

EO 15-105AA-3

E+H

**ROYAL CANADIAN AIR FORCE**



**REPAIR AND OVERHAUL  
INSTRUCTIONS**

**ELECTRIC WINDSHIELD WIPERS  
MARQUETTE**

**This EO replaces Interim Publications**

ISSUED ON AUTHORITY OF THE CHIEF OF THE AIR STAFF

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## FOREWORD

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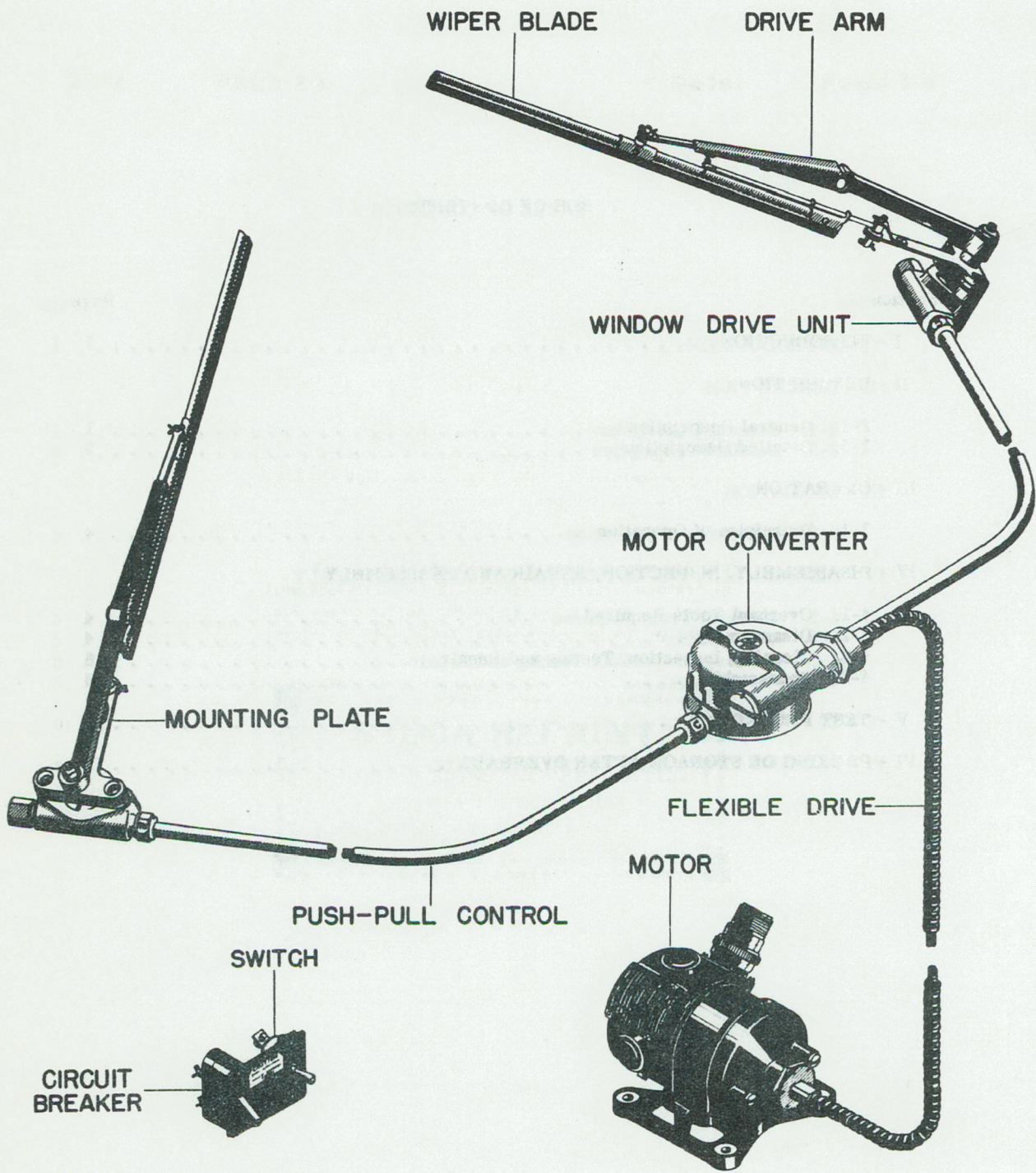


