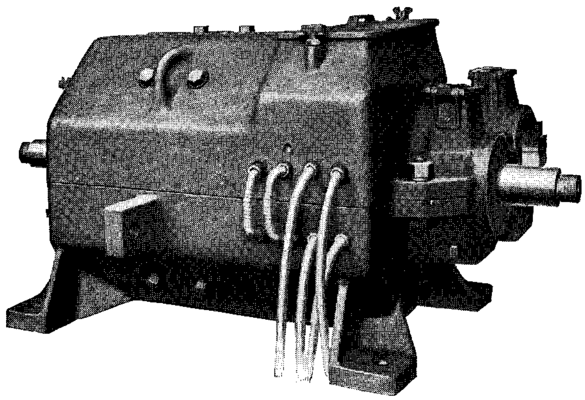
Westinghouse Steel Mill Type Direct-Current Motors

AND

Brakes



Westinghouse Type MCB Mill Motor Showing Location of Leads.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

IMPORTANT

Keep the motor clean. The most perfect installation may cause an expensive delay if it does not have proper inspection and care. The insulation must be kept clean and dry. Oil and dirt in the insulation are as much out of place as grit or sand in a bearing. In the severe service for which mill motors are built, many abuses which shorten the life of a motor and increase operating expenses can be eliminated.

Before installing or operating a motor, read the following instructions carefully and check the points to be observed.

The operating man with a large number of mill motors should check each drive under the points outlined, and may find that his maintenance expense can be materially decreased.

The importance of taking care of equipment and of saving by careful operation with motors properly applied, cannot be over-emphasized.

GENERAL INFORMATION

Westinghouse Direct-Current Mill Motors, types MC and MCO, are applicable to intermittent service such as operating steel mill auxiliaries, cranes, contractors' hoists, mine hoists, railway turn tables, transfer tables, railway lift bridges, draw-bridges, etc.

The applications in steel mills where these types are most desirable are cranes, ore bridges, roller tables, manipulator side guards, screw-downs, tilting fingers, transfer lift table mechanisms, etc., where the periods of operation are short and high momentary torques are required. The types MC and MCO motors are of a special very rugged construction, both designed to operate under the most severe service and to withstand the mechanical shocks to which mill motors are subjected. This service is in most cases intermittent. The type MC is a totally enclosed motor and the type MCO an open motor.

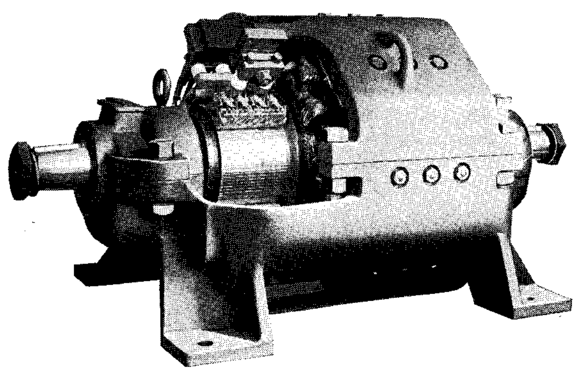


FIG. 1—WESTINGHOUSE TYPE MCOA MILL MOTOR SHOWING OPEN CONSTRUCTION OF MOTOR

For convenience in specifying motors on orders the type MC motor without countershaft brackets is known as a type MCA, with countershaft brackets as type MCB. Similarly the type MCO motor without countershaft brackets is known as the type MCOA, and with countershaft brackets as type MCOB.

The two lines are developed with and without axle brackets, and with either series or compound fields, and all motors are equipped with interpoles. Either plugging or dynamic braking can be used to obtain quick stopping. Where the friction load is low and quick reversing is wanted, it is better to use compound-wound motors and plugging control. When motors are plugged at high speeds, more than double voltage may be impressed upon the armature. The use of a light shunt field winding limits the light load speed and the heavy plugging current. When quick stopping is desired, the use of a compound-wound motor and dynamic braking is preferable.

GENERAL DESCRIPTION AND DETAILS OF CONSTRUCTION

FRAME:

The frames are cast steel and machined. By building the frames in two halves which are bolted together, the operator is able to get at the armature or fields for repairs by unloosening four nuts and lifting the top half off bodily.

In the smaller motors, frames 20 to 50, inclusive, lugs are bolted to the frames and a hinge bolt used. With the smaller sizes no crane is necessary as the top half of the frame can be swung back on the hinge and the repairs easily made.

Heavy feet are cast on the bottom half of the frame and when properly bolted down, the motor is permanently and rigidly held in place.

Two holes are drilled in the bottom of the frame for the purpose of drawing off waste oil or water in the motor due to condensation or other causes.

FIELD CIRCUIT:

Poles.—The pole pieces are built up of steel laminations riveted together. They fit against machined seats which are cast on the frame and are drawn tight by bolts which pierce the frame and thread into the laminated pole piece. The interpoles are also laminated and held to their seats by bolts.

Field Coils.—The field coils are machine wound on forms. The coils for each size of machine having the same characteristics are interchangeable. Series and interpole field coils are strap wound for the larger sizes and wire wound for the smaller sizes with asbestos covered square wire. Shunt field coils are wound with wire with a tough enamel coating and single cotton covering. They are then impregnated and dipped in bakelite so that they successfully resist high temperatures. In the coils for compound-wound machines, the series and shunt coils are taped up separately and put on the pole pieces as independent units.

It is an easy matter to change a series-wound motor to a compound-wound motor, or a compound-wound motor to a series-wound motor. It is only necessary to replace the windings on the four main poles and properly connect them.

Field Coil Leads.—The leads of all the series and shunt coils are brought out at the commutator end where they can be easily inspected through the opening.

Flexible leads are brought out from inside series and interpole coils. Where strap wound coils are used, flexible cable is soldered on the strap inside and where wire wound coils are used, the wire of the coil is brought out. The flexible leads are soldered in sleeve connections which prove to be simple and solid connections between coils.

All field coils are alike, proper polarity being obtained by wiring around frame connections.

The leads pass through the frame in soft rubber bushings and are so arranged that any disconnecting necessary to separate the frame can be done outside the motor.

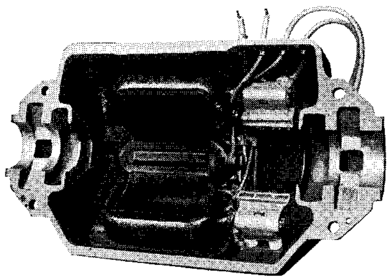


Fig. 2—Upper Half of Type MC Motor Frame

Field Coil Bracing.—The field coils are held between the overhanging pole piece and the frame, and are braced in position by a heavy steel spring between the coil and the frame. The spring is seated on pads which are cast on the frame and machined, insuring uniform assembly of all poles and coils.

Steel liners are used between the spring and the coils to insure a large bearing surface and to protect the coils.

The figures and field wiring diagrams in the back of the book show the connections for every motor.

ARMATURE ASSEMBLY:

The armature laminations are assembled on a steel spider and are held rigidly in position between end plates. The rear end plate is pressed on the spider and the front end plate is held in position by a ring key which is sprung in place. The commutator is assembled separately as a unit with the standard V-ring construction and pressed on the main spider. The shaft is also pressed in position. Oil wipers keep the oil from creeping along the shaft.

Armature Coils.—The armature coils are form wound with mica and asbestos insulation and dipped in insulating varnish. Coils for machines of the same size and voltage are interchangeable.

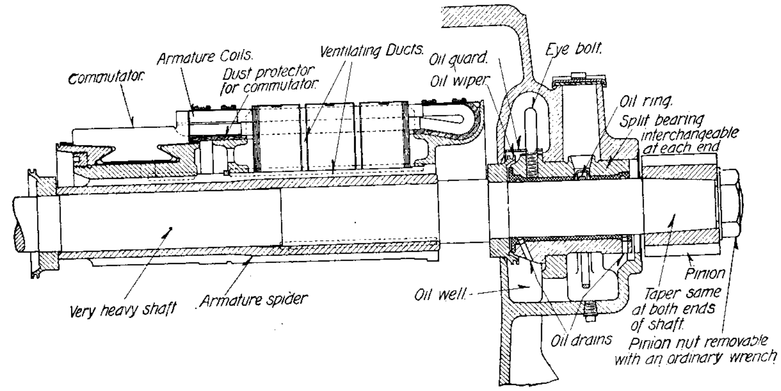


Fig. 3—Cross-Section of Armature and Bearing

After the coils are placed in the slots and temporary bands put in position, the armature is heated, then permanent bands are put on while the armature is hot. The heating tends to soften the insulation and the parmanent band put on after this, draws the coil down to its final position so that there is no loosening of coils or bands in service. When the armature is properly wound, the core bands will rest both on the armature coil and armature teeth. No wedges are used.

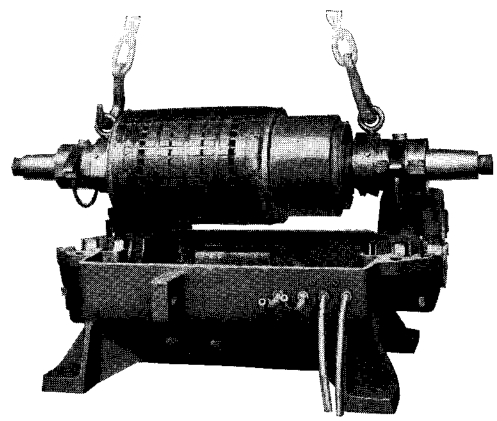


Fig. 4—Removing Armature and Bearings

Commutator.—All commutators are of the standard V-ring construction. They are first assembled as a separate unit and thoroughly seasoned and are then pressed on the armature spider. The front V-ring is wrapped with insulating cambric tape which is given several coats of insulating varnish.

White mica segments are used between bars on all commutators and all commutators are under-cut. The commutators are assembled on a shell which is forced on the same spider that carries the armature, and it is possible to press out the shaft without disturbing the commutator or windings.

BEARINGS:

The bearings consist of cast iron shells made in halves bolted together and lined with high grade babbitt. They are provided with eye bolts for the purpose of easy removal or replacement of armatures. It is feasible to carry spare armatures equipped with pinion, bearings and brake in some cases, so that delay in changing armatures can be reduced to a minimum.

Ring oiling is used with brass tube overflows to regulate the height of oil carried in the reservoir. Tin funnels are provided in the bearings so that the oiler will be able to get oil to the right place without getting it in the split between frames. When desired, bearings are arranged for grease lubrication.

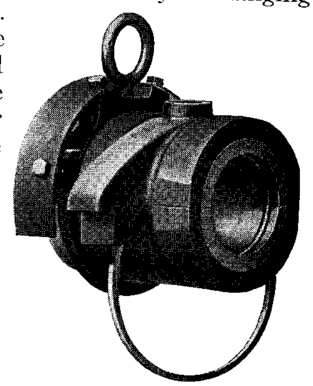


FIG. 5—ARMATURE BEARING AND OIL RING

BRUSHES AND BRUSHHOLDERS:

The brushes are set permanently at the neutral point before the motors leave the works. The spring tension is carefully adjusted when the motors are tested at the works and the design of the brushholder is such that a uniform brush tension is maintained throughout the life of the brush.

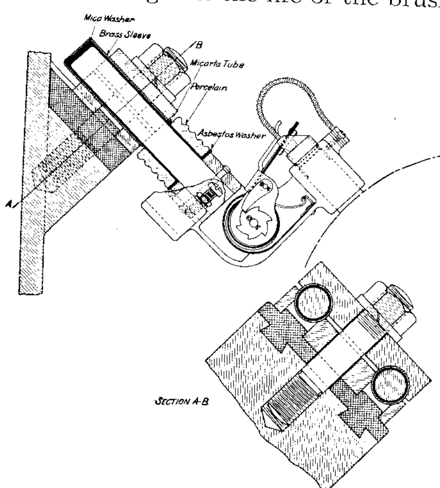


FIG. 6—CROSS-SECTION OF BRUSHHOLDER

In case it becomes necessary to increase or decrease the spring tension in service on all motors larger than frame 30, the ratchet on the side of the brushholder may be turned with a screwdriver until the desired tension is obtained. Radial adjustment of the brushholders is possible to compensate for commutator wear. The brushes used are radial and of sufficient size to give a low current density. Brush shunts are used on all brushes.

