# INSTRUCTION BOOK

## No. 1294*

# D.C. HIGH-SPEED

# CIRCUIT-BREAKERS

## TYPE RJR.

*(Patent No. 434114).*

THE BRITISH THOMSON-HOUSTON CO., LTD.,

RUGBY, ENGLAND.

EDITION D.
* *Cancels Edition C.*

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## IMPORTANT.

The apparatus described in this Instruction Book was designed, manufactured, and tested with care and, with proper attention, should give the purchaser the service which he may reasonably expect.

The purpose of this Instruction Book is to explain the function of the apparatus, and the manner in which it should be adjusted and maintained.

If these instructions are not clear, or appear incomplete in any particular, and you desire further information, this will be promptly supplied on request.

Please address such enquiries to the Company's nearest District Office or Local Representative, mentioning the particulars stamped upon the apparatus nameplate.

## CONTENTS.

# D.C. HIGH-SPEED CIRCUIT-BREAKERS, TYPE RJR.

## APPLICATION.

The Type R J R High-Speed Circuit-Breaker is employed to protect Rotary Converters, Generators, Motor-Generator Sets, Rectifiers, and Feeders from the strains and resultant damage due to short-circuit or heavy overload conditions.

The breaker is extremely simple in design and of the robust construction usually associated with contactors. The design does not involve toggles, mechanical latches, triggers, or tripping levers of any kind.

These breakers may be installed to protect old or new machines without necessitating any change in their design or arrangement. They are suitable for electrical remote operation; the control switches may therefore be mounted in any suitable position.

The installation of these breakers will, when a fault occurs, prevent the current from reaching the maximum short-circuit value, thereby greatly decreasing the mechanical strain on the plant. The breaker can be arranged to open at a definite current, or alternatively, by including special features, can be made to open at a current value varying with the rate of rise of current.

## OPERATING CYCLE.

The operating circuits, whilst in the main similar for all Type R J R Breakers, differ in detail depending on the application. The control connections have separate circuits for the holding coil and closing contactor coil.

## CLOSING THE BREAKER.

The circuit of the holding coil, with its resistance, is separate from the closing contactor coil circuit, which latter has another resistance connected in series with it. A special control switch is required, which incorporates the contacts for both opening and closing the breaker. This switch is usually of the drum-controller pattern, spring-biased to the "off" (mid) position; movement to one side opens the breaker, whilst movement to the other side closes the breaker. The connections are such that normally, in the "off" position of the switch, the holding coil circuit is completed, which circuit is still maintained when the switch is thrown to the "close" position. It will be seen that, when the switch

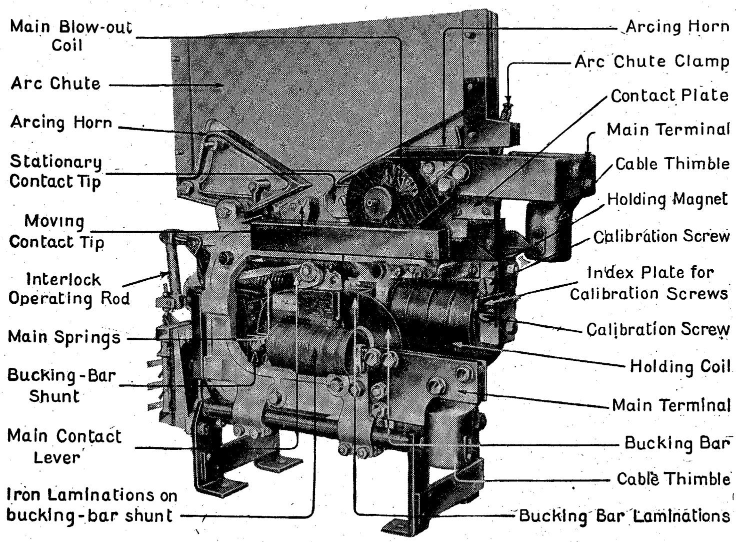

Main Blow-out Coil
Arc Chute
Arcing Horn
Stationary Contact Tip
Moving Contact Tip
Interlock Operating Rod
Main Springs
Bucking-Bar Shunt
Main Contact Lever
Iron Laminations on bucking-bar shunt
Arcing Horn
Arc Chute Clamp
Contact Plate
Main Terminal
Cable Thimble
Holding Magnet
Calibration Screw
Index Plate for Calibration Screws
Calibration Screw
Holding Coil
Main Terminal
Bucking Bar
Cable Thimble
Bucking Bar Laminations

Fig. 1.

