

a. Elevation Limit Switch. Set the telescopes at 45 degrees of elevation. Disengage the slewing clutch of the elevation oil gear. Manually elevate the gun to 87 degrees. If elevation limit switch (fig. 25) does not open at this position, adjust the limit switch cam on the gun trunnion so that it will. Manually depress the gun to minus 4 degrees. If elevation limit switch does not open at this position, adjust the limit switch cam on the gun trunnion so that it will. Manually elevate the gun to 45 degrees. Re-engage the slewing clutch. NOTE: *The elevation limit switch should make and break contact rapidly with a sharp snap action.*

b. Azimuth Switch. Adjust the azimuth switch (fig. 27) by adjusting the spring tension on the azimuth oil gear clutch lever. This does not change the switch itself but changes the timing of the clutch throw-out with respect to the switch. The azimuth switch should snap on just after the azimuth oil gear slewing clutch is engaged by throwing the slewing handle to the on position. It should snap off and the oil gear clutch disengage when the slewing handle is thrown to the off position. The azimuth switch should make and break contact rapidly with a sharp snap action.

51. REPAIR.

a. Repair will consist essentially of cleaning, and replacing worn or defective parts. Use Cable Repair Kit M7 for cable repair.

Section IX

REMOVAL AND INSTALLATION OF UNITS MOUNTED ON CARRIAGE

52. REMOVAL OF OIL GEAR M3.

a. Remove the cover C82095 (fig. 38) from the terminal compartment of the oil gear. Remove the four screws holding the power cable adapter to the front of the main case (fig. 1). Disconnect the three power wires from the terminal board (fig. 101) and withdraw them.

b. Remove the three screws holding the data cable adapter (fig. 1) to the front of the main case. Disconnect the data wires from the terminal board (fig. 101) and withdraw them.

c. Remove the five bolts anchoring the oil gear to the carriage.

d. Disconnect the rod from the lower end of the clutch lever.

e. Remove the oil gear by pulling it forward from the front of the carriage, being careful not to damage the drive shaft or coupling mechanism.

53. REMOVAL OF GUN JUNCTION BOX.

a. Remove the four long bolts securing the junction box (fig. 19) in its mounting brackets.

b. Remove the cover plate by removing the eight screws securing it. Exercise care not to damage the gasket.

c. Disconnect the 15 leads from the right-hand side of the 15-pole receptacle.

d. Loosen the follower and withdraw the 15-conductor cable.

e. Replace the junction box cover.

54. REMOVAL OF ELEVATION LIMIT SWITCH.

a. Open the switch box cover (fig. 25) and disconnect the six leads from the terminal board.

b. Loosen the follower at the bottom of the box and withdraw the 13-conductor cable.

c. Remove the two bolts from diagonal corners of the switch mounting plate and remove the switch assembly from the gun carriage.

55. REMOVAL OF AZIMUTH SWITCH.

a. Open the switch box cover (fig. 27) and disconnect the six leads from the terminal board.

b. Loosen the follower at the bottom of the box and withdraw the 13-conductor cable.

c. Disconnect the switch arm from the switch lever on the side of the box. Replace the pin in the switch lever.

d. Remove the four bolts anchoring the switch assembly to the gun carriage and remove the switch.

56. REMOVAL OF ELEVATION SWITCH.

a. Remove the switch box cover (fig. 29) and disconnect the six leads from the terminals.

b. Loosen the two followers at the end of the box and withdraw the two cables.

c. Remove the pin that connects crank B7636718 to the linkage going to the elevation oil gear slewing clutch.

d. Remove the bolts anchoring the switch to the gun carriage and remove the switch.

57. REMOVAL OF DISTRIBUTION BOX.

a. Remove cover (fig. 23).

b. Disconnect all wires going to the contact ring. *Tag all wires carefully.*

c. Loosen the two glands and withdraw the cables leading to the contact ring.

d. Remove four bolts fastening box to gun carriage.

e. Remove all clips securing cables to gun carriage.

f. Remove box. Wires that are still connected to it will follow.

58. REMOVAL OF CONTACT RING ASSEMBLY.

a. Remove screws holding support to gun carriage.

b. Lift complete assembly, with cables, away from the gun carriage.

59. INSTALLATION OF CONTACT RING ASSEMBLY.

a. All wires should be connected to the various terminals before unit is assembled. If this has not been done, disassemble the unit partially (par. 101) and connect wires, following wiring diagram (fig. 36 and 37) and color codings (fig. 113).

b. Place unit in position on carriage and anchor it with the screws provided.

60. INSTALLATION OF DISTRIBUTION BOX.

a. Fasten box to gun carriage with four bolts.

b. Wires, except those going to the contact ring, are best connected before the box is assembled. If this has not been done, these should be connected now, following wiring diagram (figs. 36 and 37).

c. Insert two cables from contact ring into box through proper openings.

d. Connect wires from contact rings to terminals in the distribution box, following wiring diagram (figs. 36 and 37).

e. Tighten gland assemblies.

f. Replace cover.

g. Color coding for cables is given on figures 120, 121, and 125.

61. INSTALLATION OF ELEVATION LIMIT SWITCH.

a. Secure the switch assembly to carriage with two bolts through the diagonal corners of the mounting plate.

b. Insert 13-conductor cable through opening at bottom of box.

c. Connect six leads to terminal board (refer to main wiring diagram, figs. 36 and 37).

d. Tighten follower.

e. Close box cover.

f. Color coding for elevation limit switch is given in figure 120.

62. INSTALLATION OF AZIMUTH SWITCH.

a. Secure the switch assembly to the gun carriage with four bolts.

b. Remove pin from switch lever.

c. Connect switch arm to switch lever. Replace pin.

d. Insert 13-conductor cable through opening at bottom of box.

e. Connect six leads to terminal board (refer to wiring diagram (figs. 36 and 37)).

f. Tighten follower.

g. Close box cover.

h. Color coding for azimuth limit switch is given in figure 121.

i. Adjust the spring tension in the linkage between the switch and the clutch lever so the switch will close just after the clutch is engaged. This does not change the switch but changes the timing of the clutch engagement with respect to the switch.

63. INSTALLATION OF ELEVATION SWITCH.

a. Anchor the switch assembly to the carriage.

b. Connect crank B7636718 to the linkage going to the elevation oil gear slewing clutch.

c. Insert the cable from the elevation oil gear through the top opening at end of box and tighten follower.

d. Insert the cable from the distribution box through the bottom opening at end of box and tighten follower.

e. Connect the six leads to terminal board (see wiring diagram (figs. 36 and 37)).

f. Fasten cover on switch box.

g. Adjust the spring tension in the linkage between the switch and the clutch lever so that the switch will close just after the clutch is engaged. This does not change the switch but changes the timing of the clutch engagement with respect to the switch.

64. INSTALLATION OF GUN JUNCTION BOX.

a. Remove junction box cover.

b. Insert 15-conductor cable into opening opposite 3-pole receptacle.

c. Connect 15 leads to right-hand side of 15-pole receptacle.

d. Tighten follower.

e. Replace junction box in its mounting brackets, fastening it with the four long bolts.

f. Figure 112 shows the wiring diagram for the gun junction box.

g. Color coding pertaining to gun junction box—contact ring cable, is shown in figure 113.

OIL GEAR, M3

CONNECTIONS FOR USE WITH 40MM. GUN, 115 VOLTS, 60 CYCLES
(WHEN NO WIRE TERMINALS ARE USED, CONNECT BY COLOR CODE)

AZIMUTH		
WIRE TERMINAL NO.	WIRE COLOR	CONNECT TO PLATE
A	BLACK } 3 WIRE CABLE	A
B	WHITE } 3 WIRE CABLE	B
C	NATURAL } 3 WIRE CABLE	C
Y	GREEN	Y
X	BROWN	X
1	RED	1
2	YELLOW	2
3	BLUE	3
6	ORANGE	6
7	WHITE	7
8	BLACK	8

ELEVATION		
WIRE TERMINAL NO.	WIRE COLOR	CONNECT TO PLATE
A	BLACK } 3 WIRE CABLE	A
B	WHITE } 3 WIRE CABLE	B
C	NATURAL } 3 WIRE CABLE	C
Y	GREEN	Y
X	BROWN	X
11	RED	3
12	YELLOW	2
13	BLUE	1
16	ORANGE	8
17	WHITE	7
18	BLACK	6

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Figure 35—Wiring Plate C82096

65. INSTALLATION OF OIL GEAR M3 (figs. 35 and 36).

a. Place oil gear on carriage.

b. Insert power leads through the opening in upper middle of main case front. Connect these leads to A, B, and C terminals on the terminal board (see wiring diagram (figs. 36 and 37)).

c. Insert data leads through the opening in right of main case front. Connect these leads to the terminal board (see wiring diagram (fig. 36)).

d. Slide the oil gear into position to engage the drive shaft. Be careful not to damage the drive shaft or coupling.

e. Anchor oil gear to carriage with the 5 bolts provided. Connect the rod from the slewing lever to the lower end of the clutch shift lever if the oil gear is used for azimuth. Connect the rod from the elevation switch to the lower end of the clutch shift lever if the oil gear is used for elevation.

f. Adjust the spring tension in the linkage to each clutch lever so that the switch will close just after the clutch is engaged. This does not change the switch but changes the timing of the clutch engagement with respect to the switch.

g. Fasten the cable adapters with the screws provided and tighten the gland assemblies.

REMOVAL AND INSTALLATION OF UNITS MOUNTED ON CARRIAGE

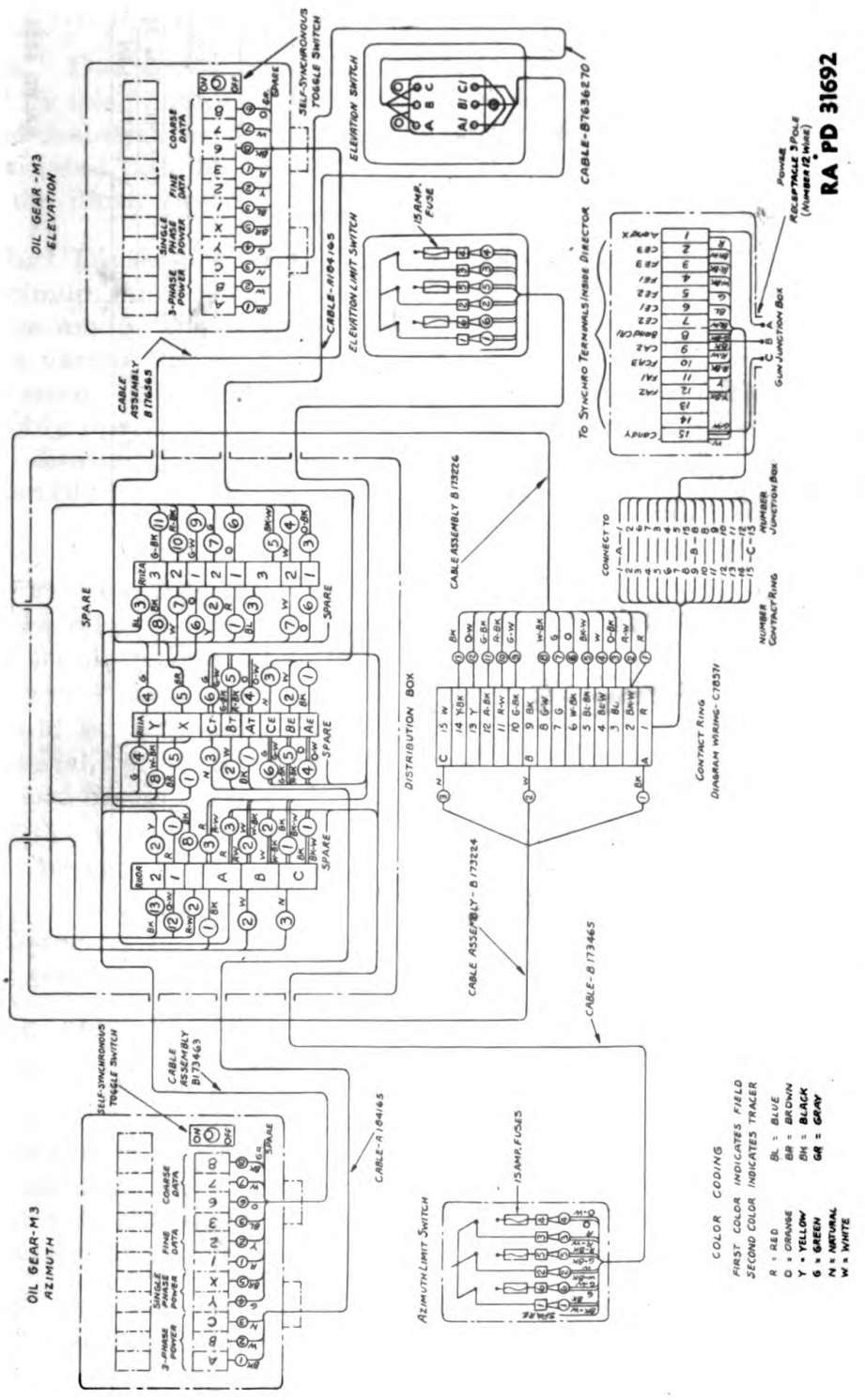

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Figure 36—Installation of Oil Gear M3 on 40-mm AA Gun Materiel M2—Wiring Diagram

ORDNANCE MAINTENANCE—REMOTE CONTROL SYSTEM M15 (FOR 40-MM GUN CARRIAGES M2, M2A1)

DIRECTOR		REMOTE CONTROL SYSTEM				
INTERNAL	TERMINAL BLOCK	GUN JUNCTION BOX	CONTACT RING	DISTRIBUTION BOX	AZIMUTH OIL GEAR M3 TERMINAL BLOCK	ELEVATION OIL GEAR M3 TERMINAL BLOCK
X	1	1	1	R110A-A THRU AZ. SWITCH TO AT	A-INDUCTION MOTOR	
				R110A-A THRU EL. LIMIT SWITCHES TO AE		A-INDUCTION MOTOR
				R110A-A VIA JUMPER TO R111A TO X	X-EXCITATION	X-EXCITATION
COARSE ELEV. 3	2	2	2	R110A BLANK		6 COARSE
				TAPED END		
FINE ELEV. 3	3	3	5	R112A-3 *(LOWER)*		1 FINE
FINE ELEV. 1	4	4	6	R112A-1 *(CENTER)*		3 FINE
FINE ELEV. 2	5	5	7	R112A-2 *(CENTER)*		2 FINE
COARSE ELEV. 1	6	6	3	R112A-1 *(LOWER)*		8 COARSE
COARSE ELEV. 2	7	7	4	R112A-2 *(LOWER)*		7 COARSE
Z	8	8	9	R110A-B THRU AZ. SWITCH TO BT	B-INDUCTION MOTOR	
				R110A-B THRU EL. LIMIT SWITCHES TO BE		B-INDUCTION MOTOR
COARSE AZIM 1			10	R112A-1 *(TOP)*	6-COARSE	
COARSE AZIM 2	9	9	11	R112A-2 *(TOP)*	7-COARSE	
COARSE AZIM 3	10	10	12	R112A-3 *(TOP)*	8-COARSE	
FINE AZIM 3					3-FINE	
FINE AZIM 1	11	11	13	R110A-1	1-FINE	
FINE AZIM 2	12	12	14	R110A-2	2-FINE	
SPARE	13	13				
SPARE	14	14				
Y	15	15	15	R110A-C THRU AZ. SWITCH TO CT	C-INDUCTION MOTOR	
				R110A-C THRU EL. LIMIT SWITCHES TO CE		C-INDUCTION MOTOR
			8	R111A-Y	Y-EXCITATION	Y-EXCITATION

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Figure 37—Continuity Chart

Section X

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

66. GENERAL.

a. Description of a disassembly operation in this section does not by itself authorize the performance of the operation by Ordnance field maintenance troops. Neither do the exploded-view illustrations associated with this section authorize disassembly to the extent shown in the illustrations.

b. Disassembly of the instrument should always be kept to the minimum limit which will permit the necessary repairs or adjustments to be made. The assembly is practically the reverse of disassembly. The various subassemblies should first be assembled, and then the subassemblies combined to complete the instrument. Where the assembly operations vary greatly from the reverse procedure of those for disassembly, a detailed description of the proper method of assembly is included in this manual.

c. Cleanliness.

(1) The most important single factor in disassembly or assembly of the oil gear unit is cleanliness. If possible, disassembly or assembly should be done in a *dust-free room* or equal facilities.

(2) Clean metal trays of sufficient size to accommodate all parts should be provided. These trays should be sheet steel or similar material, but not galvanized or coated with material which may chip off and become deposited on the parts of the oil gear unit.

(3) Parts should not be allowed to contact work benches, shelves, etc., because wood splinters may be deposited on these parts.

(4) The use of good judgment in keeping the parts clean during disassembly and assembly, will save valuable time. Remember, the oil gear unit is a precision instrument. Handle all parts carefully.

d. Metal hammers are not to be used during the disassembly or assembly. A *good* plastic hammer should be used.

e. It is recommended in all steps outlined in this section that screws, bolts and nuts be placed in their proper location after removal during disassembly. This precaution should be taken despite the fact that most of the screw, bolt, and nut types and sizes are given in the disassembly procedure.

f. The screw and bolt sizes, given in the disassembly procedure, describe diameter, threads per inch, and length, in the same sequence. "¼-20 x ¾" describes a bolt or screw as having a diameter of one-quarter inch, 20 threads to the inch, and a length of three-quarters inch.

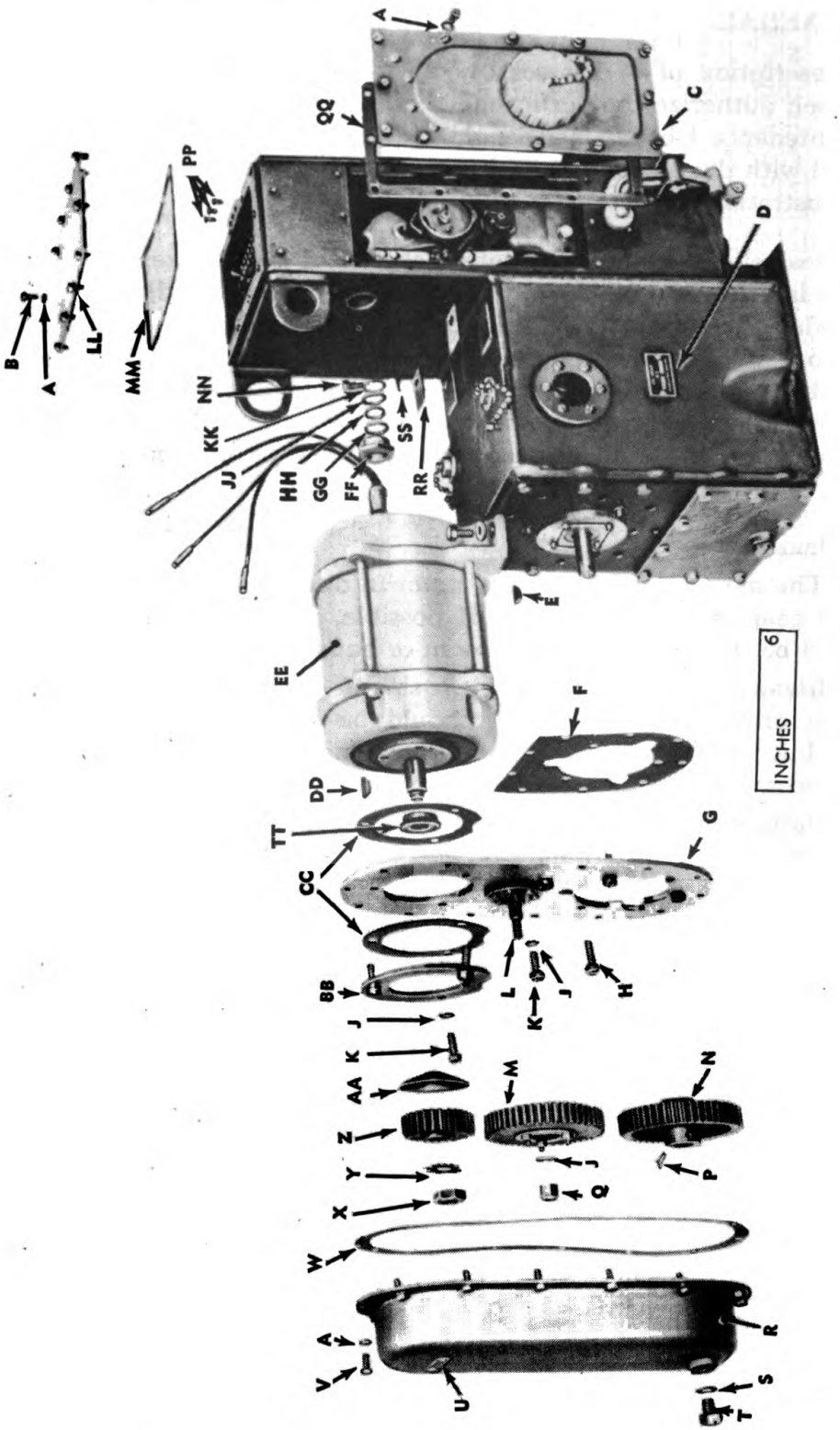

Figure 38—Removal of Induction Motor

A — WASHER-BEAX1H
B — SCREW-BCFX2DF
C — COVER, ASSEMBLY-C82079
D — PLATE, NAME-B179517
E — KEY-BGAX11B
F — GASKET-B179486
G — PLATE-C82063
H — SCREW-A314374
J — WASHER-BEAX1K
K — BOLT-BANX1BC
L — STUD-B179484
M — GEAR, ASSEMBLY-B179412
N — GEAR-B179485
P — PIN-BFAX2AA
Q — NUT-BBSX2AC
R — COVER-C82051
S — GASKET-A314409C
T — PLUG-A182197
U — PLATE, NAME-B179518
V — BOLT-BANX4AA
W — GASKET-A314161
X — NUT-BBCX2B
Y — WASHER-A314261
Z — PINION-B179423
AA — WASHER-A314260
BB — BAFFLE-A314262
CC — GASKET-A314263
DD — KEY-BGAX12B
EE — MOTOR-D75077
FF — FOLLOWER-A314430
GG — GLAND-A314428
HH — RING-A314426
JJ — GLAND-A314427
KK — GASKET-A314409B
LL — COVER, ASSEMBLY-C82095
MM — GASKET-B179506
NN — BOLT-BANX1CB
PP — SCREW-BCFX4AB
QQ — GASKET-B179512
RR — SHIM-{A314326 OR A314327}
SS — WASHER-BEAX1L
TT — SPACER-314259

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Legend for Figure 38—Removal of Induction Motor

g. Screw and bolt lengths given are from the underneath side of the head except for flat-head machine screws. Flat-head machine screw lengths are over-all lengths.

67. REMOVAL OF THE OIL.

a. Outline of Procedure.

(1) Drain oil from the main case.

(2) Drain oil from the gear compartment.

(3) Drain oil from the clutch compartment.

b. Detailed Description of Procedure.

(1) Place the oil gear on a bench so that the back edge of the main case is at the edge of the bench. Hold a clean container of 3 gallons capacity under the main case drain plug (fig. 4). Remove the drain plug and copper-asbestos gasket, and allow the oil to flow into the container. Tilt the oil gear in order to drain as much oil as possible. NOTE: *The oil will drain much more rapidly if one of the oil filter plugs is removed.*

(2) Hold container of 1-quart capacity under the gear compartment drain plug (fig. 4). Remove the drain plug and copper-asbestos gasket and allow the oil to flow into the container. Tilt the oil gear in order to drain as much oil as possible. This oil should not be mixed with oil from the main case if oil from main case is to be re-used.

(3) Place oil gear so drain plug of clutch compartment (fig. 4) clears the edge of the bench. Hold a container of 1 quart capacity under the drain plug. Remove the drain plug and copper-asbestos gasket and allow the oil to to flow into the container. This oil should not be mixed with the oil in the main case if oil from main case is to be re-used.

68. REMOVAL OF INDUCTION MOTOR (figs. 38 and 38A).

a. Outline of Procedure.

(1) Remove terminal board access cover.

(2) Disconnect motor leads from terminal board.

(3) Remove cover assembly C82079.

(4) Remove gear cover.

(5) Remove hydraulic input gear.

(6) Remove motor pinion.

(7) Remove oil baffle.

(8) Remove plate C82063.

(9) Loosen follower nut.

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

(10) Remove induction motor.

(11) Remove follower nut.

b. Detailed Description of Procedure.

(1) REMOVAL OF TERMINAL BOARD ACCESS COVER ASSEMBLY. Remove the ten ¼-20 x ½ fillister-head machine screws and tooth-type lock washers holding cover assembly to main case (figs. 38 and 38A). Lift off cover assembly and gasket B179506.

(2) DISCONNECTION OF MOTOR LEADS (figs. 38 and 38A). Remove the six 0.164-32 x ¼ fillister-head brass machine screws holding motor leads A, B, and C to terminals A, B, and C. Replace the screws with the motor leads disconnected.

(3) REMOVAL OF COVER C82079 (figs. 38 and 38A). Remove the twelve ¼-20 x ½ fillister-head machine screws and tooth-type lock washers holding cover assembly to main case. Lift off cover assembly and gasket B179512. Pull the loose end of the motor leads down into the receiver compartment. NOTE: *The leads must be withdrawn* one at a time.

(4) REMOVAL OF GEAR COVER (figs. 38 and 38A). Remove the fourteen ¼-20 x ½ hexagonal-head bolts and tooth-type lock washers holding cover to plate C82063. Lift off the cover and cover gasket A314161.

(5) REMOVAL OF HYDRAULIC INPUT GEAR (figs. 38 and 38A). Remove the cotter pin BFAX2AA holding the gear on oil pump shaft. Slide the gear off. Remove Woodruff key.

(6) REMOVAL OF MOTOR PINION (figs. 38 and 38A). Straighten washer A314261 and remove hexagonal nut BBCX2B and the washer. Remove pinion and Woodruff key.

(7) REMOVAL OF GEAR ASSEMBLY B179412. Remove the $1\frac{1}{16}$-inch self-locking hexagonal nut BBSX2AC and washer BEAX1K. Remove the gear assembly. Lift off washer A314260 and spacer A314259.

(8) REMOVAL OF OIL BAFFLE (figs. 38 and 38A). Remove the three $\frac{5}{16}$-18 x 1 hexagonal-head bolts and tooth-type lock washers holding baffle to plate C82063. The bolts are threaded into the end of the electric motor. Lift off baffle and gasket A314263.

(9) REMOVAL OF PLATE C82063 (figs. 38 and 38A). Remove the two $\frac{5}{16}$-18 x 1 hexagonal-head bolts and tooth-type lock washers holding plate to main case. Unlace the wire and remove the three socket-head cap screws A314374 ($\frac{5}{16}$-18 x 1) holding plate to hydraulic transmission.

NOTE: *In some units plate C82063 is secured to the hydraulic transmission by five socket-head cap screws.* Lift off the plate and gaskets A314263 and B179486.

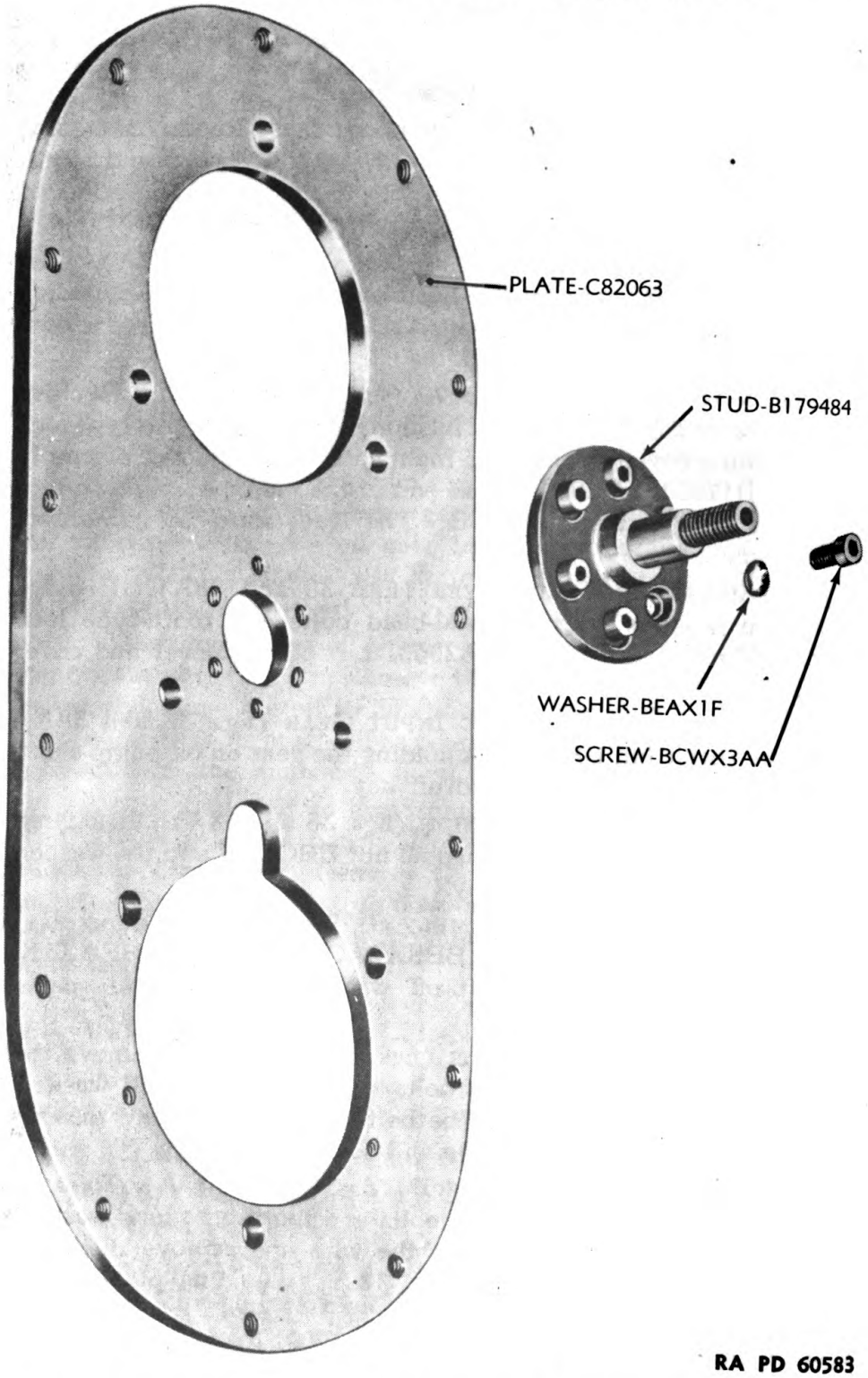


Figure 39—Removal of Stud B179494 From Plate C82063

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

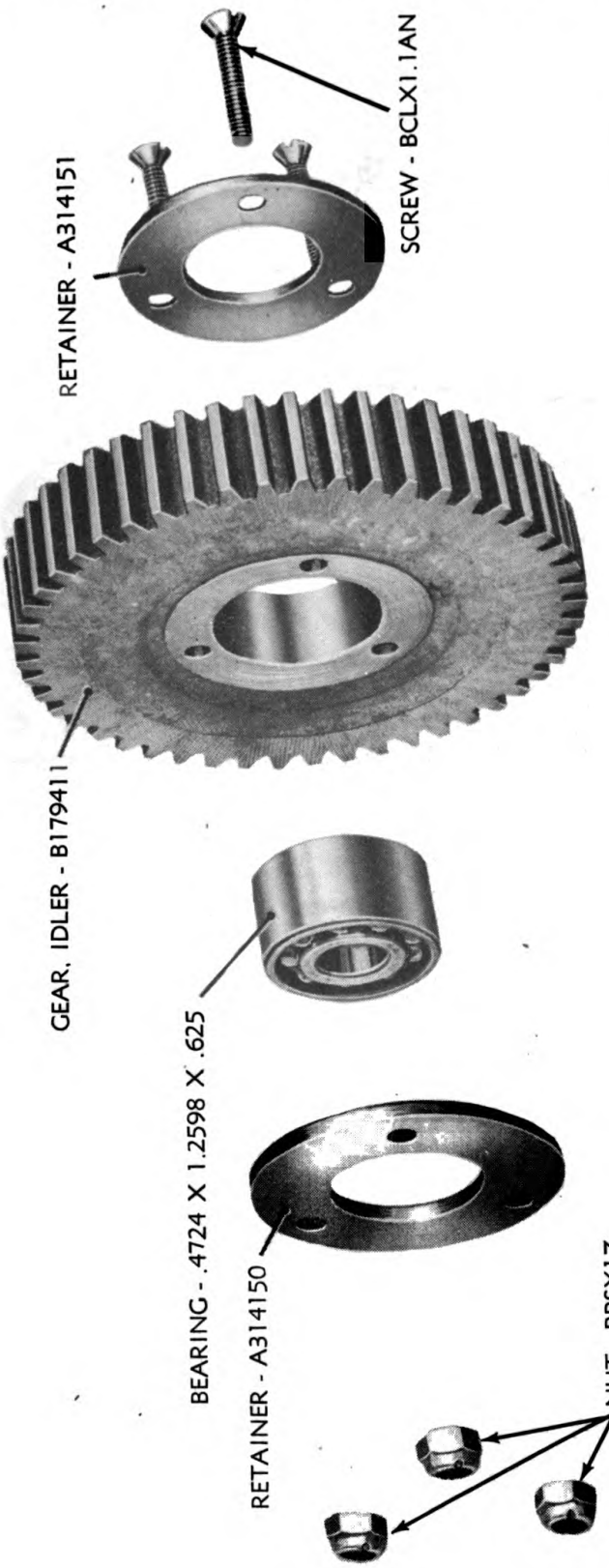


Figure 40—Disassembly of Gear Assembly B179412

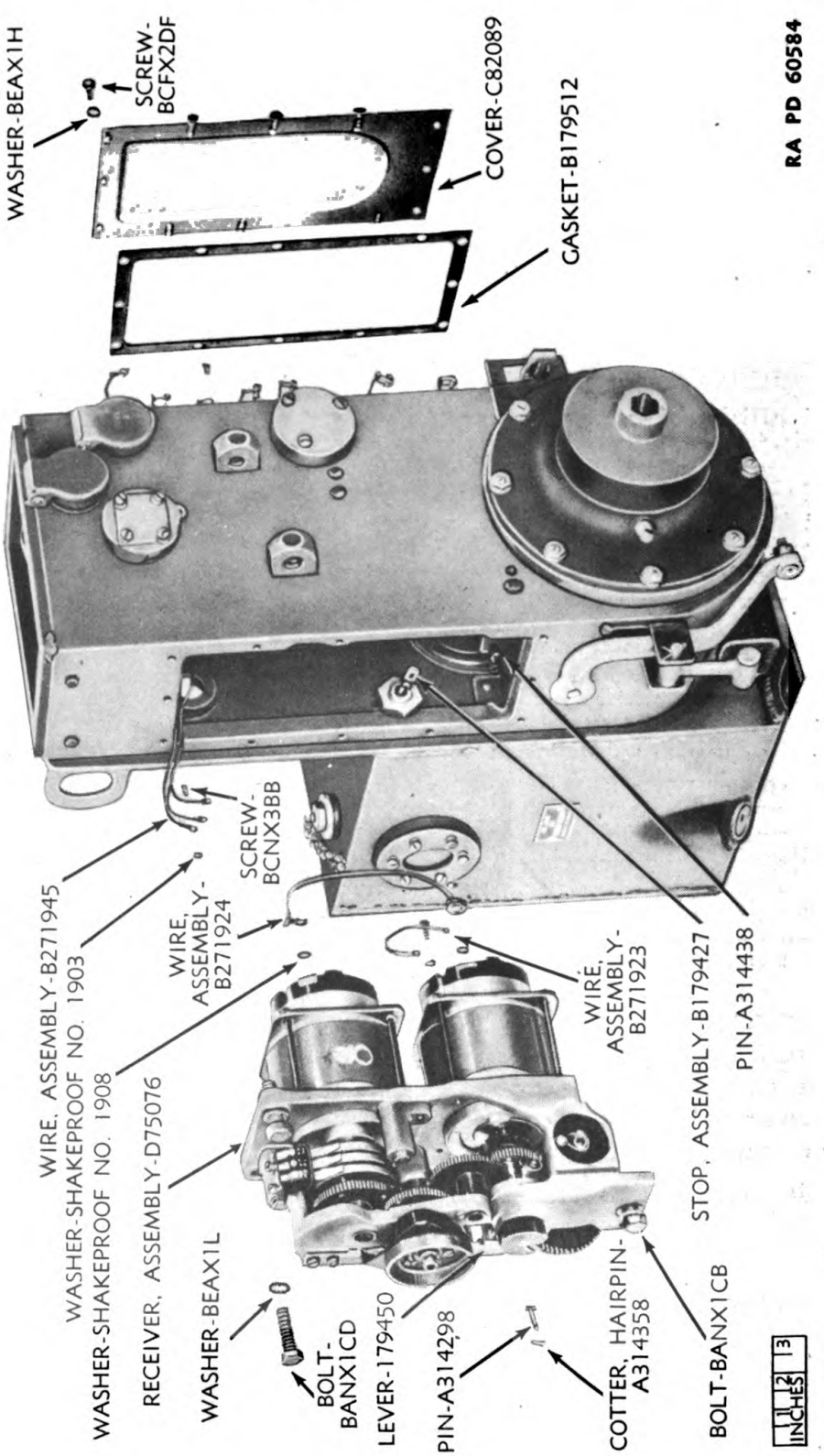


Figure 41—Removal of Receiver Assembly D75076

(10) LOOSENING OF FOLLOWER NUT (figs. 38 and 38A). The follower nut is threaded into the main case. Back it out about one turn.

(11) REMOVAL OF INDUCTION MOTOR (figs. 38 and 38A). Remove the two hexagonal-head bolts 3/8-16 x 7/8 and tooth-type lock washers holding motor to main case. Lift off the motor by moving it horizontally away from follower nut. Be careful not to damage the motor leads. Lift off shims A314326 and A314327.

(12) REMOVAL OF FOLLOWER NUT (figs. 38 and 38A). Unscrew the follower nut from main case. Lift out gland A314428, ring A314426, gland A314427, and gasket A314409B.

69. REMOVAL OF RECEIVER ASSEMBLY (fig. 41).

a. Outline of Procedure

(1) Remove cover C82089.
(2) Disconnect wires from synchros.
(3) Disconnect wires from contact brush.
(4) Disconnect stop assembly.
(5) Remove receiver assembly.

b. Detailed Description of Procedure.

(1) REMOVAL OF COVER C82089 (fig. 41). Remove the twelve 1/4-20 x 1/2 fillister-head machine screws and tooth-type lock washers holding cover to main case. Lift off cover and gasket B179512.

(2) DISCONNECTION OF WIRES FROM SYNCHROS (fig. 41). Remove the screws holding wires to synchro repeater and to synchro transmitter (fig. 40). Wires going to the repeater are marked "C" for coarse data system. Wires going to transmitter are marked "F" for fine data system. Lift off the wires and replace the screws.

(3) DISCONNECTION OF WIRES FROM CONTACT BRUSH (figs. 41, 51, and 52). Remove the screws holding the three wires to the contact brush. Lift off the wires and replace the screws. The markings on the wire terminals correspond to the markings on the contact brush terminals.

(4) DISCONNECTION OF STOP ASSEMBLY (fig. 41). Remove the hairpin cotter and pin A314298 holding the stop assembly push-pull wire to lever B179450.

(5) REMOVAL OF RECEIVER ASSEMBLY (fig. 41). Remove the two 3/8-16 x 1 1/4 and one 3/8-16 x 7/8 hexagonal-head bolts and tooth-type lock washers holding the receiver assembly to the main case. Loosen the socket-head cap screws securing the change gear group to the shaft and slide the change gear group to the extreme right-hand position. Lift out the receiver assembly. NOTE: *Receiver assembly is dowel-pinned to main case by pin A314438.*

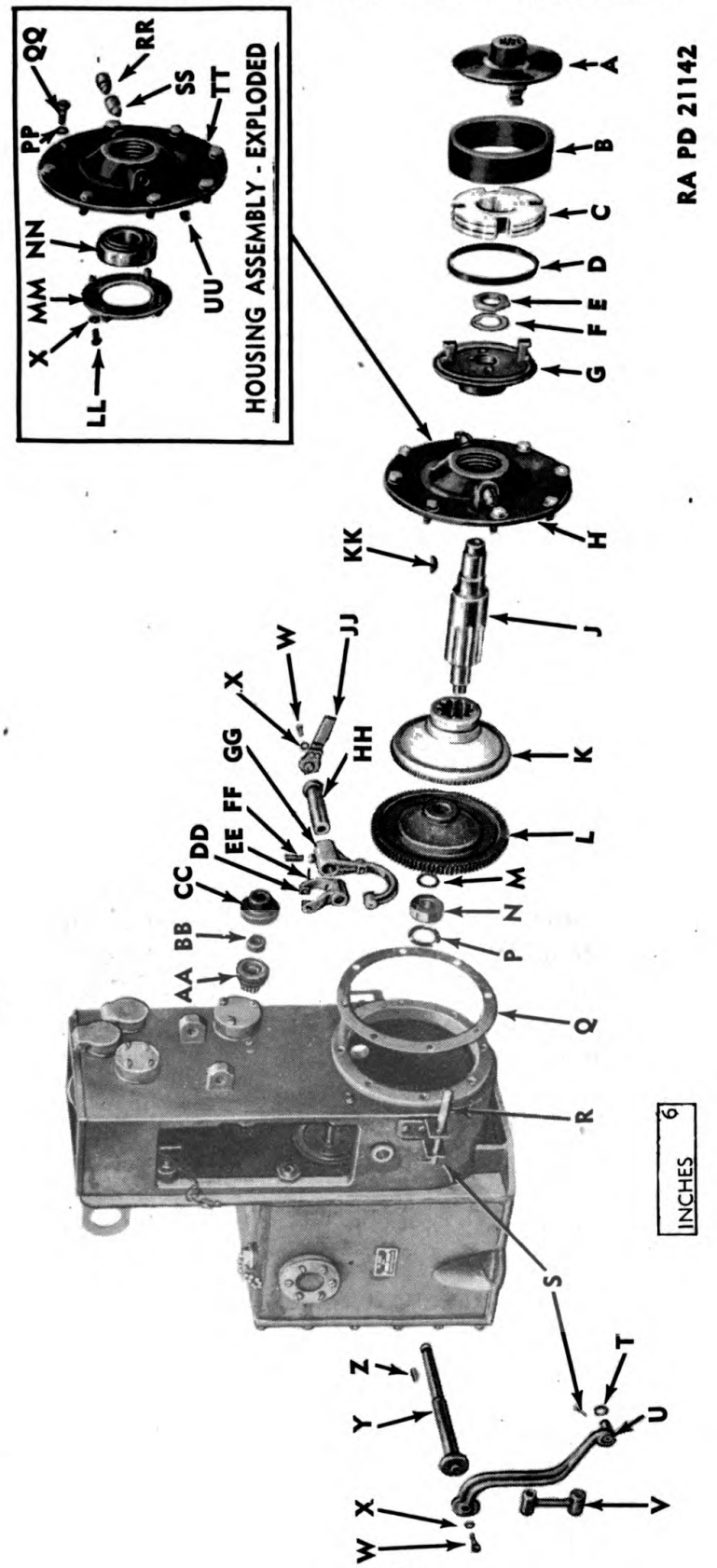


Figure 42—Removal of Clutch Assemblies

A — COUPLING - B172749
B — BAND - A182187
C — RING - A182199
D — RING, SPLIT - A182201
E — NUT - A182193
F — WASHER - A182206
G — COUPLING - B172748
H — HOUSING ASSEMBLY
J — SHAFT - B179489
K — GEAR, CLUTCH, ASSEMBLY - C82056
L — GEAR, OUTPUT, ASSEMBLY - C82053
M — WASHER - A314276
N — BEARING - .6693 X 1.5748 X .472 X .563
P — SPRING, LOADING - .971 X 1.562
Q — GASKET - A314274
R — PIN - A314317
S — PIN - BFAX1BD
T — WASHER - BEBX1H
U — LEVER, ASSEMBLY - B179462
V — LEVER - A314333
W — BOLT - BANX1AB
X — WASHER - BEAX1H
Y — SHAFT - B271258
Z — KEY - BGAX6B
AA — GEAR - B179439
BB — COLLAR - A314277
CC — COLLAR, CLUTCH, ASSEMBLY - B179495
DD — YOKE, ASSEMBLY - B271254
EE — PIN - BFAX1CD
FF — PIN - A314422
GG — YOKE, ASSEMBLY - B271256
HH — SHAFT - A314421
JJ — LEVER, ASSEMBLY - B179460
KK — KEY - BGAX12B
LL — BOLT - BANX4AE
MM — RETAINER - A314275
NN — BEARING - 1.1811 X 2.4409 X .630 X .9449
PP — WASHER - BEAX1K
QQ — BOLT - BANX1BA
RR — FITTING-CLDX6A } FITTING, LUBRICATING, PRESSURE-
SS — FITTING, 1/8-27 } VENT-RELIEF (14-15) A-7040076
TT — HOUSING - C82064
UU — PLUG - CPMX1BA

RA PD 21142A

Legend for Figure 42—Removal of Clutch Assemblies

70. REMOVAL OF CLUTCH YOKES (figs. 42, 43, and 44).

a. Outline of Procedure.

(1) Remove slewing clutch locking lever.

(2) Remove slewing clutch shaft, slewing clutch lever assembly, and slewing clutch yoke assembly.

(3) Remove slewing clutch collar assembly and spacer collar.

(4) Remove boresighting clutch lever assembly.

(5) Remove boresighting clutch and boresighting clutch yoke assembly.

b. Detailed Description of Procedure.

(1) REMOVAL OF SLEWING CLUTCH LOCKING LEVER (fig. 42). Remove cotter pin and pin A314317 holding locking lever A314333 to main case. Pin A314317 is a slip fit. Lift out the locking lever.

(2) REMOVAL OF SLEWING CLUTCH SHAFT, SLEWING CLUTCH LEVER ASSEMBLY, AND SLEWING CLUTCH YOKE ASSEMBLY (fig. 42). Remove cotter pin and pin A314422 from boresighting clutch yoke assembly B271256. Pull out the slewing clutch lever assembly and shaft B271258. Lift out the slewing clutch yoke assembly B271254.

(3) REMOVAL OF SLEWING CLUTCH COLLAR ASSEMBLY AND SPACER COLLAR (fig. 42). Slide clutch collar assembly, spacer collar, and gear B179439 off of the oil motor shaft.

(4) REMOVAL OF BORESIGHTING CLUTCH LEVER ASSEMBLY (fig. 42). Remove the ¼-20 x ⅞ hexagonal-head bolt and tooth-type lock washer holding the lever assembly B179460 to the boresighting clutch shaft. Lift off the lever assembly.

(5) REMOVAL OF BORESIGHTING CLUTCH SHAFT AND BORESIGHTING CLUTCH YOKE ASSEMBLY (fig. 42). Pull outward on end of shaft A314421. This shaft will come out easily and the yoke assembly B271256 will be disengaged. Lift out the yoke assembly.

71. REMOVAL OF OUTPUT SHAFT GROUP ASSEMBLY (fig. 42).

a. Detailed Description of Procedure. Remove the eight 5/16-18 x ¾ hexagonal-head bolts and tooth-type lock washers holding boresighting clutch housing to main case. NOTE: *The grease fitting must be removed to gain access to one bolt.* Pull out on coupling assembly or tap it lightly. Lift out the complete group assembly.

