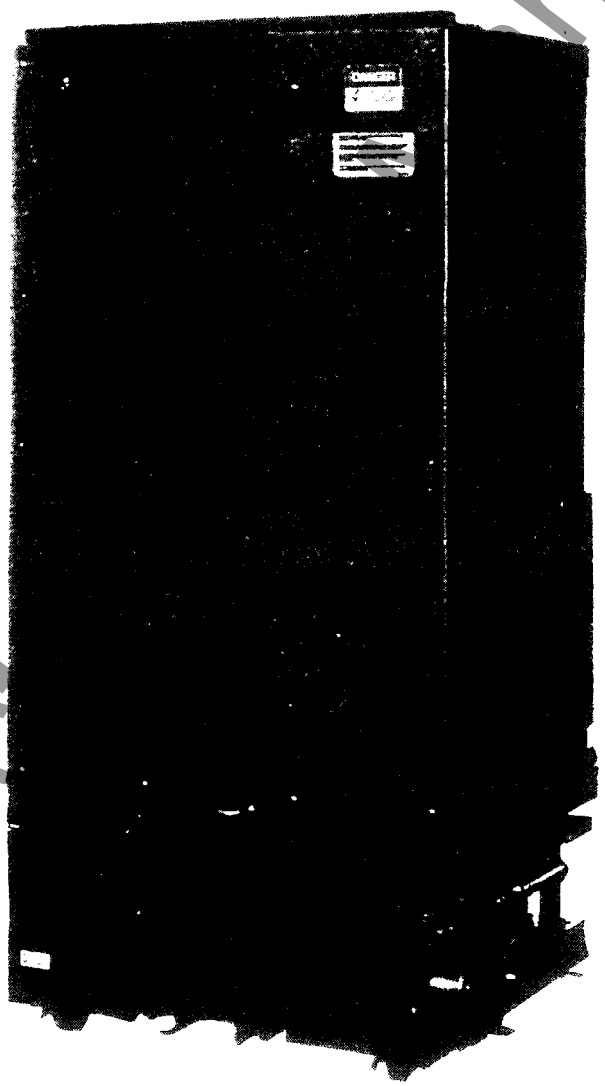
BBC
BROWN BOVERI

IB 6.2.2.7-1A

Installation/Maintenance Instructions

I-T-E Medium-Voltage Power Circuit Breakers

Type 7.5HK500, 15HK500 and 15HK750
1200 thru 3000 Amperes
7500 and 15000 Volts



Brown Boveri Electric

TABLE OF CONTENTS

INSTRUCTIONS FOR 7.5 AND 15 KV POWER CIRCUIT BREAKERS TYPE 7.5HK 500 15HK 500 AND 750

Section 1. INTRODUCTION

These instructions for installation, operation and maintenance of HK circuit breakers should be read carefully and used as a guide during installation and initial operation.

The specific ratings of each model circuit breaker are listed on the individual nameplates.

File these instructions in a readily accessible place together with drawings and descriptive data of the switchgear. These instructions are guides to proper maintenance of the equipment and prolong its life and usefulness.

Section 2. RECEIVING AND STORAGE

Immediately upon receipt of the circuit breakers, examine the cartons to determine if any damage or loss was sustained during transit. If injury or rough handling is evident, file a damage claim at once with the carrier and promptly notify the nearest District Office. The company is not responsible for damage of goods after delivery to the carrier. However, we will lend assistance if notified of claims.

Unpack circuit breakers as soon as possible after receipt . If unpacking is delayed, difficulty may be experienced in making a claim for damages not evident upon receipt. Use care in unpacking in order to avoid damaging any circuit breakers parts. Check the contents of each carton against the packing list before discarding any packing material. If any discrepancy is discovered, promptly notify the nearest district office. Information specifying the purchase order number, carton number and part numbers of damaged or missing parts should accompany the claim.

Circuit breakers should be installed in their permanent location as soon as possible. If the breakers are not to be placed in service for some time, it is required that adequate means of protection be provided. This may be done by keeping the breaker in its original shipping carton and storing in a warm (approximately 15°C) dry (50% max humidity) and uncontaminated atmosphere. If the circuit breaker cannot be stored properly due to abnormal circumstances, it must be thoroughly checked before going into service to insure that it is without damage and it has not become generally contaminated.

Section 3. CIRCUIT BREAKER INSTALLATION

3.1 GENERAL

Prior to installation of the circuit breaker into a switchboard, certain preliminary inspections are made to insure proper operation.

CAUTION CAUTION CAUTION CAUTION

PRIOR TO ANY DISASSEMBLY OR INSPECTION OF THE CIRCUIT BREAKER THE CLOSING SPRINGS SHOULD BE DISCHARGED, AND THE BREAKER SHOULD BE OPEN.

