United Delco

# POWER WINDOW MOTORS

## Service Instructions

## *Table of Contents*

# SECTION 1

## INTRODUCTION AND IDENTIFICATION OF MOTORS
## PART 1
## DOOR & QUARTER WINDOW MOTORS

Door and quarter window motors used on GM cars (1954-65) are equipped with a split series reversible type winding. They are supplied either in 6 volt or 12 volt system depending on year and make of car. (NOTE: 1954 Chev. and Pontiac applications were 6 volt system only). Motor used on 1954-56 are equipped with leads whereas all motors from 1957-65 have a "plug in" type grommet terminal assembly.

1954 thru 58 model window lift motors were constructed with round type motors whereas 1959-65 model motors are constructed with rectangular shaped motors. The round and rectangular types are interchangeable as far as application goes. (See Figures 1-1 and 1-2). NOTE: Rectangular motors shown in Figure 1-1 are less the pinion and gear assembly.

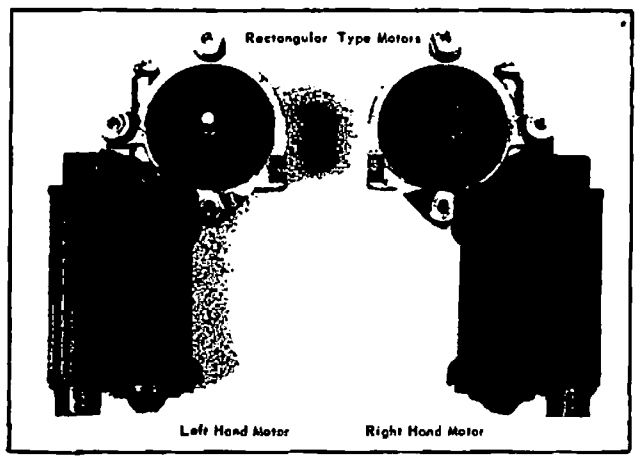



Fig. 1-1

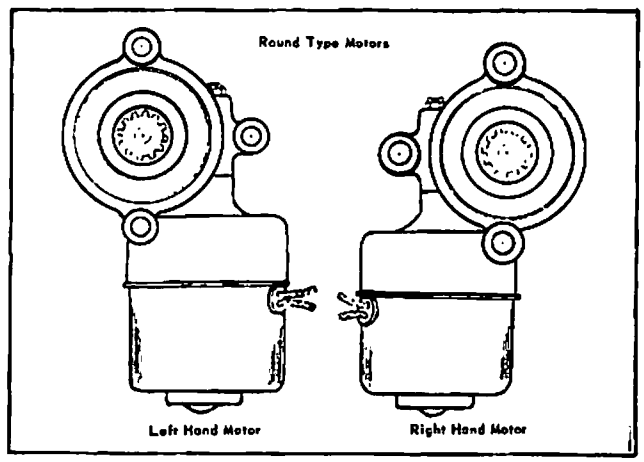



Fig. 1-2

The motors are wound with what we refer to as a split series type of field coil winding. This, in effect, means that even though we have two field coils we use them individually one at a time depending on what rotation is desired. (See wiring diagram Figure 1-3.)

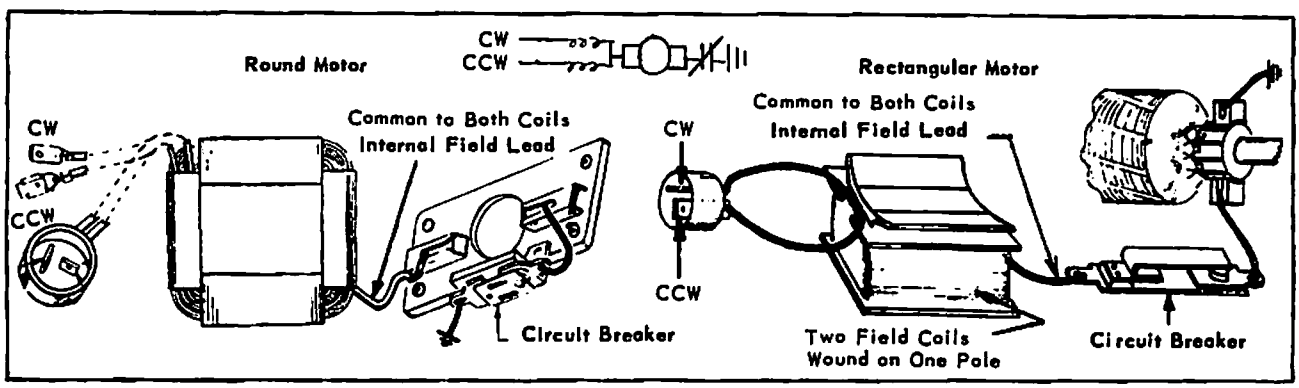



Fig. 1-3

## SECTION I - PART I (Cont'd.)

**Door and Quarter Window Motors**

All window lift motors used on G.M. cars are equipped with a circuit breaker which is attached to the brush plate located in the case assembly. Should the motor become overheated, this protective device will open the electrical circuit and after a short period of time will automatically close the electrical circuit allowing normal operation.

On Oldsmobile applications, in addition to the circuit breaker, a power relay is used. This relay provents operation of the windows when the ignition switch is in the "off" position.

Later model motors (1957-65) utilize a special connector between the motor and the wiring harness. This connector is designed with a "lock in" type of terminal plug that has been incorporated on the original equipment motors, which should eliminate the car body wiring plug becoming disconnected from the motor terminal plug. However, service motors are not equipped with the "lock in" type terminal plug, and when a service motor is used to replace an original equipment motor, care should be exercised to insure that the car wiring plug fits tight in the service motor terminal plug.

A thumb release must be depressed to disengage this connector as well as when engaging the harness to the motor.

The motor armature has a worm shaft which drives the pinion and gear assembly. On 1954 models this gear assembly consisted of a steel pinion (12 or 24 teeth) attached directly to the nylon gear.

On the 1955 model motors a flexible rubber coupling was incorporated between the nylon gear and steel pinion. This reduced the impact force of the armature worm against the nylon gear teeth when a window reached the limit of its travel in either the up or down position.

Starting in 1956 an improved type of rubber coupling between the steel pinion and nylon gear called "Unistress" was introduced and this design has carried through to present production. This "Unistress" type of rubber coupled gear is interchangeable with most of the past models and can be used to service all window motors except as noted in the pinion and gear service package chart, Listed below:

| Part No. | Application |
|---|---|
| 5097960 | Convertible quarter window motors (1954-55) |
| 5099592 | Convertible quarter window motors (1955-65) |
| 4900085 | All window motors except convertible quarter window and station wagon tail gate motors. |
| 4905338 | Station wagon tailgate motors and regular passenger car models (1954-63) |
| 4909518 | Station wagon tailgate motors for all compact models (1961-63) |
| 4913821 | All 1964-65 model station wagon tailgate motors |

## SECTION I - PART I (Cont'd.)

**Door and Quarter Window Motors**

The armature end-play adjusting screw and thrust washer arrangement was modified on the late production 1954 motors. This modification has also been retained through present production motors. See Figure 1-4.

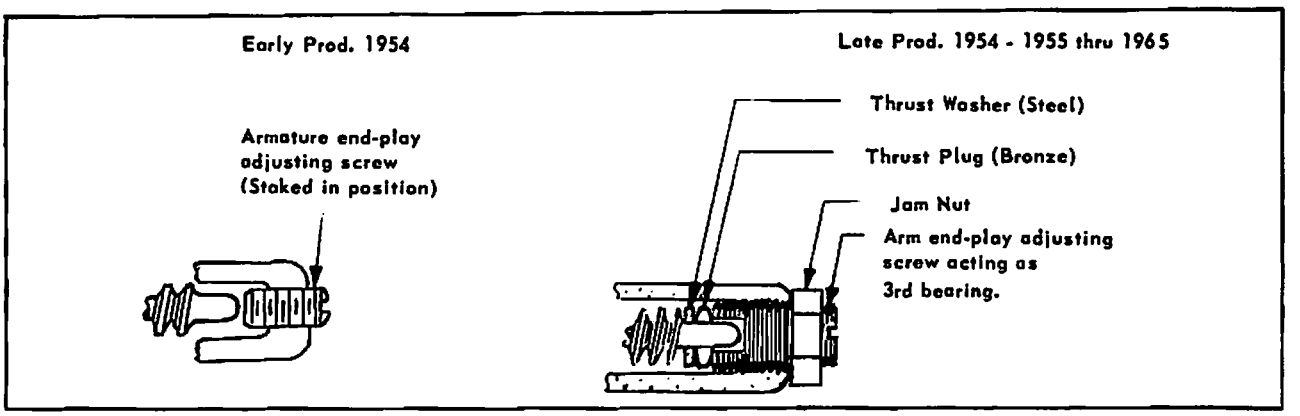



Fig. 1-4

The rectangular shaped motor was introduced in 1959 having the same performance specifications as the previous round type motors. This rectangular type motor has been carried forward to the 1960-65 models.

## PART II

### STATION WAGON TAIL GATE MOTOR

The station wagon power operated tail gate window is controlled by a conventional rectangular 12 volt D.C. reversible direction motor with an internal circuit breaker and a self locking gear drive. This motor, in appearance, is similar to the right hand motor in Figure 1-1, Page 1.

The current for this motor is obtained through the circuit breaker located beneath the instrument panel. This motor is designed and wired so that the window in the tail gate has to be lowered before opening the tail gate. There is a mechanical safety feature that prevents the tail gate handle from being actuated until the window is in the fully lowered position. This window can be controlled by the switch under the instrument panel or by the tail gate lock switch itself. When using the tail gate lock it is necessary to insert the ignition key and turn to proper position for lowering or raising window. On 9 passenger wagons there is an additional switch on the side panel in the rear section.

To prevent the window from being operated when gate is open, there is a safety switch incorporated that makes the circuit inoperative as long as the tail gate remains in the open position..

## SECTION I - PART III

### VENT WINDOW MOTORS

Vent Window Motors, Models 1957 through 1960 consist of a round 12 Volt D.C. split series reversible motor attached to a gear housing. As with other types of window motors, there are right and left hand units that differ only in the casting (See Fig. 1-5 & 1-6

Early production 1961 model vent window motors are the same as 1960 models (i.e. round motor type) whereas late production 1961 models are equipped with rectangular shaped motors and are interchangeable with the early production round type motor units. The rectangular shaped motors are used on the present line of automobiles. See Figure 1-6

The motor armature has a worm shaft which drives a gear and worm shaft assembly. The gear and worm shaft in turn operates a drive gear assembly which, when the unit is installed in the car, actuates the vent window. See Figure 1-7

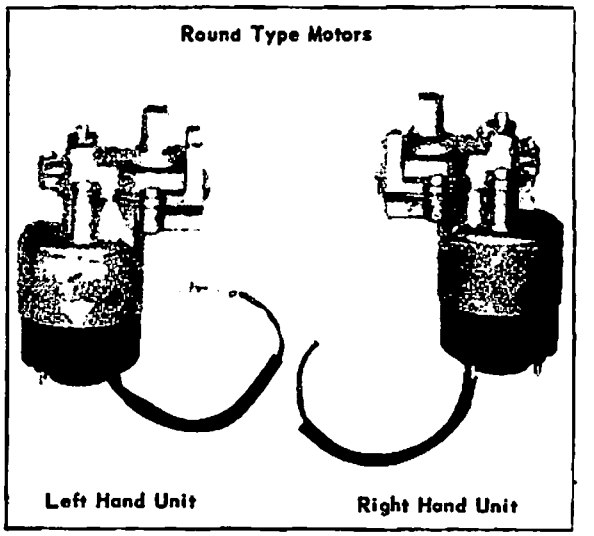



Figure 1-5

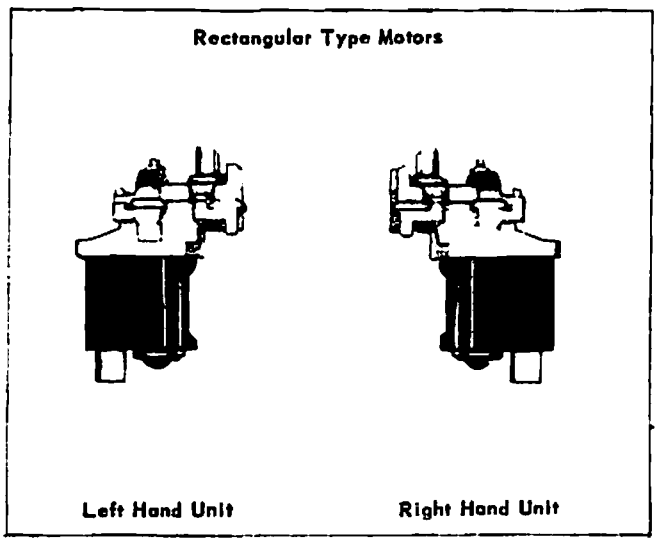



Figure 1-6

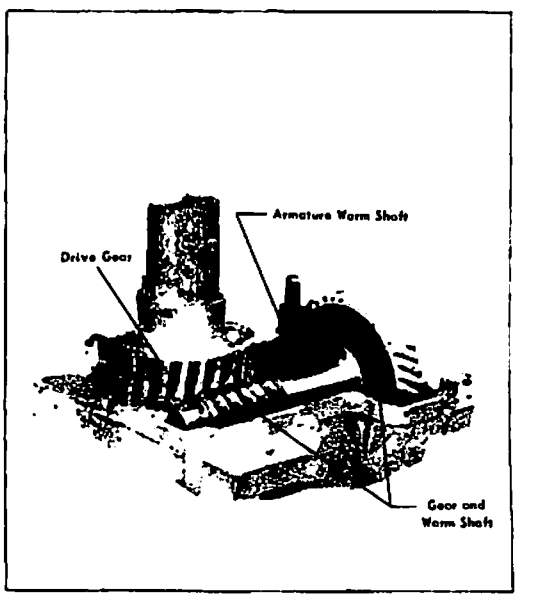



Figure 1-7

## SECTION I – PART III (CONT'D.)

### Vent Window Motors

The front door vent windows travel through a radius of approximately 120 degrees maximum. Rear door vent windows have approximately 32 degrees maximum travel. An automatic reset type circuit breaker is located internally on the motor brush plate and protects the motor windings from overheating.

## PART IV

### CENTER PARTITION WINDOW MOTOR

The center partition window motors consist of a round type motor, which is part of the gear box housing, jackscrew and nut tube assembly. This particular window motor is used on Cadillic Series 75 only. See Figure 1-8 for outline of this motor.

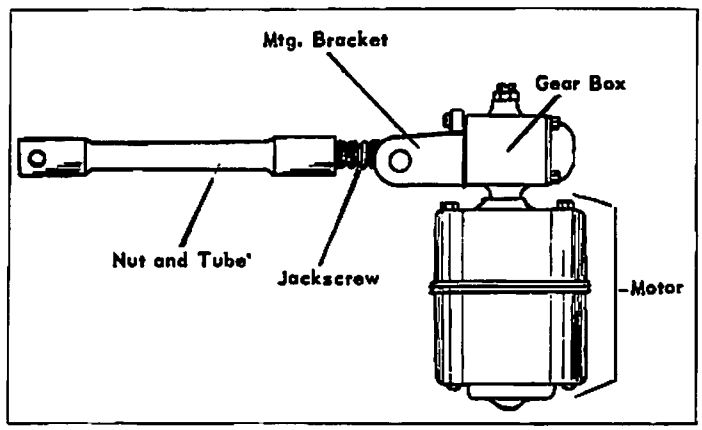



Fig. 1-8

This is a 12 volt DC reversible motor having an armature with a worm shaft that drives a 40 tooth gear. This gear is keyed to the jackscrew shaft. The nut and tube assembly is extended or retracted when the jackscrew is turned by the motor. See Figure 1-8

An automatic reset type circuit breaker is located internally on the motor brush plate and protects the motor from overheating.

The 1954-55-56 models are equipped with leads which extend out of the motor case. The 1957 and 1958 models are similar to previous models as far as mounting and performance but are equipped with a plug in type terminal grommet instead of the leads.

The 1959 thru 1965 models differ from both previous models in that the mounting bracket was modified and the jackscrew and nut tube assembly was shortened.

## SECTION I – PART V

### AMERICAN MOTORS, CHRYSLER, FORD, PACKARD MOTOR CORPORATION

Window lift motor supplied to other car manufacturers outside of The General Motors Corporation consist of both 6 and 12 volt DC, intermittent duty, reversible rotation type motors. The type of motor winding used (Series – Shunt, etc.) varied considerably from one application to another according to what each car manufacturer specifies. Certain motors are equipped with internal, automatic reset type circuit breakers mounted on the brush plate of the motor.

To obtain service motors according to make of car, order from American Motors, Chrysler, Ford or Packard car dealers. Refer to chart. (Figure 1-9) Except for motor #5047859 which may be obtained thru United Motor Service. Unless specified, all motors are 12 volt. Refer to Chart (Figure 1-9)

| | ORIG. EQUIP. MOTORS* | |
|---|---|---|
| | DELCO NO. | CAR MFG. NO. |
| **AMERICAN MOTORS:** | | |
| 1955 RH (6V) | 5047840 | – |
| LH (6V) | 5047839 | – |
| **CHRYSLER CORP:** | | |
| 2 & 4 Door Hardtop Models: | | |
| 1957-1958 Front Doors | 5044292 | – |
| Rear Door & ¼ Windows | 5044293 | – |
| 1959 Front Doors | 5044292 | – |
| Rear Doors & ¼ Windows | 5044354 | – |
| 1960 Front Doors | 5044391 | 2165742 |
| Rear Doors & ¼ Windows | 5044420 | 2165743 |
| 1964 Front | | |
| Rear | | |
| Vent | (RH) 5045386 | (LH) 5045387 |
| 1965 Front | | |
| Rear | | |
| Vent | (RH) 5045386 | (LH) 5045387 |
| **FORD MOTOR CO:** | | |
| 1954 RH & LH (6V) | 5047762 | FAA-14553 A |
| 1954-55 RH (6V) | 5047750 | FAA-14553 B |
| LH (6V) | 5047749 | FAA-14549 A |
| 1955 RH & LH (6V) | 5047846 | FEA-14553A2 |
| 1955 RH (12V) | 5047848 | 4049712 |
| LH (12V) | 5047847 | 4049713 |
| 1955-56 Lincoln Vent Window RH | 5047863 | 4049258 |
| LH | 5047862 | 4049259 |
| 1956-59 RH & LH | 5047859 | FDT-14553A2 |
| **PACKARD:** | | |
| 1955-56 RH | 5047818 | – |
| LH | 5047817 | – |

Figure 1-9

# SECTION 2

## SERVICE AND TROUBLE SHOOTING – ON THE CAR

## PART I

## DOOR AND QUARTER WINDOW MOTORS

### CAR BODY WIRING

On late model cars (1959-65) a three part wiring harness is incorporated. This consists of (1) A front cross over harness and (2 & 3) a rear door and rear quarter window harness. See (Figure 2-1) which is a typical wiring diagram, for power window application 1959-65. Note: For earlier models, refer to Car Division Shop Manuals.