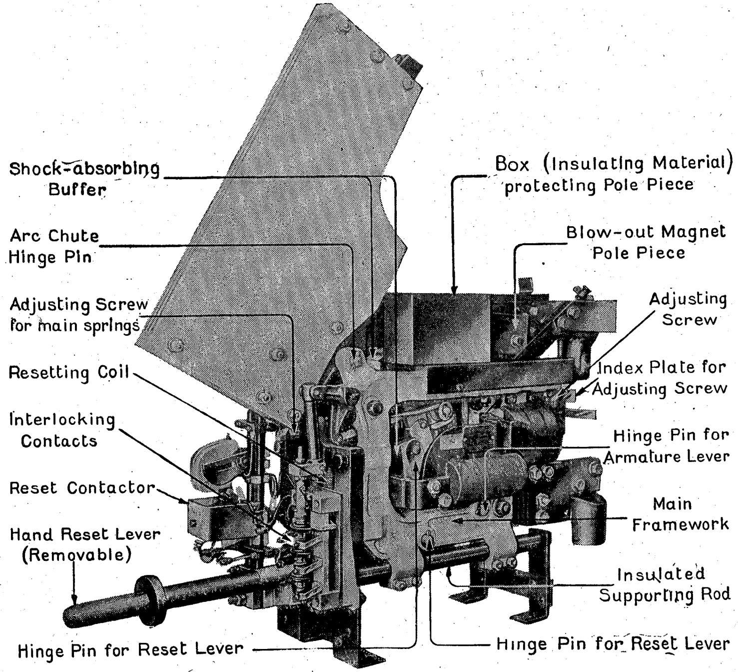
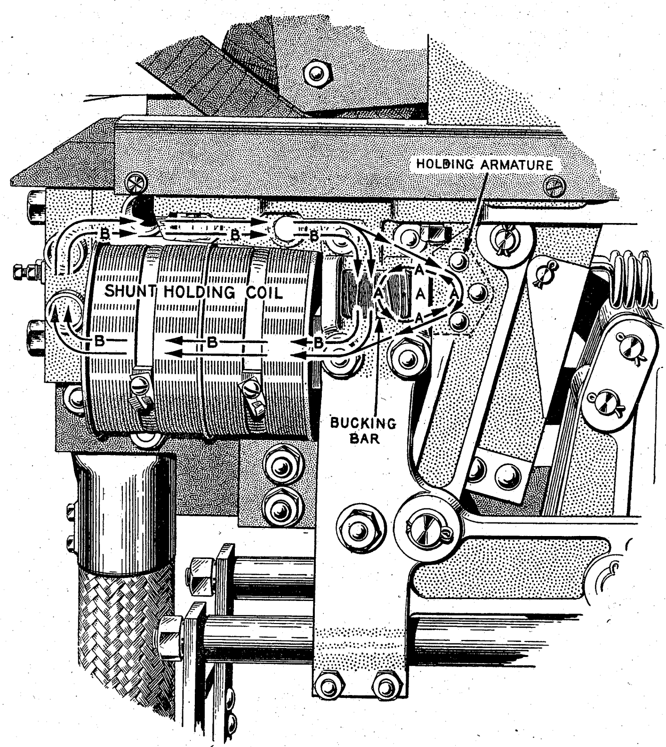

Shock-absorbing Buffer
Arc Chute Hinge Pin
Adjusting Screw for main springs
Resetting Coil
Interlocking Contacts
Reset Contactor
Hand Reset Lever (Removable)
Hinge Pin for Reset Lever
Box (Insulating Material) protecting Pole Piece
Blow-out Magnet Pole Piece
Adjusting Screw
Index Plate for Adjusting Screw
Hinge Pin for Armature Lever
Main Framework
Insulated Supporting Rod
Hinge Pin for Reset Lever

Fig. 2.

is thrown to the " close " position :—firstly, a portion of the holding coil resistance is short-circuited, thus giving the over-excitation effect necessary to prevent the holding armature being unseated—due to mechanical shock ; and secondly, the operating coil circuit of the closing contactor is completed, and the contactor closes, which in turn energizes the closing coil of the breaker.

When the breaker closes, an interlock thereon short-circuits the closing contactor coil, thus de-energizing this contactor, which, in opening, disconnects the closing coil from the supply, and allows the closing lever to return to the " off " position.




NOTE.—Outer circle arrows show normal path of flux which keeps holding armature in the closed position.

The arrows marked "A" indicate flux due to current flowing in the " bucking " bar.

The arrows marked " B " show path of holding coil flux during short-circuit conditions. It will be noticed that this flux does not pass through the holding armature.

**Fig. 3. Sketch showing magnetic circuits of holding coil and " bucking " bar.**

The return of the closing lever to the "off" position permits the main contacts of the breaker to close, thus completing the main circuit. When the control switch is released it returns to the "off" position and interrupts the coil circuit of the closing contactor, whilst still allowing the main holding coil circuit to remain completed.

## OPENING THE BREAKER NON-AUTOMATICALLY.

To open the breaker the control switch is turned to the "open" position, this having the effect of de-energizing the holding coil circuit, which allows the holding magnet to release, whereupon the breaker opens.

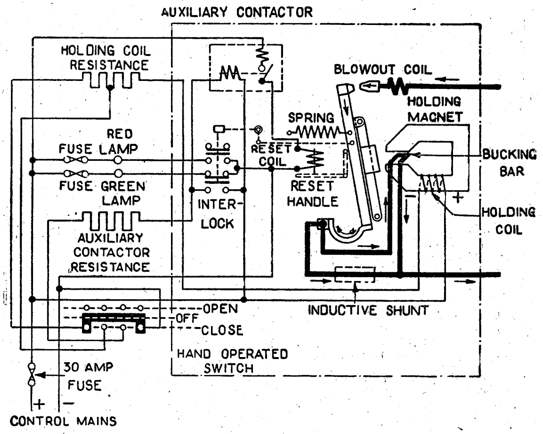
## AUTOMATIC OPENING OF THE BREAKER.