Figure 1-1. Dual-Window Installation

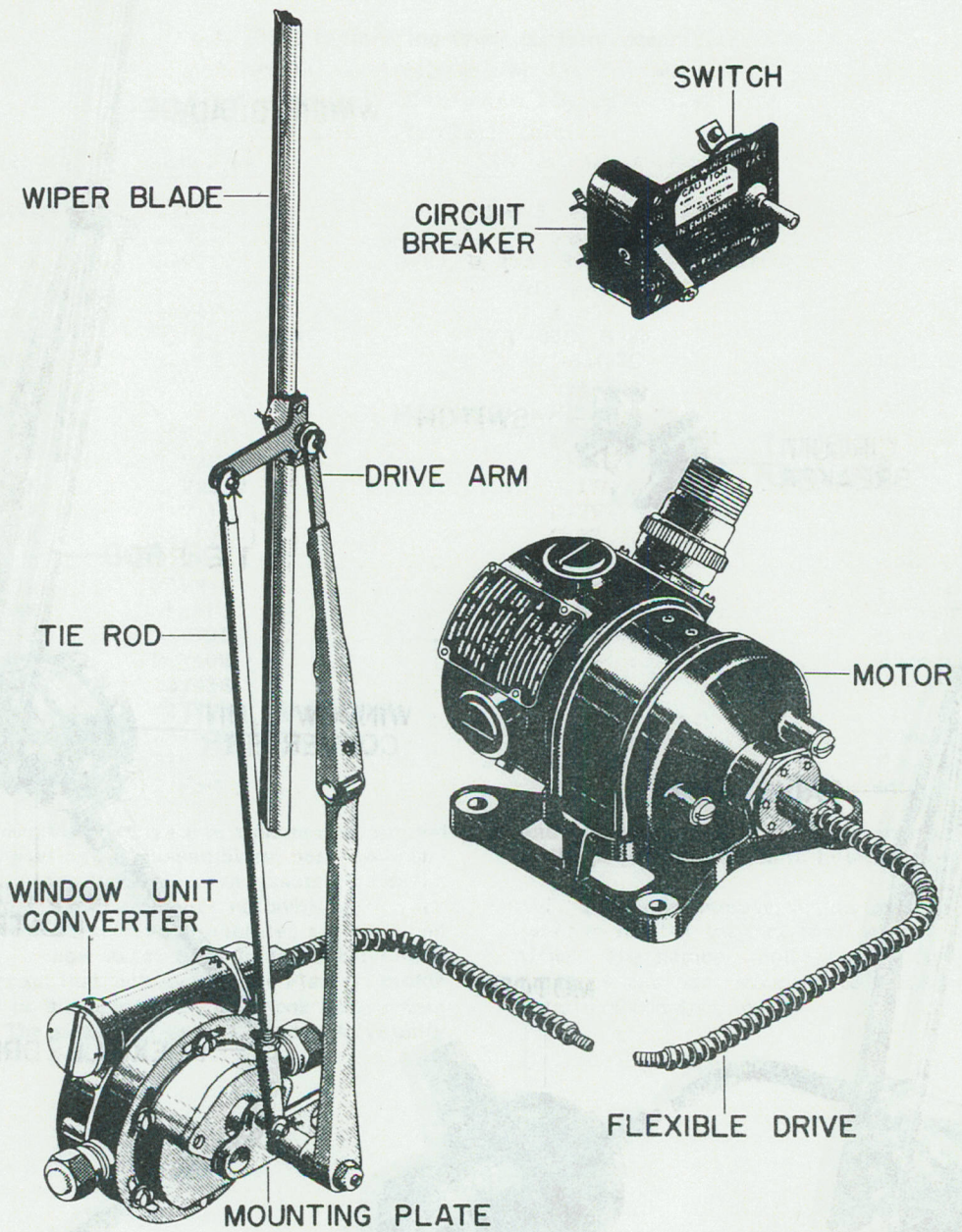


Figure 1-2. Single-Window Installation Using Window Converter

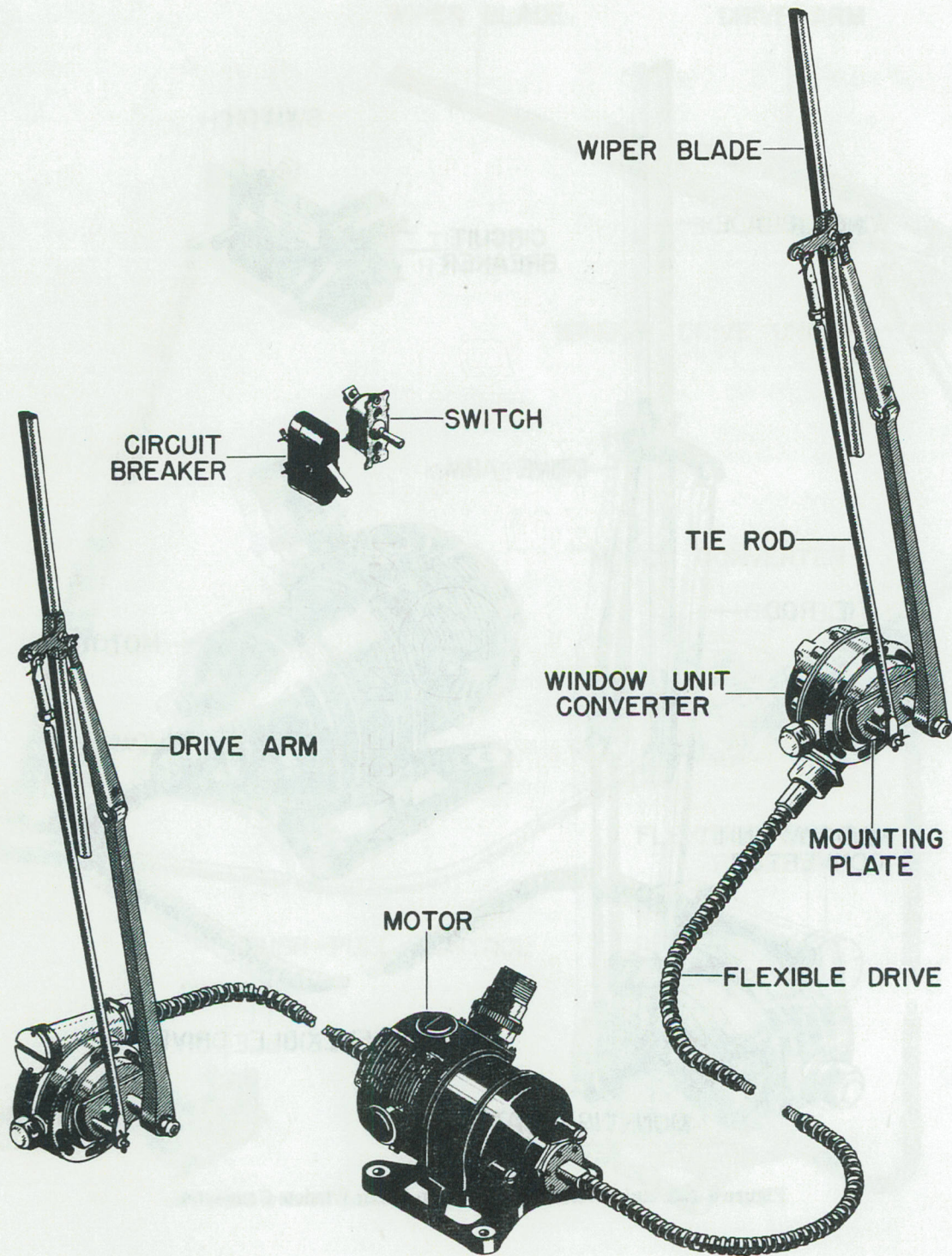


Figure 1-3. Installation Using Double-End Motor

SECTION I  
INTRODUCTION

1-1. This Engineering Order contains descriptive data and overhaul instructions for the following Electric Windshield Wipers, manufactured by the Marquette Metal Products Company, Cleveland, Ohio.

Assembly No.	Model No.	Aircraft Designation	Installation
K11848E	22V1E . . . . .	PBM-3, PBM-3C, PBM-4 . . . . .	Pilot & Copilot
K13311E	22V3E . . . . .	PB-2Y-3 . . . . .	Pilot & Copilot
K13520E	29V9E . . . . .	B-25, B-25A, B-25B, B-25C, B-25D . . . . .	Pilot & Copilot
K13720E	29V12E . . . . .	PBY-5, PBY-5A . . . . .	Pilot & Copilot
K14808E	29V4E . . . . .	A-26 . . . . .	Pilot & Copilot
K14813E	30V10E, 30V10E-1 . . . . .	B-25C, B-25D . . . . .	Bombardier
K14905E	22V6E . . . . .	PBM-3C . . . . .	Pilot & Copilot
K14908E	22V7E . . . . .	P-4Y-1 . . . . .	Pilot & Copilot
K14911E	29V19E-1 . . . . .	PV-2 . . . . .	Pilot & Copilot
K14913E	29V20E . . . . .	B-24, PB-4Y-1 . . . . .	Pilot & Copilot
K14955E	35V2E-1 . . . . .	A-26C . . . . .	Bombardier
K14971E	29V2E-2 . . . . .	B-17G . . . . .	Pilot & Copilot
K14994E	22V11E-1 . . . . .	P-2V-1 . . . . .	Pilot & Copilot
K14998E	22V13E-1 . . . . .	C-82 . . . . .	Pilot & Copilot
K15921E	22V18E . . . . .	JRM-1 . . . . .	Pilot & Copilot
K15947E	22V24E . . . . .	C-121 . . . . .	Pilot & Copilot
K15954E	39V1E . . . . .	B-35 . . . . .	Bombardier
K15969E	22V30E . . . . .	B-29 . . . . .	Pilot & Copilot
K15985E	22V40E . . . . .	C-45 . . . . .	Pilot & Copilot
K18500E	22V48E . . . . .	C-119B . . . . .	Pilot & Copilot
K18504E	22V51E . . . . .	B-25 . . . . .	Pilot & Copilot
K18512E	22V55E . . . . .	A-26 . . . . .	Pilot & Copilot
K18513E	22V56E . . . . .	CG-18A . . . . .	Pilot & Copilot
K60022E	22V5E . . . . .	C-69 . . . . .	Pilot & Copilot

1-2. Blade assemblies, drive arm assemblies, tie rod assemblies, mounting plate assemblies, push-pull control assemblies and flexible drive assemblies of the windshield wiper assemblies are not subject to overhaul. Defective parts of these assemblies are replaced by new parts or new assemblies by the service mechanic. Overhaul instructions for the electric motor will be found in the applicable handbook of overhaul instructions. The motor converters, window drive units

and window unit converters are overhauled according to the procedures given in this handbook.

1-3. The model numbers are assigned by the manufacturer to identify the individual window wiper installations. The numbers following the hyphens in model numbers and part numbers designate differences in details of construction.

SECTION II  
DESCRIPTION

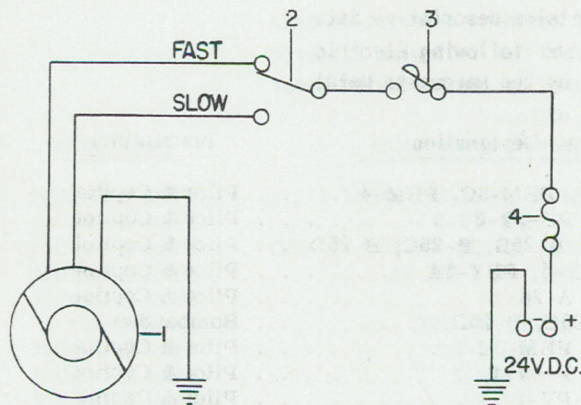
2-1. GENERAL DESCRIPTION.

2-2. Typical electric windshield wiper installations have a two-speed motor which drives a motor converter through a flexible drive shaft. Either one or two windows may be wiped by utilizing one or both ends of the converter. The rotary motion of the motor is converted to a reciprocating motion by the converter. This motion is transmitted to the window drive units by the push-pull control assemblies. The drive arm, which carries the wiper blade, is secured to the window drive unit. A

two-speed switch (2, figure 2-1) provides control in connection with the two-speed winding on the motor. The arc of sweep of the drive arm is determined by the length of the reciprocating stroke in the converter. Each installation is designed for a particular aircraft and assigned an assembly number and a model number. Synchronized wiping of pilot's and copilot's windows is provided.