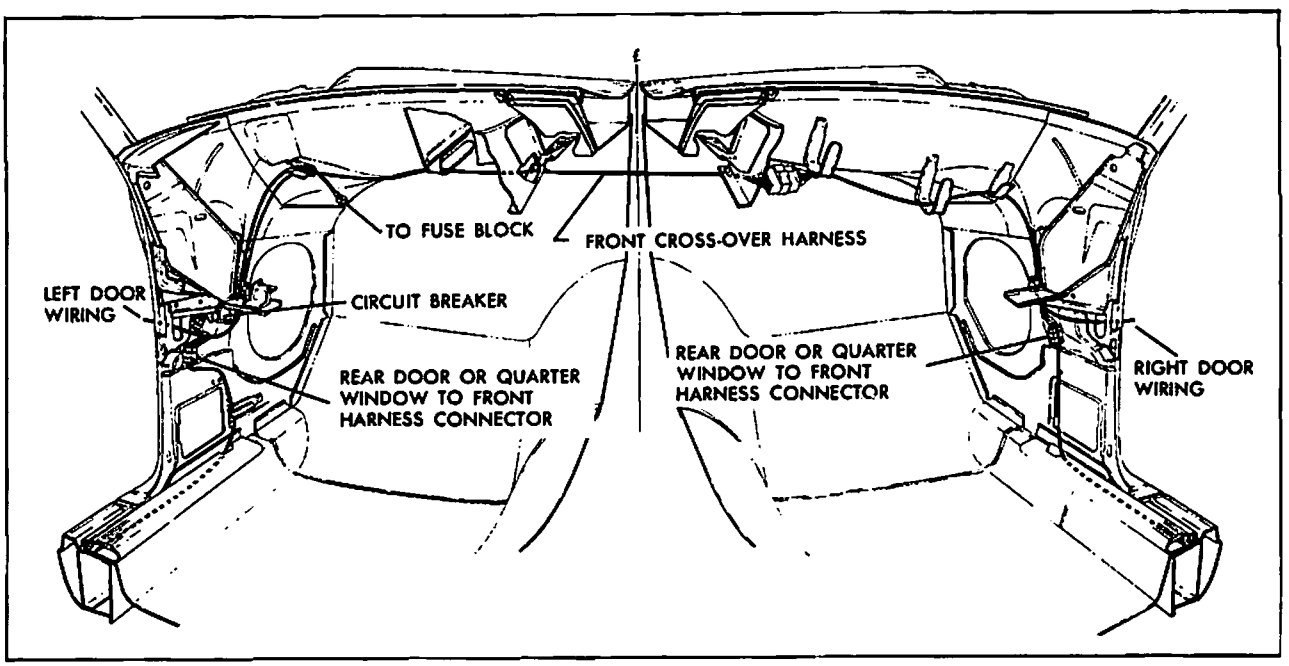



Figure 2-1

As shown in Figure 2-1, the front cross over harness is installed under the instrument panel and completes the circuit from the right door to the left door windows. The front harness also includes the wiring for the cowl vent motors when car is so equipped.

The rear door or rear quarter window harness controls the operation of the right and left rear door or quarter windows. The right and left harnesses are connected to the front cross over harness beneath the outer ends of the Instrument panel.

Typical right side wiring harness locations are shown in Figures 2-2 & 2-3. Left side wiring is very similar.

## SECTION II – PART I (CONT'D)
## DOOR AND QUARTER WINDOW MOTORS

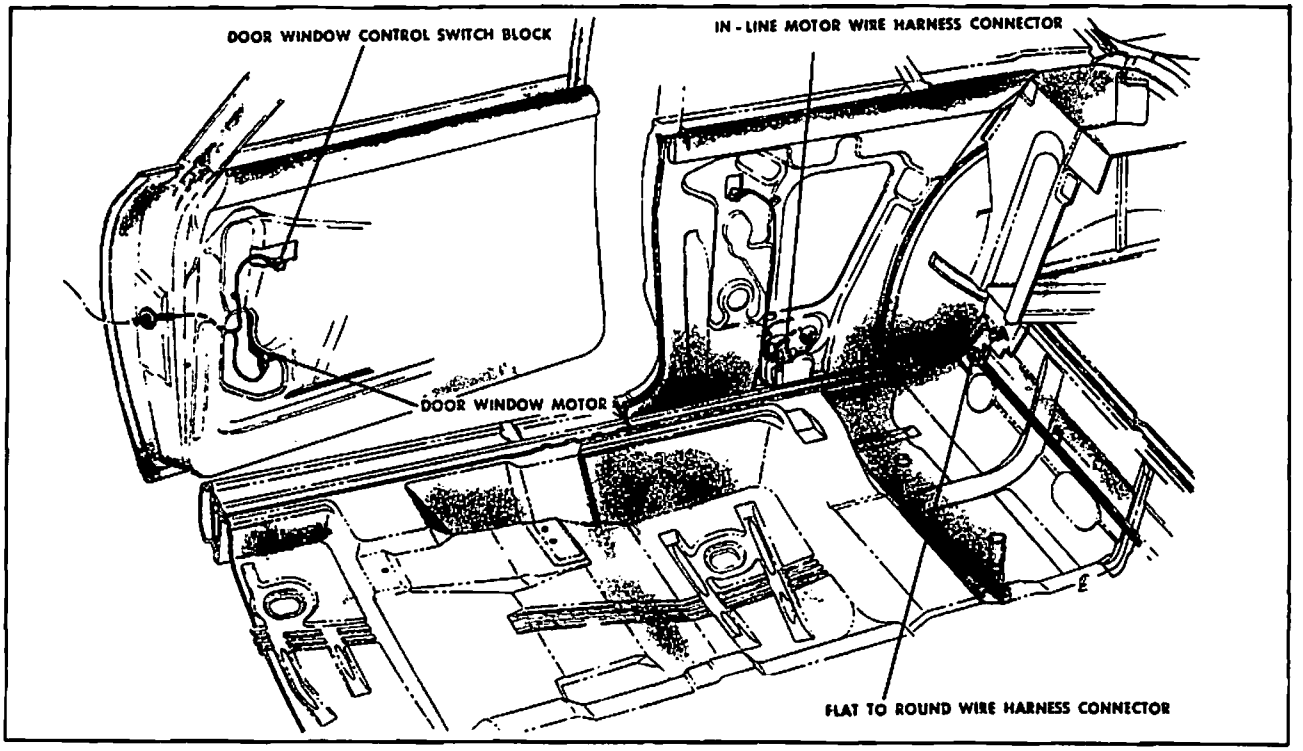



Figure 2-2

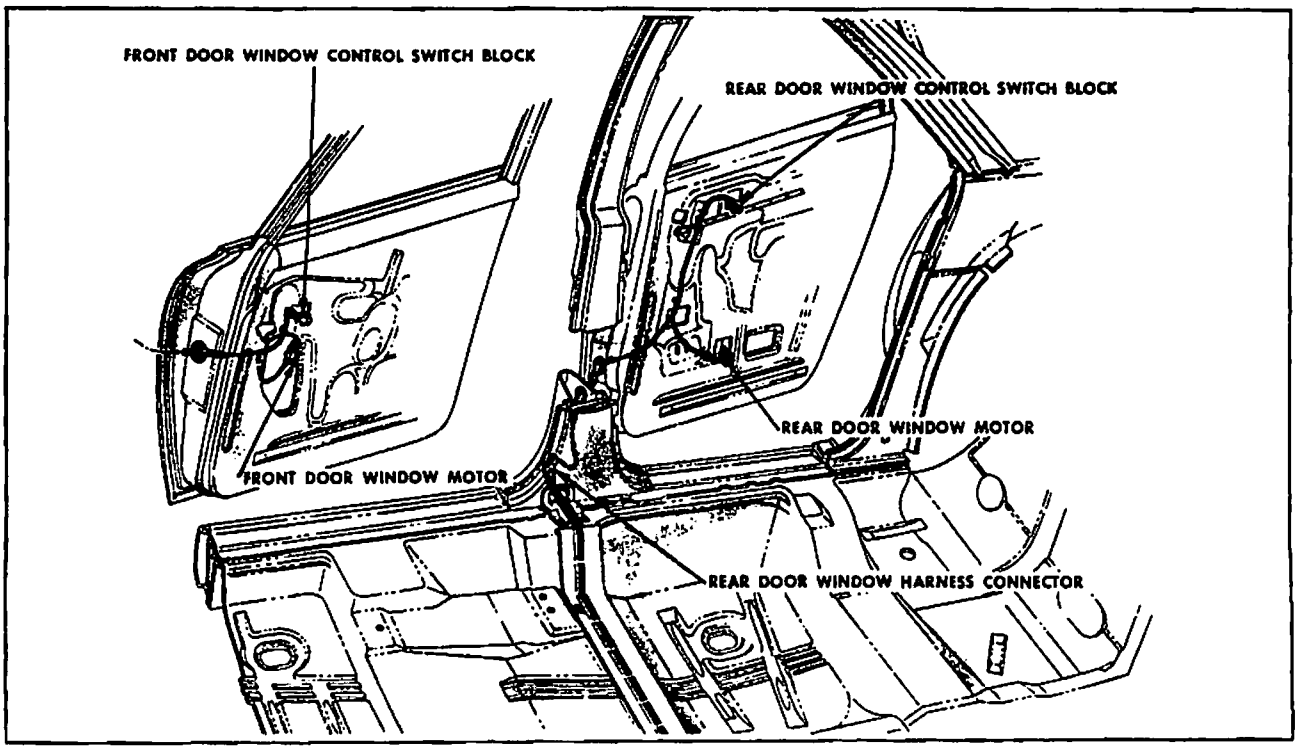



Figure 2-3

## SECTION 2-PART I (CONT'D)
## DOOR AND QUARTER WINDOW MOTORS

### TYPICAL POWER WINDOW ELECTRICAL CIRCUITS:

Except for Oldsmobile applications, power windows on all other GM cars will operate with the ignition switch "OFF". See Figures 2-4 for typical circuit used in GM cars except Oldsmobile.

Oldsmobile power window applications utilize a power relay to complete the feed circuit to the various window switches. The ignition switch when turned "ON" completes the circuit to the power relay coil. When the power relay is energized, the feed wire circuit is completed to the window switches..Figure 2-5

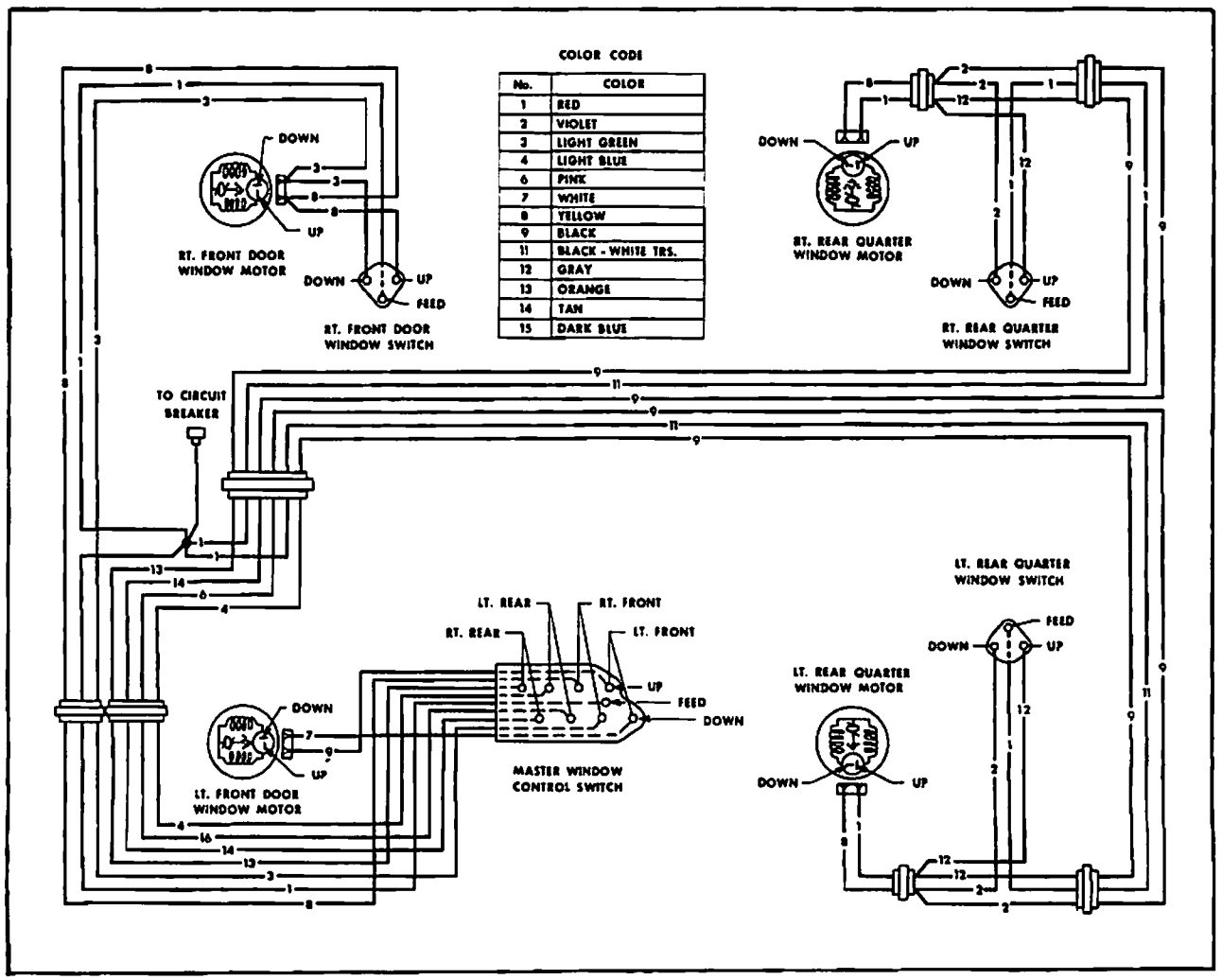



Figure 2-4

## SECTION 2-PART I (CONT'D.)
## DOOR AND QUARTER WINDOW MOTORS

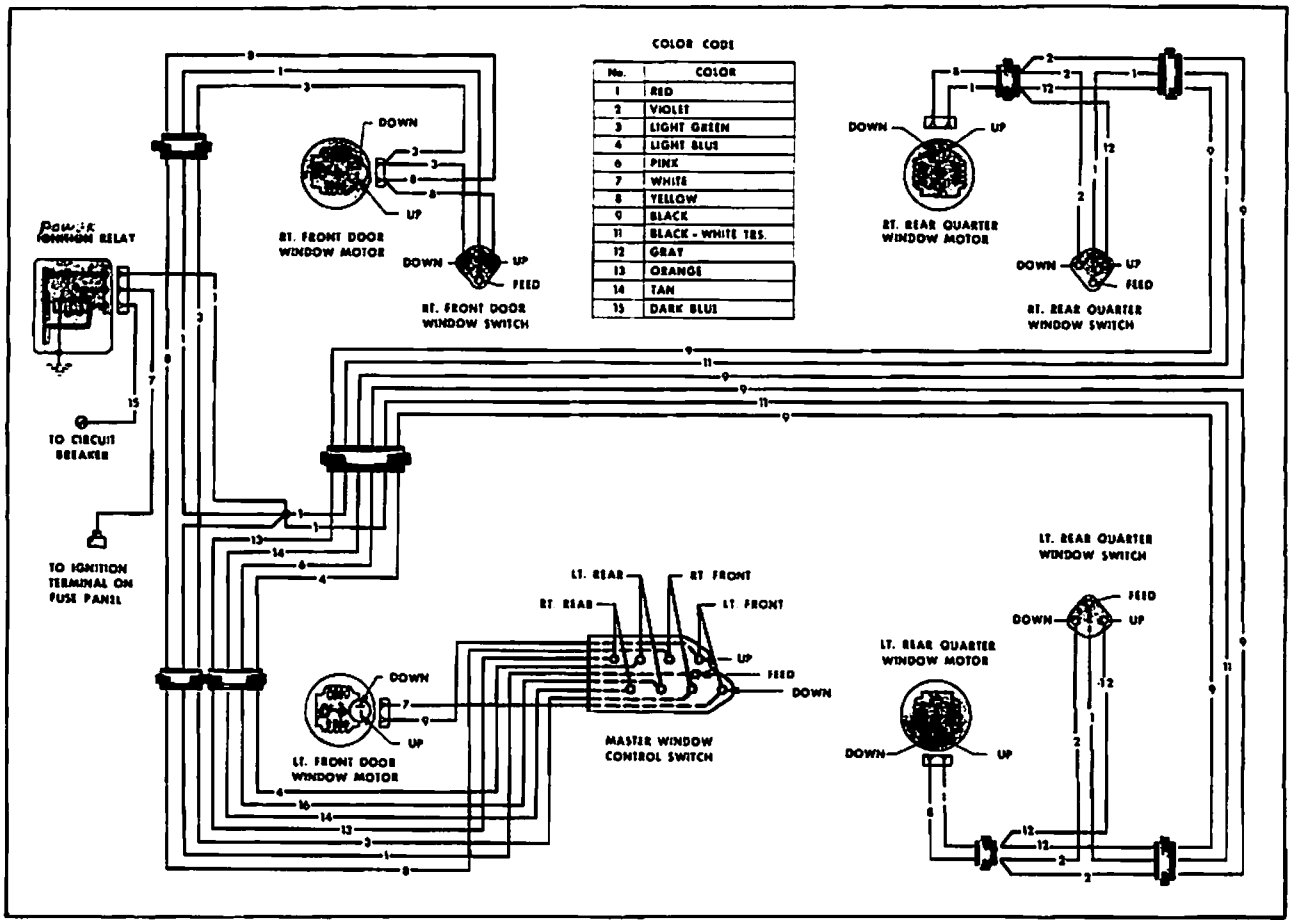



Figure 2-5

### TROUBLE SHOOTING

Short or open circuits are a common cause of inoperative window lift motors. Open circuits are generally caused by breaks in the wiring, faulty connections or mechanical failures in a component part such as a switch or circuit breaker.

Short circuits are usually caused by wires from different components of a circuit contacting each other or by a ground caused by metal screws piercing the insulation of the wire. Another reason for a short would be actual cuts in the insulation by sharp metal edges.

Listed below are five basic checking procedures that will help isolate the cause of inoperative motors and enable you to make the necessary repairs. Before beginning the checking procedure, review the wiring diagrams to familiarize yourself with the circuit. (See Figures 2-4 & 2-5)

## SECTION II – PART I (CONT'D).

## DOOR AND QUARTER WINDOW MOTORS

### CHECKING PROCEDURES

I **Checking Feed Circuit to Power Circuit Breaker.** Note: Power circuit breaker is usually located behind driver side Kick panel (Figure 2-8) or on upper shroud.

Connect one light tester lead to the battery side of circuit breaker and ground other lead. If tester does not light, there is an open or short circuit in feed circuit to breaker.

To check circuit breaker, disconnect output feed wire (the wire opposite power source feed to breaker) from breaker and with light tester check terminal from which wire was disconnected. If tester does not light, circuit breaker is inoperative.

II **Checking Feed Circuit To Window Control Switch**

Connect one light tester lead to feed terminal of switch block and ground other tester lead to body metal. (See Figure 2-6).

If tester does not light, there is an open or short circuit between switch terminal block and power source.

III **Checking Window Control Switch**

Insert one end of a #12 gauge jumper to the switch feed terminal and other end of one the motor lead terminals. (See Fig. 2-7) Note: Perform this test with both motor lead terminals.