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

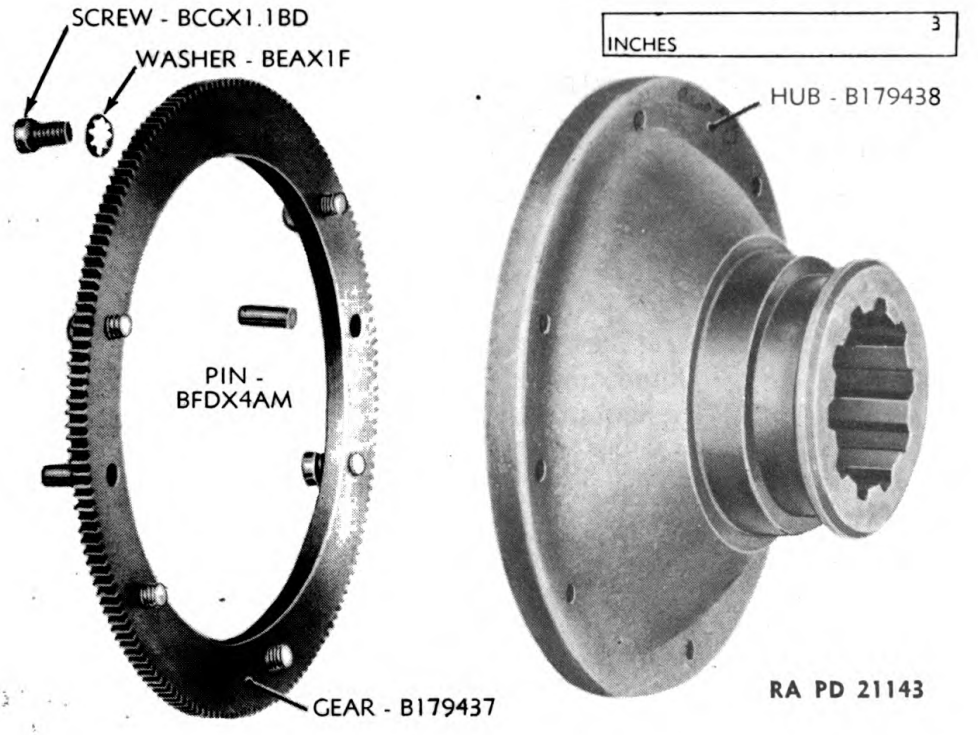


Figure 43—Dissassembly of Gear—Clutch Assembly C82056

72. REMOVAL OF TRANSMISSION AND VALVE ASSEMBLY (fig. 45).

a. Outline of Procedure.

(1) Disconnect hydraulic stop assembly from main case.
(2) Remove replenishing filter.
(3) Disconnect filter housing from main case.
(4) Remove oil reservoir inspection cover.
(5) Remove transmission and valve assembly.
(6) Disconnect wires from synchro differential.
(7) Remove oil retainer from main case (fig. 47).

b. Detailed Description of Procedure.

(1) DISCONNECTION OF HYDRAULIC STOP ASSEMBLY FROM MAIN CASE (fig. 43). Reach into compartment from which receiver assembly was removed and straighten the prongs of washer A314312. Remove nut A314313 and washer. Push stop assembly free of main case.

(2) REMOVAL OF REPLENISHING FILTER (fig. 45). Remove the six ¼-20 x ⅝ hexagonal-head bolts and tooth-type lock washers holding the filter head to filter housing. Lift out the filter head and filter.

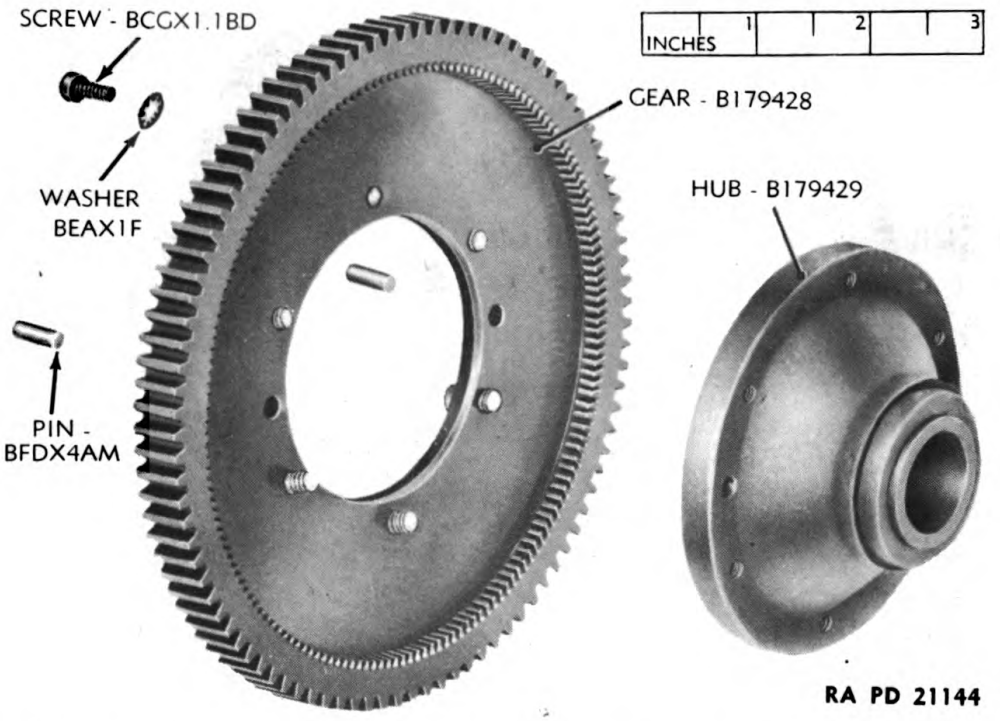


Figure 44—Disassembly of Gear—Output Clutch Assembly C82053

(3) DISCONNECTION OF FILTER HOUSING FROM MAIN CASE (fig. 45). Remove the six $\frac{5}{16}$-18 x $\frac{3}{4}$ hexagonal-head bolts and tooth-type lock washers holding the filter housing to inside of main case. Tap the filter housing lightly to break it away from the main case. Make sure gasket A314272 is not sticking to both the filter housing and the main case.

(4) REMOVAL OF OIL RESERVOIR INSPECTION COVER (fig. 45). Remove the ten $\frac{5}{16}$-18 x $\frac{7}{8}$ hexagonal-head bolts and tooth-type lock washers holding the cover B179457 to the oil reservoir cover. Lift off the inspection cover and gasket B179487.

(5) REMOVAL OF TRANSMISSION AND VALVE ASSEMBLY D75069 (fig. 45). Remove the six $\frac{5}{16}$-18 x $\frac{3}{4}$ hexagonal-head bolts and lock washers holding the reservoir cover to the main case. Grasp both shafts of the hydraulic unit and pull out of oil seal. NOTE: *Make certain that the limit stop assembly is free before pulling the unit.* When free of the seal, lift the unit as much as possible, crowding it to the left-hand side of the case to clear the linkage until the differential comes in contact with the lower frame edge. Change grip to upper and lower edge of the reservoir cover and lift to clear the differential. Crowd the unit to extreme left until clearance of

the high pressure relief valve is assured. Raise the unit, and bring back to straight position to clear the filter housing. Place the transmission and valve assembly on the bench alongside the main case. Remove the screw holding clip A314349 (fig. 47) to the main case. Remove gaskets B179488, A314272, and A314332.

(6) DISCONNECTION OF WIRES FROM SYNCHRO DIFFERENTIAL (fig. 45). Remove the six screws holding the wires of wire assembly D75085 to the differential. Lift off the wire terminals and replace the screws.

(7) REMOVAL OF OIL RETAINER FROM MAIN CASE (fig. 47). Press it from oil reservoir into the receiver compartment of the main case. Lift it out. NOTE: *Pressing the retainer in the other direction may damage it.*

73. REMOVAL OF PUSH BUTTON SWITCH ASSEMBLY, TERMINAL BOARD ASSEMBLY, AND INSULATION PLATE (fig. 46).

a. Outline of Procedure.

(1) Remove push button switch cover assemblies.

(2) Remove switch anchoring nuts.

(3) Disconnect all wires leading from terminal board.

(4) Remove push button switch assembly and terminal board assembly.

(5) Remove insulation plate.

b. Detailed Description of Procedure.

(1) REMOVAL OF PUSH BUTTON SWITCH COVER ASSEMBLIES (fig. 46). Remove the eight 0.164-32 x 3/8 flat-head machine screws holding the two cover assemblies to the main case. Lift off the two cover assemblies, two neoprene disks, two spring retainers, and two compression springs.

(2) REMOVAL OF SWITCH ANCHORING NUTS (fig. 46). Remove the four hexagonal nuts holding the two push button switches to the main case. Each pair of these nuts is thread-locked and the outside nut must be turned first.

(3) DISCONNECTION OF WIRES FROM TERMINAL BOARD (fig. 46). Remove the screws holding the wires leading from the terminal board. Do this one at a time, removing one wire and replacing the screw before removing another screw.

(4) REMOVAL OF PUSH BUTTON SWITCH ASSEMBLY AND TERMINAL BOARD ASSEMBLY (fig. 46). Remove the four 0.190-32 x 3/8 fillister-head machine screws and tooth-type lock washers holding the terminal board assembly to the main case. Lift out terminal board

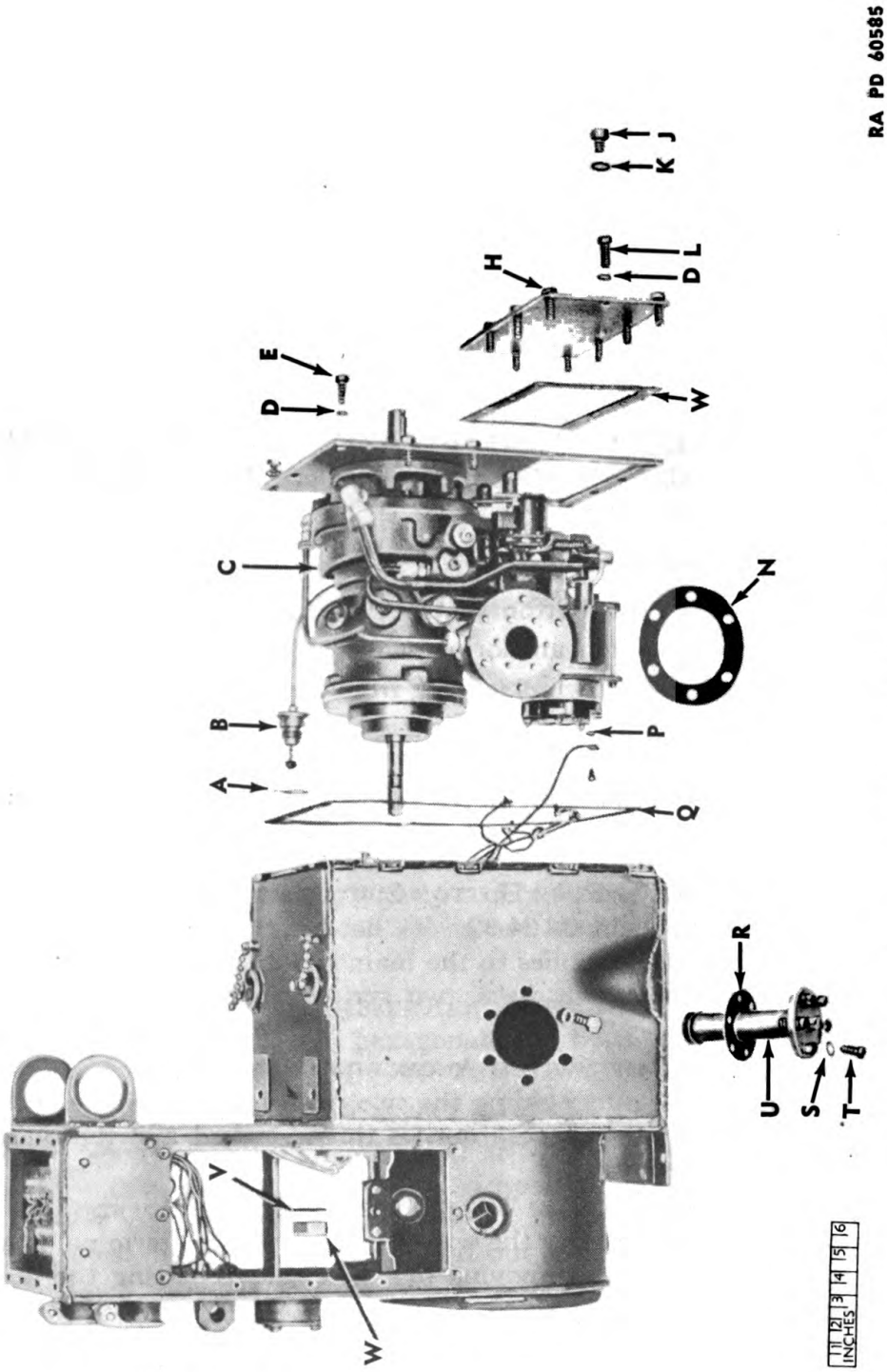
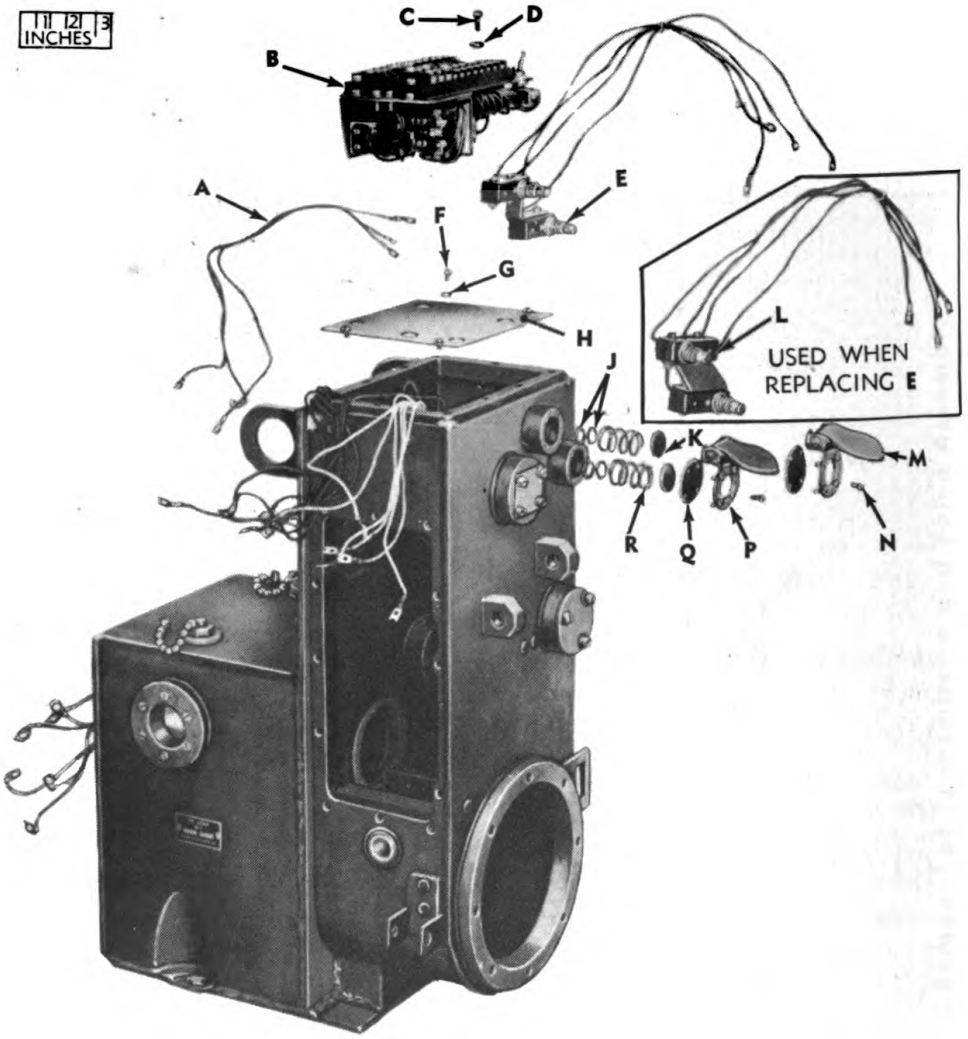


Figure 45—Removal of Transmission and Valve Assembly

A — GASKET-A314332
B — STOP, ASSEMBLY-B179427
C — TRANSMISSION AND VALVE, ASSEMBLY-D75069
D — WASHER-BEAX1K
E — BOLT-BANX1BA
H — COVER-B179457
J — PLUG-A182197
K — GASKET-A314409C
L — BOLT-BANX1BB
M — GASKET-B179487
N — GASKET-A314272
P — WASHER, SHAKEPROOF NO. 1908
Q — GASKET-B179488
R — GASKET-A314303
S — WASHER-BEAX1H
T — BOLT-BANX4AE
U — OIL FILTER
V — WASHER-A314312
W — NUT-A314313

RA PD 60585A

Legend for Figure 45—Removal of Transmission and Valve Assembly



A — WIRE, ASSEMBLY - B271945
B — BOARD, TERMINAL, ASSEMBLY - D75084
C — SCREW - BCGX1.1BD
D — WASHER - BEAX1F
E — SWITCH, PUSH BUTTON ASSEMBLY *(WITH OLD STYLE BRACKET)* - C82067
F — SCREW - BCNX1FC
G — WASHER - BEAX1E
H — PLATE - B179533
J — LOCK NUT *(FOR PUSH BUTTON SWITCH)*
K — RETAINER - A314308
L — SWITCH, PUSH BUTTON ASSEMBLY *(WITH NEW STYLE BRACKET)*
M — COVER, ASSEMBLY - B271273
N — SCREW - BCKX1EE
P — COVER, ASSEMBLY - B271272
Q — DISK - A314306
R — SPRING - A314309

RA PD 21146

Figure 46—Removal of Terminal Board Assembly, Push Button Switches, and Plates B179533

assembly and push button switch assembly. NOTE: *Lift the toggle-switch end of the terminal board assembly out first.*

(5) REMOVAL OF INSULATION PLATE (fig. 46). Remove the four 0.164-32 x ¼ round-head machine screws and tooth-type lock washers holding plate to main case. Lift out the plate.

74. REMOVAL OF WIRE ASSEMBLY D75085 (fig. 47).

a. Outline of Procedure.

(1) Remove wire seal retaining flange.
(2) Remove wire assembly.

b. Detailed Description of Procedure.

(1) REMOVAL OF WIRE SEAL RETAINING FLANGE (fig. 47). Remove the three ¼-20 x ½ hexagonal-head bolts and tooth-type lock washers holding the flange A314314 to the main case. Lift out of flange.

(2) REMOVAL OF WIRE ASSEMBLY D75085 (fig. 47). Pull the wire assembly out through the opening provided by the removal of cover C82089 (fig. 41).

75. DISASSEMBLY OF INDUCTION MOTOR.

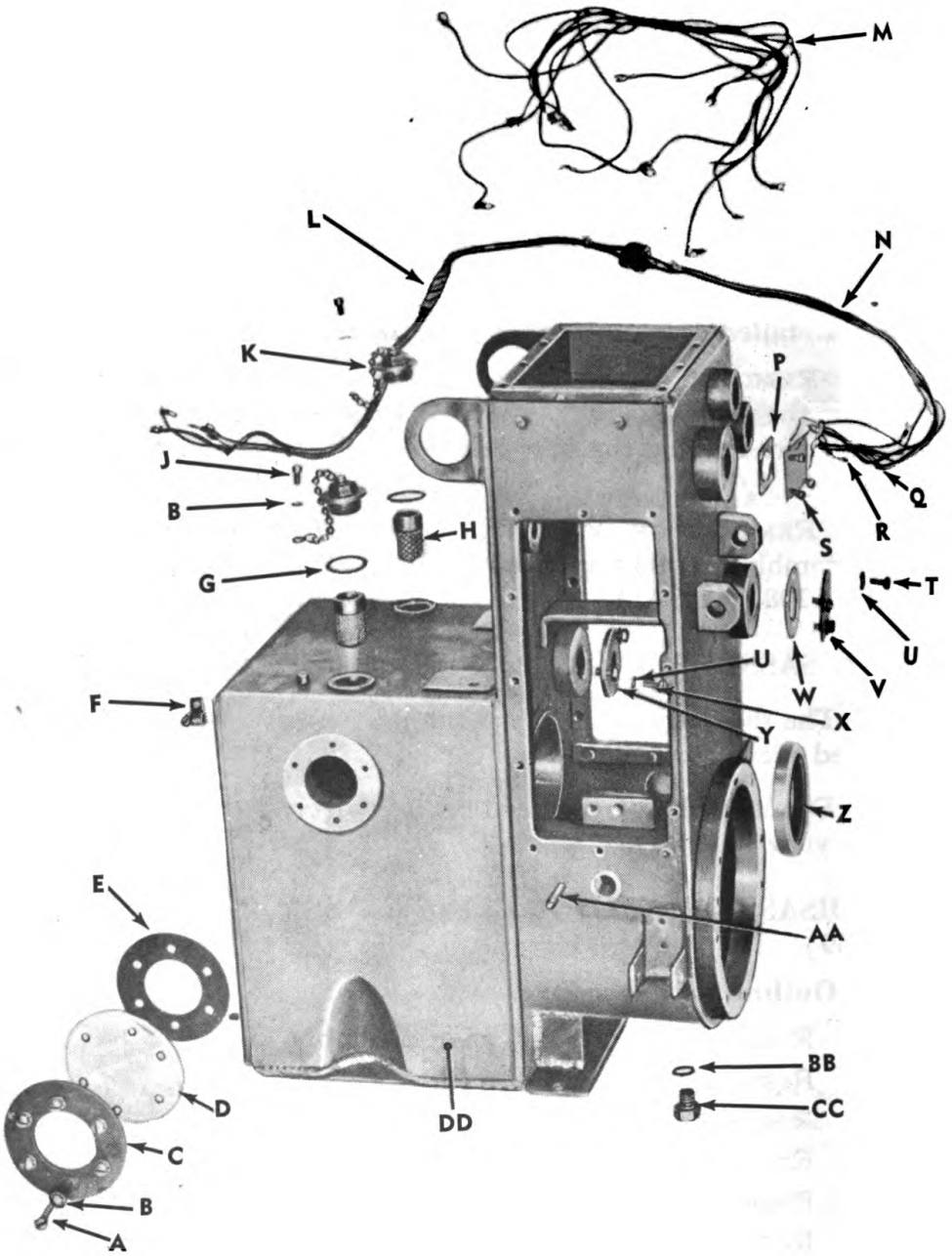
a. The disassembly of the induction motor is apparent from the exploded view (fig. 49).

b. Disassembly of terminal board cover is apparent from exploded view (fig. 50).

76. DISASSEMBLY OF RECEIVER ASSEMBLY (figs. 51 through 59).

a. Outline of Procedure.

(1) Remove bracket and gear assembly.
(2) Remove idler gear assembly.
(3) Remove shaft group assembly.
(4) Remove lever group assembly.
(5) Remove torsion spring support assembly and torsion spring.
(6) Remove contact brush.
(7) Remove contact gear and ring assembly.
(8) Remove repeater and contact assembly.
(9) Remove transmitter and coupling assembly.
(10) Remove worm wheel group assembly.
(11) Remove shaft group assembly.



RA PD 21147

Figure 47—Removal of Odds and Ends From Oil Gear M3

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

A — SCREW - BCGX1.1BG
B — WASHER - BEAX1F
C — FLANGE - A314300
D — WINDOW - A314301
E — GASKET - A314402
F — CLIP - A314349
G — GASKET - A314409A
H — FILTER - B271903
J — SCREW - BCWX3AA
K — PLUG, ASSEMBLY - B271460
L — TAPE - .010 X 1 X 2-1/2
M — WIRE, ASSEMBLIES - B271925, B271926, B271927 B271928, B271929, B271930 B271931 AND B271932
N — WIRE, LEAD, ASSEMBLY - D75085
P — GASKET - A314279
Q — SCREW - BCGX1.1BF
R — WASHER - BECX1E
S — COVER - A314278
T — SCREW - BCFX2DF
U — WASHER - BEAX1H
V — COVER - A314328
W — GASKET - A314396
X — BOLT - BANX4AA
Y — FLANGE - A314314
Z — RETAINER - A314265
AA — PIN - A314438
BB — GASKET - A314409C
CC — PLUG - A182197
DD — CASE, ASSEMBLY - D75081

RA PD 21147A

Legend for Figure 47—Removal of Odds and Ends From Oil Gear M3

b. Detailed Description of Procedure.

(1) REMOVAL OF BRACKET AND GEAR ASSEMBLY (fig. 51). Remove the three ¼-20 x 1-¾ hexagonal-head bolts and tooth-type lock washers holding the bracket and gear assembly to bracket D75075. Lift off the bracket and gear assembly. NOTE: *Two dowel pins locate the bracket and gear assembly in relation to bracket D75075.*

(2) REMOVAL OF IDLER GEAR ASSEMBLY B179454 (fig. 52). Remove nut BBSX1Z and washer A314228, holding idler gear assembly on lower stud A314227 (figs. 52 and 53). Lift off the idler gear assembly.

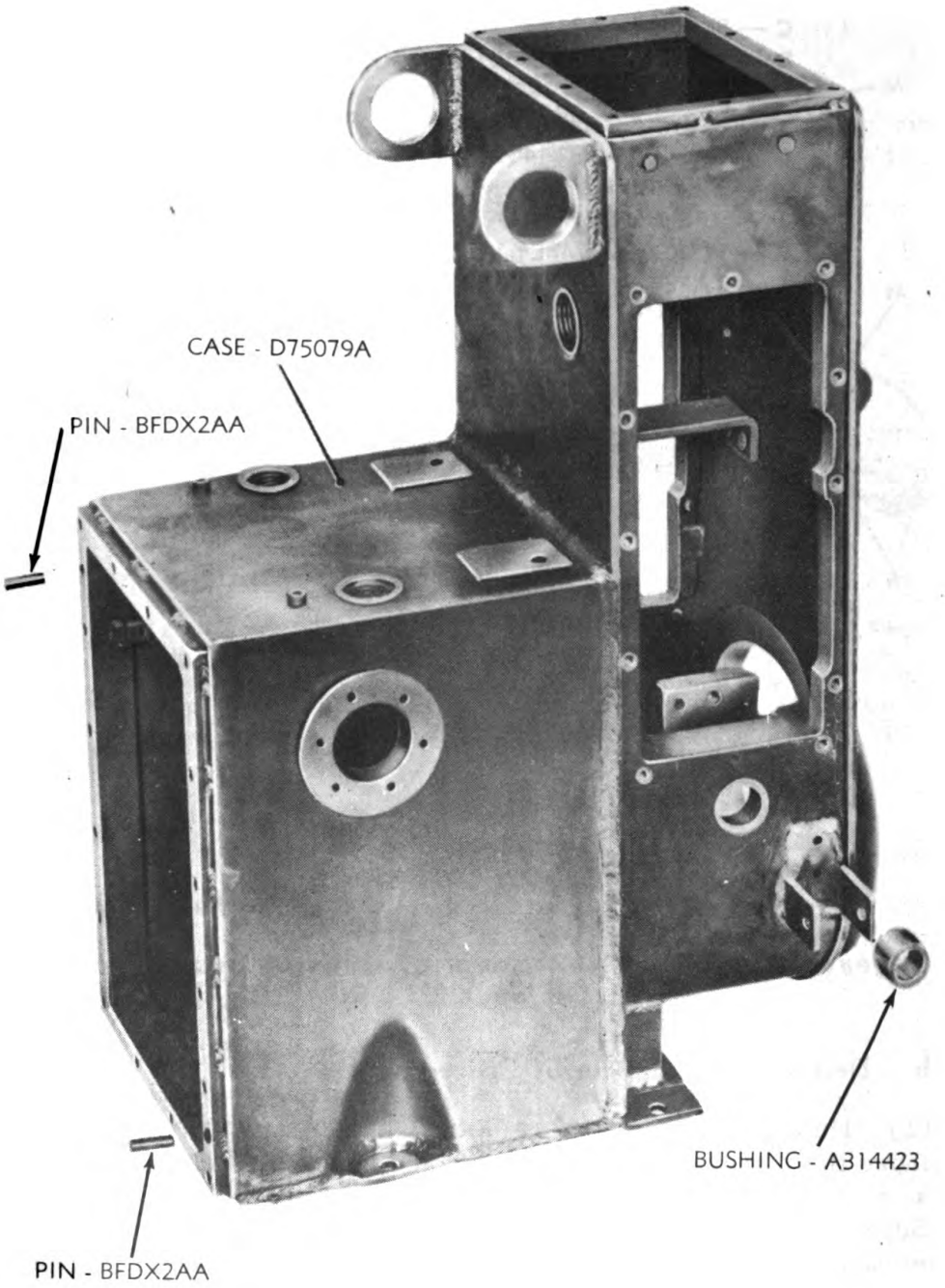
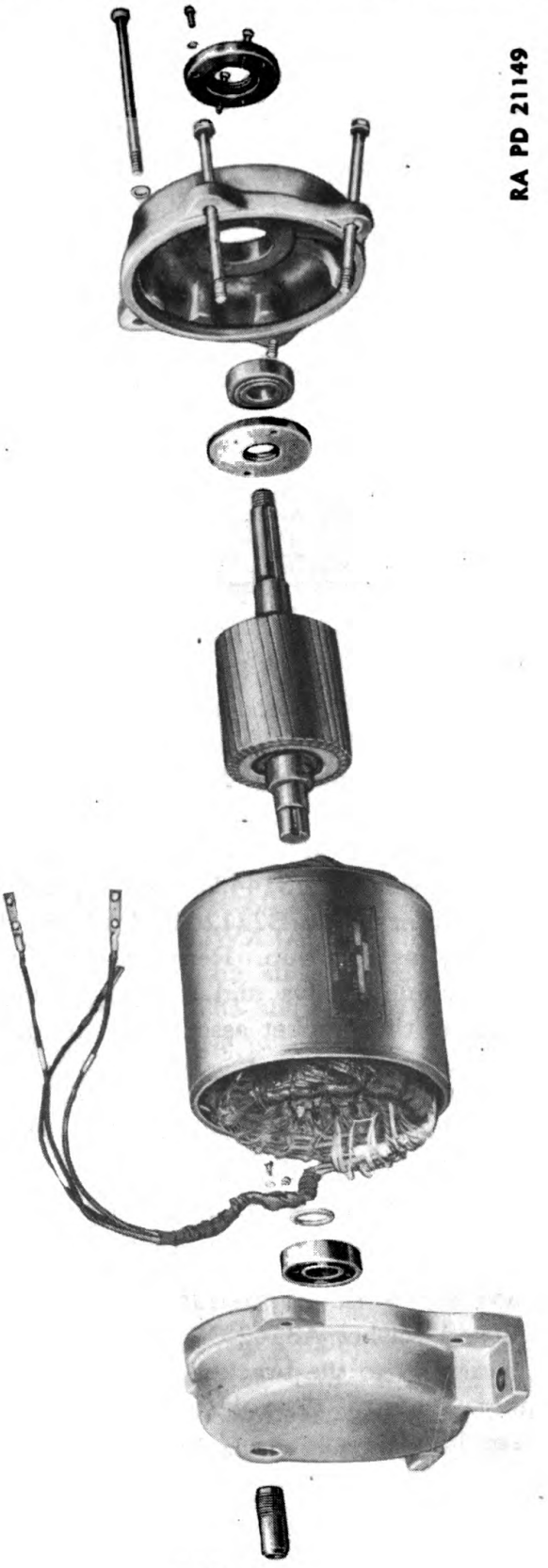


Figure 48—Disassembly of Case Assembly D75081

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21149

Figure 49—Disassembly of Induction Motor

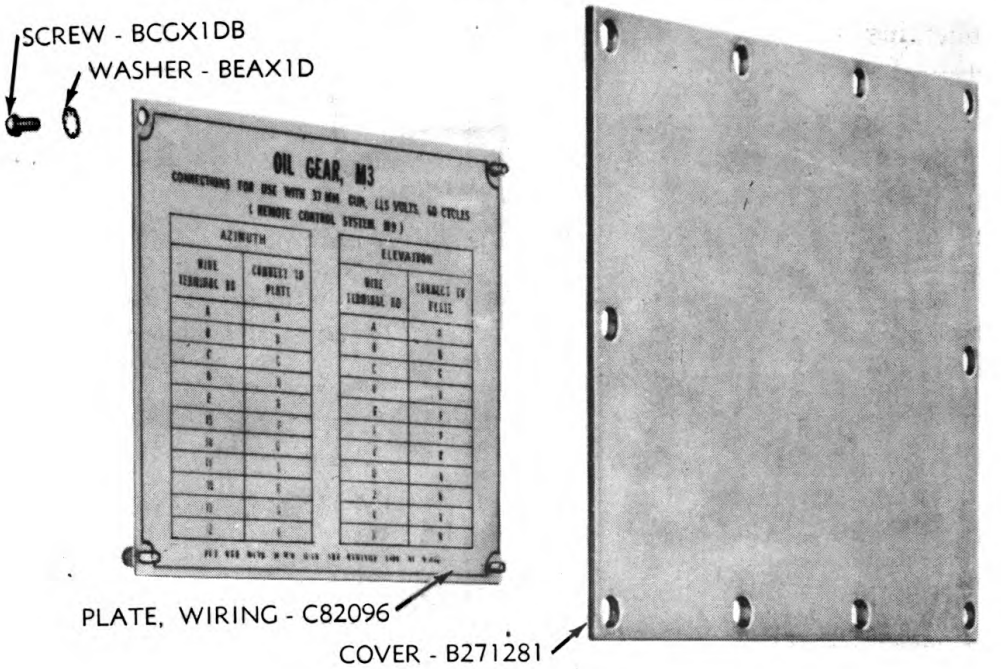


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Figure 50—Disassembly of Cover Assembly C82095

(3) REMOVAL OF SHAFT GROUP ASSEMBLY (fig. 52). Remove nut BBSX1Z and washer A314431 holding cup, cams, and adapter assembly on adapter shaft B271261. Pull off the cup, cams, and adapter assembly as a group. Remove the three 0.125-44 x 5/16 fillister-head machine screws and tooth-type lock washers holding bearing retainer to the bracket assembly. Lift out the retainer. Pull out the shaft and 3/8 x 7/8 x 7/32 ball bearing. The two Woodruff keys will be in the shaft. It may be necessary to replace nut on end of shaft and tap lightly in direction of removal to get the shaft out of gear B271259. Lift out the gear. Use a drift punch and lightly tap out disk A7575860 and 5/16 x 1/2 x 5/16 needle bearing. **CAUTION:** *This disk is very thin and will not stand a hard blow.*

(4) REMOVAL OF LEVER GROUP ASSEMBLY (fig. 54). Remove nut BBSX1Z and washer A314231 holding push-pull wire lever and roller lever assembly to the bracket assembly. Lift off the lever and lever assembly. Push the 1/2 x 11/16 x 3/4 needle bearing out of the bracket assembly.

(5) REMOVAL OF TORSION SPRING SUPPORT ASSEMBLY AND TORSION SPRING (fig. 54). Remove the two 10-32 x 3/8 fillister-head

machine screws and tooth-type lock washers holding the support assembly to the bracket assembly. Lift off support assembly and torsion spring.

(6) REMOVAL OF CONTACT BRUSH (fig. 52). Remove the two 8-32 x ½ fillister-head machine screws and tooth-type lock washers holding the contact brush to the bracket assembly. Lift off the brush.

(7) REMOVAL OF GEAR AND CONTACT RING ASSEMBLY (fig. 52). Remove nut BBSX1Z and washer A314228 holding gear and contact ring assembly on upper stud A314227 (fig. 53). Lift off gear and contact ring assembly.

(8) REMOVAL OF REPEATER AND CONTACT ASSEMBLY (fig. 51 and 58). Remove the four 10-32 x 2-¾ fillister-head machine screws, tooth-type lock washers and plate holding repeater and contact assembly to the bracket. Lift off repeater and contact assembly.

(9) REMOVAL OF TRANSMITTER AND COUPLING ASSEMBLY (figs. 51 and 59). Remove the four 0.138-32 x 5/16 fillister-head machine screws and tooth-type lock washers holding transmitter and coupling assembly to the worm wheel. Remove the four 0.190-32 x 2-¾ fillister-head machine screws, tooth-type lock washers and plate holding transmitter and coupling assembly to the bracket. Lift off transmitter and coupling assembly.

(10) REMOVAL OF WORM WHEEL GROUP ASSEMBLY (fig. 51). Loosen socket-head cap screw BCWX3AC and turn collar A314290 counterclockwise until it is off the shaft. Tap lightly on end of shaft and remove worm wheel. The shaft referred to is an integral part of the worm wheel. One of the two ⅜ x ⅞ x 7/32 ball bearings will probably come out with the worm wheel. Push the other one out.

(11) REMOVAL OF WORM SHAFT GROUP ASSEMBLY (fig. 51). Loosen socket-head cap screw BCWX3AD and pull the change gear pair C82087 from the worm shaft B179907. Lift out Woodruff key. Loosen screw BCGX1DE and unscrew the locking ring A314414 from the bracket. Remove nut BBSX1Z and washer A314431 from end of the worm shaft. Tap large end of shaft until ball bearings are free from bracket. Remove 0.2756 x 0.8661 x 0.2756 bearing and spacer A314413B from small end of shaft. Position remainder of assembly so 0.3150 x 0.8661 x 0.2756 bearing is back in the bracket. Slide worm toward small end of shaft and remove Woodruff key. Remove the worm shaft and washer A314294 by tapping on small end of shaft. Worm and spacer A314413A will drop out. Remove ball bearing from bracket.

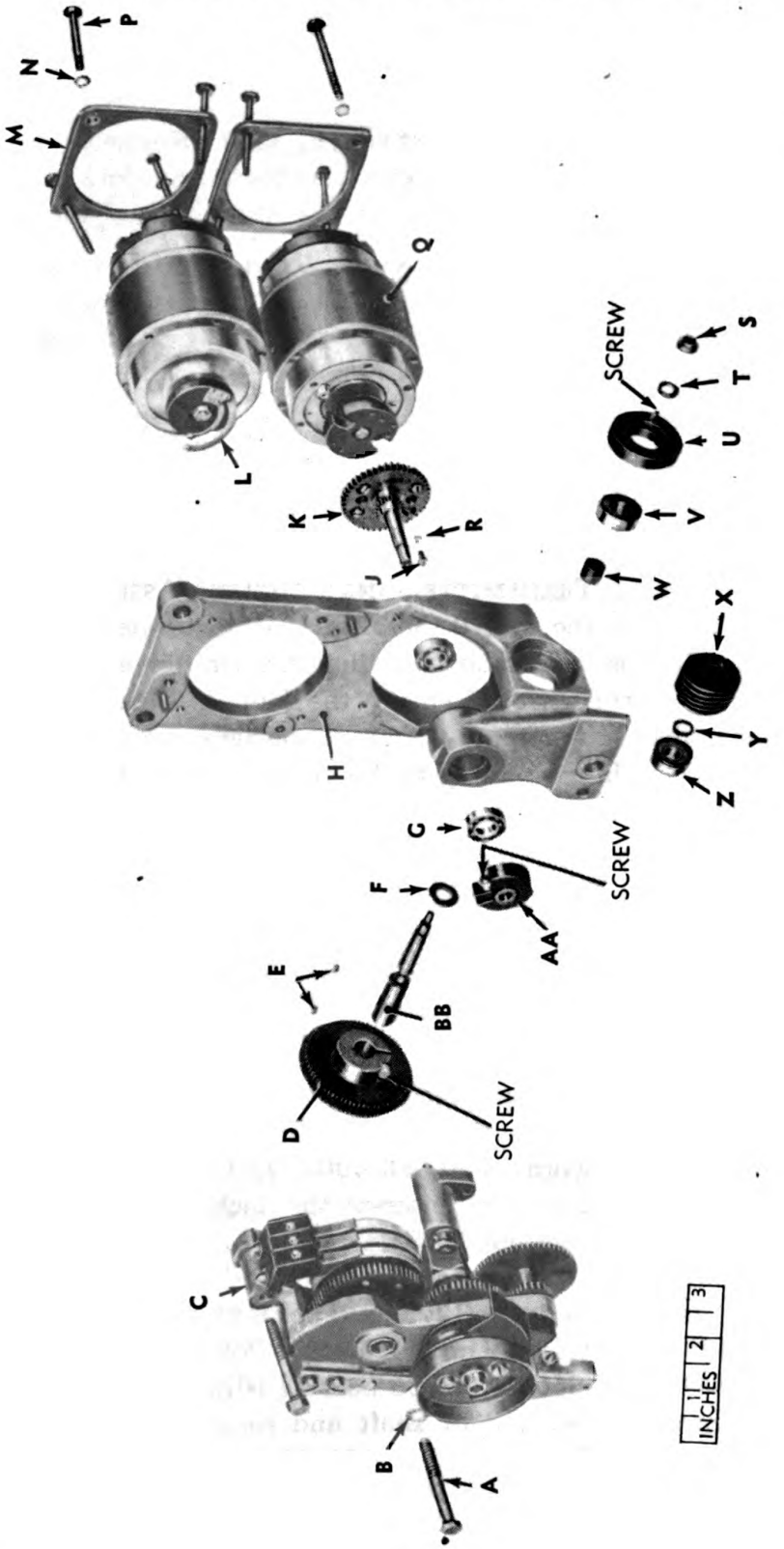
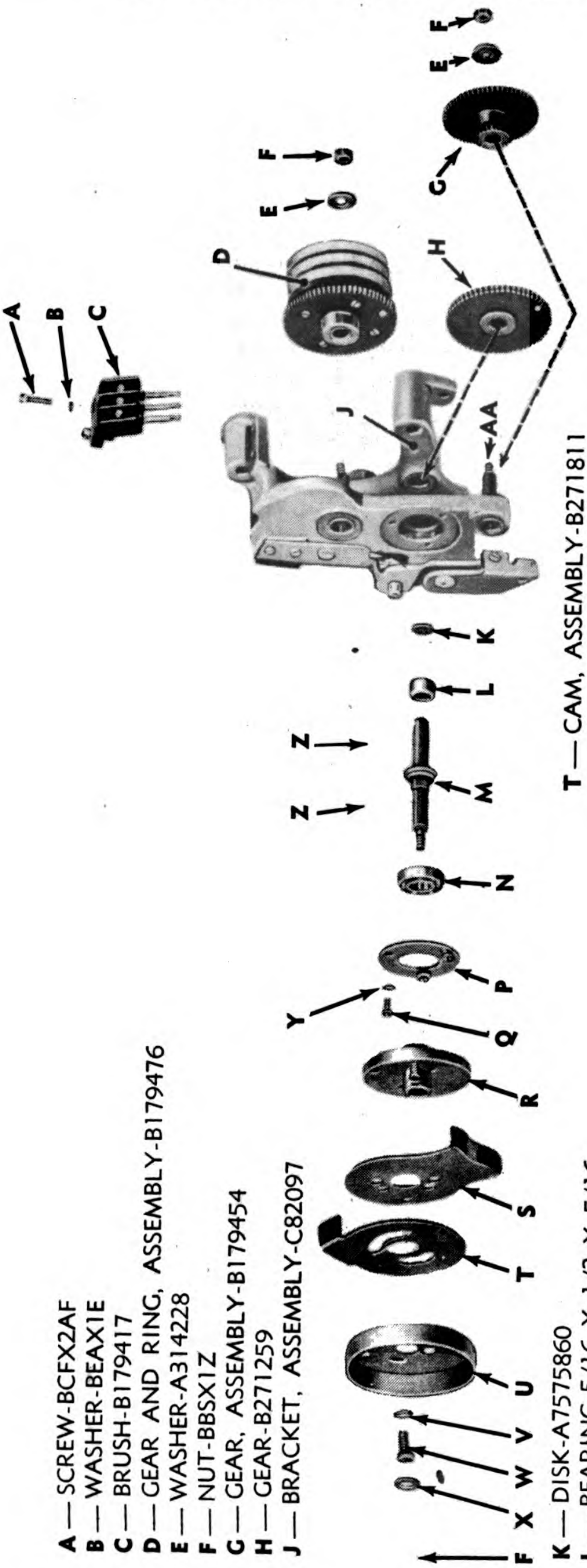


Figure 51—Disassembly of Receiver Assembly D75076

A — BOLT - BANX1AF
B — WASHER - BEAX1H
C — BRACKET, AND GEAR, ASSEMBLY - D75072
D — GEAR - C82087
E — KEY - BGAX3L
F — WASHER - A314294
G — BEARING - 3/8 X 7/8 X 7/32
H — BRACKET - D75075
J — SCREW - BCFX1ED
K — WHEEL, WORM - C82065
L — REPEATER AND CONTACT, ASSEMBLY - B179501
M — PLATE - A314412B
N — WASHER - BEAX1F
P — SCREW - BCGX1.1BU
Q — TRANSMITTER AND COUPLING, ASSEMBLY - B179493
R — WASHER - BEAX1D
S — NUT - BBSX1Z
T — WASHER - A314431
U — RING - A314414
V — BEARING - .2756 X .8661 X .2756
W — SPACER - A314413B
X — WORM - A314295
Y — SPACER - A314413A
Z — BEARING - .3150 X .8661 X .2756
AA — COLLAR - A314290
BB — SHAFT - B197907

RA PD 21153A

Legend for Figure 51—Disassembly of Receiver Assembly D75076



A — SCREW-BCFX2AF
B — WASHER-BEAX1E
C — BRUSH-B179417
D — GEAR AND RING, ASSEMBLY-B179476
E — WASHER-A314228
F — NUT-BBSX1Z
G — GEAR, ASSEMBLY-B179454
H — GEAR-B271259
J — BRACKET, ASSEMBLY-C82097
K — DISK-A7575860
L — BEARING-5/16 X 1/2 X 5/16
M — SHAFT-B271261
N — BEARING-3/8 X 7/8 X 7/32
P — RETAINER-A314415
Q — SCREW-BCCX1DD
R — ADAPTER, ASSEMBLY-B271262
S — CAM-B271263
T — CAM, ASSEMBLY-B271811
U — CUP-B271265
V — WASHER-BEAX1F
W — SCREW-BCCX1.1BF
X — WASHER - A314431
Y — WASHER-BEAX1D
Z — KEY-BCAX3L
AA — STUD-A314227

RA PD 60586

Figure 52—Disassembly of Bracket and Gear Assembly D75072

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

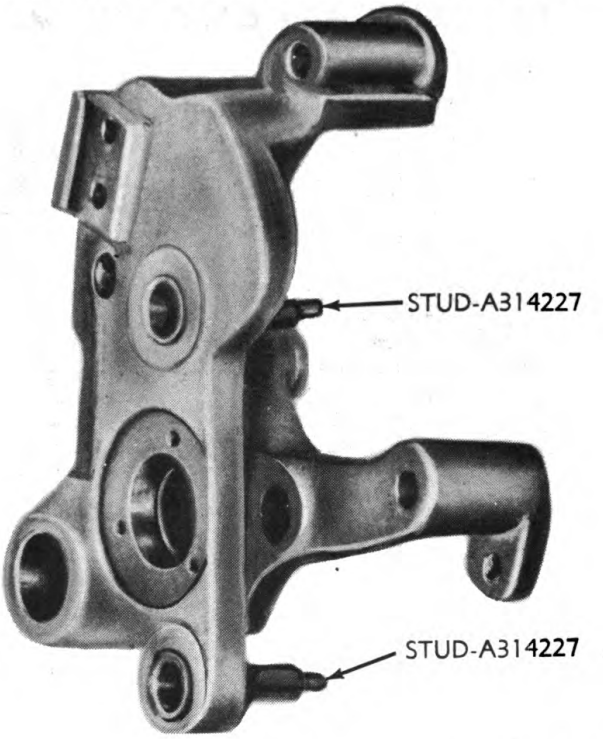


Figure 53—Bracket Assembly C82097

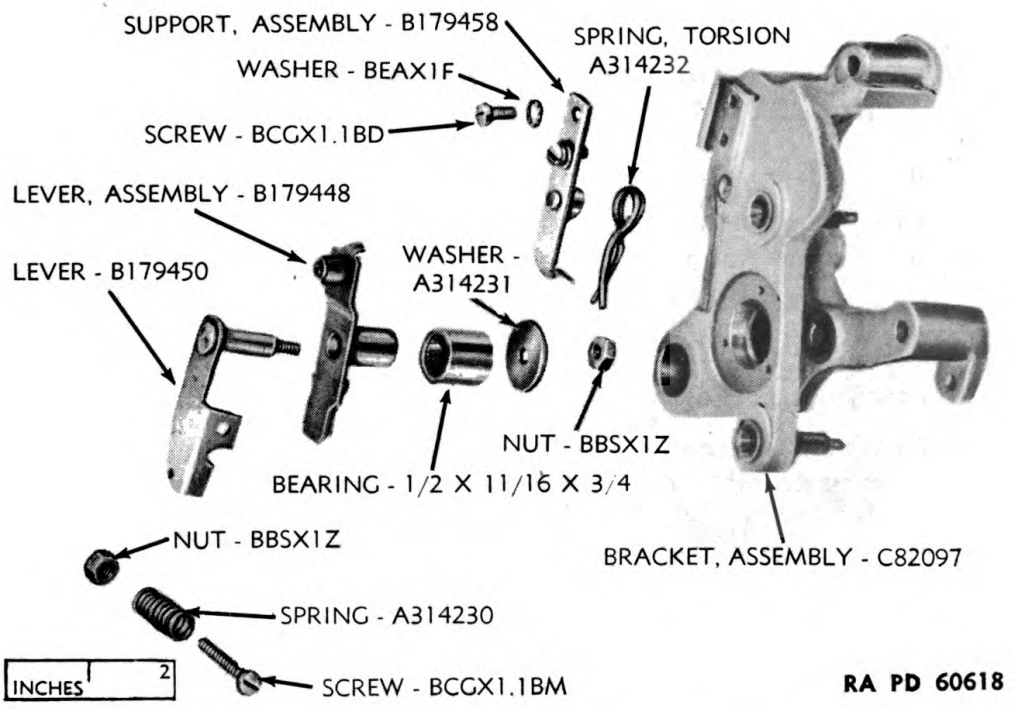


Figure 54—Final Disassembly of Bracket and Gear Assembly D75072

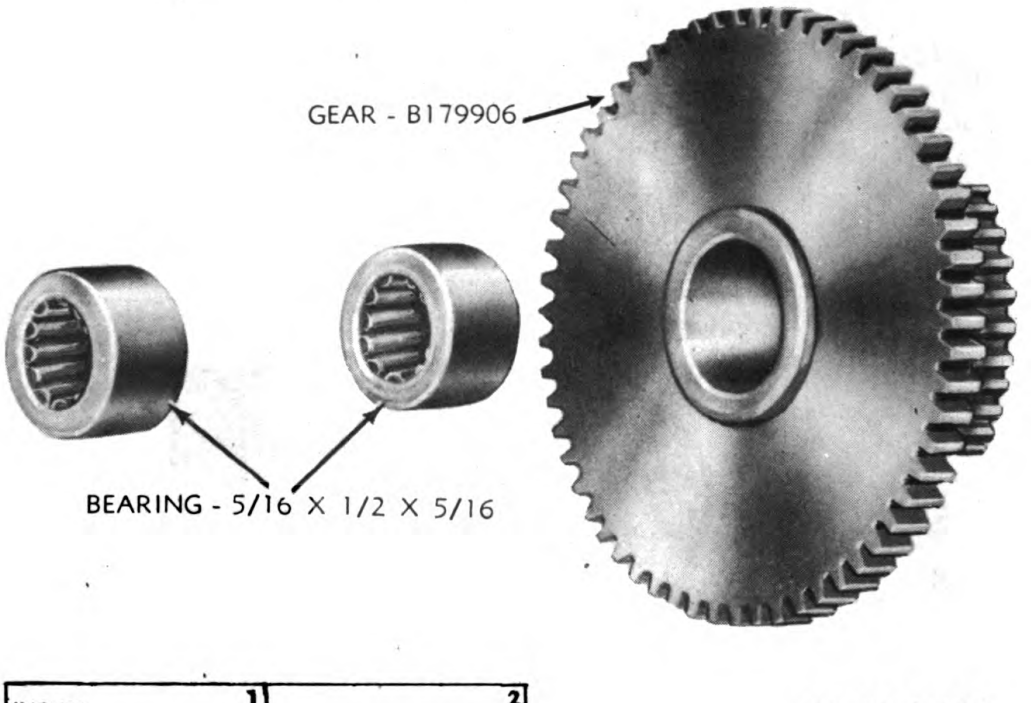


Figure 55—Disassembly of Gear Assembly B179454

77. DISASSEMBLY OF TRANSMISSION AND VALVE ASSEMBLY (fig. 49).

a. Outline of Procedure.