IF IT IS NECESSARY TO RAISE OR MOVE THE BREAKER, ATTACH THE LIFTING YOKE AT POINTS 7 (FIGURE 1), OR A FIFTH WHEEL AT POINT 5 (FIGURE 2) TO TRANSPORT THE BREAKER AS REQUIRED.

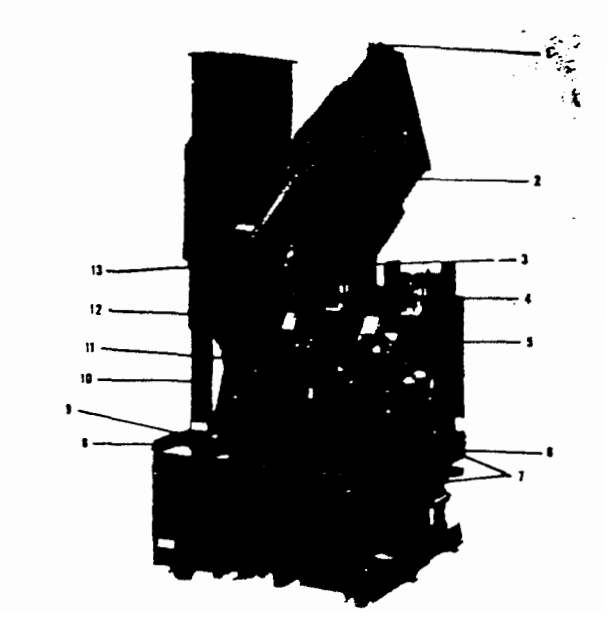


Fig. 1 — View Showing Arc Chute and Contact Structure

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes the matter should be referred to the nearest District Office.

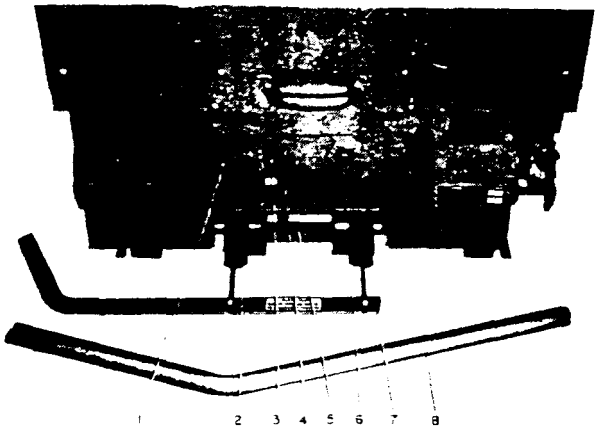


Fig. 2 — Front View of Control Panel

3.2 INSTALLATION INSPECTION

Inspect condition of circuit breaker arc chutes, contact and electrical connections prior to installing the circuit breaker into the switchboard. Even though the circuit breaker is completely adjusted and tested at the factory, shipping and handling conditions could cause defects.

3.3 REMOVING INTERPHASE BARRIERS (See Figure 3)

Remove two lower front sheet screws (9) and lift front sheet up and away from the breaker. Remove arc chute tie bar (6) at upper front of arc chutes. Pivot rear brace (1) at rear of each barrier upward, and slide the separate barriers (3) forward and away from the circuit breaker.

CAUTION CAUTION CAUTION CAUTION

THE BARRIERS WILL NOT STAND UNSUPPORTED AND MUST BE BRACED.

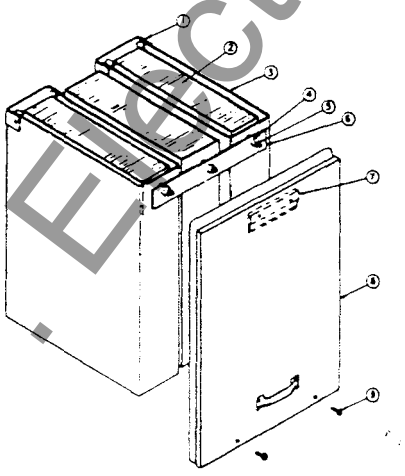


Fig. 3 — Method of Attaching Barrier Assemblies

3.4 REMOVING ARC CHUTES (See Figure 1)

Remove nut (12) and gently disconnect return connection (11). Remove bolt (8) connecting the front leg (10) of arc chute to the block (9) on base sheet of the circuit breaker. Attach accessory lifting bracket to tie bar bushing (1) at the top front of the arc chute and slowly raise the arc chute as required by means of a hoist. It will pivot at its terminal connection and then should be guided straight out of the pivot guide slot and removed away from the circuit breaker. If only a visual examination is to be made, each arc chute may be tilted back gently, hand held and tilt support (13) bolted into place between arc chute leg (10) and block (9).