2-3. Wiper installations No. K14955E, K14994E, K14998E, K18504E, K18512E and K18513E use a win-

dow unit converter instead of a motor converter and a window drive unit. Wiper assemblies No. K14994E and K15985E use a double-end motor having a flexible drive shaft connected to each end of the motor shaft. Individual converters for each window are connected to the drive shafts.



1. Motor  
2. Two-Speed Switch  
3. Circuit Breaker  
4. Fuse

Figure 2-1. Typical Wiring Diagram - Schematic

2-4. Twenty-four volts direct current is required to operate the electric motors for the windshield wipers. The motors produce 10,000 rpm at high speed and 5,000 rpm at low speed, resulting in wiper speeds of approximately 400 to 200 strokes per minute respectively.

#### 2-5. DETAILED DESCRIPTION.

##### NOTE

The following detailed descriptions cover all the assemblies used in the windshield wipers listed in paragraph 1-1.

#### 2-6. ELECTRIC MOTOR.

2-7. The electric motor is rated at one-sixth horsepower. It is provided with two windings. When the switch (2, figure 2-1) connects the high-speed winding to the electric supply line, the motor will run at approximately 10,000 rpm in one direction. Energizing the low-speed winding operates the motor at approximately 5,000 rpm in the opposite direction. An exception is found on assemblies No. K15985E and K18512E which use a rheostat in series with the high-speed winding for variable speed control. The low-speed winding is not used on these assemblies. As the rotary motion of the motor is changed to a reciprocating motion by the converter, the direction of rotation of the motor does not affect the operation of the wiper blades.

#### 2-8. FLEXIBLE DRIVE ASSEMBLY.

2-9. The flexible drive assembly consists of an outer casing and an inner flexible shaft. The casing is attached to the motor by a threaded fitting. A square shank on the flexible shaft engages a sleeve containing a square hole on the motor shaft. The other end of the flexible shaft similarly engages the worm drive shaft

of the converter. The casing is attached to the converter by a tapped fitting. The use of the flexible drive shaft assembly allows easy installation of the motor in a convenient place on the aircraft.

2-10. MOTOR CONVERTER ASSEMBLY FOR MODELS No. 22V1E, 22V3E, 22V5E, 22V6E, 22V7E, 22V18E, 22V24E, 22V30E, 22V40E, 22V48E, 29V2E-1, 29V4E, 29V9E, 29V12E, 29V19E-1, 29V20E, 30V10E, 30V10E-1 AND 39V1E. (See figure 4-1.)

2-11. The worm (27) and gear (20) of the converter provide a 50 to 1 reduction in the speed of the motor. The gear drives a crank or adapter plate (14) to which is attached a yoke block (10). The slot in the Scotch yoke (9) is engaged by the yoke block which moves the yoke and the yoke rods (8) back and forth in the housing. Each revolution of the gear produces two strokes, one in each direction. The length of the stroke is determined by the location of the yoke block on the adapter plate.

2-12. The yoke rods reciprocate in the barrels of the cover plate (6). The outer ends of the rods are tapped to receive the flexible cable of the push-pull control assemblies. The housings of the push-pull assemblies are attached to the threaded barrels of the converter cover plate.

2-13. PUSH-PULL CONTROL ASSEMBLIES FOR MODELS No. 22V1E, 22V3E, 22V5E, 22V6E, 22V7E, 22V18E, 22V24E, 22V30E, 22V40E, 22V48E, 29V2E-2, 29V4E, 29V9E, 29V12E, 29V19E-1, 29V20E, 30V10E, 30V10E-1 AND 39V1E.

2-14. The push-pull control is simply a flexible cable in a tubular housing which has one end attached to the converter and the other end to a window drive unit. The tubular housings are designed to fit individual models of aircraft. Nuts on each end rigidly fasten the housings to the converter and the window drive unit.

2-15. The flexible cable assembly has a wire rope core inside a tightly compressed coil of wire. Threaded end fittings are swaged on each end of the wire rope, holding the assembly together. The construction of the flexible cable assembly is such that it is flexible enough to slide easily around a bend of four inches radius in the tubular housing, but stiff enough to transmit the push from the converter to the window drive unit. One threaded end fitting is screwed into the outer end of the yoke rod as described in paragraph 2-12; the other end of the flexible cable is similarly attached to the rack of the window drive unit.

2-16. WINDOW DRIVE UNIT FOR MODELS No. 22V1E, 22V3E, 22V5E, 22V6E, 22V7E, 22V18E, 22V24E, 22V30E, 22V40E, 22V48E, 29V2E-2, 29V4E, 29V9E, 29V12E, 29V19E-1, 29V20E, 30V10E, 30V10E-1 AND 39V1E. (See figure 4-2.)

2-17. The rack (10, figure 4-2) of the window drive unit, which is given a reciprocating motion by the push-pull assembly, engages a pinion (9), rotating it through the arc of travel of the wiper drive arm. Different window drive units have pinions of different pitch diameters to give the arc of travel required for various aircraft.



2-18. The housing of the window drive unit is mounted inside the window to be wiped, with the pinion shaft projecting through to the outside. A 36-splined section near the outer end of the shaft provides a mounting for the drive arm.

#### 2-19. MOUNTING PLATE.

2-20. Mounting plates are installed on the outside of the aircraft. The shaft of the window drive unit passes through the skin of the aircraft and the shaft hole in the mounting plate; the same attaching hardware is used for both the window drive unit and the mounting plate.

2-21. In addition to providing a solid mounting for the window drive units, mounting plates are also used for pivot points for a tie rod or the lower end of the wiper blade. On a typical tie rod installation, the mounting plate has an extension on which is silver soldered the pivot stud. When the lower end of the wiper blade is to be pivoted, the mounting plate assembly includes a guide rod which is pivoted on a stud. A double clip on the lower end of this type blade assembly engages the guide rod, swinging it with the blade.

#### 2-22. WINDOW UNIT CONVERTER FOR MODELS No. 22V11E-1, 22V13E-1, 22V51E, 22V55E, 22V56E AND 35V2E-1. (See figure 4-3.)

2-23. The window unit converter combines the functions of the converter assembly (see paragraphs 2-10 to 2-12 inclusive) and the window drive unit (see paragraphs 2-16 to 2-18 inclusive) into a single unit. It is used on installations requiring only one window to be wiped per flexible drive assembly and where it is feasible to bring the flexible drive shaft to the proper location on the window frame. The converter mechanism is similar to the converter mechanism described in paragraphs 2-11 and 2-12. To the reciprocating yoke is riveted a rack to make a yoke assembly (7, figure 4-3). The rack meshes with a pinion (8) and drives the shaft (9). The window unit converter is mounted inside the aircraft with the pinion shaft projecting through to the outside.

#### 2-24. DRIVE ARM ASSEMBLY.

2-25. The drive arm assembly attaches to the shaft of the window drive unit or the window unit converter. It carries the wiper blade across the face of the glass. By a mechanism consisting of leaf springs, roller and adjusting screws, the arm pressure is kept uniform throughout the sweep of the blade. A 36-splined hole in the mounting head of the drive arm assembly fits

over the shaft. This arrangement provides for 10-degree steps in the mounting position of the drive arm so that the sweep of the wiper blade can be made approximately symmetrical about an axis. The drive arm is secured to the shaft by a nut.

#### 2-26. BLADE ASSEMBLY.

2-27. The wiping element, the shell which supports the wiping element, and the brackets and studs used for mounting are riveted together to form the blade assembly.

2-28. The blade assemblies are mounted in several different arrangements to wipe different shaped areas. The blade may be attached rigidly to the drive arm only, to provide a radial sweep of the same angle as the drive arm, or it may be pivoted on the drive arm and on the mounting plate to give a radial sweep of a greater angle than that of the drive arm. In connection with a tie rod assembly, the blade may be mounted to wipe areas of various shapes.

#### 2-29. TIE ROD ASSEMBLY FOR MODELS No. 22V1E, 22V3E, 22V5E, 22V6E, 22V11E, 22V18E, 22V24E, 22V30E, 22V40E, 22V48E, 22V51E, 22V55E, 29V4E, 29V9E, 29V12E, 29V19E, 29V20E AND 35V2E-1.

2-30. The tie rod is pivoted at both the mounting plate end and the blade assembly end. It has an adjustable feature so that the length between centers can be changed to vary the angular movement of the wiper blade. When wiping curved windshields, the length of the tie rod is adjusted so that the positions of the wiper blade are parallel with the plane of curve of the glass throughout the sweep of the blade.

