

# MOTORS AND GENERATORS

## Customer Engineering Reference Manual

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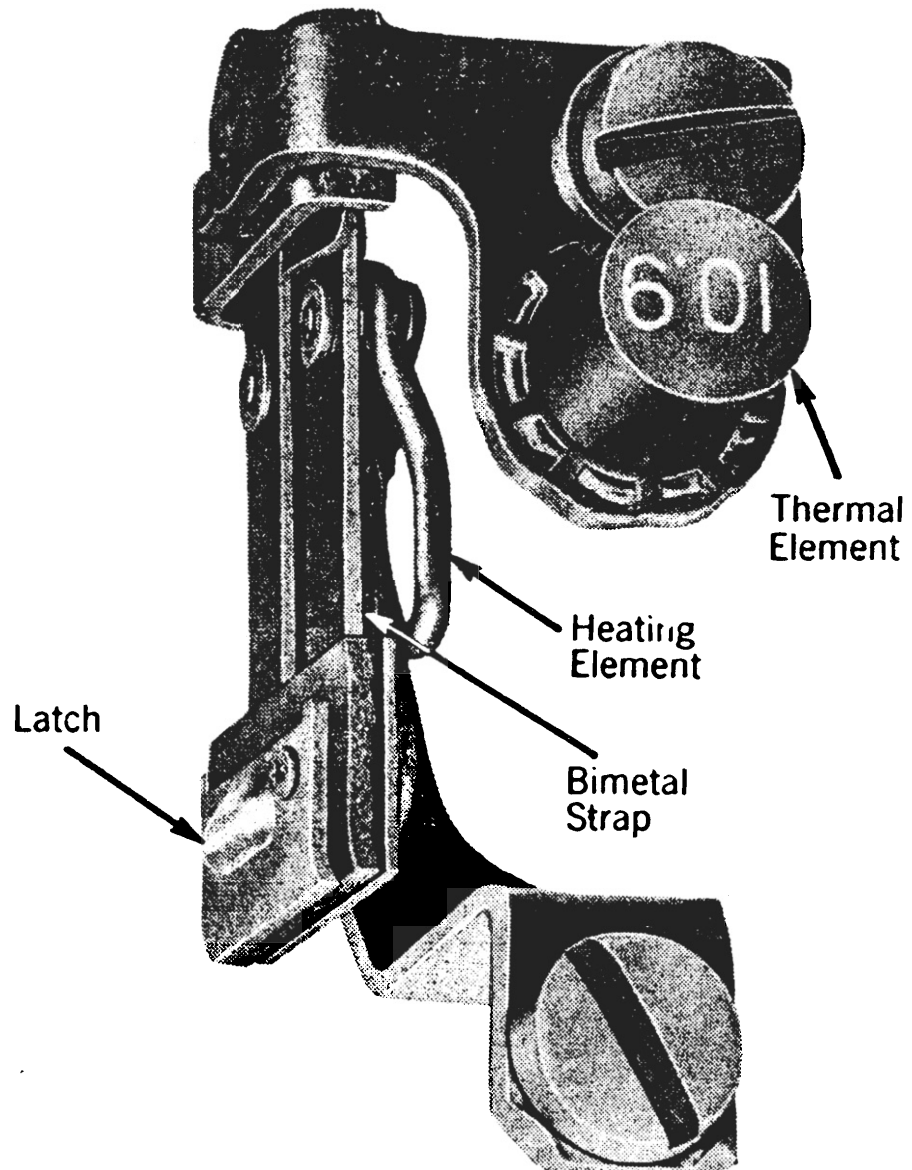
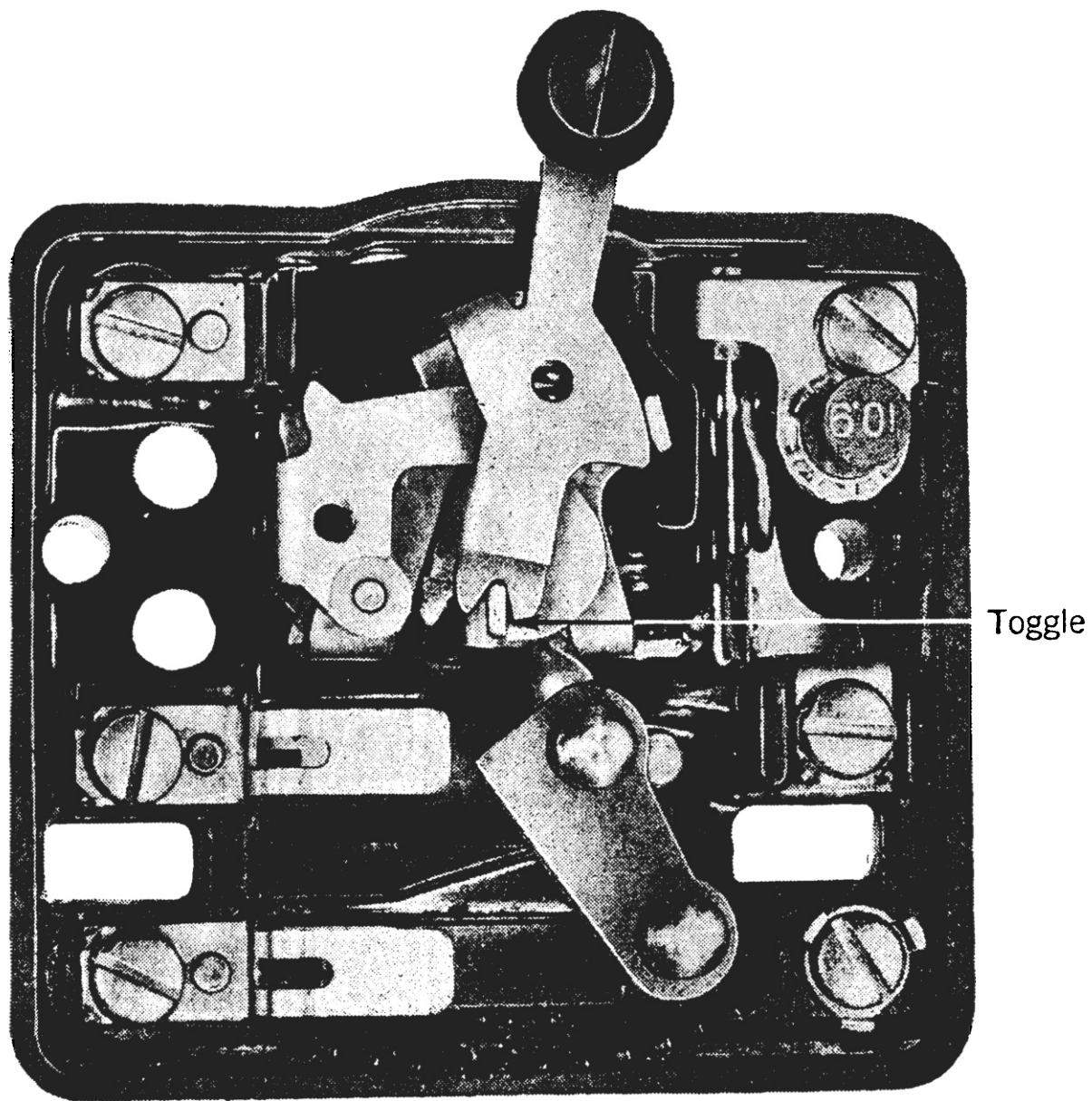


Figure 1. Sentinel Breaker Switch

# MOTORS AND GENERATORS

## GENERAL INFORMATION

Motors and generators play an important part in the operation of IBM Accounting Machines by providing independent operation for each machine unit. With the emphasis upon machines capable of independent operation, each machine is equipped with a drive motor and in many cases with a motor-generator set. Many sizes of fractional and full horsepower motors are used. These motors are furnished on all machines to conform with the voltage, frequency, and phase specifications.

To maintain these units properly, the customer engineer should concentrate his efforts primarily on the following items: starting switches, capacitors, commutators and brushes, and bearings. It is not practical for the customer engineer to undertake such jobs as rewinding an armature or field coil.

### Sentinel Breaker Switch — Figure 1

All motors are protected by sentinel breaker switches. These switches differ from a standard toggle switch in that they automatically throw the switch to OFF or the open circuit position when an overload occurs.

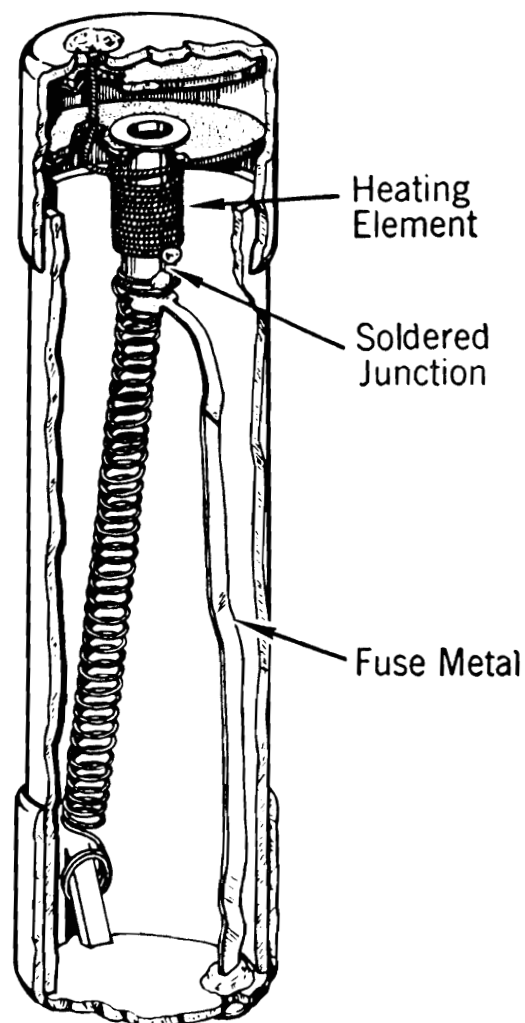
The overload sensing element serves as a latch for the fulcrum of the toggle. This sensing element is made of two strips of metal bonded together. The two metals expand at different rates when heated and cause the bimetal strap to bend. The heating element is made of resistance wire and is mounted alongside the bimetal strap.

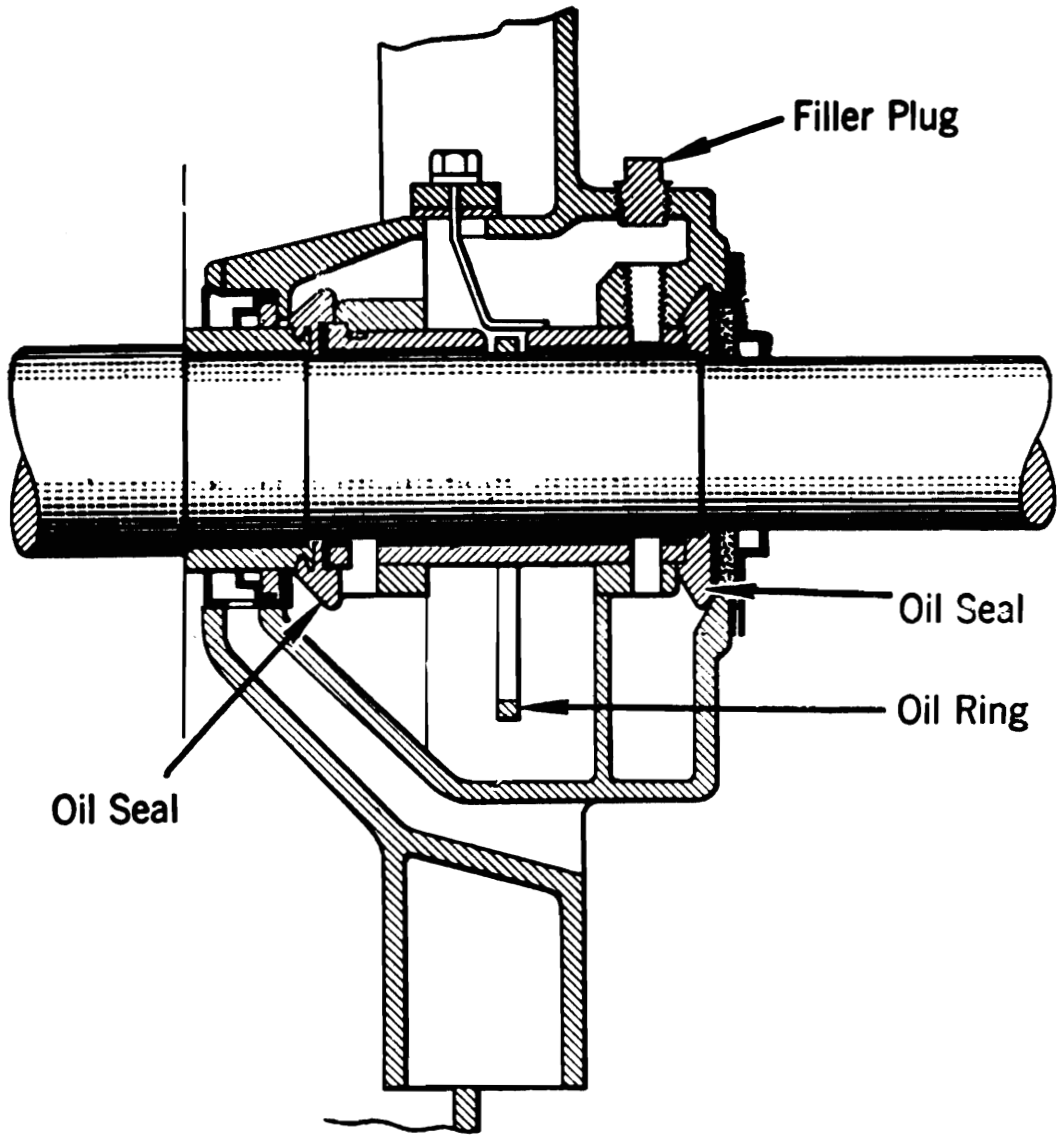
When the machine draws an overload for a time the bimetal strap becomes heated and bends, thus removing the latch from beneath the toggle fulcrum and allowing the switch to snap to the OFF or open circuit position by spring tension. The thermal elements are interchangeable and an element should be used which is rated slightly over the full load current of the motor that the switch controls. Some motors draw a much heavier current when starting than the rated current under full load. However, the starting current is drawn for such a short time that the sentinel breaker does not trip. If, however, the motor does not get up to speed within a short period of time, the sentinel breaker will trip and open the circuit. Sufficient time must be allowed for the thermal element to cool before the switch can be reset.

To restore the sentinel breaker switch to its operative position, move the lever to the extreme OFF position to relatch the toggle fulcrum. The switch may then be turned ON.