When the breaker is closed the blow-out coils, main contacts, and "bucking" bar are in series with the circuit protected; the breaker is held in the closed position by the small laminated armature on the moving contact arm which bridges the gap between the holding magnet pole faces. The "bucking" bar is located in the gap between the poles of the holding magnet and in close proximity to the armature. The current flowing through the "bucking" bar therefore produces a maximum change in the armature flux without appreciably affecting the flux in the holding magnet. On the occurrence of a short-circuit the magnetic force produced by the current in the "bucking" bar deflects the flux due to the holding coil from the armature to the iron located in the loop of the "bucking" bar in the gap of the holding magnet. The moment the flux passing through the armature is reduced to a predetermined value, the armature is released and the main contacts open with an extremely rapid action.

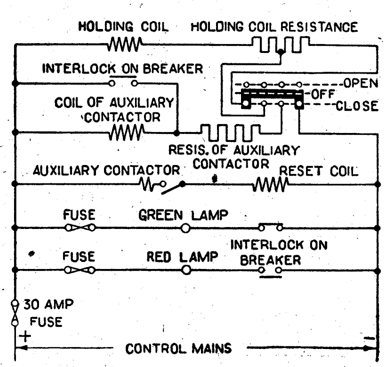
The magnetic circuits and principle of operation are illustrated diagrammatically in Fig. 3.

When the contacts of the circuit-breaker open, the arc is blown upwards by a powerful blow-out magnet excited by series coils and designed to give an intense field of small area around the contacts. When the contacts begin to part, the flux set up by the blow-out magnet forces the arc up into the long narrow slots in the arc chute where it is quickly extinguished. The arcing spaces are narrower than the contact tips, thus increasing the resistance of the arc stream for a given length and giving the maximum cooling effect to the vapours.

The 1500 and 3000 volt circuit-breakers are provided with an additional blow-out coil in the arc chute, which is automatically cut into the circuit during the time the arc is being ruptured. This auxiliary blow-out divides the arc into two parts and further assists in rupturing it.




COMPLETE CONNECTIONS.




CONTROL CIRCUITS ONLY.

Fig. 4. Diagrams of connections of high-speed circuit-breaker.

# CLOSING CYCLE.

## SMALL PATTERN BREAKERS.

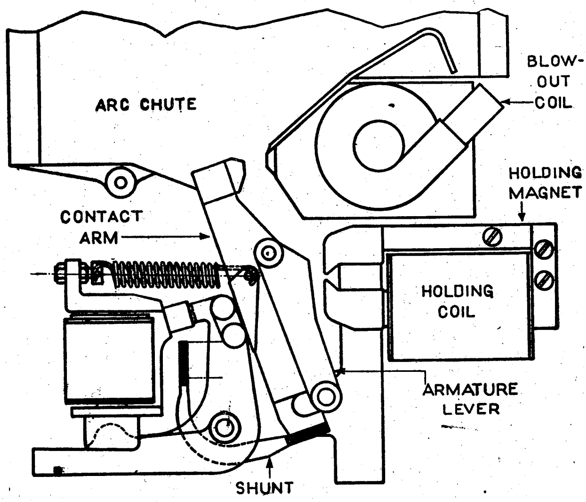



Fig. 5. 1st Stage—Breaker open.

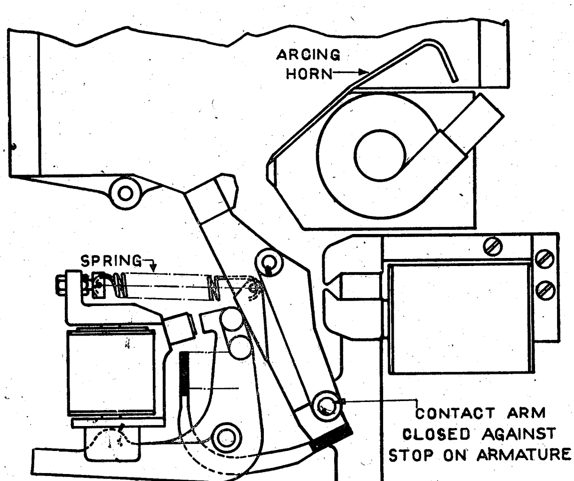



Fig. 6. 2nd Stage—Closing coil energized.

## CLOSING CYCLE (CONTINUED).

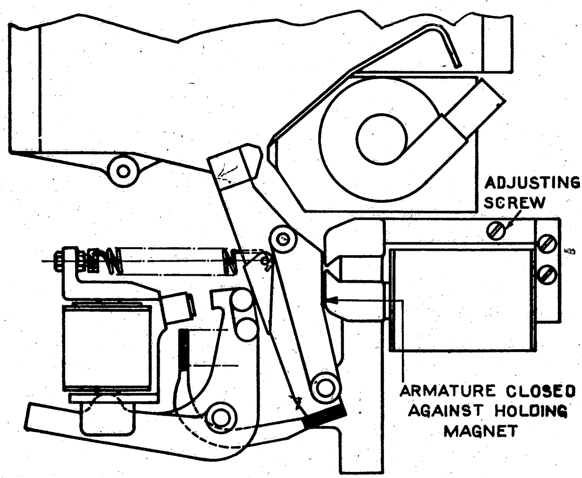



Fig. 7. 3rd Stage—Armature retained by holding magnet ; but main contacts still held open by closing lever.