#### 2-31. TWO-SPEED SWITCH AND RHEOSTAT.

2-32. A single-pole double-throw toggle switch is mounted in a position convenient to the pilots. This switch is connected so that either the high-speed or the low-speed winding of the motor may be used according to the position of the switch handle (see figure 2-1).

2-33. On Models Nos. 22V48E, 22V51E and 22V55E a Speed Control Rheostat is used in place of the Two-Speed Switch.

#### 2-34. CIRCUIT BREAKER.

2-35. A circuit breaker is installed in the line ahead of the speed control switch (see figure 2-1). It serves as an "ON" and "OFF" switch as well as protecting the circuit against overload.

## SECTION III

## OPERATION

## 3-1. PRINCIPLES OF OPERATION.

3-2. The electric windshield wipers obtain their power from the electrical system of the aircraft. The high-speed rotary motion of the electric motor is reduced by a worm and gear arrangement to window wiping speed and then changed to a reciprocating motion by a mechanism which effects a crank and connecting rod arrangement. The reciprocating motion is transmitted to a rack meshing with a pinion. This arrangement rotates the pinion back and forth through an arc, resulting in a similar movement of the wiper blade.

3-3. A flexible drive shaft transmits the rotary power of the motor to the point where it is converted to reciprocating motion. The motor can then be located in a convenient place. The push-pull control (described in paragraphs 2-13 to 2-15 inclusive) transmits the reciprocating motion from the converter to the window drive unit. The use of two window drive units, two push-pull controls and one converter permits dividing the power from one flexible drive shaft to wipe two windows.

3-4. The converter mechanism of the motor converter assembly (figure 4-1) is designed to regulate the length of the stroke as well as change the motion from rotary to reciprocating. The yoke block (10) is free to rotate on the stud of the adapter plate. The distance from the center of the stud on the adapter plate (14) to the center of the gear (20) is the effective crank length and is one-half the length of the reciprocating stroke. This distance is varied on the several converter assemblies by the mounting position of the adapter plate (14) on the gear (20). The Scotch yoke (9) and the yoke rods (8) are restricted to a linear movement by the longitudinal bores in the barrels on the cover plate (6). The yoke block engages the slot in the yoke and is free to move back and forth in the slot.

3-5. When the gear (20) is driven by the worm (27), the yoke block (10) will travel in a small circle. That motion of the yoke block which is parallel to the axis of the bores in the barrels of the cover plate is transmitted to the yoke. The motion which is perpendicular to this axis, results in the yoke block moving in the slot in the yoke. The net result is the conversion of the rotary motion to reciprocating motion.

## SECTION IV

## DISASSEMBLY, INSPECTION, REPAIR AND REASSEMBLY

## 4-1. OVERHAUL TOOLS REQUIRED.

Figure No.	Part No.	Nomenclature	Application
4-4	A17106	Spanner Wrench	Packing Nut
4-5	A17107	Spanner Wrench	Bearing Retainer Nut
4-6	A17109	Bullet Sleeve	Installing Packing over Serrations

## 4-2. DISASSEMBLY.

## NOTE

Blade assemblies, drive arm assemblies, tie rod assemblies, mounting plate assemblies, push-pull control assemblies and flexible drive assemblies of the windshield wiper assemblies are not subject to overhaul. Defective parts of these assemblies are replaced by new parts or new assemblies by the service mechanic. Overhaul instructions for the electric motor

will be found in the applicable handbook of overhaul instructions. The motor converters, window drive units and window unit converters are overhauled according to the procedures given in this handbook.

## 4-3. DISASSEMBLY OF MOTOR CONVERTER ASSEMBLIES No. D12184, D12511, D14495 AND G15700 SERIES (see figure 4-1).

a. To remove the name plate (5) from the cover plate (6), take out the three screws (4).

b. The cover plate (6) is separated from the housing assembly (31) by removing the screws (1 & 2) and the washers (3).

c. The yoke rods (8) are screwed into the Scotch yoke (9). In order to remove them, insert a stud having a 10-32 thread into one bore of the housing and engage the tapped outer end of the yoke rod. Tighten the stud as much as possible by hand. Put a steel dowel pin about two inches long and one-sixteenth-inch in diameter in the hole in the yoke rod near the yoke and back out the yoke rod at least one-quarter turn. With the aid of the stud, the yoke rod may then be unscrewed by hand. Remove both yoke rods and lift the yoke out of the cover plate.

d. Remove the cover gasket (7) and the yoke block (10).