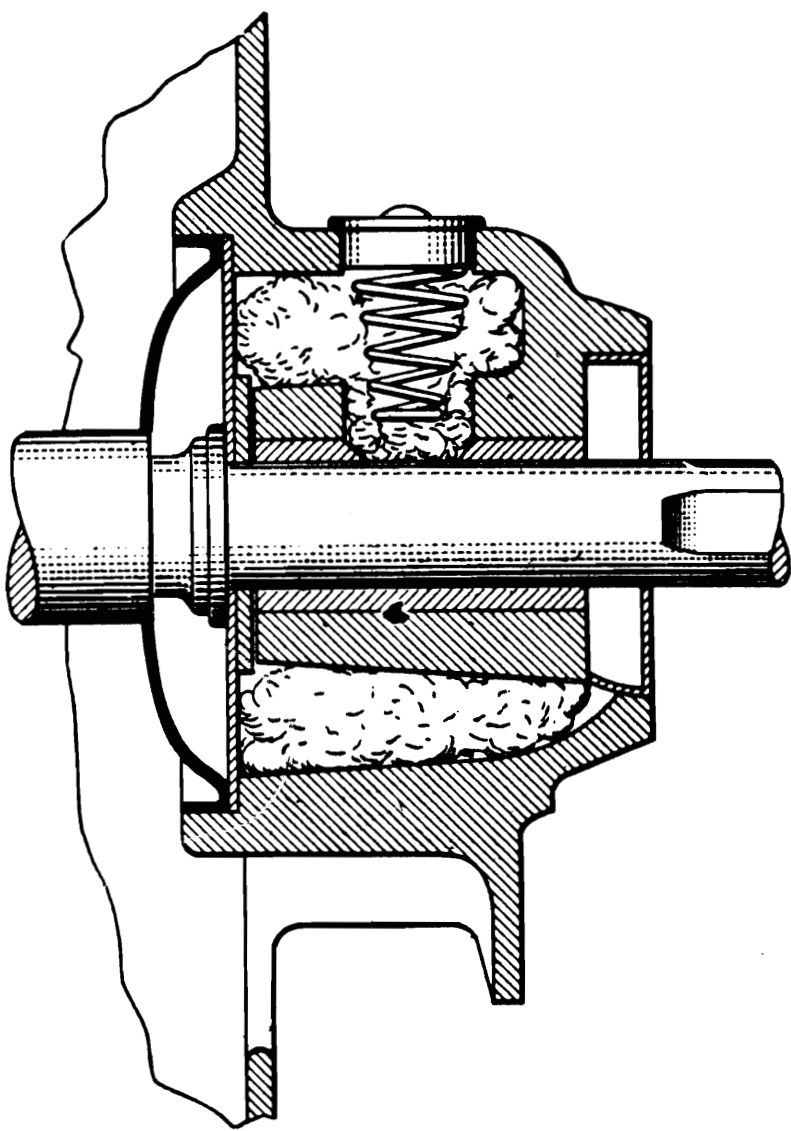
### Thermal Fuses (Fusetrons)

For some types of loads, fuses do not provide satisfactory overload protection for the equipment. An example of this is motors. A  $\frac{1}{4}$  horsepower motor which has a full load running current of about 5 amperes may require as much as 20 amperes starting current. A fuse rating of at least 15 amperes is required for starting. A 15 ampere fuse, however, would permit the motor to be seriously overloaded continuously without approaching the point where the fuse link melts. For protecting motors, then, some type of thermal fuse is desirable. This fuse will accommodate large overloads for short durations, but will blow at a small overload when subjected to it for a longer period. The construction of a thermal fuse is illustrated by Figure 2.

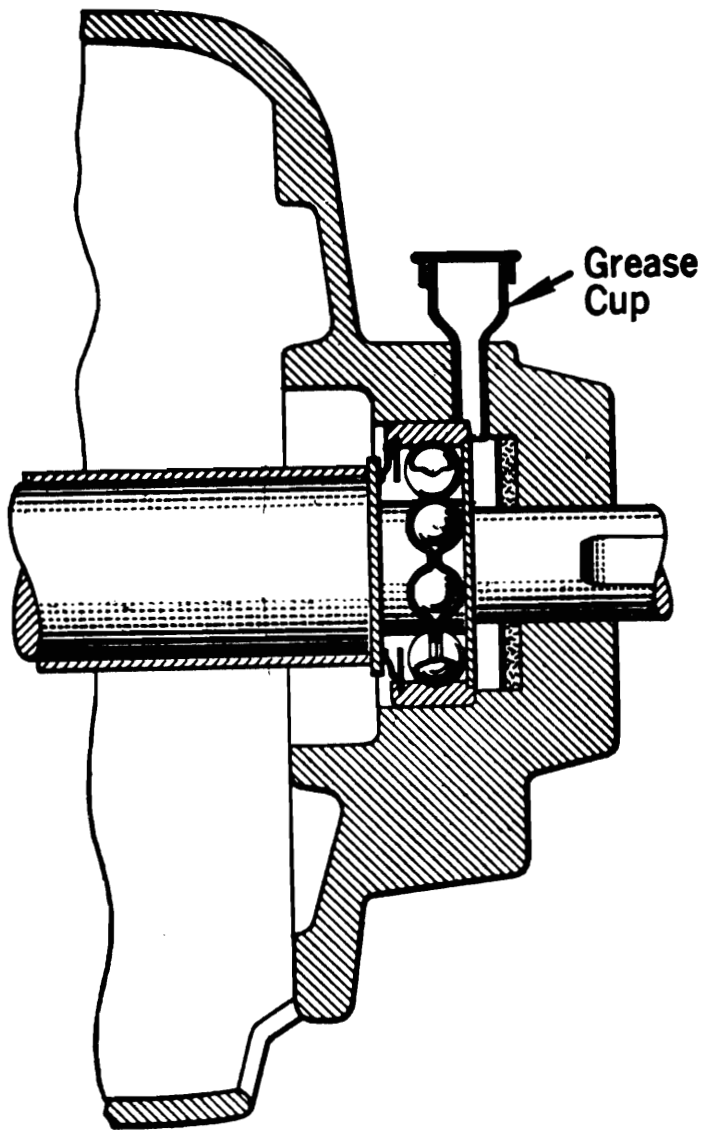




*Sealed sleeve bronze bearing*



*Wool packed bronze bearing*



*Ball bearing*

**Figure 3. Bearings**



In case of a direct short circuit, the fuse link blows as in a common fuse, and when subjected to a steady overload the heater unit gradually heats the soldered junction until the spring pulls loose the fuse link, thus opening the circuit.

## Bearings

Two general types of bearings are used in motors; ball bearings and bronze sleeve bearings, (Figures 3A, 3B and 3C). The ball bearings are pressed on the rotor shaft. If these bearings are kept properly lubricated, they should seldom require replacement. However, if it is necessary to replace a ball bearing, and if a press is available, the bearing may be replaced in the field.

The bronze sleeve bearings require line reaming. Since such facilities are not generally available, it is not advisable for the customer engineer to replace this type of bearing.

## Lubrication

Proper lubrication and cleaning provide the best preventive maintenance. Lubrication is generally provided by one of two methods, either wool packed oil cups or grease cups.

Motors with ball bearings are provided with grease cups or removable bearing caps closed with pipe plugs. One full turn of each cup is recommended for each 2 to 6 months of normal operation eight hours per day. The manufacturer's notice on the motor will indicate what the period should be. The grease in the bearing caps equipped with pipe plugs (Figure 16) should be renewed every two years.

Motors with bronze sleeve bearings are provided with oil cups or ball closing type oil wells. Four drops of IBM lubricant 9 in each end bearing cup per month for machines under a normal eight-hour day operation is recommended. A little oil regularly each month is preferable to a larger amount at the end of a longer period. In any case a motor should never have more than 30 drops of oil in each bearing cup for each 1,000 hours of use.

*Too much lubricant is as bad as too little.* Excessive lubricant will travel along the rotor shaft and gather on the commutator or be thrown onto the starting switch or field windings. Grease and oil cause deterioration of the insulation and gather dust and dirt.

Most motors are equipped with a fan for ventilation and cooling. Air drawn through the motor by the fan contains particles of dust and dirt. This dust and dirt clings to those parts of the motor which are oily. The start switch and commutator are situated in a position to catch any excess lubricant from the shaft bearings and to collect the dust and dirt drawn in by the fan. Dirt on the starting switch points will cause failure to start. Dirt on the commutator may prevent the brushes from making contact with the commutator and thus prevent the motor from starting. Dirt may also short commutator segments together which will cause the motor to run slowly and overheat. Dust on the motor windings prevents proper ventilation and results in overheating. Overheating may cause breakdown of the insulation and result in short circuits which will burn out the winding.

## Field Coils

The field coils of a D.C. motor up to  $\frac{1}{2}$  horsepower may be checked for continuity with a test light. Use D.C. and at least a 40 watt bulb. Remove the brushes and connect the test light leads to the field coil leads. If the lamp glows, the circuit is complete; if the lamp does not glow, the coil is open. To check motors larger than  $\frac{1}{2}$  horsepower, it is advisable to use an ohmmeter.

The field of an A.C. motor should be checked with an ohmmeter to detect an open field coil. Connect the ohmmeter across the field coil leads. If the ohmmeter shows a drop in the ohms value, the circuit is complete through the field. If the ohmmeter does not show a drop, the circuit is open.

## Reversing Rotation

To change the rotation but not the polarity, it is necessary to reverse either the field or the armature leads. If both are reversed, the direction of rotation is not changed.

To change the rotation of a three-phase motor, reverse any two of the three wires at the junction box.

## Heavy Duty Relays

All heavy duty relay armatures should operate freely. The points should be properly aligned and clean.

## Excitation of D. C. Generators

When starting up, a generator may fail to excite itself. This may occur even when the generator operated perfectly during the preceding run. It will generally be found that this trouble is caused by a loose connection or break in the field circuit, by poor contact at the brushes due to a dirty commutator, or perhaps by a fault in the shunt resistor. Examine all connections; try a temporarily increased pressure on the brushes; check for an open circuit at the resistor; test for an open field coil with an ohmmeter.

If everything appears to be correct and the generator still fails to "build up," the cause may be lack of residual magnetism in the field poles. Shorting across the variable resistor in the shunt field will usually remagnetize the field. If this fails, however, connect a test light, plugged into D.C. in series with the F & L (common) leads. Use a 60-75 watt bulb in the test light. All generators used in IBM machines run counter-clockwise looking at the commutator end. Check for proper rotation.

## A.C. MOTORS

Figure 4 shows the essential parts of an A.C. motor.

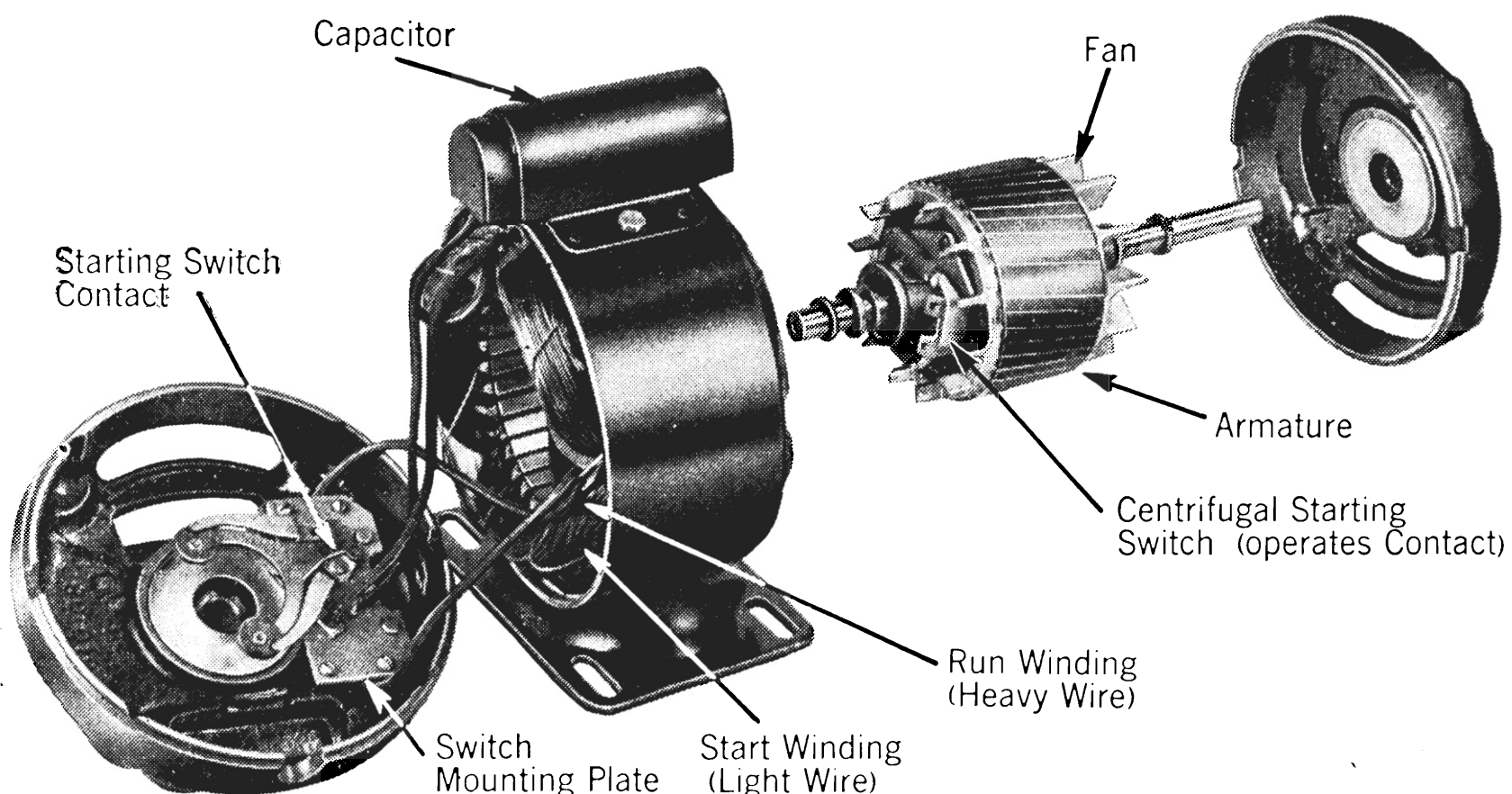


Figure 4. A. C. motor

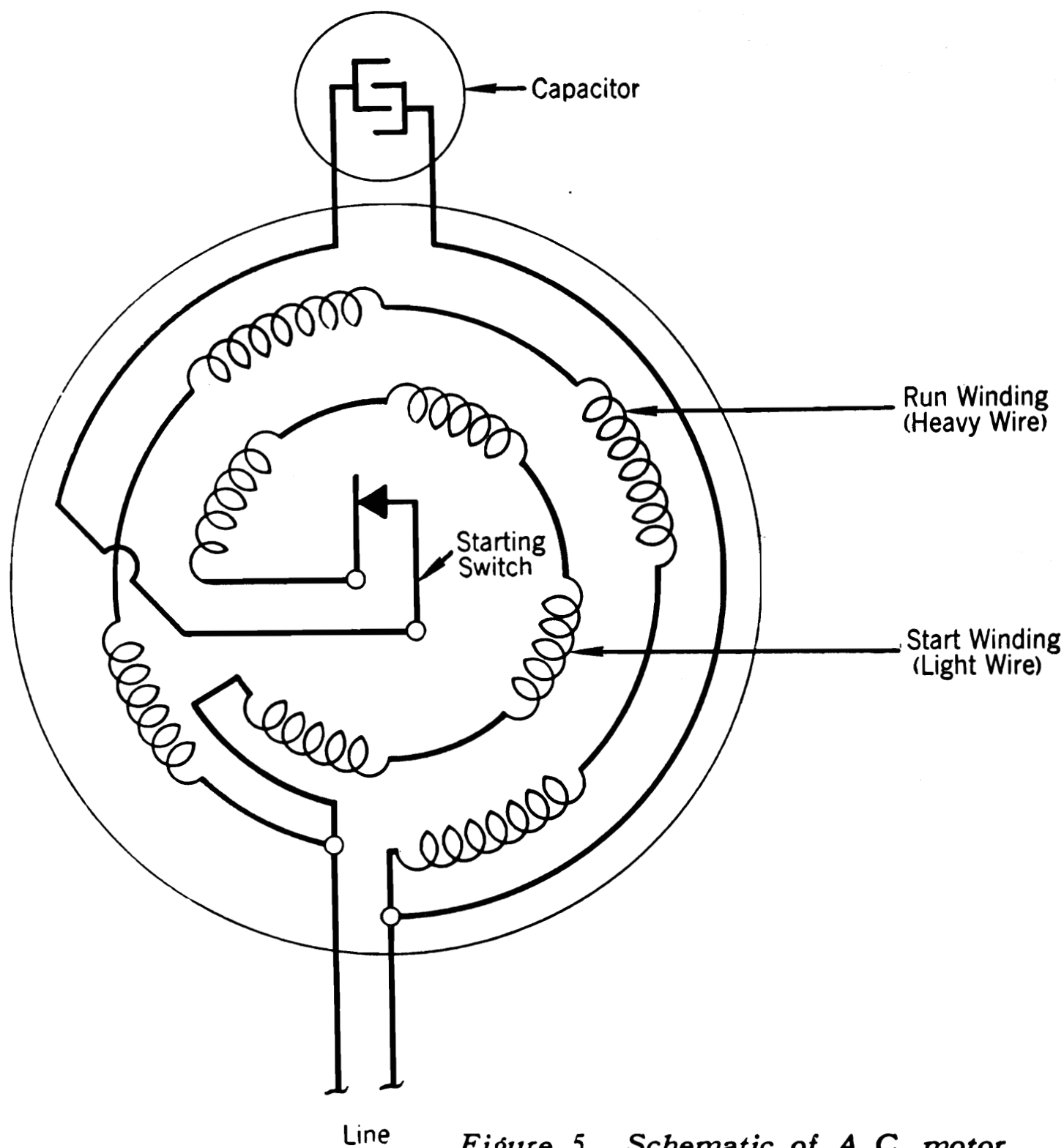


Figure 5. Schematic of A. C. motor

### Starting Switches

A single winding on a single phase induction motor would exert no turning force on the rotor. Therefore, a secondary stator winding or a wound armature must be used to obtain the revolving magnetic field necessary to provide starting torque (Figure 5). When the speed of the motor reaches 70% to 80% of normal, this secondary winding which produces a false second phase is cut out of the circuit by a centrifugal starting switch and the motor runs on the single winding.