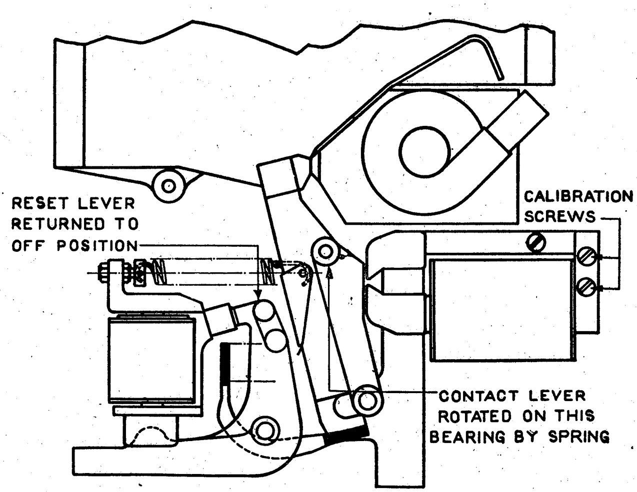



Fig. 8. 4th Stage—Closing mechanism retracted ; breaker contacts closed.

## TRIP-FREE MECHANISM.

The Type RJR circuit-breaker being "trip free" can be used to close a circuit under load and when so used affords protection against short-circuits or overload conditions which may exist at the moment the breaker is closed. The "trip free" feature is obtained by the combination of a contact lever with a second lever, on which the holding armature is mounted. The contact lever is pivoted on the armature lever in such a way as to permit rotation, whilst the armature is stationary. Assuming a breaker is in the "open" position (Fig. 5), then when the closing mechanism is energized, the roller of the closing lever strikes against the contact lever rotating it until the bottom of the contact lever engages with the armature stop, as shown in Fig. 6. Both levers are then rotated around the main bearing pin until the armature reaches the closed position. The armature is retained by the holding coil, but the contact lever is restrained from making contact by the closing mechanism as shown in Fig. 7.

As the closing mechanism is released the contact lever is rotated to the fully closed position by the pull of the main springs which are attached to the contact lever below the pivot pin. The closing mechanism must therefore be retracted before the main contacts can be closed (see Fig. 8), thus permitting the breaker to open immediately in case of an overload or short-circuit. The bottom of the contact lever is held almost stationary, when opening, by the weight of the heavy copper casting and flexible copper shunts which are attached to this end.

Note.—Whilst the principle of operation is the same for all sizes of breaker, the actual arrangement of the mechanism of the larger breakers is quite different from the above (see Fig. 13).

## LOCATION.

### CIRCUIT-BREAKERS.

These breakers may be located in any convenient position such as on the floor or gallery of a sub-station or may be mounted on a substantial framework.

The breaker may be bolted direct to a concrete floor or framework without additional insulation.

It is essential, however, that the location of the breaker allows sufficient clearance above the arc chute to ensure that the arc cannot reach earthed metal work. The minimum necessary clearances vary with the voltage and particulars are therefore included on the dimension outline print supplied with the breaker.

The breakers should invariably be installed so that they are readily accessible for inspection from all sides.

The following points should be carefully observed before installing the breaker :—

1. Do not locate the breaker where dampness prevails.
2. Provide sufficient clearance for the breaker to permit inspection and removal of the arc chute when necessary.
3. Allow sufficient space for closing the breaker manually with the closing handle.
4. Allow ample clearance between the top of the arc chute and any metal work, to prevent the arc reaching earth.
5. Choose a location where dust and metal particles cannot possibly fall into the arc chute.
6. If the breakers are not located in a closed room provision must be made by the customer to protect the operator against personal contact with the framework or other live parts of the breaker.
7. See that the breaker frame is not strained during the process of bolting down.

# INSTALLATION.

## CIRCUIT-BREAKER.

1. Carefully unpack the breaker and remove all packing material, care being exercised in so doing not to bend the interlock rods nor injure any contacts or connections.
2. Carefully clean all contact surfaces especially on interlock discs and contact tips.
3. Examine all parts to see that nothing is missing or broken ; if necessary, the nearest office of The British Thomson-Houston Co. should be communicated with at once.
4. Operate the breaker by means of the closing handle to see that it works freely and that no foreign matter is lodged in the mechanism.
5. Operate the interlocks and closing contactor by hand to see that they work freely and smoothly, and ascertain that the interlock rod and links do not jam when the breaker is in either the open or closed position. Examine the contact tips to see if good contact is made.
6. See that the holding magnet faces are clean and free from rust and that the armature properly beds on the pole face.
   It should be noted that before despatch from the Works the magnet faces are greased with vaseline to afford protection from rust during transit. This grease should be removed before putting the breaker into service.

In damp situations, however, it may be found necessary to leave a very slight film of oil on the magnet and armature faces to prevent rust; but particular care must be taken to restrict such film to the merest residue in each case.

7. Install the breaker in accordance with the recommendations given under "Location." If compressed air is available, blow out any accumulated dust or dirt from the contacts and operating parts of the breaker.
8. See that the necessary retaining resistance is connected in series with the holding coil as shown on the connection diagram.

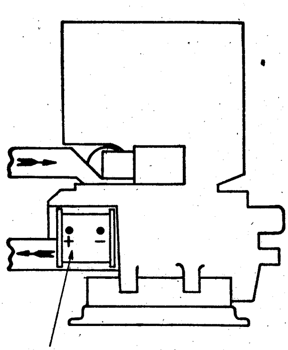
## CONNECTIONS.

The internal wiring of the breaker is completed at the factory. **All external wiring must be made in accordance with the wiring diagram supplied.**

The main frame of the Type RJR circuit-breaker is "alive" at the potential of the circuit and should not therefore be handled unless the breaker is disconnected from the circuit.

Cable thimbles are normally furnished to accommodate the outgoing cables, but if desired, the cable thimbles can be removed and the main connections made with bar copper.