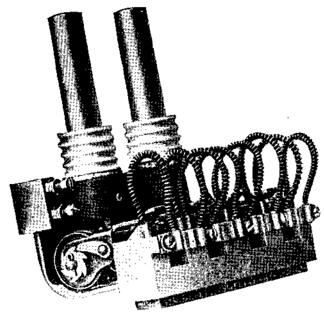


FIG. 7—BRUSHHOLDER

COVERS:

Openings are provided on front and back side of the type MC motors for inspection. When operating conditions permit, the covers can be removed, improving the ventilation and increasing the capacity of the motors somewhat. The large opening over the commutator permits the easy inspection of commutator and brushholders and easy replacement of brushes. A wire gauze cover can sometimes be made use of.

GENERAL INSTRUCTIONS WHEN INSTALLING MOTORS

Upon receipt of the motors, place them in a dry and sheltered position.

It is easily possible by rough handling or careless use of bars or hooks to do more damage to a machine than it would receive in years of regular service. Bear in mind that the armature is liable to damage, since its own weight is sufficient to crush the winding or damage the commutator if it is lowered on or swung against a projection.

If machines have been exposed to moisture, they should be carefully baked until thoroughly dry. This can also be done by passing an electric current through the winding. This current should be about one-half the full load current and should be controlled by a suitable rheostat.

ERECTION AND ALIGNMENT:

Motors should in all cases be located where they are accessible for inspection.

When possible, motors should be set level on substantial and solid foundations and should be bolted down tight. On tilting tables, motors will sometimes operate satisfactorily at an angle of as much as 15°.

Care should be taken in the alignment of the motor and gearing to eliminate vibration, the worst enemy to successful operation.

These motors have been designed to give successful operation under the most severe conditions, but as far as possible the location should be free from dust, dirt drippings and clouds of wet steam. When installed outdoors, a rain-proof shelter should be provided for the type MCO motors.

Drains should be provided so that excessive oil will not collect around the motor.

STARTING:

Before starting, the bearings should be inspected to see that they are clean and free from grit. The oil reservoirs should be filled to the overflow and the rings inspected to see that they turn freely.

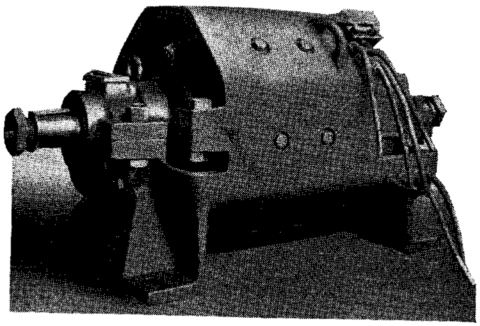


Fig. 8—Type MCOA Motor from End Opposite Commutator End Showing Leads

All electrical connections should be looked over and inspected for loose joints or defective insulation. When automatic control is used, the control operation can be checked from the master before the line switch is closed.

BRUSHES:

Inspect brushes to see that all are sliding freely in the holders. See that spring tension is uniform. The following spring tension for various size brushes used with type MC and type MCO motors is recommended:—

Brush Size.	Approx. Spring Tension.
½″ x 1½″	4½ lbs.
½″ x 1¾″	4½ lbs.
½″ x 2″	4½ lbs.
⅝″ x 1¾″	4¾ lbs.
¾″ x 1½″	4¾ lbs.
¾″ x 2	5¼ lbs.
1″ x 2″	5¾ lbs.

If brushes are not ground to fit the commutator, this should be done.

With brushes bearing on commutator, lift them enough to permit a sheet of sandpaper to be inserted. Draw the sandpaper back and forth, being careful to keep the ends of the sandpaper close to the commutator so as to keep from rounding the edges of the brushes. Emery cloth or paper should never be used.

To aid in obtaining a polished commutator when first starting, a very little paraffine is sometimes used. This can be applied with the motor running with a canvas cloth saturated with paraffine.

MAINTENANCE

INSPECTION:

It is important that motors be given frequent and intelligent inspection to insure the most successful operation. This should be done at regular intervals.

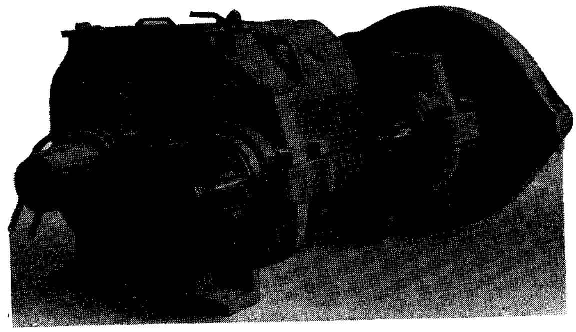


Fig. 9.—Type MCB Motor Showing Shaft Guard, Countershaft Bearings and Gear Case.

OILING:

Bearings should be regularly and intelligently oiled with a good grade of engine oil. Flooding bearings with oil by careless oilers may cause oil to reach the commutator by creeping which will cause the mica to deteriorate. At regular intervals, the bearings should be drained through the tap hole at the bottom and cleaned and refilled with fresh, clean oil.

BLOWING-OUT:

Dirt and dust are enemies to successful operation.

At regular shut-down intervals, the motor should be blown out with an air hose. An air pressure of 25-30 pounds should be used.

Commutator should be wiped off occassionally with a piece of canvas. Do not use waste. When kept clean the commutator will acquire a dark brown color and will not require anything more than an occasional wiping. The bottom drain holes in frame should be kept open.

BRUSHES:

Brushes should be inspected at intervals for signs of trouble or excessive wear and replaced with new ones when needed. When replacing worn out brushes, an inferior grade of brush should never be used.

TROUBLES

SPARKING AT COMMUTATOR:

Sparking may be due to either mechanical or electrical causes. If the former is responsible, sparks are usually small "pin sparks" caused by breaking the contact between brush and commutator or small "streamers" caused by particles of carbon breaking off the brushes. In either case the sparking varies little, if any, between light load and full load. If the sparking is due to electrical causes, the sparking varies greatly as the load is increased, and the sparks are larger and have more snap or bite. The brush contact surface is usually a true indication of the cause of sparking. If the surface is eaten away or honey-combed, the sparking is almost sure to be due to electrical causes.

The more usual mechanical causes of sparking are:—

1. **Rough commutator that is pitted.** Commutator should be turned down.

2. **Rough commutator with high bar.** Tighten up V-ring and turn off high bar.

3. **High Mica.** A piece of fine sandstone should be ground to fit the commutator and held firmly against it while it revolves. Mica should be undercut.

4. **Flat Spots.** These may be caused by a loose bar, rough commutator, soft copper in one spot or by severe flashing. In this case the commutator should be turned down in a lathe.

5. **Low or Burned-Out Mica.** This will show itself in ring fire or tiny sparks will be carried all the way around the commutator. The commutator may get excessively hot. It is caused by allowing the mica to become oil soaked after which it chars and burns out between bars, or by mica flaking out between bars. In either case, foreign conducting material gets in and aggrevates the trouble.

When this occurs, it may be effectively stopped by scraping out the burned mica and filling the space with a solution of sodium silicate (water glass) or other suitable commutator cement.

6. **Ring Fire.** This may be caused by low or burned mica or by dirt or oil collecting on the commutator. In the latter case, the commutator may be cleaned by holding a piece of clean canvas against it while rotating. The canvas may have a small amount of clean lubricating oil on it. In this case, the commutator should be wiped again with a dry cloth. Cotton waste should not be used for this purpose.

7. **Oil Creeping.** An excessive amount of oil on the machine frame or careless oiling will result in oil creeping on the shaft and V-ring. On reaching the commutator, this will result in ring fire as noted above.

series-wound. By checking with a graphic meter, the "plugging" peak can be determined, and on automatic controllers the proper increase can be made in resistance to limit the current on "plug" to the proper value automatically. The amount of resistance required varies with the light running load.

HOT BEARINGS:

When bearings exceed 75° C. by thermometer, they are over-heated from one or more of the following causes:—

1. **The lubricant used may be a poor grade or may be dirty.** Foreign substance in the oil can be avoided by using only filtered oil.
2. **Insufficient oil.** The oil reservoir should be kept filled just to the overflow.
3. **Failure of oil rings to revolve.** A ring may stick when motor is first put in service.
4. **Poor alignment—end thrust.** If motor and gear are not in proper alignment, end thrust will result under load and one bearing may over-heat.
5. **Bent shaft.** This will cause chafing and over-heating of bearing.
6. **Worn bearings—Re-babbitting.** Bearings may be worn out and should be re-babbitted with a good grade of babbitt.

REPAIRS

REPAIRING ARMATURES:

1. **Removal of armature—care of commutator.** It is very easy to remove the armature from the motor by lifting it at the eye bolts in the bearings. The armature should be hung in a suitable wooden cradle where it can be inspected.

2. **Replacing single coils.** In case of a short-circuit or open circuit in one of the coils of a two-circuit armature, temporary repairs can be made by cutting both commutator leads of the effected coil and its mate with which it is in series and putting jumpers on commutator bars thus cut out, these bars are diametrically opposite on the commutator. This method of keeping an armature in commission should not be resorted to when several adjacent coils are damaged.

Damaged coils can be replaced if care is used in handling other coils while the injured coils are being removed. In this case it will be necessary to remove armature bands and reband after repairs are made.

3. **Complete rewinding of armatures.**

(a) *Removing commutator.*

The oil wiper or guard at the commutator end is first removed by a clamp and tie rods taking a bearing in back of the wiper and on the end of the shaft. The armature coils are then disconnected from the commutator and the leads opened out to permit passing clamping bars on each side of the shaft between the commutator and the armature core. By using tie rods and a cross bar bearing on the shaft, the commutator can be pulled off. Similar methods can be used in replacing commutator, taking a bearing on the opposite end of the shaft. In doing this work, care should be used not to batter the ends of the shaft or injure the commutator.

(b) *Rewinding.*

After old banding is removed and coils are stripped out clean, the slots should be gone over with a rough file for any burrs or sharp edges in the slots.

In rewinding, the work should be done by a skilled armature winder. Instructions giving throw on various frames are given on page 31. Slot installation should be obtained from the factory.

(c) *Banding.*

This should be done the same as at the works or as near that as possible.

(d) *Checking for grounds, shorts or open circuits.*

At the works commutators are checked before being put on the armature. A lighting circuit with a lamp in series is connected across adjacent bars all the way around the commutator. If it lights the bars are shorted. After this all bars are shorted and test taken from bars to the V-ring. If lamp lights, commutator is grounded. For this latter purpose a transformer testing box should be used if possible. The proper testing voltage can be obtained from the works.

After commutator has been checked and put in place and connected to armature leads, the armature itself should be checked for shorts, open circuits and grounds.

At the shop an alternating-current magnet is used for testing for open and short circuits. The wound armature is placed in the field of the magnet and a piece of curved sheet iron is rested on the armature core while it is resolved slowly by hand in the magnet field. If the iron is sucked down against the core, a short is indicated. This or an open circuit can then be found by shorting adjacent commutator bars with a knife edge. If no short or open circuit is present, this will be indicated by sparking between all adjacent bars. When there is no spark, the coil or coils connected to these bars are open or short circuited. Both leads from the coils should be disconnected and tested out with a lighting circuit until the defective coil or connection is found.

The No. 103 230-volt armature is lap wound. This, as is the case with all lap wound armatures, cannot be tested out as outlined in the preceding paragraph on account of the presence of cross connections which must be used on this type of winding.

If such a magnet is not available, the check can be made as follows:—Connect a source of potential across the armature at two points 90° apart. This should be controlled by resistance to give about one-half full load current. Using a low reading volt-meter or milivolt meter, check the drop between adjacent bars. If no short or open is present, all readings will be approximately the same. If winding has short or open circuit, it can be detected by the difference in voltage readings obtained from bar to bar.

For testing for grounds, a testing transformer should be used and the motor subjected to the proper voltage. This is 1500 volts for repaired motors. New armatures are tested at 2400 volts.

(e) *Removing shaft.*

The armature and commutator are mounted on a spider. To remove the shaft, the front oil wiper must be pulled off, then

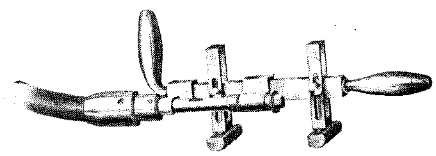


FIG. 10—MOTOR OPERATED SLOTTING TOOLS

the armature should be placed in a press and blocking applied to bear on the hub of the spider. **Pressure should be applied to the commutator end of the shaft.** The armature should be carefully lined up in the press to avoid slippage and damage to spider, commutator or winding. Care should be taken to avoid battering up the ends of the shaft.