If motor operates with jumper wire in both directions, but does not operate with switch, switch is defective.

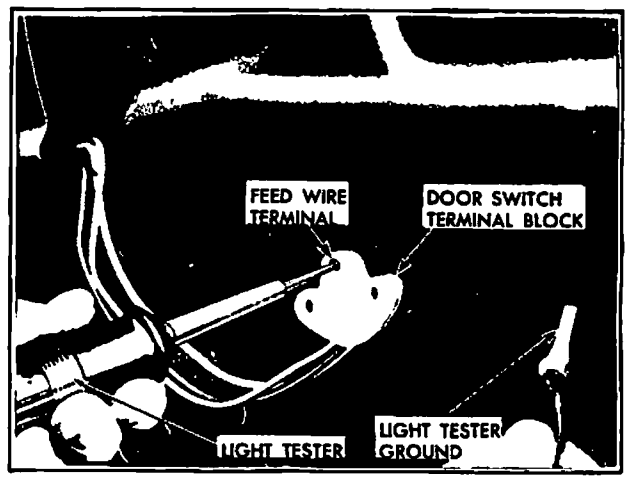



Figure 2-6

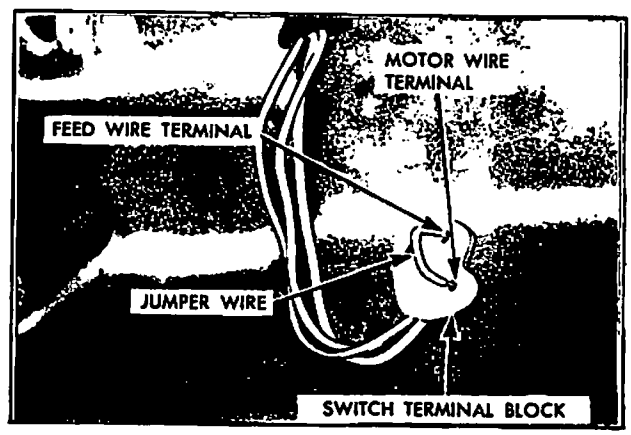



Figure 2-7

## SECTION II - PART I (CONT'D).
## DOOR AND QUARTER WINDOW MOTORS

### CHECKING PROCEDURES (Cont.)

IV **Checking Wire Between Window Switch and Window Motor**

Disengage harness connector from window motor grommet. The thumb release or harness connector must be depressed before it can be disengaged from the motor. (1957 - 65 models.)

Insert one end of #12 gauge jumper wire to switch feed terminals and the other end of one of the motor lead terminals in switch block. (See Fig. 2-7) with light tester, check for current at terminal being tested. If tester does not light, there is an open or short circuit in harness between control switch and motor connector. (See Figure 2-8)

Repeat this test with other motor lead terminal.

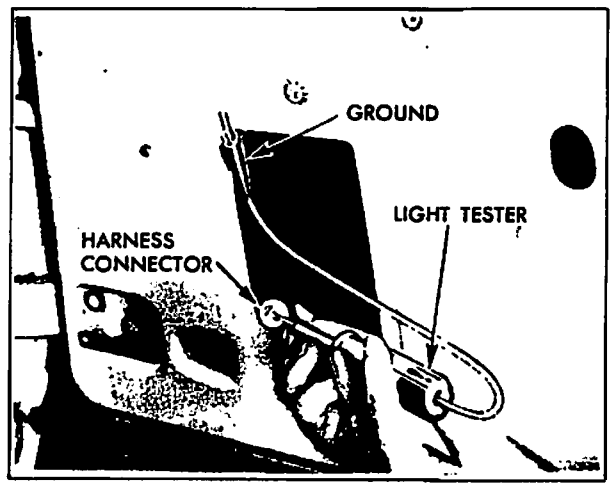



Fig. 2-8 Checking Between Switch and Motor

V **Checking The Motor**

Check window regulator and channels for possible mechanical bind of windows. Also check attachment of window motor to inner panel to insure an effective ground. Connect one end of a #12 gauge jumper wire to power source and the other end to one of the terminals on window motors. (Refer to Figure 3-2 n Section III) If motor fails to operate with a jumper wire, the motor is defective and should be replaced or repaired as the situation requires. For bench repair of motor, see Section III, Part I. Check opposite motor lead in same manner.

### CHECKING RELAY ASSEMBLY (OLDSMOBILE APPLICATION ONLY)

With a light tester, check relay feed (dark blue wire terminal). If tester does not light, there is an open or short circuit between relay and circuit breaker.

Turn ignition switch on and with light tester check output terminal of relay (red wire terminal). If tester does not light, the relay is inoperative or there is a short or open circuit between ignition switch (white wire) and relay assembly. (Check fuse at dash panel.)

## SECTION II - PART I (CONT'D)

## DOOR AND QUARTER WINDOWS

### TYPICAL WINDOW LIFT PROBLEMS AND THEIR SOLUTIONS

PROBLEM #1

None of the Windows will Operate

A- Check feed wire to circuit breaker.
B - Check the feed wire from circuit breaker for possible short or open circuit
C - Check power feed connector.
D - Check Power Relay (Olds Applications Only).

PROBLEM #2

Right door window will operate from left door master switch, but will not operate from right door control switches. Left door windows operate.

A - Check feed wire in front harness for possible short or open circuit.
B - Check right door control switch.

PROBLEM #3

Right rear door window does not operate from master control switch on left front door or from control switches on right rear door. Left door window operates.

A - Check harness connectors beneath outer ends of instrument panel for proper installation. Figure 2-1
B - Check wires in power window front harness for possible short or open circuit.
C - Check operation of rear door window control switch.
D - Check circuit from window control switch to window motor for short or open circuit.
E - Check window regulator and channels for possible mechanical failure or bind.
F - Check operation of motor.

## PART II

### STATION WAGON TAIL GATE MOTOR

Figures 2-9 and 2-10 show location of typical body wiring harness. Figures 2-11. 2-12, and 2-13 are typical schematic wiring diagrams covering the power tailgate window circuitry. Note, in particular the two relays used in the Oldsmobile circuit. Figure 2-13-

## SECTION II PART II
## STATION WAGON TAILGATE WINDOW MOTOR
### TYPICAL BODY WIRING: Refer to Figures 2-9, 2-10

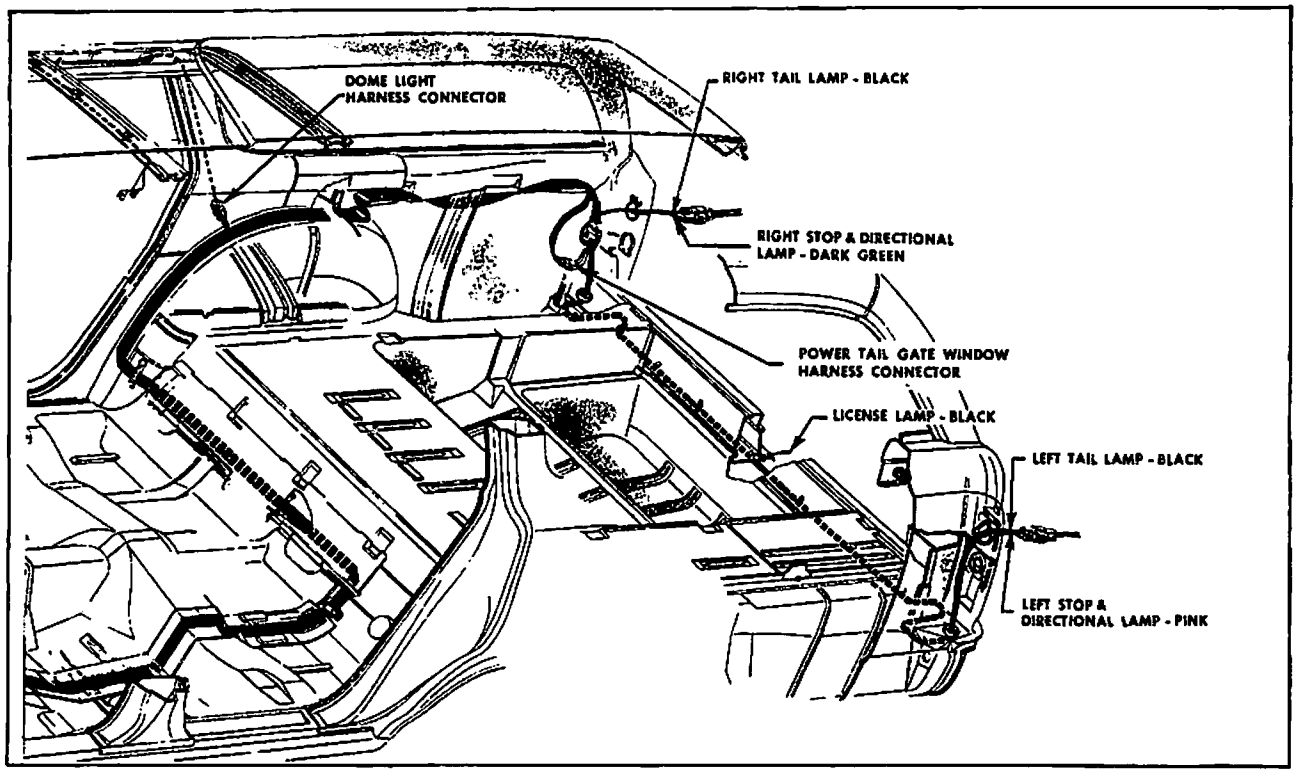



Figure 2-9

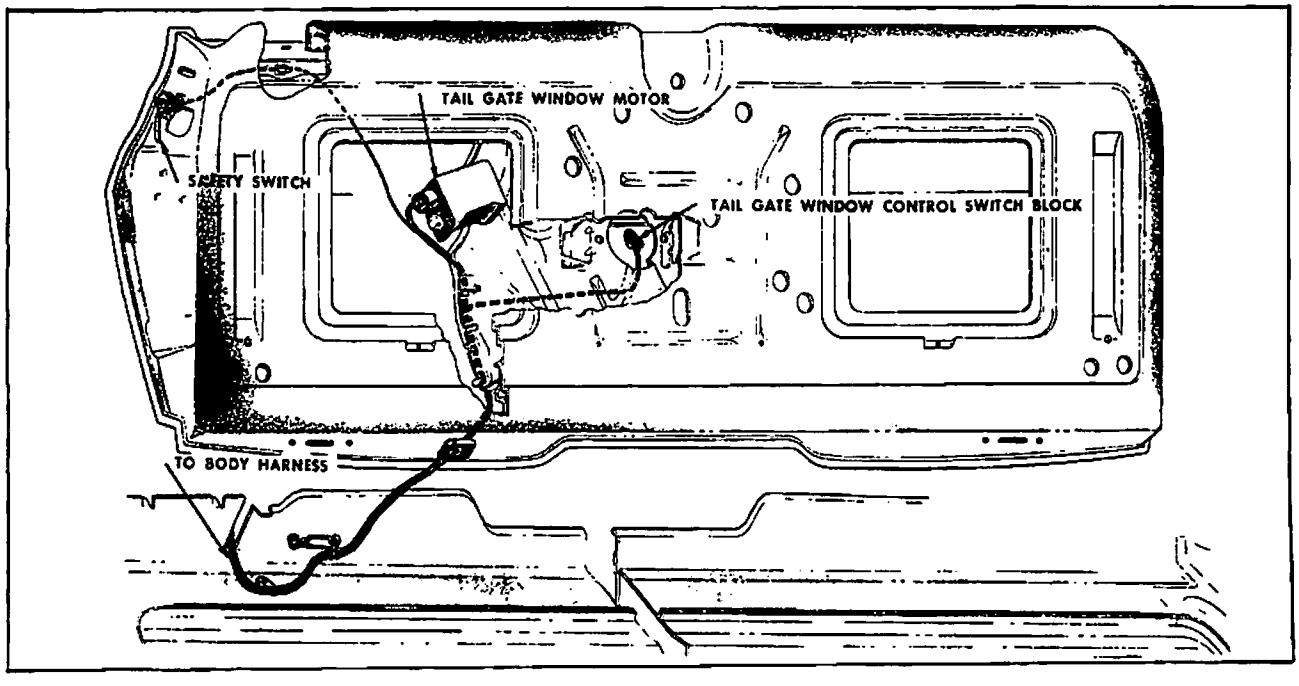



Figure 2-10

## SECTION II - PART II
## TYPICAL GM STATION WAGON (EXC. OLDSMOBILE) CIRCUITS

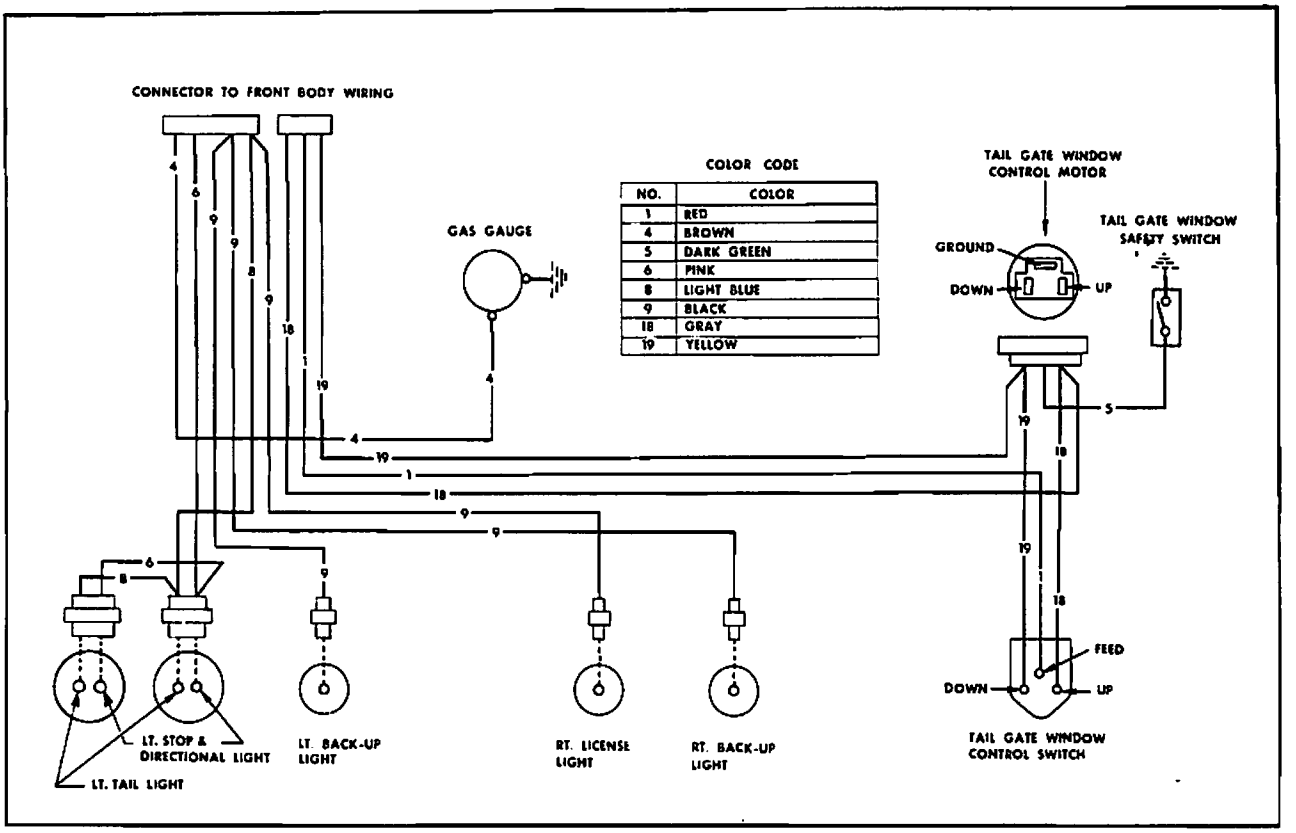



Figure 2-11

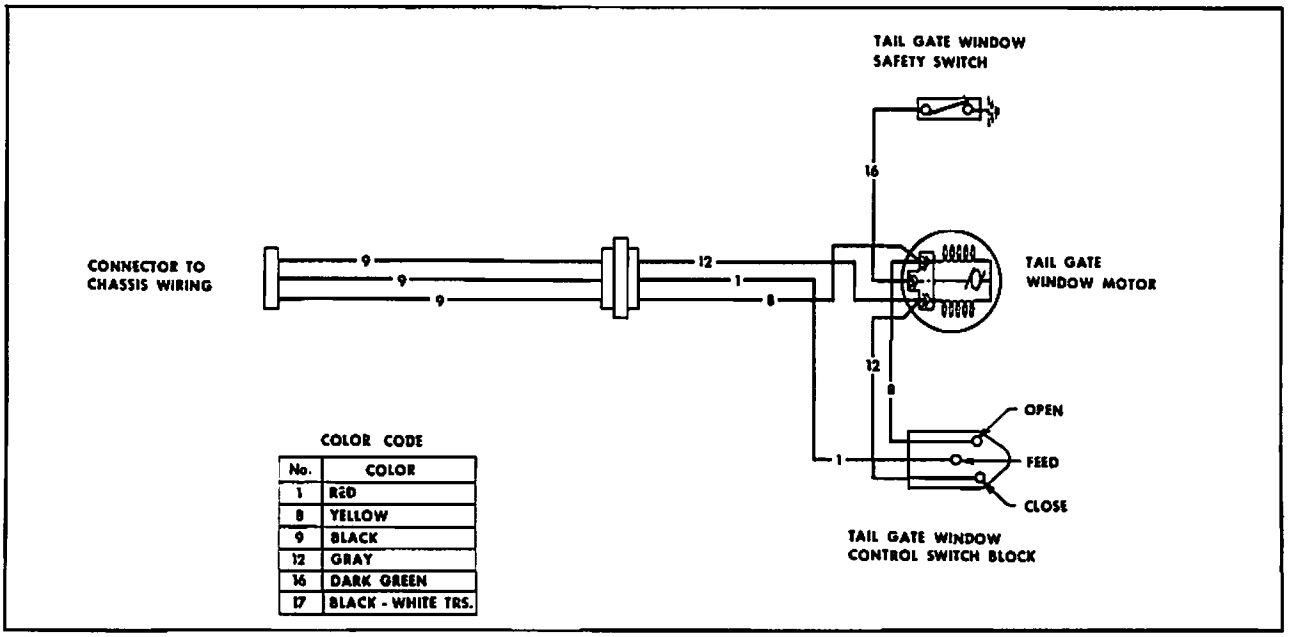



Figure 2-12

## SECTION II - PART II

## STATION WAGON TAILGATE WINDOW MOTOR

### TYPICAL CIRCUIT FOR OLDSMOBILE (SEE FIG. 2-13)

Circuit utilizes two relays in motor circuit to control up and down movement. The control switches actually complete the circuit through the relay coils. With relay coil energized, relay contacts close, completing power circuit to motor.