(1) Remove tubes, tube fitting, filter housing, and constant pressure valve assembly.

(2) Remove cover B179905.

(3) Remove hydraulic limit stop assembly.

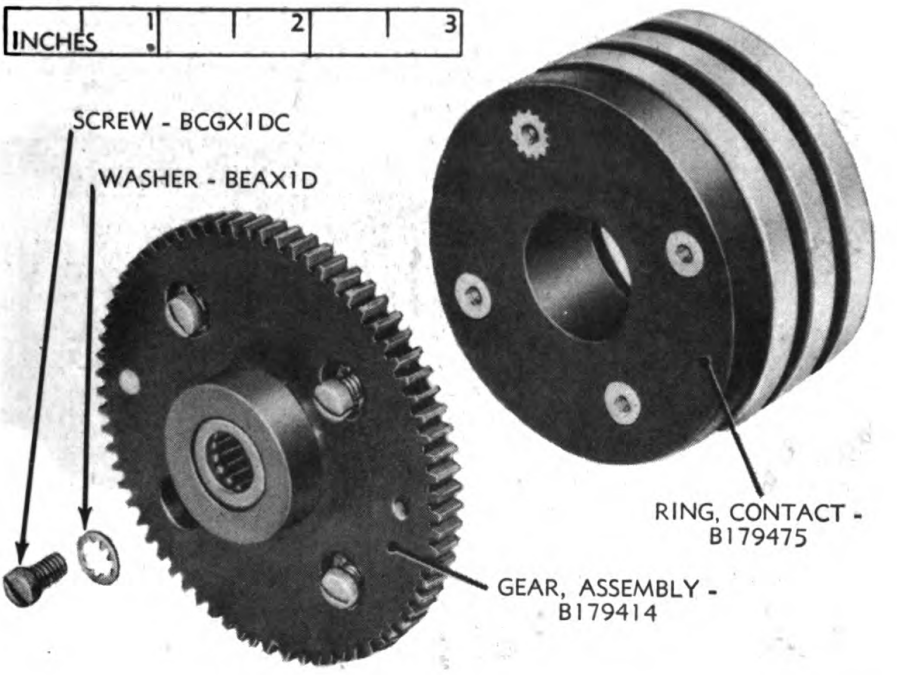
(4) Remove pin A314359.

(5) Remove screws holding valve assembly to hydraulic transmission assembly.

b. Detailed Description of Procedure.

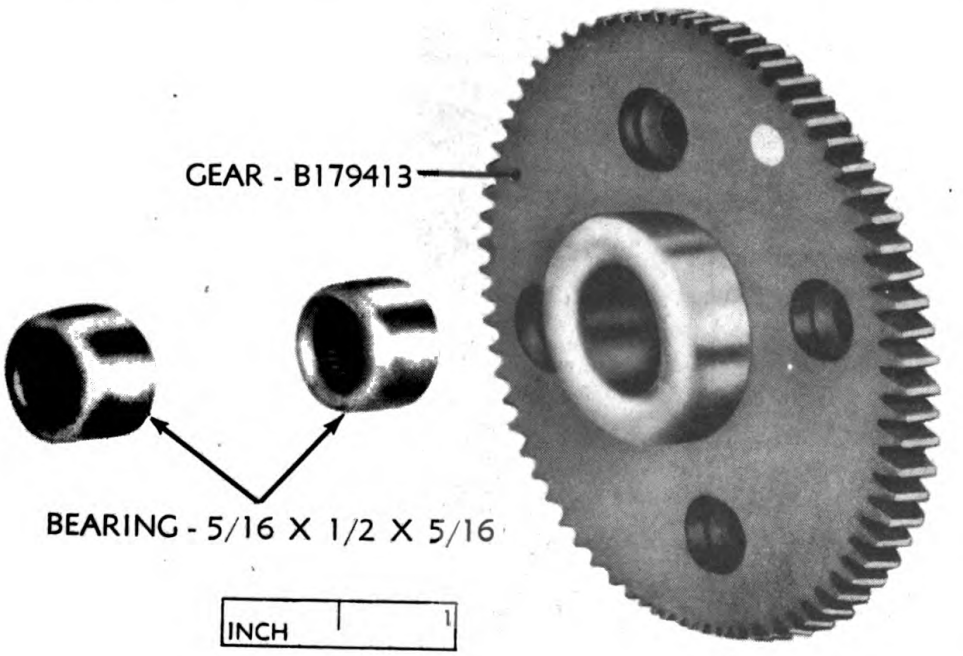
(1) REMOVAL OF TUBES, TUBE FITTINGS, FILTER HOUSING AND CONSTANT PRESSURE VALVE ASSEMBLY (fig. 49). Remove gear pump suction tube C82072. Remove tubes C82073 and C82074 supporting filter housing and valve assembly. Lift off the filter housing and valve assembly. Remove the three tube fittings from the hydraulic transmission.

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



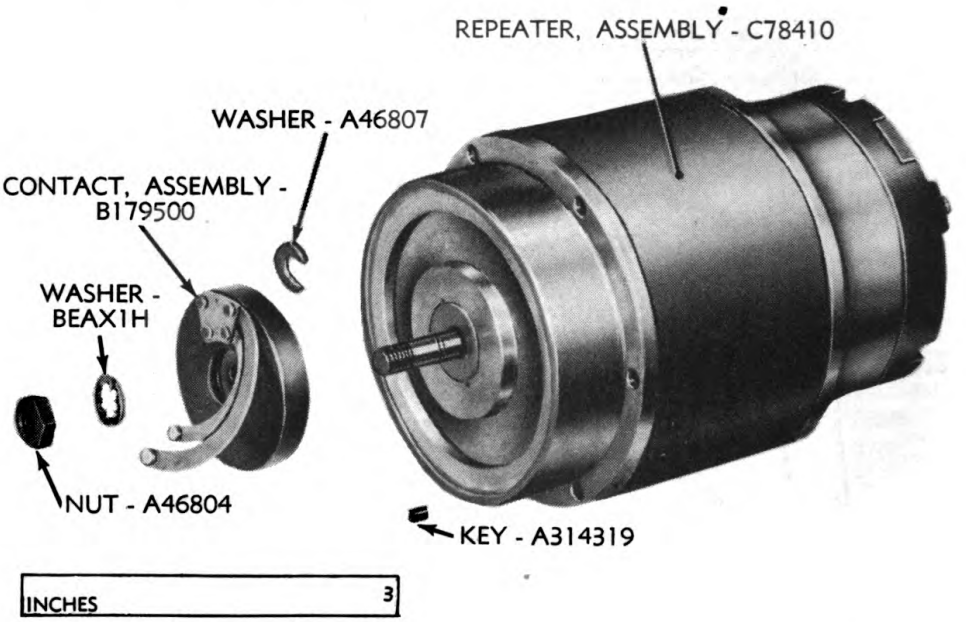
RA PD 21156

Figure 56—Disassembly of Gear and Contact Ring Assembly



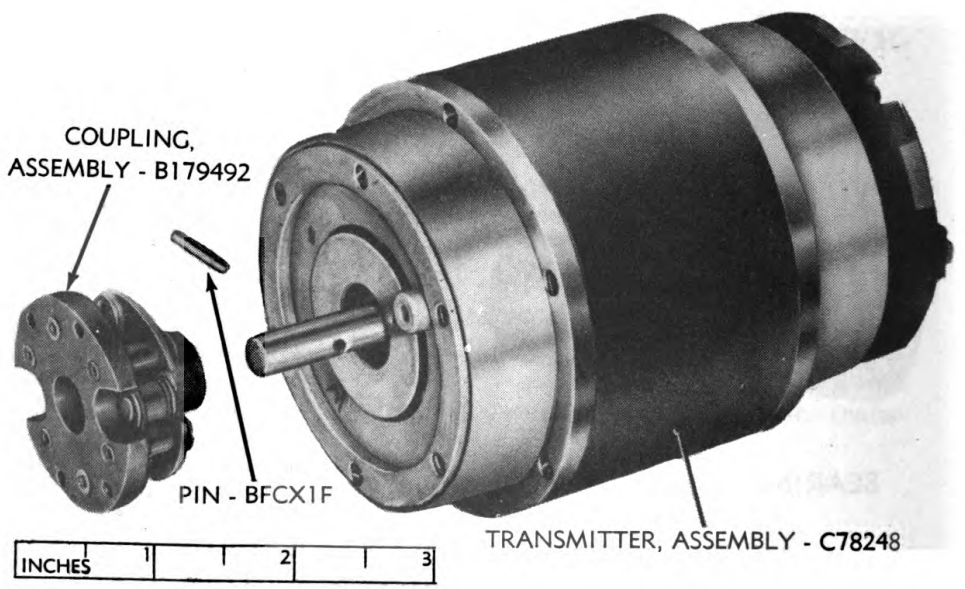
RA PD 21157

Figure 57—Disassembly of Gear Assembly B179414



RA PD 21158

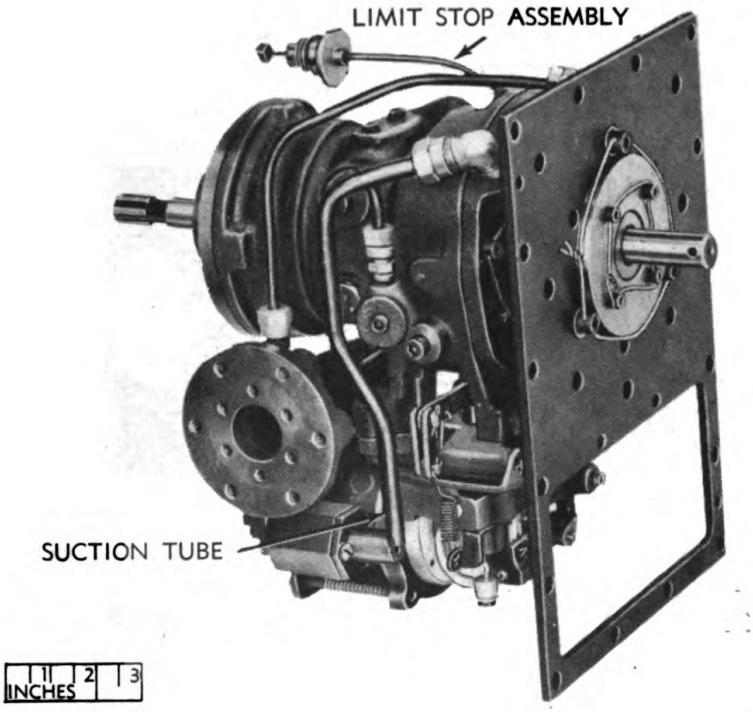
Figure 58—Disassembly of Repeater and Contact Assembly B179501



RA PD 21159

Figure 59—Disassembly of Transmitter and Coupling Assembly B179493

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21160

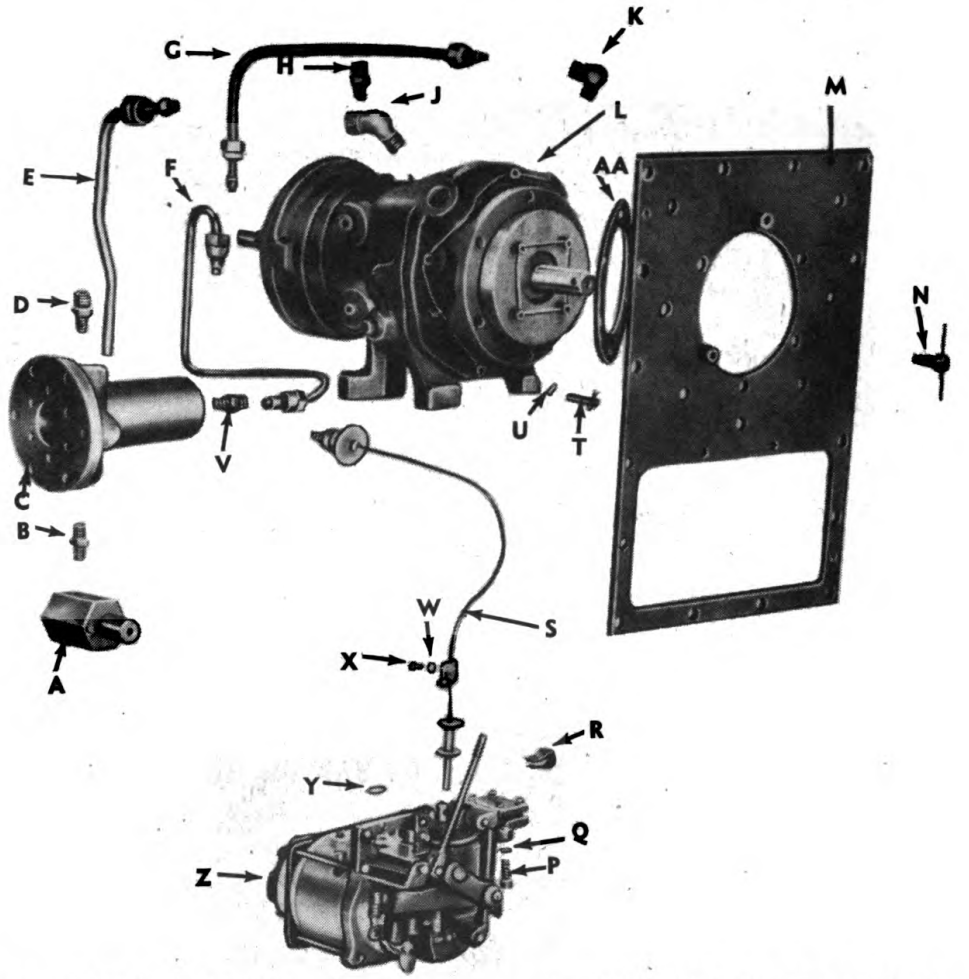
Figure 60—Transmission and Valve Assembly

(2) REMOVAL OF OIL RESERVOIR COVER (fig. 61). Remove the lock wire and three $\frac{5}{16}$-18 x $\frac{3}{4}$ socket-head cap screws holding the cover to the hydraulic transmission. Lift off the cover and gasket A314331. NOTE: *On some units it will be necessary to remove the socket-head cap screws at an earlier stage of disassembly.*

(3) REMOVAL OF HYDRAULIC LIMIT STOP ASSEMBLY (fig. 57). Remove the two 0.190-32 x $\frac{3}{8}$ fillister-head machine screws and tooth-type lock washers holding the stop assembly to valve assembly D75066. Lift off the stop assembly. CAUTION: *Do not bend or kink the stop assembly.*

(4) REMOVAL OF PIN A314359 (fig. 57). Remove hairpin cotter from one end of the pin. Use pliers to compress the C spring sufficiently to relieve the tension on the pin. Pull out pin.

(5) REMOVAL OF SCREWS HOLDING VALVE ASSEMBLY TO HYDRAULIC TRANSMISSION ASSEMBLY (fig. 61). Remove the four $\frac{1}{4}$-20 x $\frac{3}{4}$ hexagonal-head bolts, socket-head cap screws, and tooth-type lock washers holding valve assembly D75066 to hydraulic transmission. Separate the two units, being careful not to bend the dither rod. The C spring will fall out. Lift off neoprene gasket A314354.



A — VALVE, ASSEMBLY-B179908
B — NIPPLE-A314437
C — HOUSING-C82069
D — FITTING, STRAIGHT-FOR 1/4 DIA. TUBE
E — TUBE-C82072
F — TUBE-C82074
G — TUBE-C82073
H — FITTING, STRAIGHT-FOR 1/4 DIA. TUBE
J — ELBOW, 90° FOR 3/8 DIA. TUBE
K — ELBOW, 90° FOR 1/4 DIA. TUBE
L — UNIT, HYDRAULIC TRANSMISSION, ASSEMBLY-D75082
M — COVER-B179905
N — SCREW-A314373
P — BOLT, HEX. HEAD-BANX1AA
Q — WASHER-BEAX1H
R — SPRING-A314344
S — STOP, ASSEMBLY-B179427
T — PIN-A314359
U — COTTER, HAIRPIN-A314356
V — FITTING, STRAIGHT-FOR 1/4 DIA. TUBE
W — WASHER-BEAX1F
X — SCREW-BCCX1.1BD
Y — GASKET-A314354
Z — VALVE, ASSEMBLY-D75066
AA — GASKET-A314331

RA PD 60587

Figure 61—Disassembly of Transmission and Valve Assembly

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

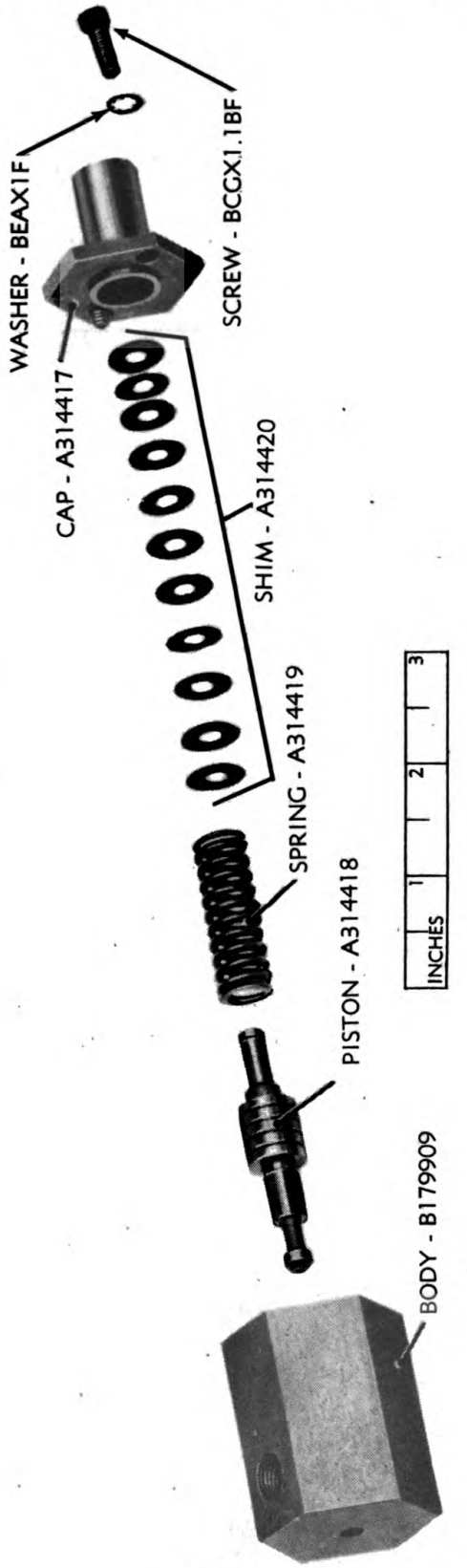


Figure 62—Disassembly of Valve Assembly B179908

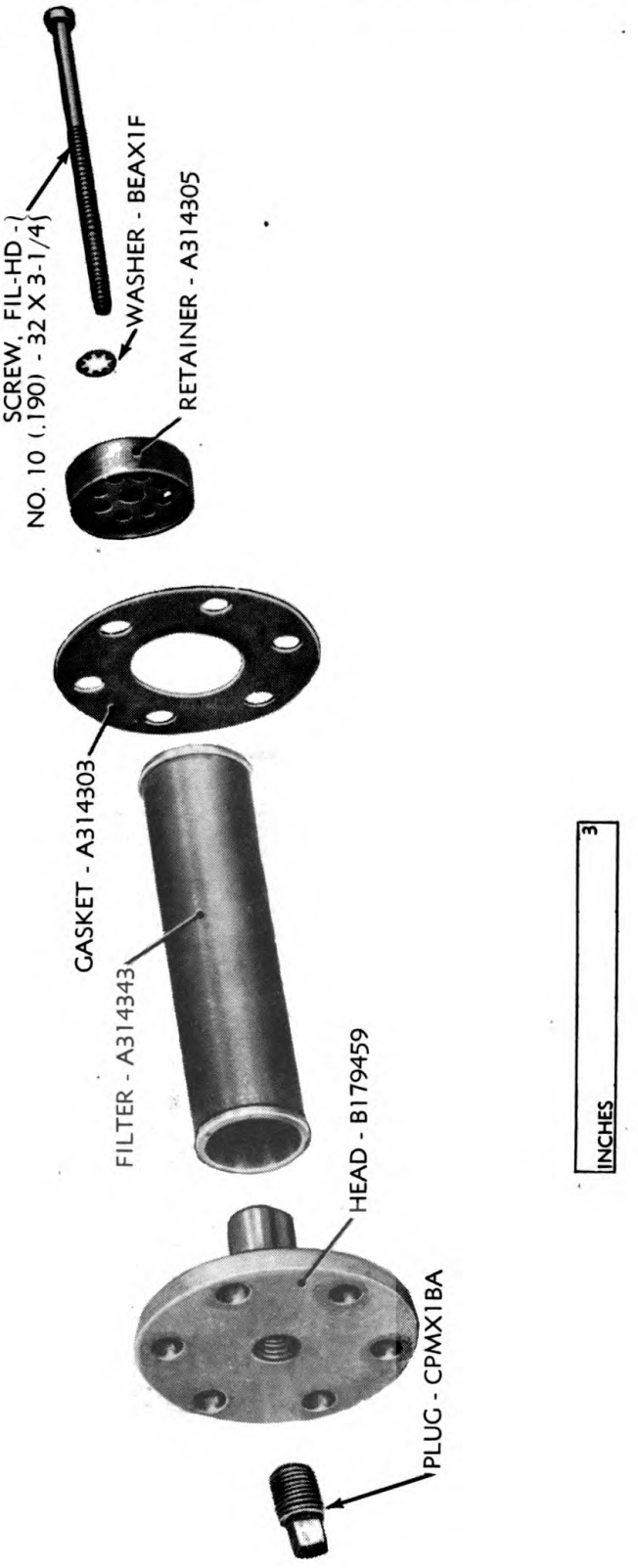
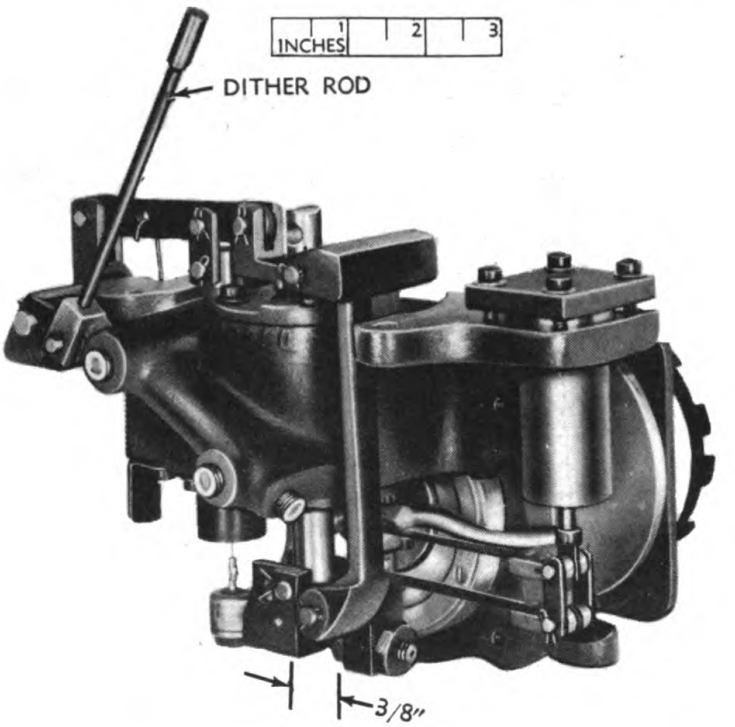


Figure 63—Filter Parts—Exploded View

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21164

Figure 64—Valve Assembly D75066

78. DISASSEMBLY OF VALVE ASSEMBLY D75066.

a. Outline of Procedure.

(1) Remove dither rod.

(2) Remove dither lever spring and dither lever spring bracket.

(3) Remove dither linkage

(4) Remove error corrector pivot link.

(5) Remove error corrector block.

(6) Remove error corrector link assembly.

(7) Remove differential and stop assembly and differential lever assembly.

(8) Remove oil dashpot cylinder and oil dashpot orifice assembly.

(9) Remove dither sleeve and pilot piston.

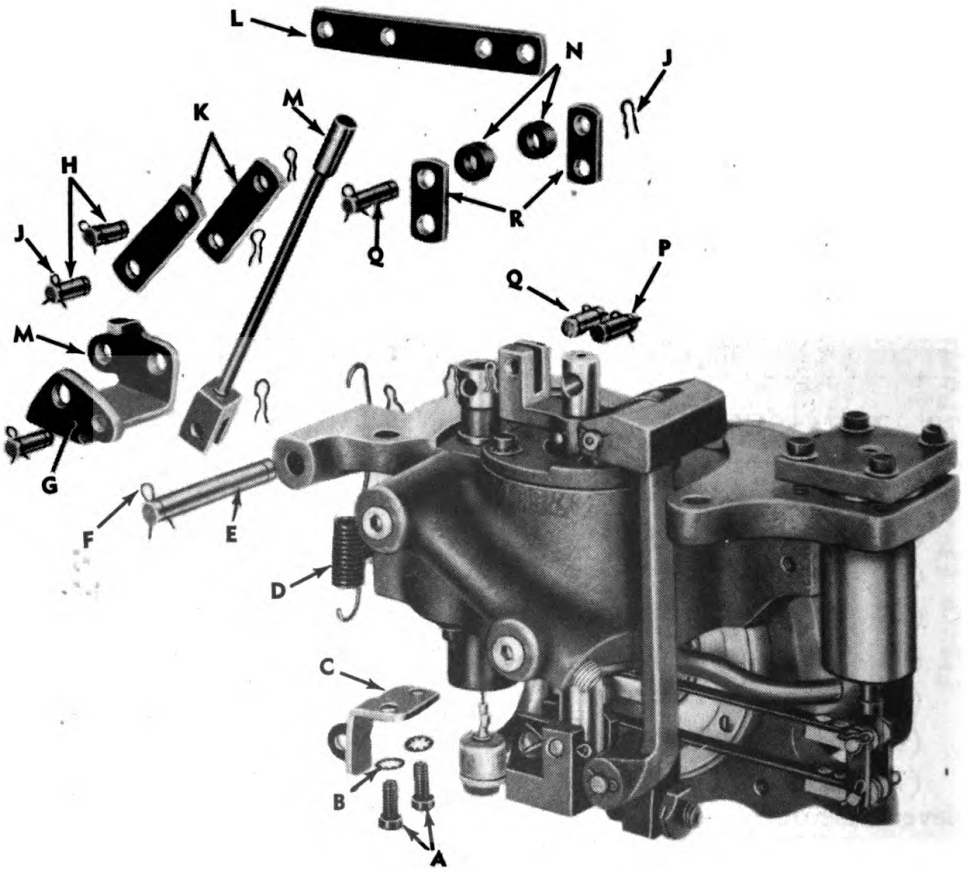
(10) Remove power piston shaft lower bushing and power piston assembly.

b. Detailed Description of Procedure.

(1) REMOVAL OF DITHER ROD (fig. 65). Remove hairpin cotter and pin A314361. Lift off dither rod.

ORDNANCE MAINTENANCE—REMOTE CONTROL SYSTEM M15 (FOR 40-MM GUN CARRIAGES M2, M2A1)

A — SCREW - BCFX2AD
B — WASHER - BEAX1E
C — BRACKET - B179508
D — SPRING - A314353
E — PIN - A314360
F — COTTER, HAIRPIN - A314356
G — LINK - B179426
H — PIN - A314361
J — COTTER, HAIRPIN - A314357
K — LINK - A314351
L — LEVER - A314352
M — ROD, DITHER - B179455
N — SPACER - A314355
P — PIN - A314323
Q — PIN - A314363
R — LINK - A314348



RA PD 21165

Figure 65—Removal of Dither Linkage From Valve Assembly D75066

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

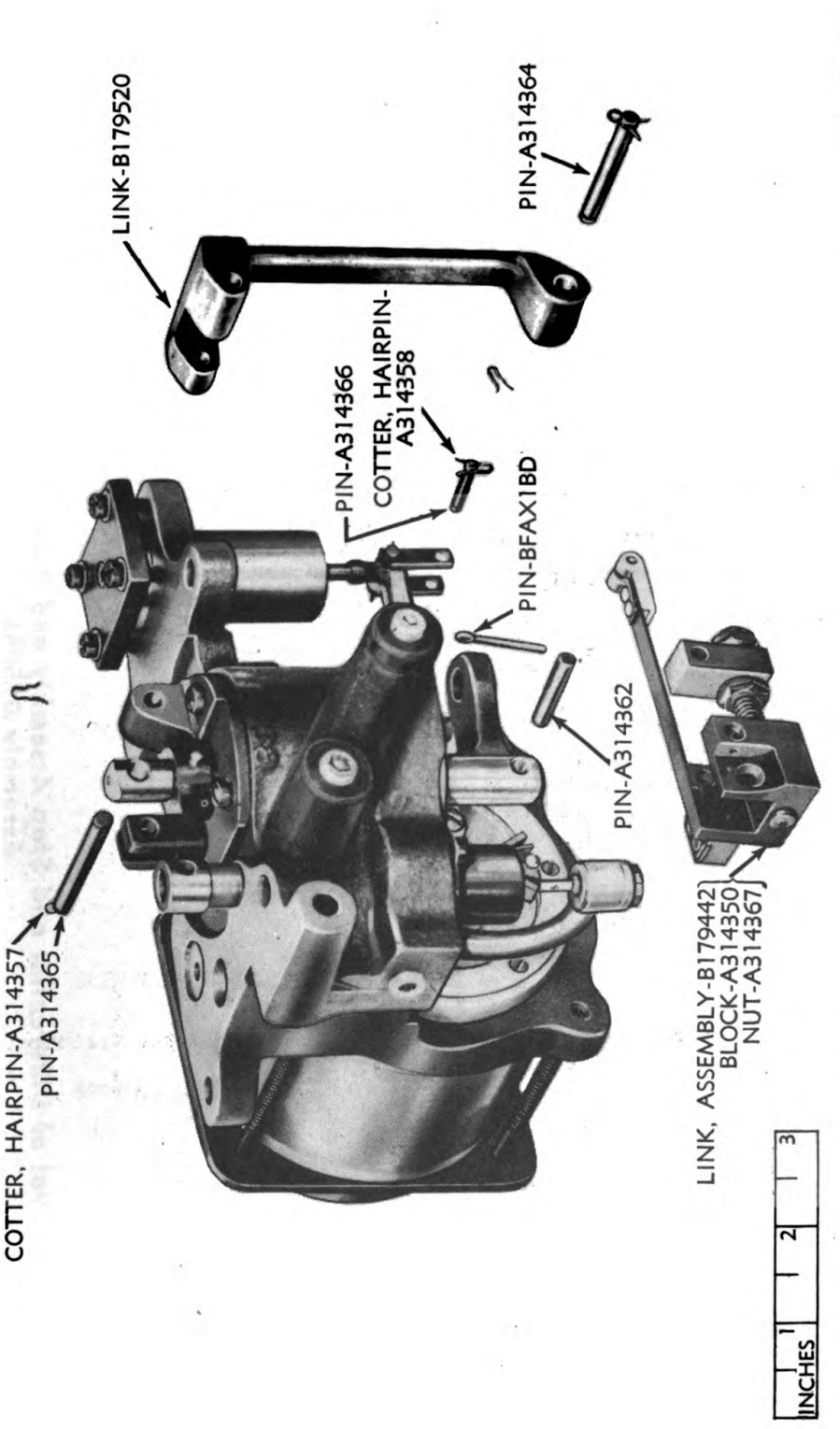


Figure 66—Removal of Error Corrector Parts From Valve Assembly D75066

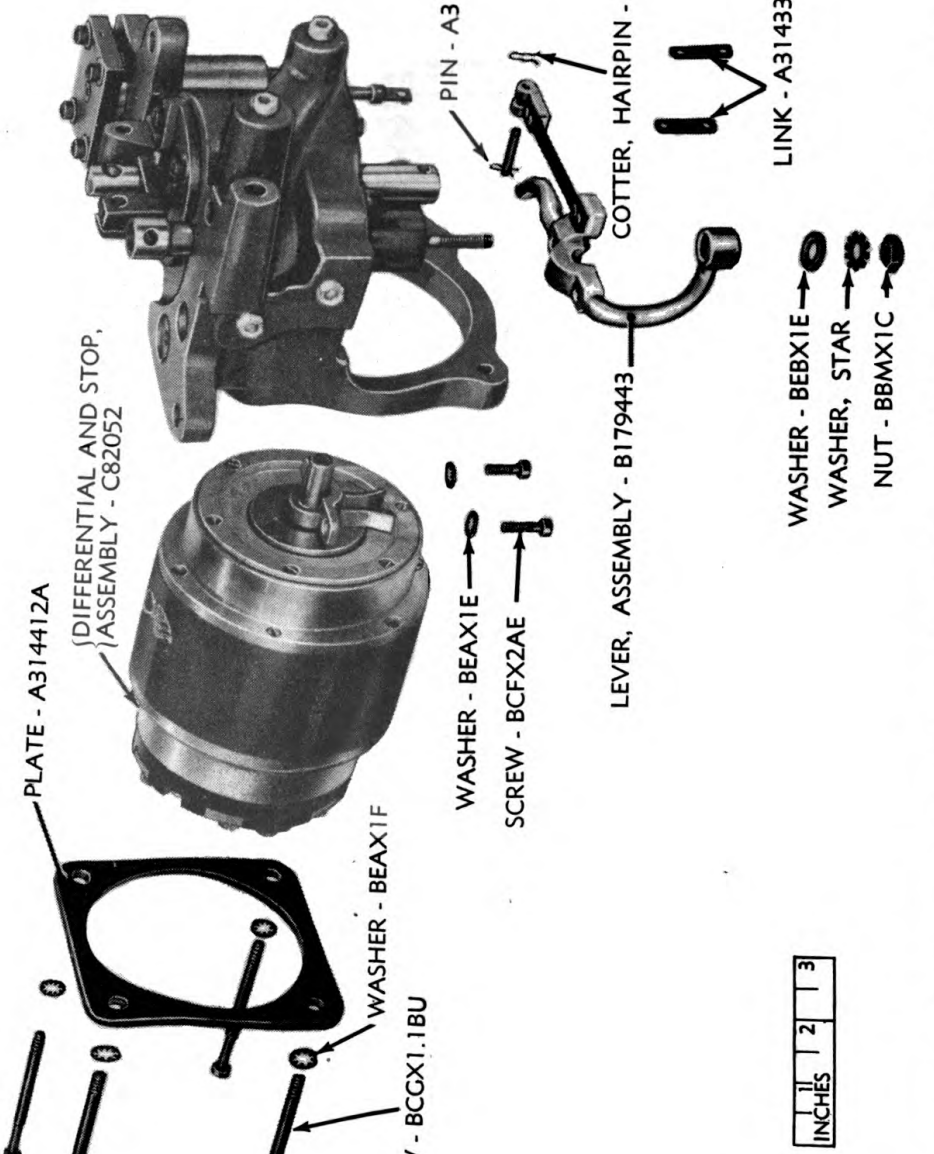
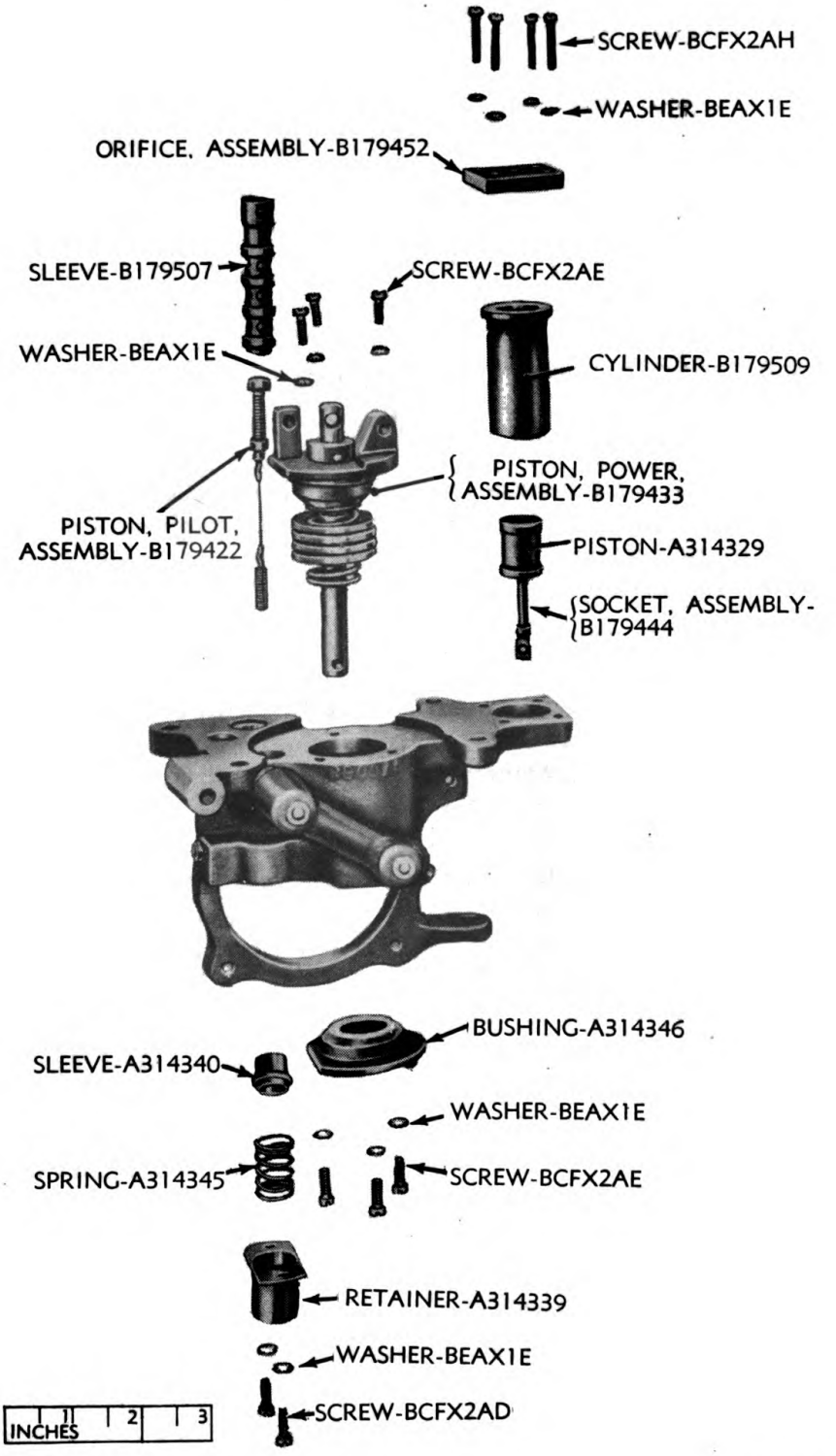


Figure 67—Removal of Differential and Stop Assembly and Differential Lever Assembly From Valve Assembly D75066

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 60589

Figure 68—Removal of Dither Sleeve, Pilot Piston, Power Piston Assembly, and Oil Dashpot Parts From Valve Assembly D75066

(2) REMOVAL OF DITHER LEVER SPRING AND DITHER LEVER SPRING BRACKET (fig. 65). Unhook the spring. Remove the two 0.164-32 x 3/8 fillister-head machine screws and tooth-type lock washers holding the bracket to the body casting. Lift off the bracket.

(3) REMOVAL OF DITHER LINKAGE (fig. 65). Remove the hairpin cotters and pins connecting the dither link B179426, two links A314351, dither lever A314352, and two links A314348. Lift off the links and lever.

(4) REMOVAL OF ERROR CORRECTOR PIVOT LINK (fig. 66). Remove the hairpin cotters and pins holding the link B179520 to the error corrector block A314350 and to upper bushing (fig. 65) of power piston shaft. Lift off the link.

(5) REMOVAL OF ERROR CORRECTOR LINK ASSEMBLY (fig. 66). Remove the cotter pin, hairpin cotters, and pins holding the link assembly to power piston assembly and to oil dashpot links. Lift off the link assembly.

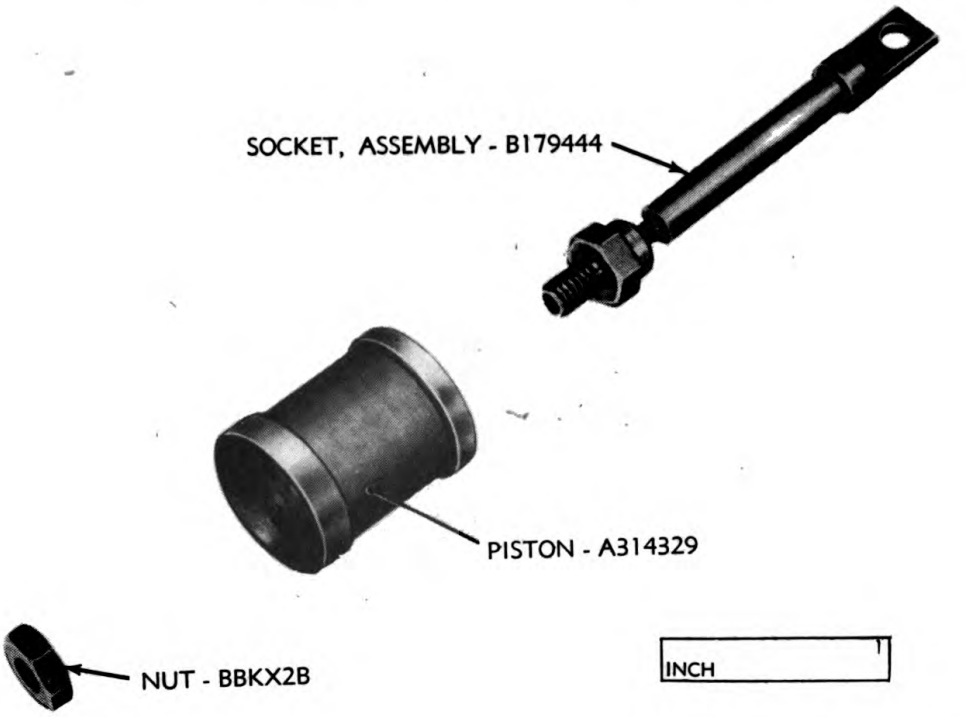
(6) REMOVAL OF DIFFERENTIAL AND STOP ASSEMBLY, AND DIFFERENTIAL LEVER ASSEMBLY (fig. 67). Remove the hairpin cotters and pin holding the differential lever assembly B179443 to the oil dashpot links A314330 and to oil dashpot socket assembly. Remove nut BBMX1C and plain washer BEBX1E holding the differential lever assembly to the pilot piston assembly. Remove the two 0.164-32 x 7/16 fillister-head machine screws and tooth-type lock washers holding the differential lever assembly to the differential and stop assembly. Remove the four 0.190-32 x 2 3/4 fillister-head machine screws, tooth-type lock washers and plate holding differential and stop assembly to the body casting. Lift off differential and stop assembly. Lift off differential lever assembly.