The principle on which the high-speed circuit-breaker operates requires that the polarity of the holding coil be in correct relation to the direction of current flow in the "bucking" bar. **Care must therefore be taken that the direction of current flow through the main circuit and the connections to the holding coil are correct.**




Arrows indicate direction of main current to trip the breaker when the polarity of the holding coil is as shown.

If it is found more convenient to arrange the external connections so that the direction of main current is opposite to that shown, then the polarity of the holding coil terminals must be reversed.

**Fig. 9. Sketch showing correct polarity of holding coil.**

The diagram, Fig. 9, shows the direction of main current flow to trip the breaker with the holding coil polarity as shown.

### WIRING DIAGRAMS.

Typical wiring diagrams are shown in Fig. 4, but these should not be used for installation purposes.

## ADJUSTMENTS.

### CALIBRATING AND ADJUSTING SCREWS.

The current required in the "bucking" bar to trip the circuit-breaker is fixed by the magnetic flux holding the armature closed. Any change of calibration is effected by keeping constant the ampere turns of the holding coil and varying the flux or holding power of the armature by changing the reluctance of the holding coil magnetic circuit. For this purpose two calibrating screws (see Fig. 10) are inserted in the magnetic circuit near the end of the holding coil. By withdrawing both of these screws the reluctance of the holding magnetic circuit is increased, thus decreasing the magnetic flux holding the armature closed and allowing a lower main current in the "bucking" bar to trip the breaker. The breaker is calibrated by marking the trip current for a number of different positions of these calibrating screws on the adjacent brass plate.

Another similar screw, marked "adjusting," is used for compensating for changes in calibration due to the wear of the contact tips of the breaker. The current required to trip the breaker, at any given setting, increases somewhat as the contacts wear. Where accuracy of setting is desired, the trip point can be checked and any increase compensated for by moving the adjusting screw.

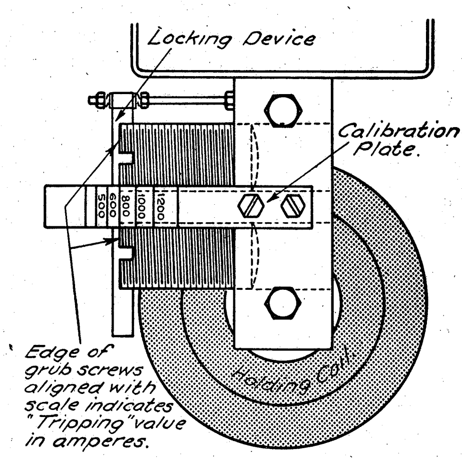



Fig. 10. Sketch showing calibration plate and screws.

It is only necessary to make this compensating adjustment at one setting of the breaker. When the contact tips are renewed, the adjusting screw should be returned to the original position.

Special breakers are sometimes supplied having a fixed tripping point ; in such cases no adjustment of tripping value is possible.

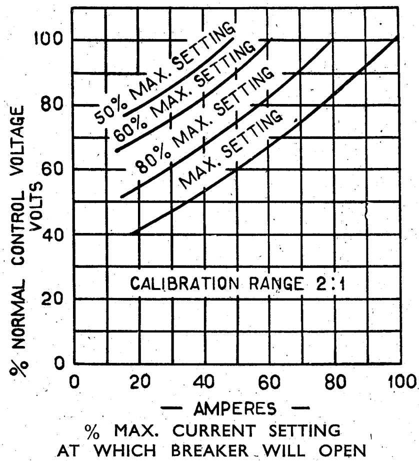



Fig. 11. Curve showing how "tripping" point of breaker is affected by variation of control voltage.

**EFFECT OF VOLTAGE FLUCTUATION ON CALIBRATION.**

When the holding coil of the circuit-breaker is excited from a source subject to considerable fluctuation of voltage, the magnetic flux in the holding coil circuit will also vary with the voltage thus changing the calibration of the breaker accordingly. This change is more noticeable at the lower tripping points of the breaker than at the higher, because of the fact that at higher tripping points the iron in the magnetic circuit of the holding coil is more nearly saturated. A change in voltage at this point does not produce the same change in magnetic flux, as when running at a lower density, in the iron. Fig. 11 shows the effect of these changes of control voltage on the tripping point of the breaker when set to trip at different values. This curve is for a breaker having a calibration range of 2 : 1.

When the voltage of the circuit supplying energy for the holding coil is variable (as from a storage battery during the over charge period), the current in this holding coil should be held constant at a specified value by means of an adjusting rheostat using an ammeter in the circuit to read the current. If several high-speed circuit-breakers are installed in a station, a single rheostat may be used to hold constant a potential on an auxiliary bus from which all of the holding coils are energized, and a voltmeter should be used to read the potential of the regulated bus.

## SPECIAL BREAKERS FOR TRACTION SYSTEMS.

In certain cases a high-speed breaker with specially-extended bucking-bar shunt is supplied for applications—such as traction line-sectionalizing equipments—where the voltage may vary between fairly wide limits. Such breakers are adjustable as regards "tripping" point by altering the length, and therefore the resistance of the bucking-bar shunt in circuit (see Fig. 12).

With such breakers the "calibrating" screws are set before despatch to give the required reluctance in the magnetic circuit, and should not be tampered with. To change the tripping value, the short-circuiting clamp is moved to the required position (see arrow) on the parallel extension loops, the front one of which is calibrated in amperes. After adjustment, the bolts on the short-circuiting clamp should be thoroughly tightened.