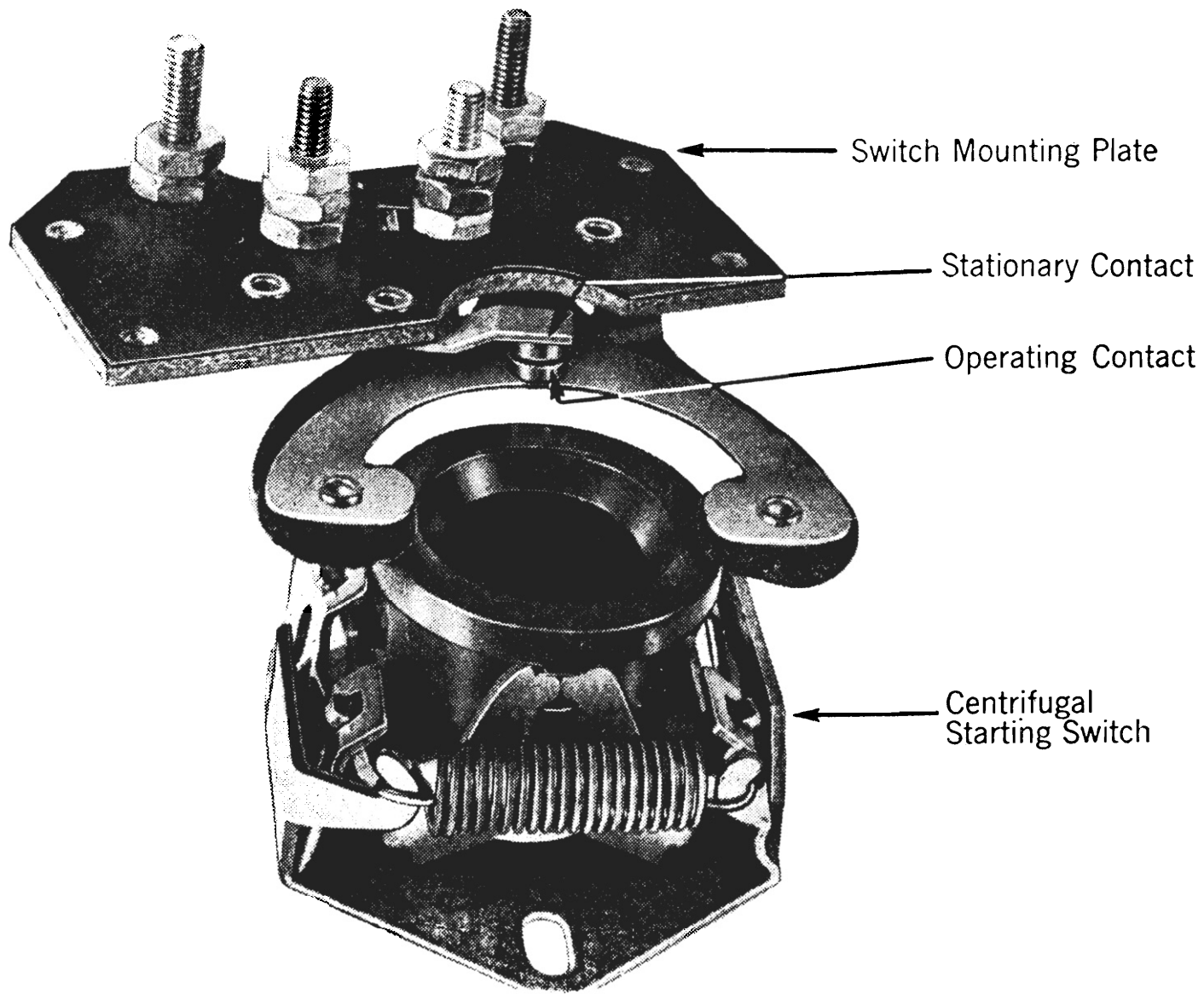
Most A.C. motors used on IBM equipment are of the capacitor or split phase type rather than the repulsion induction type which requires a wound armature.

The starting switch consists of a set of contact points and a throwout mechanism which operates by centrifugal force to open the points when the rotor approaches its rated speed (Figure 6).

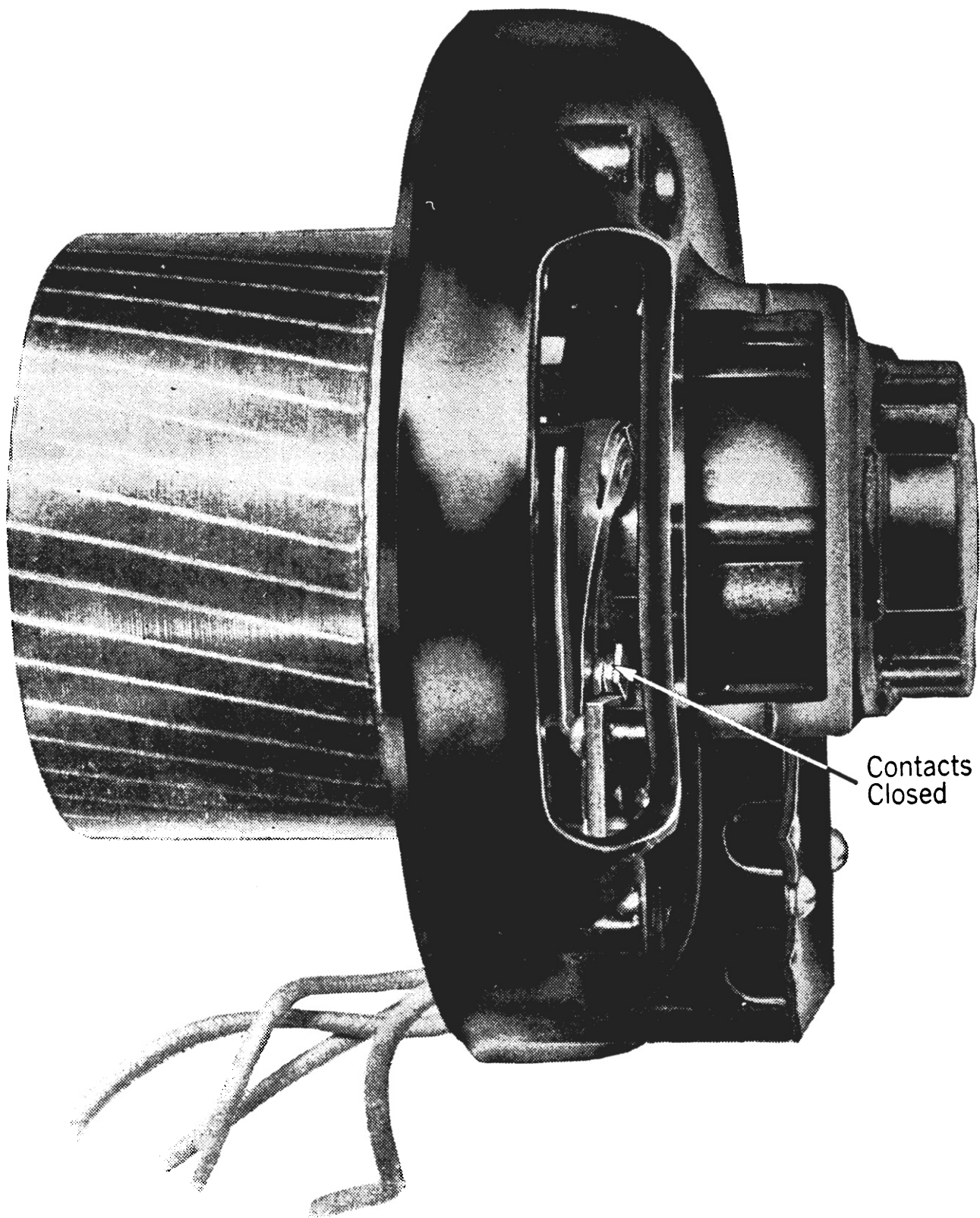
The points of the starting switch may become dirty, may fail to close or fail to open. In the first two cases the motor will fail to start, while in the latter case the motor will run hot and eventually burn out the starting winding. The starting winding is a finer wire which is designed to carry a current for only a short time. The start switch may in some cases be visually checked without removing the end bells of the motor. On other motors it is necessary to check it with a test lamp or to remove the end bells.

To test the operation of a starting switch:

1. Test for power to the motor leads. If there are heavy duty relay points in the circuit, they must be held closed.
2. Remove the cover over the capacitor.



**Figure 6. Starting switch**



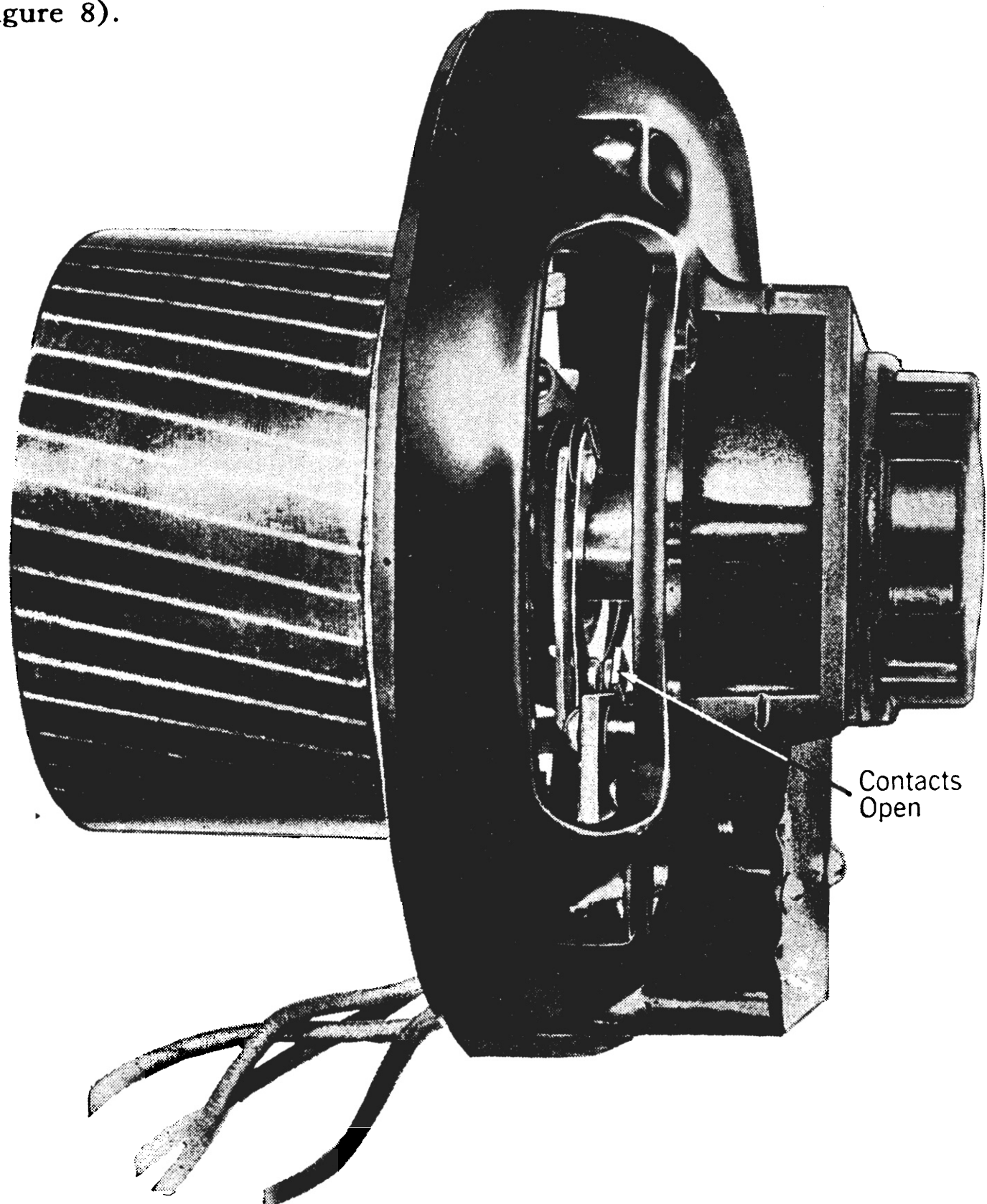
**Figure 7. Starting contact (normal position)**