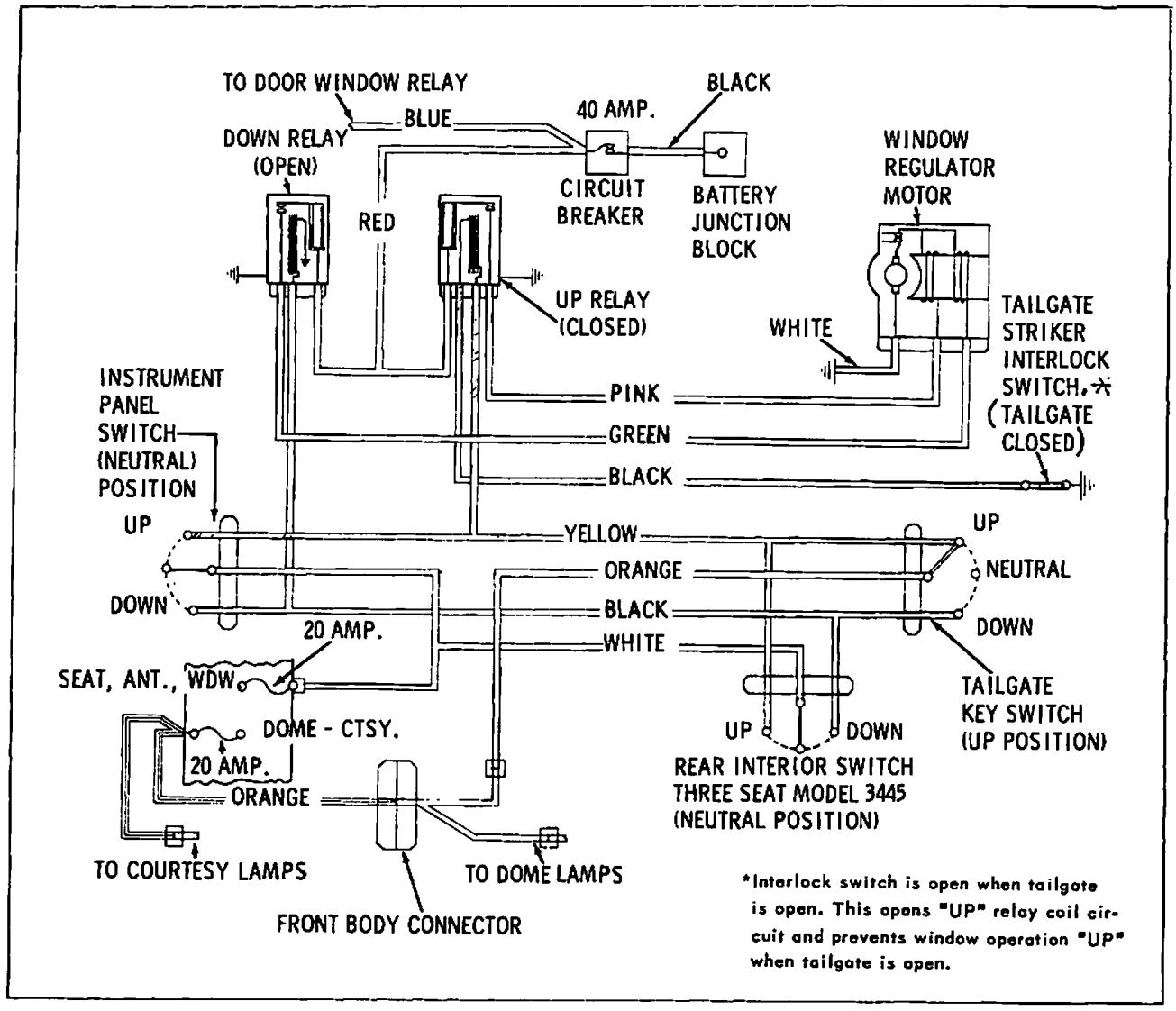



Figure 2-13

## SECTION II PART II
## STATION WAGON TAILGATE WINDOW MOTOR

Before performing an intensive checking procedure to determine if the failure is in the circuit, check the connectors at the front and rear body wiring harness for proper installation. The following checking procedures may be used to check the operation of a switch or motor after the cause of the electrical failure has been traced to a particular part of the circuit.

**CHECKING PROCEDURES:** NOTE: The following procedures apply to all GM Applications but keep in mind that Olds applications utilize relays to control up and down operation.

#1 **Checking Circuit Breaker**

Refer to Part I of this section. "Checking Feed Circuit Continuity at Circuit Breaker." Page 5

#2 **Checking Feed Circuit Continuity at Control Switch on Instrument Panel**

(A) Connect one light tester lead to feed terminal of switch block and ground other lead to body metal. Refer to Figure 2-6

(B) If tester fails to light, there is an open or short circuit between switch and power source.

#3 **Checking Control Switch at Instrument Panel**

To isolate dash switch and operate motor, proceed as follows:

(A) Disengage harness connector from switch.

(B) Use a jumper wire and insert one end into the red wire (feed) terminal. Figure 2-7. Insert other end into either of the other terminal openings. If tailgate window motor fails to operate, try jumper in other motor terminal.

(C) If the tail gate window motor operates with jumper wire but does not operate with the contact switch, the switch is defective.

#4 **Checking Control Switch at Rear Quarter or Tail Gate Lock Switch**

(A) Disconnect terminal block from switch.

(B) Determine if there is current to the switch terminal block. Fig. 2-6.

(C) Using a jumper wire, repeat the checking process outlined in Step 3 above.

#5 **Checking Circuit Between Front and Rear Harness at Connector**

(A) Remove rear quarter trim to gain access to front and rear connector.

(B) Check connector for proper engagement. If connector is engaged properly and motor does not operate, proceed as follows:

1. Disengage connector and check with test light for power. If tester does not light, there is a short or open circuit in the feed wire.
2. To check up and down cycle circuits, actuate window control switch at instrument panel or quarter trim panel. With test light, check continuity at wire terminal being energized.

## SECTION II – PART II
## STATION WAGON TAILGATE WINDOW MOTORS

### CHECKING PROCEDURES (Cont'd.)

#6 Checking the Tailgate Window Motor

Refer to Part I, Section II, Page 6. "Checking Door Window Motors"

#7 Checking Operation of Safety Switch

(A) With tail gate open, depress switch to simulate the tail gate being closed. If motor does not operate either switch is defective or the circuit is open from the motor to the switch.

(B) To check for defective switch, connect one end of test light to a source of power and the other lead to the safety switch terminal. If the tester lights when the switch lever is actuated, the switch is operative. Keep safety switch depressed during this operation.

### TYPICAL PROBLEMS AND SOLUTIONS FOR TAILGATE MOTORS

PROBLEM #1

The tail gate window operates up and down from tail gate switch, and the rear quarter switch (9 passenger style) but does operate from switch at the instrument panel.

(A) Check affected wiring for open or short circuit and check connector at switch for proper installation.

(B) Check operation of switch.

PROBLEM #2

With the tail gate closed, the window operates downward but does not operate upward when the switch at the instrument panel, rear quarter or tail gate is actuated.

(A) Check operation of safety switch..

(B) Check connectors at safety switch for proper installation.

(C) Check affected wiring for open or short circuit.

## SECTION II – PART II
## STATION WAGON TAIL GATE WINDOW MOTORS

### CHECKING PROCEDURES (Cont'd.)

PROBLEM #3

The window will not operate "up" or "down" from any of the control switches.

(A) Check operation of circuit breaker.

(B) Check affected circuit for open or short circuit. (Check connections of body and tail gate jumper harness at left lower edge of tail gatel)

(C) Check harness to motor connections.

(D) Check tail gate mechanical parts for bind or failure.

(E) Check operation of motor with #12 guage jumper wire.

## PART III
## VENT WINDOW MOTOR

Checking vent window motors for open or short circuits, refer to Part I of this section. Review the checking procedures and trouble shooting as outlined in Part I, also be sure to familiarize yourselt with wiring diagrams in Figures 2-4 and 2-5 and 2-14.

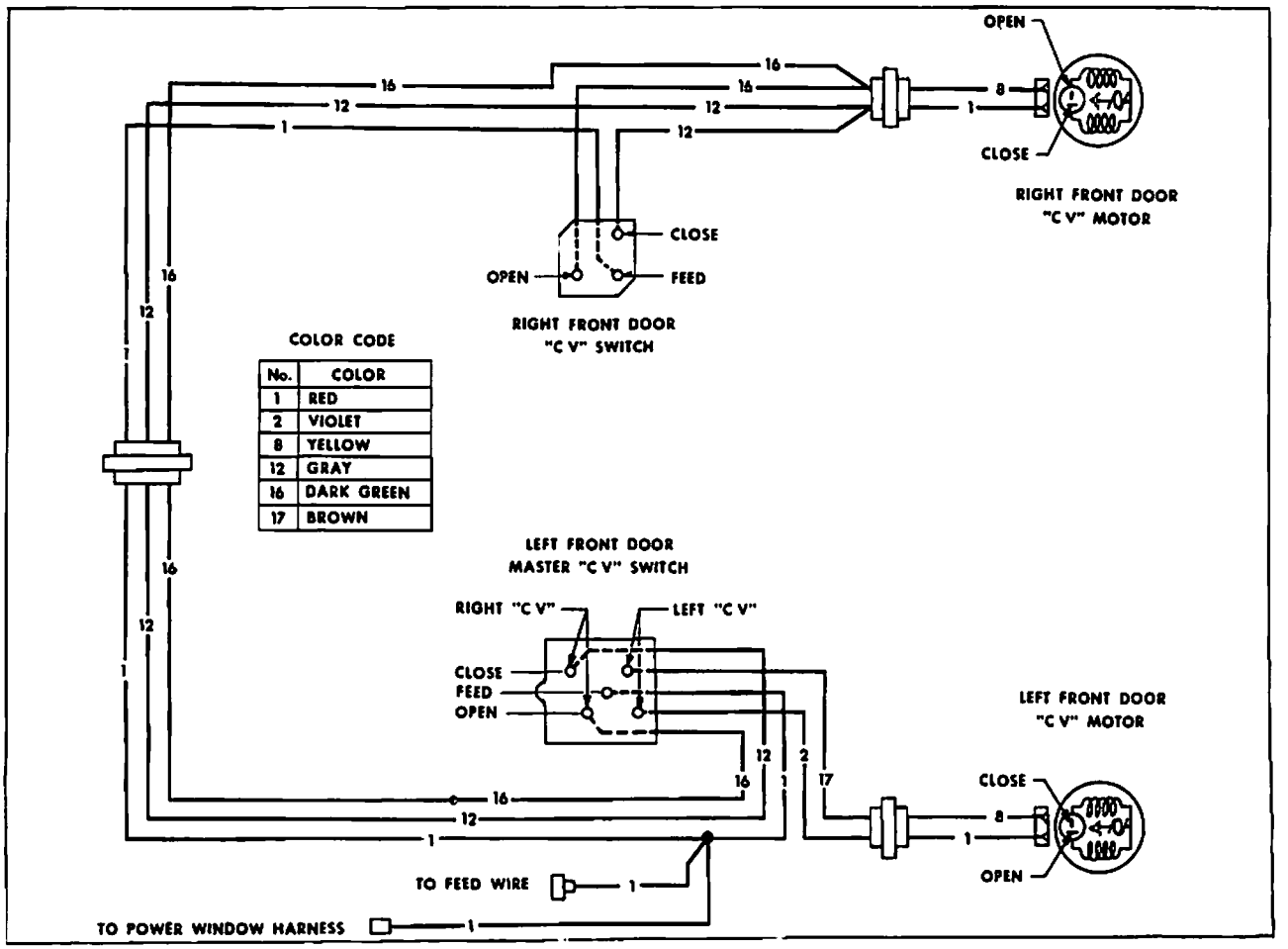



Figure 2-14

## SECTION II - PART IV

### CENTER PARTITION WINDOW MOTOR

When checking the center partition window motor for open or short circuits, refer to Part 1 of this section. The checking procedures and trouble shooting would be similar to that outlined.

## SECTION II PART V

### AMERICAN MOTORS, CHRYSLER, FORD AND PACKARD MOTOR CAR CORPORATIONS

For checking procedures and trouble shooting in motors used on above automobiles, refer to Shop Manuals issued by particular corporations.

# SECTION 3

## BENCH INSPECTION AND TEST PROCEDURES – MOTORS DETACHED

## PART I

## DOOR AND QUARTER WINDOW MOTORS

### BENCH OPERATION OF MOTOR

For 6 volt or 12 volt, refer to Section I, Page 1 of this manual. (Figures 1-1 and 2-1).

### ADJUSTMENTS

Armature end-play is the only adjustment required on window lift type motors.

To adjust armature, proceed as follows: Refer to Figure 3-8 for location of armature adj. screw.

1. Operate motor as explained under "Bench Operation."
2. With the ammeter connected in the (⚡) feed wire circuit, tighten armature end-play adjusting screw until current starts to rise. Then back off slowly until current draw returns to normal. Back off adjusting screw an additional 1/8 turn and tighten lock-nut.

### INSPECTION AND TEST PROCEDURES

The following tests are based on the assumption that the repairman has tried to operate the motor and has found it inoperative or not meeting the performance specifications and has disassembled the motor.

1. Armature Test
2. Field Assy. Test
3. Brush Assy. and Related Wiring Inspection
4. Gear and Pinion Assy.

**Armature Tests:**

A. **Grounded** – Connect test light (110 Volt AC) between armature lamina and commutator, If armature is grounded, the lamp will light.

B. **Open** – A bar to bar check with the test light will indicate an open armature (Fig. 3-1). If lamp does not light between any two adjacent commutator bars, an open armature is indicated.

C. **Shorts** – DO NOT CHECK WINDOW LIFT MOTORS ON A GROWLER. A growler check of window lift armatures will always indicate a shorted armature.

Usually when the armature is shorted, the motor will operate but will draw high current and vibrate.

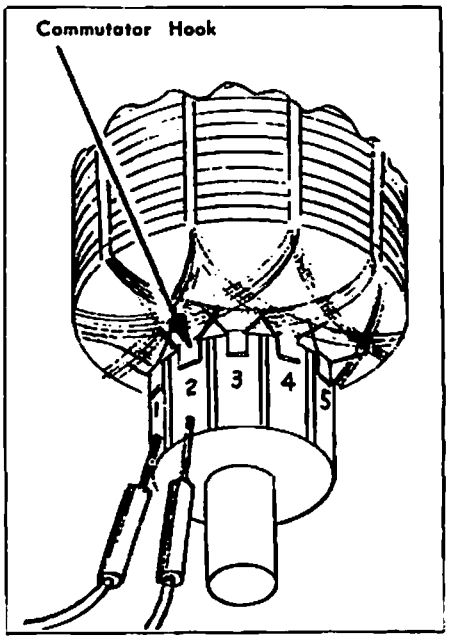


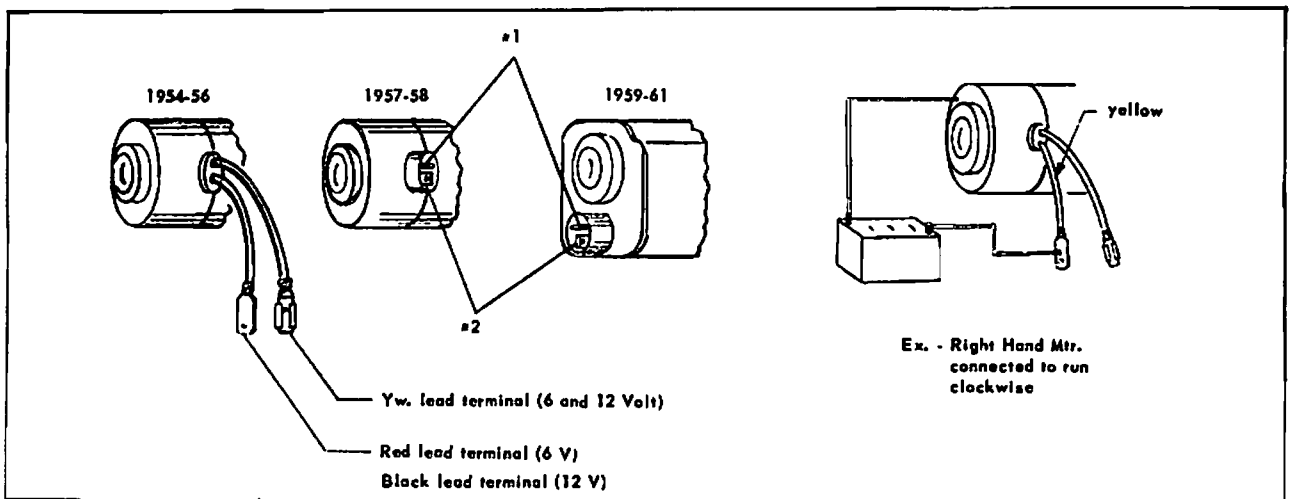

Figure 3-1

## PART I (CONT'D.)

### DOOR AND QUARTER WINDOW MOTORS – BENCH TEST AND OVERHAUL PROCEDURES

**BENCH OPERATION:** Operate motor as folows to determine type of trouble that exists.

1. Determine if motor is 6 or 12 volt. NOTE-Motors are all 12 volt unless equipped with red and yellow leads.
2. Determine if motor is right or left hand type. (See Figures 1 and 2) Section I.
3. Refer to Lead Chart below (See Figure 3-2). Connect an ammeter between (+) side of power source and lead or terminal indicated for desired rotation, then connect ground (-) side of power source to motor housing.
4. Check performance against values given in performance table for both clockwise and counter clockwise rotation. (See Figure 3-3)




| MOTOR TYPE | *RIGHT HAND MOTOR ROTATION | | *LEFT HAND MOTOR ROTATION | |
|---|---|---|---|---|
| | CLOCKWISE | COUNTER CLOCKWISE | CLOCKWISE | COUNTER CLOCKWISE |
| 6 Volt Mtrs. With Leads | Yellow | Red | Red | Yellow |
| 12 Volt Mtrs. With Leads | Yellow | Black | Black | Yellow |
| 12 Volt Mtrs. With "Plug In" Type Terminal Grommet | #2 Terminal | #1 Terminal | #1 Terminal | #2 Terminal |

*Rotation looking at pinion gear

Figure 3-2

### MOTOR PERFORMANCE SPECIFICATIONS

| MOTOR VOLTAGE | PINION GEAR FREE SPEED (RPM'S) | CURRENT DRAW (AMPERES) | | |
|---|---|---|---|---|
| | | FREE SPEED | (OPERATING WINDOW) | (STALL) |
| 6 Volt Motors | 85 – 100 | 18 – 21 | 34 Max. | 70 Max. |
| 12 Volt Motors (Exc. Tail Gate Models) | 85 – 100 | 9 – 10 | 15 Max. | 32 Max. |
| 12 Volt Tail Gate Motor | 110 Max. | 9 – 10 | 17 Max. | 32 Max. |

Figure 3-3

Note: Values given in the above chart will vary somewhat according to the condition of the battery or type of voltage supply being used for testing.

## PART I (CONT'D.)
## DOOR AND QUARTER WINDOW MOTORS – BENCH TEST AND OVERHAUL PROCEDURES

### Field Assembly Test

NOTE: Visually inspect all solder connections and leads for breaks or frayed insulation.

A. Grounded – With armature removed and brushes insulated from each other, connect test light between field lamina (round type motors) or field frame (rectangular type) and the lead terminals or grommet terminals. If test lamp lights, the fields are grounded.