(7) REMOVAL OF DASHPOT CYLINDER AND ORIFICE ASSEMBLY (fig. 68). Remove the four 0.164-32 x 3/4 fillister-head machine screws and tooth-type lock washers holding cylinder and orifice assembly to the body casting. Lift off orifice assembly. Lift out the cylinder. Piston has dropped out.

(8) REMOVAL OF DITHER SLEEVE AND PILOT PISTON (fig. 51). Remove the two 0.164-32 x 3/8 fillister-head machine screws and tooth-type lock washers holding dither sleeve spring retainer to body casting. Lift off retainer, dither spring, and dither spring sleeve. Lift out pilot piston assembly and dither sleeve B179507.

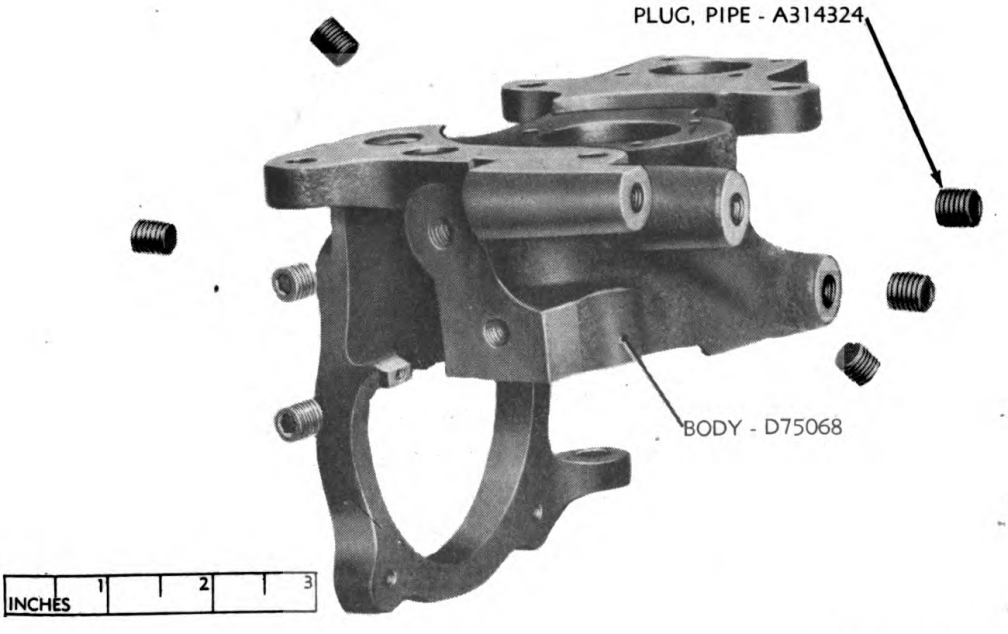
(9) REMOVAL OF LOWER BUSHING AND POWER PISTON ASSEMBLY (fig. 68). Remove the three 0.164-32 x 7/16 fillister-head machine screws and tooth-type lock washers holding the bushing to the body casting. Lift out the bushing. Remove the three 0.164-32 x 7/16 fil-

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21171

Figure 69—Removal of Socket Assembly B179444 From Piston A314329



RA PD 21172

Figure 70—Removal of Pipe Plugs From Valve Assembly D75066

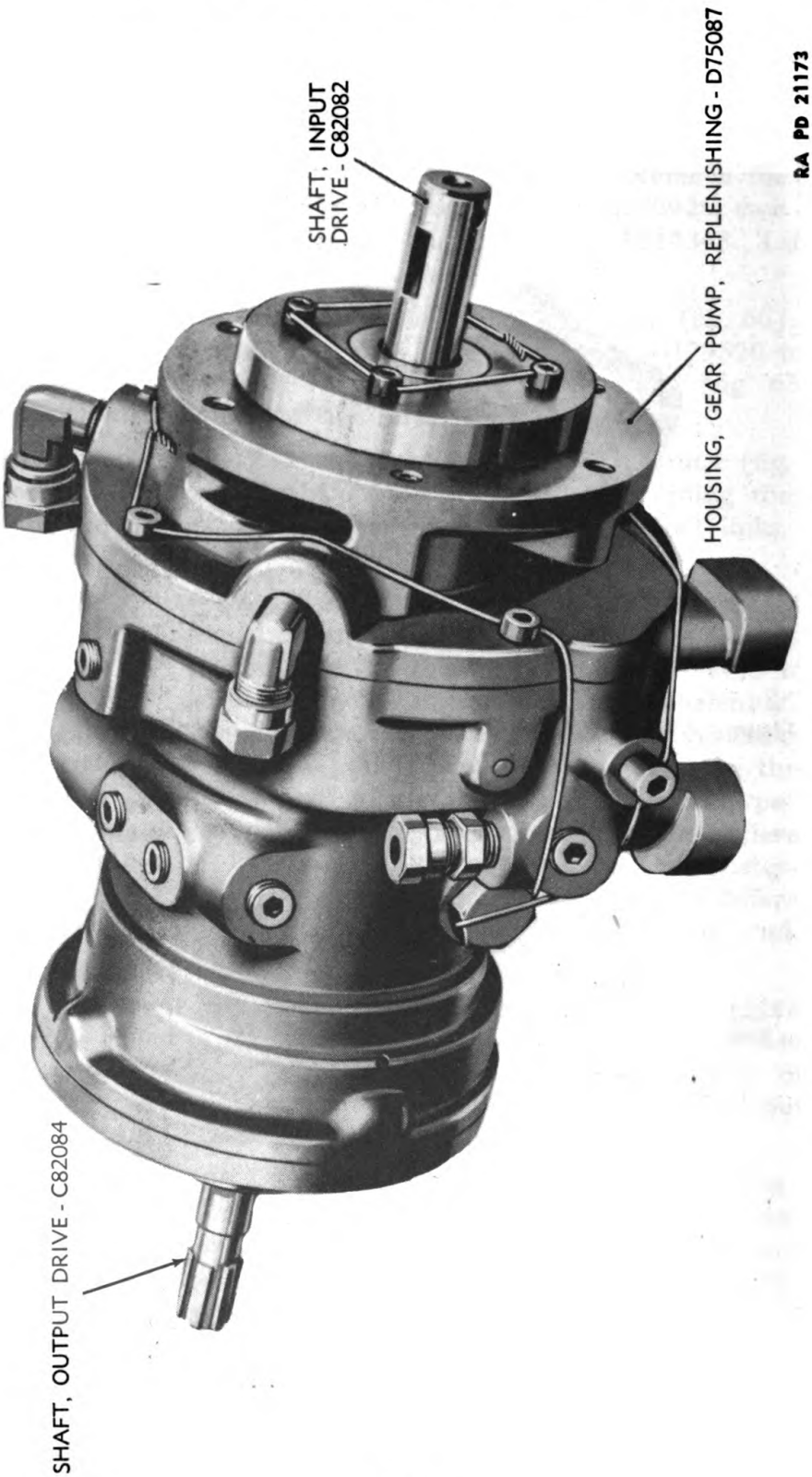


Figure 71—Hydraulic Variable Speed Transmission

lister-head machine screws and tooth-type lock washers holding the power piston assembly to the body casting. Lift out the power piston assembly.

79. DISASSEMBLY OF HYDRAULIC TRANSMISSION.

a. General. Cleanliness is one of the most important factors in the disassembly of the hydraulic transmission. After disassembly, wash all parts thoroughly in solvent. Blow off excess cleaning fluid and dry with air pressure if available, and immediately immerse in oil. High pressure air must be filtered clear of oil, dirt, and moisture. Bearings, pistons, and other parts, having sliding fits or close running surfaces, should be coated with hydraulic oil before assembly.

b. Procedure.

(1) REMOVE GEAR PUMP HOUSING AND DRIVE SHAFT ASSEMBLY (figs. 71 and 72). Remove locking wire and four gear pump housing mounting screws. Pull on end of drive shaft until shaft and housing begin to slide free from case. With one hand push stroke control race to its neutral position and continue to pull on the drive shaft. The shaft and housing can be removed easily without the rear ball bearing hooking on the stroke control race.

(2) REMOVE INPUT DRIVE SHAFT FROM GEAR PUMP HOUSING. Remove oil seal housing locking wire and four mounting screws. Carefully slide oil seal housing (fig. 74) off end of shaft, being careful not to cut oil seal on the key slot in the shaft. Press out oil seal only if replacement is necessary. Remove drive shaft by placing housing on vise (fig. 73). Use brass covers on vise to protect surfaces. Do not tighten vise, but allow housing to rest on top. Tap drive shaft out.

(3) DISASSEMBLE GEAR PUMP HOUSING ASSEMBLY (fig. 74). Remove locking wire and six gear pump cover mounting screws. Lift off gear pump cover. Remove the two pump gears and bushing. The driven gear shaft can be pressed or tapped out of housing the short way.

(4) REMOVE STROKE CONTROL RACE ASSEMBLY (figs. 75 and 76). Remove locking wire and the roller cage pin screws; then remove roller cage pins. Lift stroke control race and the two caged rollers out of case. Slip the two stroke control roller plates and shims off pins in body. Mark body, roller cages, and plates to assure assembly of the components in their previous positions. NOTE: *Shims are not shown.*

(5) REMOVE INPUT UNIT FLAT VALVE (fig. 77). Pry apart the two ends of the snap ring which fits over the flat valve and remove. Lift flat valve off the two retaining pins. The three tumblers, pistons, and springs are now free to be removed. Lift out the two equalizer

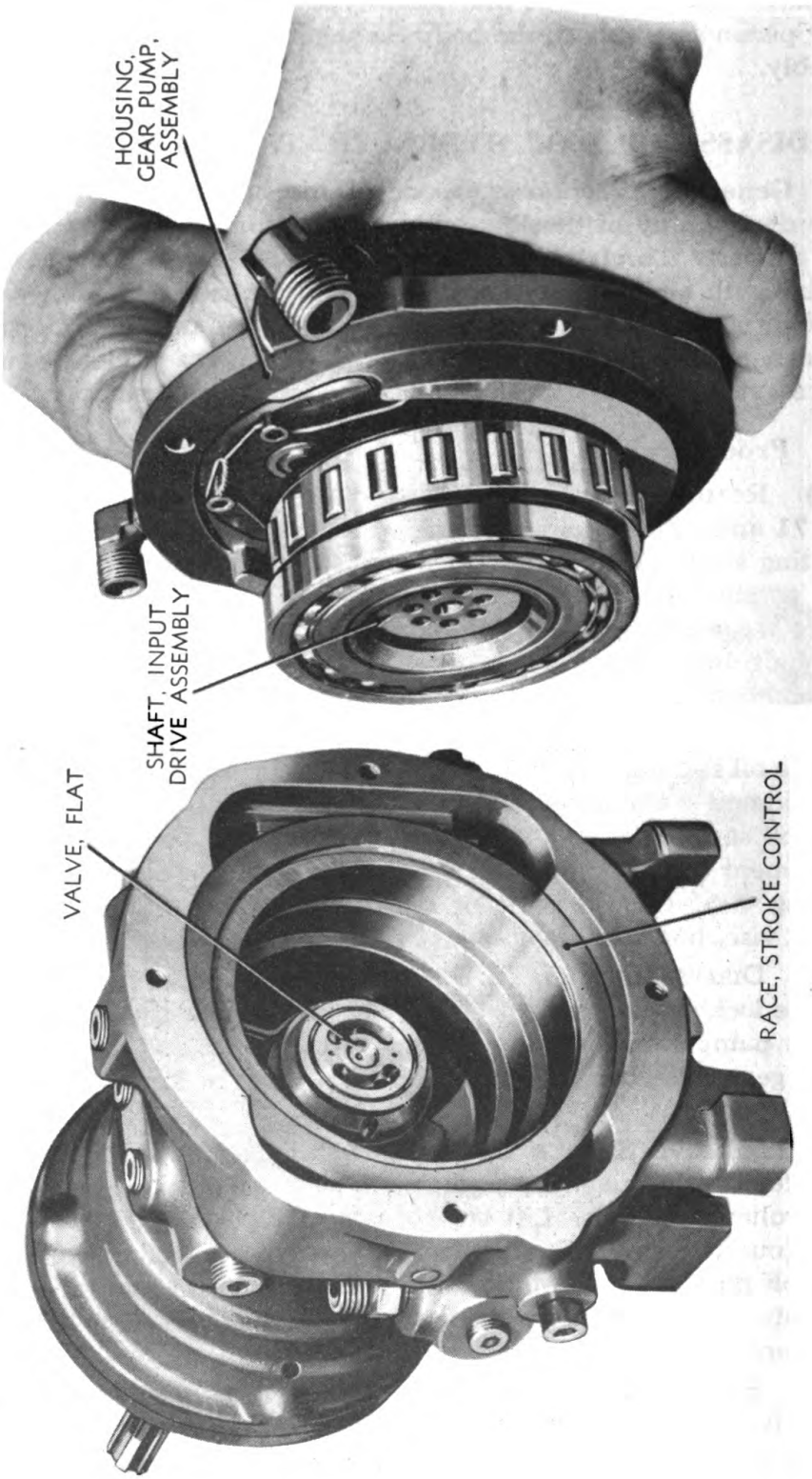
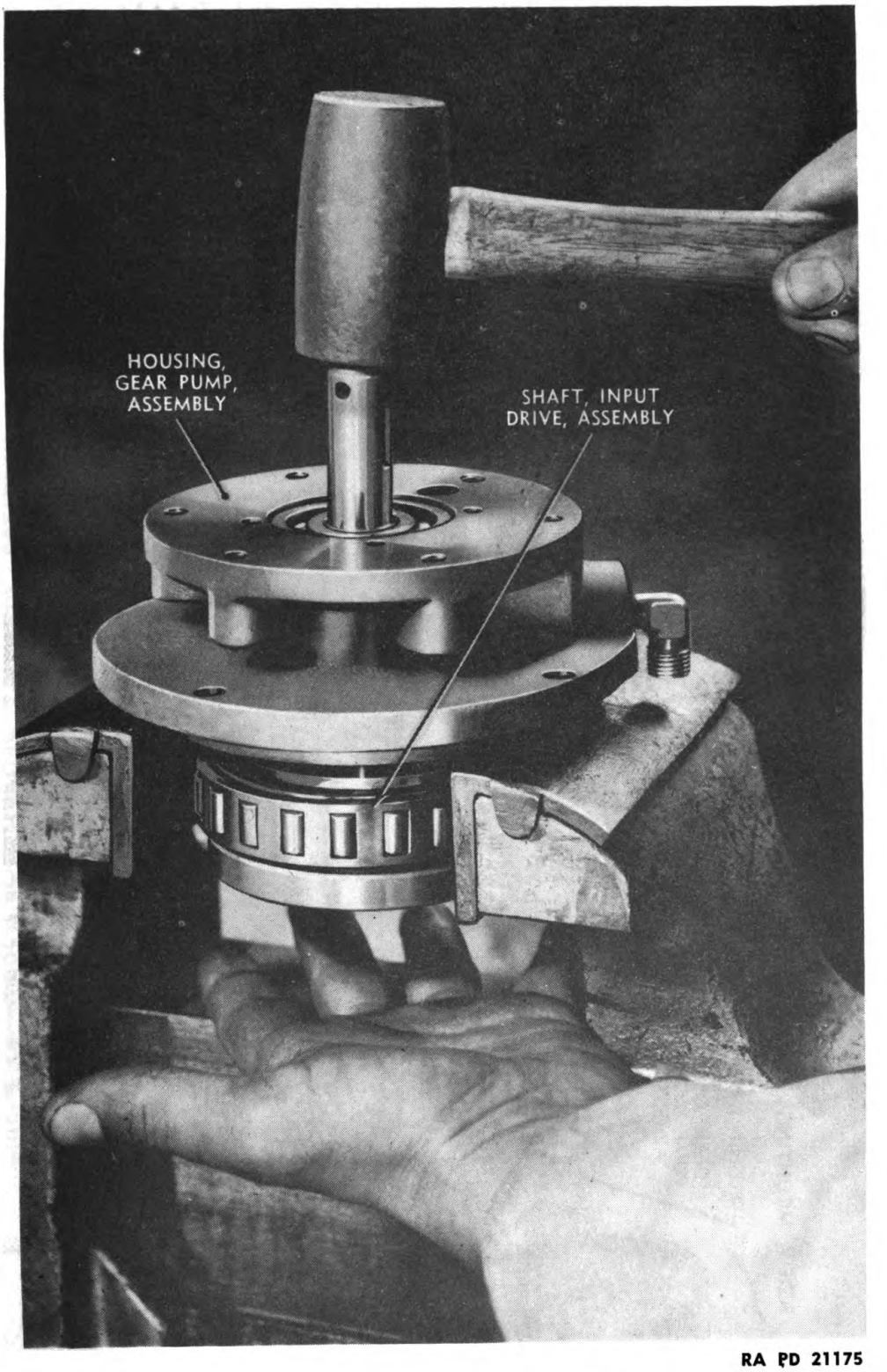


Figure 72—Removal of Gear Pump Housing and Drive Shaft Assemblies

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21175

Figure 73—Removal of Drive Shaft From Gear Pump Housing

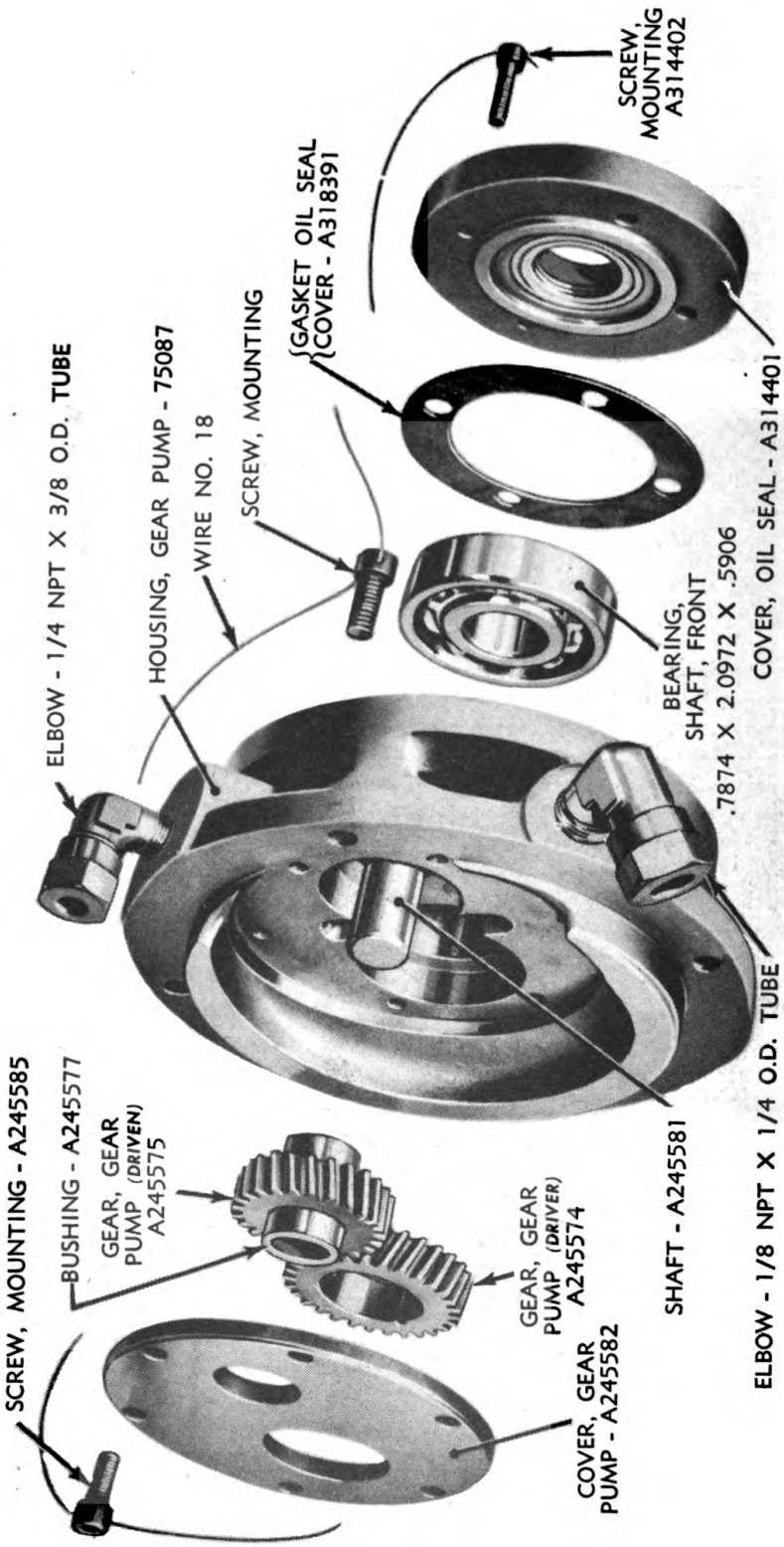


Figure 74—Gear Pump Housing Assembly—Exploded View

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

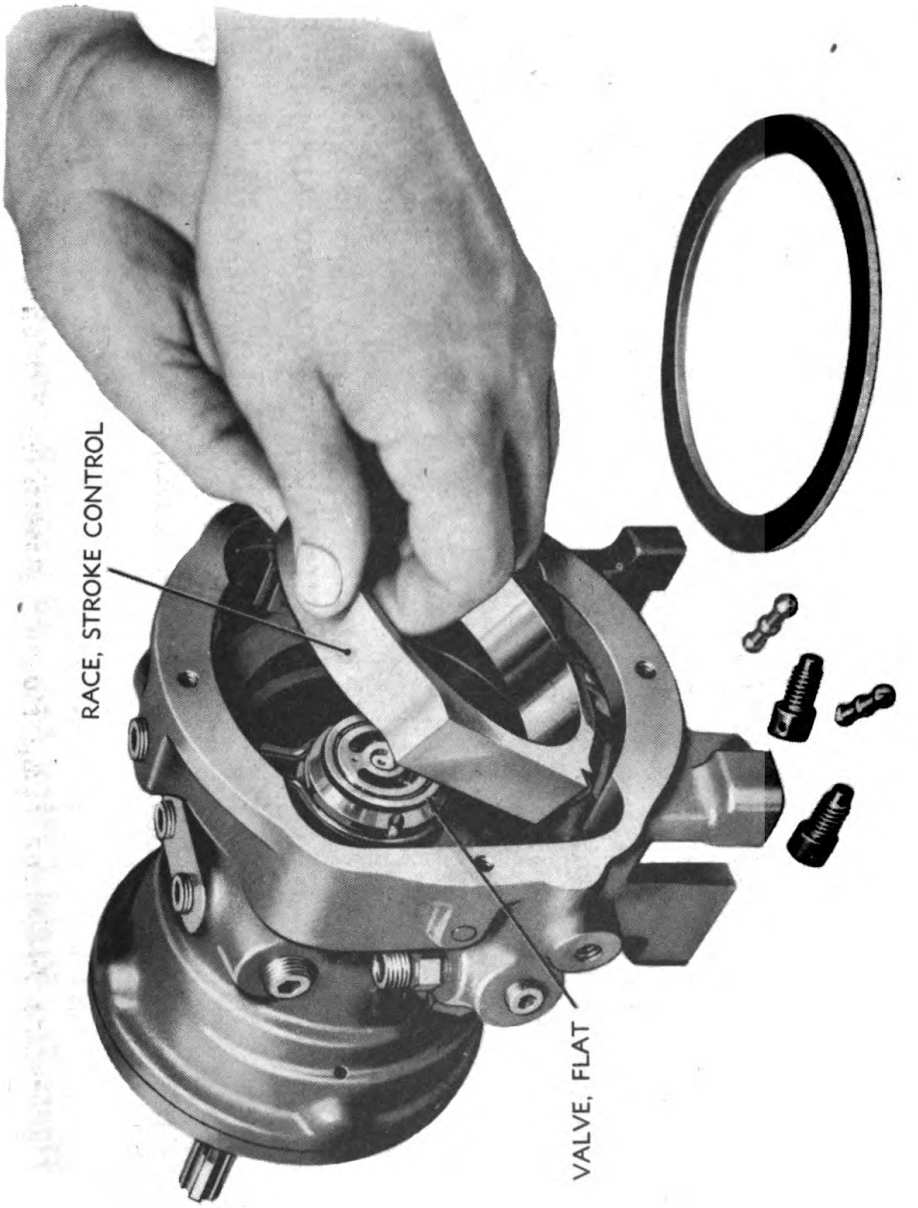


Figure 75—Removal of Stroke Control Race

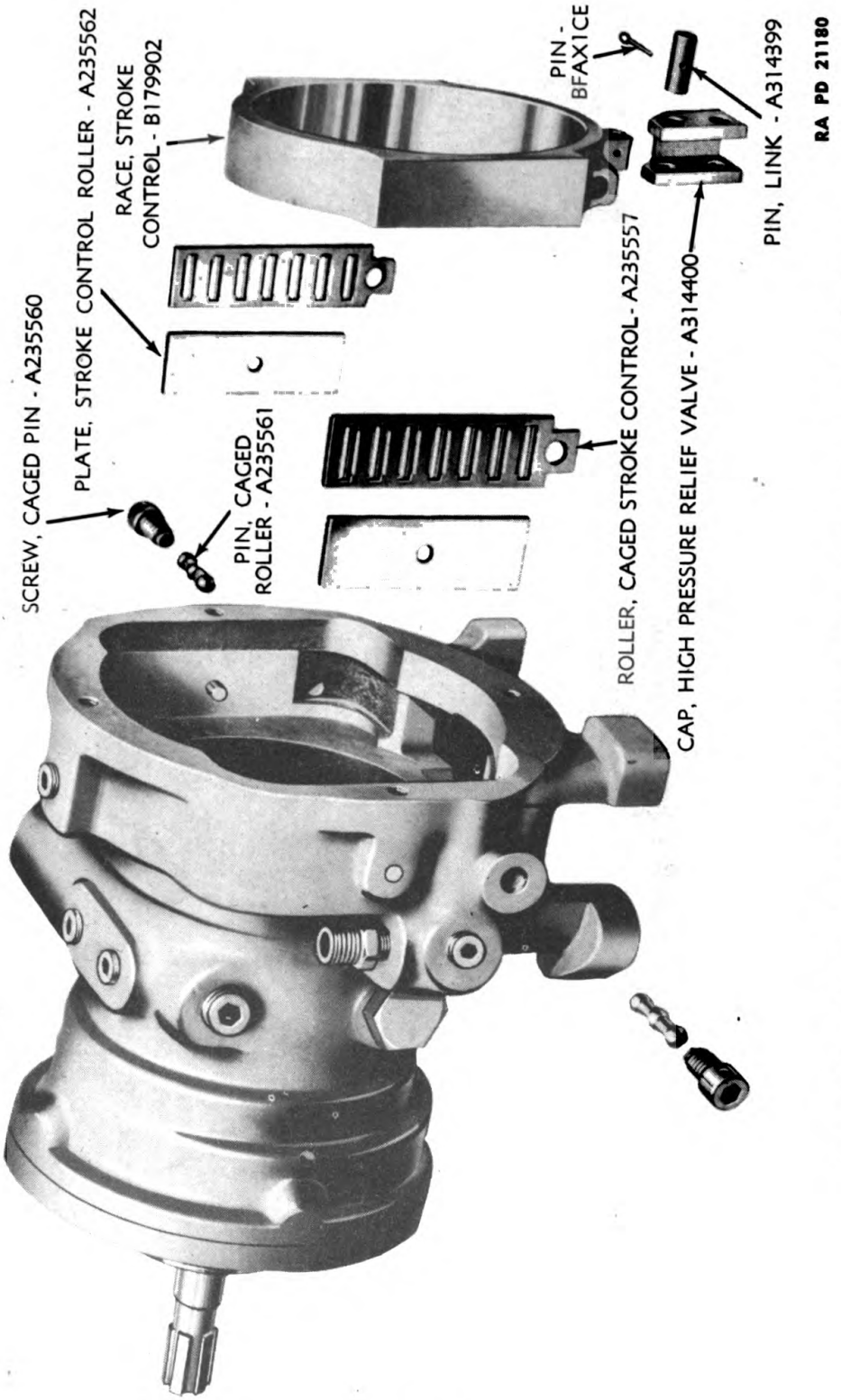


Figure 76—Stroke Control Race and Caged Rollers—Exploded View

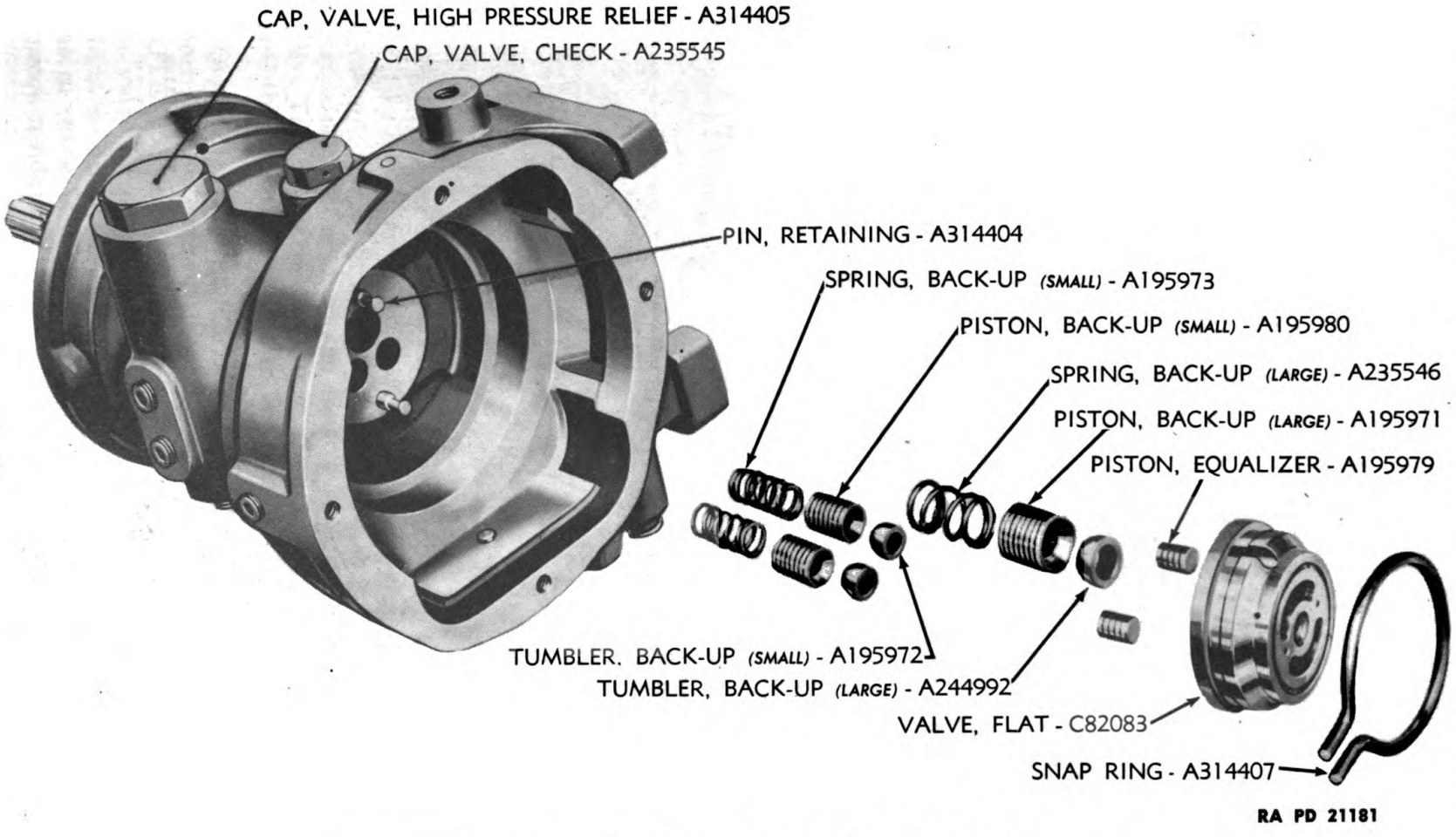
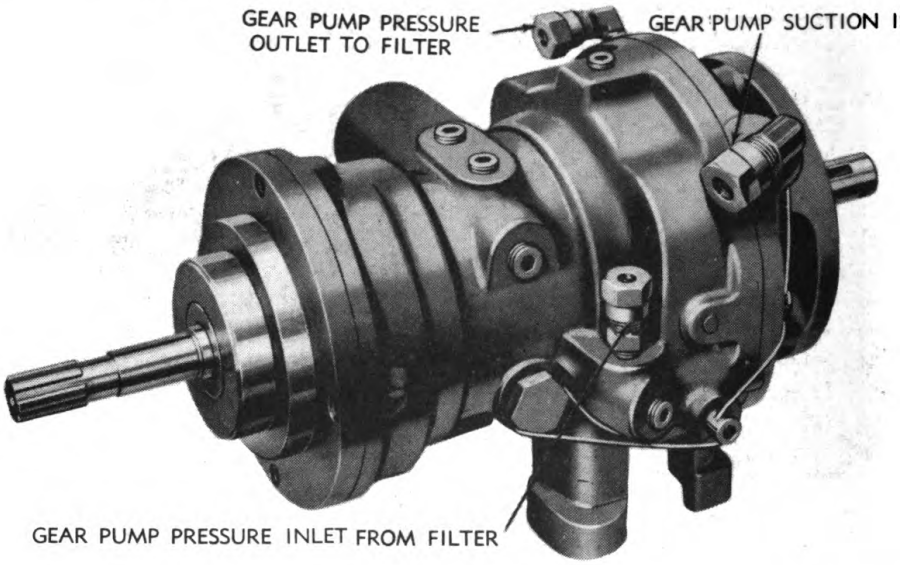
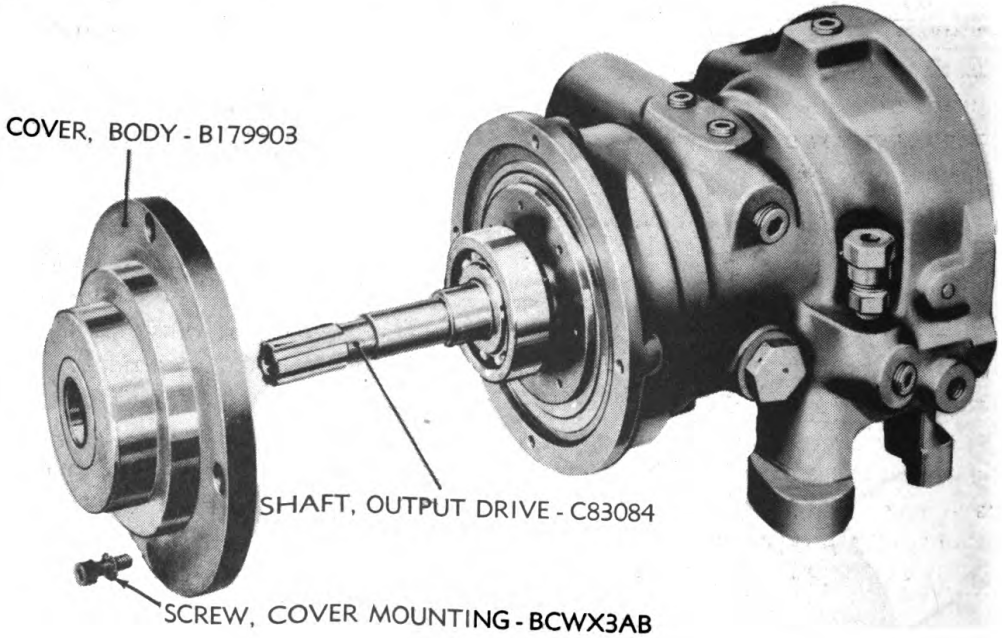


Figure 77—Input Flat Valve Assembly—Exploded View



RA PD 21182

Figure 78—Hydraulic Variable Speed Transmission

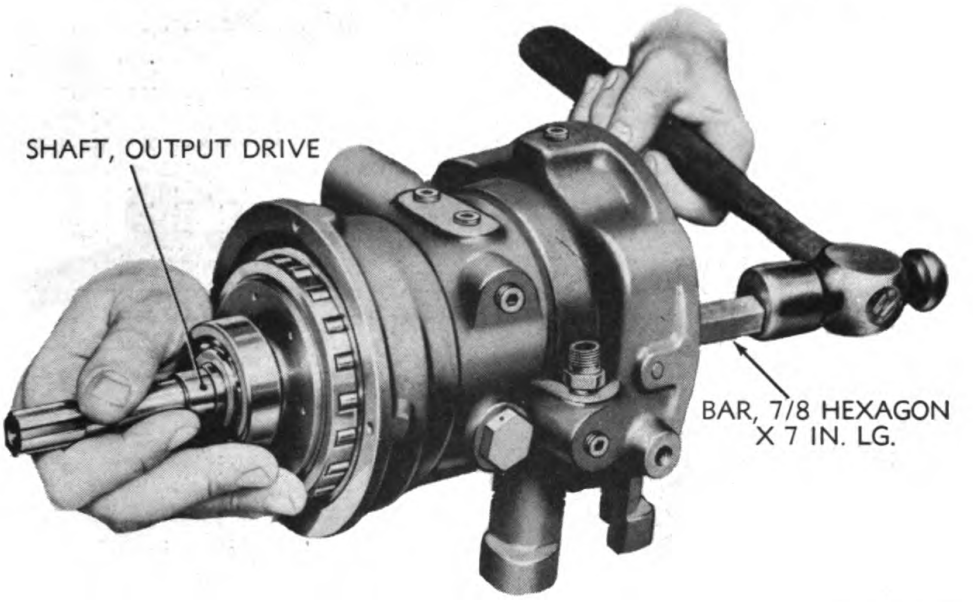


RA PD 21183

Figure 79—Removal of Body Cover

pistons from the flat valve. If necessary, insert a 6-32 screw in end of piston to remove it. CAUTION: *Do not get the slightest scratch on surfaces of flat valve.*

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21184

Figure 80—Removal of Output Drive Shaft Assembly

(6) REMOVE OUTPUT END COVER (figs. 78 and 79). Remove four cover screws and lock washers; then lift off cover. In removing cover be careful not to cut oil seal on splines of shaft. If necessary, press oil seal out of cover. NOTE: *A tough paper sleeve should be wrapped around the shaft when the cover is being removed. The sleeve will protect the oil seal from the shaft spline.*

(7) REMOVE OUTPUT END DRIVE SHAFT ASSEMBLY (figs. 80 and 81). With a $\frac{5}{8}$-inch hexagonal brass bar, 7 inches long, inserted through one of the cored passages in the body, tap out the drive shaft assembly (fig. 80). *In case the outer race does not move with the shaft, it will be necessary to tap the race with a $\frac{3}{16}$-diameter steel rod through the two drilled holes in the body (fig. 81). This procedure is necessary to prevent the rear ball bearing from cocking and becoming damaged. When the shaft and outer race have moved a short distance, the shaft and rear ball bearing will slide out of the body.* To remove the outer race, continue tapping with the steel rod until the outer race is free to be removed.

(8) REMOVE THE OUTPUT UNIT FLAT VALVE (fig. 82). Pry apart the two ends of the snap ring and lift it off of the flat valve. NOTE: *Do not get slightest scratch on surfaces of flat valve.* Raise flat valve off of retaining pins. The tumblers and pistons then are free to be removed. Lift out the two equalizer pistons from the flat valve. If necessary, insert a 6-32 screw in the end of piston to remove it.

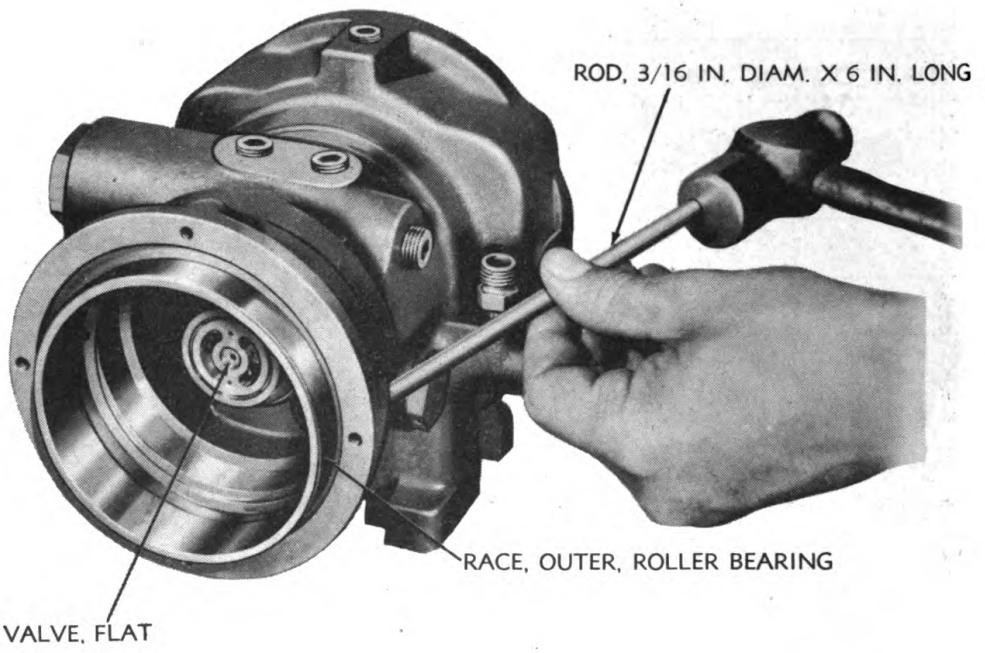


Figure 81—Removal of Roller Bearing Outer Race

(9) DISASSEMBLE CHECK VALVES (fig. 83). Remove the locking wire, two check valve caps, gaskets, springs, and plungers.

(10) DISASSEMBLE HIGH PRESSURE RELIEF VALVE (fig. 83). Unscrew and remove hexagonal relief valve cap, and its gasket. Remove relief valve spring shims, spring, spring guide, spacer bushing, and plunger for inspection. If plunger sticks in bushing, insert an 8-32 screw in end of plunger to pull it out, or remove pipe plug below seat and tap out plunger with a $\frac{3}{16}$-inch rod.

80. DISASSEMBLY OF PUSH BUTTON SWITCH ASSEMBLY (fig. 84).

a. Outline of Procedure.

(1) Remove wires.

(2) Remove push button switch bracket.

b. Detailed Description of Procedure.

(1) Remove the screws holding the five wires to the two switches.

(2) Remove the four 0.112-40 x 1 fillister-head machine screws, safety nuts, and plain washers holding bracket to the two switches.