## STEEL LAMINATIONS IN THE LOOP OF THE BUCKING BAR.

Changes in calibrating range are produced by changing the dimensions of the steel laminations in the loop of the "bucking" bar and by inserting brass shims under the supporting plate of the core of the holding coil. Both of these are easily removed and care should be taken to see that these parts are properly replaced, should the breaker for any reason be dismantled. These adjustments are usually completed before despatch and should not be changed by anyone who is not familiar with the characteristics of the breaker.

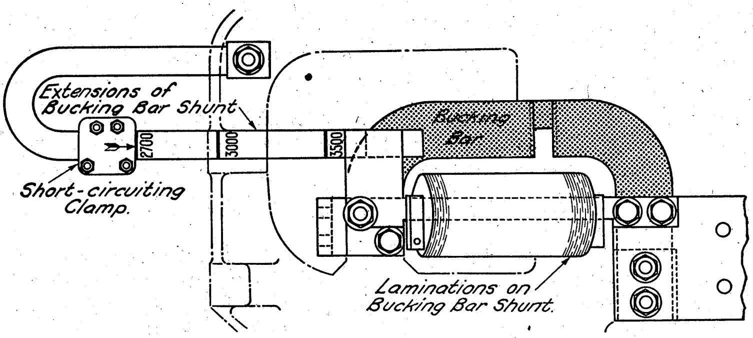



Fig. 12. Sketch illustrating method of calibrating breakers fitted with extended bucking-bar shunt.

## SPRING ADJUSTMENTS.

The springs of the circuit-breaker are set to give a tension of approximately 250/300 lb. (small breakers), 400/500 lb. (medium breakers), and 800/860 lb. (large breakers) with the breaker closed. If the breaker is to be dismantled, the exact distance between the projection of the closing coil casting used as an anchor for the springs and the cross piece to which the stationary ends of the springs are attached, should be accurately measured. When the breaker is re-assembled, the springs can be re-set to their original tension by this measurement.

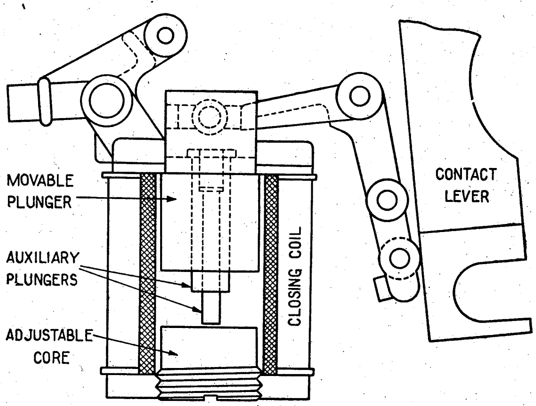



Fig. 13. Sketch of closing mechanism for large pattern high-speed breakers.

## ADJUSTMENT OF CLOSING MECHANISM.

Type RJR breakers are made in various sizes; but for the purpose of this Instruction Book they can be divided into two groups, viz:—small and medium breakers, and large breakers.

Breakers in the first group have a single contact arm, comprised of 7 plates (small) and 11 plates (medium), whilst those in the second group have a double contact arm.

### BREAKERS HAVING SINGLE CONTACT ARM.

The core in the top of the closing magnet is made in the form of a screw, and is adjustable. It is locked in place by a small punching, which fits into one of the four slots cut on top. A movable pin is fitted in the centre of this core in such a way as to extend below the bottom end. This pin partially short-circuits the air gap when striking against the moving plunger, and thus prevents excessive strains in the mechanism when closing. It also secures a most important feature, in that it retards the dropping back of the closing lever when the contacts are closing, thus preventing excessive shock, which would otherwise tend to unseat the holding armature of the breaker when the main contacts touch.

The adjustment of this core is most important and in order to ascertain the best position, the closing core should be set so that the top of the pin is $\frac{1}{8}''$ below the top edge of the core when the closing lever is lifted to the extreme position in the direction of closing; the core should then be raised or lowered a quarter-turn at a time until a position is reached where on closing the breaker no visible bouncing takes place and a noticeable pause in movement occurs just before the main contact tips touch.

Care should be taken not to raise the core of the closing magnet more than is absolutely necessary to eliminate bouncing, that is to say, when the plunger reaches the end of its upward travel it must move the pin upwards through the core of the closing magnet, so as to obviate excessive strains in the mechanism when closing.

### BREAKERS HAVING DOUBLE CONTACT ARM.

On the large sizes of high-speed breaker the closing mechanism is somewhat different to that just described. Here the adjustable core is located at the bottom of the closing magnet frame; the main (top) plunger carries two gravity controlled auxiliary plungers which telescope into the main plunger when the latter moves downwards towards the adjustable core.

By altering the position of the adjustable core, the moment at which the auxiliary plungers leave the core-face can be varied in relation to the position of the main contacts at that moment and thus the retarding effect—due to the sudden reduction in flux—may be made to occur earlier or later as required. In order to ascertain what position is best suited to conditions on site the core should be screwed up as far as possible or alternatively until the main plunger just strikes it when the breaker is closed by hand. When this position has been found, the adjustable core should be withdrawn, a quarter-turn at a time, until a satisfactory closing characteristic is obtained, whereupon the adjustable core should be securely locked in position by means of the locking-strip provided.