Bl Open – Connect test light between the yellow lead or No. 1 terminal and brush holder (round motors) or circuit breaker (rectangular motors.) Then connect test light between black lead or No. 2 terminal and same brush holder or circuit breaker (Fig's. 3-4 & 3-5) If test lamp fails to light, an open field is indicated.

C. Shorted – A shorted condition in either the field or armature is very difficult to determine due to the extremely low resistance of the windings. However, a motor having a shorted field or armature usually draws considerably more current than normal. Sometimes the shorted condition can be located by carefully examining the armature and field windings. The coating on a few turns of the wire will become darker near the area of the short.

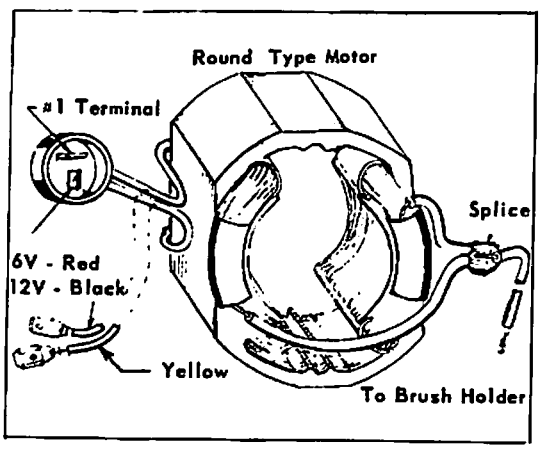



Figure 3-4

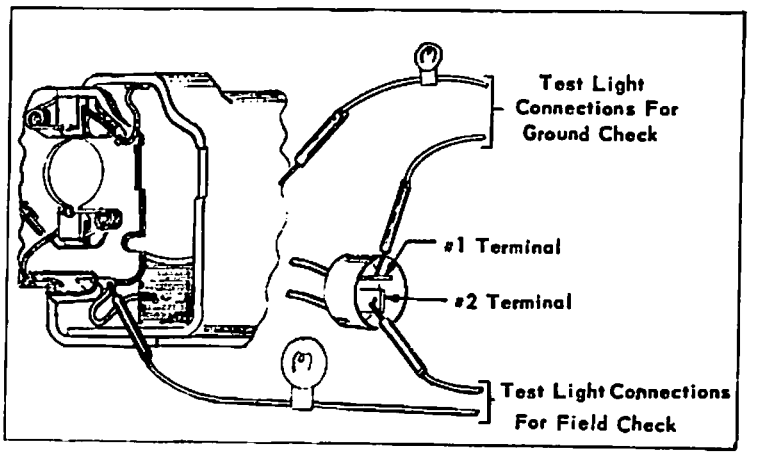



Figure 3-5

### Brush Assembly and Related Wiring Inspection

*Check the following items:*

(a) Brushes slide freely in the brush holders.
(b) Brush springs not broken or damaged; positioned properly in rectangular motors.
(c) All solder connections.
(d) Circuit breaker contacts are not burnt and are properly cleaned.
(e) Be sure the thrust plug is not damaged and is properly located in the bearing.

## PART I (CONT'D.)

### Gear and Pinion Assembly Inspection

On 1954 motors equipped with gear and pinion assemblies that were not rubber coupled, always replace the gear assembly using the service gear package indicated in the chart on Page 2

Check the rubber coupled type gears for the following:

(A) Nylon gear teeth are not damaged or distorted.
(B) The bond between the rubber and steel pinion is secure. This can be easily checked by reinstalling the gear assembly in the housing and exerting a turning force on the steel pinion. CAUTION: Do not attempt to turn the steel pinion over 16° to 18° deflection.
(C) Gear Assembly Shaft is not loose in the nylon gear.

## DISASSEMBLY AND ASSEMBLY PROCEDURES

Disassembly of the motor is divided into three sections:

(A) Gear and pinion assembly removal.
(B) Motor dieassembly (round motors)
(C) Motor disassembly (rectangular motors)

### Gear and Pinion Assembly Removal

1954-55 Models – Pierce the pinion gear dust cover with an ice pick or small screwdriver, pry out the cover and lift out the gear. (See Figure 3-6)

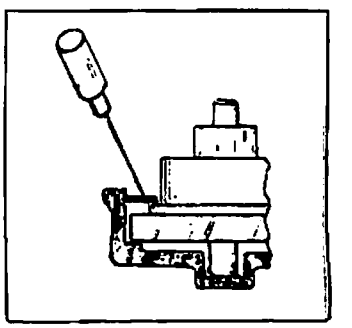


Figure 3-6

1956-65 Models – These motors are equipped with the "Unistress" type of rubber coupled gear which has a rubber lip to take the place of the pinion gear dust cover. When a motor is equipped with this type of gear, it is necessary to only work the gear out of the housing.

### Motor Disassembly–Round Type Motor

Refer to Figure 3-8 for nomenclature and location of parts. This view shows typical 1954-56 type of motor having two external feed wires. The 1957-65 models have terminal grommet assembly as shown in Figure 3-7. To disassemble motor, refer to Figure 3-9.

## PART I (CONT'D.)
## DOOR AND QUARTER WINDOWS – BENCH TEST AND OVERHAUL PROCEDURES

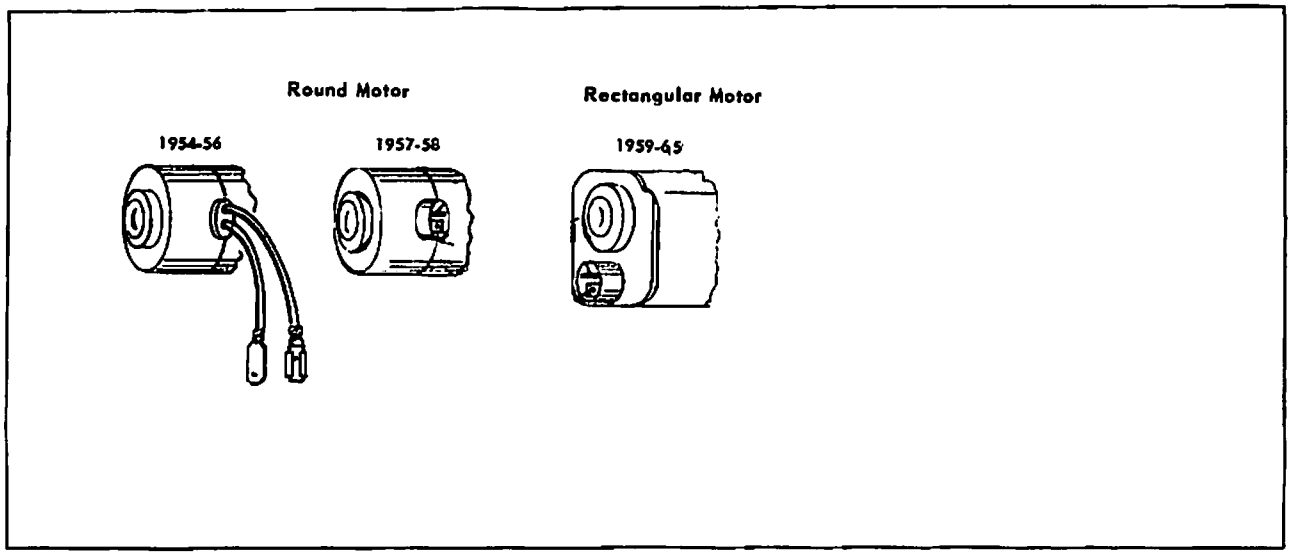



Figure 3-7

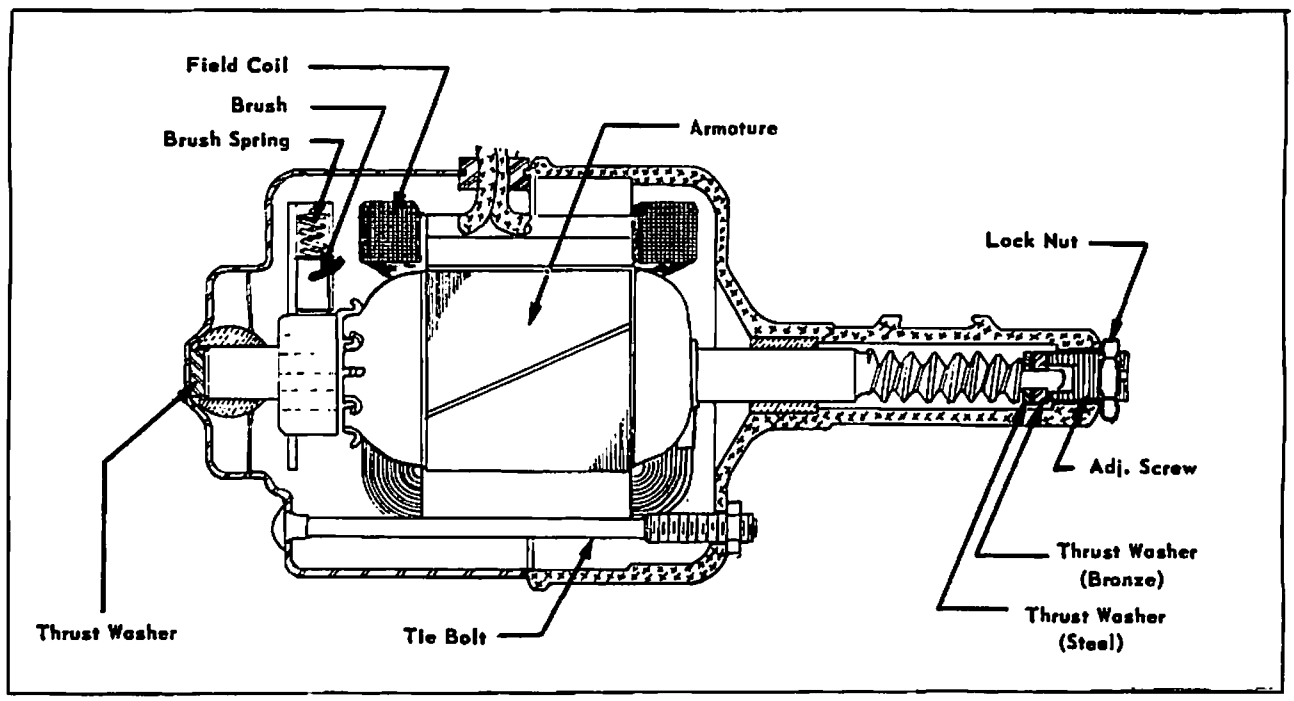



Figure 3 - 8

When disassembling the round type motor, refer to the seven step procedures listed below: Refer to Figure 3-10

1. Remove tie bolt nuts and slide out tie bolts.
2. Partially loosen the case and brush assembly from the field by striking the case around its circumference with a rawhide or plastic mallet.

## PART I (CONT'D.)

## DOOR & QUARTER WINDOW MOTORS–BENCH TEST AND OVERHAUL PROCEDURES

**Round Motor Disassembly (Cont'd.)**

3. Back the case assembly, together with the armature, away from the housing being careful to keep the armature commutator in position between the case assembly brushes. IMPORTANT: To retain the armature commutator in the recommended position, back the case away approximately 1/8" to 3-16" at a time and push the armature back into position each time by inserting a screwdriver into the armature worm shaft that projects into the gear box and pushing it toward the case.

4. When the armature worm clears the housing bearing, remove the thrush washer and thrust plug from the end of the armature worm. NOTE: Thrust washer and plug are used on all motors listed except 1954 first style.

5. (a) To separate armature from case while still retaining the brush-springs and brushes in place, fashion a spring similar to that shown in Fig. 3-9 and insert behind the brush leads as shown.

   (b) Pull the armature out of the case and install "U" shaped brush retainer spring. Part Number 5096576, as shown in Figure 3-9

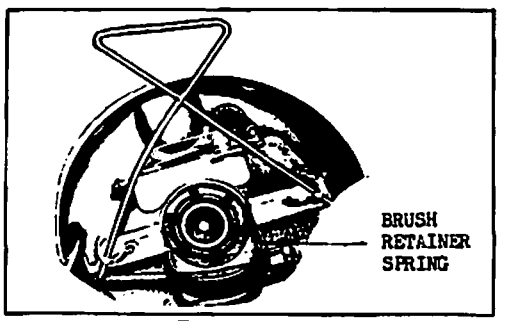
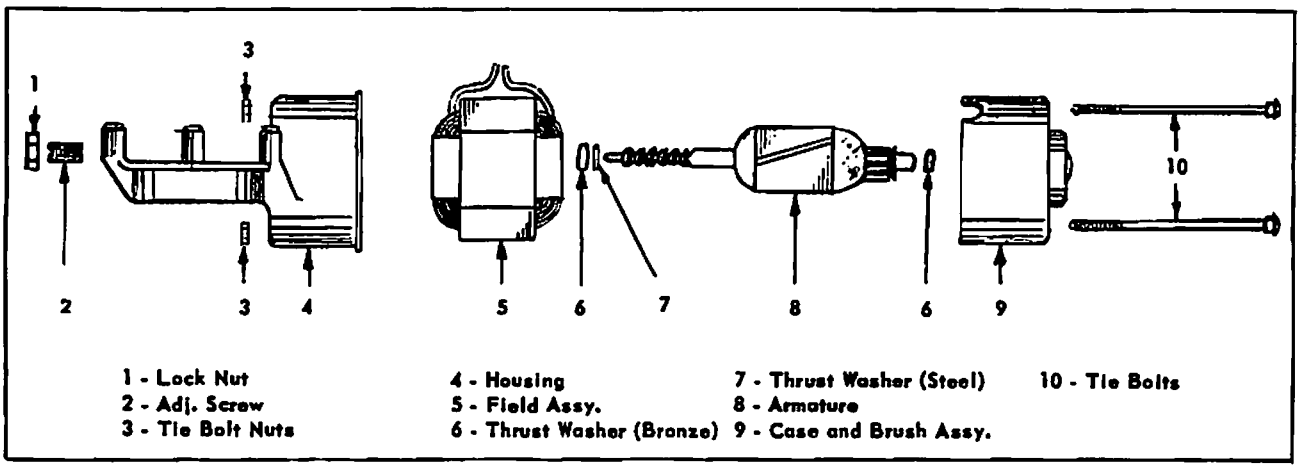


Figure 3-9

CAUTION: Be careful not to lose the nylon thrust bearing when the armature is removed.

6. To separate the case assembly from the field, unsolder the internal field lead (black) that connects onto the brush holder.




1 - Lock Nut
2 - Adj. Screw
3 - Tie Bolt Nuts
4 - Housing
5 - Field Assy.
6 - Thrust Washer (Bronze)
7 - Thrust Washer (Steel)
8 - Armature
9 - Case and Brush Assy.
10 - Tie Bolts

Figure 3-10

7. Field assembly removal. Clamp that part of the field lamina that extends out of the die cast housing in a vise and carefully wedge the housing off the field. To reassemble motor, reverse the procedure outlined above.

**Motor Disassembly Rectangular Type Motor**

When disassembling the rectangular type motor, refer to Figure 3-11 and the seven step procedure listed below;

IMPORTANT: After any repair requiring disassembly of the motor section, be sure to seal around the joints where the frame and field butts against both the housing and the end cap. Also seal thoroughly around the edge of the terminal grommet and the bolt heads. Undercoat material used to undercoat cars may be used.

## PART I (CONT'D.)
## DOOR AND QUARTER WINDOW MOTORS – BENCH TEST AND OVERHAUL PROCDDURES

**Rectangular Motor Disassembly (Cont(d.)**

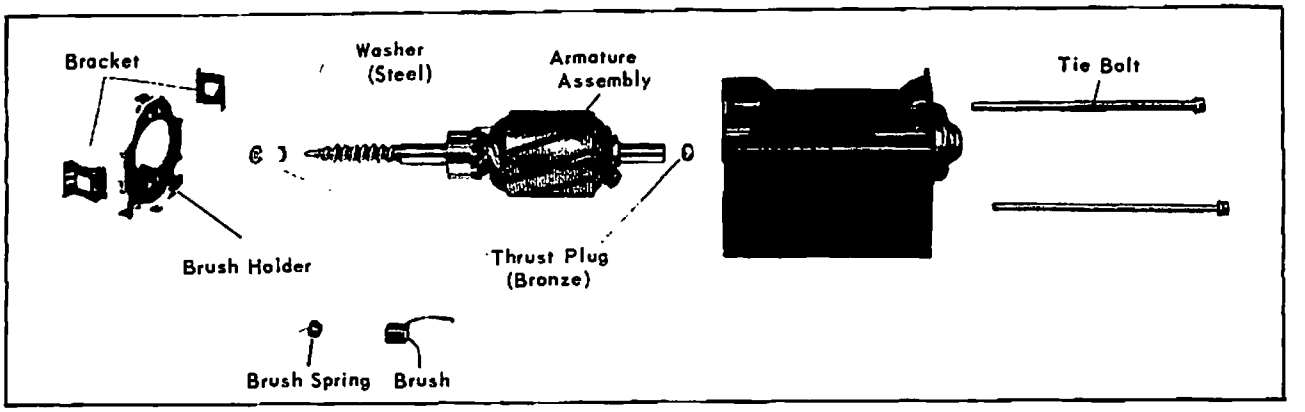



Figure 3-11

To disassemble motor section, proceed as follows:

1. Remove pinion gear assembly from gear housing.
2. Remove the two tie bolts.
3. Using a mallet tap the edge of the gear housing that butts against the frame.
4. Stand the motor upright (gear housing on top) and lift the gear housing off the armature worm. CAUTION: The thrust washer and thrust plug located on the end of the armature worm will probably be pulled off during this step. Be sure and save these parts for reassembly.
5. Maintain motor in the upright position and release the brush spring tension against the brushes as shown in Figure 3-12. Then push the brushes inside the brush holder to allow clearance for the armature commutator when armature is removed.
6. Lift brush plate assembly up over the armature worm and pull armature out of frame and field assembly.
7. To remove brush plate and circuit breaker assembly, remove brush identified as "A" in Figure 3-13 and unsolder internal field lead from circuit breaker terminal identified as "B" in Figure 3-13.

Reverse the above procedures to reassemble the motor.