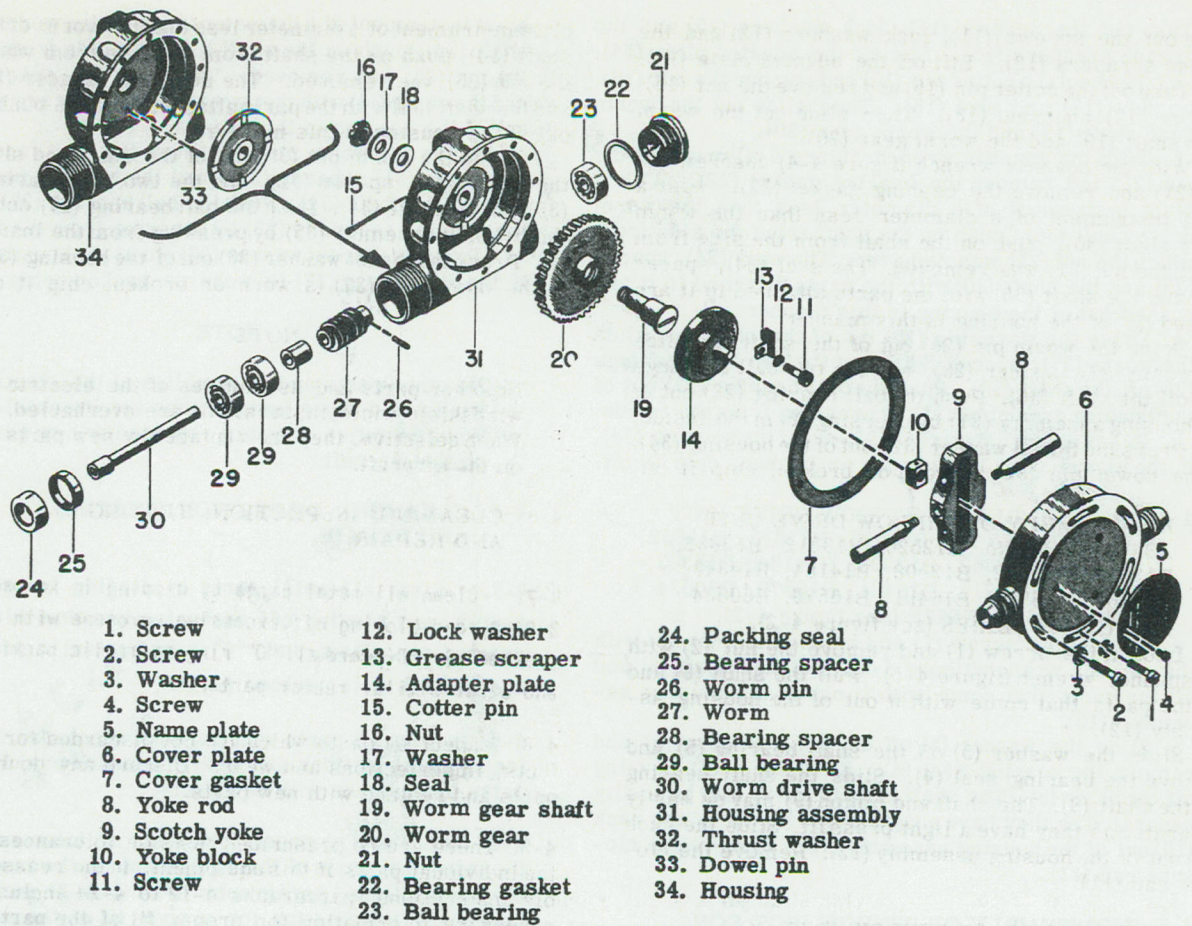


Figure 4-1. Motor Converter Assembly-Exploded View

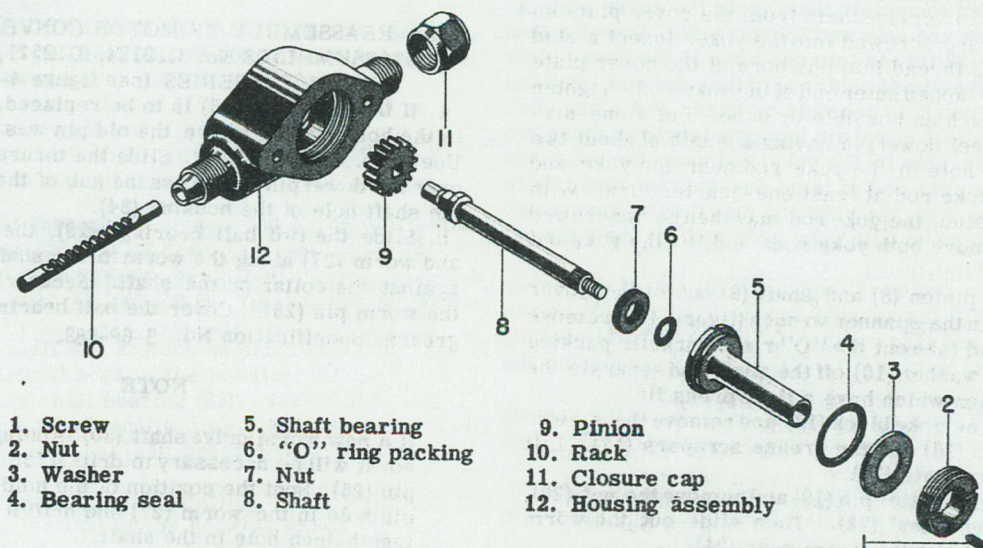


Figure 4-2. Window Drive Unit - Exploded View

Take out the screws (11), lock washers (12) and the grease scrapers (13). Lift off the adapter plate (14).

e. Take out the cotter pin (15) and remove the nut (16), washer (17) and seal (18). Then slide out the worm gear shaft (19) and the worm gear (20).

f. With the spanner wrench (figure 4-4) unscrew the nut (21) and remove the bearing gasket (22). With a blunt instrument of a diameter less than the worm drive shaft (30), push on the shaft from the side from which the nut (21) was removed. The seal (24), spacer (25) and the shaft (30) with the parts attached to it are pushed out of the housing in this manner.

g. Drive the worm pin (26) out of the shaft and slide the worm (27), spacer (28), and the two ball bearings (29) off the shaft (30). Push the ball bearing (23) out of the housing assembly (31) by pressing from the inside.

h. Press the thrust washer (32) out of the housing (34). If the dowel pin (33) is worn or broken, chip it off.

#### 4-4. DISASSEMBLY OF WINDOW DRIVE UNIT ASSEMBLIES No. B12526, B13812, B13832, B13857, B13862, B13908, B14184, B14343, B14767, B15711, B16491, B16579, B60034 AND G15650 SERIES (see figure 4-2).

a. Loosen the screw (1) and remove the nut (2) with the spanner wrench (figure 4-5). Pull the shaft (8) and all the parts that come with it out of the housing assembly (12).

b. Slide the washer (3) off the shaft bearing (5) and remove the bearing seal (4). Slide the shaft bearing off the shaft (8). The shaft and pinion (9) may be easily separated as they have a light press fit. Slide the rack (10) out of the housing assembly (12). Remove the closure cap (11).

#### 4-5. DISASSEMBLY OF WINDOW UNIT CONVERTER ASSEMBLY No. D15485 SERIES (see figure 4-3).

a. Remove the screws (1 & 2) and washers (3). Separate the cover plate (4), and parts which come with it, from the housing and gearing assembly (14). Take off the cover gasket (5).

b. The yoke assembly (7) and yoke rods (6) must be disassembled to remove them from the cover plate as the yoke rods are screwed into the yoke. Insert a stud having a 10-32 thread into one bore of the cover plate and engage the tapped outer end of the yoke rod. Tighten the stud as much as possible by hand. Put a one-sixteenth-inch steel dowel pin having a length of about two inches in the hole in the yoke rod near the yoke and back out the yoke rod at least one-quarter turn. With the aid of the stud, the yoke rod may then be unscrewed by hand. Remove both yoke rods and lift the yoke out of the cover.

c. Slide the pinion (8) and shaft (9) out of the cover plate (4). With the spanner wrench (figure 4-5) remove the nut (11) and take out the "O" ring hydraulic packing (12). Slip the washer (10) off the shaft and separate the shaft and pinion which have a light press fit.

d. Take off the yoke block (13) and remove the screws (15), washers (16) and the grease scrapers (17). Lift off the adapter plate (18).

e. Take out the cotter pin (19) and remove the nut (20), washer (21) and seal (22). Then slide out the worm gear shaft (23) and the worm gear (24).

f. With the spanner wrench (figure 4-4) unscrew the nut (25) and remove the bearing gasket (26). With a

blunt instrument of a diameter less than the worm drive shaft (34), push on the shaft from the side from which the nut (25) was removed. The seal (28), spacer (29) and the shaft (34) with the parts attached to it are pushed out of the housing in this manner.

g. Drive the worm pin (30) out of the shaft and slide the worm (31), spacer (32), and the two ball bearings (33) off the shaft (34). Push the ball bearing (27) out of the housing assembly (35) by pressing from the inside.

h. Press the thrust washer (36) out of the housing (38). If the dowel pin (37) is worn or broken, chip it off.

#### NOTE

No other parts and assemblies of the electric windshield wiper installations are overhauled. When defective, they are replaced by new parts on the aircraft.

#### 4-6. CLEANING, INSPECTION, TESTING AND REPAIR.

4-7. Clean all metal parts by dipping in kerosene, 3-GP-8, and blowing off excessive kerosene with compressed air. Discard all "O" ring hydraulic packings, and other similar rubber parts.

4-8. Inspect all parts which are not discarded for defects, imperfections and wear. Discard any doubtful parts and replace with new parts.

4-9. There are no prescribed tests or tolerances for the individual parts of this equipment. In the reassembly instructions, paragraphs 4-12 to 4-14 inclusive, necessary information for proper fit of the parts of each assembly will be found.

4-10. There are no repair instructions for these equipments. All defective or doubtful parts are replaced by new parts on reassembly.

#### 4-11. REASSEMBLY.

#### 4-12. REASSEMBLY OF MOTOR CONVERTER ASSEMBLIES No. D12184, D12511, D14495 AND G15700 SERIES (see figure 4-1).

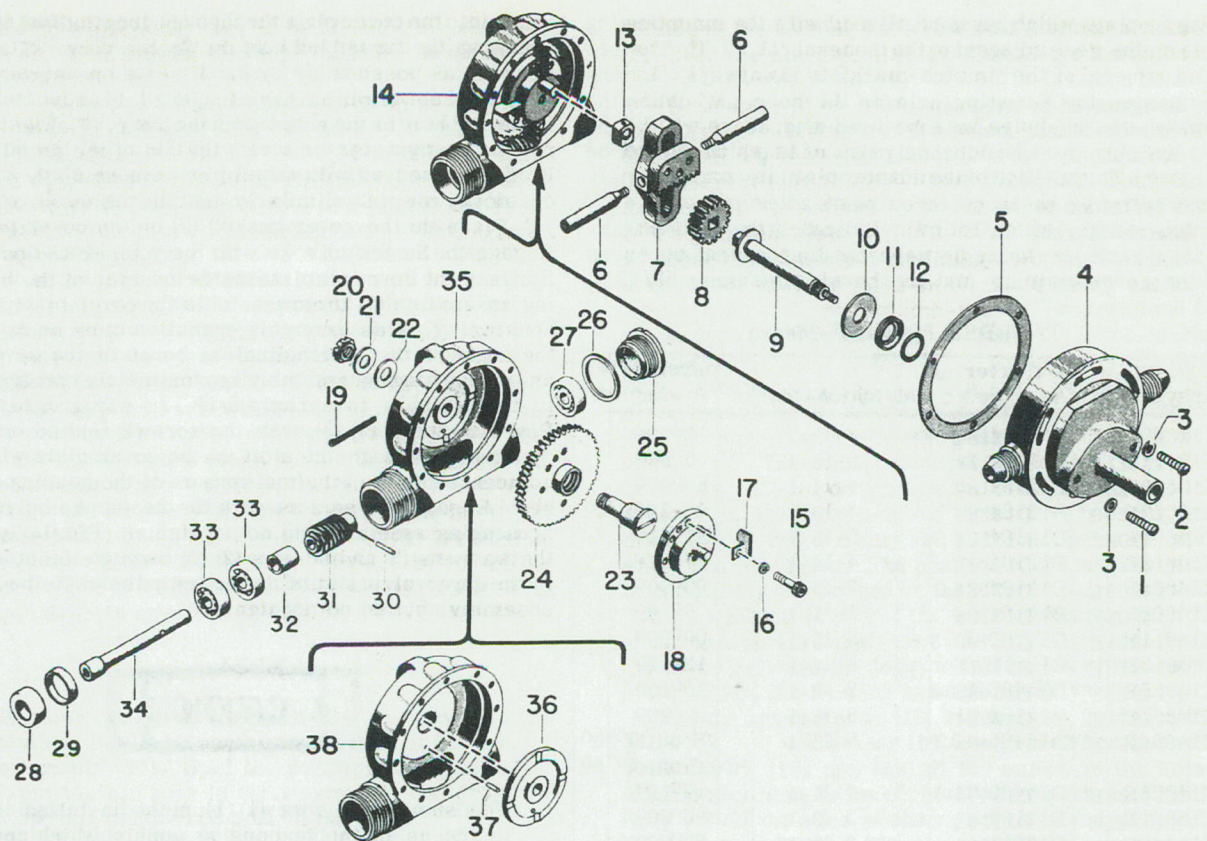
a. If the dowel pin (33) is to be replaced, drill a hole in the housing (34) where the old pin was chipped off. Use a No. 43 (.089) drill. Slide the thrust washer (32) over the dowel pin and press the hub of the washer into the shaft hole of the housing (34).