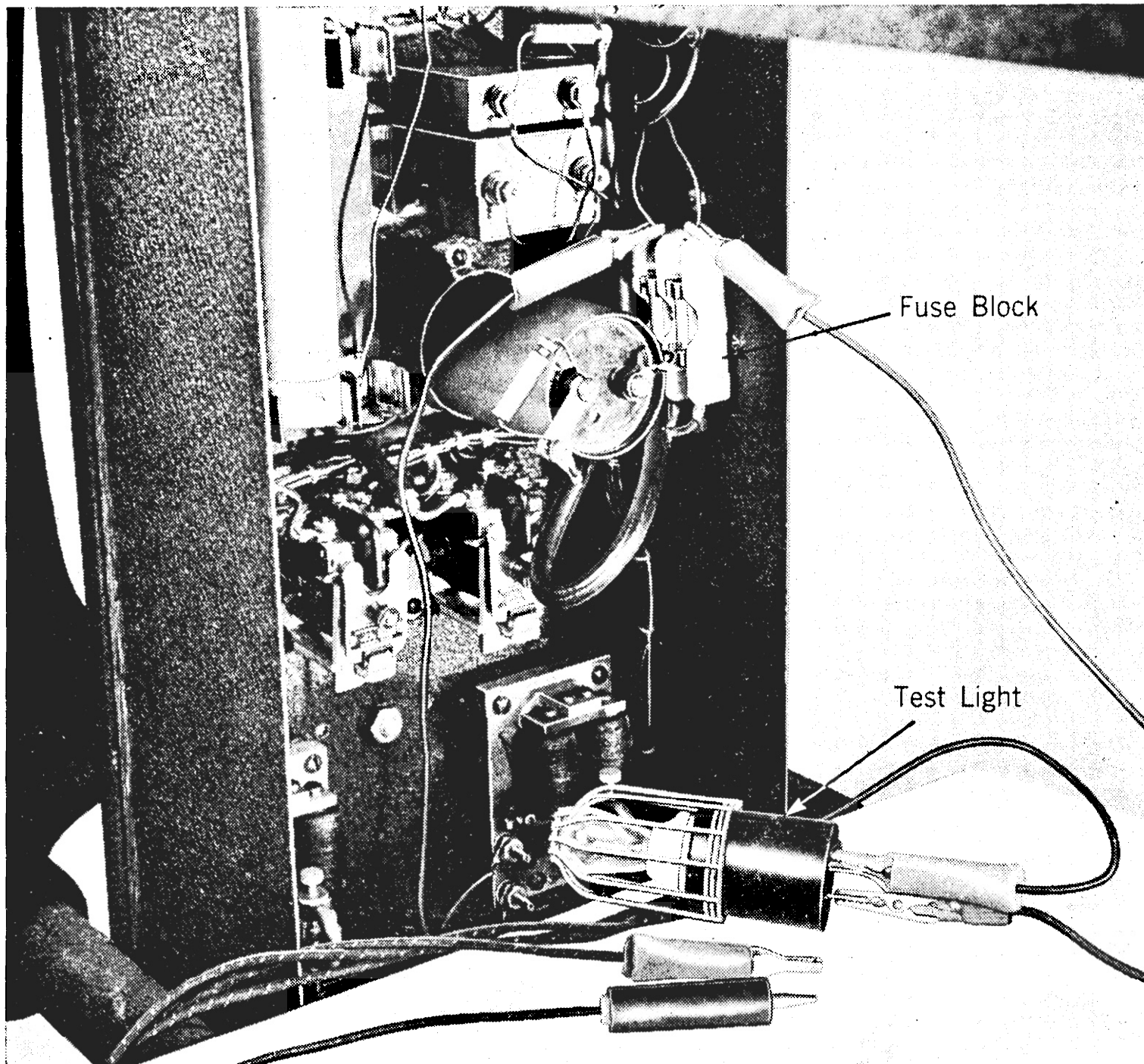
3. Remove one wire from the starting capacitor.
4. Short the male terminals on the base of the test light together.
5. Connect the test light so that one lead is on the wire which was disconnected from the capacitor and the other lead is on the capacitor wire which remains connected to the motor. Turn on the main line switch and depress the start key. When the motor starts, the lamp should light. When the motor reaches operating speed, the light should go out. If the lamp fails to light when the start key is depressed and the motor relay is energized, it indicates that the points of the starting switch are probably dirty or sticking open. An open circuit in the start winding would give the same result; however, open coils occur much less frequently than starting switch failures. If the lamp continues to glow after the motor gets up to speed, it indicates that the switch is sticking and remains closed. The point in some motors may be cleaned and adjusted through a hole in the underside of the end bell. For other motors, it may be necessary to remove the end bells to clean the point or to adjust the switch operating mechanism.

If a starting switch must be replaced:

1. Remove both end bells and rotor.
2. Remove switch mounting plate.
3. Disconnect wires and remove defective switch mechanism.
4. Install new switch. Set switch end bell on table and place rotor shaft in bearing. Check to be sure that the fingers of the switch close the contact when in normal position (Figure 7) and allow the contact to open when the throwout mechanism is moved to its extended (running) position (Figure 8).







*Figure 9. Source of 110V direct current*

### Testing a Capacitor

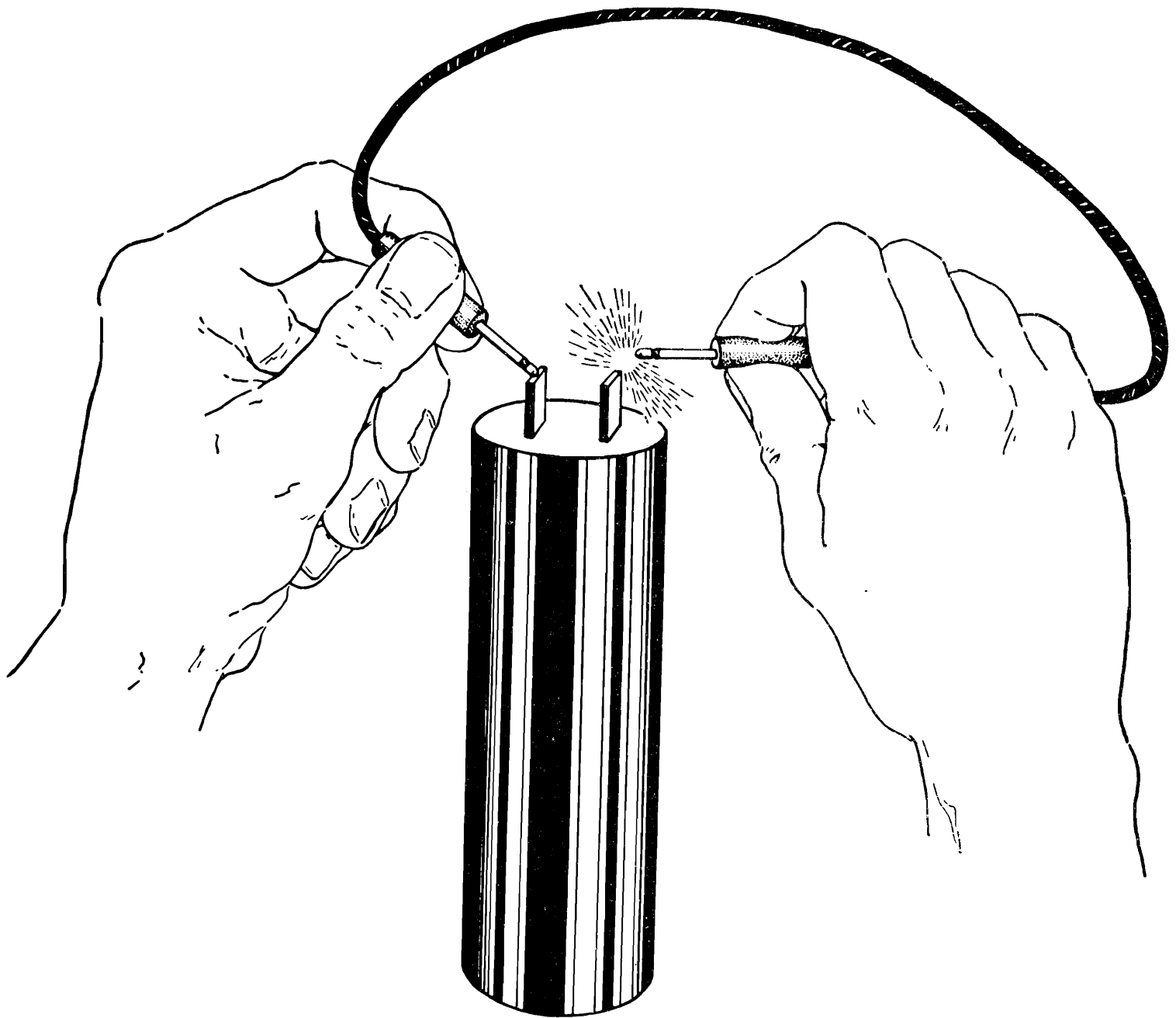
The capacitor type motor will fail to start if the capacitor (condenser) is defective. If the motor continues to run after the shaft is spun by hand in the direction of rotation with power on the motor, the difficulty is either in the capacitor or start winding. Caution: Remove the belts before turning the motor by hand with the power on. If the capacitor is defective, substituting another capacitor will remedy the difficulty. The capacitor puts the start winding  $90^\circ$  out of phase with the run winding to provide starting torque.

To test a capacitor, proceed as follows:

1. Disconnect the capacitor leads.
2. Connect the test light to a source of 110 volt D.C. (If 110 D.C. is not available from an outlet, it may be obtained at the fuse block of the sorter where 110 volt D.C. from the rectifier enters the sorting circuits (Figure 9).

3. Connect the test light leads to the capacitor terminals. The light should flash when the terminals are touched. If the test light continues to glow, the capacitor is shorted and should be replaced.

4. Disconnect the test light leads and hold one end of a wire against one terminal of the now charged capacitor; move the other end of the wire toward the other terminal of the capacitor. When the end of the wire almost touches the other terminal of the capacitor, it should discharge with an arc (Figure 10). If there is no arc, it indicates the capacitor does not take a charge and is therefore defective. It is assumed that the capacitor will be discharged immediately; otherwise, the charge will leak off and no spark will result. This might lead one to believe erroneously that the capacitor was defective.



*Figure 10. Discharging a capacitor*

## Two and Three-Phase Motors

Two- and three-phase motors have no capacitor or starting switch. The only care required is regular cleaning and lubrication.

The following section is devoted to additional information concerning specific machines for which additional removal procedures are required.

## D.C. MOTORS

### Commutators and Brushes

All D.C. motors and generators employ a wound armature, a commutator, and brushes (Figure 11). A commutator is perhaps the most important feature in a motor or generator as it is the most sensitive to abuse. For satisfactory operation, the brushes and commutator of a generator must be kept in good condition. Under proper operating conditions the commutator should run smoothly and true with a dark, glossy surface and without excessive heating. To keep these parts in good order, the main thing to guard against is excessive sparking at the brushes.

Sparking at the brushes may be due to various causes. These causes, some of which are listed below, apply to the motor as well as the generator

1. The machine may be overloaded. The overload may be due to a ground and leak on the line, or a dead short-circuit which should cause the fuse to blow or the sentinel switch to trip.

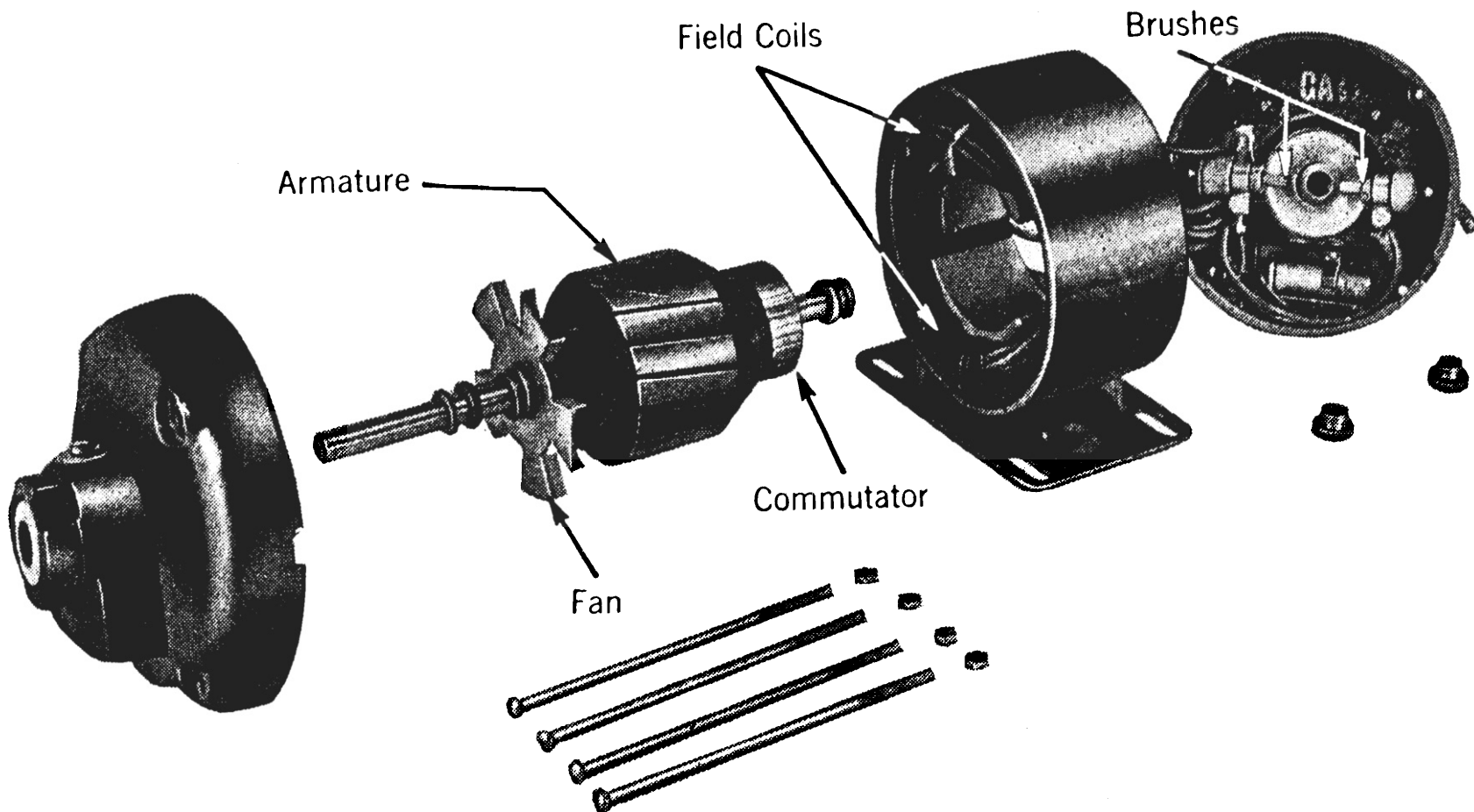


Figure 11. D. C. motor

2. The brushes may not be set exactly at the point of commutation. This is set at the factory and should not require changing unless they have loosened and shifted during shipment or have possibly been bumped. This can be corrected by moving the rocker back and forth until sparking is at a minimum.

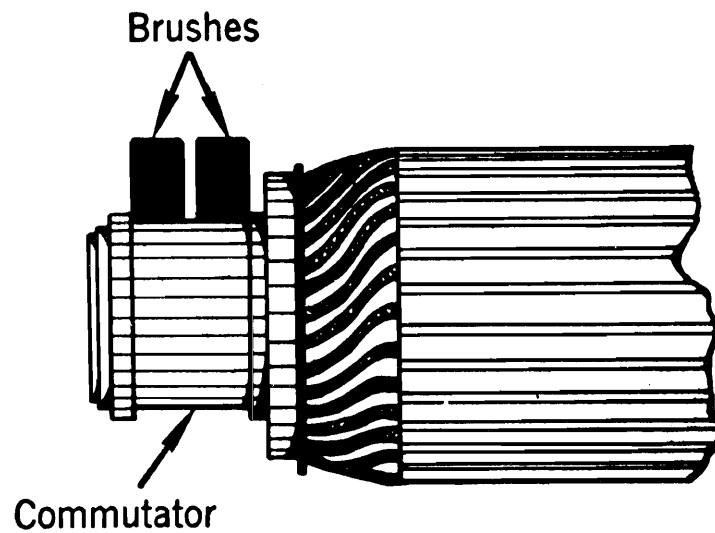
3. The brushes may be burned on the ends. If they are badly burned, the brushes should be replaced.

4. The brushes may be sticking or wedged in the brush holder. The brushes should be kept free from binds and the brush holder should be kept clean of carbon dust and oily deposits. Before a new brush is inserted, it may be filed lightly to remove any roughness which might cause a brush to stick in the holder.

5. The brushes may not be fitted to the surface of the commutator. The brushes may be properly fitted to the commutator surface by the use of the brush seating stone. This stone is pressed lightly against the surface of the commutator until it powders slightly. It has abrasive qualities which cause the brushes to wear to conform to the surface of the commutator. When brushes are removed, mark the direction of the bevel and the position of the brush and be sure to replace the brushes in the same position and with the bevel in the same direction as it was before the brushes were removed.

6. The commutator may be rough, dirty, oily, or worn out. A commutator may be smoothed and cleaned with fine sandpaper (5-0 or finer). *Never* use emery cloth. Emery dust is a conductor and will cause shorts between the segments of the commutator. As one segment becomes shorted with another, the motor runs slower and hotter. For the same reason oil and dirt should be kept from between the segments of the commutator. If the space between the commutator segments becomes filled and dirt piles up on the surface of the commutator, the brushes will bounce. The commutator becomes blackened and low spots form from continual sparking. If the brushes wear a deep slot in the commutator, the brushes may bind on the sides of the slot and bouncing will result (Figure 12).