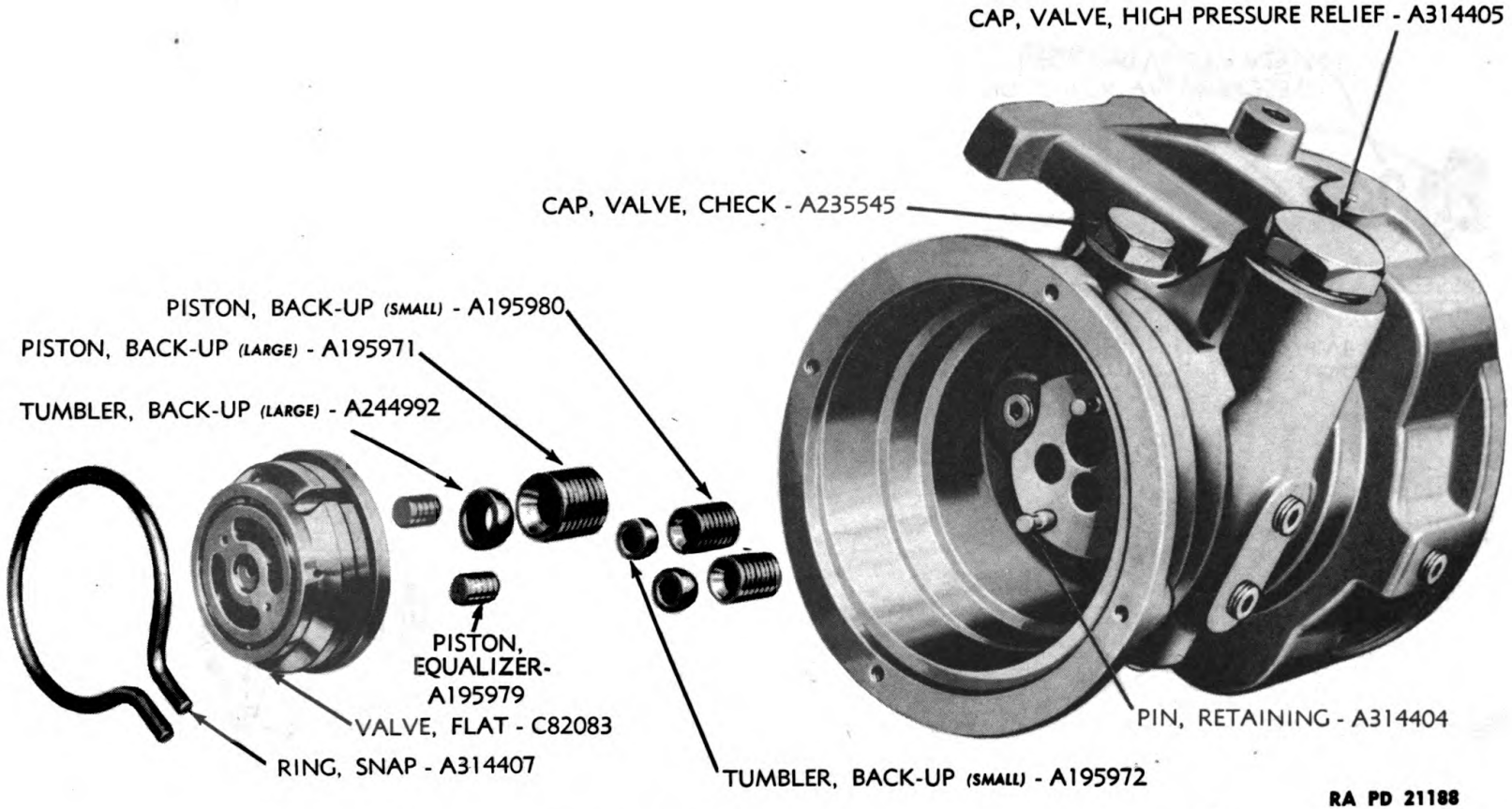


Figure 82—Output Unit Flat Valve Assembly—Exploded View

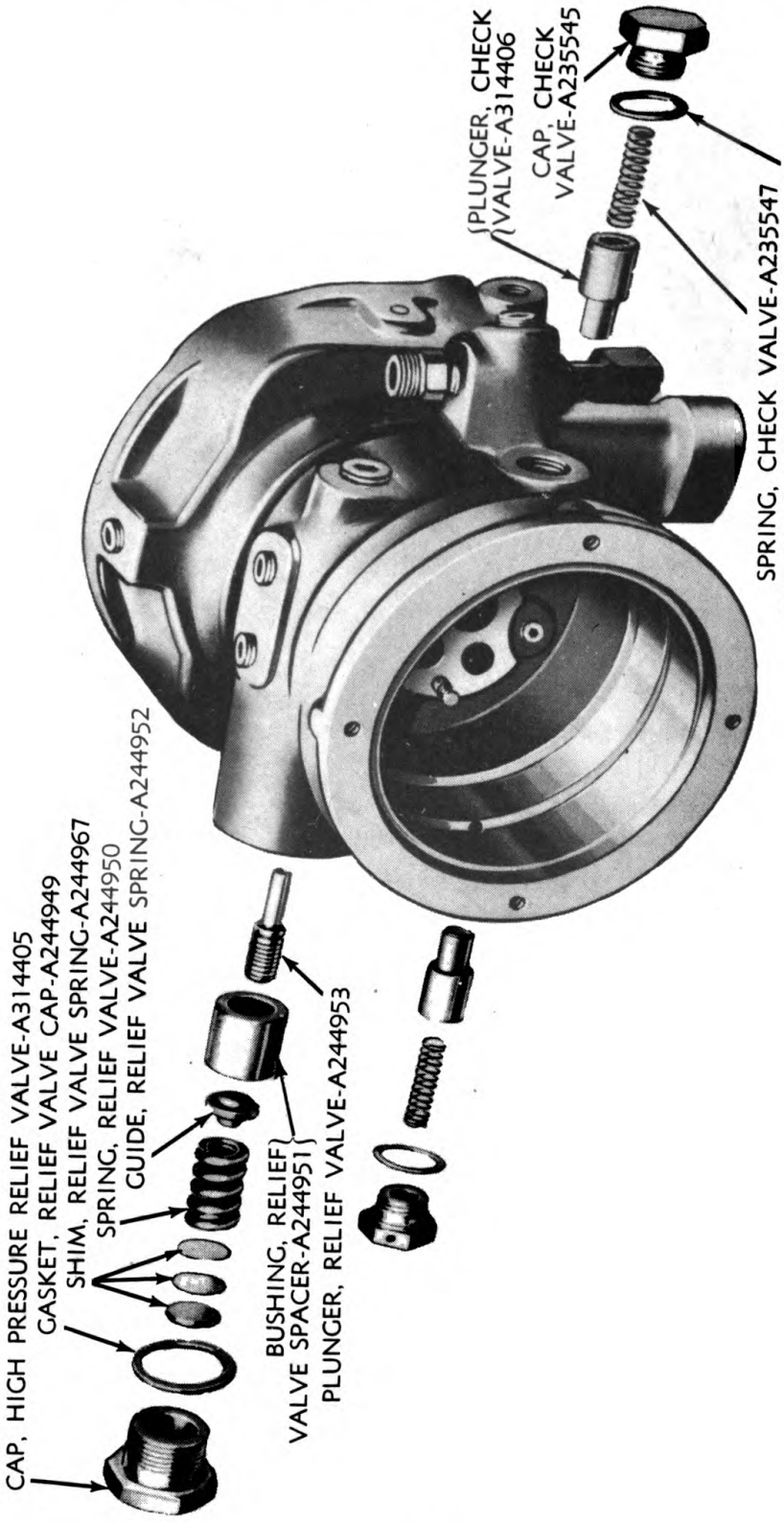
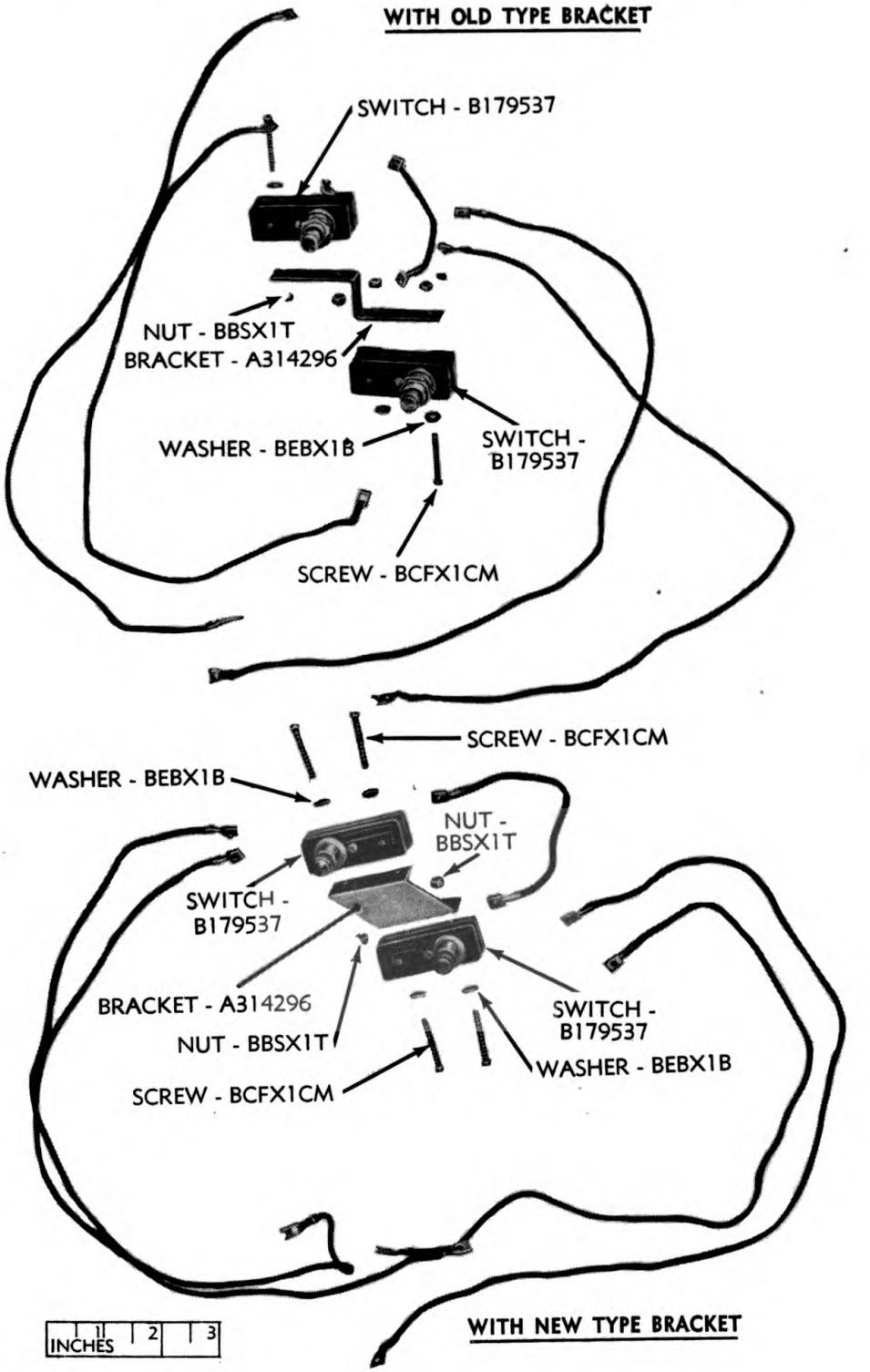


Figure 83—High Pressure Relief Valve and Check Valves—Exploded Valves

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21190

Figure 84—Disassembly of Push Button Switch Assembly C82967

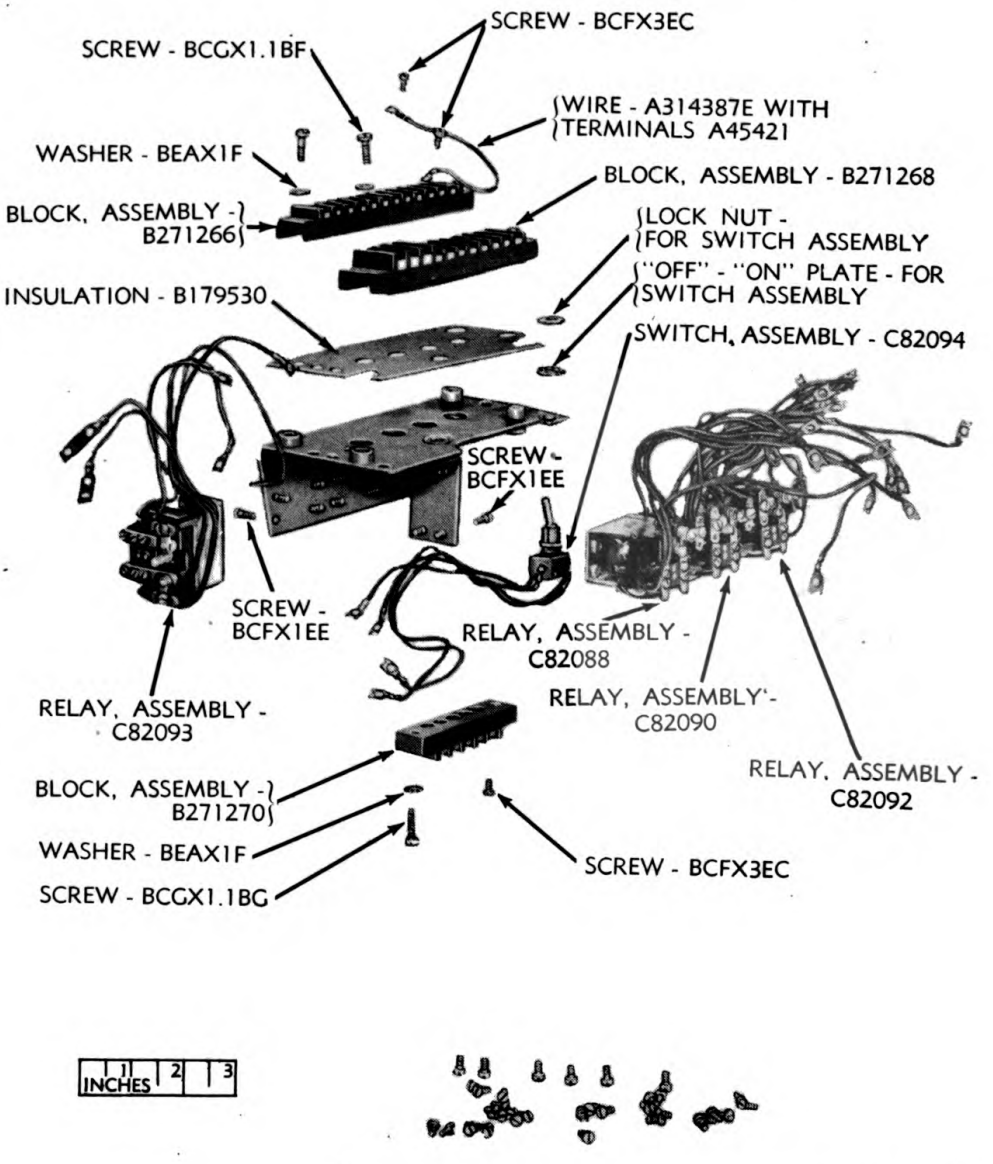


Figure 85—Disassembly of Terminal Board Assembly D75084

81. DISASSEMBLY OF TERMINAL BOARD ASSEMBLY (figs. 85, 86, 87, and 88).

a. Outline of Procedure.

(1) Disconnect all wires.

(2) Remove block assembly B271270.

(3) Remove block assemblies B271268 and B271266 and insulation B179530.

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

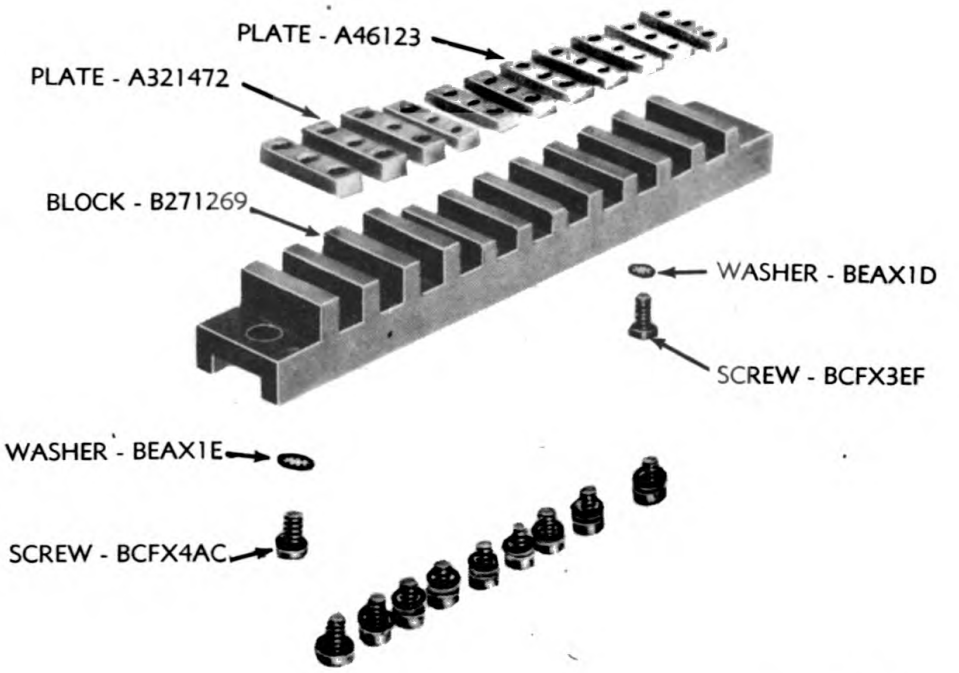


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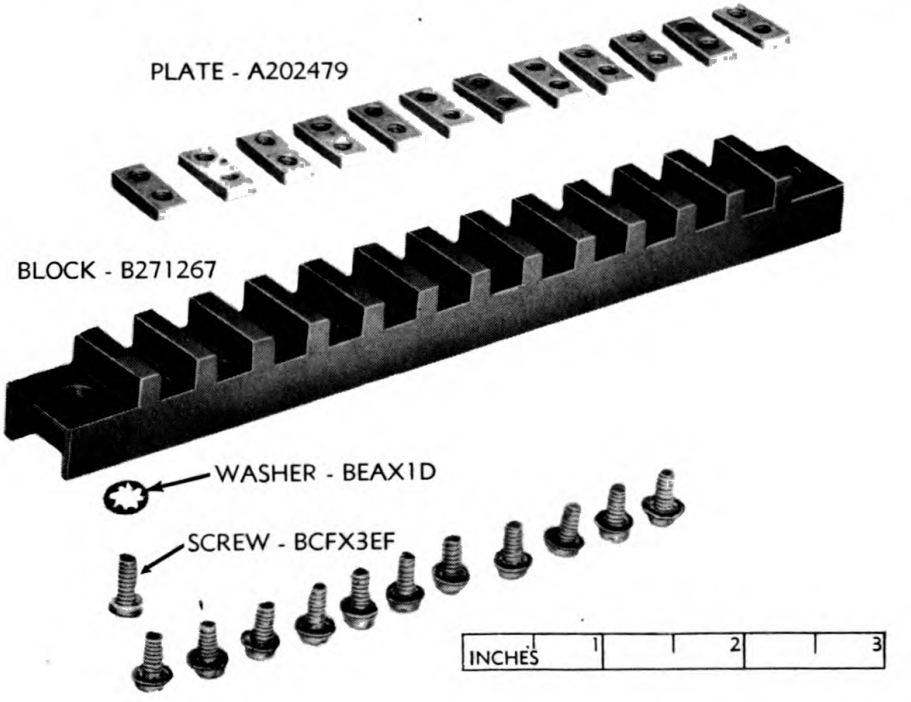
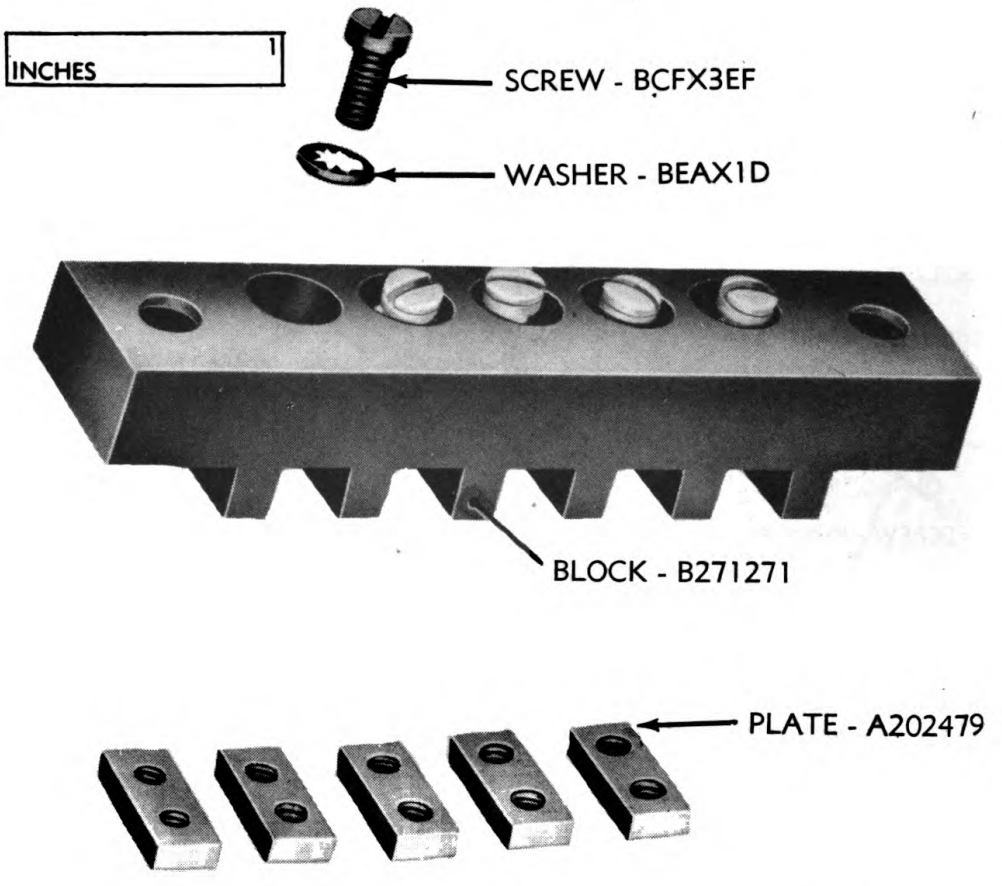
Figure 86—Disassembly of Terminal Block Assembly B271268



RA PD 21193

Figure 87—Disassembly of Terminal Block Assembly B271266



RA PD 21194

Figure 88—Disassembly of Terminal Block Assembly B271270

(4) Remove toggle switch assembly.

(5) Remove relay assemblies.

b. Details of disassembly are apparent from exploded views.

82. REASSEMBLY OF TERMINAL BOARD ASSEMBLY.

a. Reassemble the relay assemblies to the terminal board bracket. Figure 89 shows correct location of each relay. Each relay is held to the bracket by four 0.138-32 x 3/8 fillister-head machine screws (fig. 85).

b. Place the toggle switch assembly in position with one nut below the bracket and with "OFF-ON" plate and other nut above the bracket (fig. 85). Lock firmly in position.

c. Place insulation on the bracket (fig. 85). Place block assemblies B271268 and B271266 in their respective positions on the

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

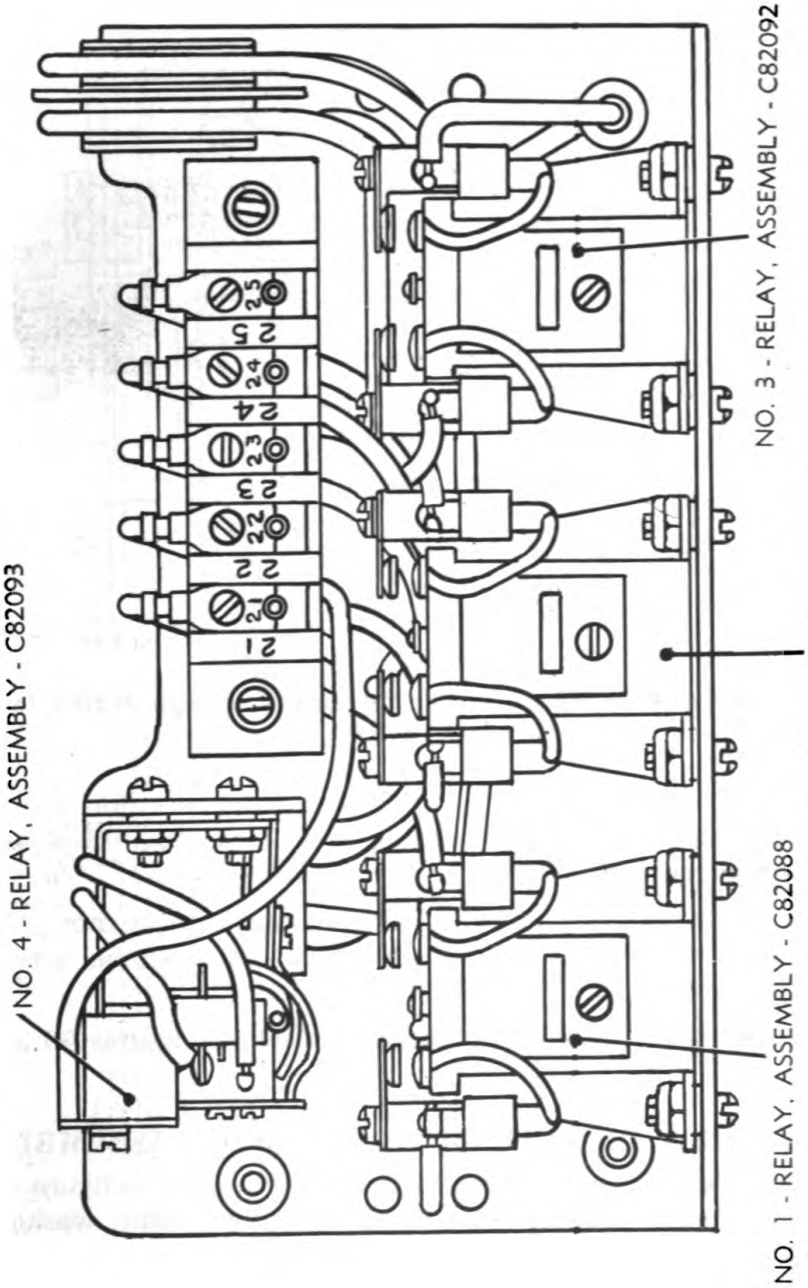


Figure 89—Location of Relays

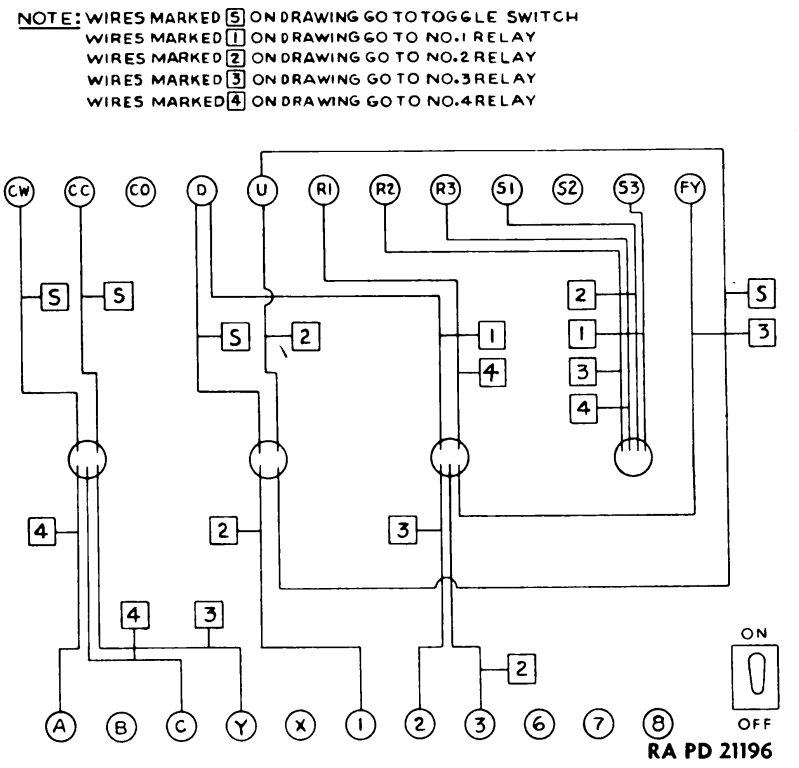


Figure 90—Arrangement of Wires Passing Through Holes in Insulation B179530

insulation. Replace the 0.190-32 x ½ fillister-head machine screws and tooth-type lock washers for holding the block assemblies and insulation to the bracket.

d. Place block assembly B271270 in position and anchor it to the bracket with two 0.190-32 x ⅝ fillister-head machine screws and tooth-type lock washers.

e. Reconnect wires to terminal board as shown in figures 90 and 91.

83. REASSEMBLY OF PUSH BUTTON SWITCH ASSEMBLY.

a. Reassemble the two switches to bracket as shown in figure 84. Use four 0.112-40 x 1 fillister-head machine screws, plain washers, and safety nuts for holding switches to the bracket.

b. Connect the five wires to the two switches as shown in figure 92.

84. REASSEMBLY OF HYDRAULIC TRANSMISSION.

a. Assemble flat valves, pistons, tumblers, and springs (figs. 77 and 82). From the input end insert the three hollow back-up

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

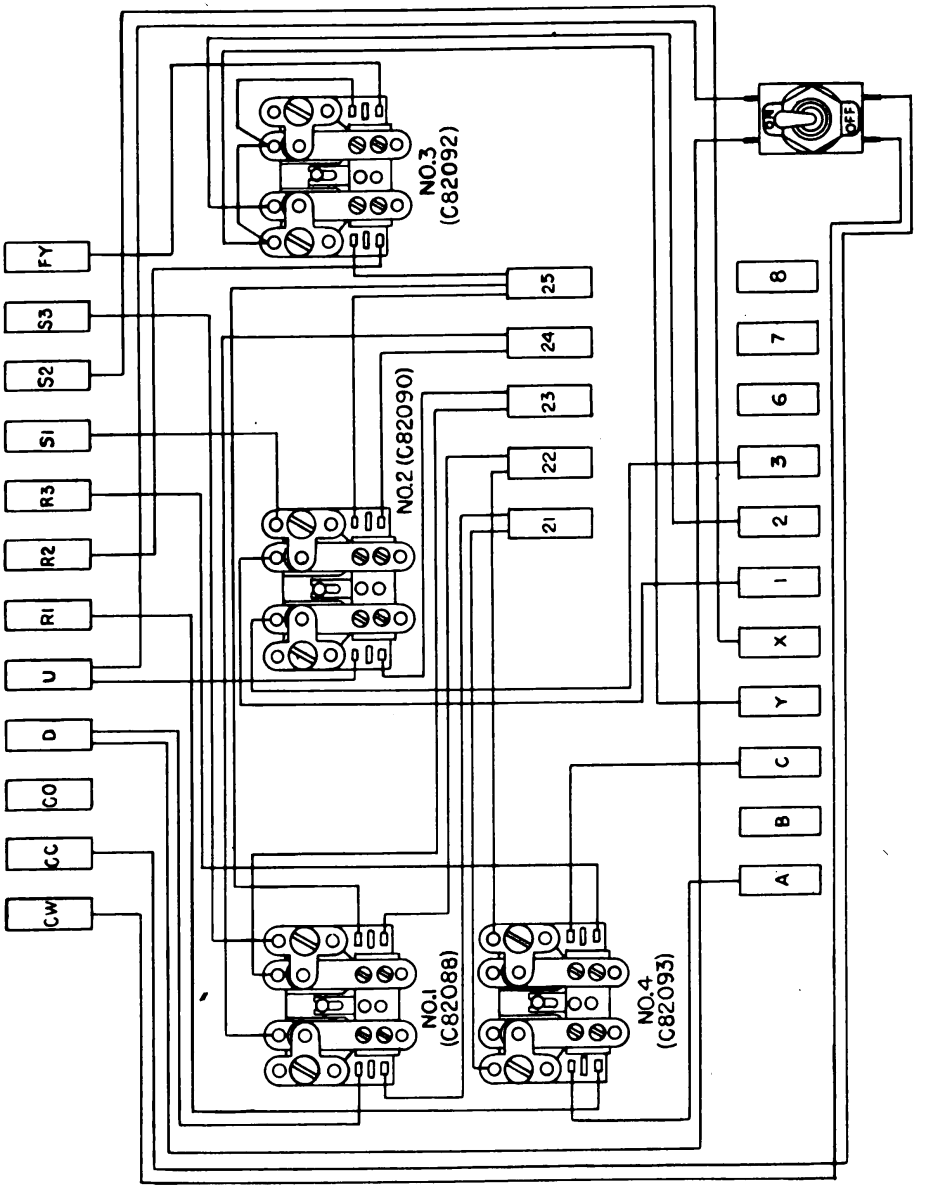


Figure 91—Terminal Board Assembly—Wiring Diagram

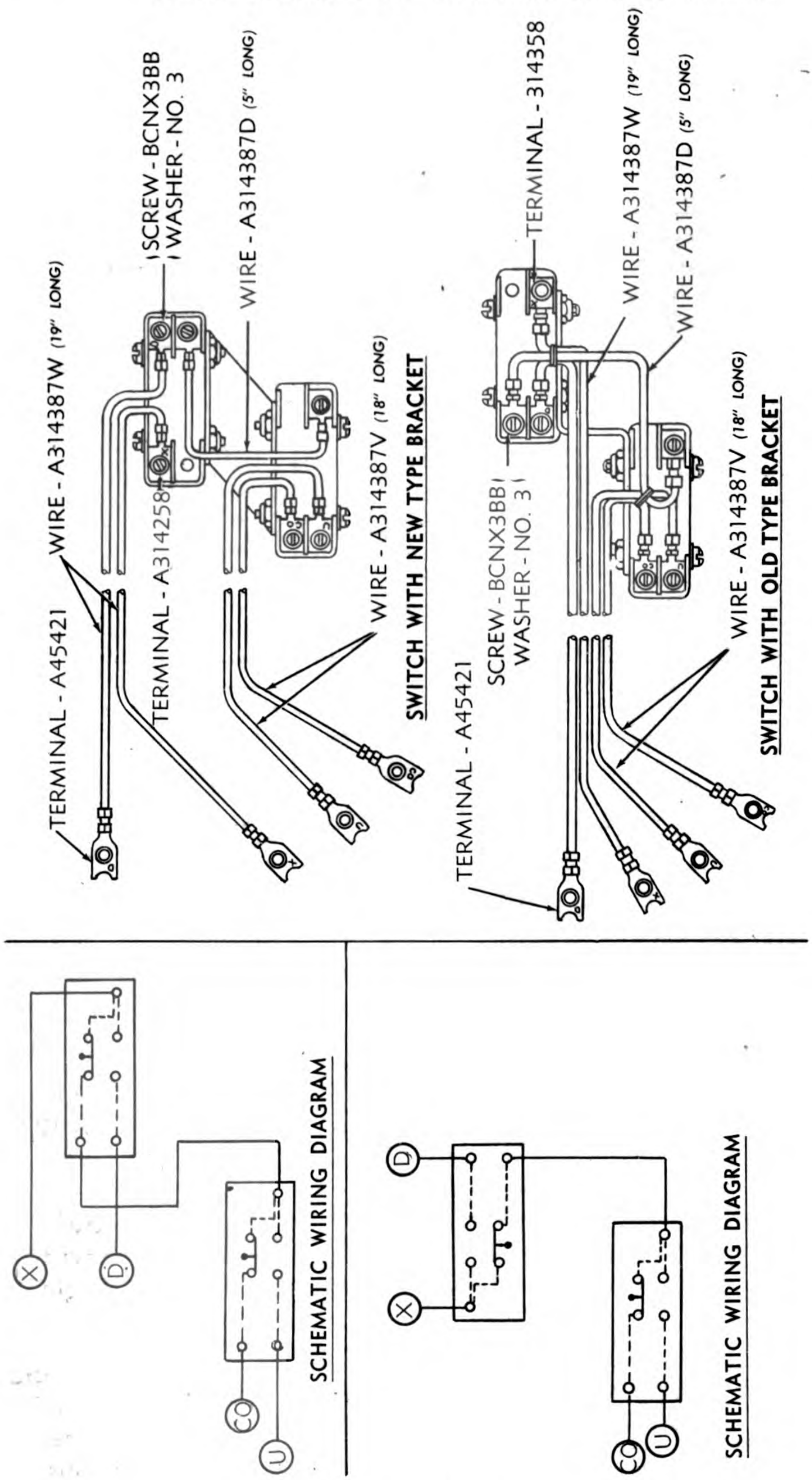


Figure 92—Push Button Switch Assembly C82067

pistons with concave face outwards into their respective bores, and place their tumblers onto the pistons. Insert the two equalizer pistons in flat valve, with tapped ends outward. Each piston must have an easy sliding action in its bore. Place the flat valve over the two retaining pins so that the flat surface faces the tumblers, and the large holes and two small holes line up with the corresponding holes in the body. Slip the snap ring over the flat valve and retaining pins. From the output end, insert the three back-up springs into their respective bores in the body, and insert the other three pistons and tumblers in the same fashion as on the input end, and place the flat valve over the assembly. Lock the flat valve in place with the other snap ring.

b. Assemble Input Drive Shaft, Cylinder, Piston, and Bearing Assembly. Press rear ball bearing onto cylinder hub. Arrange rear ball bearing with surface marked "THRUST HERE" away from spacer ring.

c. Assemble Gear Pump Housing Assembly (fig. 74). Press gear pump driven gear shaft into housing the short way, until it is flush with front face of housing. Slip driven gear and bushing over shaft assembly and insert driver gear. Turn gears to see if they turn freely. Fasten gear pump cover to housing with six socket-head screws. Lock screws with wire. Place gear pump housing assembly in an arbor press with face down on a steel ring. Insert Woodruff key in drive shaft keyway and slip shaft with key through either keyway in driver gear. Place a brass bar on the ported end of drive shaft and press front bearing down until it bottoms in housing. Place oil seal housing on arbor press, with male pilot downward, set oil seal in place with closed end on top, and press oil seal flush with housing. Fasten gasket and oil seal housing to gear pump housing with four socket-head screws. Lock screws with wire (fig. 71).

d. Assemble Stroke Control Race (figs. 75 and 76). Assemble all components in their previous positions. Place shims and caged roller plates over their respective pins inside of body. Set stroke control race in body with link protruding out of bottom of body. Slip the two caged rollers between the stroke control race and roller plates with hole in roller cage directly above the hole in the stroke control race. Slip the two caged roller pins through the body, the roller cage, and into the holes in the stroke control race. Screw the two caged roller pin screws behind each of the two pins and tighten screws firmly into place. Lock screws with wire.

e. Assemble Drive Shaft Assembly and Gear Pump Housing (figs. 71 and 72). Set spacer ring in body counterbore over stroke control race. Tap ported end of drive shaft to be sure shaft shoulder is tight against front ball bearing. Insert shaft and gear pump housing

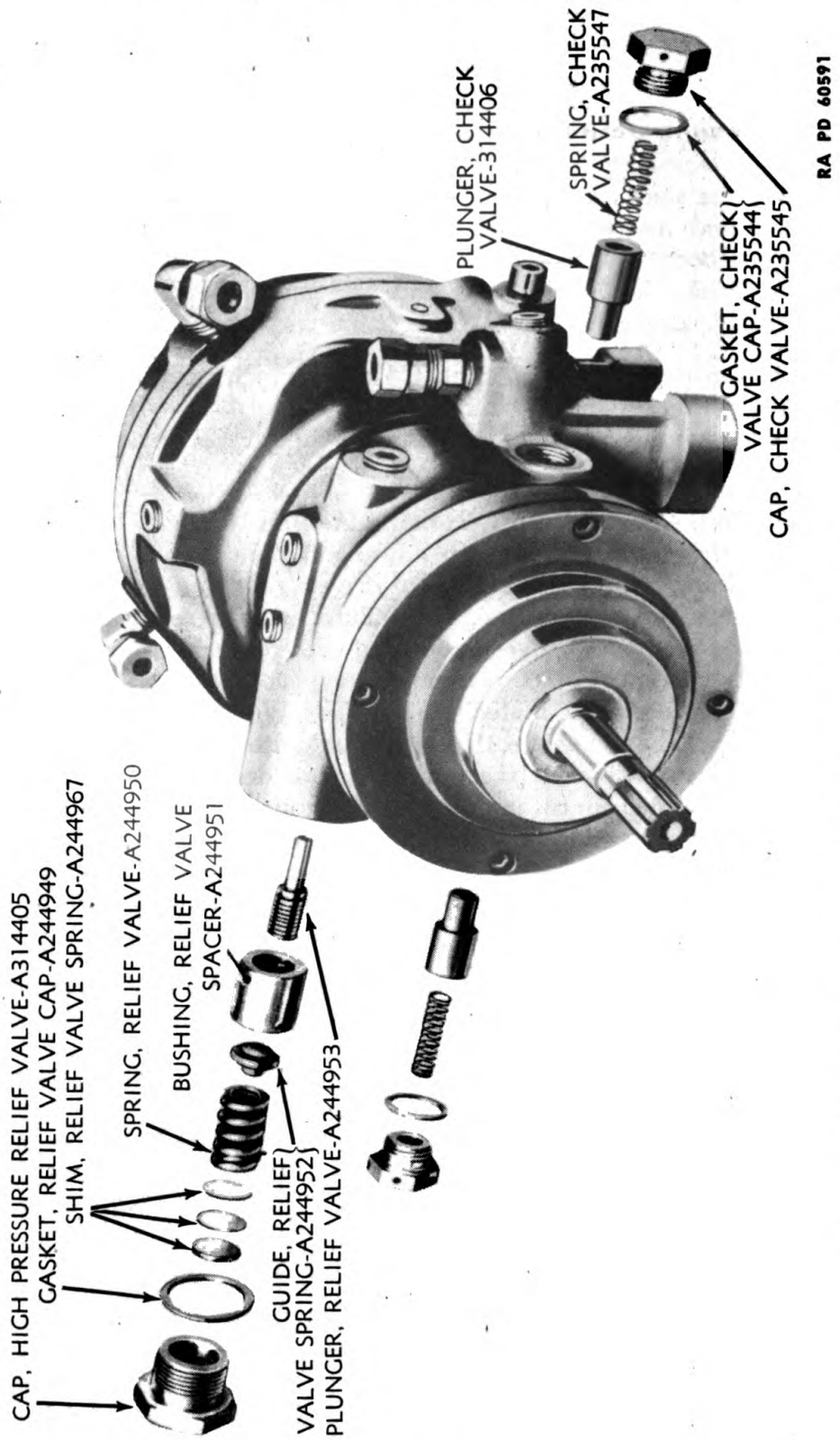


Figure 93—High Pressure Relief Valve and Check Valves—Exploded View

assembly into body. See figure 71 for position of gear pump suction, and discharge ports in relation to the transmission body. Fasten housing to pump body with four socket-head screws. Lock screws with wire.

f. Assemble Output Drive Shaft, Cylinder, Pistons, and Bearings Assembly. Press rear ball bearing ring onto cylinder hub. Arrange rear ball bearing with surface marked "THRUST HERE" away from spacer ring. Place ported end of shaft on a brass bar and press front ball bearing onto shaft. Arrange front ball bearing with surface marked "THRUST HERE" away from cylinder.

g. Assemble Output Drive Shaft Assembly in Body (fig. 79). Place drive shaft assembly into the output end of the body and tap into place until the rear ball bearing bottoms in its counterbore. *If the outer race of the roller bearing has not been removed from the body, it will be necessary to have it out far enough to allow the rear ball bearing to slide in its counterbore.* After the shaft is in place, tap the outer race down until it bottoms in the body.

h. Assemble Output End Cover to Body (fig. 79). In case oil seal has been removed, place cover in an arbor press with inside face down and set oil seal in cover with closed end on top. Press oil seal flush with cover face. Slip cover over shaft, being careful not to cut oil seal. NOTE: *Place a tough paper sleeve around the shaft while sliding the seal over the splines of the shaft.* Line up the cover with the body so that the maximum eccentricity on the body coincides with the maximum eccentricity of the cover. Tap the cover into place and fasten with four mounting screws and washers.

i. Assemble High Pressure Relief Valve (fig. 93). Insert the high pressure relief valve plunger into bushing. Place spring guide on plunger and heavy relief valve spring on guide. Slip the copper gasket on cap, insert shims between top of spring and counterbore in cap, and screw the hexagonal cap over spring.

j. Assemble Check Valves (fig. 93). Insert the two check valve plungers into their respective bores in the body. Place spring behind each plunger. Slip gasket over each check valve cap and tighten both firmly into place and lock caps with wire.

85. REASSEMBLY OF VALVE ASSEMBLY D75066 (figs. 14 and 66).

a. During assembly of the valve assembly, all parts should be checked continuously to make certain that no excessive friction or binding is present.

b. Place power piston assembly in body casting and position it as shown in figure 14. Anchor it to the body with three 0.164-32 x $\frac{7}{16}$ fillister-head machine screws and tooth-type lock washers. Place the

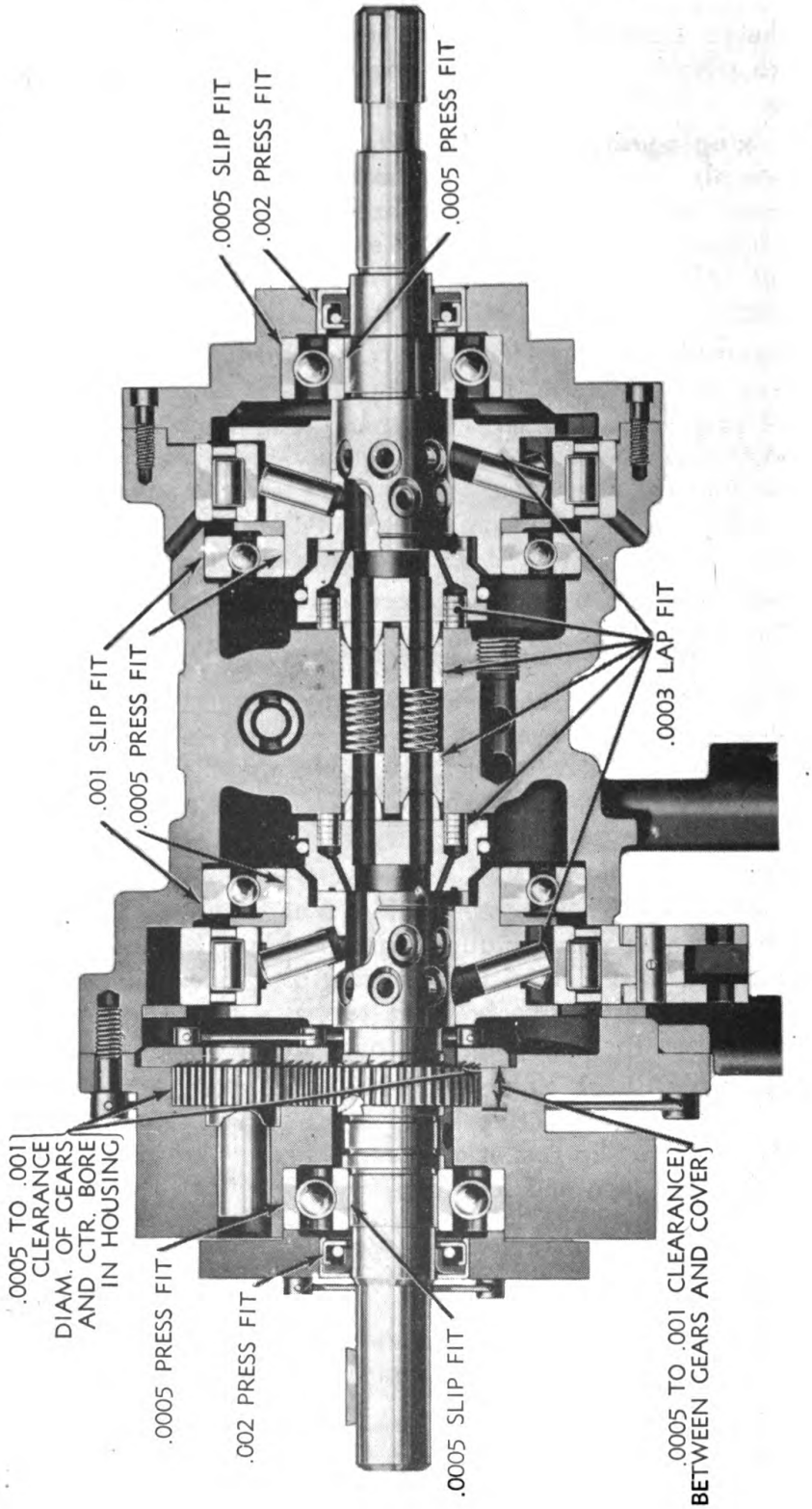
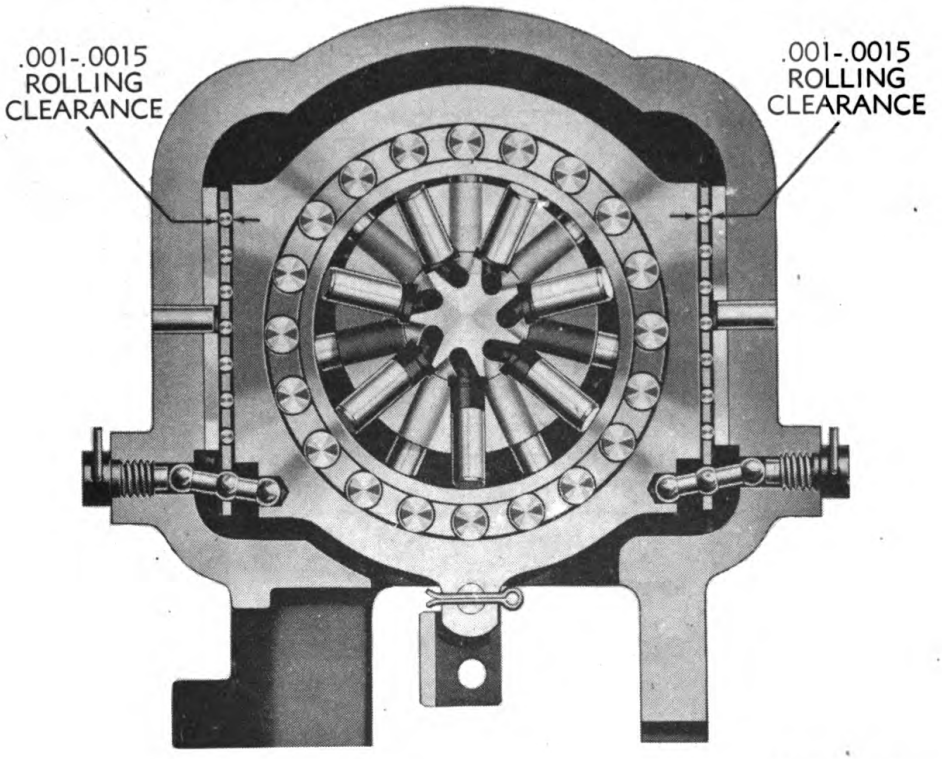


Figure 94—Clearances and Tolerances in Hydraulic Variable Speed Transmission

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 21204

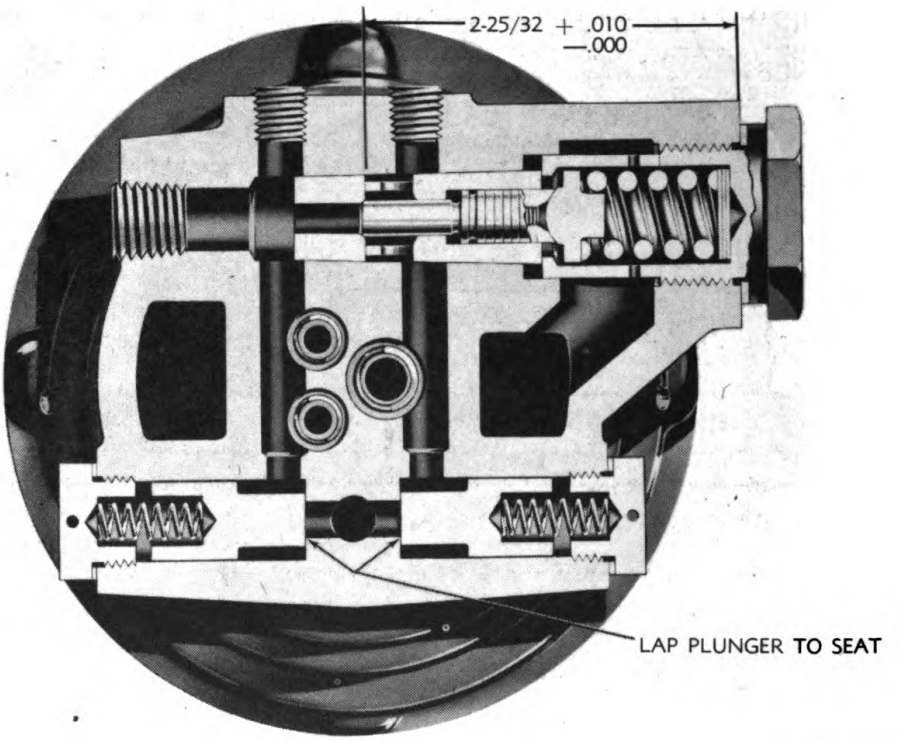
Figure 95—Clearances and Tolerances in Hydraulic Variable Speed Transmission

lower bushing as shown in figure 14. Anchor it to body casting with three 0.164-32 x 7/16 fillister-head machine screws and tooth-type lock washers.

c. Reassemble the dither sleeve, pilot piston assembly, dither spring sleeve, dither spring, and dither sleeve spring retainer as shown in figure 14. Anchor dither sleeve spring retainer with two 0.164-32 x 3/8 fillister-head machine screws and tooth-type lock washers.

d. Place dashpot cylinder and orifice assembly in their proper positions on body casting (fig. 14). Anchor them to body with four 0.164-32 x 3/4 fillister-head machine screws and tooth-type lock washers.

e. Place the differential and stop assembly and differential lever assembly in position as shown in figure 66. Anchor the differential and stop assembly to body casting with plate, four 0.190-32 x 2 3/4 fillister-head machine screws, and tooth-type lock washers. Anchor differential lever assembly to differential and stop assembly with two 0.164-32 x 7/16 fillister-head machine screws and tooth-type lock washers. Place dashpot piston and socket assembly in dashpot cylinder. Use pin and hairpin cotter to fasten one end of differential lever



RA PD 21205

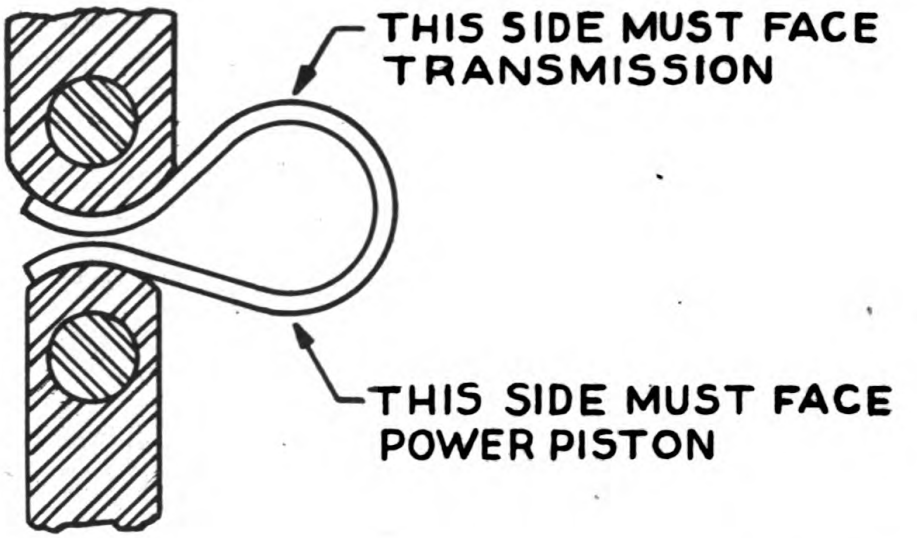
Figure 96—Clearances and Tolerances in Hydraulic Variable Speed Transmission

assembly to socket assembly and dashpot links. Attach the other end of the differential lever assembly to the pilot piston assembly with plain washer BEBX1F, tooth-type lock washer, and nut BBMX1C.

f. Use pin and cotter pin to fasten error corrector link assembly B179442 to lower end of power piston assembly (figs. 14 and 66). Use pin and hairpin cotter to fasten end of the error corrector link assembly to the dashpot links.

g. Use pin and hairpin cotter to fasten the error corrector pivot link B179520 to the error corrector block and to upper bushing of power piston (figs. 14 and 66).

h. Use pin and hairpin cotter to fasten the two links A314348 to top end of dither sleeve (figs. 14 and 65). Use pin and hairpin cotter to fasten the selected end of the dither lever A314352 to power piston assembly and to links A314348. Use pin and hairpin cotter to fasten the two links A314351 to the other end of dither lever. Use pin and hairpin cotter to fasten the dither link B179426 to body casting. Use pin and hairpin cotter to fasten the two links A314351 to the dither link.