(f) *Turning commutator.*

On turning down a commutator, a diamond point tool should be used. This will be set with the cutting edge at right angles to the work and will give a very smooth finish. The best speed for this is from 500 to 600 f.p.m. Care should be taken in putting the armature in the lathe not to damage the shaft centers and to have the work run true.

(g) *Undercutting.*

The mica should be kept undercut to a depth of from 1-32" to $\frac{1}{16}$ inch. This should be done with a regular tool for this purpose. The Westinghouse Electric & Manufacturing Co. carries undercutting tools for motor operation. See Fig. 10. After undercutting, the edges of the bars should be scraped and well rounded off so that no copper burrs extend across the undercut slot.

REPAIRING FIELDS:

When field repairs are made without taking the motor out of operation, a single coil is generally repaired and no check is made on the others. In the case of shunt field coils all coils should be checked, as the other coils may be damaged. With current in the coils, polarity can be checked with a compass and in the case of compound-wound motors, care should be taken that series and shunt fields agree. These can be checked one at a time.

To remove the field coils, the bolts holding the pole piece must be taken out when the pole piece and coil can be removed from the frame after which the coil can be removed from the pole piece.

In replacing the field coils, care should be taken to place them so that the leads come in position shown in the corresponding diagram. (See back of book).

The coils should be carefully handled and in the case of the shunt coils, care should be used not to use so many liners behind the coil as to crush it and start short circuit between turns, when the pole piece bolts are tightened.

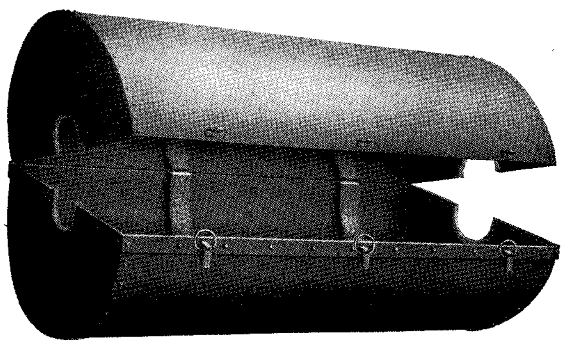


FIG. 11—STEEL ENVELOPE FOR SPARE ARMATURES

RE-BABBITTING BEARINGS:

The bearing shells may be refilled with babbitt by assembling them on a mandrel of suitable size. Paper or sheet iron liners should be used to separate the two halves, channels being provided for the babbitt to flow through or the two halves can be filled separately. Care should be taken to prevent the babbitt filling the oil groove at the center of the top shell and the two oil drain holes at the ends of the lower shell. Oil guard grooves should be chipped around the bearings at each end and connected with the two drains. The best grade of genuine babbitt should be used for pouring motor bearings. After pouring the bearing should be scraped or bored and reamed to fit.

CARE OF REPAIRED ARMATURES:

After an armature is repaired, it will sometimes be allowed to lie around the mill until needed and may suffer damage before it is needed. The use of a steel envelope is recommended similar to that shown in Fig. 11. The weight of the armature is carried by bearings and when it is needed it will be in the same condition as when it left the repair shop.

SPARE PARTS

It is important that a full line of spare parts be carried. For this reason, it is advisable to carry complete spare motors which can be dropped in place in a very short time and repair work done later. Repairs on mill motors should be done in the shop where facilities are present for skillful work.

DONT'S

1. Don't use emery cloth or paper on commutator.
2. Don't let armature weight rest on end coils or commutator.
3. Don't run without oil.
4. Don't flood motor with oil.
5. Don't use acid flux when soldering electrical connections.
6. Don't let water or steam play on commutator.
7. Don't let an old motor wreck itself because of worn out bearings.
8. Don't let brushes wear until contact is broken.
9. Don't delay repairs.

METHOD OF CHECKING LOAD CYCLE AGAINST RATING SHEETS OF MOTOR

Fig. 12 represents current curve which is obtained from an application where the motor is brought up to speed and then plugged and reversed. Three accelerating switches are used and it is assumed that the plugging resistance is such as to give constant peaks when the line switch and accelerating switches come in after plugging. Such a curve is obtained in reversing main roll table applications.

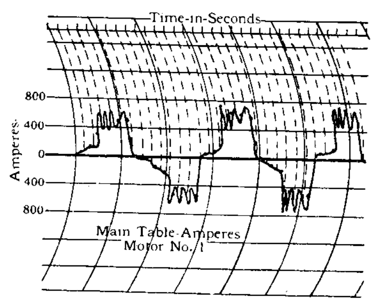


Fig. 12—Analysis of Load Curve

To check load cycle with the paper speed known, divide the curve into second or half second periods as shown by dotted lines. Mark the middle point of each section on the curve as shown. Square the current value at each of these middle points and add the results. Divide by the number of periods taken and take the square root of the quotient. This value will now be the R.M.S. current over the period chosen and if a cycle has been used which is representative of the operation for any length of time, one-half hour, 1 hour, 5 hours, etc., by checking the current rating for one-half, 1, 5 hours, etc., from the rating sheet, it can be seen at once whether the motor is suitable or whether a motor of higher or lower capacity should be used.

DIRECT CURRENT MAGNET BRAKES TYPE B

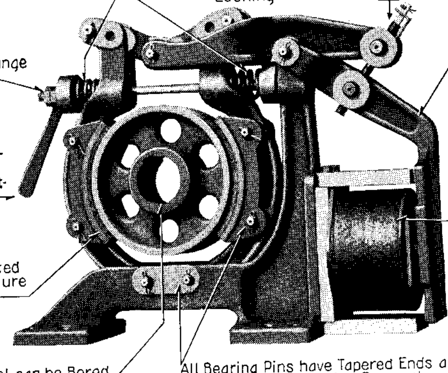


FIG. 13—TYPE B MAGNET-OPERATED BRAKE

BRAKE APPLICATIONS

On application where quick, accurate stopping is wanted, such as in screwdowns, side-guards, manipulator fingers, etc., or when it is desired to hold the load when power is off, such as in crane service, magnetic brakes should be used.

Type B brakes operate on the well known toggle principle, the brake setting and releasing as power goes off or on. The

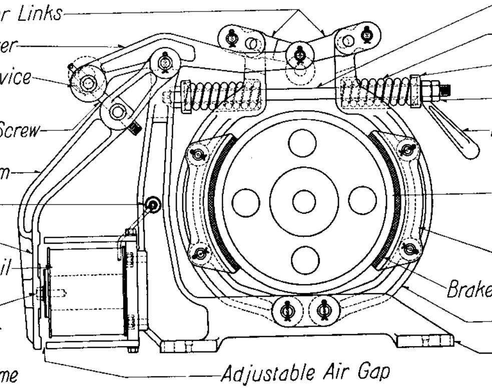


FIG. 14—OUTLINE OF TYPE B MAGNET-OPERATED BRAKE FRAMES NOS. 10, 100, AND 200

brakes can be equipped with either series or shunt operating coils. The series brakes are used on service, employing dynamic braking such as crane hoists and the majority of steel mill applications. Shunt brakes are required under the following conditions:—

a. Where a drift point is required as on lift bridges, trolley motion of ore bridges and similar applications.

b. Where the motor current passes through a low point at some time during the cycle.

c. In some cases where resistance is used in shunt with the armature to obtain slow-down, as on skip hoists, bell hoists and car dumpers.

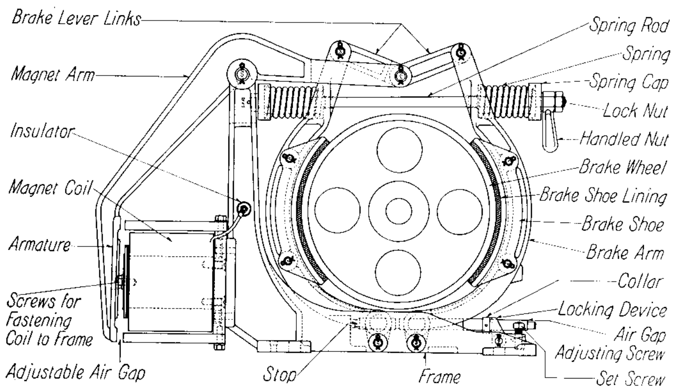


FIG. 15—DIAGRAM OF TYPE B MAGNET-OPERATED BRAKE FRAME NO. 300

All shunt coils are wound for low voltage and are equipped with an adjustable series resistor and discharge resistor.

In general, series brakes should be used where possible, as they are faster in operation than the shunt brakes, on account of the lower inductance of the series coil.

Brakes with series coils will release the shoes at 40% of the rated motor current with springs set for torque given in the table. For example, coils can be supplied for use with the No. 10 brake which is used with No. 20 type MC motor which will release the shoes at 40% of the continuous current if the spring is set to give 30 pounds torque; at 40% of the one hour rated current if the spring is set to give 50 pounds torque; and at 40% of the half hour rating if the coil is set to give 70 pounds torque. Higher releasing torques can be obtained by tightening springs and in this case the releasing current will be higher.

Brake Frame No.	MC or MCO Motor Frame No.	Max. Brake Torque in Lbs. at 1 Ft. Radius			Max. Hp.	Max. Safe Rpm. of Brake Wheel
		†½ Hour	†1 Hour	†Continuous		
10	20	70	50	30	25	2400
100	{30, 40}	250	175	110	55	2000
200	{50, 60, 70}	1000	700	400	150	1300
300	{80, 90, 100, 103}	3200	2000	800	400	1000

†Heating cycle of magnet. This should be the same as that of the motor with which it is used.

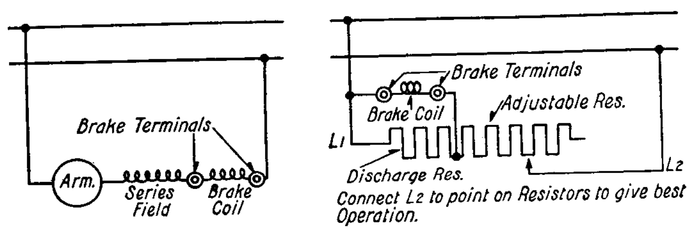


Fig. 16—Series Coil | Fig. 17—Shunt Coil

Diagrams of Connections

MOUNTING:

When mounting the type B brake, the brake wheel should be exactly centered between the brake arms when the brake is in the released position.

In case the distance from center line of the brake wheel and the bottom of the brake is less than the corresponding dimension of the motor, steel or iron plates of the necessary thickness can be placed beneath the brake frame or base.

Electrical connections should be made according to Figures 16 and 17.

AIR GAP ADJUSTMENT:

The following table gives the air gaps to which the magnet armature and core should be adjusted:—

Brake Frame No.	Air Gap.
10	¼ inch.
100	⅜ inch.
200	½ inch.
300	⅞ inch.

The brakes should be inspected at regular intervals and, as the shoes wear, the adjustable air gap should be set as near as possible to the dimensions given in the air gap table. The time interval of inspection will vary with the conditions under which the brake is operating. A brake operating at its full torque rating will require adjustment more often than a brake that is operating at only 50% of its torque rating. This time interval can be determined by experience. The adjustment of the air gap on Frames No. 10, 100 and 200 is by means of the air gap adjusting screw, shown in Figure 14. Remove the locking device and turn the screw until the brake arm drops to the point for the desired air gap. Replace the locking device after each setting.

Figure 15 shows the device in the base of the frame for making the necessary air gap adjustment of the No. 300 brake frame. Loosen the set screw so as to allow the locking device to clear the collar on the adjusting screw. Turn the adjusting screw until the proper air gap is obtained. After making the adjustment, tighten the set screw securely, forcing the locking device over the collar and the adjusting screw against the stop.

On all brake frames except the No. 300, provision is made for changing the pins in the brake lever links of the toggle when all possible adjustment of air gap has been made with the pins in the position shown in Figure 14. To make the change, insert the pins in the new holes, and turn the air gap adjusting screw until the necessary setting of the air gap is obtained.

ADJUSTING THE RETARDING OR HOLDING TORQUE

Turn the handled nut on the spring supporting rod to the right to increase torque and to the left to decrease torque. The best setting of the spring tension to suit the application is obtained by trial after the brake is installed. After the proper setting is found, fasten the handled nut in position by means of the lock nut furnished.

MAINTENANCE

REPLACING WORN BRAKE SHOES:

Take off handled nut and remove spring supporting rod. Take out the pin holding the brake lever links of the toggle, remove the two pins securing the brake shoe to the brake arm and slip shoe up over brake wheel and out.