7. The carbon in the brushes may be unsuitable, making a change of brushes necessary.



*Figure 12. Brushes binding on commutator*

8. If the mica insulation between the commutator segments projects above the segments, it will cause the brushes to spark (Figure 13). The mica should be undercut to eliminate this condition. The saw edge of the chute blade cleaner makes a satisfactory tool for cleaning between the commutator segments and for undercutting the mica. The commutator should be checked at least once every six months. It is advisable to remove the brushes before the armature is removed from any motor or generator.

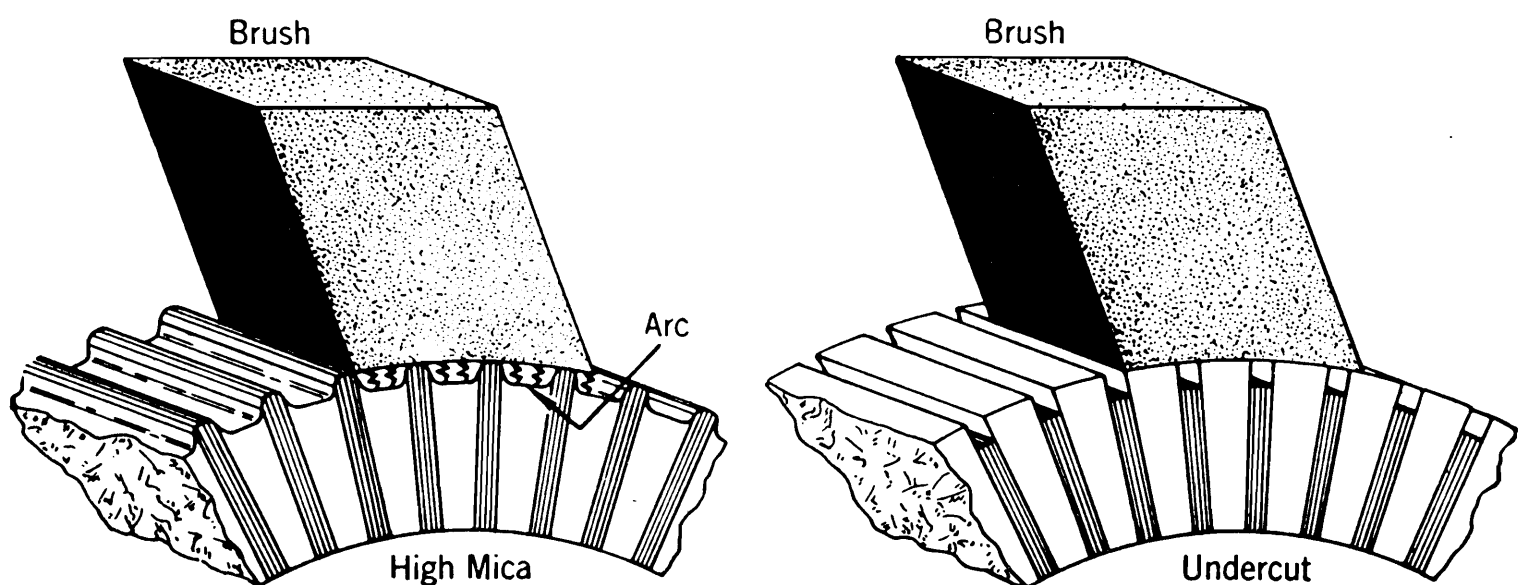
9. Open circuits or loose connections in the armature. This condition may be recognized by a bright spark that appears to pass completely around the commutator.

There are two general kinds of sparking that can be readily distinguished. One kind of sparking, due to bad adjustment of the brushes, a short circuit, open circuit or ground in the armature, can be identified by the bluish color of the spark. This spark is small when the brushes are near the neutral plane, and increases in size and brilliancy as the brushes recede from the correct positions on the commutator.

Sparking due to a dirty commutator can be identified by the reddish color of the spark and a sputtering or hissing sound.

## Armature

The easiest method of checking for an open armature coil is by observation. If an armature has an open coil, a bright blue spark will appear at the brush at the point where the open coil exists.



*Figure 13. Commutator*



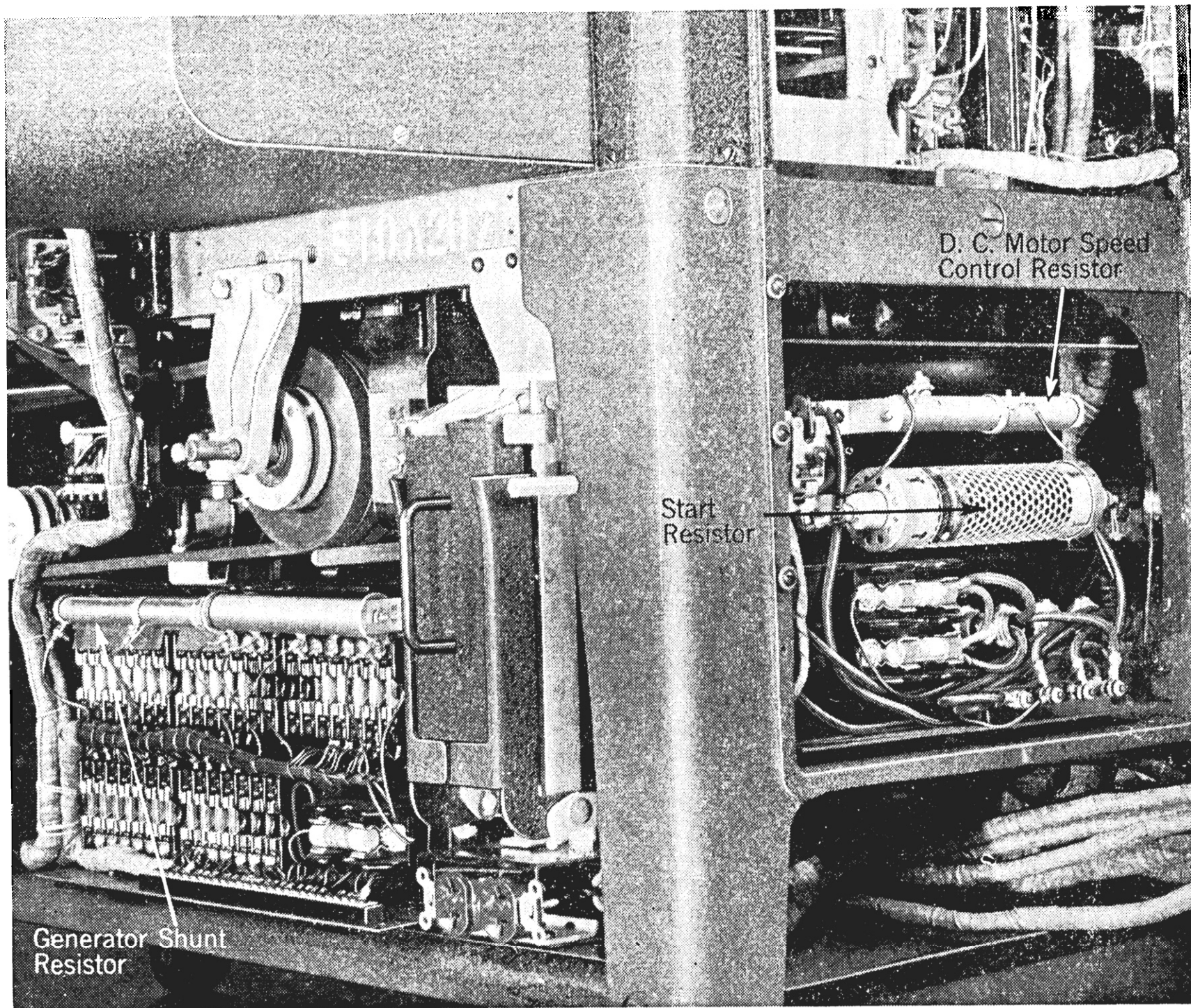


Figure 14. Control resistors

## ALPHABETICAL ACCOUNTING MACHINE, TYPE 405

### D.C. Generator

The generator on all *May 1st* or later machines is bolted to the underside of the upper base. The generator output is rated at 15 amperes at 40 volts. There are two models now in use, the Westinghouse and the Holtzer-Cabot.

Two sets of brushes are used in both models to assure good commutation.

The power supplied by the generator can only be as good as the motor which drives it. The output of the generator may be varied by the resistor in the shunt field. To increase voltage output, decrease the resistance; to decrease voltage output, increase the resistance (Figure 14).

### Corrective Methods

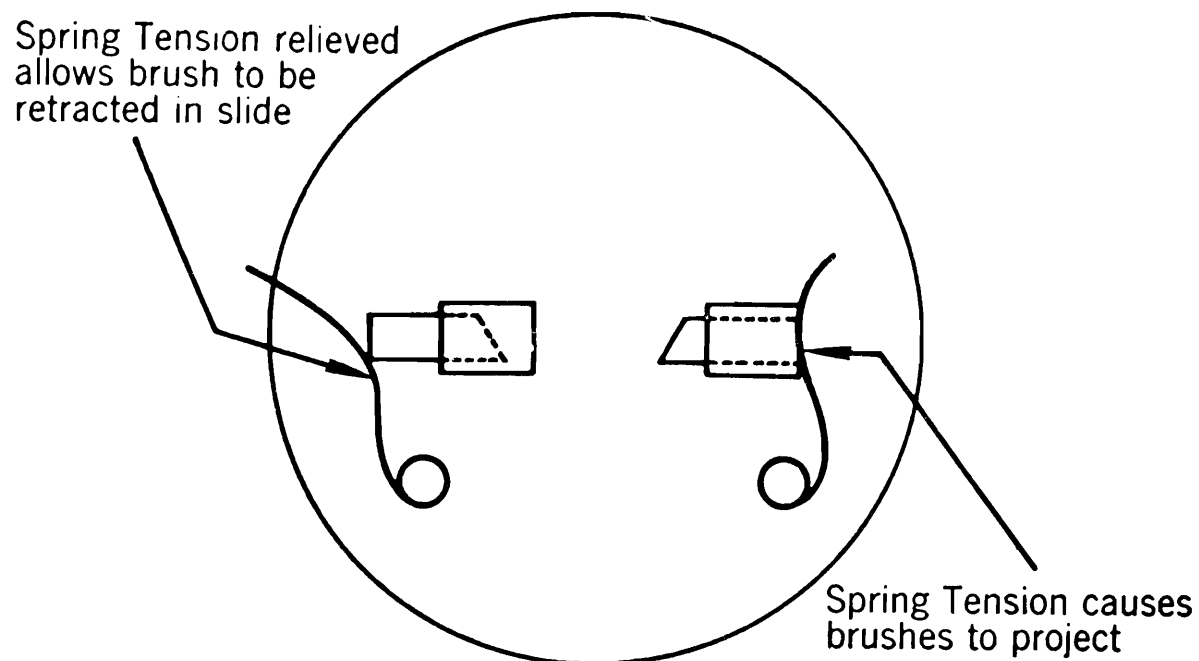
For most corrective procedures, the complete generator need not be removed. Removal of the armature alone is sufficient to allow access to bearings, commutators and brushes.

To remove the armature:

1. To remove the belts and the belt tightener pulley bracket.
2. Remove the four screws from the front end bell.
3. It is advisable to remove the brushes before removing the armature.

When the brushes are removed note the direction of the bevel and be sure to replace the brushes with the bevel in the same relative position as it was before the brushes were removed.





*Figure 15. Replacing generator brushes*

4. Pull the armature out from the front of the machine.
5. Remove the rear end bell; the brushes and grease cup are readily accessible for cleaning.
6. The old grease should be cleaned from the bearing and replaced with new IBM lubricant 21 approximately every two years. Fill the bearing housing approximately half full.
7. All carbon and dust should be cleaned from the entire generator with a brush and a cloth.

To replace the armature:

1. Be sure the brushes are removed from their slides or that the spring tension is relieved by placing a spring hook or rubber band beneath the brush tension spring. See that the brushes are pushed back in their slides; otherwise, the commutator will jam against the brushes and damage them (Figure 15).
2. Replace the rear end bell.
3. Check from front to be sure that all wires, brushes, etc., are out of the way of the armature, and that the brass shims are in the bearing housing.
4. Place the armature into the motor housing, being careful to align the bearing with the bearing housing.
5. Replace four screws in the front end bell.
6. Replace brushes in position.
7. Replace the belt tightener pulleys and belts.

If a direct short occurs across the generator, the load will be excessive. The motor will draw an extra heavy current and will cause the thermal element on the main line switch to trip.

### Changing the Polarity of a Generator with a Self-Excited Field

At times it may be necessary to reverse the polarity of a generator to make it conform to the polarity of an auxiliary machine, as in the case of a Type 405 and a Gang Summary Punch designed for independent operation. The relays of both machines must operate with the same polarity to prevent short circuiting and blowing fuses.

1. Disconnect the F generator lead either at the shunt resistor in the fuse box or at the motor terminal plate.

2. If 110 volt D.C. is available, place a 40 watt bulb in the test lamp and connect to 110 D.C. Connect one lead of the test lamp to the F lead and touch the other momentarily to the L lead either at the bus in the fuse box or at the motor terminal plate.

If 110 D.C. is not available, connect one wire to each of the positive and negative sides of the 40 volt generator on another machine. These two wires may be connected momentarily to the F and L leads of the 405 generator. The A and F leads from the motor binding posts 7 and 8 are reversed from the notation on the blueprint. The F lead goes to the sliding contact and the A lead goes to the stationary contact.

### 3. Test with voltmeter for polarity.

If polarity is not changed, reverse the wires from the test light to the generator field windings. Recheck the polarity with the voltmeter. All generators are set at the factory for a definite polarity. Check the blueprint for proper polarity.

## D.C. Motor

A one-horsepower motor is used. The shunt field resistor is used to control the speed. It is placed above the fuse panel as shown in Figure 14. To increase the speed of the motor, increase the resistance; to decrease the speed, decrease the resistance.

The start resistor is in series with the start winding of the motor. When the generator "builds up" to 24 volts, the heavy duty relay is energized and its points shunt out the start resistor. The start resistor is mounted on the binding post panel on the lower base just inside the right end relay gate (Figure 14).

The armature of the D.C. motor may be removed in the same manner as the armature of the generator is removed.

## A.C. Motor

A one-horsepower motor is used on the Type 405. There is a capacitor in series with the start winding and a capacitor in series with the run winding of the Holtzer-Cabot motor. In this motor, the start capacitor is an electrolytic type of 378-420 mfd. capacity. The run capacitor is an oil type of 9 mfd. capacity.

The Westinghouse motor uses only a start capacitor.

## AUTOMATIC REPRODUCING PUNCH, TYPE 513

### Motor Generator Sets — Figure 16

The combination sets now in use are the Westinghouse and the Electric Specialty Company models.

The vertically mounted sets now in use are manufactured by Holtzer-Cabot, Westinghouse and Delco.