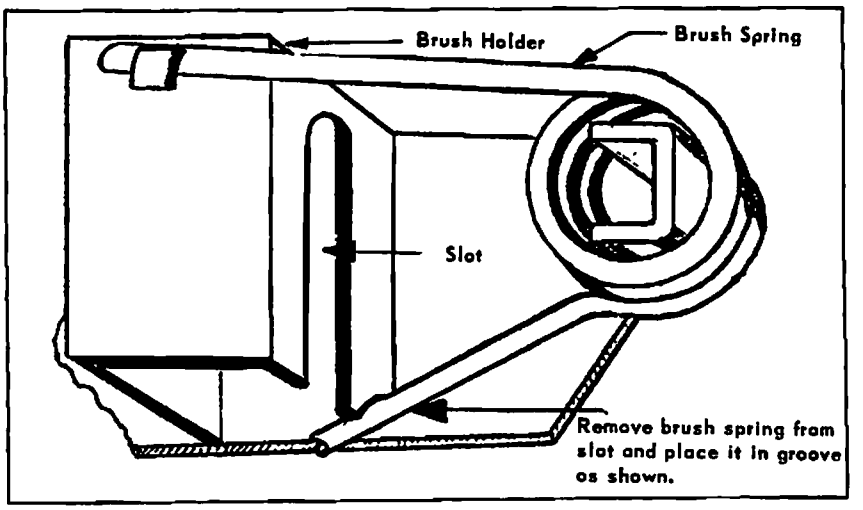



Figure 3-12

## PART I (CONT'D.)
## DOOR AND QUARTER WINDOW MOTORS - BENCH TEST AND OVERHAUL PROCEDURES

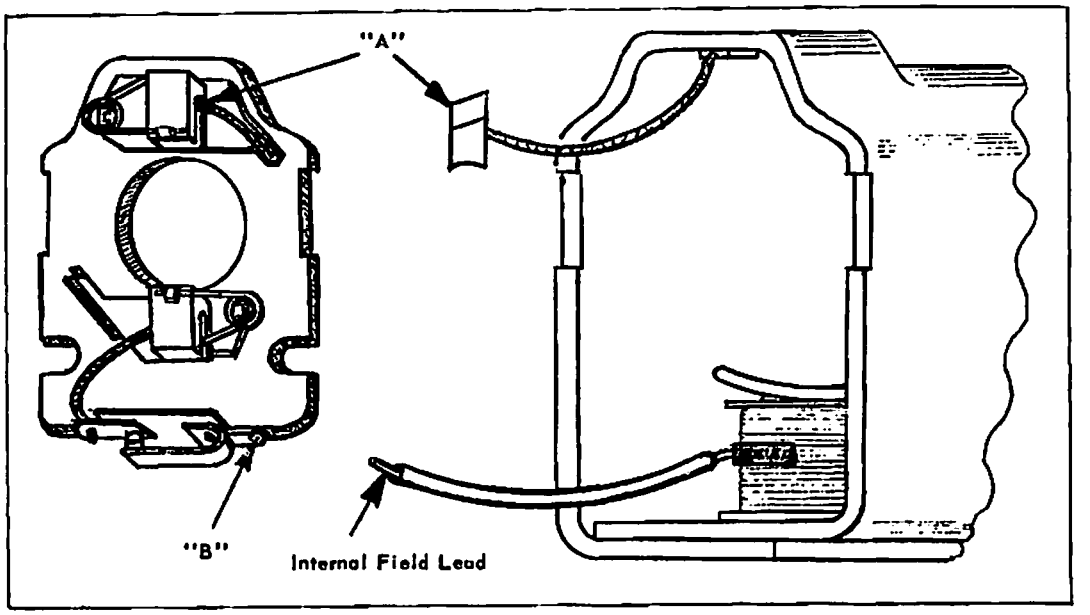



Figure 3-13

**LUBRICATION:**

1. Motor Bearings – Medium grade of machine oil.
2. Both ends of armature shaft – Dasco #2 HMP Grease Manufactured by D. A. Stuart Oil Company, Chicago, Ill.
3. Gear Box – Pack Set Screw
   – Pinion Shaft Hole in Housing
   – Nylon Gear Teeth
   – Rubber lip of "Unistress"
   – Type of gear

   Dasco No. 2 HMP Grease. Manufactured by D. A. Stuart Oil Company, Chicago, Illinois.

## PART II

### STATION WAGON TAILGATE WINDOW MOTORS

The station wagon tailgate motors are rectangular type motors very similar to the door and quarter window motors covered in Part I. In 1959-61 this type motor used a two terminal "plug in" grommet. The motor was internally grounded. In 1962 thru 65 models the use of a three terminal plug in grommet was incorporated. (See Figure 3-14) The third terminal of the plug in type grommet is used to connect the motor to ground externally. Bench testing and disassembly procedures are very similar to those covered in Part I of Section III. Figure 3-15 shows internal motor wiring for 3 terminal type of "plug in" grommet.

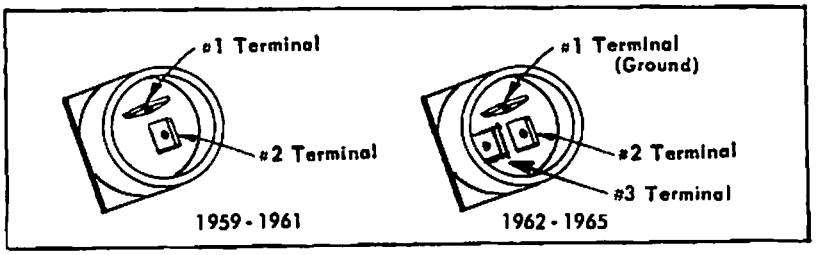



Figure 3-14

## PART III

## BENCH TEST AND OVERHAUL PROCEDURES

## VENT WINDOW MOTORS

To operate motor for bench testing proceed as follows:

(A) Determine if motor is right or left hand type. (Fig. 3-16)

(B) Refer to Figure 3-17 below. Connect an ammeter between (+) side of power source and lead to terminal indicated for desired rotation. Then connect ground (-) side of power to motor housing.

(C) Check performance against values given in performance table for both clockwise and counter clockwise rotations.

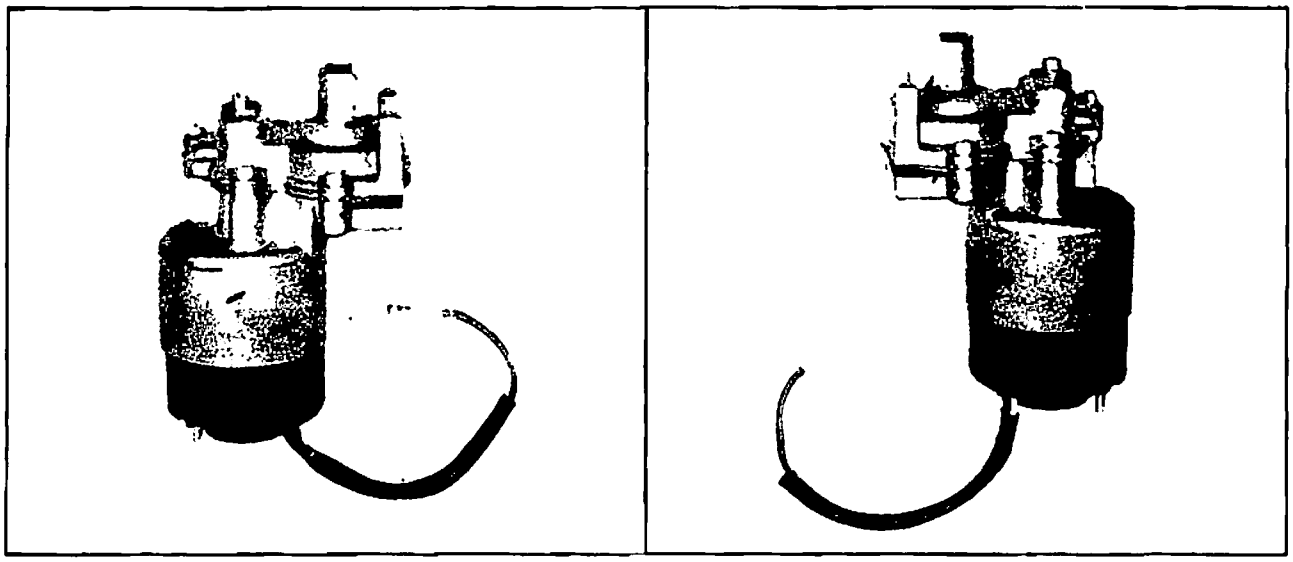


Figure 3-16

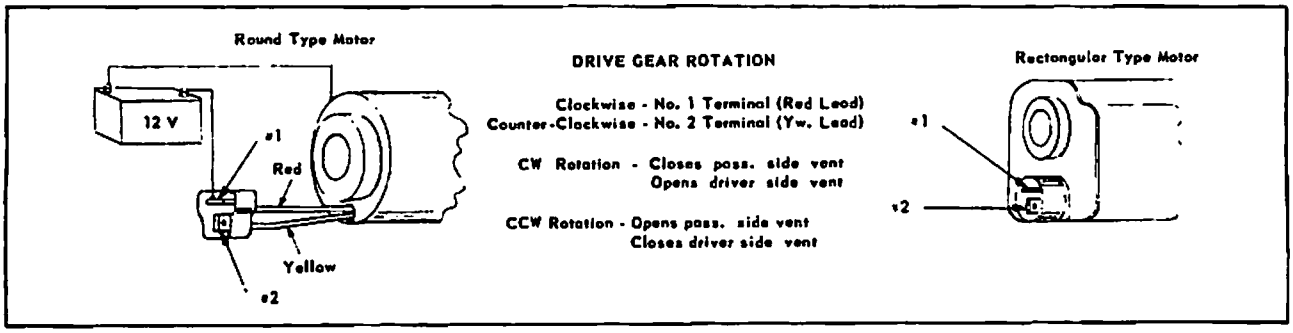



Figure 3-17

## BENCH TEST AND OVERHAUL PROCEDURES

### PART III (CONT'D.)

**PERFORMANCE DATA:**

| | |
|---|---|
| Operating Voltage | 12 VDC |
| Current Draw: | |
| Free Speed (Bench Operation) | 9–11 Amps |
| Installed in Car | 14 Amps (Max.) |
| Stall | 24 Amps (Max.) |
| Operating time to open or close Vent Windows | 2–3.5 Seconds |

**ADJUSTMENTS:**

Armature end play is the only adjustment required on vent window motors.

To adjust armature end play proceed as follows:

1. Connect up unit to operate (CW or CCW) with an ammeter in the feed wire circuit. (Figure 3-18)
2. Tighten end play adjusting screw until current draw starts to increase.
3. Back off additional 1/8 turn and tighten lock nut.

Note: For all operation bench tests install an ammeter (0-30 amps) in the feed wire circuit.

**INTERNAL WIRING:**

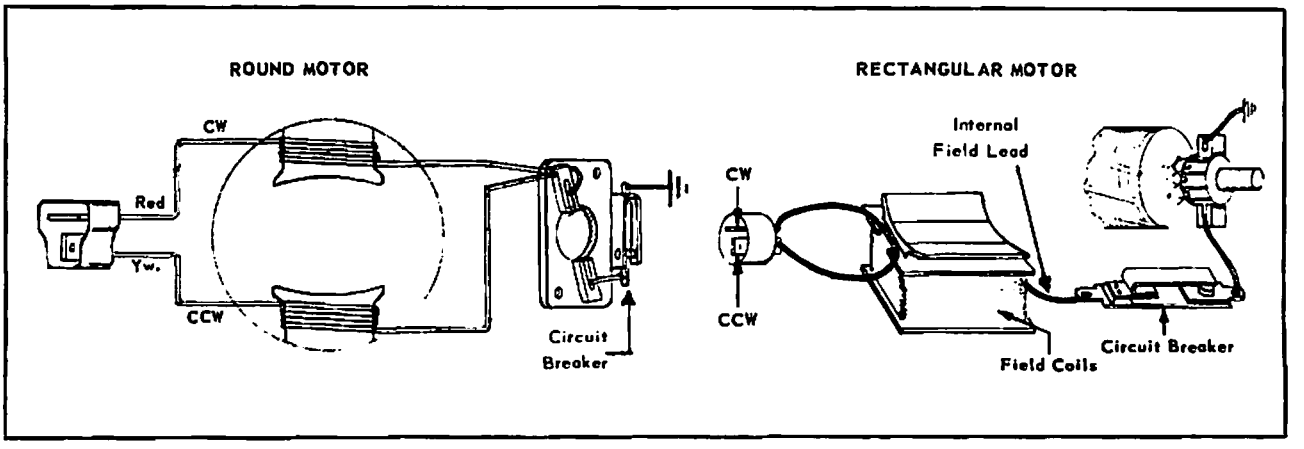



Figure 3-18

## BENCH TEST AND OVERHAUL PROCEDURES
## PART III (CONT'D.)

### ARMATURE TESTS:

1. Adjust armature end play and recheck current draw.
2. If current draw is still high, disassemble gear box and recheck current draw.
   - If current draw is normal, gear trouble is indicated.
   - If current draw is above normal, proceed to Step 3.
3. Disassemble motor and check armature as explained in Section 3, Page 1.
   CAUTION: DO NOT check armatures on a growler.

### FIELD ASSEMBLY TEST:

Note: Visually inspect all solder connections and leads for breaks or frayed insulation.

Grounded – Refer to Figure 3-19

(a) Disassemble motor section as necessary to gain access to the brush plate and circuit breaker assembly and insert a thin piece of cardboard between the circuit breaker contacts

(b) Using a 110 Volt AC test light touch one prod to #1 terminal and touch the other prod to the field lamina. If lamp lights, the field is grounded.

Open – Refer to Figure 3-19

(a) Disassemble motor as necessary to gain access to the brush plate and circuit breaker assembly.

(b) Using a 110 Volt AC test light touch one prod first to the #1 terminal and touch the other prod to the brush holder (round motor) or circuit breaker terminal (rectangular motor) where field coil leads are attached. Repeat this step with the #2 terminal. If lamp fails to light, an open field coil is indicated.

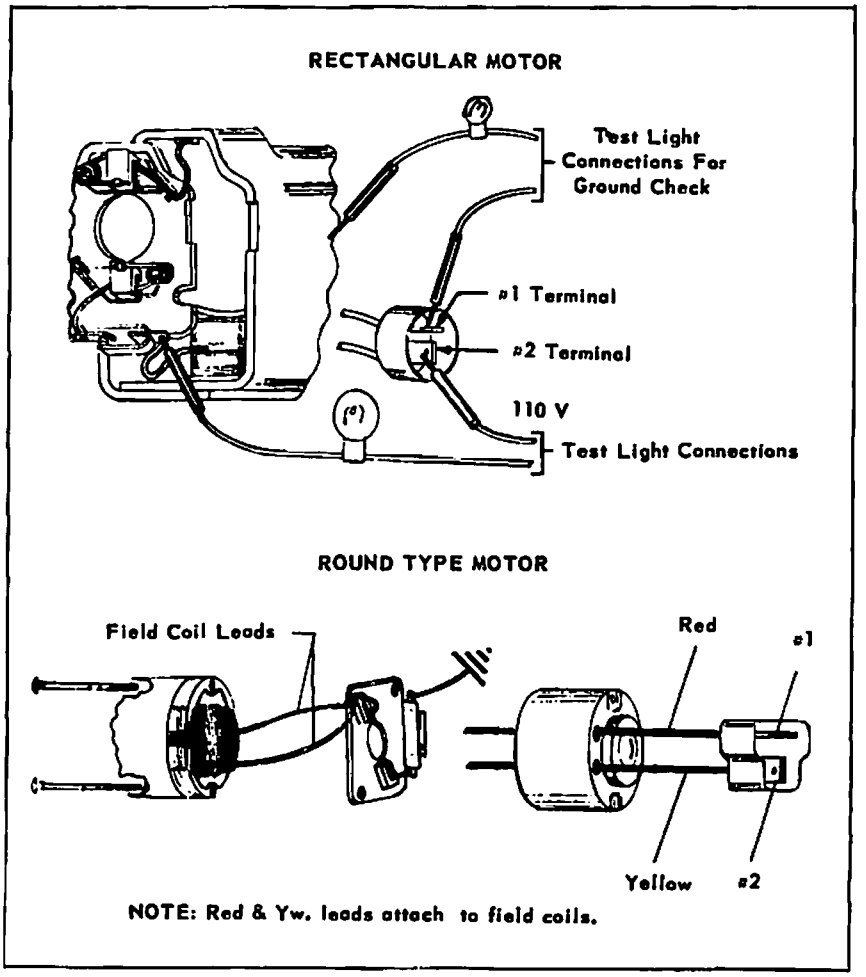



Figure 3-19

Shorted

Visually check for shorted field coils. Usually when a shorted condition exists, some of the coil turns will turn very dark.

## BENCH TEST AND OVERHAUL PROCEDURES
## PART III (CONT'D.)

### BRUSH ASSEMBLY AND RELATED WIRING INSPECTION

Check the following:

(a) Brushes slide freely in the brush holders.
(b) Brush springs not broken or damaged; positioned properly in rectangular type motors.
(c) All solder connections
(d) Circuit Breaker contacts are clean and closed.

### DISASSEMBLY – ASSEMBLY PROCEDURE:

CAUTION: Be sure to re-seal the units after any disassembly.

### GEAR BOX (REFER TO FIG. 3–20)

1. Remove the four screws that secure the upper half of the gear housing to the lower half and carefully remove the upper housing and drive gear as an assembly..
2. To remove drive gear from upper housing, carefully slide seal off drive gear shaft.
3. Lift nylon gear and worm shaft out of lower half of housing and slide the bearings off the shaft ends.

To reassemble gear box, reverse Steps 1 through 3.

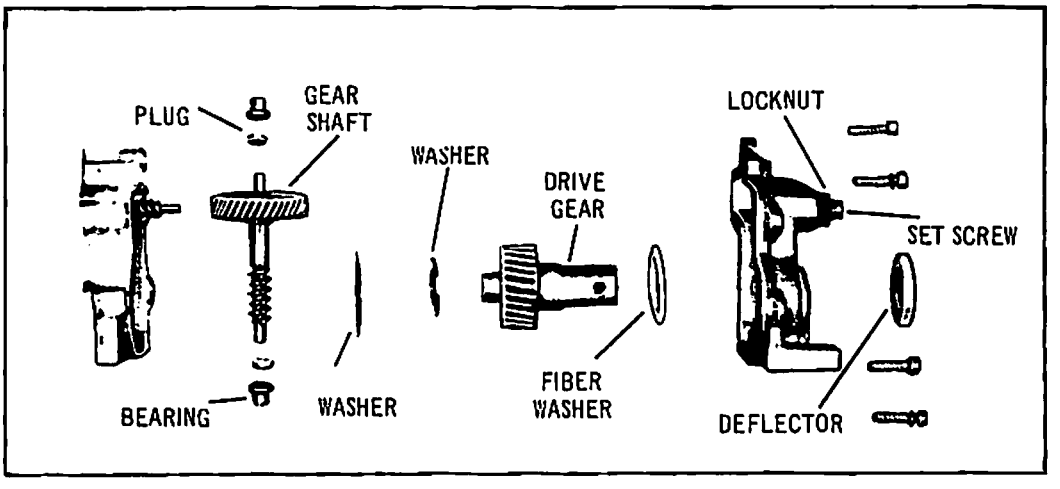



Figure 3-20

### MOTOR DISASSEMBLY ROUND TYPE MOTOR (REFER TO FIG. 3–21)

## BENCH TEST AND OVERHAUL PROCEDURES

## PART III (CONT'D.)

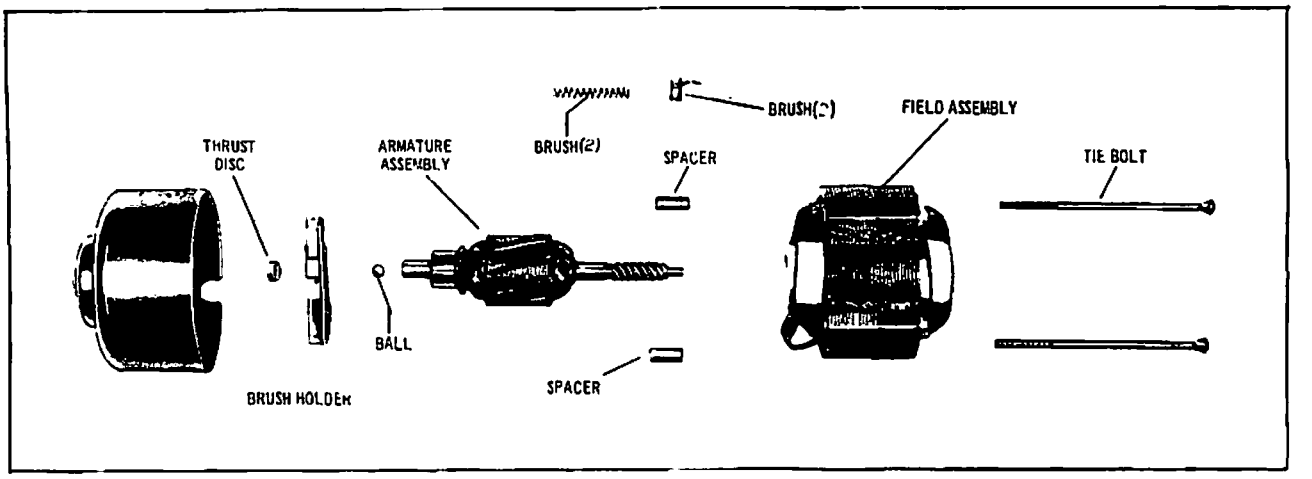



Figure 3-21

1. Disassemble gear box.
2. Remove tie bolt nuts and slide motor case back until it clears the armature shaft and the brush plate assembly.
3. Insert a "U"shaped brush retainer clip between the brushes. This will retain the brushes and brush springs in their respective holders while the armature is being removed..
4. Scribe a line along the side of housing and exposed field lamina to insure correct re-assembly.
5. Remove the nuts and washers that secure the brush plate and field assembly and slide the tie bolts out of the housing. Be careful not to lose the brush plate spacers.
6. Lift field and brush plate out of housing as an assembly.
7. To separate brush plate from field assembly unsolder field leads from brush holder.
8. Slide armature out of housing.