b. Slide the two ball bearings (29), the spacer (28) and worm (27) along the worm drive shaft (30) and up against the collar on the shaft. Secure by installing the worm pin (26). Cover the ball bearing races with grease, Specification No. 3-GP-683.

#### NOTE

If a new worm drive shaft (30) is being installed, it will be necessary to drill it for the worm pin (26). Spot the position of the hole from the pin hole in the worm (27) and drill a one-sixteenth-inch hole in the shaft.

c. Insert the ball bearing (23) into the housing as-



- |                                |                                  |                      |
|--------------------------------|----------------------------------|----------------------|
| 1. Screw                       | 14. Housing and gearing assembly | 26. Bearing gasket   |
| 2. Screw                       | 15. Screw                        | 27. Ball bearing     |
| 3. Washer                      | 16. Washer                       | 28. Packing seal     |
| 4. Cover plate                 | 17. Grease scraper               | 29. Bearing spacer   |
| 5. Cover gasket                | 18. Adapter plate                | 30. Worm pin         |
| 6. Yoke rod                    | 19. Cotter pin                   | 31. Worm             |
| 7. Yoke assembly               | 20. Nut                          | 32. Bearing spacer   |
| 8. Pinion                      | 21. Washer                       | 33. Ball bearing     |
| 9. Shaft                       | 22. Shaft seal                   | 34. Worm drive shaft |
| 10. Washer                     | 23. Worm gear shaft              | 35. Housing assembly |
| 11. Nut                        | 24. Worm gear                    | 36. Thrust washer    |
| 12. "O" ring hydraulic packing | 25. Nut                          | 37. Dowel pin        |
| 13. Yoke block                 |                                  | 38. Housing          |

Figure 4-3. Window Unit Converter Assembly - Exploded View

sembly (31) through the tapped end of the longitudinal bore. Place the bearing gasket (22) on the nut (21) and fill the nut with grease, Specification 3-GP-683. Install nut (21). Tighten the nut with the spanner wrench (figure 4-4).

d. Insert shaft and assembled parts into other end of the longitudinal bore of the housing. Make sure that shaft engages ball bearing (23). Soak a new seal (24) in machine oil, Specification 3-GP-60. Install spacer (25) and seal (24); press seal in tightly around shaft.

e. Apply grease, Specification 3-GP-683, to the thrust washer (32) of the housing assembly (31) and place the worm gear (20) in the housing on the thrust washer. Put grease, Specification 3-GP-683, on the worm gear shaft (19) and insert it through the center of

the gear and into the thrust washer. From the outside of the housing put a new seal (18) and a washer (17) over the worm gear shaft. Install the nut (16) and secure with cotter pin (15).

f. The adapter plate (14) is designed to be mounted on the worm gear (20) in one of several positions in order to provide the different amounts of travel required by the different installations. (See paragraph 3-4.) The numeral "1" is stamped adjacent to one mounting hole in the gear; numerals "1," "2," "3," etc. are stamped adjacent to the several mounting holes in the adapter plate. The adapter plate on each assembly must be mounted so that the "match-marks" correspond to those given for that assembly in Table I - Match-Marks at the end of this subparagraph. The first numeral of the "match-mark" designates the mounting hole on the

adapter plate which must be aligned with the mounting hole on the gear adjacent to the numeral "1." The second numeral of the "match-mark" is always "1" and designates the mounting hole on the gear. When the "match-mark" holes have been aligned, there will be two and only two additional pairs of holes which can be aligned. The position of the adapter plate is completely determined by those three pairs of holes. Table I - Match-Marks, which follows, indicates the "match-marks" and the angle between the longitudinal bores of the cover plate (6) and the housing assembly (31).

TABLE I - Match-Marks

Wiper Assy No.	Converter Assy No.	Match-Marks	Converter Angle*
K11848E	D12184	3-1	12°
K13311E	D12184	6-1	65°
K13520E	D12184	4-1	90°
K13720E	D12184	3-1	82-1/2°
K14808E	D12184	5-1	81°
K14813E	D12184	4-1	77°
K14905E	D12184	3-1	90°
K14908E	D12184	1-1	0°
K14911E	G15700-3	5-1	90°
K14913E	D12511	4-1	12°
K14955E	**D15485-8	2-1	10°
K14871E	D12184	8-1	90°
K14994E	**D15485-10	5-1	Pilot 30° Copilot 5°
K14998E	**D15485-1	4-1	12°
K15921E	D12184	3-1	90°
K15947E	D12511	3-1	80°
K15954E	D12511	3-1	0°
K15969E	D14495	3-1	0°
K15985E	D14495	2-1	Pilot 75° Copilot 90°
K18500E	D14495	1-1	90°
K18504E	**D15485-3	4-1	Pilot 90° Copilot 60°
K18512E	**D15485-16	4-1	Pilot 75° Copilot 90°
K18513E	**D15485-15	4-1	0°
K60022E	D12511	3-1	76°

\* The converter angle is the angle between the longitudinal bores of the cover plate (6, figure 4-1) and the housing assembly (31).

\*\* Window Unit Converter (see paragraph 4-14 for re-assembly instructions).

g. Fill the adapter plate (14) with grease, Specification 3-GP-683, put lock washer (12) and grease scraper (13) over screw (11) and install the screw in the holes aligned according to the correct "match-marks." Similarly install the other washers, scrapers and screws in the other two holes. The tops of the screws must be flush with the adapter plate. Stake screws in place against adapter plate and wipe off excess grease.

h. Check the fit of the yoke block (10) with the adapter plate (14) and with the Scotch yoke (9). Be sure the block will work freely; then install it by slipping it over the pivot on the adapter plate. If the yoke block shows signs of wear, replace with a new block.

i. Place the Scotch yoke (9) in the cover plate (6) and install a stud having a 10-32 thread into the tapped end of one yoke rod (8). Insert the yoke rod, threaded end

first, into the cover plate through one longitudinal bore, engaging the tapped hole on the Scotch yoke. Tighten as much as possible by hand. Place a one-sixteenth-inch steel dowel pin having a length of about two inches in the hole in the yoke rod near the yoke. Tighten yoke rod another quarter turn with the aid of the dowel pin. Hold yoke rod with dowel pin; remove stud, then take out dowel pin. Similarly install the other yoke rod.

j. Place the cover gasket (7) on the cover plate (6). Engage the Scotch yoke with the yoke block and put the flange of the cover plate inside the opening of the housing assembly (31) to assemble the cover plate with the housing. This assembly operation must be made with the angle of the longitudinal bores of the cover plate and the housing assembly approximately that designated in the table in paragraph 4-12, subparagraph "f." Place washers (3) over the screws (1) and insert the screws through the slots of the cover plate which are adjacent to the longitudinal bore of the housing assembly. Engage the screws with the tapped holes of the housing assembly but do not tighten. Similarly install the washers (3) and screws (2) through the other slots in the cover plate and in the tapped holes in the housing assembly, but do not tighten.



The shorter screws (1) must be installed in the holes in the housing assembly which are adjacent to the longitudinal bore. If screws which are too long are used, they will protrude into the bore and prevent the worm from revolving.

k. With the aid of a protractor adjust the angle between the center lines of the two bores to exactly that given in Table I - Match-Marks in paragraph 4-12, subparagraph "f." Tighten screws (1 & 2) and recheck the angle. If the deviation is more than one degree, readjust until the angle is within this tolerance.