RA PD 21206

Figure 97—C Spring A314344

i. Anchor dither lever spring bracket to body casting with two 0.164-32 x 3/8 fillister-head machine screws and tooth-type lock washers. Hook dither lever spring to the dither lever spring bracket and to the dither lever (figs. 14 and 65).

j. Use pin and hairpin cotter to fasten the dither rod to the dither link.

86. REASSEMBLY OF TRANSMISSION AND VALVE ASSEMBLY (figs. 60 and 61).

a. Place neoprene gasket A314354 in position. Carefully push dither rod into hydraulic transmission. Engage the four 1/4-20 x 3/4 hexagonal-head bolts and tooth-type lock washers which hold the valve assembly to the hydraulic transmission. Use pliers to compress the C spring and insert spring between end of power piston assembly and oil pump stroke ring. NOTE: *The "C" spring must be positioned as shown in figure 97 or it will not stay in. Make sure neoprene gasket A314354 is correctly positioned, and tighten the four socket-head cap screws.*

b. Use pliers to compress the C spring sufficiently to pin the power piston assembly to the stroke control link (fig. 8). Lock pin in place with hairpin cotters.

c. Rotate the input shaft by hand and observe the action of the dither push rod and the dither linkage. There should be no indication of excessive friction or binding. Manually displace the power

piston in one direction. Release it and observe if it returns to its original position. Repeat the procedure, moving the power piston in the other direction. Failure of the piston to return to its original position indicates binding.

d. With a spring scale, check that a force of not more than 18 ounces need be applied to the stop assembly push-pull wire to move the limit stop spool. A force of more than 18 ounces indicates kinking or binding of the push-pull wire. Insert the lower end of the stop spool in its guide hole in the body casting. Anchor stop assembly to body casting with two 0.190-32 x 3/8 fillister-head machine screws (fig. 61).

e. Place gasket A314331 and oil reservoir cover against pump end of hydraulic transmission. Anchor the cover and gasket to hydraulic transmission with three 5/16-18 x 3/4 socket-head cap screws. Use holes at 12 o'clock, 4 o'clock, and 8 o'clock. Lock the cap screws with wire (fig. 61). NOTE: *If plate C82063 is of the type with one cutaway section, only one screw will be replaced at this time.*

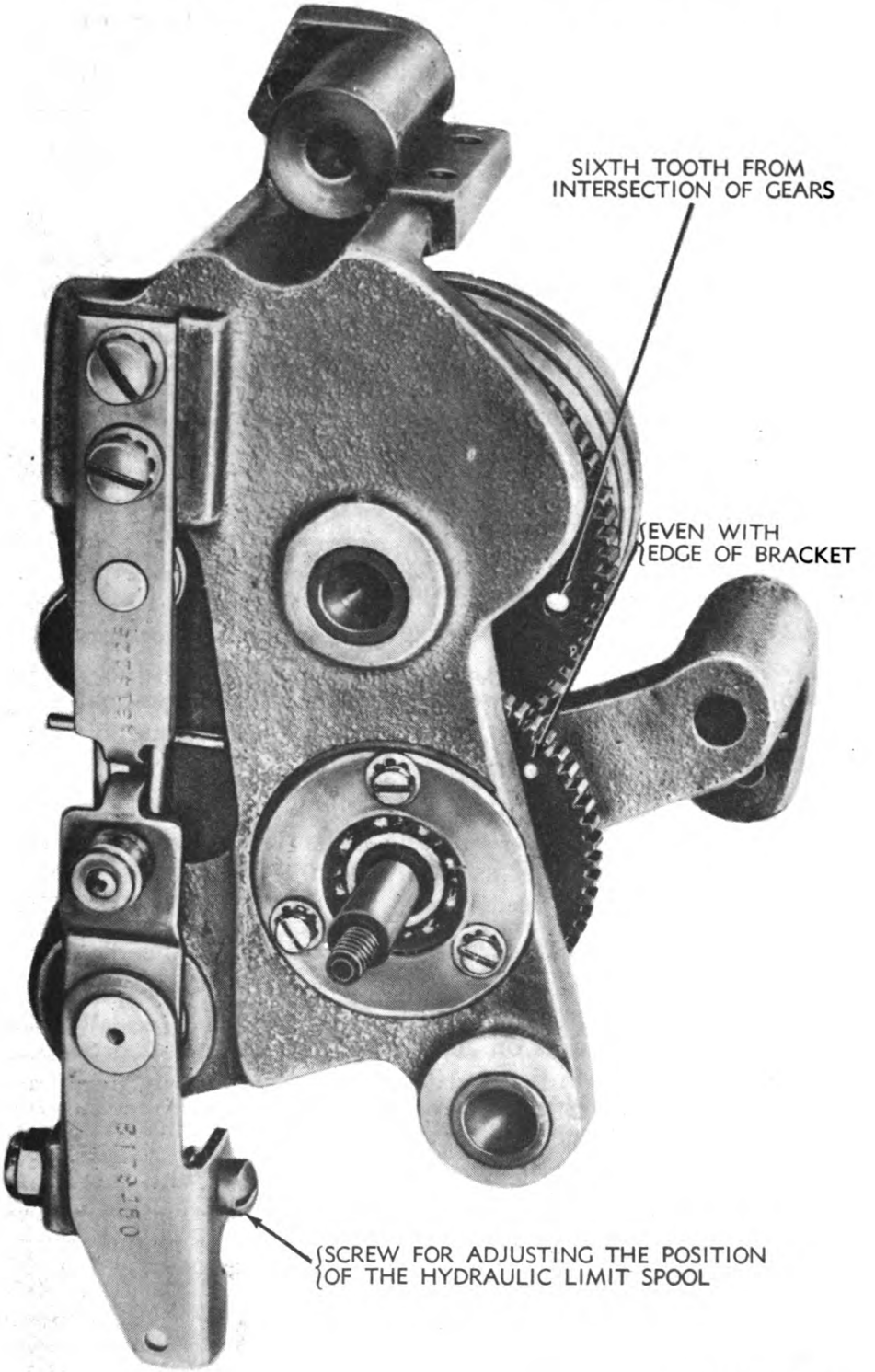
f. Reassemble the three tube fittings to the hydraulic transmission as shown in figures 60 and 61. Reassemble constant pressure valve assembly to filter housing. Reassemble tubes C82073 and C82074 to filter housing. Reassemble tubes C82073, C82074, and C82072 to hydraulic transmission.

87. REASSEMBLY OF RECEIVER ASSEMBLY (figs. 51, 52, 54, and 98).

a. Place washer A314294 on worm shaft (fig. 51). Feed the shaft through selected opening in bracket C75075, through 0.3150 x 0.8861 x 0.2756 bearing and through spacer A314413A. Insert Woodruff key in shaft. Feed the shaft through the worm, spacer A314413B, opening in bracket D75075, 0.2756 x 0.8661 x 0.2756 bearing, and washer A314431. Turn nut BBSX1Z on end of shaft and tighten it. Position the assembly so that the ball bearings are in bracket D75075. Reassemble locking ring to bracket D75075. Turn it clockwise until worm shaft has no end play but turns freely. Lock it in position. Install change gear pair C82087 and Woodruff key on large end of worm shaft with larger gear facing outward. Lock in position. NOTE: *Gear will be correctly positioned on the shaft during final assembly.*

b. Place 3/8 x 7/8 x 7/32 ball bearing on shaft of worm wheel (fig. 51). Insert shaft through hole in bracket D75075. Place a second 3/8 x 7/8 x 7/32 bearing on worm wheel shaft. Attach collar A314290 to shaft and make it up until worm wheel has no end play but turns freely. Lock the collar in position.

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3



RA PD 60592

Figure 98—Correct Relative Positioning of White Dots When Engaging the Adapter Gear With the Contact Ring Gear During Reassembly of Bracket and Gear Assembly

c. Place transmitter and coupling assembly in position and anchor it to bracket D75075 with plate, four 0.190-32 x 2¾ fillister-head machine screws, and tooth-type lock washers (fig. 51). Fasten worm wheel to coupling assembly with four 0.138-32 x 5/16 fillister-head machine screws and tooth-type lock washers.

d. Place repeater and contact assembly in position and anchor it to bracket D75075 with plate, four 0.190-32 x 2¾ fillister-head machine screws, and tooth-type lock washers (fig. 51).

e. **Reassembly of Bracket and Gear Assembly.**

(1) Place gear and contact ring assembly on selected stud of bracket assembly C82097 (fig. 52). Anchor the gear and contact ring assembly to the stud with washer A314228 and nut BBSX1Z.

(2) Place contact brush in position and anchor it to bracket assembly C82097 with two 0.164-32 x ½ fillister-head machine screws and tooth-type lock washers (fig. 52).

(3) Place loop of torsion spring around stud of torsion spring support assembly (fig. 54). Anchor the support assembly to bracket assembly C82097 with two 0.190-32 x ⅜ fillister-head machine screws and tooth-type lock washers. Stud side of support assembly must face bracket assembly.

(4) Push the ½ x 11/16 x ¾ needle bearing into bracket assembly C82097 (fig. 54). Reassemble roller lever assembly and push-pull wire lever to bracket assembly C82097 and anchor them to the bracket assembly with washer A314231 and nut BBSX1Z.

(5) Place disk A7575860 and 5/16 x ½ x 5/16 needle bearing in bracket assembly C82097 (fig. 52). Place Woodruff key in selected end of the adapter shaft B271261. Hold gear B271259 in assembly position with white dots on gear B271259 and gear and contact ring assembly as shown in figure 103, and push the shaft through opening of bracket assembly C82097, through gear B271259, and into the needle bearing. Place ⅜ x ⅞ x 7/32 bearing and bearing retainer in position and anchor them to bracket assembly with three 0.125-44 x 5/16 fillister-head machine screws and tooth-type lock washers. Place Woodruff key and adapter assembly, on the adapter shaft, and anchor them with washer A314431 and nut BBSX1Z. Place hydraulic limit cup and cams up against adapter assembly and anchor them in place with two 0.190-32 x ½ fillister-head machine screws and tooth-type lock washers. See paragraph 41 for setting of cams for elevation or azimuth.

(6) Place idler gear assembly B179454 on remaining stud of bracket assembly C82097 with the large gear away from bracket

(fig. 52). Anchor the idler gear assembly to the stud with washer A314228 and nut BBSX1Z.

f. Place bracket and gear assembly in position for assembly to bracket D75075, and engage the two dowel pins (fig. 51). Anchor it with three ¼-20 x 1¾ hexagonal-head bolts and tooth-type lock washers.

88. REASSEMBLY OF INDUCTION MOTOR.

a. The reassembly of induction motor is apparent from the exploded view (fig. 49).

89. REASSEMBLY OF WIRE ASSEMBLY D75085 TO MAIN CASE.

a. The reassembly of wire assembly D75085 to the main case is apparent from figure 47. Anchor wire seal retaining flange to main case with three ¼-20 x ½ hexagonal-head bolts and tooth-type lock washers.

90. REASSEMBLY OF TRANSMISSION AND VALVE ASSEMBLY TO MAIN CASE.

a. Press oil retainer into main case (fig. 47). *Do this from the oil reservoir side.* Closed end of seal must face oil reservoir.

b. Place gasket B179488 on main case (fig. 45).

c. Place transmission and valve assembly alongside the main case. Connect the wires of wire assembly D75085 (fig. 47) to the synchro differential. The markings on the wire terminals must coincide with the markings on the differential terminals.

d. Place gasket A314332 on stop assembly and hold it in place with grease. Place gasket A314272 against the filter housing and hold it in place with grease (fig. 45).

e. Anchor clip A314349 (fig. 47) to main case with one screw. Attach a length of string or wire to the stop assembly and thread it through the hole in the main case.

f. Slowly lower the transmission and valve assembly into main case, guiding the end of the stop assembly through the hole in the main case by means of the string or wire. Make certain that the reservoir cover is properly seated on the dowel pins and that gasket B179488 is in place. Anchor the reservoir cover and gasket B179488 to the main case with six 5/16-18 x ¾ hexagonal-head bolts and lock washers (fig. 45).

g. Make sure gasket A314272 is in place on filter housing (figs. 4 and 45) and anchor the filter housing to main case with six 5/16-18 x ¾ hexagonal-head bolts and tooth-type lock washers.

h. Place gasket B179487 and oil reservoir inspection cover B179457 on the reservoir cover. Anchor them to the reservoir cover with ten $\frac{5}{16}$-18 x $\frac{7}{8}$ hexagonal-head bolts and tooth-type lock washers (fig. 45).

i. Remove the length of string or wire from the limit stop assembly. Anchor the stop assembly to the main case with washer A314312 and nut A314313. Bend one prong of the washer against a flat of the nut (fig. 41).

j. Reassemble filter and filter retainer to the filter head with 0.190-32 x 3¼ fillister-head machine screw and tooth-type lock washer (fig. 45).

91. REASSEMBLY OF CLUTCH YOKES AND OUTPUT SHAFT GROUP ASSEMBLY TO MAIN CASE (figs. 42 and 99).

a. Place 0.971 x 1.562 loading spring in recess in main case. Assemble clutch gear assembly, output gear assembly, washer A314276, and 0.6693 x 1.15748 x 0.472 x 0.563 bearing on the output shaft. Cover the bearing and gears with grease and insert the bearing in recess in main case (fig. 42).

b. Hold boresighting clutch yoke assembly B271256 in position for assembly. Make certain that the clutch yoke shoes are positioned properly. Insert boresighting clutch shaft A314421 through opening of main case and through opening of boresighting clutch yoke assembly (figs. 42 and 99).

c. Place gear B179439, spacer collar, and slewing clutch collar assembly in position on oil motor shaft (figs. 42 and 99).

d. Hold slewing clutch yoke assembly B271254 in position for assembly. Make certain that the clutch yoke shoes are positioned properly. Insert slewing clutch shaft B271258 and Woodruff key through opening in main case, through opening in slewing clutch yoke assembly, and into the boresighting clutch shaft (figs. 42 and 99). Grease shaft before inserting.

e. Insert pin A314422 through hole in boresighting clutch yoke assembly, through hole in boresighting clutch shaft, and into groove of the slewing clutch shaft. Insert cotter pin BFAX1CD through boresighting clutch yoke assembly and pin A314422 (figs. 42 and 99).

f. Place boresighting clutch lever assembly in position for assembly to the boresighting clutch shaft. Anchor it to the shaft with tooth-type lock washer and ¼-20 x $\frac{7}{8}$ hexagonal-head bolt (fig. 99).

g. Place slewing clutch lever assembly in position for assembly to slewing clutch shaft. Anchor it to the shaft with tooth-type lock washer and ¼-20 x $\frac{7}{8}$ hexagonal-head bolt (fig. 42).

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

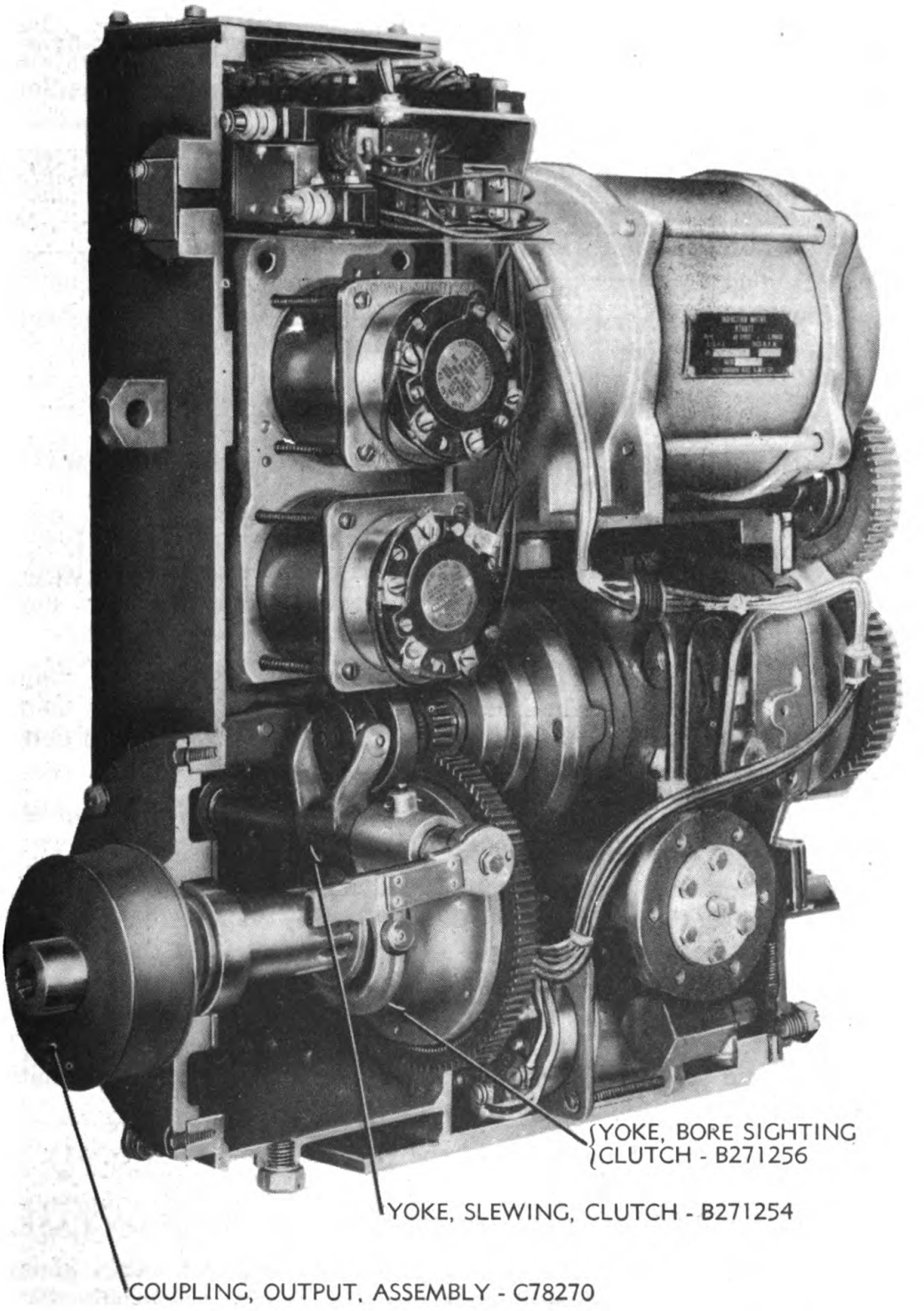


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Figure 99—Oil Gear M3—Cutaway View

h. Reassemble slewing clutch locking lever to main case. Use pin A314317 and cotter pins. See instructions paragraph 41 covering setting of locking lever for elevation and setting of locking lever for azimuth. Grease all gears.

i. Place 1.1811 x 2.4408 x 0.630 x 0.9449 bearing in boresighting clutch housing (fig. 42). Pack it with grease and hold it in place with the bearing retainer, four ¼-20 x ⅝ hexagonal-head bolts and tooth-type lock washers. Place gasket A314274 and boresighting clutch housing on the output shaft and anchor to main case with eight 5/16-18 x ¾ hexagonal-head bolts and tooth-type lock washers. Replace grease fitting.

j. Reassemble output coupling to the output shaft (fig. 42).

92. REASSEMBLY OF RECEIVER ASSEMBLY TO MAIN CASE.

a. Fasten the three wires B271945 to the contact brush B179417 with three 0.099-48 x 3/16 round-head brass machine screws and tooth-type lock washers. Markings on wire terminals must coincide with markings on brush terminals (figs. 41 and 52).

b. Place receiver assembly in position for assembly to main case and engage the dowel pin. Anchor the assembly to the main case with two ⅜-16 x 1¼, and one ⅜-16 x ⅞, hexagonal-head bolts and tooth-type lock washers (fig. 41).

c. Use pin A314298 and hairpin cotters to fasten the stop assembly push-pull wire to lever B179450 (fig. 41).

d. Fasten the wire assemblies B271923, B271924, B271925; B271926, B271927, B271928, B271929, B271930, B271931, and B271932 to the terminals of the synchro repeater and the synchro transmitter (figs. 101 and 107). A tooth-type lock washer goes under each terminal. Wires going to the repeater are marked "C" for coarse data system. Wires going to the transmitter are marked "F" for fine data system. Number and XY markings on wire terminals must coincide with markings on synchro terminals.

e. Grease all of the gears of the receiver assembly (fig. 41).

93. REASSEMBLY OF INDUCTION MOTOR TO MAIN CASE.

a. Place follower nut, gland A314428, ring A314426, gland A314427 and gasket A314409B on motor lead wire nipple (fig. 38). Insert motor leads through opening in main case and set motor in position. Start follower nut into opening of main case. Place shims A314326 and A314327 between motor base and main case. Anchor

motor to main case with two 3/8-16 x 7/8 hexagonal-head bolts and tooth-type lock washers.

b. Place gasket B179486 in position (fig. 38). It may be necessary to loosen slightly the two bolts anchoring the motor to the main case so that plate C82063 can be properly positioned. Place gasket A314263, plate C82063, gasket A314263, and oil baffle in position for assembly to motor. Anchor them to the motor with three 5/16-18 x 1 hexagonal-head bolts and tooth-type lock washers.

NOTE: *The bolts screw into the motor.* Anchor the plate C82063 to hydraulic transmission with three 5/16-18 x 1 socket-head cap screws. In some units, plate C82063 is secured to the hydraulic transmission with five 5/16-18 x 1 socket-head cap screws. Lock the cap screw heads with wire. Anchor the plate C82063 to main case with two 5/16-18 x 1 hexagonal-head bolts and tooth-type lock washers.

c. Assemble spacer A314259, washer A314260, Woodruff key, and pinion gear to motor shaft (fig. 38). Hold in place with washer A314261 and hexagon nut BBCX2B. Bend one prong of washer against flat of nut.

d. Fasten idler gear support stud to plate C82063 with six 0.190-32 x 3/8 socket-head cap screws and tooth-type lock washers (fig. 39). Place idler gear assembly on the stud and anchor with plain washer BEBX1K and safety nut BBSX2AC.

e. Reassemble Woodruff key and gear B179485 on oil pump shaft (fig. 38). Anchor the gear with cotter pin BFAX2AA.

f. Make sure the shimming between motor base and main case is correct, and tighten follower nut (fig. 38).

g. Place gasket A314161 and gear cover in position for assembly to plate C82063 (fig. 38). Anchor them to the plate with fourteen 1/4-20 x 1/2 hexagonal-head bolts and tooth-type lock washers.

94. REASSEMBLY OF INSULATION PLATE, PUSH BUTTON SWITCH ASSEMBLY, AND TERMINAL BOARD ASSEMBLY TO MAIN CASE.

a. Insert motor wires, receiver wires, and lead wire D75085 through selected holes of the plate. Figure 100 shows correct holes for the various wires. Anchor the plate to the main case with four 8-32 x 1/4 round-head machine screws and tooth-type lock washers (fig. 46).

b. Insert the stems of the two push button switches through openings in main case. Lock in position with four hexagonal nuts (fig. 46).

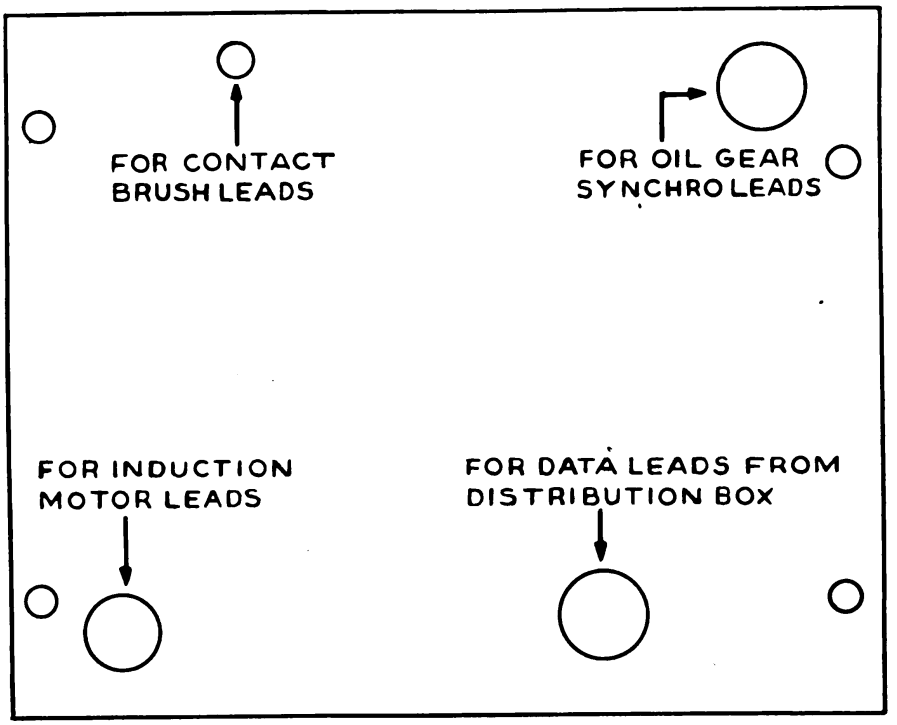

Figure 100—Plate B179533

c. Place the two compression springs, two spring retainers, two neoprene disks, and two push button switch cover assemblies in position for assembly to main case (fig. 46). Anchor them with eight 0.164-32 x 3/8 flat-head machine screws.

d. Place terminal board assembly on top of unit and connect wires to it according to wiring diagram (fig. 101).

e. Anchor terminal board assembly to main case with four 0.190-32 x 3/8 fillister-head machine screws and tooth-type lock washers (fig. 46).

f. Place gasket B179506 and terminal board access cover assembly in position for assembly to main case. Anchor them with ten 1/4-20 x 1/2 fillister-head machine screws and tooth-type lock washers (fig. 46).

g. Place gasket B179512 and cover C82089 in position for assembly to main case (fig. 41). Anchor them with twelve 1/4-20 x 1/2 fillister-head machine screws and tooth-type lock washers.

h. Place gasket B179512 and cover assembly C82079 in position

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

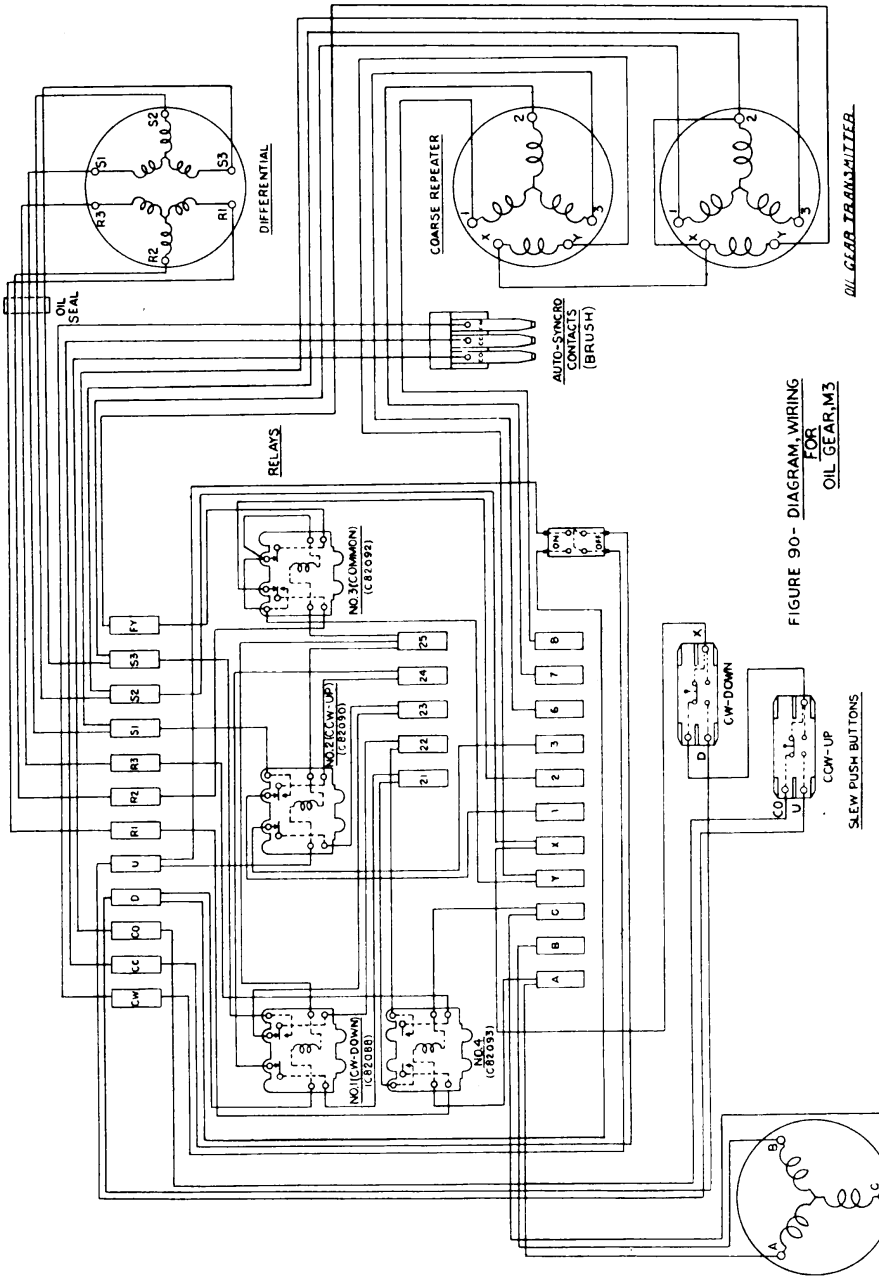

FIGURE 90- DIAGRAM, WIRING FOR OIL GEAR, M3

Figure 101—Oil Gear M3—Wiring Diagram

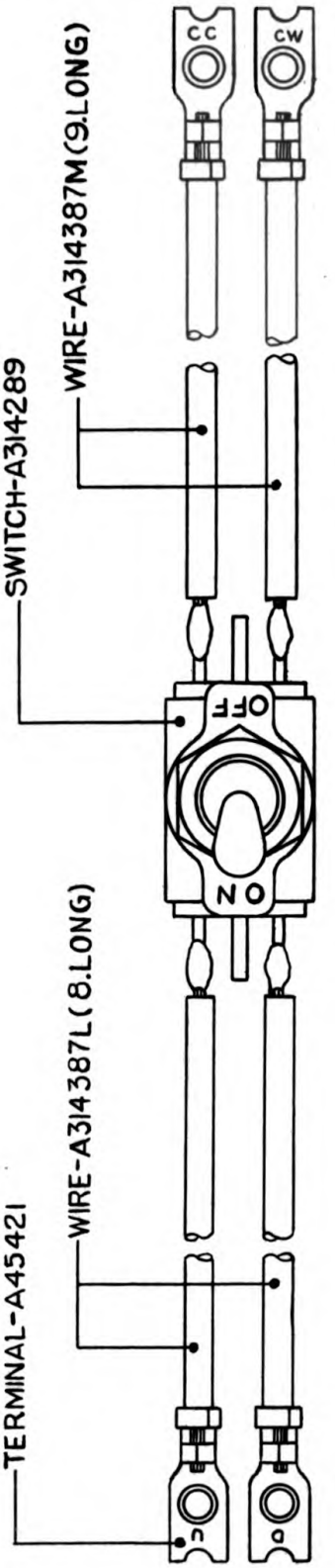

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Figure 102—Switch Assembly C82094

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

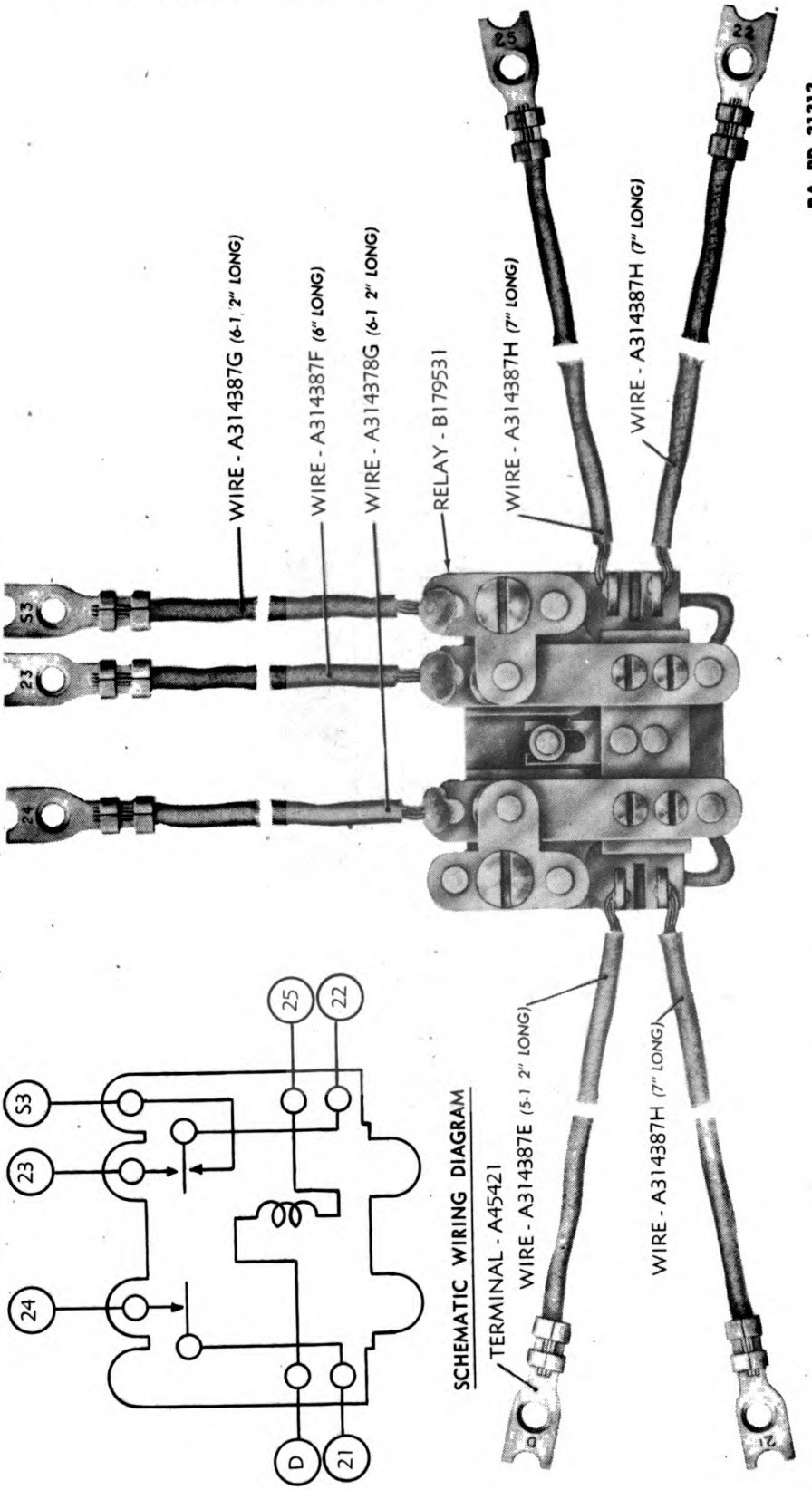

Figure 103—Relay Assembly C82088 (No. 1)

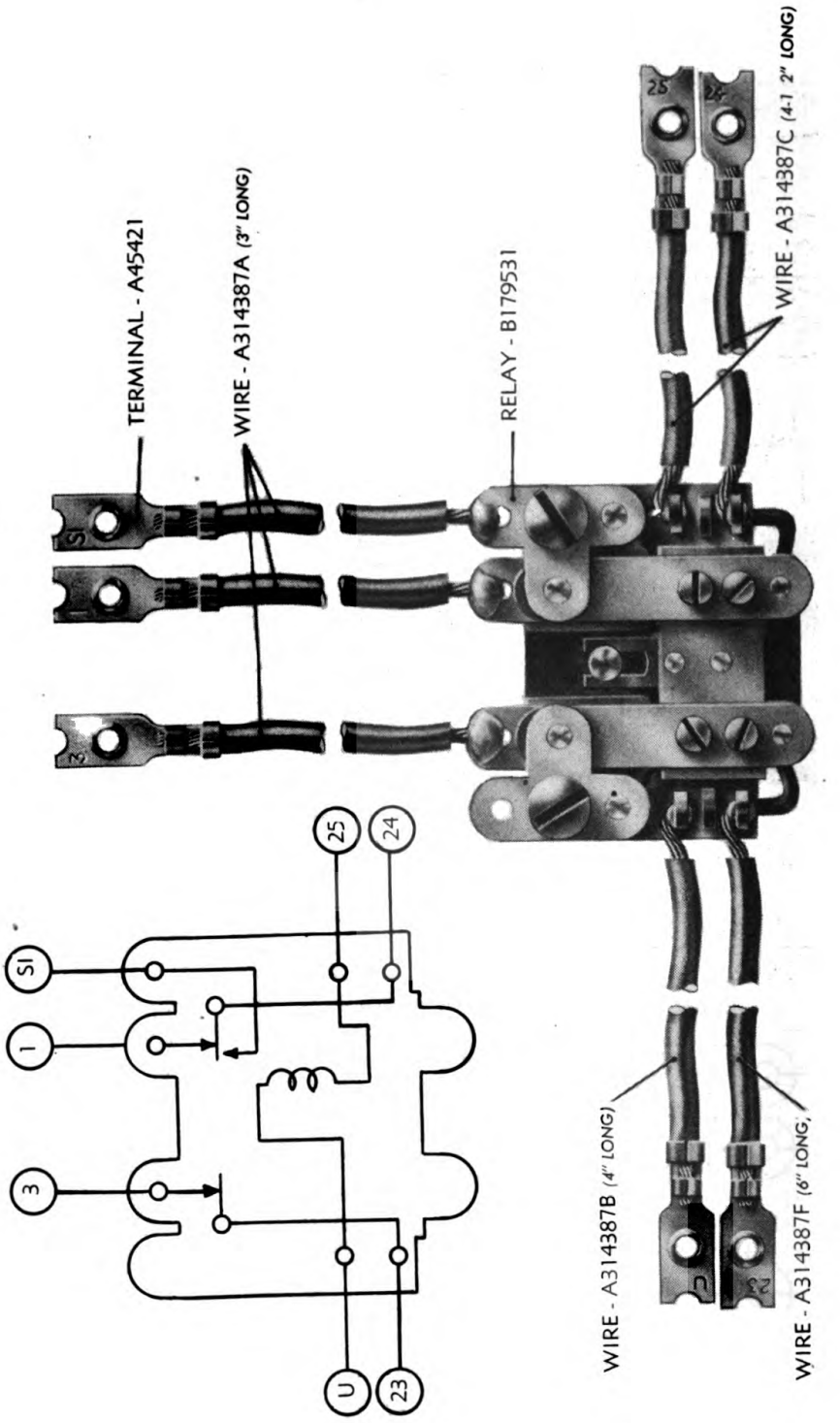

Figure 104—Relay Assembly C82090 (No. 2)

DISASSEMBLY AND ASSEMBLY OF OIL GEAR M3

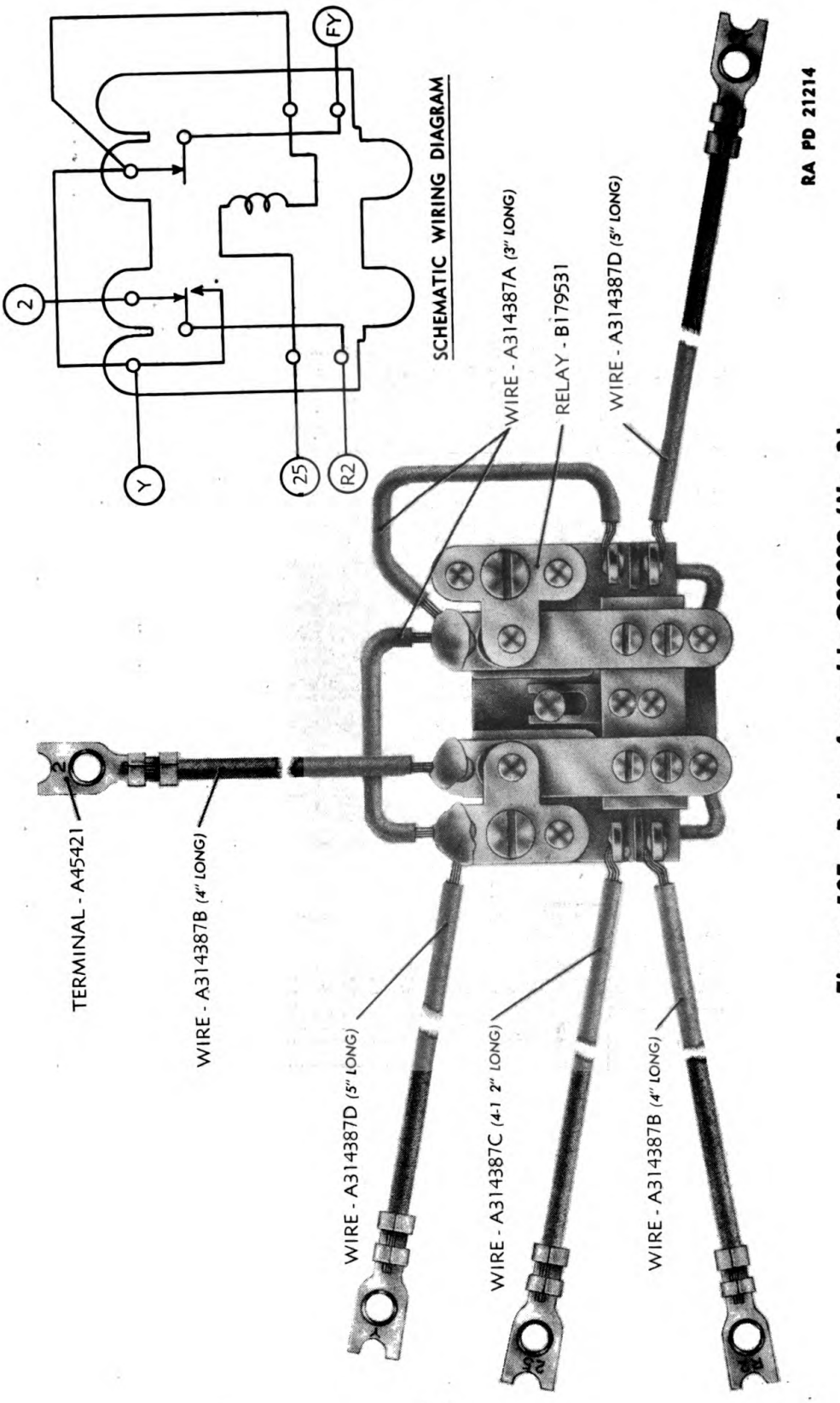

Figure 105—Relay Assembly C82092 (No. 3)

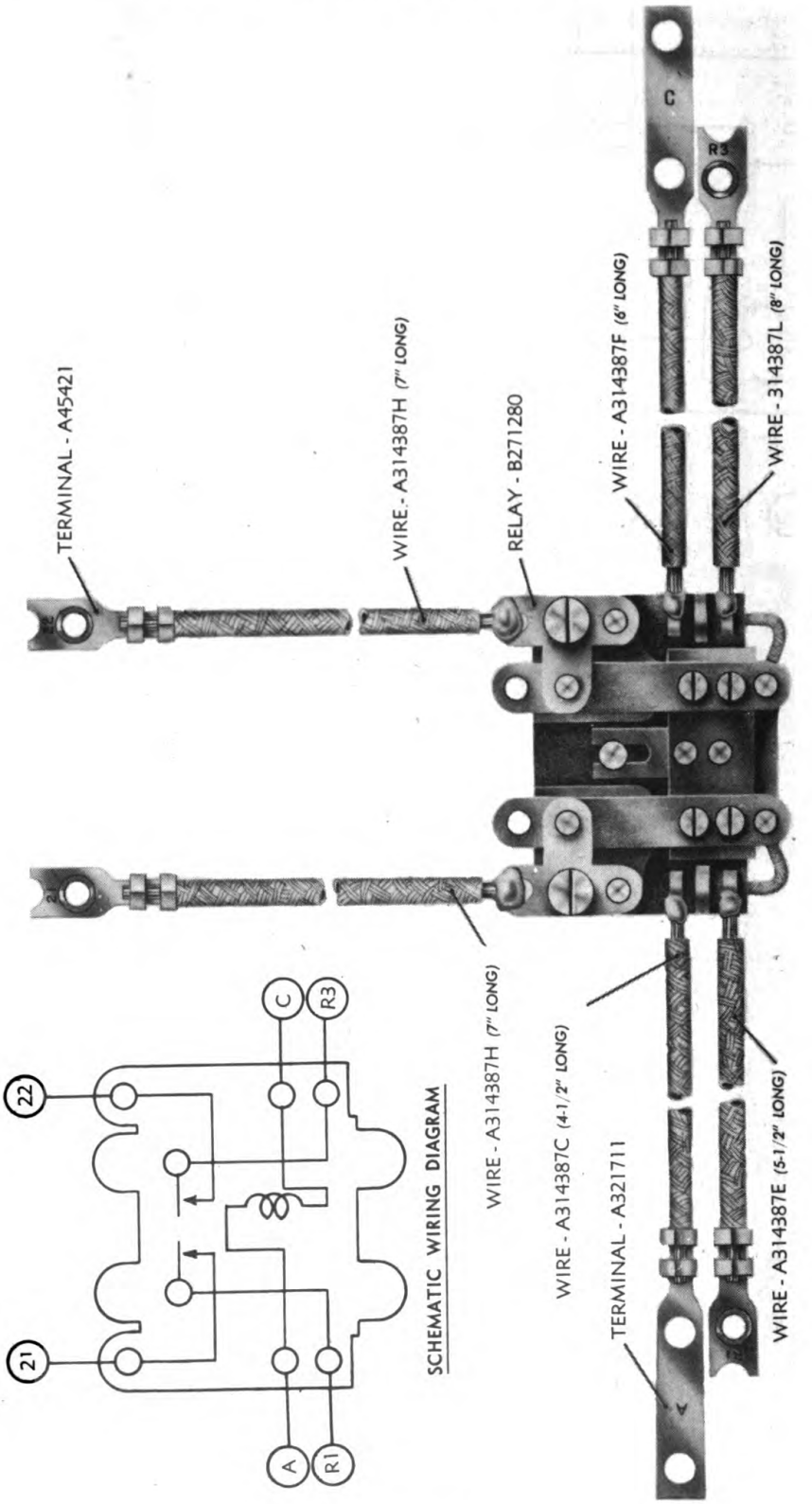

Figure 106—Relay Assembly C82093 (No. 4)

WIRE ASSEMBLY	TERMINAL MARKING	UNIT TERMINAL CONNECTS TO	WIRE NUMBER	WIRE LENGTH	TERMINAL MARKING	UNIT TERMINAL CONNECTS TO
B271923	X	SYNCHRO TRANSMITTER	A314387C	4-1/2"	F2	SYNCHRO TRANSMITTER
B271924	X	SYNCHRO TRANSMITTER	A314387K	7-1/2"	X	SYNCHRO REPEATER
B271925	C1	SYNCHRO REPEATER	A314387W	19"	8	TERMINAL BOARD
B271926	C2	SYNCHRO REPEATER	A314387X	21"	7	TERMINAL BOARD
B271927	C3	SYNCHRO REPEATER	A314387X	21"	6	TERMINAL BOARD
B271928	CY	SYNCHRO REPEATER	A314387Y	23"	Y	TERMINAL BOARD
B271929	F1	SYNCHRO TRANSMITTER	A314387Y	23"	S3	TERMINAL BOARD
B271930	F2	SYNCHRO TRANSMITTER	A314387Y	23"	S2	TERMINAL BOARD
B271931	F3	SYNCHRO TRANSMITTER	A314387Y	23"	S1	TERMINAL BOARD
B271932	FY	SYNCHRO TRANSMITTER	A314387X	21"	FY	TERMINAL BOARD
B271945	CO	CONTACT BRUSH	A314387R	14"	CO	TERMINAL BOARD
B271945	CW	CONTACT BRUSH	A314387R	14"	CW	TERMINAL BOARD
B271945	CC	CONTACT BRUSH	A314387R	14"	CC	TERMINAL BOARD
D75085	R1	SYNCHRO DIFFERENTIAL	B179534A	45"	R1	TERMINAL BOARD
	R2	SYNCHRO DIFFERENTIAL	B179534C	44"	R2	TERMINAL BOARD
	R3	SYNCHRO DIFFERENTIAL	B179534E	43"	R3	TERMINAL BOARD
	S1	SYNCHRO DIFFERENTIAL	B179534F	42"	S1	TERMINAL BOARD
	S2	SYNCHRO DIFFERENTIAL	B179534D	43"	S2	TERMINAL BOARD
	S3	SYNCHRO DIFFERENTIAL	B179534B	44"	S3	TERMINAL BOARD
NO ASSEMBLY NUMBER	X	TERMINAL BLOCK	A314387E	5-1/2"	S2	TERMINAL BLOCK

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Figure 107—Breakdown of Wire Assemblies

for assembly to main case (fig. 38). Anchor them with twelve ¼-20 x ½ fillister-head machine screws and tooth-type lock washers.

i. Test the oil gear and make adjustments according to instructions given in section VII.