The whole object of this equipment is to eliminate "bouncing" of the contacts. When properly adjusted, no visible bouncing should take place, and a noticeable pause in movement should occur just before the contact tips touch; there should be no tendency for breaker to "kick" open during the closing cycle, if properly adjusted.

## PUTTING INTO SERVICE.

### PRELIMINARY TESTS.

Before putting the Type RJR circuit-breaker into service:—

1. Check carefully all connections in conjunction with the wiring diagrams supplied.
2. Ascertain that none of the low-voltage control wiring is connected, or closely adjacent, to the high voltage parts of the breaker.

3. Set the calibration screws to the correct value for the circuit to be protected.
4. Inspect the faces of the holding magnet and laminated armature to ensure they are clean and that no metal particles have become lodged thereon. This is important, because these faces are bedded to make a good magnetic joint and the presence of dirt may prevent the holding coil from retaining the breaker in the closed position and in any case would materially reduce the tripping current value.
5. Test the control circuits to make sure that the breaker operates satisfactorily before attempting to pass main current through its contacts.
6. Ascertain if the breaker will release properly. This should be done, after the generator has been connected to the bus-bars, by arranging to pass sufficient current through the breaker when, if the connections have been correctly made, the breaker should release. Should the breaker fail to release at approximately the current value for which it is set, it will probably be found that the current through the main circuit or through the holding coil is reversed.

## INDUCTIVE SHUNT.

The circuit-breaker is sometimes equipped with an inductive shunt across the " bucking " bar, which carries a portion of the main current. Under steady load conditions the distribution of the current between this shunt and the " bucking " bar is determined by the resistance of the two parallel circuits. With rapidly rising current, however, such as occur during short-circuits the division of current is determined by the inductance as well as the resistance. Iron laminations are assembled on the " bucking " bar shunt to provide the necessary fixed inductance.

The inductance of the shunt is adjusted to give a lower tripping point for rapidly rising currents than for steady currents. Thus, when a short-circuit occurs, the current rises at a very rapid rate, and the breaker opens at a lower value than would be the case with a steady load. The proportion of resistance to inductance in the two circuits is such that resistance predominates for ordinary overload, but in case of short-circuits, inductance predominates, resulting in a lowering of the trip point. If the breaker is found to be too sensitive, particularly when closing on to loads near the trip point value, the induction ratio may be reduced by removing some of the laminations from the " bucking " bar shunt. The total length of iron on the " bucking " bar shunt should not be less than $1\frac{1}{2}$ inches as under this condition the trip point is about the same for rapidly rising currents as for steady overloads.

# MAINTENANCE.

## (1) INSPECTION.

The high-speed circuit-breaker should be thoroughly inspected at regular intervals as dictated by the service conditions—at the longest every six months—in order to take note of any wear which may occur during operation. The following points should be observed.

(*a*) Examine the main contact tips: the slight roughening of the contact surface, due to rupturing of the arc formed when opening, has been found in actual practice to afford better contact (i.e. less resistance and consequently less heating) than an absolutely smooth surface. If, however, large globules of copper are formed, such should be chipped off. Under no circumstances should the main contact tips be filed.

(*b*) Clean the faces of the holding magnet and armature and apply a thin layer of light grease.

(*c*) Remove any copper deposits found in the channels of the arc chutes. Clearance between the arc chute sides and contact tips is of necessity small and, unless the copper deposit—emanating from the arc, formed when opening circuit under load—is cleaned off occasionally, there is a grave risk of leakage which may finally result in the breaker failing to clear the arc. This particularly applies to high voltage systems—especially at 3000 volts D.C. Cleaning of the arc chute should be done at least once every 500 operations* of the breaker; but examination will show whether it is necessary or desirable to clean the arc chute more frequently.

(*d*) Check the adjustment of the interlock mechanism and observe that the interlock rod is not jammed when the breaker is closed. Replace badly worn or pitted contacts if necessary.

(*e*) Operate the breaker by means of the closing handle to make sure that it is operating freely.

(*f*) Examine all connection studs, etc., with a view to disclosing any loose connections if such exist, particular attention being paid to the main contact tips (see Fig. 14). The monel-metal bolts on the moving contact head and the counter-sunk headed screws fixing the stationary contact tip must be kept thoroughly tight at all times.

(*g*) Examine generally all moving parts with a view to replacing them if they are badly worn.

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* The breaker is usually fitted with a counter to register the number of operations.

**(2) CONTACT TIPS.**

Both the stationary and moving contact tips are renewable. The contacts may be inspected by unfastening one end of the arc chute and turning it back on the supporting pin. If desired,

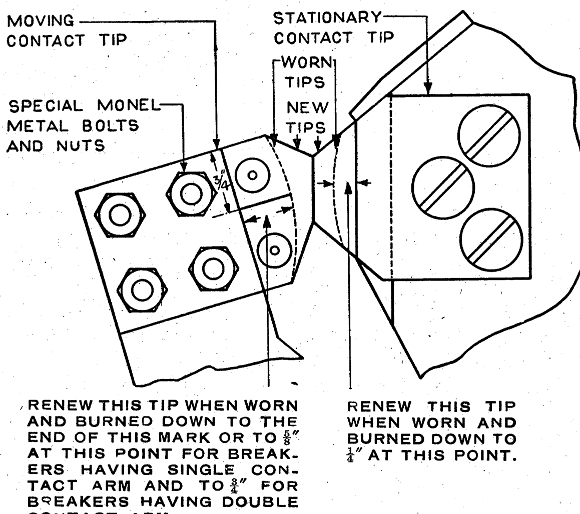


Fig. 14. Sketch of main contact tips.