1. Install name plate (5) with the screws (4).

4-13. REASSEMBLY OF WINDOW DRIVE UNIT ASSEMBLIES No. B12526, B13812, B13832, B13857, B13862, B13908, B14184, B14343, B14767, B15711, B16491, B16579, B60034 AND G15650 SERIES (see figure 4-2).

a. Slide the rack (10) into the housing assembly (12). See that these parts have an easy fit; the rack should slide out when the housing is tipped. Press the pinion (9) on the shaft (8).

b. Put a moderate amount of grease, Specification 3-GP-683, on the rack. Reinsert the rack in the housing. Place the shaft (8) in the housing assembly so that the tooth of the pinion having the punch mark is between the two punch-marked teeth on the rack. Be sure the rack is centered in the housing during this operation.

c. Slide the shaft bearing (5) over the shaft and into the housing. If the shaft bearing is provided with a notch, mesh the notch with the pin in the housing. Install a new bearing seal (4) between the bearing and the housing and place the washer (3) over the shaft and against the seal and bearing. Install the nut (2) and tighten with the spanner wrench (figure 4-5). The shaft

should be sufficiently free to be turned back and forth by hand. If it passes this test, tighten the screw (1) and install the closure cap (11).

d. If the shaft is not sufficiently free to be turned by hand, tap the unit with a soft hammer. If this procedure fails, disassemble the unit as described in paragraph 4-4. Check the fit of the disassembled parts, replace any doubtful parts with new parts, and reassemble as described in this paragraph, subparagraphs "a" to "c" inclusive.

#### 4-14. REASSEMBLY OF WINDOW UNIT CONVERTER ASSEMBLY No. D15485 SERIES (see figure 4-3).

a. If the dowel pin (37) is to be replaced, drill a hole in the housing (38) where the old pin was chipped off. Use a No. 43 (.089) drill. Slide the thrust washer (36) over the dowel pin and press the hub of the washer into the shaft hole of the housing (38).

b. Slide the two ball bearings (33), the spacer (32) and worm (31) along the worm drive shaft (34) and up against the collar on the shaft. Secure by installing the worm pin (30). Cover the ball bearing races with grease, Specification 3-GP-683.

#### NOTE

If a new worm drive shaft (34) is being installed, it will be necessary to drill it for the worm pin (30). Spot the position of the hole from the pin hole in the worm (31) and drill a one-sixteenth-inch hole in the shaft.

c. Insert the ball bearing (27) into the housing assembly (35) through the tapped end of the longitudinal bore. Place the bearing gasket (26) on the nut (25) and fill the nut with grease, Specification 3-GP-683. Install nut (25). Tighten the nut with the spanner wrench (figure 4-4).

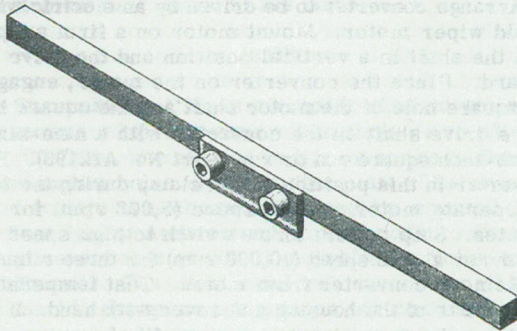


Figure 4-4. Spanner Wrench

d. Insert shaft and assembled parts into other end of the longitudinal bore of the housing. Make sure that the shaft engages ball bearing (27). Soak a new seal (28) in machine oil, Specification 3-GP-683. Install spacer (29) and seal (28); press seal in tightly around shaft.

e. Apply grease, Specification 3-GP-683, to the thrust washer (36) of the housing assembly (35) and place the worm gear (24) in the housing on the thrust washer. Put grease, Specification 3-GP-683, on the worm gear shaft (23) and insert it through the center of the gear and into the thrust washer. From the

outside of the housing put a new seal (22) and a washer (21) over the worm gear shaft. Install the nut (20) and secure with cotter pin (19).

f. The adapter plate (18) is designed to be mounted on the worm gear (24) in one of several positions in order to provide the different amounts of travel required by the different installations. (See paragraph 3-4.) The numeral "1" is stamped adjacent to one mounting hole in the gear; numerals "1," "2," "3," etc., are stamped adjacent to the several mounting holes in the adapter plate. The adapter plate on each assembly must be mounted so that the "match-marks" correspond to those given for that assembly in Table I - Match-Marks at the end of subparagraph "f" of paragraph 4-12. The first numeral of the "match-mark" designates the mounting hole on the adapter plate which must be aligned with the mounting hole on the gear adjacent to the numeral "1." The second numeral of the "match-mark" is always "1" and designates the mounting hole on the gear. When the "match-mark" holes have been aligned, there will be two and only two additional pairs of holes which can be aligned. The position of the adapter plate is completely determined by these three pairs of holes. Table I - Match-Marks at the end of subparagraph "f" of paragraph 4-12 indicates the "match-marks" and the angle between the longitudinal bores of the cover plate (4) and the housing assembly (35).

g. Fill the adapter plate (18) with grease, Specification 3-GP-683, put washer (16) and grease scraper (17) over screw (15) and install the screw in the holes aligned according to the correct "match-marks." Similarly install the other washers, scrapers and screws in the other two holes. The tops of the screws must be flush with the adapter plate. Stake screws in place against adapter plate and wipe off excess grease.

h. Check the fit of the yoke block (13) with the adapter plate (18) and with the yoke assembly (7). Be sure the block will work freely; then install it by slipping it over the pivot on the adapter plate. If the yoke block shows signs of wear, replace with a new block.

i. Press the pinion (8) on the shaft (9). Soak a new "O" ring hydraulic packing (12) in machine oil, Specification 3-GP-60. Place packing in cover plate (4) and install nut (11). Tighten nut with the spanner wrench (figure 4-5). Slide the washer (10) on the shaft and place the bullet sleeve (figure 4-6) over the serrations on the end of the shaft. Insert the shaft through the cover plate (4). Remove the bullet sleeve from over the end of the shaft.

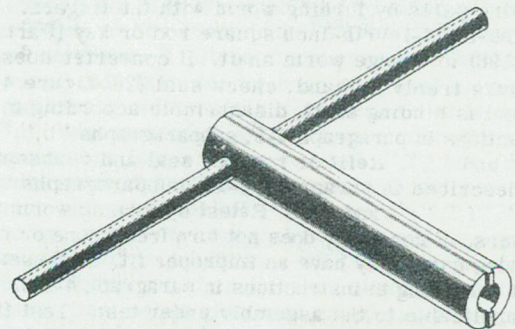


Figure 4-5. Spanner Wrench

j. Place the yoke assembly (7) in the cover plate (4), meshing the teeth of the rack with the pinion (8). Install

a stud having a 10-32 thread into the tapped end of one yoke rod (6). Insert the yoke rod, threaded end first, into the cover plate through one longitudinal bore, engaging the tapped hole in the yoke assembly. Tighten as much as possible by hand. Place a one-sixteenth-inch steel dowel pin having a length of about two inches in the hole in the yoke rod near the yoke. Tighten the yoke rod another quarter turn with the aid of the dowel pin. Hold the yoke rod with the dowel pin; remove stud, then take out the dowel pin. Similarly install the other yoke rod. Slide the yoke assembly to one side and fill the cover plate (4) with grease, Specification 3-GP-683; slide the yoke assembly to the other side of the cover plate and wipe off excess grease. Again fill the cover plate with grease.

k. Place the cover gasket (5) on the housing and gearing assembly (14). Engage the yoke assembly (7) with the yoke block (13) and place the cover plate (4) on the housing and gearing assembly so that the angle of the longitudinal bores of the cover and the housing is ap-

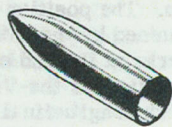


Figure 4-6. Bullet Sleeve

proximately that designated in Table I - Match-Marks in paragraph 4-12, subparagraph "f." Place washers (3) over the screws (1) and insert the screws through the slots of the cover which are adjacent to the longitudinal bore of the housing. Engage the screws with the tapped holes of the housing but do not tighten. Similarly install the washers (3) and the screws (2) through the other slots in the cover plate and in the tapped holes in the housing, but do not tighten.