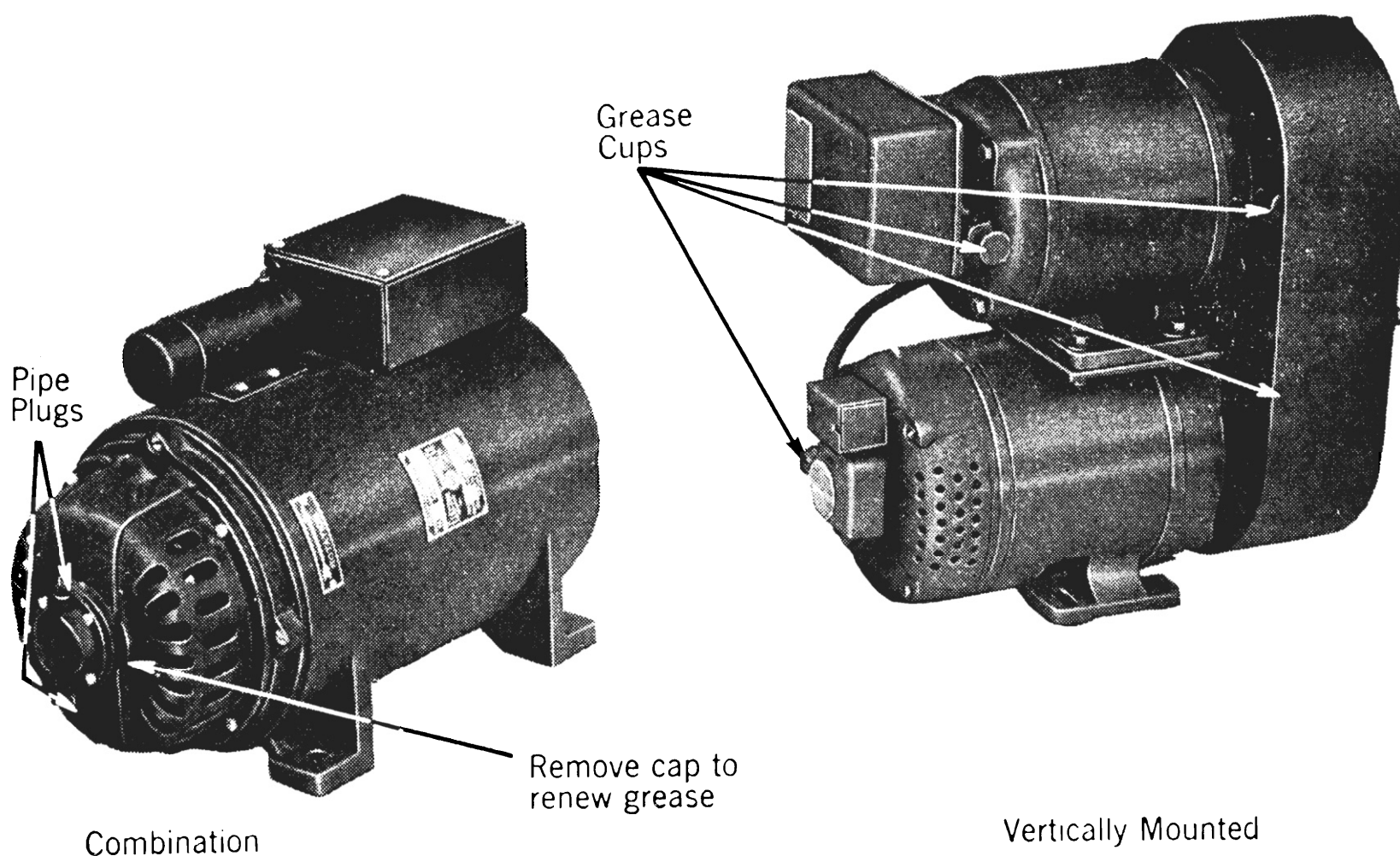


Figure 16. Motor generator sets

## Lubrication

All motor generator sets on the 513 use ball bearings which require IBM lubricant 21. The bearings should be checked once every 6 months.

To check the Electric Specialty combination set, remove the four screws from the bearing cap and remove the cap. The cap should be approximately half full of grease.

To check the Westinghouse combination set, remove the end plug and check the bearing housing. It should also be at least half full of grease.

## Corrective Methods

If the generator fails to provide the proper current, the following procedure may be followed:

1. Check the motor to see that it runs.
2. Check the variable resistor in the field circuit of the generator for an open circuit.
3. Check the brushes; see that they touch the commutator and have good tension.
4. Check the surface of the commutator for wear, dirt and oil.
5. If the generator fails to "build up" and everything appears to be correct, the cause may be lack of residual magnetism in the field poles. Shorting across the 50-ohm variable resistor will usually remagnetize the field. However, if this fails, connect a test light plugged into D.C. in series with the F and L (common) leads. Use a 60-75 watt bulb in the test light.

Standard 405 motors and generators are used in the vertically mounted models. The care of these is covered under Type 405 Motor and Generator care. If the motor fails to run, check the fusetrons in addition to the corrective methods given on page 14.

A direct short across the generator will cause the input circuit to open. This circuit may be controlled by a thermal element or fusetrons.

## Drive Motor

The drive motor used is the same type of motor used for the sorter. However, the capacitor used on the A.C. motor is a larger one than that used on a sorter motor because the Type 513 is required to start so frequently. The windings on this motor are glass-insulated to withstand a greater heat generated by frequent starting.

## AUTOMATIC MULTIPLIER, TYPE 601

### A.C. Motor

The  $\frac{1}{2}$  horsepower motor, either A.C. or D.C., is used. The motor and generator are located beneath the upper base.

This motor runs counter-clockwise facing the end opposite the shaft.

The A.C. motor used previous to 1939 runs at 1640 R.P.M. The motor now in use runs at 1725 R.P.M. If the motor is changed from 1640 R.P.M. to 1725 R.P.M., the pulley must be changed.

### D.C. Motor

The resistors between  $A_1$  and  $F_1$  in the shunt field are for speed control. An increase in resistance will increase the speed of the motor; a decrease in resistance will decrease the speed of the motor.

The capacitor across the motor brushes is provided for radio interference elimination.

## Generator — Figure 17

This generator is designed to supply 78 volts A.C. and 48 volts D.C. There is a single common field winding and the two armatures are wound

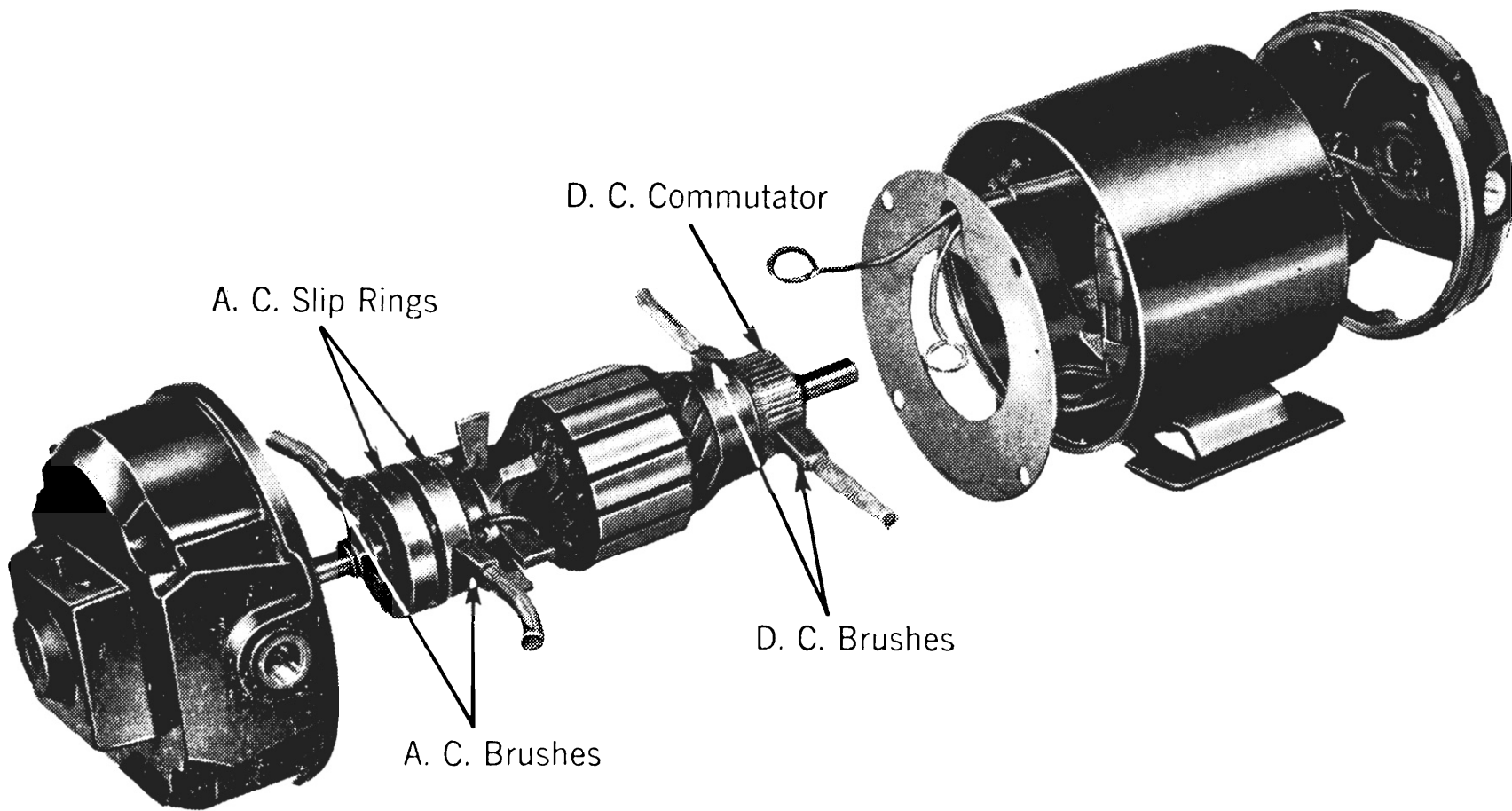


Figure 17. Generator—Type 601 Automatic Multiplier

on the same shaft, one for the A.C. and one for the D.C. There are three wires from the D.C. winding. The long white wire (A-2) is the common to both the armature and field coils. The red wire (F) is the field lead and the green wire (G) is the armature lead. In this machine the armature (G) and field (F) leads are both wired to the same side of the fuse.

Direct current supply for the control of the relays and punching mechanism in the machine is obtained from the commutator end of the generator, designated "D.C." on the wiring diagram.

Alternating current supply is obtained from slip rings located in the other end of the generator. This source of current supply is designated "A.C." on the wiring diagram.

The generator drive and gearing of the machine is arranged to provide for one complete A.C. wave per cycle point of machine operation. An A.C. wave is used for energizing all counter magnets, multiplying plate magnets, and column shift plate magnets. The circuit controls in each case are arranged to provide proper timing relation to the A.C. wave.

To time the generator to the machine:

1. With the two cap screws removed from the flexible generator coupling, set the machine at any numbered index line.
2. Turn the generator until the mark —/— (or red paint line) on the commutator is aligned with the pointer on the front (D.C.) end of the generator.
3. Find the two holes in the connector where the two cap screws will fit without turning the generator and insert the screws.
4. Turn the machine manually and check machine index lines with the paint or scratch mark on the generator. Check at 9, 5 and 1 on the index.
5. The second generator commutator mark —/—/— (or yellow paint line) is approximately  $140^\circ$  after the making point and is correct for current "lag" plus normal duration time. The breaking point must be used for timing purposes. Emitters and card brush circuit breakers should be timed to break at this yellow line.

The generator is designed to operate at 2400 R.P.M.

The D.C. from the generator serves to excite the single common field. Therefore, if for any reason the D.C. generator fails, the A.C. generator will fail also. However, it is possible to get D.C. without A.C.

The 2400 R.P.M. speed of this generator magnifies the tendency for brushes on the commutator (D.C.) to chatter. This cuts down the current in the field coils and affects both the A.C. and D.C. output.

The A.C. brushes are fitted with the curvature on the long face (Figure 17). The D.C. brush is fitted with the curvature on the short face.

Both sets of brushes must be removed before the armature is removed. If a short circuit appears across either the A.C. or D.C. line, it will cut both the A.C. and D.C. output to a negligible value.

## ELECTRIC ACCOUNTING MACHINE, TYPE 285

All 110 volt Type 285 machines require a drive motor and a reset motor; 220 volt machines require a dynamotor in addition to the drive and reset motors.

All the motors used on a Type 285 require D.C.

### Drive Motor

The drive motor must operate at two different speeds for list and non-list operations. This is accomplished by varying the resistance in the shunt field of the motor. When the resistance is increased, the speed of the motor is increased; when the resistance is decreased, the speed of the motor is decreased. The motor operates at approximately 900 R.P.M. on list speed and approximately 1700 R.P.M. on non-list speed.

### The Dynamotor—Figure 18

The dynamotor is used to convert from 220 D.C. to 110 D.C. A single common field winding serves for both the motor and generator armatures. The dynamotor requires the same general care as D.C. motors and generators. Refer to the corrective methods summary chart for additional information.

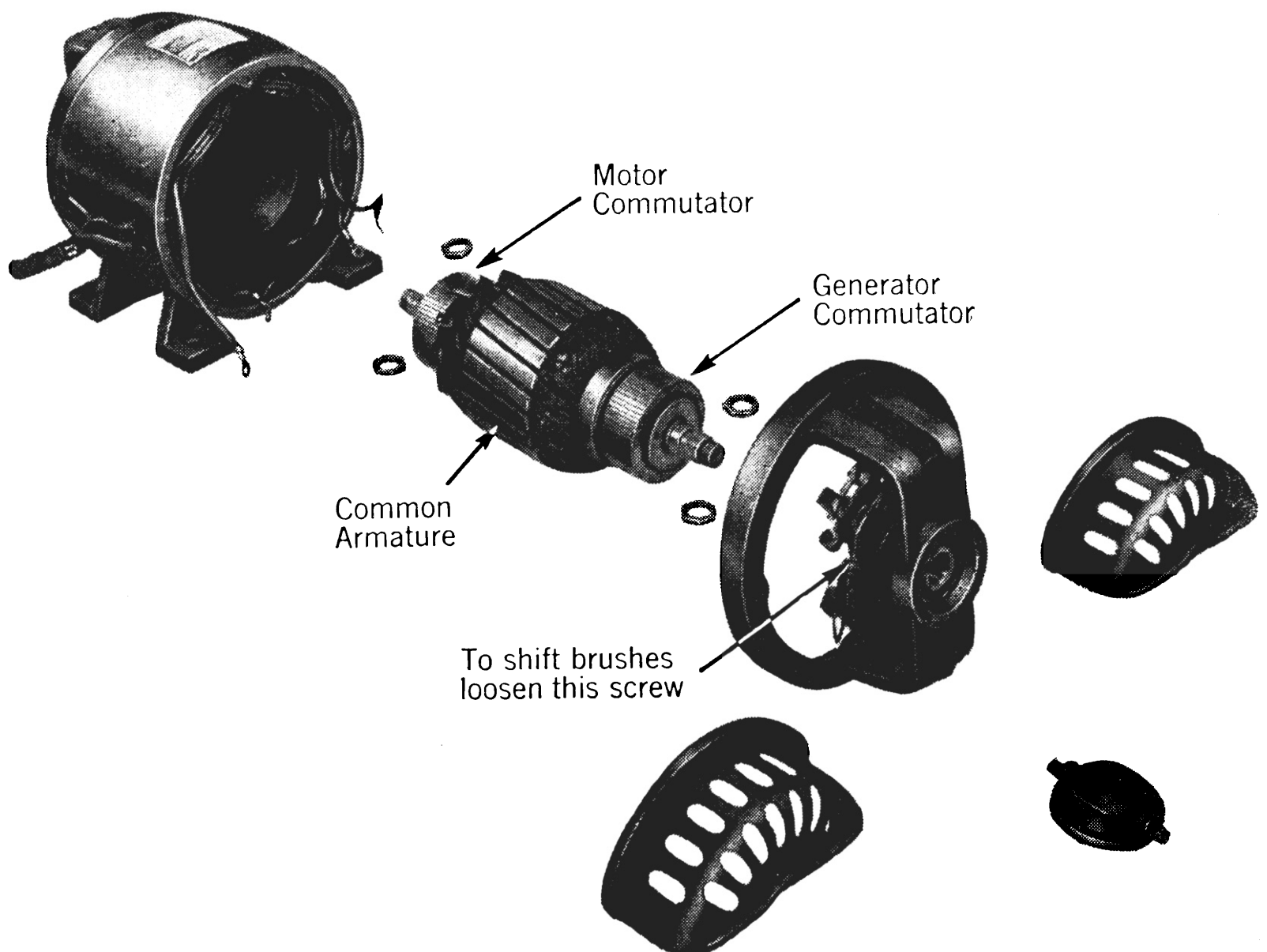
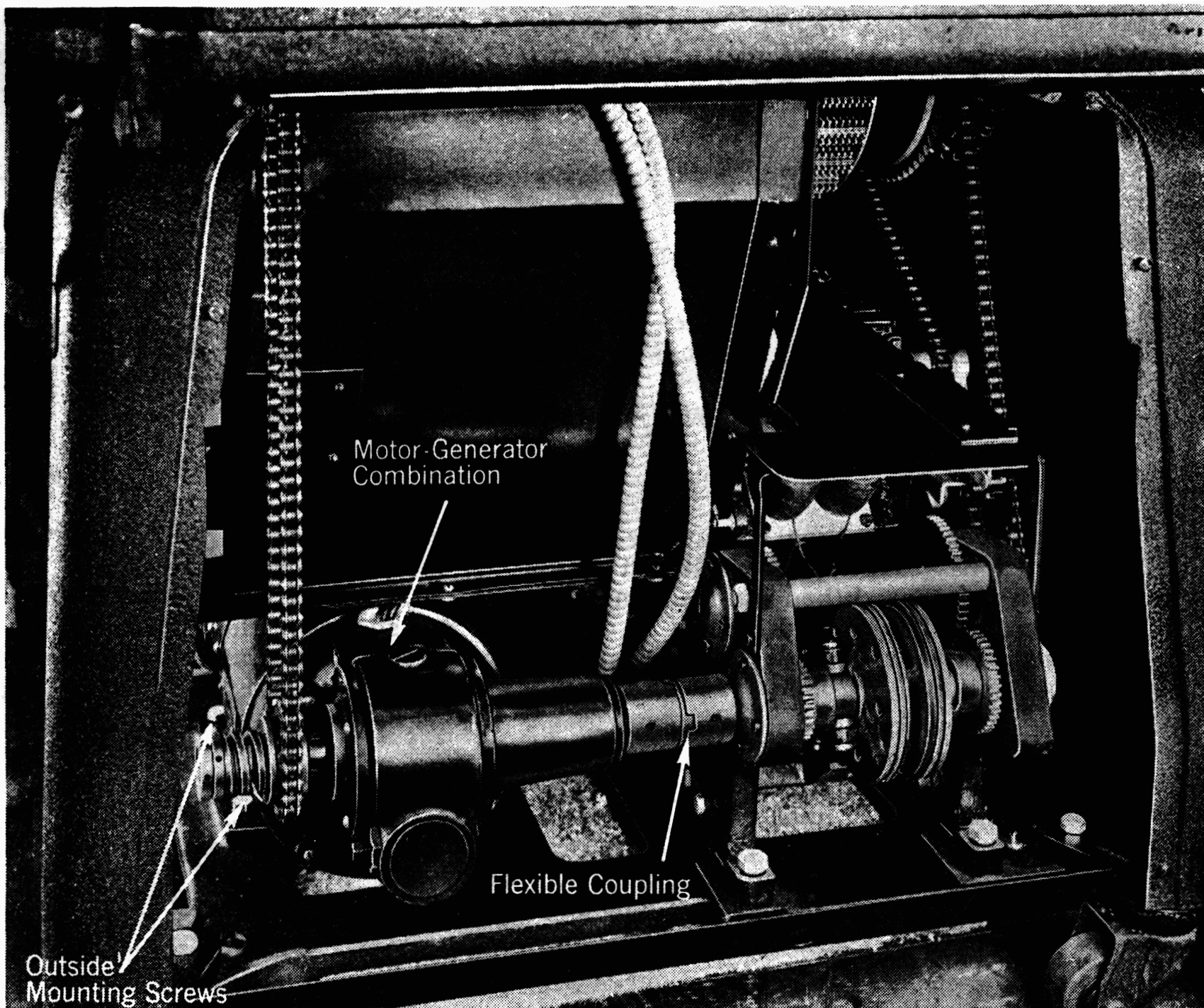


