INSTRUCTION BOOK B 5041.
(Second Edition.)

INSTRUCTIONS

FOR RE-WINDING AND REPAIRING

Railway-Type

Motor Armatures.

THE BRITISH WESTINGHOUSE ELECTRIC & MFG. CO., LTD.,
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Contents.

Printed and Published by the
WESTINGHOUSE COMPANIES' PUBLISHING DEPARTMENT,
Manchester and London.

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The Armature.

Type.—The Armatures referred to in this publication are of the Railway Type, and include those which are used for crane as well as traction work. They are all drum wound.

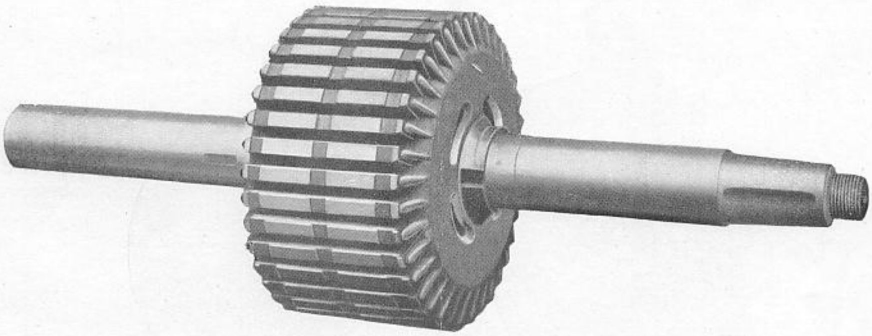

Fig. 1.—Armature Shaft and Core (unwound).

The Core.—The core is built-up of discs which are punched from thin sheets of soft steel. Slots are punched around the periphery of each disc, and when the separate discs are assembled these slots form grooves in which the winding is placed.

The Commutator.—The commutator is built-up of hard copper bars, thoroughly insulated with mica throughout. The commutator "neck," or portion slotted for the leads, projects above the brush surface sufficiently to enable the connections to be made with facility.

The Coils.—The coils are composed of separately-insulated sections which are then insulated together. Such are shown in Fig. 3. The commutator connecting leads are in most cases brought out at the bottom face of the coil.

The coils are designed with particular reference to good ventilation, ease of winding, insulating, and repairing; and also to general symmetry and rigidity. Each coil is wound on a mould or former to give it the exact shape required when on the core, so that no bending or hammering is necessary; and the coils, being all of the same shape, are interchangeable. Complete coils are generally made up of a number of single sections wound separately and assembled side by side. (See Table on page 16). When two or more sections are thus assembled, the leads of the different coils are marked by different coloured sleeves to enable them to be distinguished

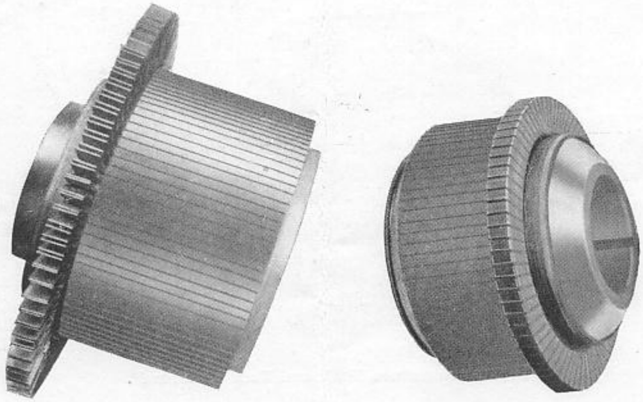

Fig. 2.—Commutator for Strap-coil Armature on left, ditto for Wire-coil Armature on right.

from one another in connecting. The coils are fully insulated (as shown in Fig. 3) when sent from the factory, and require no additional insulation before being placed on the core, with the exception that the core slots should be lined as described on page 7. The commutator leads are cut uniformly to the required length, and are tinned back 2″ in order to allow for a slight variation in length while assembling. Where the leads are insulated together, no extra insulation is required between them and neighbouring coils when assembling. When the leads are not insulated together, two thicknesses of oiled duck are inserted between them and the coils. Those coils which have their leads brought out on the bottom face have a slight dip in order to allow the top leads of the neighbouring coil to cross over them when in position on the armature without unduly protruding.