### CAUTION

The shorter screws (1) must be installed in the holes in the housing which are adjacent to the longitudinal bore. If screws which are too long are used, they will protrude into the bore and prevent the worm from turning.

l. With the aid of a protractor adjust the angle between the center lines of the two bores to exactly that given in Table I - Match-Marks in paragraph 4-12, subparagraph "f." Tighten screws (1 & 2) and recheck the angle. If the deviation is more than one degree, readjust until the angle is within this tolerance.

## SECTION V

### TEST PROCEDURE

#### 5-1. TEST EQUIPMENT.

5-2. The motor converter assemblies and the window unit converter assemblies are tested with the motor for the electric windshield wipers as the driving unit. No other special equipment is required to perform the tests on this equipment.

#### 5-3. TEST OF MOTOR CONVERTERS AND WINDOW UNIT CONVERTERS.

5-4. Test converter for proper assembly and fit of moving parts by turning worm with the fingers. Use a nine-sixty-fourth-inch square rod or key (Part No. A12198) to engage worm shaft. If converter does not operate freely by hand, check seal (24, figure 4-1). If seal is binding shaft, disassemble according to instructions in paragraph 4-3, subparagraphs "b," "d," "e" and "f." Refit or replace seal and reassemble as described in paragraph 4-12, subparagraphs "d," "e," "f," "g" and "k." Retest by turning worm with fingers. If converter does not turn freely, one or more moving parts may have an improper fit. Disassemble unit according to instructions in paragraph 4-3 or 4-5, as applicable to the assembly under test. Test fit of all parts which are required to move in relation to other parts. Replace with new parts any parts which may be causing the converter to bind. Reassemble according to instructions in paragraph 4-12 or 3-14 as applicable.

5-5. Perform "run-in" test of converter as follows:

- a. Arrange converter to be driven by an electric windshield wiper motor. Mount motor on a firm support with the shaft in a vertical position and the drive end upward. Place the converter on the motor, engaging the square hole of the motor shaft and the square hole of the drive shaft on the converter with a nine-sixty-fourth-inch square rod or key (Part No. A12198). Hold converter in this position with a clamp during the test.
- b. Operate motor at slow speed (5,000 rpm) for two minutes. Stop motor; throw switch to high speed and run motor at this speed (10,000 rpm) for three minutes.
- c. Remove converter from motor. Test temperature of all parts of the housing and cover with hand. If any section is hot to the touch, improper fit of moving parts is indicated. Disassemble unit according to instructions in paragraph 4-3 or 4-5, as applicable. Examine fit of parts, giving particular attention to those located in the hot area of the housing or cover. Replace any parts which appear doubtful. Reassemble according to instructions in paragraph 4-12 or 4-14, as applicable. Retest converter.

5-6. Test travel of yoke rods (8, figure 4-1) as follows:

- a. Install a 10-32 stud in the outer end of one yoke rod. Use a nine-sixty-fourth-inch square rod or key (Part No. A12198) to operate the worm shaft. Turn the worm shaft until the stud is at its innermost position. Carefully place a pencil mark on the stud where it enters



the housing. The inner side of the pencil mark must be sharp and exactly in line with the edge of the housing in order to measure the travel accurately.

b. Turn the worm shaft until the stud is at its outermost position. With a rule graduated to sixty-fourths of an inch, determine the travel of the yoke rods by accurately measuring the distance from the edge of the housing to the inner side of the pencil mark. The amount of travel must be within the limits given in Table II - Yoke Rod Travel.

TABLE II - Yoke Rod Travel

Converter Assy No.	Converter Match-Marks	Yoke Rod Travel (inches)			Adapter Plate No.
		Max.	Min.	Nom.	
D12184	1-1	29/32	7/8	.890	B12496
D12184	3-1	47/64	23/32	.725	B12496
D12184	4-1	45/64	43/64	.687	B12496
D12184	5-1	21/32	5/8	.640	B12496
D12184	6-1	51/64	49/64	.778	B12496
D12184	8-1	7/8	27/32	.858	B12496
D12511	3-1	1/2	15/32	.485	B12510
D12511	4-1	29/64	7/16	.445	B12510
D14495	1-1	13/32	3/8	.389	B14539
D14495	2-1	19/64	9/32	.292	B14539
D14495	3-1	1/4	15/64	.245	B14539
D15485-1	4-1	29/64	7/16	.445	B14539
D15485-3	4-1	29/64	7/16	.445	B14539
D15485-8	2-1	19/64	9/32	.292	B14539
D15485-10	5-1	27/64	25/64	.405	B12510
D15485-15	4-1	45/64	43/64	.687	B12496
D15485-16	4-1	29/64	7/16	.445	B12510
G15700-3	5-1	21/32	5/8	.640	B12496

c. If the amount of travel is not within the limits given in Table II - Yoke Rod Travel in paragraph 5-6, subparagraph "b," check to see that the adapter plate (14, figure 4-1) is correctly installed according to the "match-marks" given in the table.

## NOTE

The numeral "1" is stamped adjacent to one mounting hole in the gear; numerals "1," "2," "3," etc. are stamped adjacent to the several mounting holes in the adapter plate. The adapter plate on each assembly must be mounted so that the "match-marks" correspond to those given for that assembly in Table II - Yoke Rod Travel. The first numeral of the "match-mark" designates the mounting hole on the

adapter plate which must be aligned with the mounting hole on the gear adjacent to the numeral "1." The second numeral of the "match-mark" is always "1" and designates the mounting hole on the gear.

d. If the adapter plate is correctly installed, check the part number stamped on the adapter plate to see that the correct plate has been installed. The correct adapter plate part number is listed for each converter assembly in Table II - Yoke Rod Travel in paragraph 5-6, subparagraph "b."

e. If the correct adapter plate has been correctly installed, but the amount of travel is not within the allowable limits, there may be an error in marking or drilling the adapter plate or worm gear (20, figure 4-1). Examine several adapter plates of the same part number to check for a possible error. Replace a doubtful adapter plate or gear with a new part. To replace adapter plate or gear, disassemble as much as necessary according to the instructions in paragraph 4-3 or 4-5, as applicable. Reassemble as described in paragraph 4-12 or 4-14, as applicable. Then retest according to procedures in paragraphs 5-4 and 5-5 and paragraph 5-6, subparagraphs "a" and "b."

f. After the converter assembly has satisfactorily passed all tests, secure screws (1 & 2, figure 4-1) and nut (21) with lock wire.

#### 5-7. TEST OF WINDOW DRIVE UNIT ASSEMBLIES

No. B12526, B13832, B13857, B13862, B13908, B14184, B14343, B14767, B15711, B16491, B16579, B60034 AND G15650 SERIES.

5-8. Hold unit in one hand and turn the shaft back and forth with the other hand. If the shaft is not sufficiently free to be turned by hand, tap the unit with a soft hammer. If this procedure fails, disassemble the unit as described in paragraph 4-4. Check the fit of the disassembled parts, replace any doubtful parts with new parts, and reassemble as described in paragraph 4-13, subparagraphs "a" to "c" inclusive. The unit is satisfactory when the shaft can be turned back and forth by hand.

## NOTE

Tests for the electric motors used with the electric windshield wipers will be found in the applicable overhaul instruction handbook. There are no tests for the other parts and assemblies of the electric windshield wiper installations.

## SECTION VI

## PACKING OR STORAGE AFTER OVERHAUL

## 6-1. SPECIAL STORAGE PROCEDURES.

6-2. Protect the threads on the barrel portions of the motor converter assemblies, window drive units, and window unit converter assemblies by covering with No. 6 pressed paper thread protectors.

6-3. There are no other requirements for storing these assemblies.

## 6-4. SPECIAL PACKING INSTRUCTIONS.

6-5. There are no special packing instructions for electric windshield wiper equipment.

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Part No.	Description	Quantity	Part No.	Description	Quantity
012141	...	...	012141	...	...
012142	...	...	012142	...	...
012143	...	...	012143	...	...
012144	...	...	012144	...	...
012145	...	...	012145	...	...
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012147	...	...	012147	...	...
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012150	...	...	012150	...	...
012151	...	...	012151	...	...
012152	...	...	012152	...	...
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SECTION 4  
 PACKING AND STORAGE OF THE OVERHEAD

4-1. SPECIAL STORAGE PROCEDURES

4-1.1. ...  
 4-1.2. ...  
 4-1.3. ...

4-2. SPECIAL PACKING INSTRUCTIONS

4-2.1. ...  
 4-2.2. ...  
 4-2.3. ...