To reassemble motor reverse Steps 1 through 8.

## MOTOR DISASSEMBLY RECTANGULAR TYPE (REFER TO FIG. 3–22)

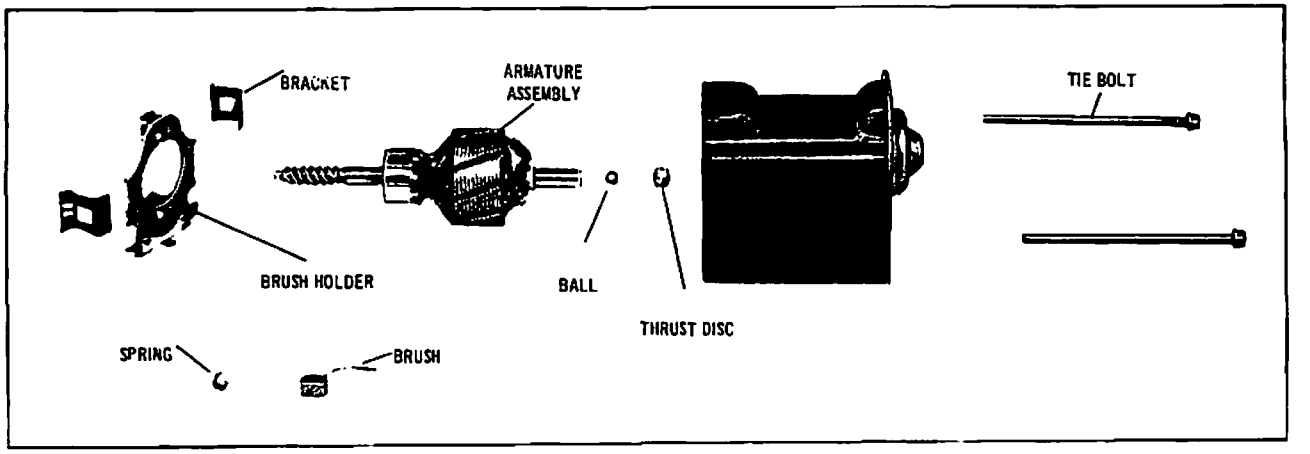



Figure 3-22

1. Disassemble gear box.
2. Remove tie bolts and lift gear box housing off worm shaft of armature.

## BENCH TEST AND OVERHAUL PROCEDURES
## PART III (CONT'D.)

3. Position brush springs in disassembly position as shown in Figure 3–23.
4. Lift brush plate assembly out of housing until it clears the armature worm.
5. Remove grounded brush from brush holder.
6. Lift armature out of frame and field assembly.
   CAUTION: The thrust plate may be stuck to the end of the armature shaft. Save this part for reassembly.
7. To separate brush plate from frame and field assembly, unsolder the field lead that attaches to the circuit breaker terminal. (Figure 3–24)
   NOTE: Re–use brush plate mounting brackets when replacing brush plate and circuit breaker.

TO ASSEMBLE MOTOR REVERSE STEPS 1 THRU 7

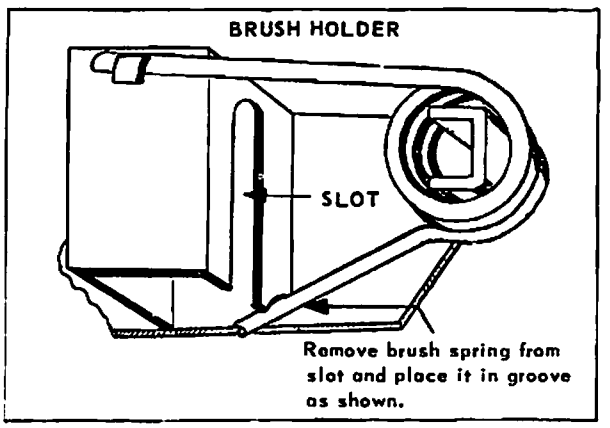



Figure 3-23

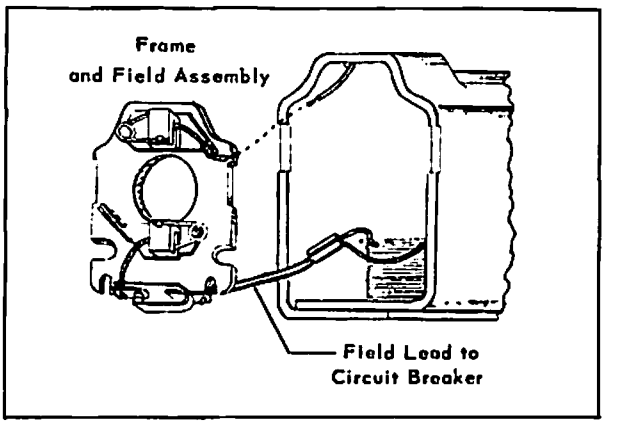



Figure 3-24

**LUBRICATION:**

| | |
|---|---|
| Armature shaft and bearings | Light Grade Machine Oil |
| Nylon gear and worm shaft | HMP Delco Remy Cam and Ball Grease |
| Drive gear | HMP Delco Remy Cam and Ball Grease |

## PART IV

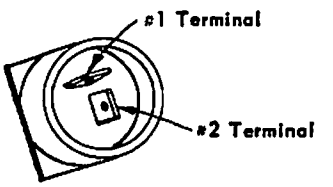
## CENTER PARTITION WINDOW MOTORS
## BENCH TEST AND OVERHAUL PROCEDURES

To operate motor for bench testing proceed as follows:

(A) Connect an ammeter between (+) side of power source and lead to terminal indicated for desired rotation. Then connect ground (-) side of power source to motor black lead. (Refer to Fig. 3–25)

(B) Check performance against values given in table for clockwise and oounter clockwise rotation.

1. Using an ammeter in the feed wire circuit connect power source to motor leads or terminals shown in the chart below.




| Motor No. | To Extend Unit * | | To Retract Unit ** | |
|---|---|---|---|---|
| | Hot Lead | Ground Lead | Hot Lead | Ground Lead |
| 5047757 | Red | Black | Yellow | Black |
| 5047954 | #1 Terminal | Black | #2 Terminal | Black |
| 5044325 | #1 Terminal | Black | #2 Terminal | Black |

* Jackscrew Rotation **CLOCKWISE** looking at tube end.
**Jackscrew Rotation **COUNTER-CLOCKWISE** looking at tube end.

2. Check performance against data shown in the following chart.

Figure 3-25

**PERFORMANCE DATA:**

Applied Voltage . . . . . .10.5-12 DC

Current Draw:
(a) Operating in Car. . . . . .18 Amps Max.
(b) Free Speed (Bench) . . . . . .12 Amps Max.
(c) Stall . . . . . .45 Amps Max.

Jackscrew Speed (RPM's) . . . . . .

## PART IV (CONT'D.)

## BENCH TEST AND OVERHAUL PROCEDURES

### ADJUSTMENTS:

The only adjustment required is armature end play. To adjust end play proceed as follows:

1. Loosen armature adjusting screw locknut.
2. Tighten adjusting screw until finger tight. Then back off screw 1/8 turn and tighten locknut. (End play should not exceed .015".)

### INSPECTION AND TEST PROCEDURES:

The following tests are based on the assumption that the repairman has tried to operate the motor and has found it inoperative or not meeting the performance specifications and has disassembled the motor.

### ARMATURE TESTS:

| | | |
|---|---|---|
| Open | – | See Section 3, Page 1 |
| Grounded | – | See Section 3, Page 1 |
| Shorted | – | Check armature on a growler |

**FIELD ASSEMBLY TESTS:** Refer to Figure 3-26

**NOTE:** Visually inspect all solder connections and leads for breaks or frayed insulation.

Ground Test: Using a test light, check individually between feed wire terminals and field lamina. (Note: Be sure steel case is isolated from field lamina and housing). If lamp lights, a grounded field is indicated.

Open Test: Connect a test light between terminal #1 or red lead terminal and the internal field lead that connects to the brush holder. Next connect test light between #2 terminal and the internal field lead. If lamp fails to light in either case, an open field is indicated. Check splice joint at internal field lead connection to field coils.

Shorted: Shorted fields usually cause a motor to draw excessive current and run slow. This, in turn causes the motor to overheat with the result that some of the turns of field coils turn black or very dark in color.

## BENCH TEST AND OVERHAUL PROCEDURES

## PART IV (CONT'D.)

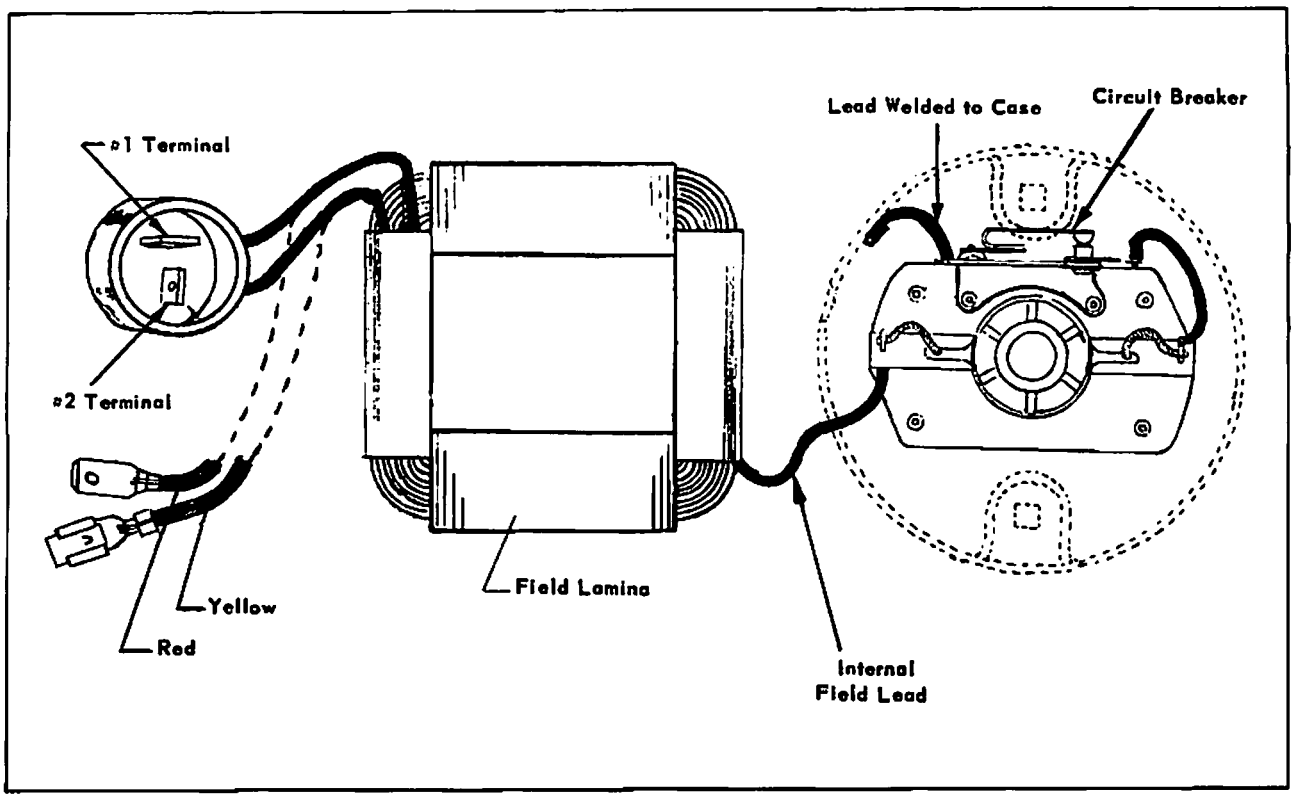



Figure 3-26

### BRUSH ASSEMBLY AND RELATED WIRING INSPECTION

Check the following items:

(a) Brushes slide freely in the brush holders.
(b) Brush springs are not broken or damaged.
(c) All solder connections.
(d) Circuit breaker contacts are not burnt and are properly closed.
(e) Be sure the thrust plug is not damaged and is properly located in the bearing.

### DISASSEMBLY AND ASSEMBLY PROCEDURE:

NOTE: The motor section of these units may be disassembled independently of the gear box or vice versa.

## BENCH TEST AND OVERHAUL PROCEDURES
## PART IV (CONT'D.)

The following steps should be observed when disassembling the motor section. (Refer to Fig. 3-28.

1. Remove tie bolts.
2. Partially loosen the motor case from the field. (Striking the case with a suitable mallet should accomplish this.)
3. The case assembly with the armature still assembled in it should be slowly backed away from the field and housing until completely free from the gear box. To keep the armature in position in the case assembly screw the nut and tube assembly toward the outer end of the jackscrew then turn the jackscrew counter-clockwise. This will apply pressure on the armature in the direction of the case assembly.
4. Remove the armature from the case assembly as follows:
   (a) Hold the brushes in position in the brush holder by inserting the points of a tool such as tweezers with the points spread apart, into the brush pigtails at the point of their entry into the brushes.
   (b) Carefully lift out the armature and place a "U" shaped spring, part number 5096576 between the brushes. (Be sure to remove this spring after reassembly of armature in the case.)
   (c) If necessary, remove the armature thrust plug from the case assembly bearing.
5. To completely free the case assembly from the motor, simply unsolder the internal field lead which is connected to the brush holder. (Fig. 3-26.)
6. Removal of the field assembly without doing any damage is somewhat more difficult because it has been forced into the housing under light pressure. A thorough check of the field to determine whether or not it is defective should be made before any attempt at removal is made.

If it is found necessary to replace the field, clamp in a vise that part of the field lamina that extends out of the housing, then wedge the housing off the field using a couple of heavy duty screwdrivers.

### GEAR BOX DISASSEMBLY:

(Refer to Fig. 3-27)

1. Remove the 4 cover attaching screws.
2. Remove the jackscrew nut and lock washer.
3. Remove the ball bearing assembly, spacer, gear, key in the order indicated and slide the jackscrew shaft out of the gear box.

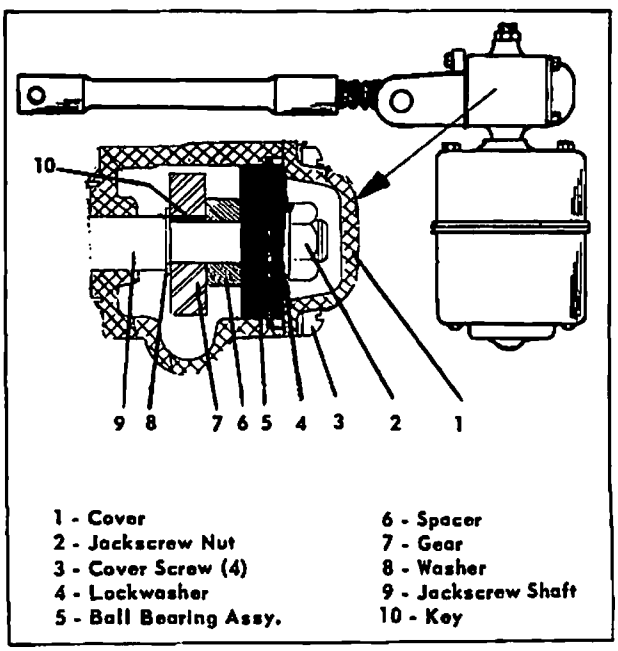
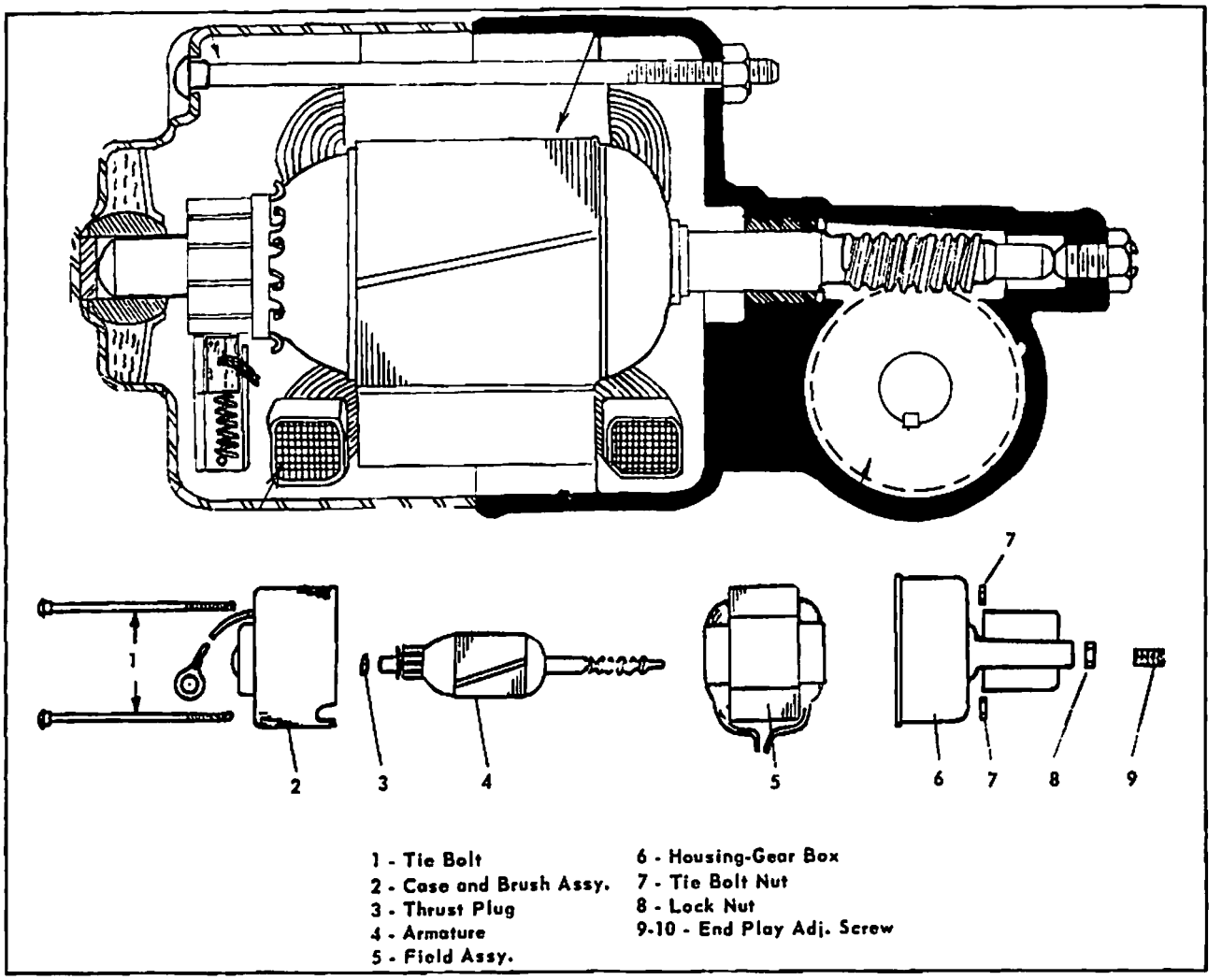



Figure 3-27

## BENCH TEST AND OVERHAUL PROCEDURES
## PART IV (CONT'D.)




1 - Tie Bolt
2 - Case and Brush Assy.
3 - Thrust Plug
4 - Armature
5 - Field Assy.
6 - Housing-Gear Box
7 - Tie Bolt Nut
8 - Lock Nut
9-10 - End Play Adj. Screw

Figure 3-28

**LUBRICATION:**

Motor

| | |
|---|---|
| Both ends of armature shaft | – Light Grade of Machine Oil |
| Housing Bearing | – Light Grade of Machine Oil |

Gear Box

| | |
|---|---|
| Gear Teeth | – Delco Cam and Ball Grease |
| Jackscrew Threads | – Delco Cam and Ball Grease |
| Jackscrew Bearing Surfaces | – Delco Cam and Ball Grease |

## PART V

### AMERICAN MOTORS, CHRYSLER, FORD, PACKARD MOTOR CAR CORP

### BENCH TEST AND OVERHAUL PROCEDURES

When bench testing motors for manufacturers other than G. M., we recommend that all information such as wiring diagrams and circuits be obtained from auto manufacturer's manuals.