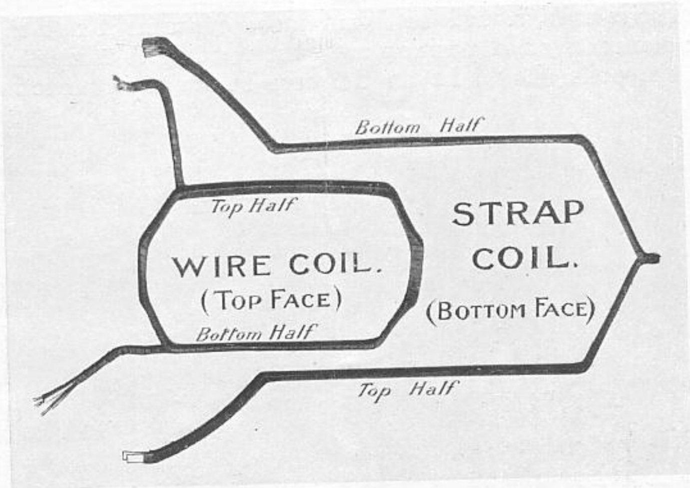

Fig. 3.—Wire and Strap Coils.

The leads of all coils consist of extensions of the copper wire or strap forming the coil, there being no joints. The wire coils differ in form from the strap coils (Fig. 3), and in the case of the latter, it will be seen that the leads are formed to the exact shape required for connecting them to the commutator, so that bending is avoided. The leads of the wire coils are easily bent.

Winding.

To Wind an Armature.—If the armature is to be wound with wire coils, it will be found more convenient not to put the commutator in position until the winding is completed, as all the coils should be on the core before any connecting is

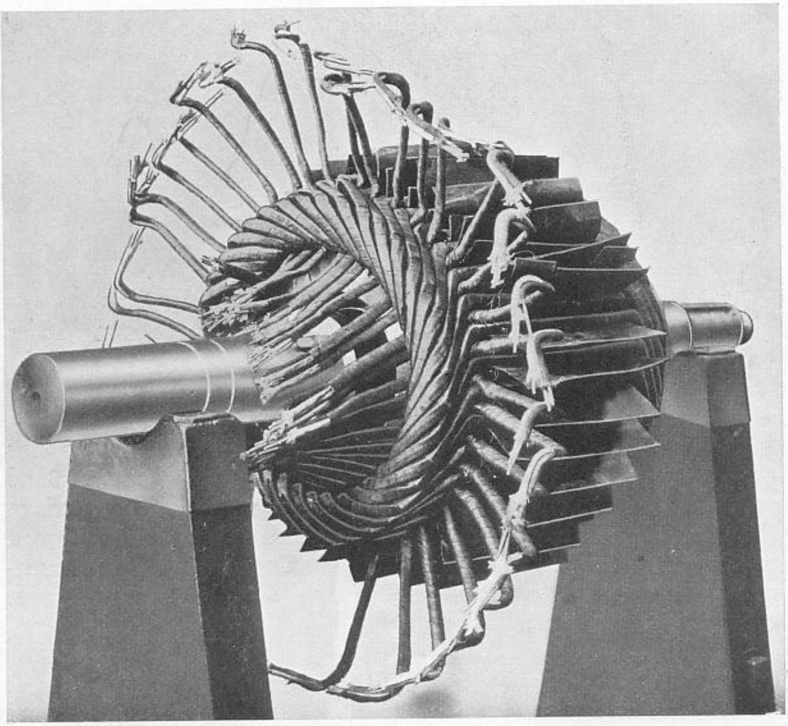

Fig. 4.—Wire-coil Armature being Wound.

done (Fig. 4). If, on the other hand, the winding consists of strap coils, the commutator should be put on the shaft before any of the coils are placed in the slots (Fig. 5).

Before any coils are put on, a 2″ wide strip of treated linen should, if room permits, be bent or woven into the slots at each end of the core, with $\frac{1}{4}''$ projecting beyond the edge of the core. The treated fullerboard cells should then be placed in the slots with their ends on the top of this linen strip.