REPLACING COILS:

Disconnect the leads and remove the two screws fastening the coil to the magnet base. Lift the magnet arm and slip coil out over the core.

REPAIR PARTS

When ordering repair parts, specify the name of the part wanted, referring to the accompanying illustrations and give the style and number and stock order number of the brake and the voltage of the circuit on which it is used. The style number of the brake will be found stamped on the name plate.

WIRING DIAGRAMS SHOWING CONNECTIONS AROUND FRAME

MOTOR VIEWED FROM COMMUTATOR END

The diagrams show connections for compound-wound motors. For series-wound motors use the same diagrams, omitting the shunt winding and leads f + and f—.

For field coil connections, see figs. 24 to 30.

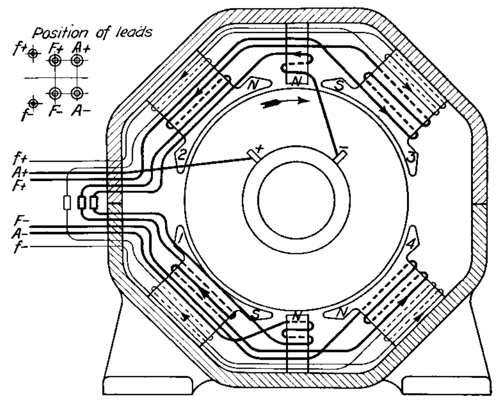


FIG. 18—TYPE MC MOTOR FRAMES 20 TO 80 INCLUSIVE

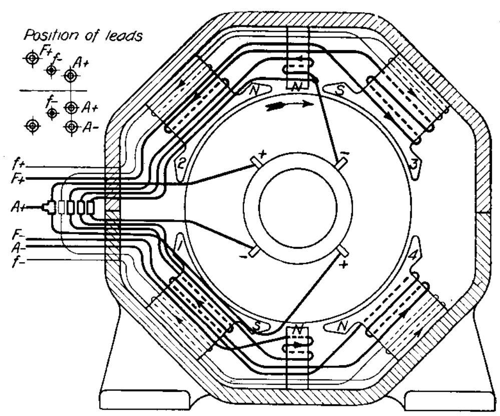


FIG. 19—TYPE MC MOTOR FRAMES 90 AND 100 AND 103 WITH TWO-CIRCUIT ARMATURE.

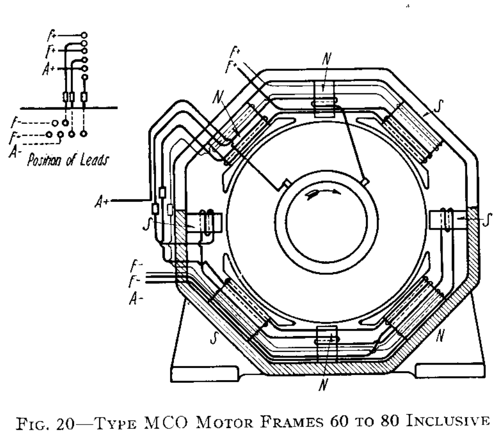


FIG. 20—TYPE MCO MOTOR FRAMES 60 TO 80 INCLUSIVE

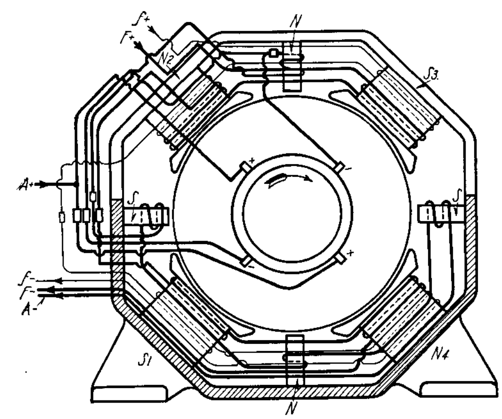


FIG. 21—TYPE MCO MOTOR FRAMES 90 AND 100 AND 103 WITH TWO-CIRCUIT ARMATURE

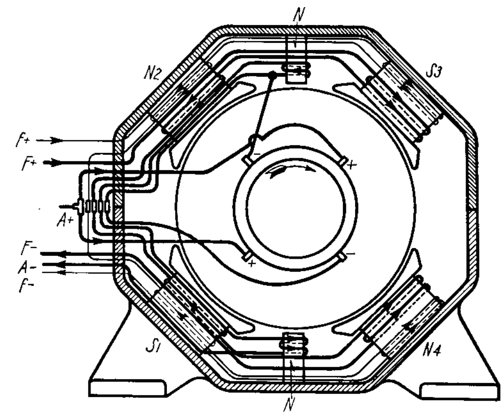


Fig. 22—Type MC Motor Frame 103 with Multiple Wound Armature

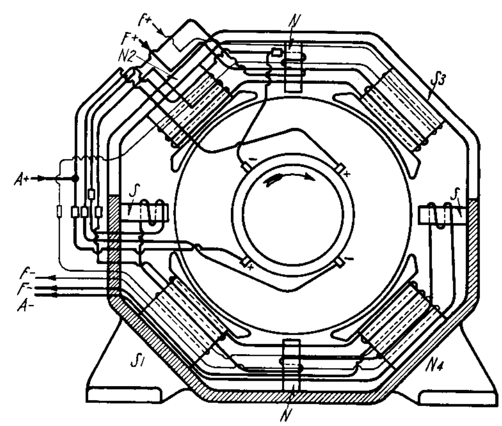


Fig. 23—Type MCO Motor Frame 103 with Multiple Wound Armature

DIAGRAMS SHOWING CONNECTIONS OF FIELD COILS

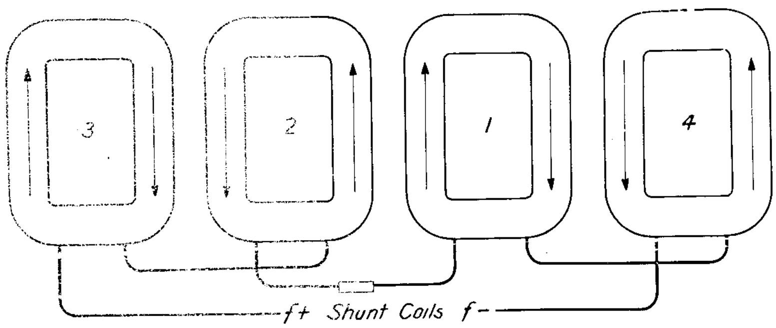


FIG. 24—CONNECTIONS FOR SHUNT COILS FOR ALL TYPE MC AND MCO COMPOUND-WOUND MOTORS

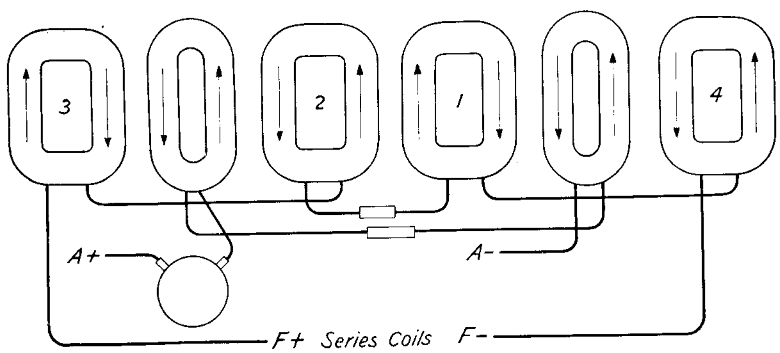


FIG. 25—CONNECTIONS FOR SERIES-WOUND MOTORS AND FOR SERIES AND COMMUTATING-POLE COILS OF COMPOUND-WOUND MOTORS—TYPE MC MOTOR FRAMES 20 TO 80 INCLUSIVE

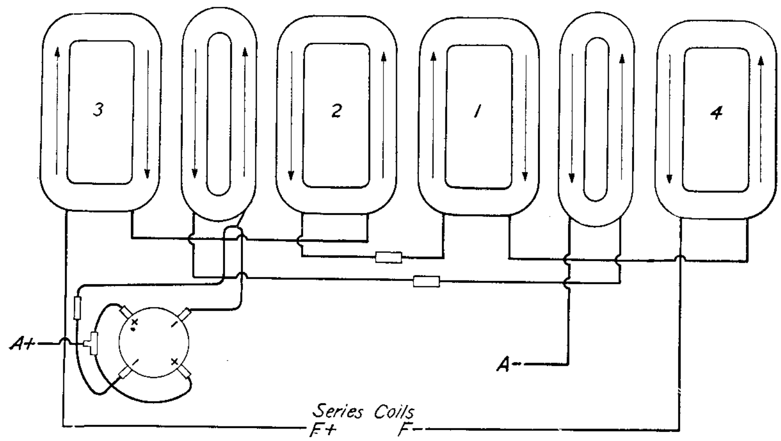


FIG. 26—CONNECTIONS FOR SERIES-WOUND MOTORS AND FOR SERIES AND COMMUTATING-POLE COILS OF COMPOUND-WOUND MOTORS—TYPE MC MOTOR FRAMES 90 AND 100. AND 103 WITH TWO-CIRCUIT ARMATURE.

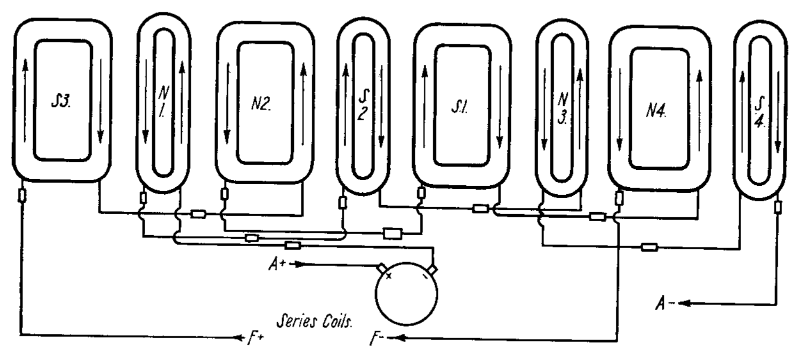


FIG. 27—CONNECTIONS FOR SERIES-WOUND MOTORS AND FOR SERIES AND COMMUTATING-POLE COILS OF COMPOUND-WOUND MOTORS—TYPE MCO MOTOR FRAMES 60 TO 80 INCLUSIVE

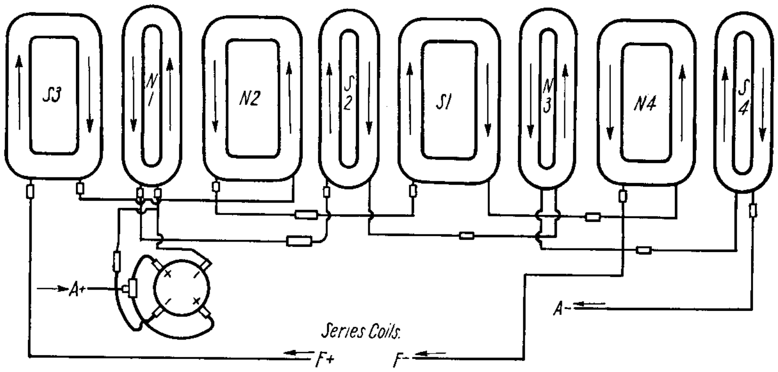


FIG. 28—CONNECTIONS FOR SERIES-WOUND MOTORS AND FOR SERIES AND COMMUTATING-POLE COILS OF COMPOUND-WOUND MOTORS—TYPE MCO MOTOR FRAMES 90 AND 100 AND 103 WITH TWO-CIRCUIT ARMATURE.