Listed below are type of motor windings and lead connections to operate motors.

A – AMERICAN MOTORS TYPE (Figure 3-29) Mtr. Nos. 5047839 – 5047840 6 VOLT

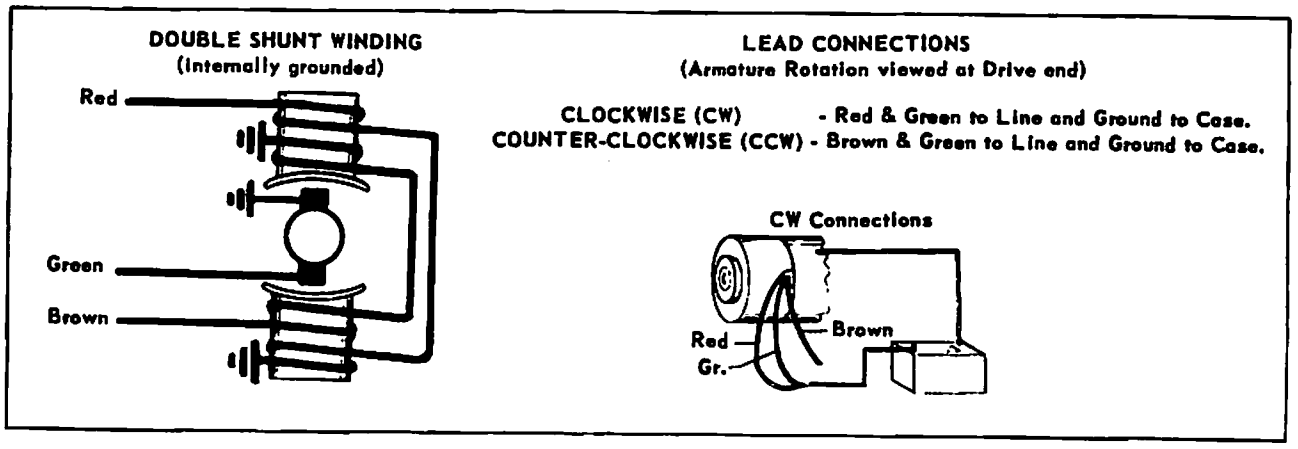



Figure 3-29

B – CHRYSLER CORP. TYPES (Figure 3-30 – Motors 5044292 – 293 – 354) 12 VOLT
(Figure 3-31 – Motors 5044391 – 5044420) 12 VOLT

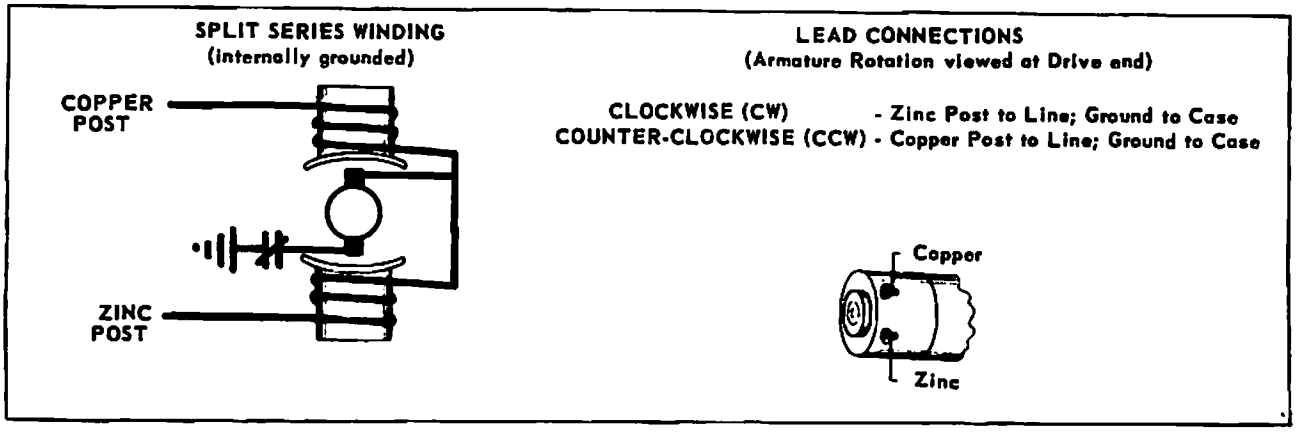



Figure 3-30

## BENCH TEST AND OVERHAUL PROCEDURES
## PART V (CONT'D.)

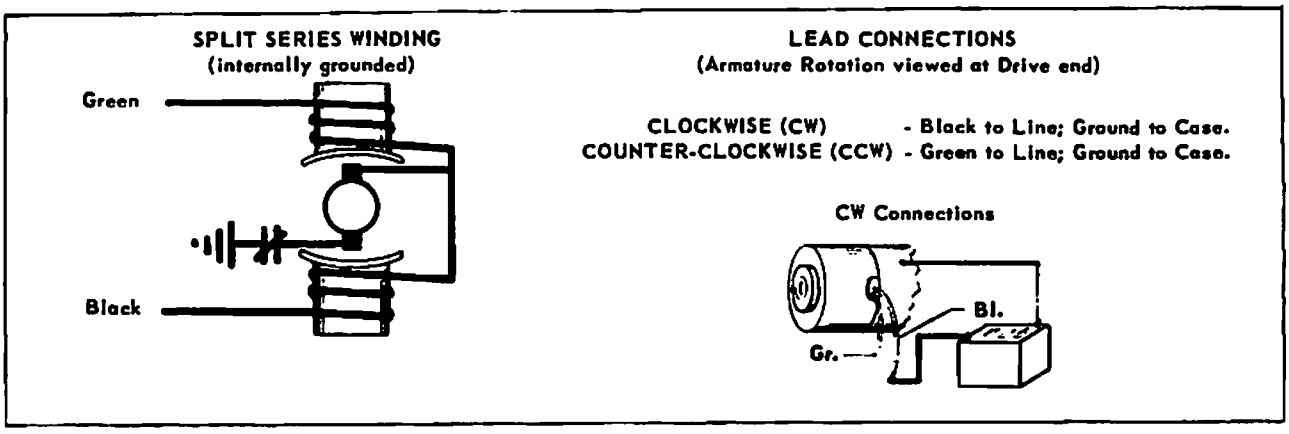



Figure 3-31

C – FORD MOTOR CO. TYPES (Figure 3-32 – Motor Nos. 5047749 – 5047750 – 5047762 – 6 VOLT)
(Figure 3-33 – Motor Nos. 5047846 – 6 VOLT)
(Figure 3-33 – Motor Nos. 5047859, 5047847 – 848 – 862 – 863 – 12 VOLT)

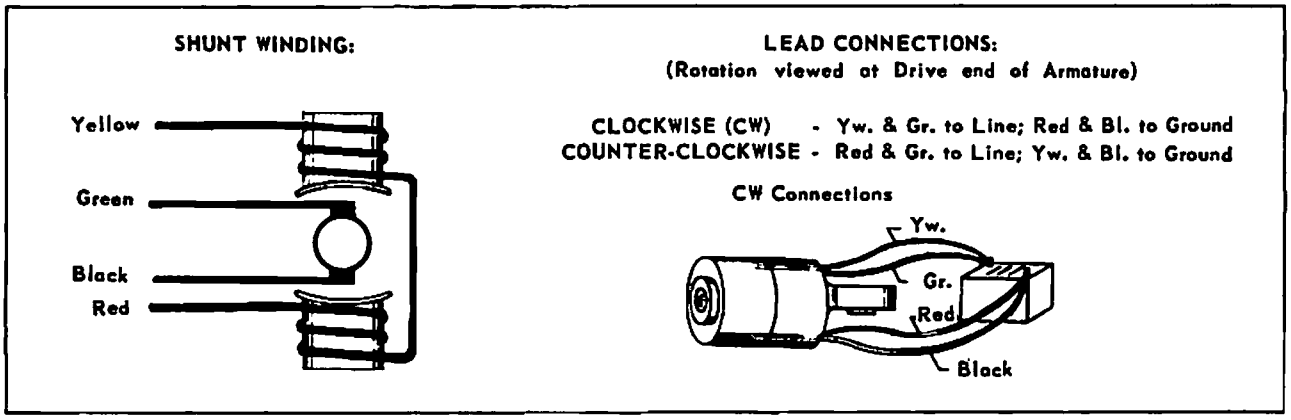



Figure 3-32

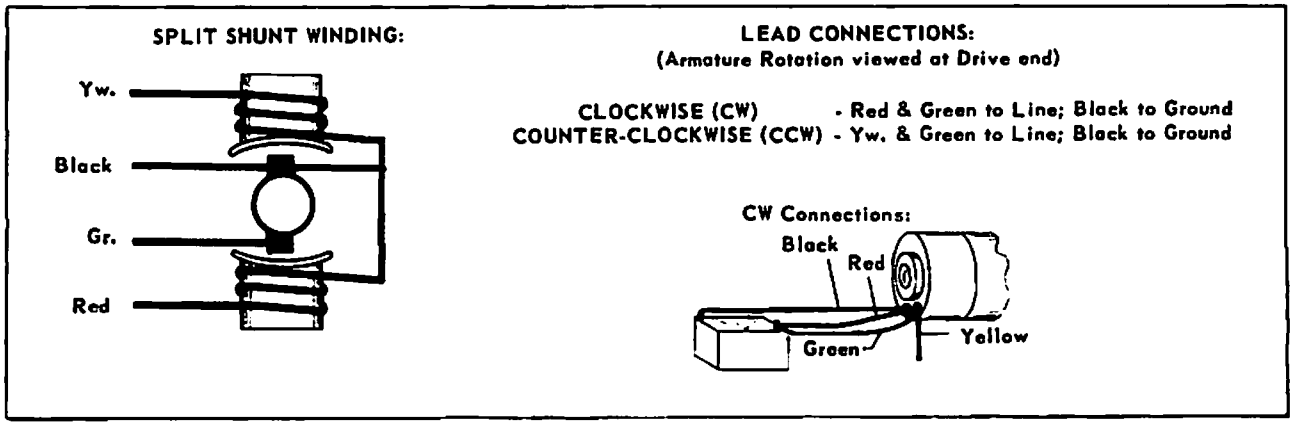



Figure 3-33

## BENCH TEST AND OVERHAUL PROCEDURES
## PART V (CONT'D.)

D – PACKARD MOTOR CO. TYPES (Figure 3-34 – Motor Nos. 5047817 – 5047818 – 6 VOLT)

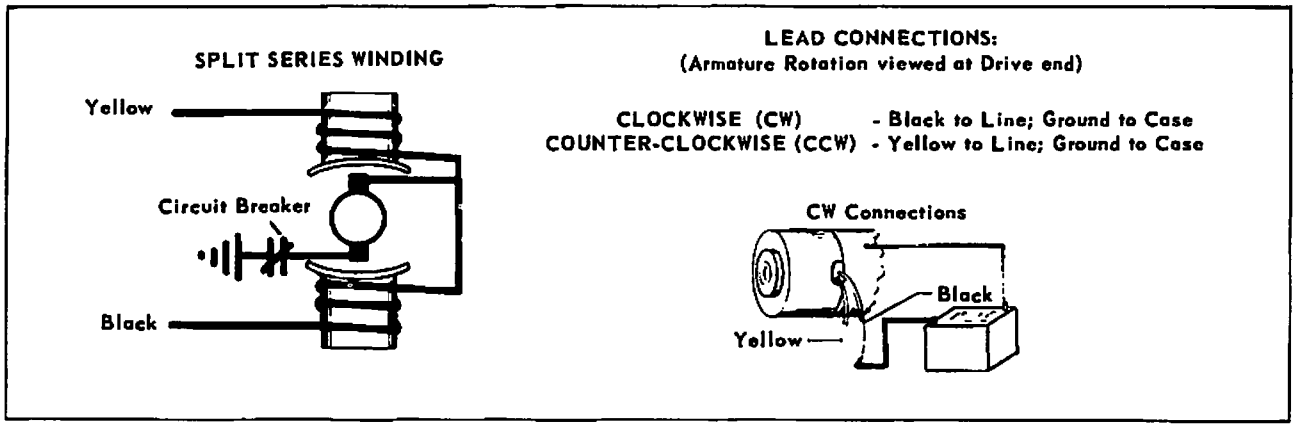



Figure 3-34

### PERFORMANCE DATA:

| MOTOR NO. | OPERATING VOLTAGE | CURRENT DRAW (MAX.) (FREE SPEED) | CURRENT DRAW (STALL) (MAX.) |
|---|---|---|---|
| 5044292 | 12 | 12 | 32 |
| 5044293 | 12 | 20 | 62 |
| 5044354 | 12 | 20 | 55 |
| 5044391 | 12 | 14 | 42 |
| 5044420 | 12 | 14 | 42 |
| 5047749 | 6 | 18 | 115 |
| 5047750 | 6 | 18 | 115 |
| 5047762 | 6 | 16 | 115 |
| 5047817 | 12 | 14 | 45 |
| 5047818 | 12 | 14 | 45 |
| 5047839 | 6 | 18 | 125 |
| 5047840 | 6 | 18 | 125 |
| 5047846 | 6 | 20 | 115 |
| 5047847 | 12 | 12 | 65 |
| 5047848 | 12 | 12 | 65 |
| 5047859 | 12 | 10 | 40 |
| 5047862 | 12 | 4 | 9 |
| 5047863 | 12 | 4 | 9 |

## BENCH TEST AND OVERHAUL PROCEDURES
## PART V (CONT'D.)

### CONSTRUCTION OF MOTORS:

The general construction of window lift motors 5047749 – 750, 5047817 – 818, 5047839 – 840, 5047847 – 848, 5047862 – 863 is very similar to that shown in Figure 3-28, Section 3, Page 19.

The construction of motors 5047762, 5047846, 5047859 is shown in Figure 3-35.

The general construction of motors 5044292 – 293, 5044354, 5044391 and 5044420 is very similar to that shown in Figure 3-35 except that the armature has a thrust ball located in the commutator end of the armature shaft as shown in Figure 3-36.

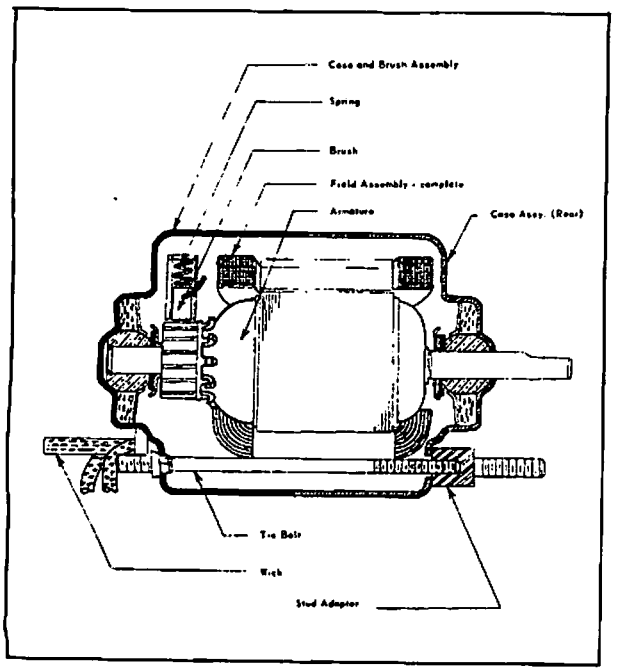



Figure 3-35

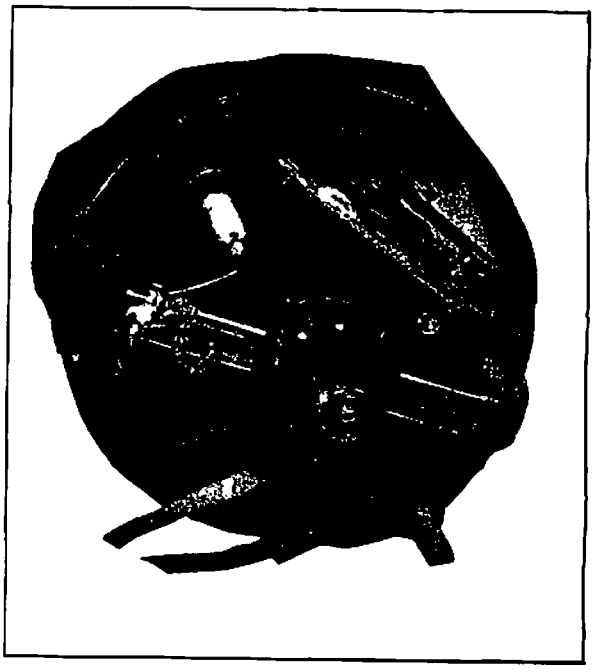


Figure 3-36