The winder stands with the commutator end of the shaft to his left, and takes the coil in hand with the bottom face fronting the core, and the connecting leads to the left. He then first puts the bottom half of the coil (viz., that which is nearest to him), in a slot, and then the top half in its corresponding slot. The latter, however, is only inserted temporarily, as it has afterwards to be raised to allow of the insertion of the bottom half of another coil. Thus, after three-

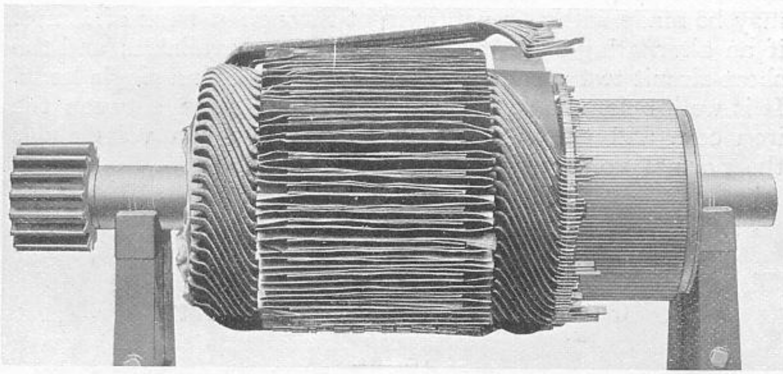

Fig. 5.—Strap-Coil Armature being Wound.

fourths of the coils have been assembled on the core, the top halves of the first coils must be lifted in turn, so that the bottom halves of the remaining coils may be slipped in under them into their respective slots.

The leads from the bottom halves of the wire-wound coils should be bent downward at an angle of about 45 degrees to the shaft axis, as shown in Fig. 4. In the case of the strap-wound coils, each should be connected to its proper commutator bars as it is being placed on the armature core (Fig. 5). (See Table and Diagram of connections for Throw, pages 14-16).

The top and bottom halves of the wire and strap coils are marked in Fig. 3, and they are so called according as they are to be laid at the top or the bottom of the armature slot; each slot—it being remembered—carrying the halves of two separate coils, one above the other.

After the coils are in place, it may be necessary to even them up slightly with a mallet. In doing so, special care should be exercised not to injure the insulation.

Should the coils not go easily into the slots, they should be rubbed with paraffin wax. To drive the coils down to the bottom of the slots, a wooden or fibre drift and a mallet weighing about two pounds, are used, injury to the fullerboard cells being carefully avoided.

During the process of winding, the work should be tested at various stages for short-circuits and earths. The earth test may be made with 500-volt current through a bank of lamps, if an alternating-current testing set is not available; and the short-circuit test with 110-volt current through a single lamp. It is well, before soldering, to test the insulation between the iron core and the winding with at least 1,000 volts above the normal voltage of the machine.

Connecting to Commutator.

Wire-wound Armatures.—The connecting leads to the commutator should be uniformly bent to their proper position, and their tinned ends then turned upwards, after which the commutator should be pressed on to the shaft. As about to be explained, the bottom leads are first connected, insulated, and tested, and afterwards the top leads, the connections of both being finally soldered.

After determining the proper "throw" (c-d) of the bottom leads, i.e., those from the bottom halves of the coils (see explanation and Table on pages 14-16), place them all in regular order in their proper commutator bars, a piece of ¼″ treated hemp rope being previously wound round the commutator V ring, adjacent to the commutator bars, so as to form a supporting cushion for the leads. A 1″ wide treated surgical tape is interwoven or zig-zagged between the leads as they are put in place one after the other on the commutator, this being done in such a manner that the intertwining tape forms an insulating barrier between the neighbouring leads.

When all the bottom leads have been placed in the commutator bars, a magneto test or lamp test should be made by placing the terminals of the magneto or lamp circuit on successive adjacent pairs of commutator bars to find if there are any short-circuits either in the commutator or the coils.