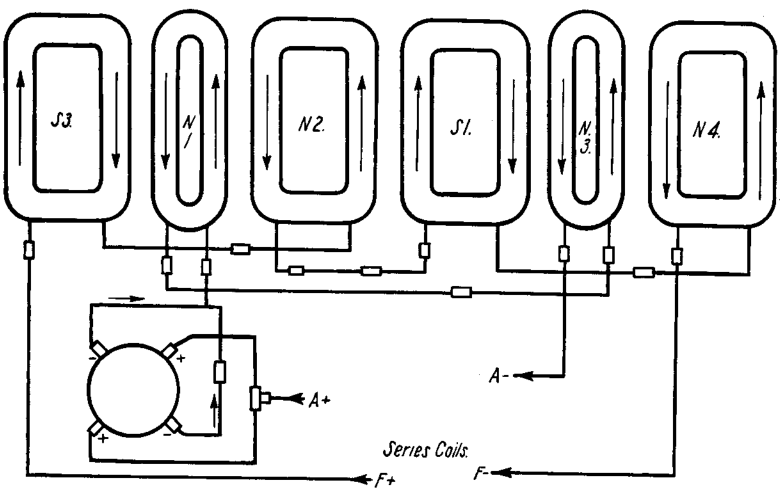


FIG. 29—CONNECTIONS FOR SERIES-WOUND MOTORS AND FOR SERIES AND COMMUTATING-POLE COILS OF COMPOUND-WOUND MOTORS—TYPE MC MOTOR FRAME 103 WITH MULTIPLE WOUND ARMATURE

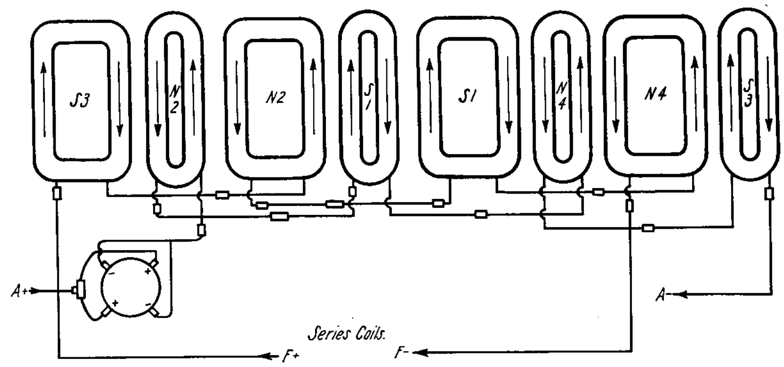


FIG. 30—CONNECTIONS FOR SERIES-WOUND MOTORS AND FOR SERIES AND COMMUTATING-POLE COILS OF COMPOUND-WOUND MOTORS—TYPE MCO MOTOR FRAME 103 WITH MULTIPLE WOUND ARMATURE

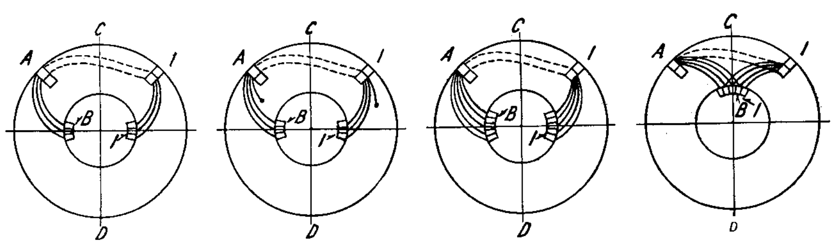


FIG. 31 FIG. 32 FIG. 33 FIG. 34

DIAGRAMS OF ARMATURE COIL CONNECTIONS REFERRED TO ON PAGE 22

NOTE—Where there is a dead, or idle, coil, as in Fig. 32, it is the first coil unit in right of slots 1 and A and is part of the first coil with which the winding is begun.

ARMATURE COIL CONNECTION DATA FOR TYPES MC AND MCO MOTORS

Frame No.	*Fig. No.	Slots 1 to A	Bars 1 to B	Coil Connection Data
				230 VOLTS
20	32	1– 7	1–51	CD, the center line of commutator bar No. 27, is on center line of slot No. 4.
30	31	1– 8	1–42	CD, the center line of mica between commutator bars Nos. 22 and 23, is on center line of tooth between slots Nos. 4 and 5.
40	31	1– 9	1–51	CD, the center line of commutator bar No. 27, is on center line of slot No. 5.
50	31	1– 8	1–45	CD, the center line of commutator bar No. 24, is on center line of tooth between slots Nos. 4 and 5.
60	31	1–10	1–54	CD, the center line of mica between commutator bars Nos. 28 and 29, is on center line of tooth between slots Nos. 5 and 6.
70	32	1–11	1–79	CD, the center line of commutator bar No. 41, is on the center line of slot No. 6.
80	32	1–10	1–71	CD, the center line of commutator bar No. 37, is on the center line of tooth between slots Nos. 5 and 6.
90	32	1– 9	1–63	CD, the center line of commutator bar No. 33, is on the center line of slot No. 5.
100	31	1–10	1–57	CD, the center line of commutator bar No. 30, is on the center line of tooth between slots Nos. 5 and 6.
103	34	1–11	1– 2	CD, the center line of commutator bar No. 3, is on the center line of slot No. 6.
				550 VOLTS
30	33	1– 9	1–79	CD, the center line of commutator bar No. 42, is on the center line of slot No. 5.
40	32	1–10	1–75	CD, the center line of commutator bar No. 39, is on the center line of tooth between slots Nos. 5 and 6.
50	33	1–10	1–89	CD, the center line of commutator bar No. 47, is on the center line of tooth between slots Nos. 5 and 6.
60	32	1–10	1–71	CD, the center line of commutator bar No. 37, is on the center line of tooth between slots Nos. 5 and 6.
70	32	1–11	1–79	CD, the center line of commutator bar No. 41, is on the center line of slot No. 6.
80	32	1–10	1–71	CD, the center line of commutator bar No. 37, is on the center line of tooth between slots Nos. 5 and 6.
90	33	1–13	1–119	CD, the center line of commutator bar No. 62, is on the center line of slot No. 7.
100	33	1–11	1–114	CD, the center line of mica between commutator bars Nos. 59 and 60, is on the center line of slot No. 6.
103	33	1–10	1–89	CD, the center line of commutator bar No. 47, is on the center line of tooth between slots Nos. 5 and 6.

*Page 30.

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Westinghouse

Types MC and MCO

Direct-Current Mill Motors

INSTRUCTION BOOK

Westinghouse Electric & Manufacturing Company

East Pittsburgh Works — East Pittsburgh, Pa.

I. B. 5189-A

IMPORTANT NOTICE

Keep the motor clean. The most perfect installation may cause an expensive delay if it does not have proper inspection and care. The insulation must be kept clean and dry. Oil and dirt in the insulation are as much out of place as grit or sand in a bearing. In the severe service for which mill motors are built, many abuses which shorten the life of a motor and increase operating expenses can be eliminated.

Before installing or operating a motor, read the following instructions carefully and check the points to be observed.

The operating man with a large number of mill motors should check each drive under the points outlined, and may find that his maintenance expense can be materially decreased.

The importance of taking care of equipment and of saving by careful operation with motors properly applied, cannot be over-emphasized.

Westinghouse

Types MC and MCO Direct-Current Mill Motors

GENERAL INFORMATION

Westinghouse Direct-Current Mill Motors, types MC and MCO, are applicable to intermittent service such as operating steel mill auxiliaries, cranes, contractors' hoists, mine hoists, railway turn tables, transfer tables, railway lift bridges, draw bridges, etc.

The applications in steel mills where these types are most desirable are cranes, ore bridges, roller tables, manipulator side guards, screw-downs, tilting fingers, transfer lift table mechanisms, etc., where the periods of operation are short and high momentary torques are required. The types MC and MCO motors are of a special very rugged construction, both designed to operate under the most severe service and to withstand the mechanical shocks to which mill motors are subjected. This service is in most cases intermittent. The type MC is a totally enclosed motor and the type MCO an open motor.

The two lines are developed with and without countershaft brackets and with either series or compound fields, and all motors are equipped with interpoles. Either plugging or dynamic braking can be used to obtain quick stopping. Where the friction load is low and quick reversing is wanted, it is better to use compound-wound motors and plugging control. When motors are plugged at high speeds, more than double voltage may be impressed upon the armature. The use of a light shunt field winding limits the light load speed and the heavy plugging current.

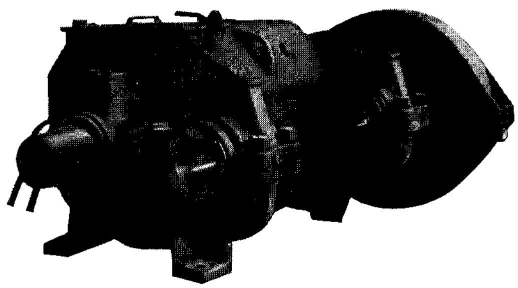

Fig. 2—Type MC Motor With Countershaft Brackets and With Gear Case in Place

GENERAL DESCRIPTION AND DETAILS OF CONSTRUCTION

Frame

These motors have massive cast steel frames. The frames are split horizontally so that the top half can be readily swung back or lifted off. A large opening with easily removable dust proof cover is provided over the commutator for inspection and adjustment of brushes. Also there are hand holes closed by dust proof covers at each end of the bottom half of the frame which aid in inspection. Two holes are drilled in the bottom of the frame for the purpose of drawing off any water that may accumulate due to condensation or other causes. Wide-spreading feet, reinforced with ribs, are cast integral with the lower half of the frame.

All electrical connections required between the two halves of the frame are made outside the frame. This is of great convenience in lifting off the top half of the frame.

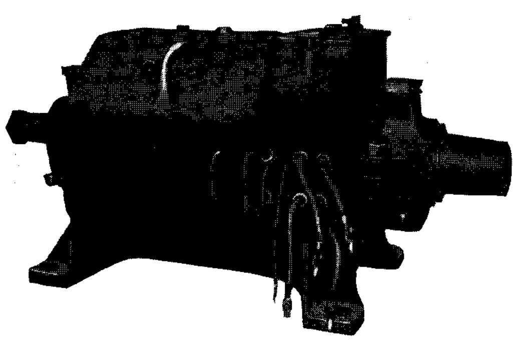

Fig. 1—Type MC Motor Without Countershaft Brackets

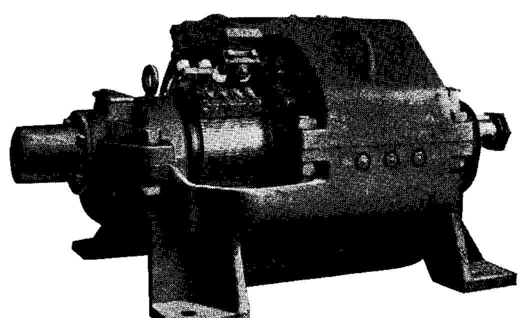

Fig. 3—Type MCO Motor Without Countershaft Brackets

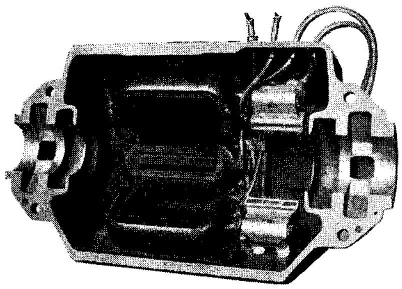

Fig. 4—Upper Half of Type MC Motor Frame

Field Circuit

Poles—The main pole pieces are built up of steel laminations riveted together. The interpoles are also laminated. It is possible to remove all poles without taking the lower half of the frame from its foundation. See Fig. 5.

Field Winding

The series and commutating field coils are wound of strap copper with asbestos between turns or of asbestos covered square wire, depending on the motor size. The coils are insulated with mica, taped with asbestos tape, and then dipped in insulating varnish and baked. For compound wound motors, each shunt coil is wound with cotton covered enameled wire, impregnated with a high grade insulating compound, and given a bakelite coating. Movement of the coil relative to the pole piece is prevented by a heavy steel washer spring between the frame and coil. Brass or steel washers between the spring washer and coil, and between the pole tip and coil give protection to the coil insulation.

Any MC motor can be changed readily from series to compound or vice versa by changing from one set of standard field coils to another standard set.

Armature Assembly

The armature laminations are assembled on a spider and are held rigidly in position between end plates. The rear end plate is pressed on the spider and the front end plate is held in position by a ring key which is sprung in place. The commutator is assembled separately as a unit with the standard V-ring construction and pressed on the main spider. Oil wipers keep the oil from creeping along the shaft.

Armature Coils—The armature coils are form wound with mica and asbestos insulation and dipped in insulating varnish. Coils for machines of the same size and voltage are interchangeable.

The armature is heated and temporary bands are wound on while the insulation is soft and pliable which permits the coils to be drawn down snugly in the slots. The armature is then dipped in varnish and baked hard. After cooling, the temporary bands are removed and the permanent bands are wound on the cold armature. When the armature is properly wound the core bands will rest both on the armature coil and teeth. No wedges are used.