Section XI

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

95. GENERAL.

a. Normally in maintenance, assembly of an entire remote control system to a gun carriage will not be necessary. Individual parts, however, may fail and repairs become necessary. The extent of disassembly needed for any repair job should be determined by the repairman when he makes his detailed inspection. Care and close attention should be exercised during disassembly, cleaning, adjustment, and reassembly.

b. All components should be marked or tagged as they are disassembled to insure correct position in reassembly. If parts are not so marked or tagged, considerable difficulty may be encountered in the final adjustment. Reference marks may be scribed when deemed advisable.

c. Bolts, stubs, and nuts which secure the parts to the carriage are carriage parts and may be identified by referring to Standard Nomenclature Lists and to Technical Manuals on the carriage. In assembling parts to the gun carriage, close attention should be paid to figures and wiring diagrams.

96. GUN JUNCTION BOX.

a. Major Disassembly.

(1) Remove top cover and cover gasket (fig. 108).

(2) Remove and tag all remaining wires from top contacts of 15-pole receptacle.

(3) Remove 15-pole receptacle from body (fig. 109).

(4) Remove 3-pole receptacle from gasket. Wires will follow (fig. 109).

b. 15-pole Receptacle Disassembly. Figure 110 is self-explanatory.

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

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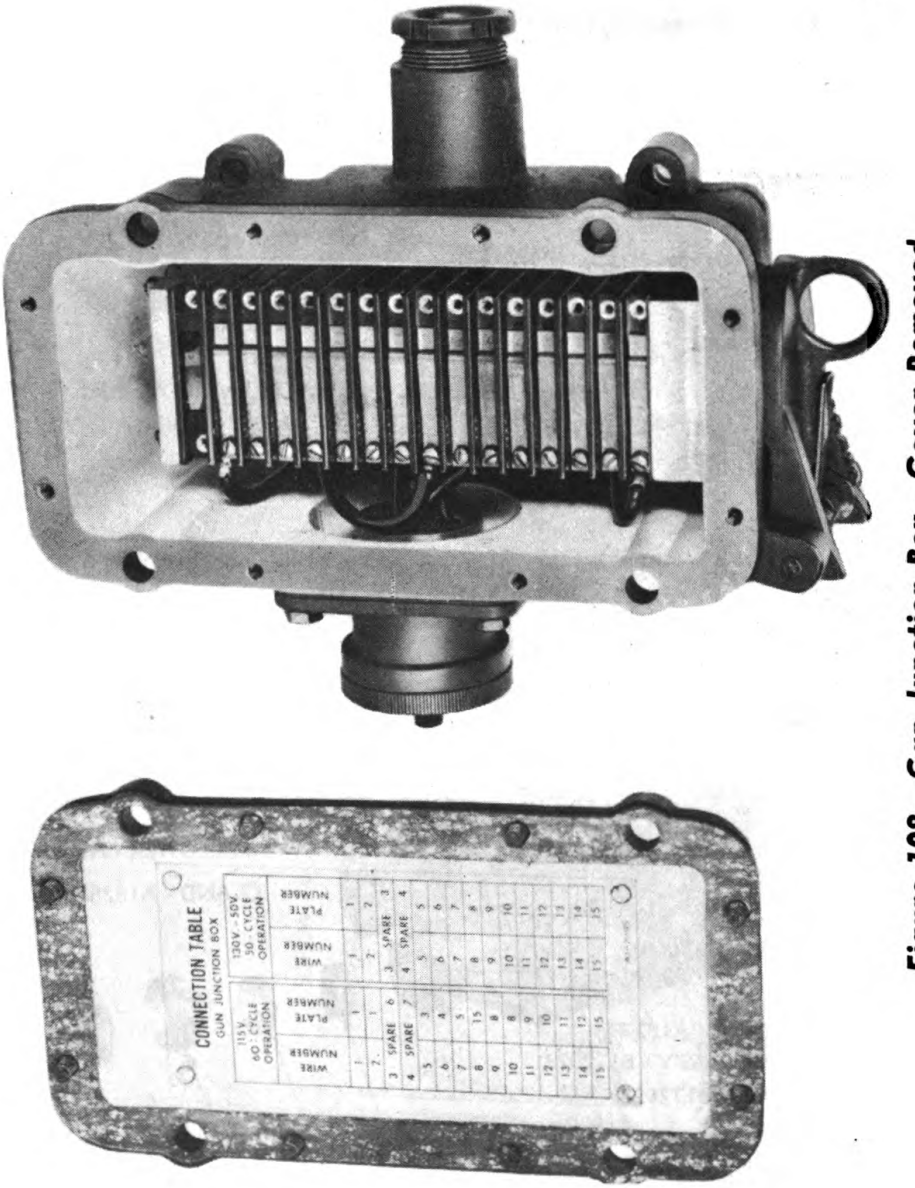

Figure 108—Gun Junction Box—Cover Removed

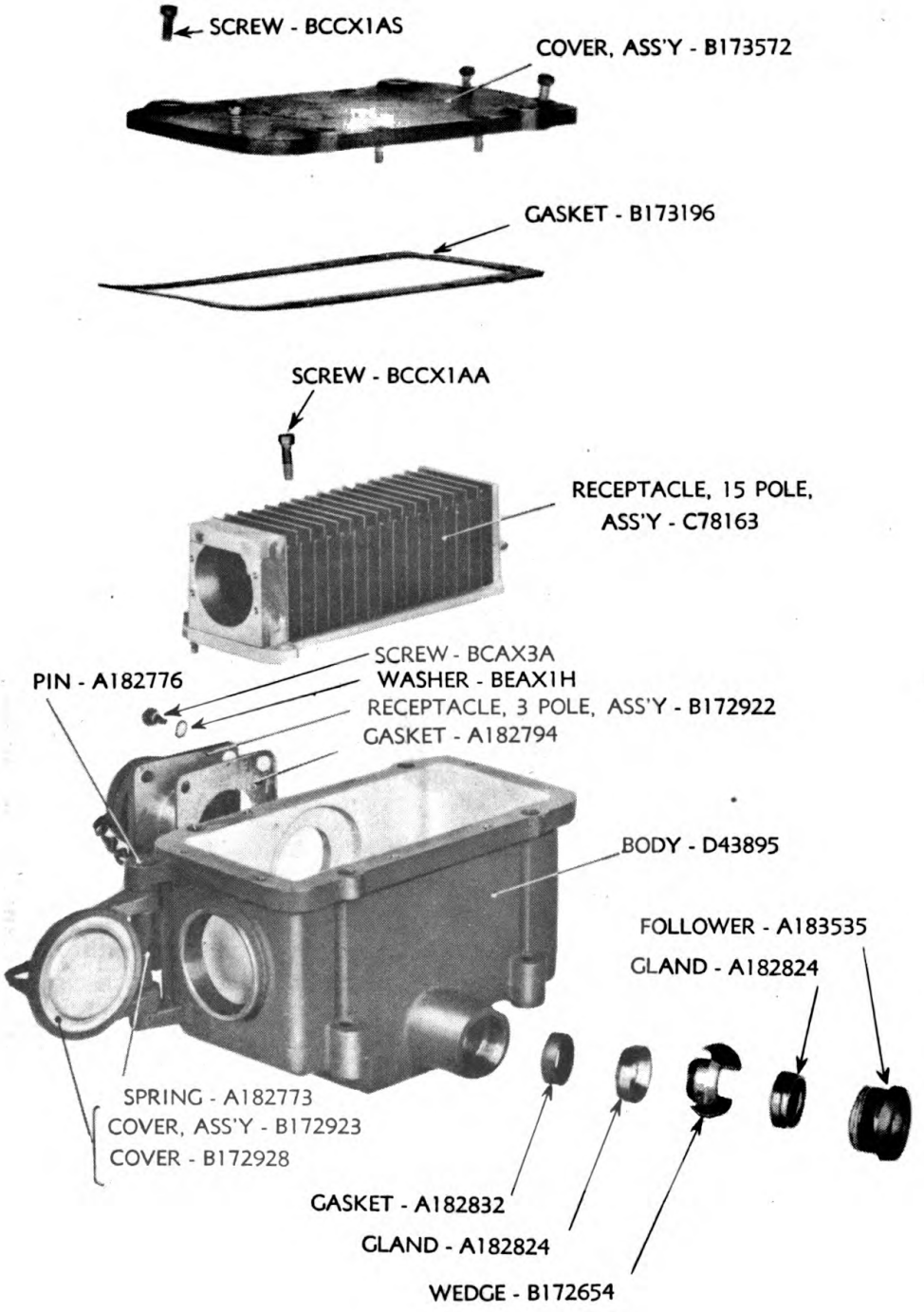

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Figure 109—Gun Junction Box Assembly—Exploded Side View

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

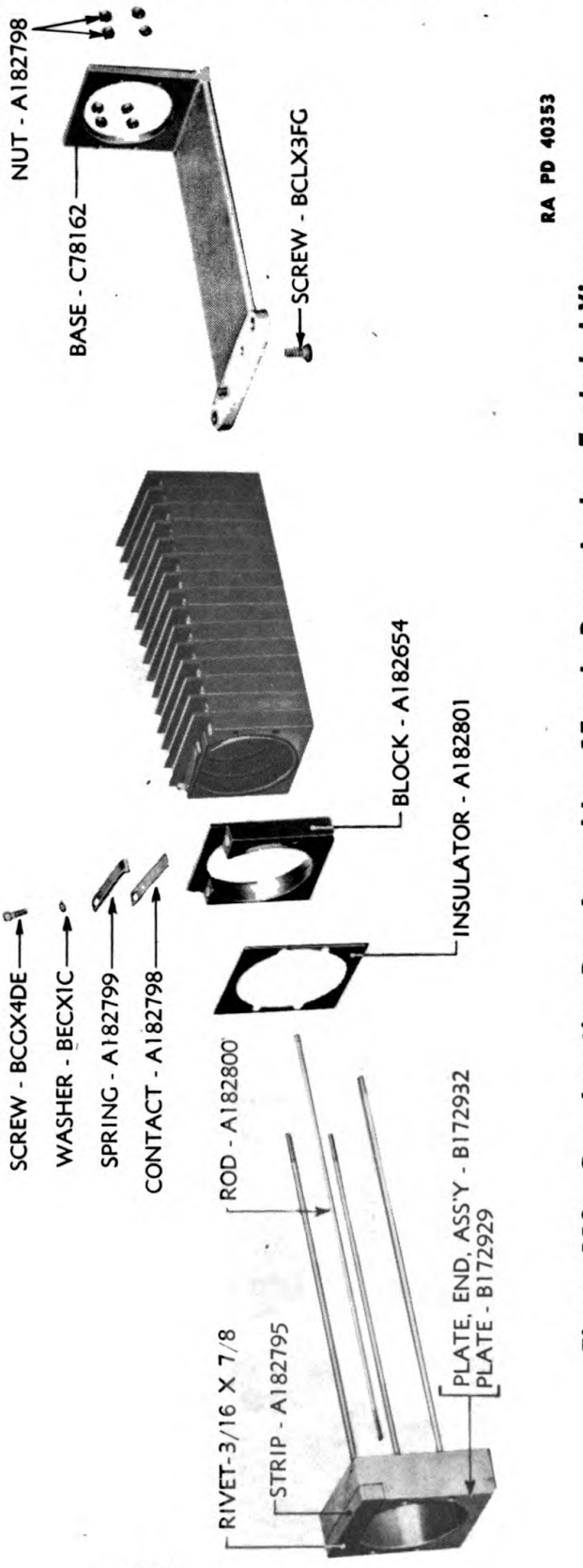


Figure 110—Gun Junction Box Assembly—15-pole Receptacle—Exploded View

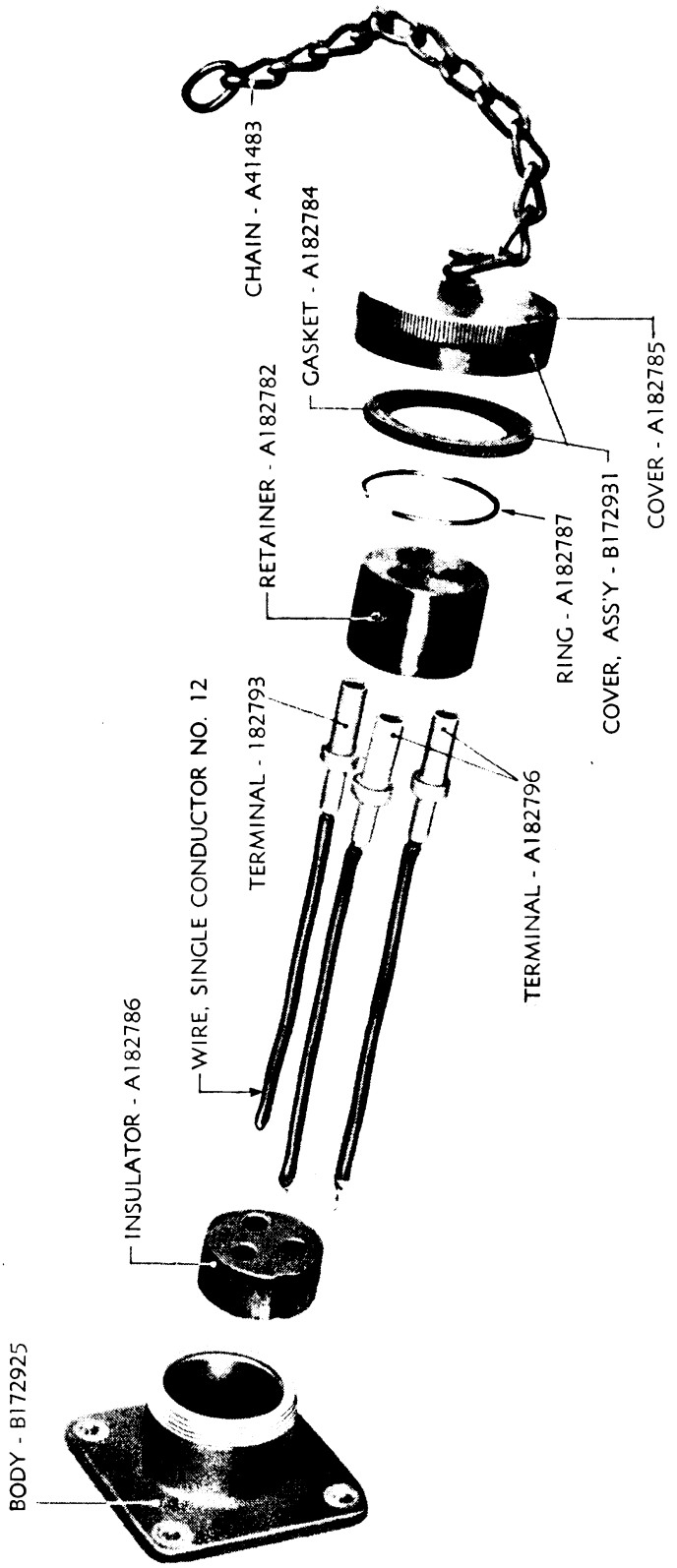
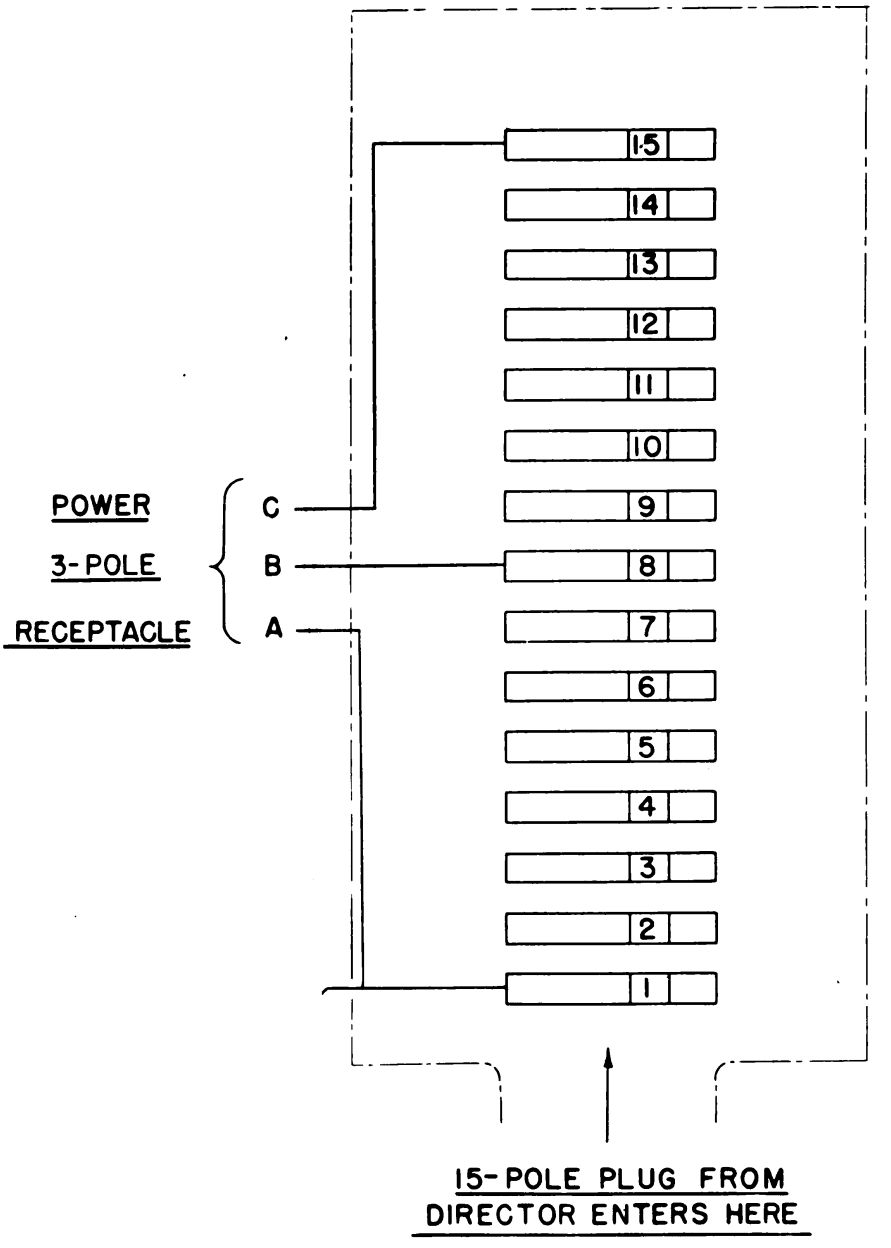


Figure 111—Gun Junction Box Assembly—3-pole Receptacle—Exploded Front View

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12



RA PD 60593

Figure 112—Gun Junction Box—Wiring Diagram

c. 3-pole Receptacle Disassembly. Figure 111 is self-explanatory.

d. Disassembly of Outlet to Contact Ring. Figure 109 shows the disassembly of this outlet.

e. Assembly. Assembly is substantially the reverse of disassembly. Care must be exercised to make all joints watertight. All

CABLE B173228 COLOR CODING OF CONDUCTORS CONNECTED TO TERMINAL A182670		
TERMINAL NUMBER	COLOR CODING OF CONDUCTORS	
	FIELD	TRACE
1	RED	———
2	BLACK	WHITE
3	BLUE	———
4	BLUE	WHITE
5	BLUE	BLACK
6	WHITE	BLACK
7	GREEN	———
8	GREEN	WHITE
9	BLACK	———
10	GREEN	BLACK
11	RED	WHITE
12	RED	BLACK
13	YELLOW	———
14	YELLOW	BLACK
15	WHITE	———

RA PD 60594

Figure 113—Color Coding for Cable B173228

terminals in the 3-pole receptacle are not the same size, so do not try to force a large one in a small hole. Figure 112 gives the wiring diagram. Color coding for gun junction box—contact ring cable is shown in figure 113.

97. ELEVATION LIMIT SWITCH.

a. Major Disassembly (fig. 114).

(1) Remove trip lever assembly.

(2) Remove switch lever assembly.

(3) Remove base plate.

(4) Remove adapter and gasket.

b. Switch Box Disassembly.

(1) Remove stud (figs. 114 and 115). Figure 115 shows an azimuth switch, but details are the same except for the switch lever.

(2) A clip is fastened by the stud to the inside of the box. Push this clip up toward the spindle, thereby releasing spindle (fig. 115).

(3) Slide spindle away from box.

(4) Remove screw holding shaft to side of box, opposite spindle.

(5) Lift end of shaft above edge of box and withdraw it to the right. Figure 116 shows an exploded view of the shaft assembly.

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

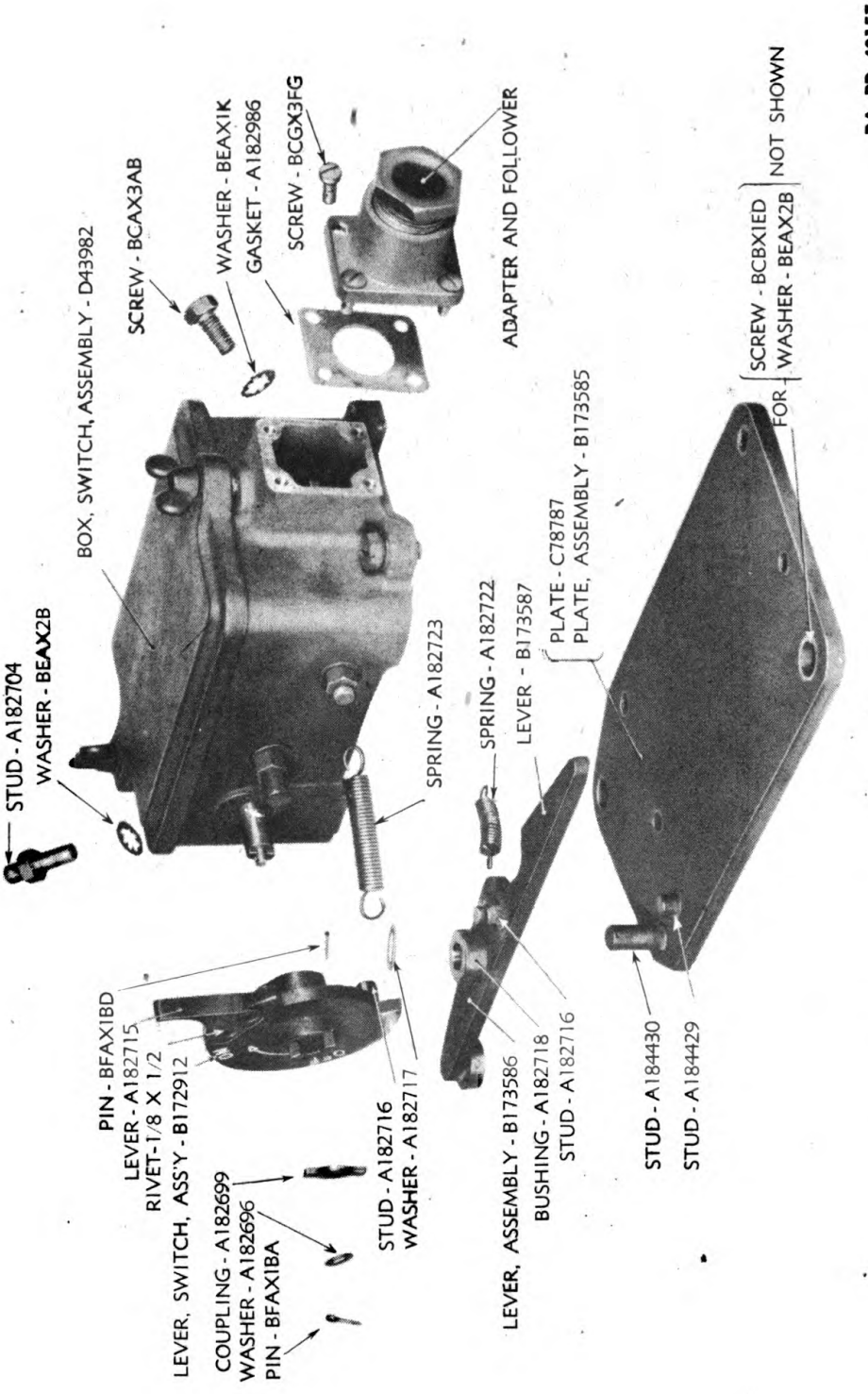


Figure 114—Elevation Limit Switch—Major Disassembly

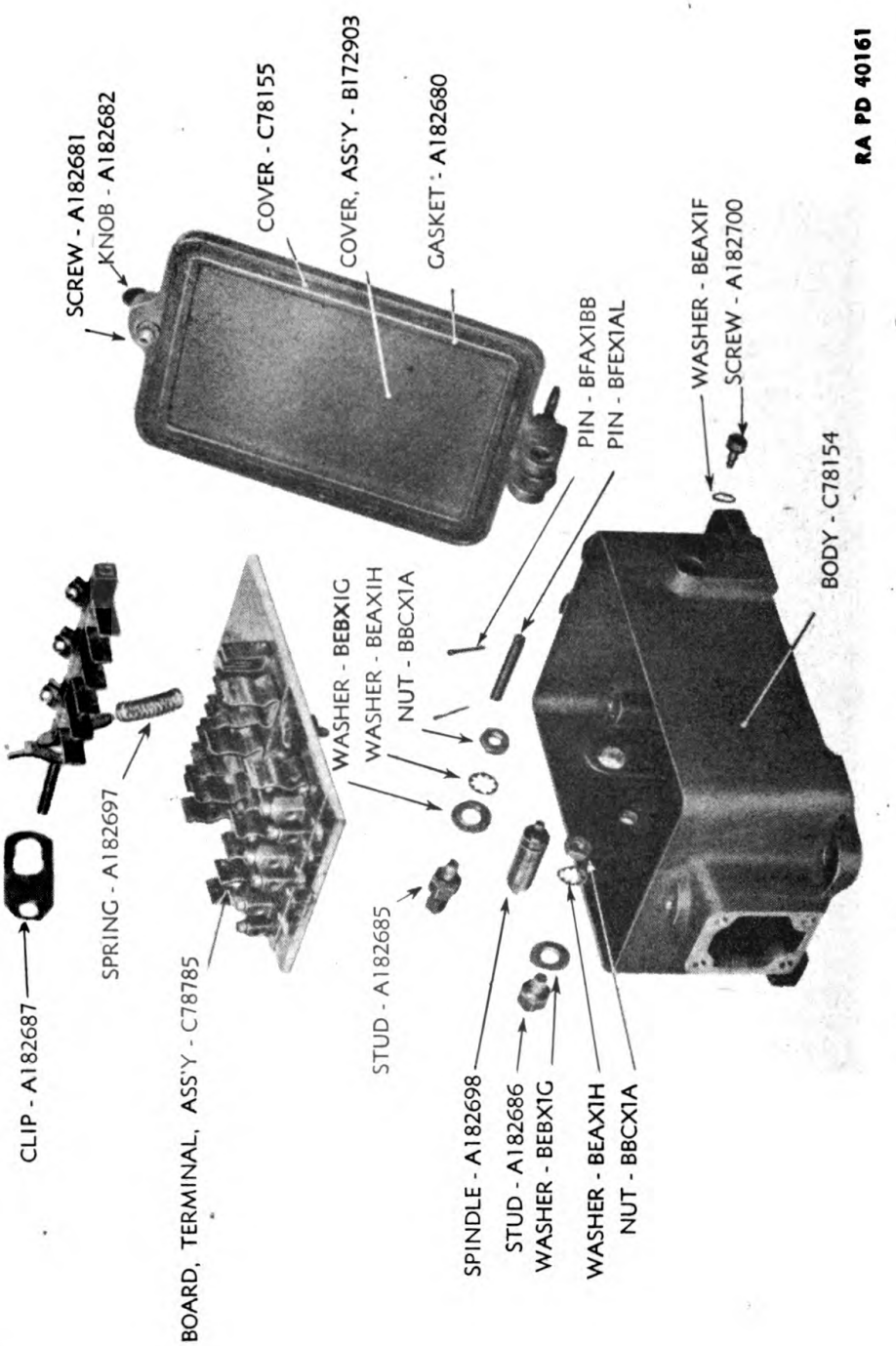


Figure 115—Azimuth Switch—Major Disassembly

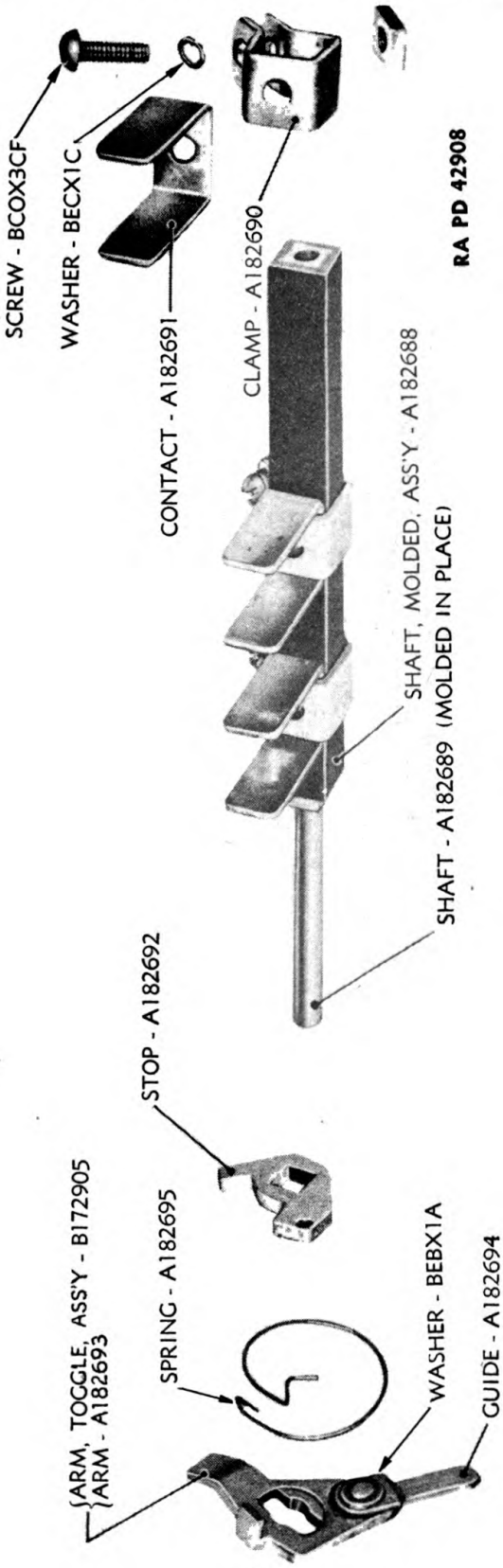


Figure 116—Toggle Arm and Switch Shaft Assemblies

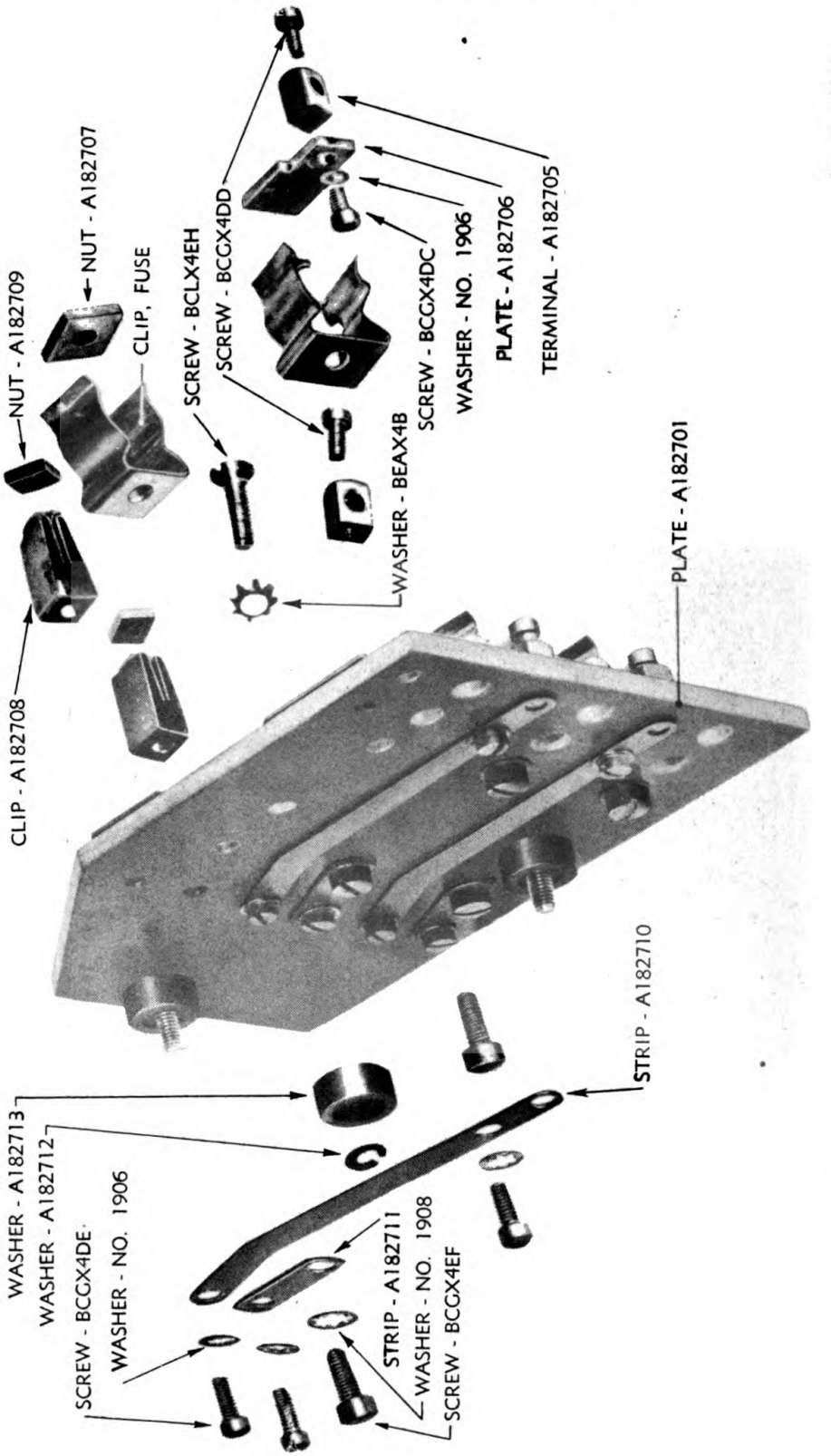


Figure 117—Terminal Board Assembly—Bottom View

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

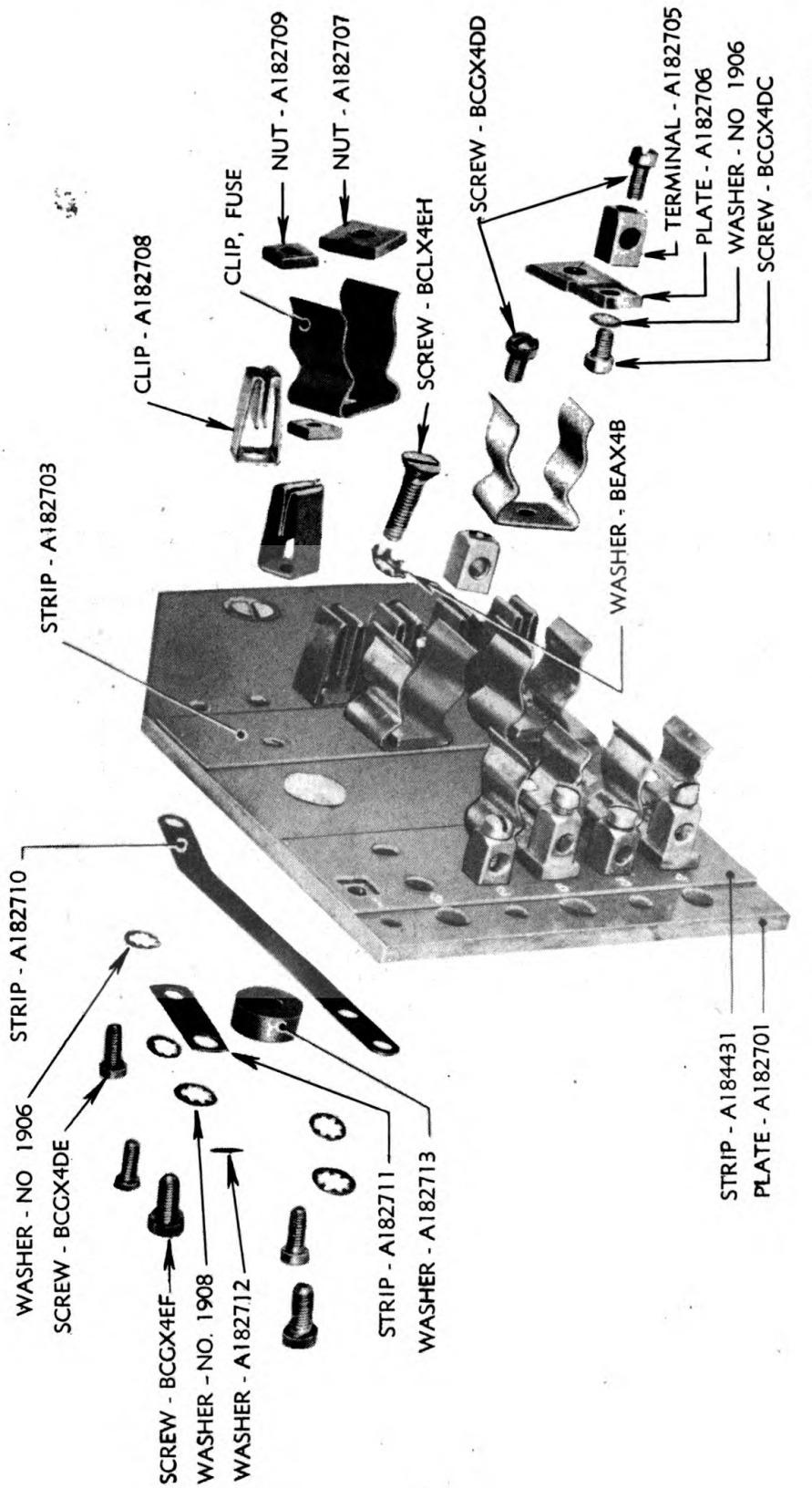


Figure 118—Terminal Board Assembly—Top View

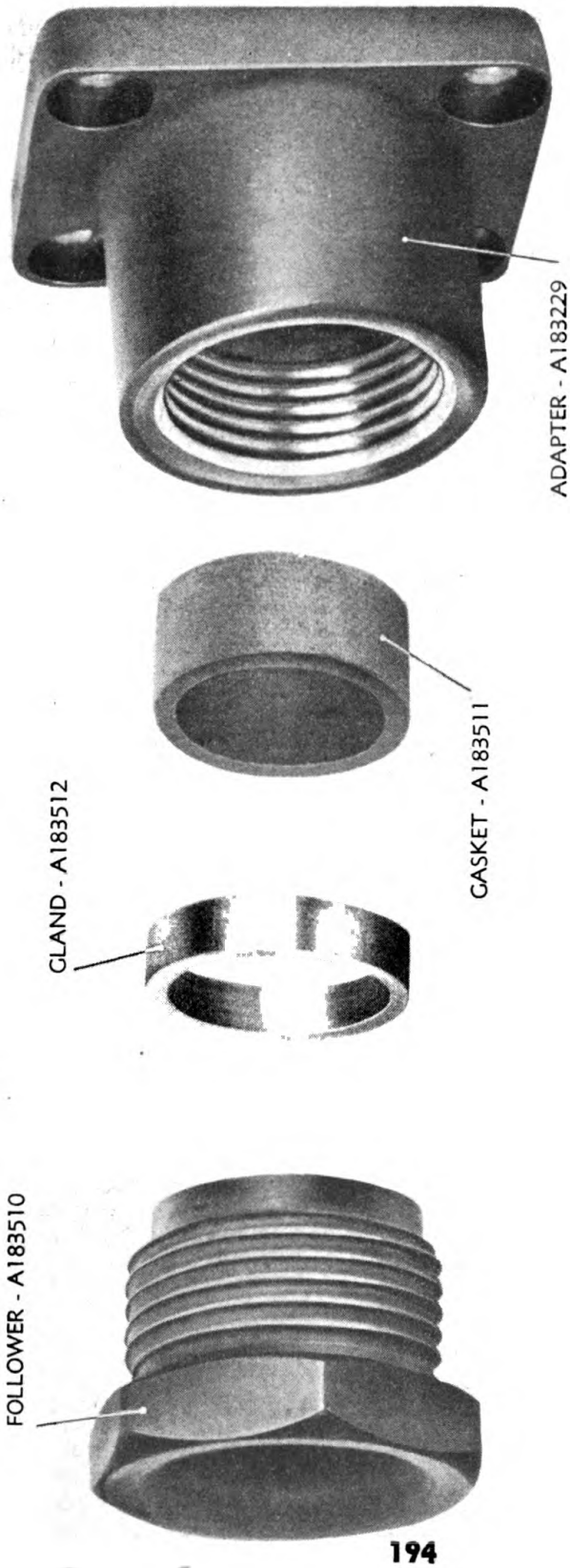


Figure 119—Adapter and Follower Parts—Exploded View

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

CONDUCTOR NUMBER	COLOR CODING	
	FIELD	TRACE
1	BLACK	WHITE
1	BLACK	———
2	WHITE	BLACK
2	WHITE	———
3	RED	WHITE
3	RED	———
4	ORANGE	WHITE
4	ORANGE	———
5	RED	BLACK
5	GREEN	BLACK
6	GREEN	WHITE
6	GREEN	———
SPARE	ORANGE	BLACK

RA PD 42912

Figure 120—Color Coding for Elevation Limit Switch—Distribution Box Cable

CONDUCTOR NUMBER	COLOR CODING	
	FIELD	TRACE
1	BLACK	WHITE
1	BLACK	———
2	WHITE	BLACK
2	WHITE	———
3	RED	WHITE
3	RED	———
4	ORANGE	WHITE
4	ORANGE	———
5	RED	BLACK
5	GREEN	BLACK
6	GREEN	WHITE
6	GREEN	———
SPARE	ORANGE	BLACK

RA PD 42913

Figure 121—Color Coding for Azimuth Switch—Distribution Box Cable

(6) Loosen the three screws and lift terminal board out of box (fig. 115).

c. Terminal Board Disassembly. Figures 117 and 118 show the terminal board disassembly. They are self-explanatory.

d. Adapter Disassembly. Figure 119 shows the adapter disassembly. It is self-explanatory.

e. Assembly.