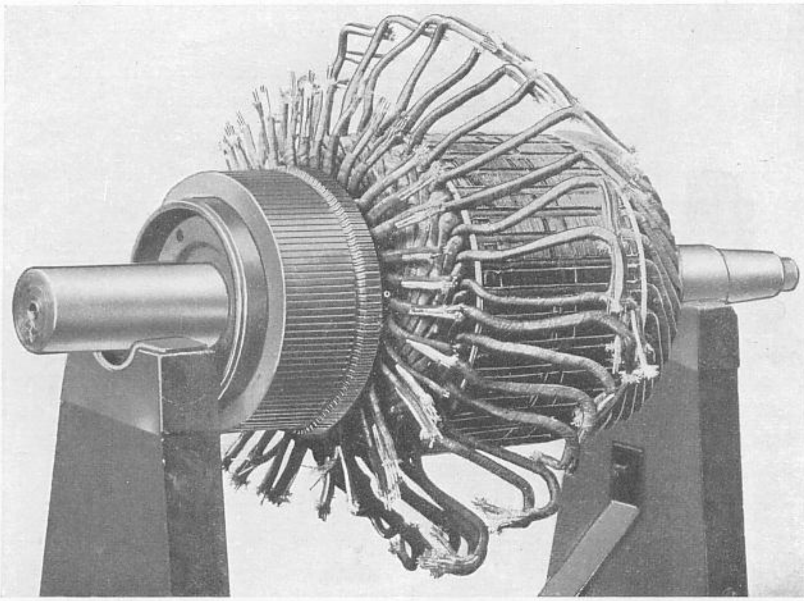

Fig. 6.—Wire-Coil Armature with Coils and Commutator ready for connection.

A few layers of treated surgical tape are then put over the leads right up to the back of the commutator neck to insulate them from the top ones.

The top leads of the coils, i.e., those from the top halves of the coils, should be placed in the commutator bars in a similar manner to the bottom leads, the throw (e-f) being about equal to the throw (c-d). These throws, as well as the total throw (c-f) on the commutator, are given in the table on page 16.

When the number of commutator bars is the same as the number of armature slots, all the leads from one side of each coil are connected to the same bar, the coil sections being thus connected-up in parallel.

When the number of commutator bars (plus one) is twice the number of armature slots, half the leads from one side of each coil (which in this case is either double or quadruple) are connected in parallel to the commutator, except those of the spare coil-section at the end of the winding, which has no corresponding bar. The spare top and bottom leads of this coil are to be cut off about one inch from the end of the cells, and insulated with tape.

All leads should be taped-up close to the commutator to prevent short-circuiting between adjacent leads.

After the commutator is fully connected, and before the connections are soldered, take a magneto and ring up all round the commutator between adjacent bars. If the bell does not ring in every case, there is an open circuit due to the leads being crossed at that point or at one diametrically opposite, or to two breaks in the coils.

After testing, the commutator connections must be soldered, a comparatively hard solder being used. One containing about 58% of lead to 42% of tin is very satisfactory for this purpose, the flux being resin dissolved in alcohol or methylated spirits (7lbs. of resin to 4 pints of methylated spirits will be found a satisfactory proportion). On no account should "killed spirits" or acid be used as a flux.

Care should be taken not to allow any solder to fall at the back of the commutator and short circuit the adjacent leads or commutator bars. This is the more easily preventible if the armature is slightly tilted (commutator downwards) when soldering.

Strap-Wound Armatures.—The connecting of a strap winding is very simple, and, as already explained, is done as the coils are placed on the armature, the commutator being already in position. The proper throws having been ascertained from the Table on page 16, the coils are placed on the armature and connected in regular order, the bottom half of each coil being put in place first. The connections should be tested and soldered in a similar manner to those of the wire-wound armatures.

Bands and Wedges.

The number and size of bands vary with the size and speed of the armature, so that the arrangement of bands should be noted before dismantling the winding, in order that the new bands may be similarly arranged.