Commutator—All commutators are of the standard V-ring construction. They are first assembled as a separate unit and thoroughly seasoned and are then pressed on the armature spider. The front V-ring is wrapped with insulating cambric tape which is given several coats of insulating varnish.

White mica segments are used between bars on all commutators and all commutators are under-cut. The commutators are assembled on a shell which is forced on the same spider that carries the armature, and it is possible to press out the shaft without disturbing the commutator or windings.

Bearings

The bearings consist of cast iron shells made in halves bolted together and lined with high grade babbitt. They are provided with eye bolts for the purpose of easy removal or replacement of armatures. It is feasible to carry spare armatures equipped with pinion, bearings and brake wheel, so that delay in changing armatures can be reduced to a minimum.

Ring oiling is used with brass tube overflows to regulate the height of oil carried in the reservoir.

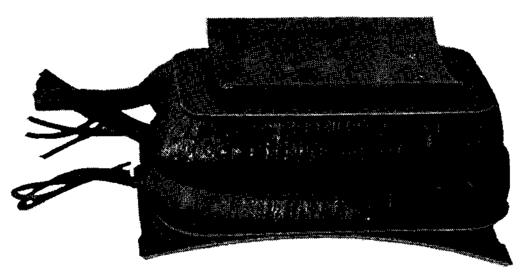

Fig. 5—Pole Piece with Compound Winding

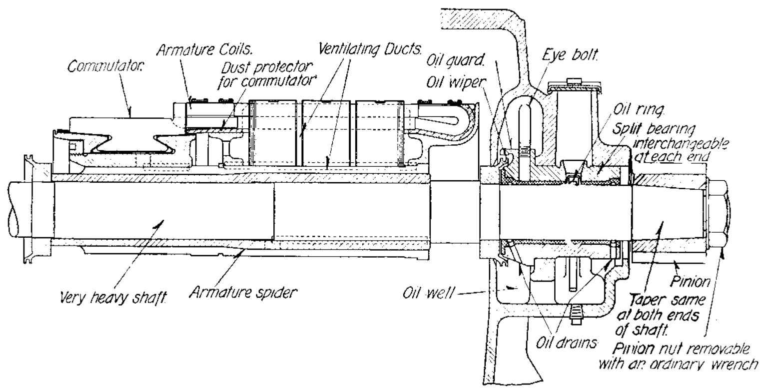

Fig. 6—Cross-Section of Armature and Bearing

Brushes and Brushholders

The brushes are set permanently at the neutral point before the motors leave the works. The spring tension is carefully adjusted when the motors are tested at the works and the design of the brushholder is such that a uniform brush tension is maintained throughout the life of the brush.

In case it becomes necessary to increase or decrease the spring tension in service on all motors larger than frame 30, the ratchet on the side of the brushholder may be turned with a screwdriver until the desired tension is obtained. Radial adjustment of the brushholders is possible to compensate for commutator wear. The brushes used are radial and of sufficient size to give a low current density. Brush shunts are used on all brushes.

Covers

Openings are provided on front and back side of the type MC motors for inspection. When operating conditions permit, the covers can be removed, improving the ventilation and increasing the capacity of the motors somewhat. The large opening over the commutator permits the easy inspection of commutator and brushholders and easy replacement of brushes. A wire gauze cover can sometimes be made use of.

INSTALLATION

General

Upon receipt of the motors, place them in a dry and sheltered position.

It is easily possible by rough handling or careless use of bars or hooks to do more damage to a machine than it would receive in years of regular service. Bear in mind that the armature is liable to damage, since its own weight is sufficient to crush the winding or damage the commutator if it is lowered on or swung against a projection.

If machines have been exposed to moisture, they should be carefully baked until thoroughly dry. This can also be done by passing an electric current through the winding. This current should be about one-half the full load current and should be controlled by a suitable rheostat.

Fig. 7—Armature Bearing and Oil Ring

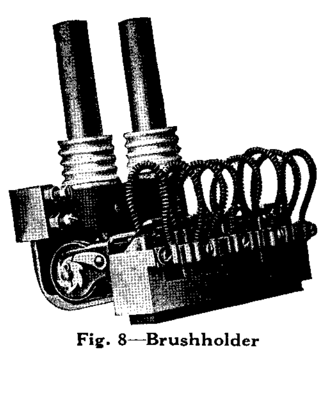

Fig. 8—Brushholder

10. **Brushes Sticking in Holders**—This is caused sometimes by dirt working between brush and holder and will cause unequal division of current in brushes. Brushes should be removed, brush boxes wiped out. If brush is sticking in one spot, it can be sandpapered down until a smooth sliding fit results.

11. **Worn-Out Brushes**—Worn brushes should be replaced with new ones before the contact with commutator is broken.

12. **Too Small Contact Surface of Brushes.**—Brushes should be ground to fit commutator.

The more usual electrical causes of sparking are:—

1. **Motor Over-Loaded**—A graphic ammeter should be used in checking this; if the motor is reversing, a zero center meter should be used. The shunt should be placed in the armature circuit. The readings obtained should be analyzed together with the performance curves of the motors. These performance curves can be obtained from standard leaflets. If the peaks are not excessive, the current curve should be integrated or averaged, taking the time into consideration and the R.M.S. (root-mean-square) value of current obtained checked against the continuous rated current of the motor. If it exceeds the rating of the motor, the motor should be either ventilated or replaced by a larger motor.

An example of this is given at the end of the book on motors.

2. **Open Circuit in Winding or Loose Connection in Commutator**—This trouble will show itself as a bright ring of fire which appears to pass completely around the commutator and by excessive sparking at the edge of the brushes. It can generally be located immediately by a blackened bar at point of open circuit.

3. **Short Circuit on Commutator**—This will generally show itself by a spark which appears to revolve with the commutator. This will give the appearance of a high bar and will very quickly burn out an armature coil.

Heating of Field Coils

The field coils of mill motors are designed for 75° C. rise and may in some cases appear to be excessively hot but by taking temperatures, by thermometer, it will often be found they are within their rating.

Excess current and over-heating can be caused by over-voltage on the shunt winding. The coils are designed for 10% over-voltage.

If one shunt coil becomes partially short-circuited, an extra strain is thrown on all the others and when the coil is replaced, all the others should be checked to see whether they are weakened. This can be done by placing the four in series and checking the drop across each one when full voltage is impressed on the set.

If the motor is very much over-loaded, the radiated heat of the series and interpole coils and armature may be sufficient to overheat the shunt coils. This will show in other ways first.

Armature Heating May Result from any of the Following:

1. Partial short-circuit between coils will cause excessive local heating of the affected coils.
2. Short circuit on commutator will cause the armature to heat up and may or may not show itself in sparking at the commutator.
3. Overload is the usual cause of armature heating. This will generally show itself in bad commutation but where it is the continuous load rather than the peaks, this will not be so. Where overload is suspected the load cycle should be checked with a graphic meter as outlined later.

Commutator Heating

The commutator may over-heat from excessive sparking or over-loads and if so, can be taken care of as outlined under commutation.

If the brush pressure is too high, the friction of the brush on commutator may heat it up.

Bucking

Bucking or flashing between arms of opposite polarity is usually caused by excessive voltage generated in the coils short-circuited by the brush or between adjacent commutator bars or abnormally low surface resistance on the commutator between adjacent brush arms. Any condition tending to produce poor commutation increases the likelihood of bucking.

Bucking is generally caused by the following:

1. Rough or very dirty commutator. Commutator should be ground smooth or wiped clean.
2. A drop of water on the commutator from the roof, leaky steam pipes or other source.
3. Sudden over-loads on the motor.

4. Reversing or plugging the motor at high speed may cause the motor to flash-over. At high speed, if the motor is suddenly plugged, more than double normal voltage may be impressed on the armature, causing the motor to buck over. On applications where the friction load is light, the motor will reach high speed if allowed to run. On such applications when the service is plugging, compound-wound motors are preferable to series-wound. By checking with a graphic meter, the "plugging" peak can be determined, and where suitable magnetic controllers are used, the plugging resistance can be increased to limit the current on "plug" to the proper value automatically. The amount of resistance required varies with the light running load.

Hot Bearings

When bearings exceed 75° C. by thermometer, they are overheated from one or more of the following causes:

1. **The Lubricant Used May Be a Poor Grade or May Be Dirty**—Foreign substance in the oil can be avoided by using only filtered oil.

2. **Insufficient Oil**—The oil reservoir should be kept filled just to the overflow.

3. **Failure of Oil Rings to Revolve**—A ring may stick when motor is first put in service.

4. **Poor Alignment—End Thrust**—If motor and gear are not in proper alignment, end thrust will result under load and one bearing may over-heat.

5. **Bent Shaft.** This will cause chafing and over-heating of bearing.

6. **Worn Bearings—Re-babbitting.**—Bearings may be worn out and s h o u l d be re-babbitted with a good grade of babbitt.

METHOD OF CHECKING LOAD CYCLE AGAINST RATING SHEETS OF MOTOR

Fig. 11 represents current curve which is obtained from an application where the motor is brought up to speed and then plugged and reversed. Three accelerating switches are used and it is assumed that the plugging resistance is such as to give constant peaks when the line switch and accelerating switches come in after plugging. Such a curve is obtained in reversing main roll table applications.

To check load cycle with the paper speed known, divide the curve into second or half second periods as shown by dotted lines. Mark the middle point of each section on the curve as shown. Square the current value at each of these middle points and add the results. Divide by the number of periods taken and take the square root of the quotient. This value will now be the R.M.S. current over the period chosen and if a cycle has been used which is representative of the operation for any length of time, one-half hour, 1 hour, 5 hours, etc., by checking the current rating for one-half, 1, 5 hours, etc., from the rating sheet, it

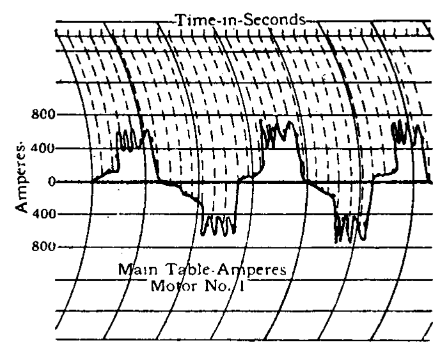

Fig. 11—Analysis of Load Curve

can be seen at once whether the motor is suitable or whether a motor of higher or lower capacity should be used.

On applications where reversing is frequent and where a study of a graphic load chart indicates the motor is overloaded, it must not be assumed that a change to a larger motor will remedy the situation. Where the motor armature WR^2 is an appreciable portion of the WR^2 of the drive as a whole, a change to a larger motor may increase the WR^2 of the drive to such an extent that the overloaded condition will not be relieved. In this case, gear ratios and resistor values must be investigated. The motor manufacturer is willing to assist in the study of such drives.

DON'TS

1. Don't use emery cloth or paper on commutator.
2. Don't let armature weight rest on end coils or commutator.
3. Don't run without oil.
4. Don't flood motor with oil.
5. Don't use acid flux when soldering electrical connections.
6. Don't let water or steam play on commutator.

7. Don't let brushes wear until contact is broken.
8. Don't let a motor wreck itself because of worn out bearings.
9. Don't wreck the motor by continuing the use of worn out gearing.
10. Don't delay repairs.

REPAIRS

Repairing Armatures

1. **Removal of Armature—Care of Commutator**—It is very easy to remove the armature from the motor by lifting it at the eye bolts in the bearings. The armature should be hung in a suitable wooden cradle where it can be inspected.

2. **Replacing single coils**—In case of a short-circuit or open circuit in one of the coils of a two-circuit armature, temporary repairs can be made by cutting both commutator leads of the affected coil and its mate with which it is in series and putting jumpers on commutator bars thus cut out, these bars are diametrically opposite on the commutator. This method of keeping an armature in commission should not be resorted to when several adjacent coils are damaged.

Damaged coils can be replaced if care is used in handling other coils while the injured coils are being removed. In this case it will be necessary to remove armature bands and re-band after repairs are made.

3. **Complete rewinding of armatures.**

(a) *Removing commutator.*

The oil wiper or guard at the commutator end is first removed by a clamp and tie rods taking a bearing in back of the wiper and on the end of the shaft. The armature coils are then disconnected from the commutator and the leads opened out to permit passing of clamping bars on each side of the shaft between the commutator and the armature core. By using tie rods and a cross bar bearing on the shaft, the commutator can be pulled off. Similar methods can be used in replacing commutator, taking a bearing on the opposite end of the shaft. In doing this work, care should be used not to batter the ends of the shaft or injure the commutator.