particularly when replacing the tips, the pole pieces may be removed by taking out two screws one of which supports each of the insulating block and boxes covering the ends of the pole pieces. Remove the two nuts, one of each end of the core of the series blow-out coil. The supporting screws can easily be removed by inserting a screwdriver in the hole in the top of the insulating boxes. The contact tips should be replaced when worn to the dimensions given in Fig. 14. The stationary contact tip is held by three screws. The moving contact tip is removed by unfastening the four supporting bolts, which extend through the arm, the contact surfaces being clamped against the surface of the aluminium contact arm. The surface of this alloy oxidizes when exposed to the air and this oxide must be removed before replacing the contact tip. The contact surfaces should be cleaned by polishing with emery cloth and a coating of vaseline applied to prevent the formation of more oxide. **It is important that the vaseline be applied as soon after cleaning as possible and it should not be removed after the new tip has been assembled.**

It is very desirable, after renewing main contacts on site, to make—if facilities exist—a contact resistance test, in order to ascertain that the joints as made are likely to be satisfactory. This test is also likely to prove of use if local heating occurs on the main current carrying parts of the breaker, due to excessive over-loading in service.

Referring to Fig. 15, it will be seen that this shows both main contact tips of the breaker ; the letters A, B, C, and D indicate the points on the various parts between which the contact resistance measurements are to be taken. The figures given in the table below indicate the resistance values which are likely to be obtained ; if, when taking the measurements, the values obtained are higher than these, the joints should be very carefully inspected to make sure that they are in order. It will be realized that the contact resistance between the main contacts is likely to vary quite considerably, depending on the condition of the contacts, due to arcing, etc. For this reason a range of values is given between which the contacts will operate satisfactorily. If the actual resistance comes outside this range, then the contacts should be faced up, and the contact pressure should be checked.

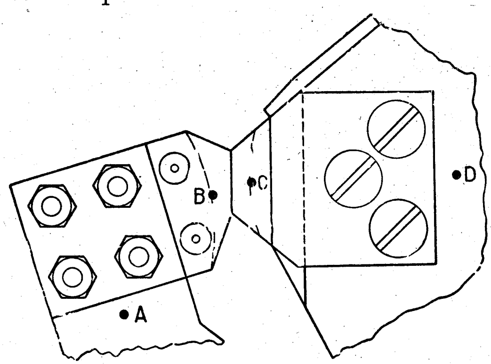


Fig. 15. Contact resistance—voltmeter tapping points.

CONTACT RESISTANCE IN OHMS.

| Size of Breaker | Moving Contact Head Points A—B | Main Contacts Points B—C | Fixed Contacts Points C—D |
|---|---|---|---|
| Small and Large | ·000003 | ·00001 to ·000024 | ·000002 |
| Medium | ·0000016 | ·00001 to ·000014 | ·0000016 |

Contact resistance measurements should be taken with a current flowing through the breaker *at least* equivalent to the minimum value as stamped on the calibration plate ; preferably a higher value should be used. The points of contact across which the voltmeter is to be tapped should be very carefully cleaned before making the tests.

**(3) CALIBRATING COIL.**

To enable the calibration of a breaker to be checked without passing main current through the contacts, a multi-turn calibrating coil is provided. This coil is mounted inside the "bucking" bar loop, the leads being brought out to terminals mounted on the "bucking" bar.

Tests must be made with the holding coil "hot," that is to say, the coil must have been energized for at least 3 hours.

To make a test, the breaker should first be isolated from the main circuit and then the calibrating coil connected, through an ammeter and adjusting rheostat, to a low voltage D.C. supply.

The breaker should be closed electrically in the usual manner and then the current in the coil should be increased until the breaker trips. This value of tripping current should be checked against that given on the calibration plate for the particular setting in use.

It should be noted that the direction of current flow in the calibrating coil must be correct and therefore if the breaker fails to trip, the connections to the coil should be reversed.

The calibrating coil is only suitable for intermittent duty and therefore care should be taken when testing not to overheat the coil.

**(4) SPRINGS.**

The contactor and interlock springs may become weak, due to prolonged use, and fail to perform their function; in such cases the faulty spring should be renewed without delay.

When the main springs have to be replaced for any reason the new springs should be adjusted in accordance with the instructions given on page 15.

**(5) LOCKING OF CONNECTIONS.**

Connection studs are furnished with a lock-washer or lock-nut, which must be screwed up tightly when connections are completed on site. Care must be exercised to ensure that all connections are secured in position by the proper application of lock-washer or lock-nut, whichever is supplied.

**(6) SPARES AND RENEWALS.**

When ordinary spare and new parts are required, much delay and uncertainty will be avoided if customers state carefully in every case the full particulars given on the nameplate attached to the circuit-breaker, and in addition describe as fully as possible the part or parts required.

# NOTES.



## NOTICE.

BEFORE RETURNING APPARATUS FOR REPAIRS OR OTHER REASON, PLEASE COMMUNICATE WITH HEAD OFFICE, NEAREST DISTRICT OFFICE OR LOCAL REPRESENTATIVE—QUOTING SERIAL NUMBER—WHEN THE NECESSARY INSTRUCTIONS WILL BE SENT.

COMPLIANCE WITH THIS REQUEST WILL AVOID DELAY AND INCONVENIENCE.

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**of a Manufacturing Company**
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