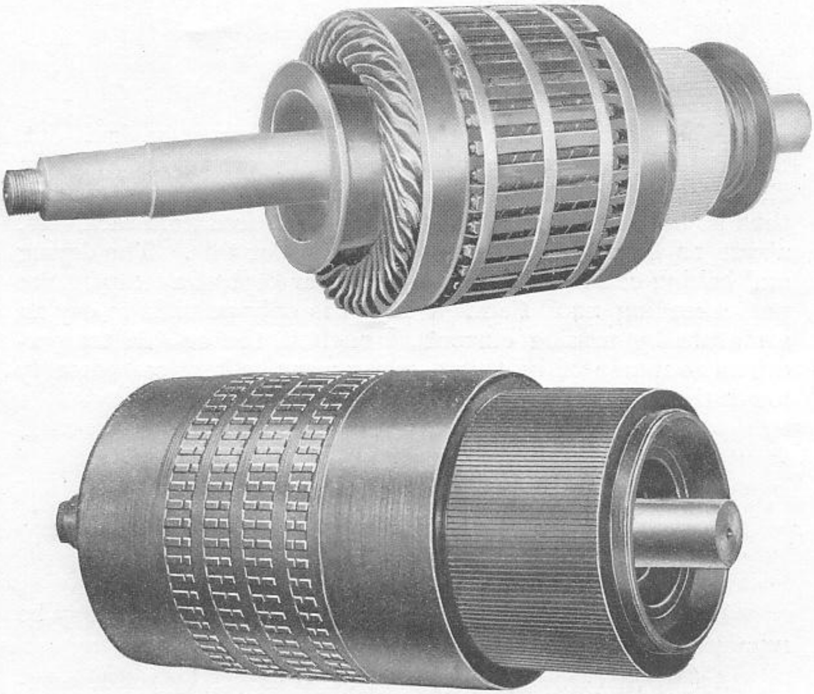

Fig. 7.—Complete Wire- and Strap-Wound Armatures.

Wire-wound armatures should have bands on each end of the coils beyond the core, as far out as possible without danger of the band slipping over the end. All bands round the body of the core should be insulated from the core and coils with about 0.01 in. insulating paper. Bands that are placed over the ends of coils should be insulated with three turns of 0.01 in. linen tape, with mica between the turns; this tape and mica extending about $\frac{1}{8}$in. on each side of the band. The bands should be put on with quite a strong tension on the wire, sufficient to make a good firm band, and to bring the coils down so that they will not project above the surface of the core at any point. The individual turns of the band should be well soldered together, and further held in several places with thin tin or copper clips soldered to the bands.

Finishing.

All armatures when completely wound must be dried out, then thoroughly sprayed, painted, or preferably dipped in B.W. plastic or B.W. insulating varnish. The armature must then be baked until the coating is dry and free from tackiness, about 12 hours being usually necessary for this. The drying and baking can best be done in a heater kept at a temperature not exceeding 220° Fah.. When it is only possible to dry an armature by passing current through it, the outside temperatures as measured by thermometer must be kept considerably lower than this.

Repairs.

If a coil open-circuits, short-circuits, or earths, it may be repaired or replaced as follows :—

An Open Circuit can readily be detected by pitted commutator bars, which occur at points diametrically opposite. To find the defective coil, raise the two upper leads at each of the pitted bars, *i.e.* four leads altogether, and test with a magneto between them and all the other bars of the commutator. The bell will not ring when connected with one of the leads, that is, the lead of the defective coil; but in the case of the other three leads it will ring when connected to one bar at least. If the defect is a broken lead, it can be easily spliced with a wire of the same size, and connected as before.

If it is not in a lead, the open circuit is probably due to the burning of one or more turns of the coil, owing to a short-circuit or earth. In such a case, the coil will have to be cut out and replaced by a new one.

A Short-Circuit can be detected by the smell of burnt insulation, or the charred condition of the insulation on the faulty coil. This can only be repaired by cutting out or replacing the coil.

An Earth may sometimes be seen on the surface, where the insulation and often the coil or iron core, is burnt. If it cannot be located in this manner, test the armature for earth with about normal voltage. If the arcing to the armature core cannot then be seen or heard, raise a few upper leads at different points of the commutator, thus dividing the winding into several parts. When the earthed division is located, raise the upper leads and test them for earth separately. One or more coils will then possibly be found defective. If all the coils appear earthed, it is usually the commutator that is defective.

To Cut out a Damaged Coil.—Disconnect the damaged coil from the commutator, and after cutting off the leads, insulate the exposed parts with tape. Then short-circuit the commutator bars to which the leads of the damaged coil were connected, with a short-circuiting wire or "jumper" of the same size as that used in the winding.

If it can be avoided, armatures should not be run with more than four coils cut out, except when the cut-out coils are distributed fairly evenly around the armature.

To Remove a Damaged Coil it will be necessary to cut off the bands and remove the wedges, and raise a sufficient number of leads and coils to admit of the removal of the defective coil. The new coil can then be put in place.

Explanation of Table giving Throw of Coils.

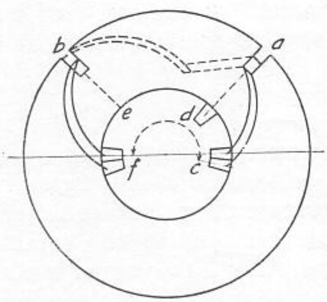

Fig. 8.