(b) *Rewinding.*

After old banding is removed and coils are stripped out clean, the slots should be gone over with a rough file for any burrs or sharp edges in the slots.

In rewinding, the work should be done by a skilled armature winder. Instructions giving throw on various frames are on page 16. Slot insulation should be obtained from the factory.

(c) *Banding.*

See paragraph on Armature Coils, page 4.

(d) *Checking for grounds, shorts or open circuits.*

At the works commutators are checked before being put on the armature. A lighting circuit with a lamp in series is connected across adjacent bars all the way around the commutator. If it lights the bars are shorted. After this all bars are shorted and test taken from bars to the V-ring. For this latter purpose a transformer testing box as described in the Westinghouse Annual Catalogue under "Insulation Testing Equipment," should be used. The proper testing voltage can be obtained from the Works.

After commutator has been checked and put in place and connected to armature leads, the armature itself should be checked for shorts, open circuits and grounds. At the shop an alternating-current magnet is used for testing for open and short circuits as described in the Westinghouse Catalogue under "Armature Testing Equipment". The wound armature is placed in the field of the magnet and a piece of curved sheet iron is rested on the armature core while it is revolved slowly by hand in the magnet field. If the iron is sucked down against the core, a short is indicated. This or an open circuit can then be found by shorting adjacent commutator bars with a knife edge. If no short or open circuit is present, this will be indicated by sparking between all adjacent bars. When there is no spark, the coil or coils connected to these bars are open or short circuited. Both leads from the coils should be disconnected and tested out with a lighting circuit until the defective coil or connection is found.

The No. 103, 230-volt armature is lap wound. This, as is the case with all lap wound armatures, cannot be tested out as outlined in the preceding paragraph on account of the presence of cross connections which must be used on this type of winding.

If such a magnet is not available, the check can be made as follows:—Connect a source of potential across the armature at two points

90° apart. This should be controlled by resistance to give a sufficient current flow through the armature so that an appreciable reading can be obtained on a low reading voltmeter or millivoltmeter between adjacent bars. If no short or open is present, all readings will be approximately the same. If winding has short or open circuit, it can be detected by the difference in voltage readings obtained from bar to bar.

For testing for grounds, a testing transformer should be used and the motor subjected to the proper voltage. This is 1500 volts for repaired motors. New armatures are tested at 2400 volts.

(e) *Removing shaft.*

The armature and commutator are mounted on a spider. To remove the shaft, the front oil wiper must be pulled off, then the armature should be placed in a press and blocking applied to bear on the hub of the spider. **Pressure should be applied to the commutator end of the shaft.** The armature should be carefully lined up in the press to avoid slippage and damage to spider, commutator or winding. Care should be taken to avoid battering up the ends of the shaft.

(f) *Turning commutator.*

On turning down a commutator, a diamond point tool should be used. If this is set with the cutting edge at right angles to the work it will give a very smooth finish. The best speed for this is from 500 to 600 f.p.m. Care should be taken in putting the armature in the lathe not to damage the shaft centers and to have the work run true.

(g) *Undercutting.*

The mica should be kept undercut to a depth of from $\frac{1}{32}$ to $\frac{1}{16}$ inch. This should be done with a special tool. The Westinghouse Electric & Manufacturing Company can furnish undercutting tools for motor operation. See Fig. 13. After undercutting, the edges of the bars should be scraped and well rounded off so that no copper burrs extend across the undercut slot.

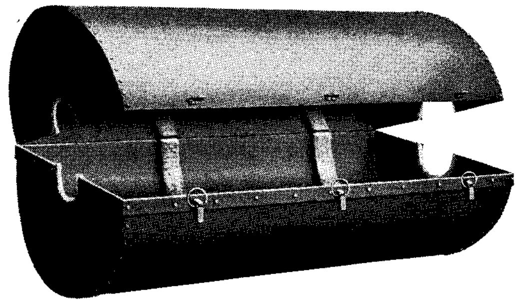

Fig. 12—Steel Envelope for Spare Armatures

Repairing Fields

When field repairs are made without taking the motor out of operation, a single coil is generally repaired and no check is made on the others. In the case of shunt field coils all coils should be checked, as the other coils may be damaged. With current in the coils, polarity can be checked with a compass and in the case of compound-wound motors, care should be taken that series and shunt fields agree. These can be checked one at a time.

To remove the field coils, the bolts holding the pole piece must be taken out when the pole piece and coil can be removed from the frame after which the coil can be removed from the pole piece.

In replacing the field coils, care should be taken to place them so that the leads come in position, shown in the corresponding diagram. (See Page 16 of this book).

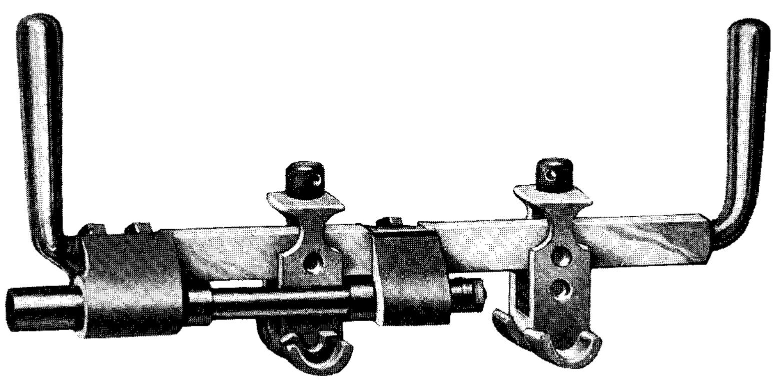

Fig. 13—Motor Operated Slotting Tool

The coils should be carefully handled and in the case of the shunt coils, care should be taken not to use so many liners behind the coil as to crush it and start short circuit between turns, when the pole piece bolts are tightened.

Re-babbitting Bearings

The bearing shells may be refilled with babbitt by assembling them on a mandrel of suitable size. Paper or sheet iron liners should be used to separate the two halves, channels being provided for the babbitt to flow through or the two halves can be filled separately. Care should be taken to prevent the babbitt filling the oil groove at the center of the top shell and the two oil drain holes at the ends of the lower shell. Oil guard grooves should be chipped around the bearings at each end and connected with the two drains. The best grade of genuine babbitt should be used for pouring motor bearings. After pouring the bearing should be scraped or bored and reamed to fit.

Care of Repaired Armatures

After an armature is repaired, it will sometimes be allowed to lie around the mill until needed and may suffer damage before it is needed. The use of a steel envelope is recommended similar to that shown in Fig. 12. The weight of the armature is carried by bearings and when it is needed it will be in the same condition as when it left the repair shop.

RENEWAL PARTS

It is important that a full line of renewal parts be carried. For this reason, it is advisable to carry complete spare motors which can be dropped in place in a very short time and repair work done later. Repairs on mill motors should be done in the shop where facilities are present for skillful work.

Repairing

Repair work can be most satisfactorily accomplished at our Works, or nearest Service Shop. However, interchangeable renewal parts can be furnished, as listed below, to customers, who are equipped for doing repair work.

Recommended Stock of Renewal Parts

The following is a list of the renewal parts and the minimum quantities of each that should be carried in stock. These are the parts most subject to wear in ordinary operation and damage or breaking due to possible abnormal conditions. The maintenance of such stock will minimize service interruptions due to breakdowns.

		No. of Motors		
Number of Motors in use up to and including		**2**	**5**	**15**
Name of Parts	No. Per Set	Quantity Recommended		
Armature (complete)	1	1	1	1
Armature Coil	1 set	1 set	1 set	2 sets
Rewinding material	1 set	1 set	1 set	2 sets
†Field Coil—shunt	4	2	2	4
Field Coil—series	4	2	2	4
Field Coil—commutating	4	2	2	4
Commutator	1	0	1	1
Brush	1 set	1 set	2 sets	3 sets
Brushholder	1 set	¼ set	¼ set	½ set
Bearing	2	2	2	4
Oil Ring	1 set	1 set	1 set	2 sets

†Used only on Compound Wound Motor.
These recommendations are for motors up to and including 100 Hp. ratings.

Instructions for Ordering

When ordering renewal parts, give complete name plate reading. Always give the name of the part wanted, also the stock order number or style number of the apparatus on which the part is to be used.

WIRING DIAGRAMS—CONNECTIONS AROUND FRAME

Motor Viewed from Commutator End

The diagrams (Figs. 14 to 19) show connections for compound-wound motors. For series-wound motors use the same diagrams, omitting the shunt winding and leads f + and f —.

For field coil connections, see Figs. 20 to 27.

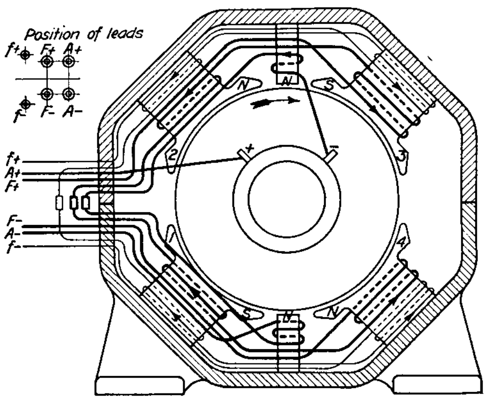

Fig. 14—Type MC Motor Frames 20 to 80 Inclusive

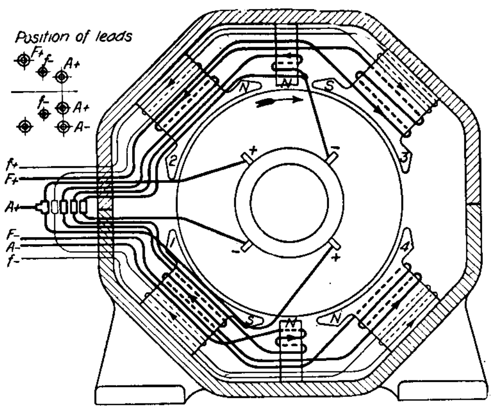

Fig. 15—Type MC Motor Frames 90, 100 and 103 with Two-Circuit Armature

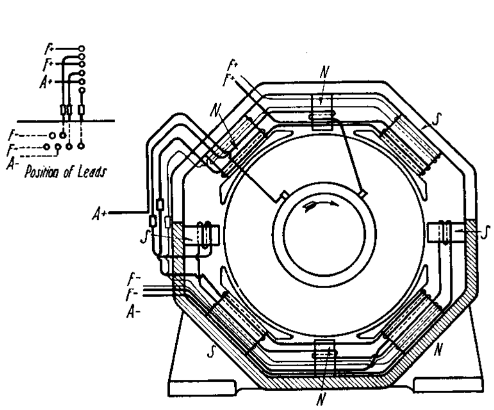

Fig. 16—Type MCO Motor Frames 60 to 80 Inclusive

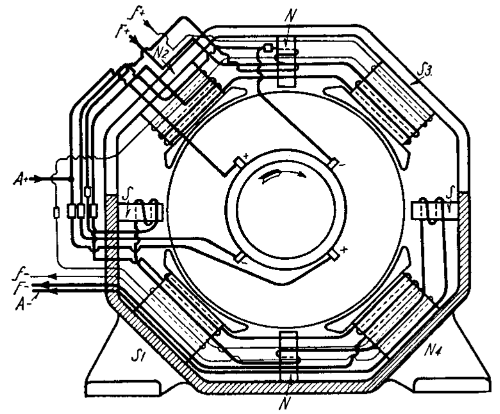

Fig. 17—Type MCO Motor Frames 90, 100 and 103 with Two-Circuit Armature

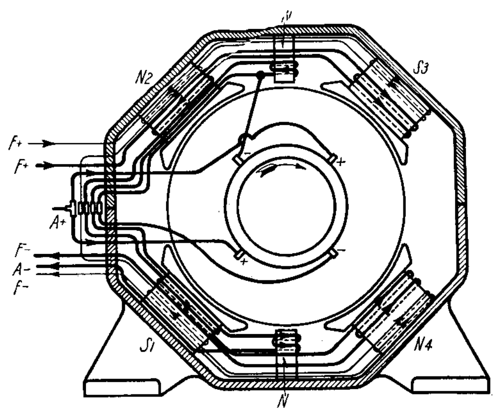

Fig. 18—Type MC Motor Frame 103 with Multiple Wound Armature

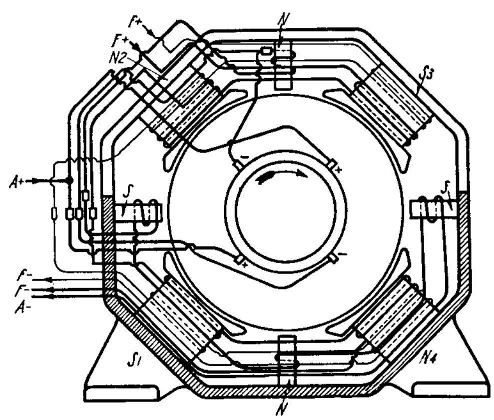

Fig. 19—Type MCO Motor Frame 103 with Multiple Wound Armature

WIRING DIAGRAMS—CONNECTIONS OF FIELD COILS

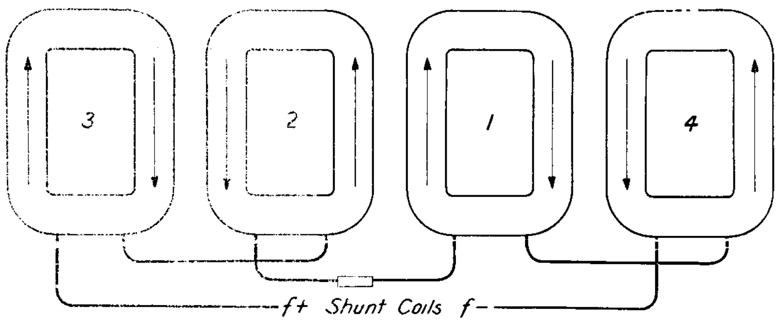

Fig. 20—Connections for Shunt Coils for all Types MC and MCO Compound Wound Motors