(1) Assembly is substantially the reverse of disassembly. Make certain all joints are watertight. Switch blades must be properly alined and contacts must be tight. Take care that assembly of strips is correct.

(2) The color coding for the elevation limit switch-distribution box cable is shown on figure 120. Refer to figure 36 for wiring of the switches.

98. AZIMUTH SWITCH.

a. This is mechanically identical with the elevation limit switch, except for the switch lever (fig. 115). Color coding for azimuth switch is given in figure 126.

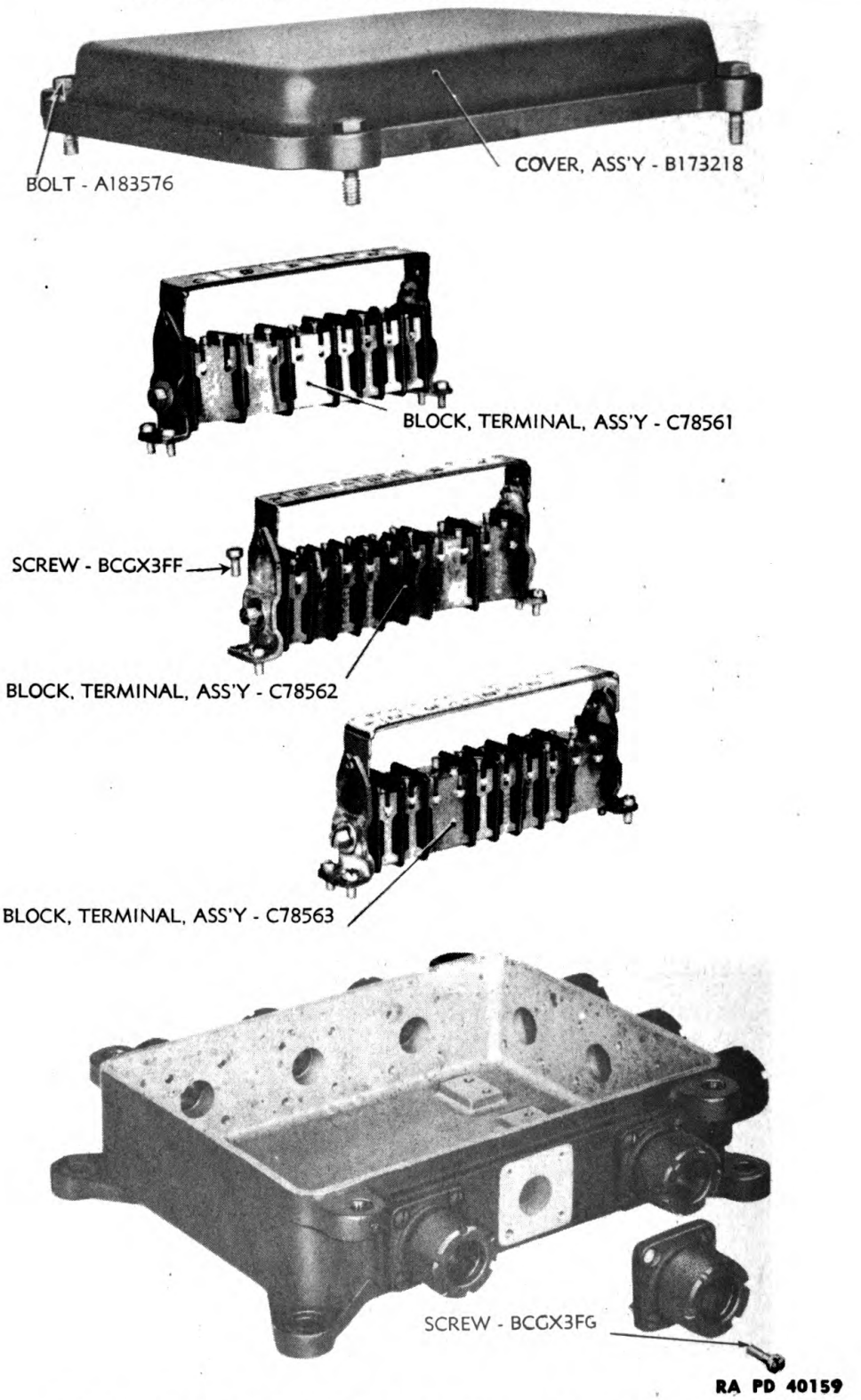


Figure 122—Distribution Box Assembly—Exploded View

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

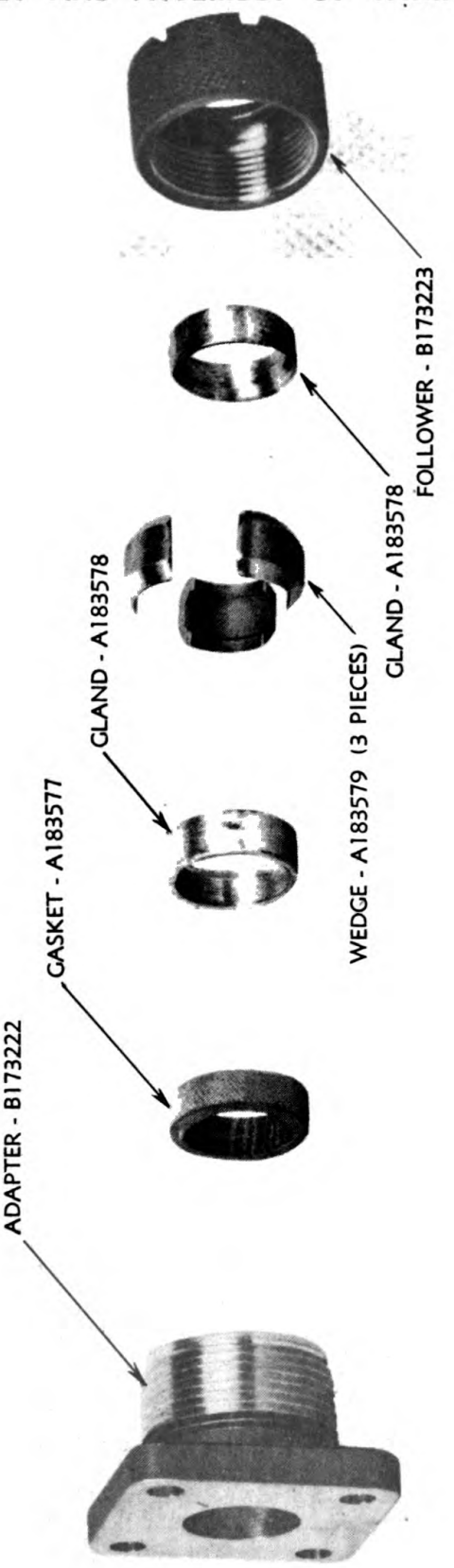


Figure 123—Distribution Box Assembly—Cable Gland Assembly

Figure 124—Distribution Box Assembly—Terminal Block Assembly C78502—Exploded View

COLOR CODING OF CONDUCTORS CONNECTED TO TERMINAL A182670		
TERMINAL NUMBER	COLOR CODING	
	FIELD	TRACE
1	RED	———
2	RED	WHITE
3	ORANGE	BLACK
4	WHITE	———
5	BLACK	WHITE
6	ORANGE	———
7	GREEN	———
8	WHITE	BLACK
9	GREEN	WHITE
10	RED	BLACK
11	GREEN	BLACK
12	ORANGE	WHITE
13	BLACK	———

RA PD 42929

Figure 125—Color Coding for Contact Ring—Distribution Box Cable

99. ELEVATION SWITCH.

a. Disassembly and assembly pictures were not available when this manual was compiled. Refer to figures 36 and 37 for wiring of the switch.

100. DISTRIBUTION BOX.

a. Major Disassembly.

(1) Disconnect wires from terminal strips. Tag all wires carefully.

(2) Loosen followers of cable gland assemblies (fig. 122).

(3) Withdraw cables. Followers, glands, wedges, and gaskets will come out with cables. Remove from cables.

(4) Remove terminal blocks.

b. Cable Gland Disassemblies. Figure 123 shows a cable gland disassembly. It is self-explanatory.

c. Terminal Block Disassembly.

(1) Remove screws holding ends of rod to brackets (fig. 124).

(2) Remove screws holding strip holders to brackets.

(3) Remove brackets and slide rod out of assembly. Individual components are thus separated.

d. Assembly. Assembly is substantially the reverse of disassembly. Make sure all joints are watertight. Be certain components of terminal block go together in their proper order. Figure 36 shows the wiring diagram. Figures 120, 121, and 125 show the color codings for three of the cables entering the distribution box. No color coding is provided for the 3-conductor cables.

101. CONTACT RING.

a. Major Disassembly.

(1) Drive cotter pin from nut which holds plug spindle against support (fig. 131).

(2) Remove nut and lift support and receptacle assemblies away from plug and adapter assemblies.

(3) Remove cover of receptacle assembly from support. Gasket and insulator tube can also be slipped off assembly.

(4) Unfasten wires from molded receptacle housing. Tag all wires carefully.

(5) Remove screws holding plate to support, and lift support and wires away from plate and receptacle.

(6) Remove adapter assembly from plug assembly.

(7) Loosen followers and remove cables from support.

b. Support Disassembly. Figure 127 shows the support disassembly. It is self-explanatory.

c. Receptacle Disassembly.

(1) Remove the two plates (fig. 128) from the molded housing.

(2) Unscrew all contact posts from molded housing.

(3) Work spring contact rings and insulators out of molded housing. Do not use a metal rod or hammer directly against rings or spacers.

d. Plug Disassembly.

(1) Disconnect wires from plug terminal blocks (fig. 129).

(2) Remove screws in end nut (fig. 130). These have been staked.

(3) Remove end nut, using spanner wrench.

(4) Slide off washer and end insulator.

(5) Removal of individual contact rings demands removal of contact rods (ends shown in fig. 129) and numbered contact blocks. As these ends are staked upon assembly, it may be difficult to remove rods without damaging ends. After ends of rods are freed from

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

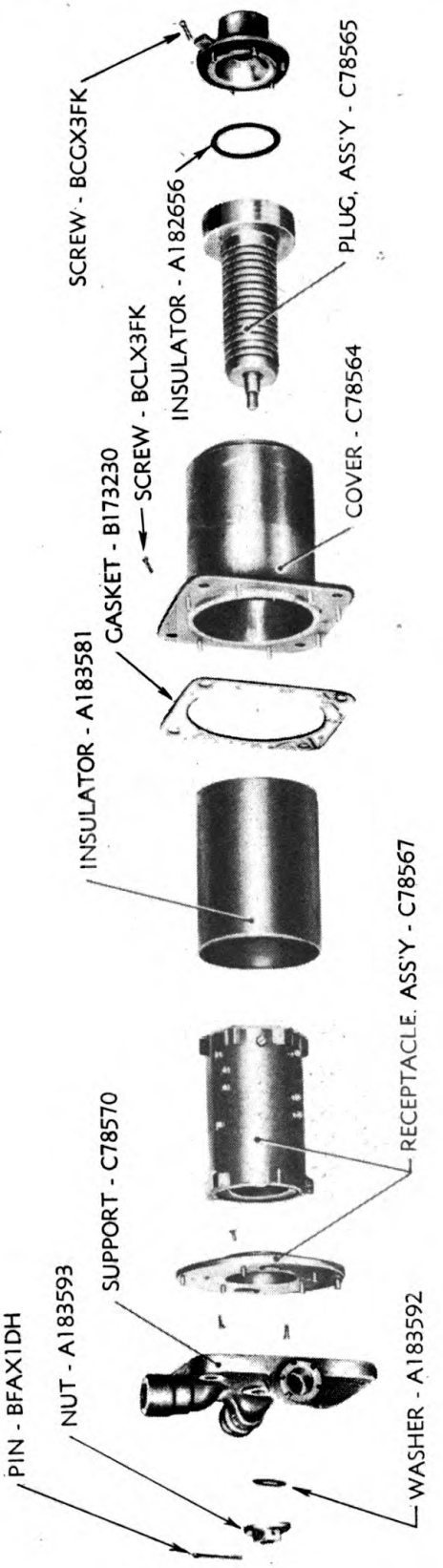


Figure 126—Contact Ring—Major Disassembly

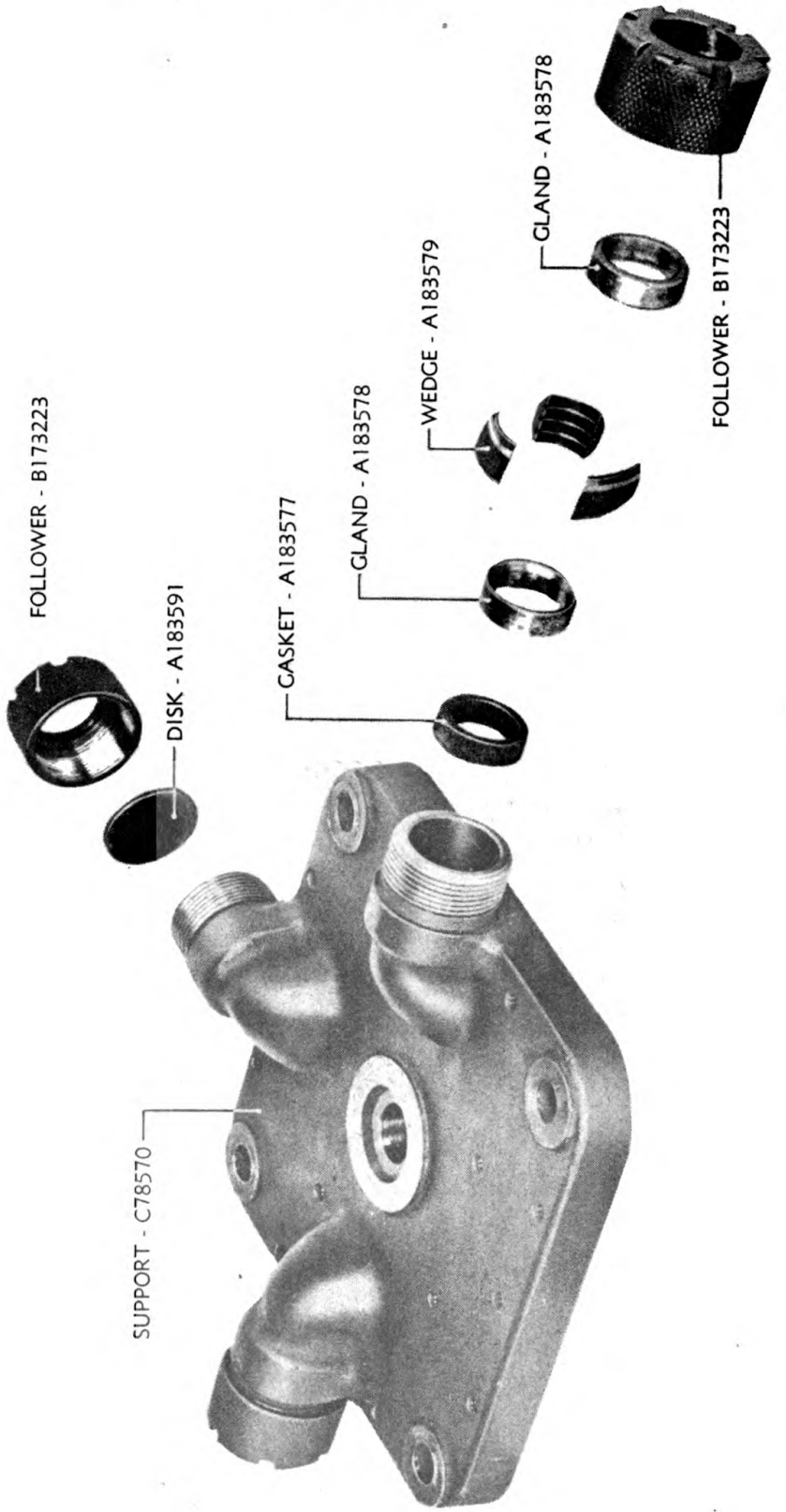


Figure 127—Contact Ring Assembly—Support

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

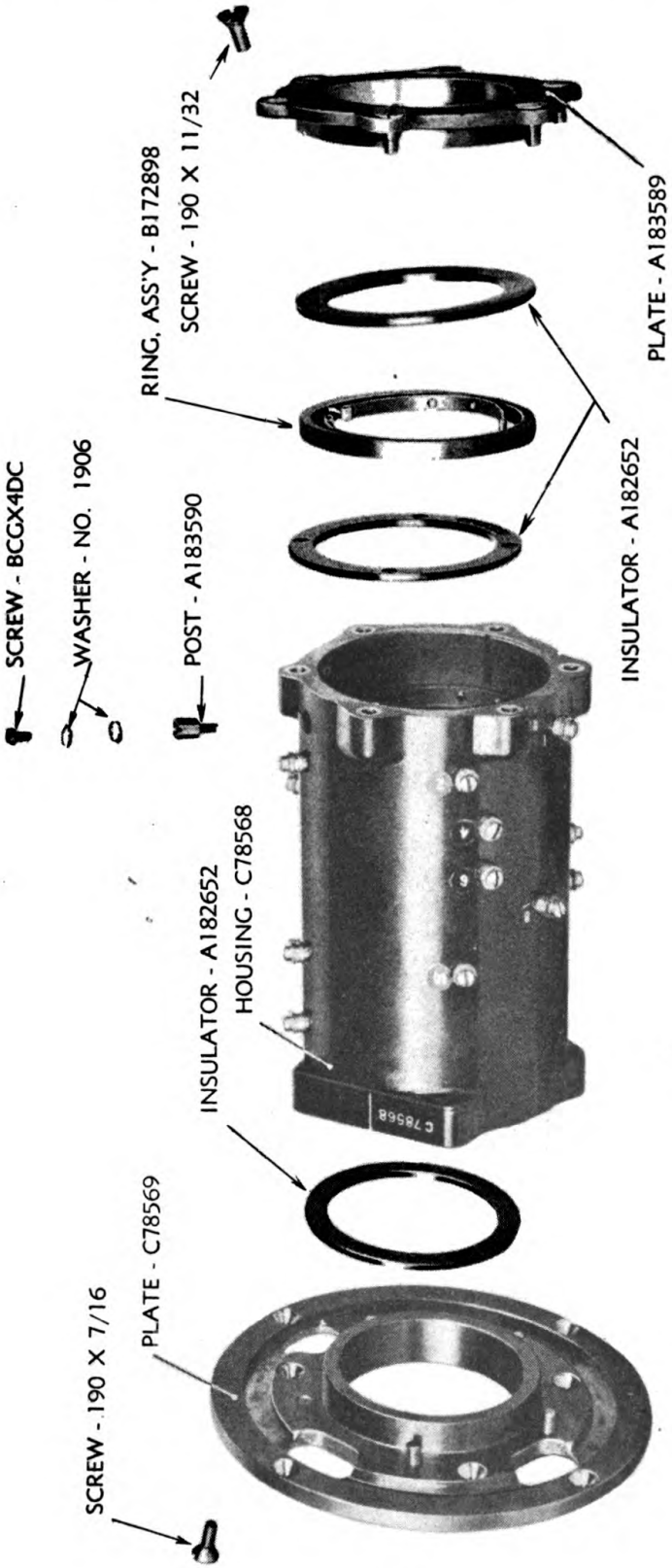
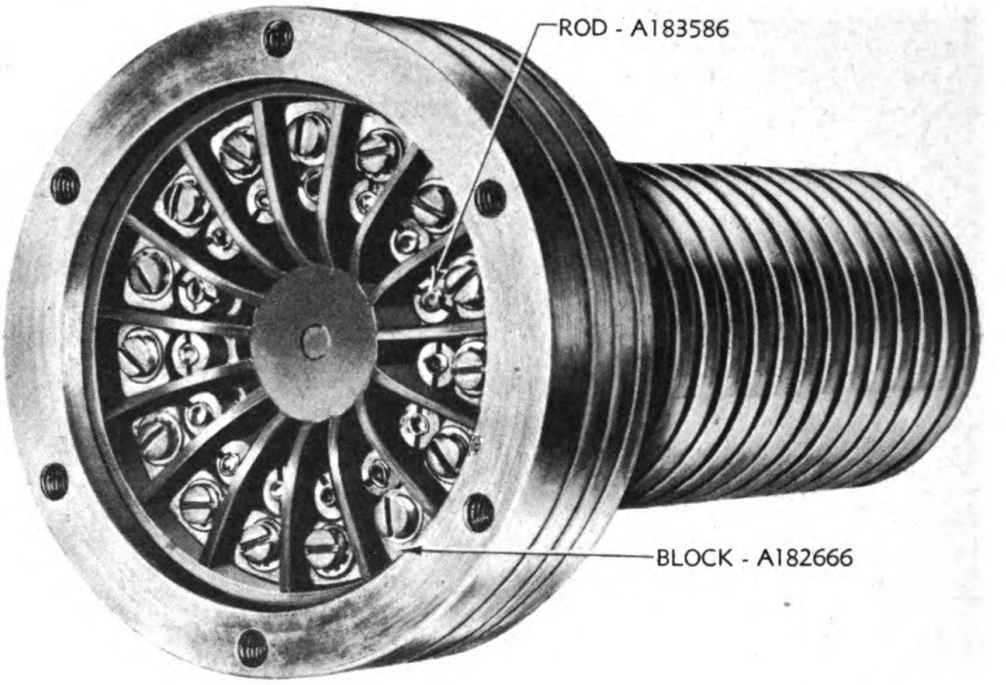


Figure 128—Contact Ring Assembly—Receptacle Assembly—Exploded Bottom View



RA PD 42933

Figure 129—Plug Assembly—Bottom End

nuts, individual rings with their attached rods may be slipped off the spindle. Be sure sufficient tagging is done to enable reassembly in proper order. This is extremely important.

e. Adapter Disassembly. Figure 131 shows the adapter disassembly. It is self-explanatory.

f. Assembly. Assembly is substantially the reverse of disassembly. Fill lubricating grooves at top and bottom of plug assembly with grease during assembly. It is particularly important that contact rings be replaced on the spindle in proper order and connected to the proper terminals. Be sure all joints are watertight. Figure 132 and color codings in figures 113 and 125 should be followed.

102. 15-POLE D-TYPE PLUG.

a. Figure 134 is self-explanatory for both assembly and disassembly.

b. Color coding of figure 133 should be followed in connecting cables to rings.

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

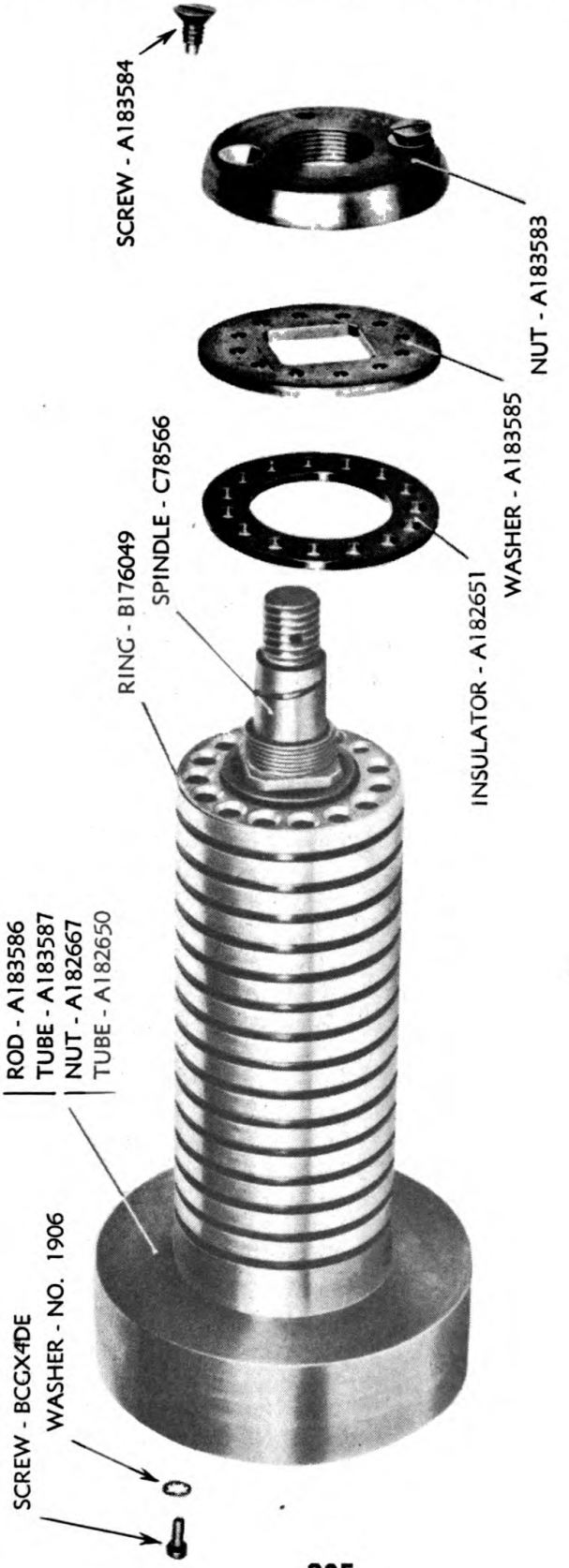


Figure 130—Contact Ring Assembly—Plug Assembly—Exploded Top View

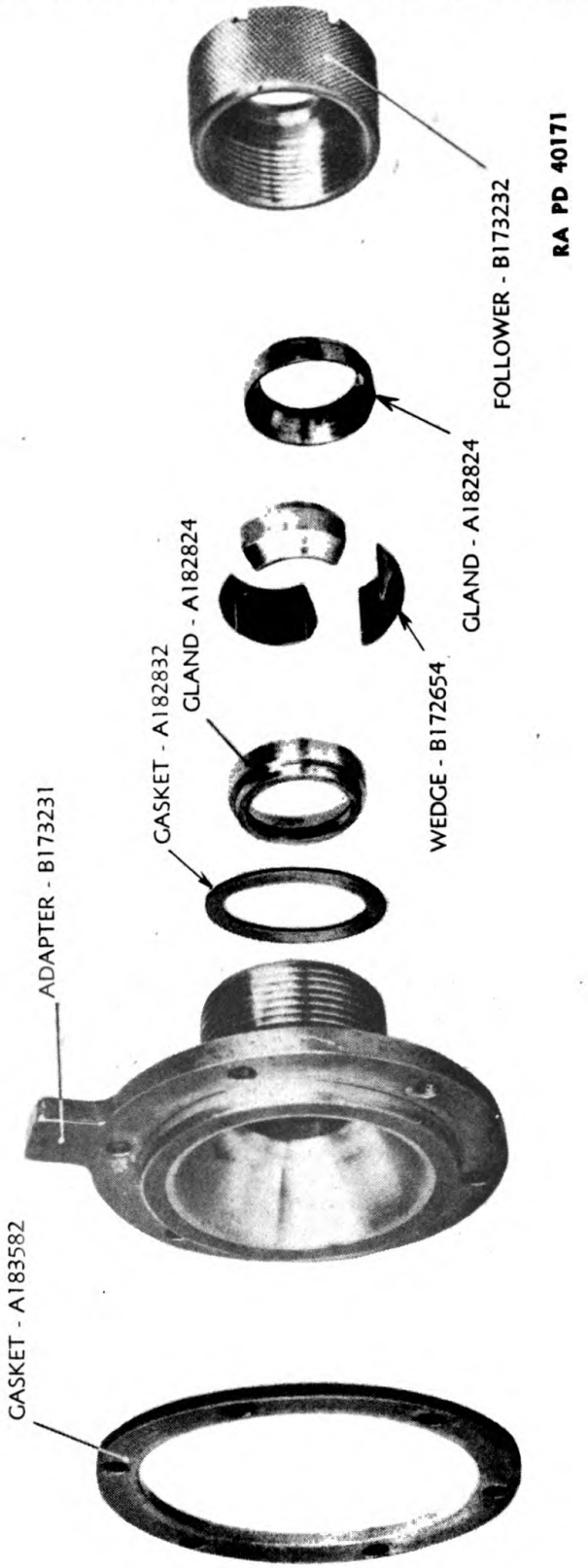


Figure 131—Contact Ring Assembly—Adapter and Gland—Exploded View

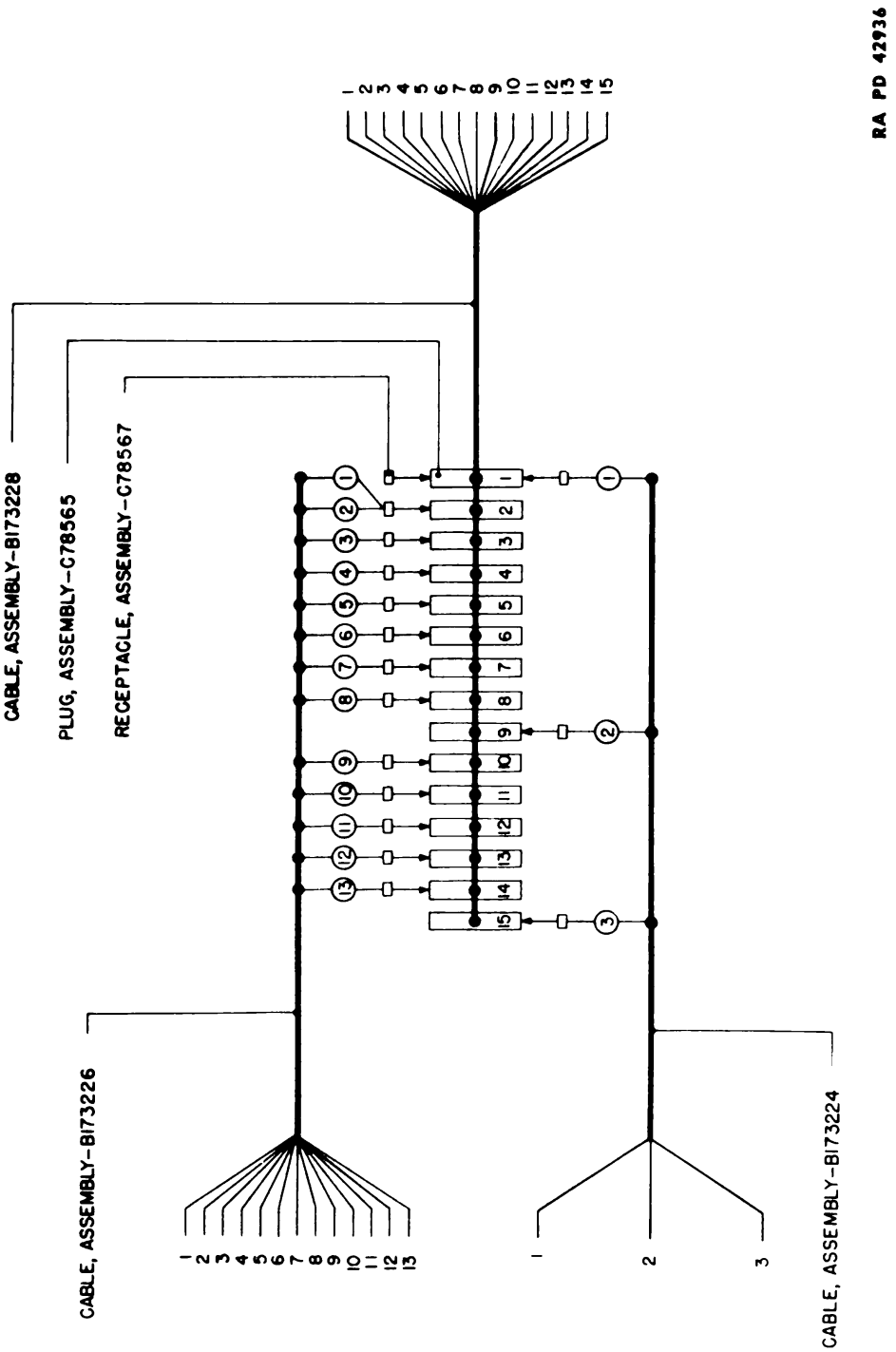


Figure 132—Contact Ring—Wiring Diagram

15 CONDUCTOR TRANSMISSION CABLE, BI72655
COLOR CODING OF CONDUCTORS CONNECTED TO TERMINALS

CONNECT COLOR CODED CONDUCTORS TO TERMINALS MARKED IN		COLOR CODING OF CONDUCTORS	
"D" PLUG PREDICTOR END	"D" PLUG GUN JUNCTION BOX END	FIELD	TRACE
1	1	RED	———
2	2	BLACK	WHITE
3	3	BLUE	———
4	4	BLUE	WHITE
5	5	BLUE	BLACK
6	6	WHITE	BLACK
7	7	GREEN	———
8	8	BLACK	———
9	9	GREEN	WHITE
10	10	GREEN	BLACK
11	11	RED	WHITE
12	12	RED	BLACK
13	13	YELLOW	———
14	14	YELLOW	BLACK
15	15	WHITE	———

RA PD 31779

Figure 133—Color Coding for 15-pole D-type Plug

103. 3-POLE PLUG.

a. Disassembly.

(1) Unscrew cover (figs. 136 and 137).

(2) Remove gasket.

(3) Remove ring, using sharp tool.

(4) Pull out retainer.

(5) Unscrew body from spring assembly follower.

(6) Force sufficient cable into body to enable fingers to be pulled out of insulator, drawing the attached wire after them.

(7) Unsolder wires from fingers.

(8) Pull out insulator.

(9) Withdraw cable from spring assembly.

(10) Remove gasket and washer.

b. Assembly. Assembly is substantially the reverse of disassembly. All soldered joints should be painted with insulating varnish. Color coding is given in figure 135.

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

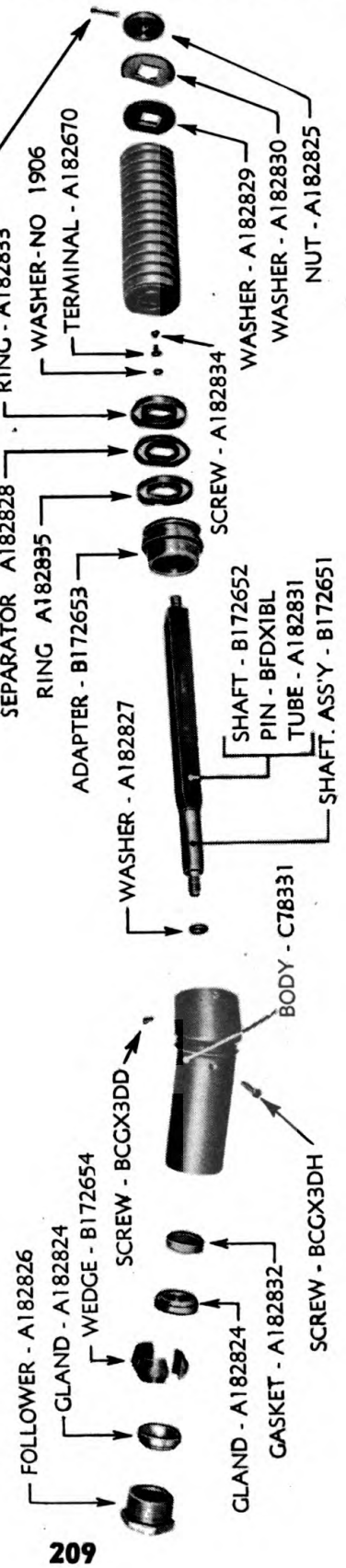


Figure 134—15-conductor Plug Assembly—Exploded View

CONNECT COLOR CODED CONDUCTORS TO FINGERS MARKED IN		COLOR CODING OF CONDUCTORS
3-POLE PLUG (TO GENERATING UNIT M5)	3-POLE PLUG (TO RECEPTACLE BOX)	
A	A	NATURAL
C	C	BLACK
B	B	WHITE

RA PD 42944

Figure 135—Color Coding for 3-pole Plug

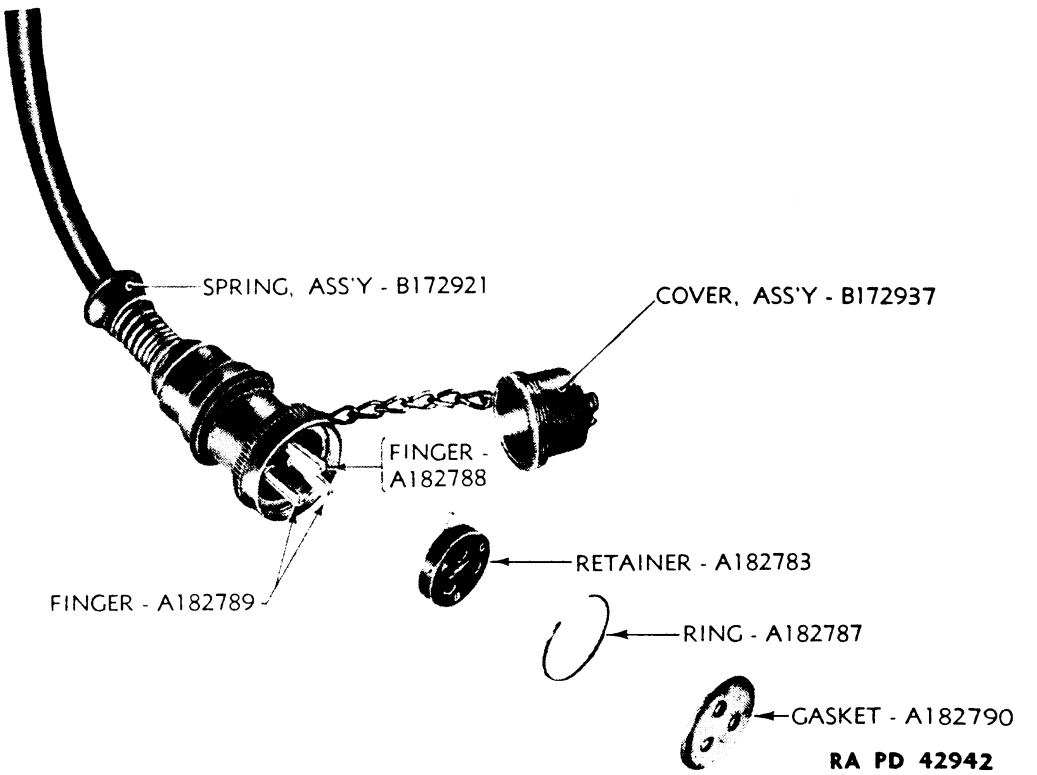


Figure 136—3-pole Plug

DISASSEMBLY AND ASSEMBLY OF WIRING SET M12

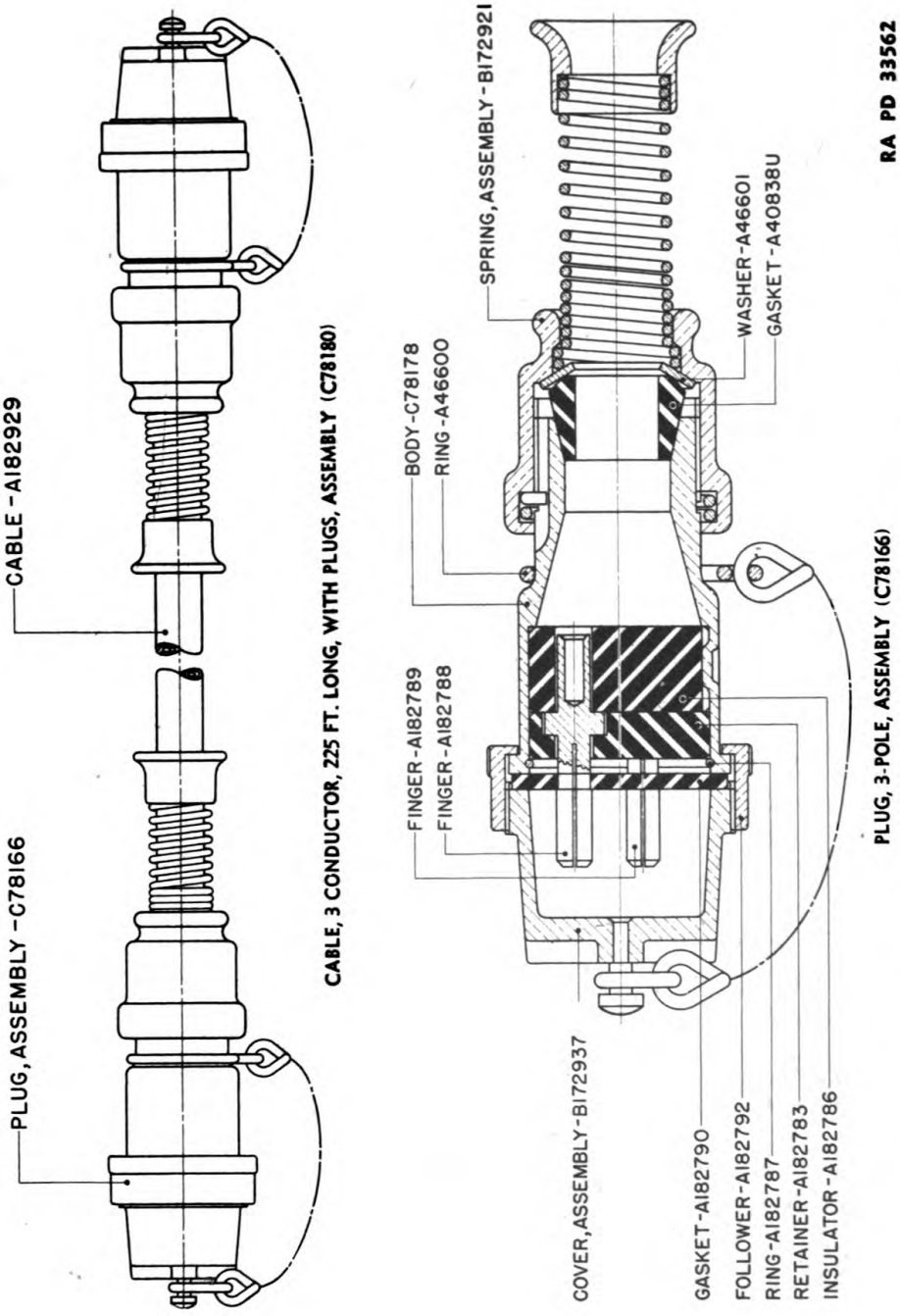


Figure 137—Cable Assembly—Assembled and Sectional Views

Section XII

OPERATION UNDER UNUSUAL CONDITIONS

104. TROPICAL CLIMATES.

a. There is no indication that any special precautions need to be taken due to tropical climates except that great emphasis must be placed on first and second echelon maintenance in order to prevent condensation, corrosion, and fungus growth, particularly in junction boxes and other electrical equipment.

105. ARCTIC CLIMATES.

a. Low temperatures tend to freeze the moving parts by congealing the oil and grease. This will be evidenced by stiffness of operation. At temperatures lower than zero degree, the oil gears should be operated with special recoil oil, as this oil has best low temperature properties for the oil gear.

b. The error corrector dashpot action is slow at temperatures under plus 30 degrees Fahrenheit. This increases the duration of error between gun and director, following a change in tracking rate.

c. The oil gear induction motor will bring the pump end of the hydraulic transmission up to speed in about 8 minutes, starting from a temperature of minus 40 degrees Fahrenheit. The director must be stationary during this time and should be alined with the gun, so that the electric motor will have a minimum load. Set generator for maximum voltage and start only one motor at a time during extreme cold. Reset generator voltage for 125 when units have been warmed up.

d. At temperatures below zero, operate the entire system—gun, director, and control system—at frequent intervals. The frequency will depend on the severity of the cold.

106. DESERT.

a. Dust and sand are the principal foes of desert operation, and will penetrate through the slightest opening, interfering greatly with the operation of the precision mechanisms.

b. Do *not* remove any cover plates in the presence of dust or sand.

c. Proper lubrication is doubly important in desert operations. Moving parts must be kept running in the midst of dust and sand, and at the same time excessive oil, or oil on the outside of moving parts, will accumulate dust and sand quickly, to the point of interfering with operations. Therefore, extra care must be observed to insure correct but not excessive lubrication.

Section XIII

REFERENCES

107. PUBLICATIONS INDEXES.

The following publications indexes should be consulted frequently for latest changes or revisions of references given in this section and for new publications relating to materiel covered in this manual:

a.	Introduction to Ordnance Catalog (explaining SNL system)	ASF Cat. ORD 1 IOC
b.	Index (index to SNL's)	ASF Cat. ORD 2 OPSI
c.	Index to Ordnance Publications (listing FM's, TM's, TC's and TB's of interest to Ordnance personnel, OPSR, FSMWO's, BSD, S of SR's, OSSC's, and OFSB's, and including alphabetical listing of Ordnance major items with publications pertaining thereto)	OFSB 1-1
d.	List of Publications for Training (listing MR's, MTP's, FM's, TM's, TR's, TB's, MWO's, SB's, WDLO's, and FT's)	FM 21-6
e.	List of Training Films, Film Strips, and Film Bulletins (listing TF's, FS's, and FB's, by serial number and subject)	FM 21-7
f.	Military Training Aids (listing graphic training aids, models, devices, and displays)	FM 21-8

108. STANDARD NOMENCLATURE LISTS.

a.	Cleaning, preserving, and lubricating materials; recoil fluids, special oils, and miscellaneous related items	ORD 5 SNL K-1
b.	**Fire Control Materiel.**	
	Director, A.A., M5 (for 37-mm A.A. gun carriage); and Director, A.A., M6 (for 40-mm A.A. gun carriage)—Parts and equipment	SNL F-209
	Gun, automatic, 40-mm, M1; and Carriage, gun, 40-mm, M2 (A.A.)	SNL A-50
	System, remote control, M1 (for 37-mm A.A. gun carriage M3A1); and System, remote control, M5 (for 40-mm A.A. gun carriage M2)—Parts and equipment	SNL F-208

Tools, maintenance, for repair and overhaul of fire control and sighting equipment ..... SNL F-272

Unit, generating, M5 (for director M5); and Unit, generating, M6 (for directors M4 and M7 with data transmission system)—Parts and equipment ..... SNL F-227

109. EXPLANATORY PUBLICATIONS.

a. Fire Control Materiel.

40-mm automatic gun M1, and 40-mm antiaircraft gun carriage M2 ..... TM 9-252

Antiaircraft artillery field manual: Gunnery ..... FM 4-110

Antiaircraft artillery field manual: Service of the piece, 40-mm fire unit ..... FM 4-160

Antiaircraft artillery: Gunnery, fire control, and service of the piece, antiaircraft automatic weapons (case III firing) ..... FM 4-113

Antiaircraft artillery; Gunnery, fire control, position finding, and horizontal fire, antiaircraft automatic weapons (case I firing) ..... FM 4-112

Instruction guide: Generating unit, M5 ..... TM 9-2616

Instruction guide: The instrument repairman TM 9-2602

Ordnance Maintenance: Directors M5 and M6 TM 9-1659

Ordnance Maintenance: Generating Unit M5 TM 9-1616

b. Gun Materiel.

Ordnance maintenance: Gun and top carriage of 40-mm antiaircraft gun materiel M2 TM 9-1252

Ordnance maintenance: Lower carriage of 40-mm antiaircraft gun materiel M2 ..... TM 9-1253

c. Maintenance and Inspection.

A.A. cable systems; cable repair kits, all types; and voltage controller M1 ..... TM 9-649

Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department ..... TM 9-850

Maintenance of materiel in hands of troops ..... OFSB 4-1

Sighting and fire control instruments—lubrication, general ..... OFSB 6-9

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