Figure 18. Dynamotor—Type 285 Electric Accounting Machine





*Figure 19. Motor generator—Type 801 Proof Machine*

### PROOF MACHINE, TYPE 801

A combination motor-generator is used on the Type 801 (Figure 19). The motor may be either A.C. or D.C. The generator produces 32 to 40 volts D.C. for operation of relays and solenoids.

#### Lubrication

The motor-generator is equipped with bronze sleeve bearings. These bearings require four drops of oil each month for normal eight-hour day usage.

The worm gear is lubricated with IBM lubricant 15. The housing should be filled to the level of the overflow or check plug. There is a breather hole in the top of the housing to prevent the lubricant from being forced through the grease seals.

#### A.C. Motor

The A.C. motor is a  $\frac{1}{4}$  horsepower split-phase type of motor which requires no capacitor. The A.C. motor has a starting switch as shown in Figure 5.

#### D.C. Motor

A  $\frac{1}{4}$  horsepower D.C. motor is used on the motor-generator of a D.C. machine.

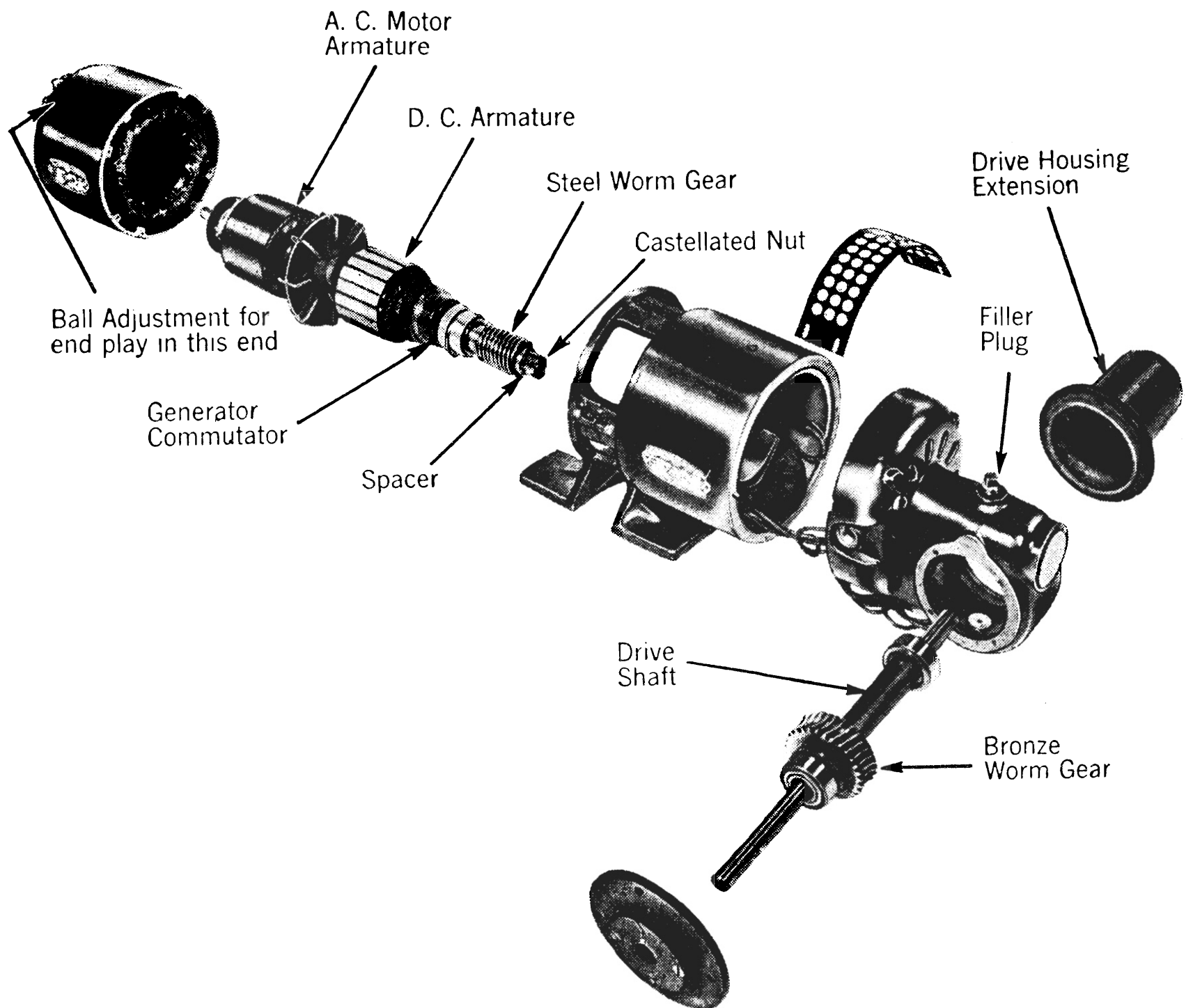


Figure 20. Drive mechanism—Type 801 Proof Machine

### Drive Mechanism — Figure 20

The motor drives a worm and gear power unit which furnishes motive power to the machine. The lubrication of this worm gear is very important. There are three grease seals in the unit. If grease leakage becomes pronounced any or all of the seals may be replaced.

The worm gear is keyed to the shaft. This worm gear may be replaced most easily if the motor generator set is removed from the base.

### To Remove the Motor Generator Combination

1. Loosen the two inside mounting screws.
2. Remove the two outside mounting screws.
3. Remove the two generator wires from the fuse block.
4. Remove the cover over the BX cable terminal box.
5. Remove the solderless connectors from the motor leads.
6. Loosen BX cable clamp at terminal box.
7. Slide motor generator assembly to the left far enough to disengage the flexible coupling and raise assembly to relieve tension from the chain so that it may be removed.
8. The motor generator set may now be removed from the front of the machine.

To remove the bronze gear after the motor generator has been removed from the machine.

1. Loosen screws and remove flexible coupling from shaft.

2. Remove the four screws from the right housing extension and remove the extension.

3. Remove the screws from the left side of the housing.

4. Remove the bronze gear and shaft assembly from the left.

If it is required to remove the steel worm gear:

1. Force front housing cover opposite the end of the worm shaft out of housing. (This cover is sealed to housing with cement.)

2. Remove the cotter key from the castellated nut on the end of the worm shaft.

3. Remove the castellated nut and spacer from the worm shaft.

4. From the side openings the worm may be forced from shaft and the key and worm gear removed.

To remove the motor generator armature shaft these additional steps will be required:

1. Remove the brushes from both the motor and generator. Note the position so that they may be properly replaced.

2. Remove the four screws from the generator housing and four screws from the motor end bell.

3. On a D.C. motor assembly, disconnect the two field coils of the motor and generator. These are fastened together with a small bolt and taped. One connection is made on each side of the unit. The A.C. motor has no field wire connection between the motor and generator.

4. Remove the generator field housing.

5. The armature and worm shaft may now be pulled from the assembly and the worm gear may be removed from the shaft.

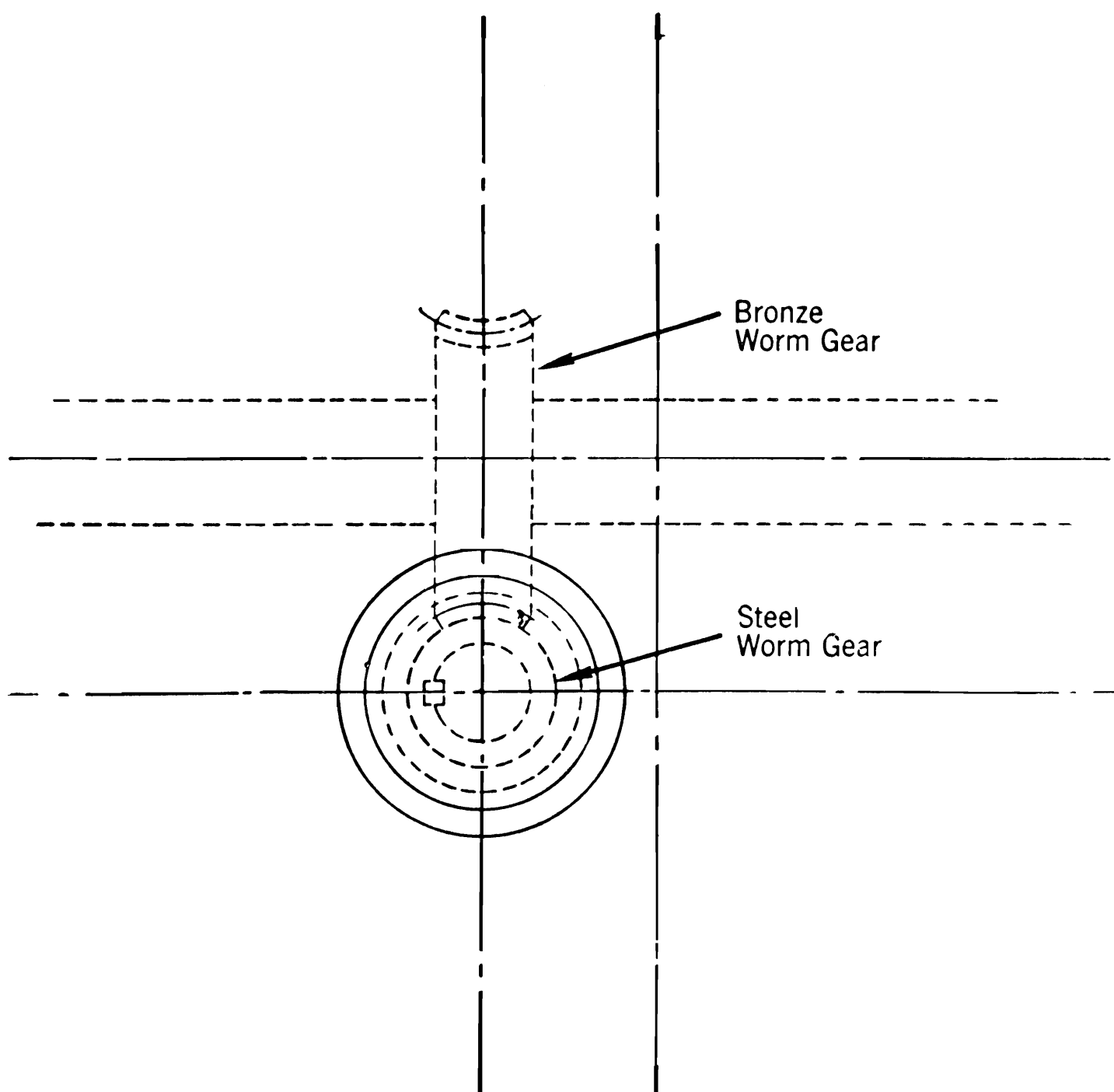


Figure 21. Alignment of drive gears

## Armature End Play

In the end bell of the generator there is a ball bearing and screw adjustment by means of which the armature end play may be adjusted. This bearing requires IBM lubricant 21. The armature shaft should be adjusted for .003" end play.

When replacing the worm gear, be sure the center line of the bronze gear and the center line of the worm gear line up (Figure 21). These gears are placed at an angle of 90° to each other. Shims on either end of the worm shaft provide an adjustment to obtain this condition. A simple means of determining when the center lines of the gears are aligned is to assemble the unit as nearly in alignment as possible by sight. Then listen to the gears when they are running. The point at which the gears make the least noise provides the best alignment. This should be checked without the chain.

The drive shaft coupling should be so aligned that there is no perceptible wobble in the drive housing extension (Figure 20). This alignment is obtained by shimming beneath the motor generator.

## PUNCHES AND VERIFIERS, TYPES 016, 031, 052

The punch motor is a 1/60 horsepower series-wound motor. The motor is rated as a universal motor; however, the armature used on the A.C. motor is wound for 100 volts and the armature used on the D.C. motor is wound for 110 volts. Therefore, a motor with a 100 volt armature will run fast on D.C. and a motor with a 110 volt armature will run slow on A.C.

The part number for a 100 volt A.C. motor is 167750. The part number for a 110 volt D.C. motor is 102437. The part number for a 110 volt armature is 280296.

## Brushes and Commutators

The brushes and commutators will require the most attention. The brushes should be free in their holders and should make good contact with the commutator.