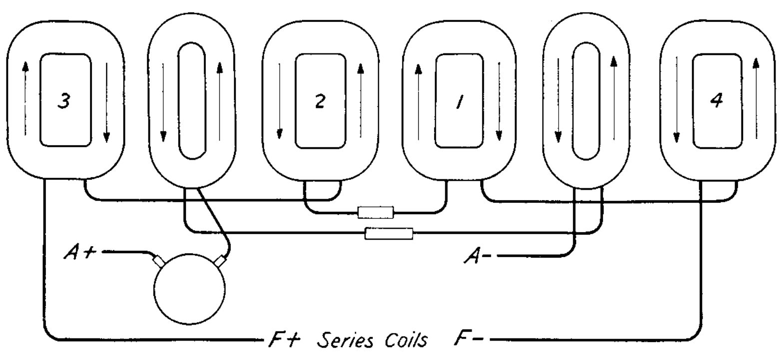

Fig. 21—Connections for Series-Wound Motors and for Series and Commutating-Pole Coils of Compound-Wound Motors—Type MC Motor Frames 20 to 80 Inclusive

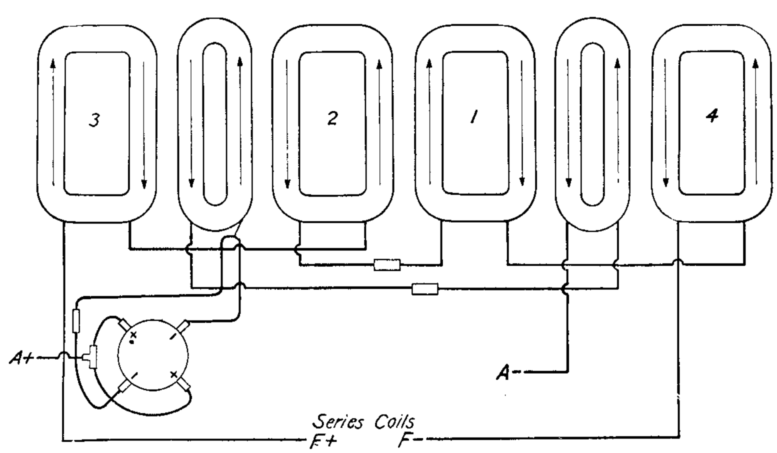

Fig. 22—Connections for Series-Wound Motors and for Series and Commutating-Pole Coils of Compound-Wound Motors—Type MC Motor Frames 90 and 100; and 103 with Two-Circuit Armature.

WIRING DIAGRAMS—CONNECTIONS OF FIELD COILS—Continued

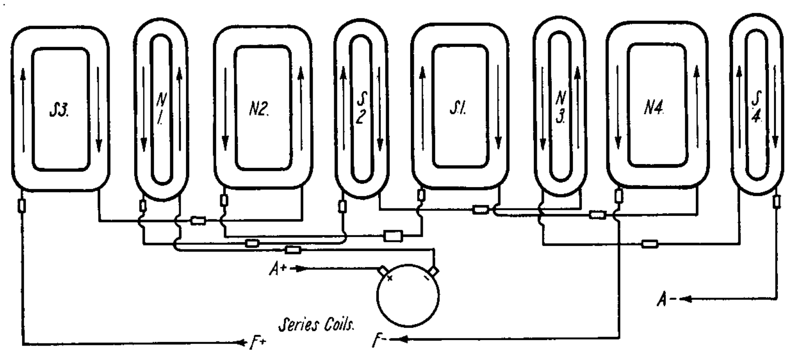

Fig. 23—Connections for Series-Wound Motors and for Series and Commutating-Pole Coils of Compound-Wound Motors—Type MCO Motor Frames 60 to 80 Inclusive

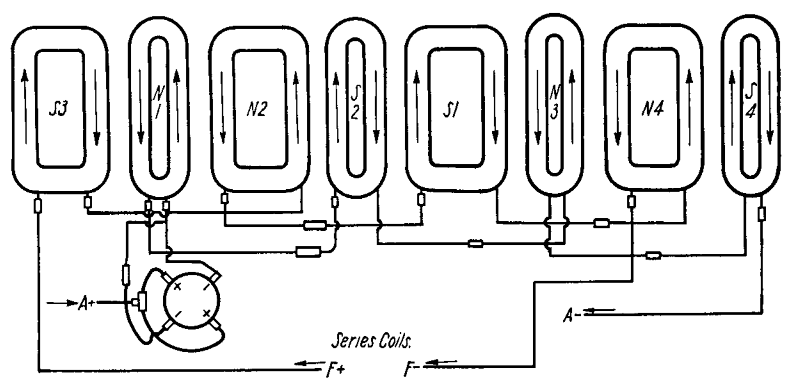

Fig. 24—Connections for Series-Wound Motors and for Series and Commutating-Pole Coils of Compound-Wound Motors—Type MCO Motor Frames 90 and 100; and 103 with Two-Circuit Armature

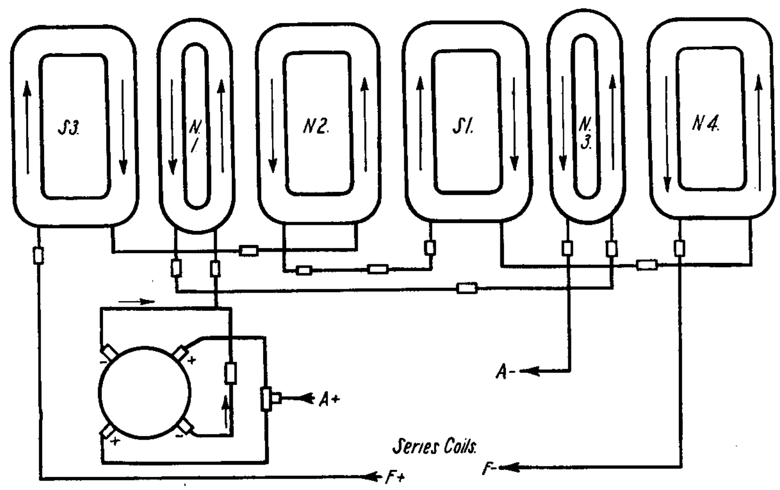

Fig. 25—Connections for Series-Wound Motors and for Series and Commutating-Pole Coils of Compound-Wound Motors—Type MC Motor Frame 103 with Multiple Wound Armature

WIRING DIAGRAMS—CONNECTIONS OF FIELD COILS—Continued

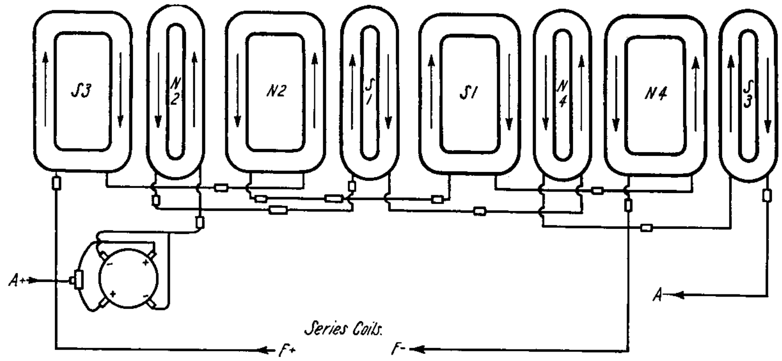

Fig. 26—Connections for Series-Wound Motors and for Series and Commutating-Pole Coils of Compound-Wound Motors—Type MCO Motor Frame 103 with Multiple Wound Armature

WIRING DIAGRAMS—CONNECTIONS OF ARMATURE COILS

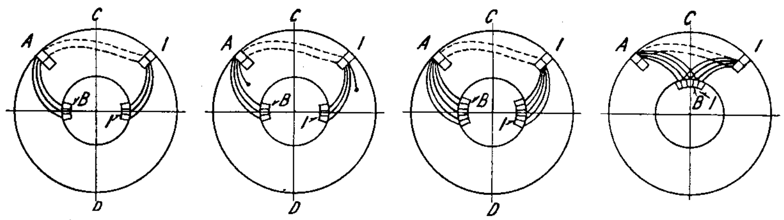

Fig. 27 **Fig. 28** **Fig. 29** **Fig. 30**

Diagrams of Armature Coil Connections

Note—Where there is a dead, or idle, coil, as in Fig. 28, it is the first coil unit in right of slots 1 and A and is part of the first coil with which the winding is begun.

ARMATURE COIL CONNECTION DATA

Frame No.	Fig. No.	Slots 1 to A	Bars 1 to B	Coil Connection Data
				230 VOLTS
20	28	1- 7	1-51	CD, the center line of commutator bar No. 27, is on center line of slot No. 4
30	27	1- 8	1-42	CD, the center line of mica between commutator bars Nos. 22 and 23, is on center line of tooth between slots Nos. 4 and 5
40	27	1- 9	1-51	CD, the center line of commutator bar No. 27, is on center line of slot No. 5.
50	27	1- 8	1-45	CD, the center line of commutator bar No. 24, is on center line of tooth between slots Nos. 4 and 5.
60	27	1-10	1-54	CD, the center line of mica between commutator bars Nos. 28 and 29, is on center line of tooth between slots Nos. 5 and 6.
70	28	1-11	1-79	CD, the center line of commutator bar No. 41, is on the center line of slot No. 6.
80	28	1-10	1-71	CD, the center line of commutator bar No. 37, is on the center line of tooth between slots Nos. 5 and 6.
90	28	1 -9	1-63	CD, the center line of commutator bar No. 33, is on the center line of slot No. 5.
100	27	1-10	1-57	CD, the center line of commutator bar No. 30, is on the center line of tooth between slots Nos. 5 and 6.
103	30	1-11	1- 2	CD, the center line of commutator bar No. 3, is on the center line of slot No. 6.
				550 VOLTS
30	29	1- 9	1-79	CD, the center line of commutator bar No. 42, is on the center line of slot No. 5.
40	28	1-10	1-75	CD, the center line of commutator bar No. 39, is on the center line of tooth between slots Nos. 5 and 6.
50	29	1-10	1-89	CD, the center line of commutator bar No. 47, is on the center line of tooth between slots Nos. 5 and 6.
60	28	1-10	1-71	CD, the center line of commutator bar No. 37, is on the center line of tooth between slots Nos. 5 and 6.
70	28	1-11	1-79	CD, the center line of commutator bar No. 41, is on the center line of slot No. 6.
80	28	1-10	1-71	CD, the center line of commutator bar No. 37, is on the center line of tooth between slots Nos. 5 and 6.
90	29	1-13	1-119	CD, the center line of commutator bar No. 62, is on the center line of slot No. 7.
100	29	1-11	1-114	CD, the center line of mica between commutator bars Nos. 59 and 60, is on the center line of slot No. 6.
103	29	1-10	1-89	CD, the center line of commutator bar No. 47, is on the center line of tooth between slots Nos. 5 and 6.