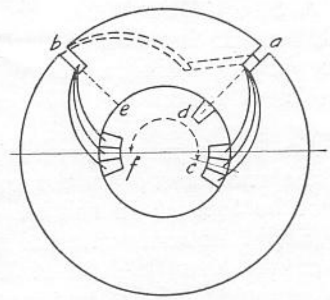

Fig. 9.

Figs 8 and 9.—Diagram for finding "Throws" of Coils and Leads.

Fig. 8 shows the connection of a double coil to the commutator, and Fig. 9 the connection of a triple coil. As most of the armatures to be dealt with have triple coils, we will take the No. 220 in the following list for the sake of example, and make reference to Fig. 9. In the latter, *a* and *b* represent two slots in the armature, and *c*, *d*, *e*, and *f*, various bars on the commutator; the core and commutator being viewed from the end.

Suppose that the winding of the armature is about to be started as directed on page 6, and that *a* is the slot into which the bottom half of the first coil is inserted; then the throw, as given in the fourth column of the Table on page $16\,^{(a\text{-}b)}_{(1\text{-}10)}$ signifies that the top half of the coil goes in the tenth slot from *a*, counting *a* as one. The bottom and top halves of the second coil go in the next slots to *a* and *b* in a counter-clockwise direction, as viewed from the commutator end, and so on with the remaining coils.

The throw of the leads to the commutator bars is found as follows:—*d* is the segment in line with the core slot carrying the bottom half of the coil from which the leads emerge. Call this 17 (see Table) and count backwards to unity, then No. 1 will give the position of *c*, and the bottom lead is connected thereto. When, as in this case, there are three leads from the coil, the middle lead is connected to segment No. 1, and the others to the segments on either side of it, as shown in Fig. 9. If the armature is a double-coil one, the leads are connected as in Fig. 8. The *e* column in the Table gives the distance from *c* of the commutator segment *e* in line with the slot *b*, and the *f* column the distance from *c* of the group of commutator segments *f* to which the leads of the top half of the coil are to be joined.

The *e* column gives the number obtained by counting the commutator bars from *c* to *e*, *e* being the bar in line with slot *b*, and *c* counted as one. Similarly, the column *f* gives the number obtained by counting from *c* to *f*, *f* and *c* being the segments to which the leads from the top and bottom halves of a coil are respectively connected. Connections from other coils are similarly made in regular order round the commutator.

It will be noticed that in some cases two numbers are given in the *d* and *e* columns. This indicates that the armature slot *a* or *b* (as the case may be) is in line with the mica strip between these segments.

Table of Throws.

Type No. of Motor and Armature.	Armature Coil.	No. of Commutator Bars.	Sections per complete Coil. Coils with one, two, three, and four sections are termed single, double treble, and quadruple coils respectively.	THROWS. Armature Slots. Bottom half of coil. Top half of coil.	Commutator Bars. Bottom leads.		Commutator Bars. Top leads.	
				a—b	*c*	*d*	*e*	*f*

Wire-Wound Armatures.

	Mould No.							
46	425-P	105	3	1-9	1	15/16	39/40	54
49-B	424-P	105	3	1-9	1	15/16	39/40	54
80	9147-D	117	3	1-10	1	17	44	60
200	9153-P	111	3	1-9	1	17	41	57
202	9161-P	135	4	1-9	1	19	51	69
220	9147-D	117	3	1-10	1	17	44	60
230	9198-D	123	3	1-10	1	18/19	45/46	63
240	9192-P	123	3	1-10	1	18/19	45/46	63

Strap-Wound Armatures.

	Former No.							
50-M	6093	177	3	1-14	1	26	65	90
53	8033	159	3	1-13	1	23	59	81
53	8220	123	3	1-10	1	18/19	45/46	63
53	2271	118	2	1-14	1	17/18	43/44	60
83	6469	196	4	1-12	1	28	72	99
83-M	1895	71	1	1-17	1	11	27	37
83-M	6642	111	3	1-9	1	17	41	57
83-M	8831	185	5	1-9	1	27/28	67/68	94
86	4118	159	3	1-13	1	23	59	81

In cases where there is more than one Mould or Former No. to any given type of motor, and there is a difficulty in locating the right one; or when the type No. is not included in the above list, it is best to write to our nearest District Office, giving the serial number and rating of the motor.

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