The brush caps should not be tightened excessively. Excessive tightening will result in breaking the caps.

There are two styles of brush caps for Westinghouse motors. One style has the threaded portion made of brass and the other style is made entirely of bakelite.

## PRINTING PUNCHES, TYPES 034, 035, 036

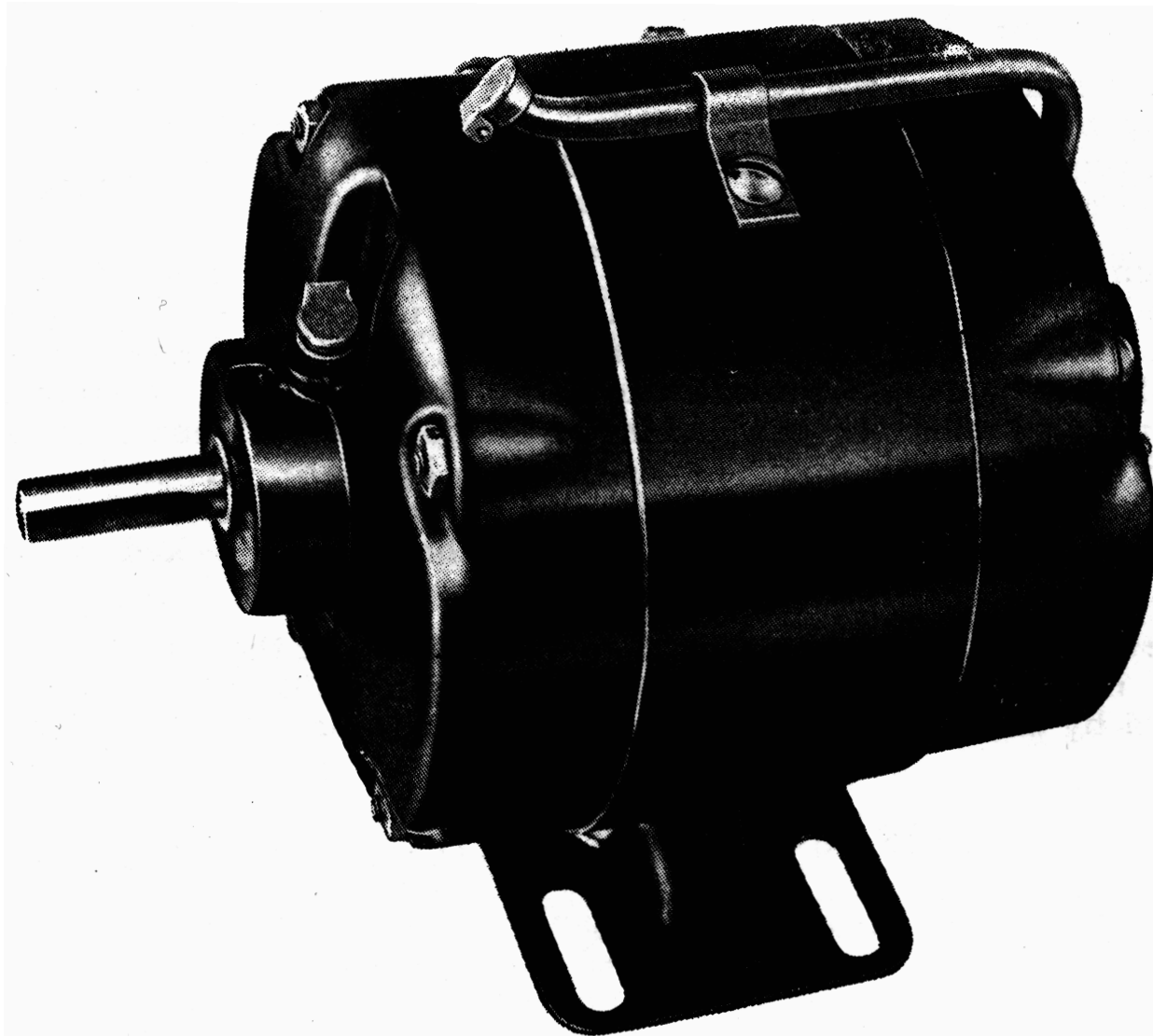
### Motor

A 1/4 horsepower motor is now used on all printing punches. The 1/4 horsepower motor replaces the 1/6 horsepower motor to eliminate overloading and overheating. This motor is the same type of motor as that which is used on the sorters and requires the same care for maintenance. The rotation is counter-clockwise facing the end opposite the shaft.

### Generator

A 110 volt compound wound generator is used to supply current for the operation of all relays and solenoids in this machine. The output of the generator may be varied by the resistor in the shunt field.

To increase voltage output, decrease the resistance; to decrease the voltage output, increase the resistance.



*Figure 22. Fully enclosed motor*

### FACSIMILE POSTING MACHINE, TYPE 954

A 1/70 horsepower motor is used on a facsimile posting machine. This motor is fully enclosed to comply with Underwriters' specifications, and *only a fully enclosed motor can be used* (Figure 22).

The end bells must be removed when it is desired to make an inspection of any part of the motor.

### COLLATOR, TYPE 077 and INTERPRETER, TYPE 552

#### Motors

The Type 077 and 552 machines use the same motors as the sorter. The rotation is counter-clockwise facing the end opposite the shaft. Corrective methods for these motors will be the same as those found under A.C. and D.C. motors.

#### Generators

Belt-driven generators are now being used on these machines.

There are two models of the belt-driven generator in use: the IBM generator, part number 192677, and the Westinghouse generator. The IBM generator shaft is  $\frac{1}{2}$ " in diameter and the Westinghouse generator shaft is  $\frac{5}{8}$ " in diameter. If generators are interchanged, the proper pulleys must also be supplied.



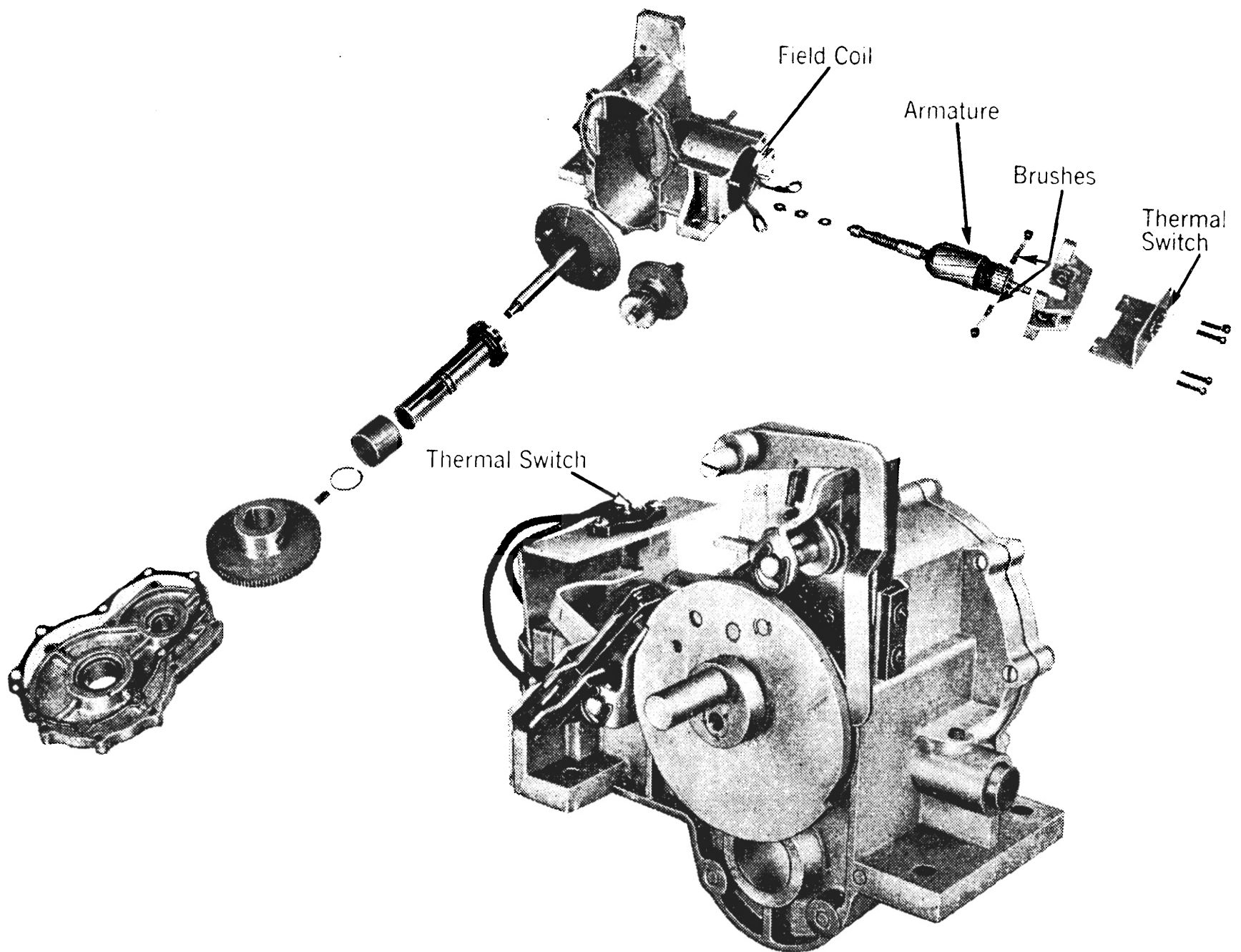


Figure 23. Drive motor—Type 805 Test Scoring Machine

### TEST SCORING MACHINE, TYPE 805

A combination motor and drive housing is used on the test scoring machine (Figure 23). The motor is 1/10 horsepower universal type, with a rated speed of 7000 R.P.M. The motor is protected from overload by a thermal switch. This switch opens the circuit to the motor if the machine jams or the motor becomes excessively hot during operation.

#### Lubrication

The worm gear runs in a housing which contains IBM lubricant 9. The toggle drive gear in the top of the same housing is lubricated with IBM lubricant 21 packed around the shaft.

## Corrective Methods

If the motor fails to start:

1. Check for power to the motor.
2. Check to see that the thermal switch is latched.
3. Check the motor brushes.
4. Check for binds in the operating mechanism by turning the armature by means of a screwdriver.
5. Test for an open field coil with an ohmmeter.

The field may be removed while the unit is in the machine:

1. Remove the motor brushes.
2. Remove the four screws from the rear bearing bracket. (The bracket is matched to the housing and doweled with the bearing in alignment. Be sure to replace the bracket so that the numbers stamped on it appear on the right side of the motor housing.)
3. The field may now be removed from the assembly.

The motor and drive unit must be removed from the base before the armature can be removed from the assembly.

To remove the motor and drive unit:

1. Loosen two screws, one in each of the collars which operate the paper shutter trip lever. These screws are just behind the platen, one on each end of the shaft just inside the base casting.
2. Remove the blue steel clip from the lower end of the motor key bell crank.
3. Pull shaft toward left end of machine.
4. Remove blue steel clip from the toggle pin and remove the toggle pin.
5. Remove the toggle link from the motor drive shaft. Caution: when replacing this unit, be sure the toggles are in the up position before raising the motor mounting bracket.
6. Remove the two rear batteries.
7. Remove the tubes from the item count chassis (tube and relay mounting plate).
8. Remove the two rear mounting screws from the item count chassis and pivot the chassis down about the two front screws.
9. Remove the four mounting screws and remove the motor and drive assembly.

To replace the motor:

1. Fasten motor to bracket with the four mounting screws.
2. Raise the motor mounting bracket and replace the two rear screws. Tighten the mounting screws very firmly.
3. Raise the item count chassis and replace the two rear screws.
4. Replace the motor key shaft and readjust the paper shutter trip levers.
5. Connect the motor key bell crank to the motor key shaft. Replace clip.
6. Replace the toggle link and toggle pin. Replace clip.

## CORRECTIVE METHODS SUMMARY

TYPE	KIND OF FAILURE	PROBABLE CAUSE	CORRECTIVE METHODS
Capacitor and Split-phase	Fails to start	Thermal element in thermal overload switch burned out or switch tripped.	Reset switch or replace element.
		Open circuit to motor.	Check with light for power to motor.
	Motor hums but fails to start.	Defective capacitor.	Replace capacitor.
		Points of starting switch not closed.	Clean and adjust starting switch.
		Open circuit in start or run winding.	Remove end bell and check for broken wires. Check with test light for continuity. If open, return to Endicott.
	Runs slowly and unevenly and heats excessively.	Starting switch not opening.	Check centrifugal throwout springs. Check contacts.
		Bearings gummed or worn.	Remove old lubricant. Clean shaft and bearing. Add new lubricant.
		Capacitor in run circuit open or shorted.	Replace capacitor.
	D.C. and Universal	Fails to start.	Thermal element in thermal overload switch burned out or switch tripped.
Open circuit to motor.			Check with test light for power to motor.
Brushes not making contact with commutator.			Check for sticking brushes and replace worn brushes.
Runs slowly and overheats.		Open circuit in field coil.	Remove end bell and check for broken wires. Check with test light for continuity. If open, return to Endicott.
		Dirty or rough commutator.	Clean and smooth with 5-0 sandpaper; if very rough turn down armature in lathe.
		Shorted commutator segments or high mica.	Clean between segments and undercut mica.
Generators	Fails to "build up."	Shorted windings on armature.	Return to Endicott.
		Open resistor in series with field coil.	Replace resistor.
	Voltage low.	Open field coil.	Return to Endicott.
		Too much resistance in field.	Adjust variable resistor for lower resistance.
		Brushes not making good contact with commutator.	Check for sticking brushes and replace worn brushes.
		Commutator dirty or rough, or high resistance short between bars.	Undercut between commutator bars. Clean and smooth with 5-0 sandpaper, if very rough turn down armature in lathe.
		Short circuit on output.	Remove short.
		Short in armature windings.	Return to Endicott.
Input voltage low on D.C.	Increase input voltage.		

# MOTOR AND GENERATOR SUMMARY

MACHINE TYPE NO.	A.C.—D.C.—UNIV	H.P.	MANUFACTURER	SHAFT SIZE	LUBRICANT
075, 080	A.C. D.C.	1/4	G. E. or Westinghouse	5/8"	9
405	A.C.	1	Westinghouse	3/4"	21
			Holtzer-Cabot	5/8"	21
	D.C.	1	Holtzer-Cabot	5/8"	21
	Gen.		Westinghouse	5/8"	21
			Holtzer-Cabot	5/8"	21
513	A.C.	1/4	G. E.	1/2"	9
	D.C.	1/4	G. E.	1/2"	9
	A.C. Combination	1	Westinghouse		21
			Elec. Spec.		21
	D.C. Combination	1	Elec. Spec.		21
601	A.C.	1/2	G. E.	3/4"	9
	D.C.	1/2	G. E.	3/4"	9
	Gen.		Westinghouse	1/2"	9
285	Drive-D.C.	1/8	G. E. or West.	5/8"	9
	Reset-D.C.	1/8 - 1/16	G. E.	1/2"	15
	Dynamotor		Elec. Spec. Co.		21
921	40 Volt D.C.	1/100	Robbins and Meyers	3/16"	9
	110 Volt D.C.				
801	A.C. Combination	1/4	Westinghouse or Robbins & Meyers		15
	D.C. Combination	1/4			15
016, 031	A.C.	1/60	G. E. and Westinghouse		9
	D.C.	1/60			9
034, 035 036	A.C.	1/4	G. E. or Westinghouse	5/8"	9
	D.C.				
	Gen.		G. E.	1/2"	9
954	A.C.	1/20	G. E.		9
	D.C.				
077, 552	A.C.	1/4	G. E. or Westinghouse	5/8"	9
	D.C.				
	Gen.		IBM	1/2"	9
			Westinghouse	5/8"	
805	A.C. or D.C.	1/10	Robbins & Meyers		9 & 21