CAUTION CAUTION CAUTION CAUTION

BE SURE RETURN CONNECTION IS CLEAR AND DOES NOT CATCH ON THE ARC CHUTE. BLOCK THE WHEELS TO PREVENT THE BREAKER FROM ROLLING

3.5 ARC CHUTE EXAMINATION

Examine arc chutes carefully before placing into service. Look for any breakage to liner plates and arc chute plates. Check for presence of any foreign particles such as chips of ceramic and metal. Inspect exterior for any damage or deformation. The polyester glass moldings occasionally have some small cracks develop in resin-rich areas, but these cracks do not indicate defective material and should not cause concern.

3.6 INSULATION STRUCTURE

All insulated parts should be checked for damage. Any dust or dirt should be removed by compressed air or wiped with a clean, lint-free cloth saturated with an oil-free solvent. This is important because the soot or dirt can accumulate and, with moisture, place the circuit breaker in jeopardy, dielectrically. The lead support moldings are polyester glass and occasionally have some resin-rich cracks or crazing develop, but these do not indicate defective material and should not cause concern.

3.7 MANUAL SLOW-CLOSE TO CHECK CONTACT PRESSURE (Figure 2)

NOTE: Insure that accessories that affect electrical/mechanical operation are set in their operating positions: i.e., undervoltage devices should be energized or mechanically closed; mechanical interlocks, key or other, should be properly set, etc.

1. Turn racking screw clockwise approximately two to three turns until the racking-unlocking lever snaps into the first position corresponding to the "DISCONNECT" position.
2. Engage manual charge handle (8) with charging

lever (3). Pump charging lever until breaker closing springs snap into charge position, then remove handle.

3. Insert BOTH tangs of spring retainer bracket (7) into holes of closing spring guides (2).

4. Pull manual close lever (4) to discharge closing springs onto tangs of spring retainer bracket (7). At this time the contacts will partially close.

5. Re-engage manual charge handle (8) with charging lever (3), then slowly pump to slow-close breaker contacts. Check contact pressure as listed in paragraph 5.2. Use the manual trip button (6) to open the breaker.

6. To remove spring retainer bracket (7) from circuit breaker, continue pumping until closing springs are again heard to snap into fully-charged position. Spring retainer bracket can now be removed.

7. Discharge closing springs by pulling manual close lever (4) and pushing manual trip button (6) at the same time to effect trip-free operation. (The breaker can be closed first and then tripped.)

3.8 INSTALLING ARC CHUTES (See Figure 1)

CAUTION CAUTION CAUTION CAUTION

BE SURE RETURN CONNECTION (11) IS CLEAR AND DOES NOT CATCH ON THE ARC CHUTE.

Position arc chute (2) in tilted position, squarely down into its rear pivot guide slots and fingers (3) (avoid bumping and chipping of all moldings), then lower slowly into position. Securely fasten return connection by nut (12) and rebolt front arc chute support leg to hold-down block.

3.9 INSTALLING INTERPHASE BARRIERS (See Figure 3)

1. Slide the right and left interphase barriers (3) as marked, in place between the lead support moldings and inside of clips on the outside moldings, and pivot rear brace downward behind the arc chutes.

2. Install the arc chute tie bar at the upper front on the arc chutes.

3. Lift front sheet in place so that it hooks over arc chute tie bar.

4. Secure barrier front sheet in place with two lower front sheet screws.

3.10 INSTALLING CIRCUIT BREAKER INTO COMPARTMENT (See Figures 2 and 4)

NOTE: CLOCKWISE rotation of racking crank for inserting breaker. COUNTERCLOCKWISE rotation of racking crank for removal of breaker.

1. Turn motor disconnect switch (if supplied) (1) Figure 2) to "OFF" position.

2. Engage racking crank (4, Figure 4) and push racking unlocking lever (3) to left, then rotate racking crank counterclockwise only until resistance to motion is felt. (DO NOT FORCE.) (If closing springs were left in charged condition, they will automatically discharge.)

3. Engage fifth wheel with hole guide (5, Figure 2) and push circuit breaker into compartment until stopped.

4. Engage racking crank and rotate clockwise until racking mechanism automatically stops at "DISCONNECT" position. (Breaker is now held captive in compartment.)

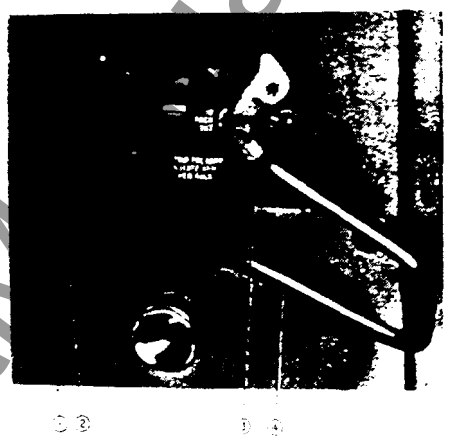


Fig. 4 — Method of Racking Circuit Breaker

5. To rack circuit breaker to "TEST" position, push racking unlocking lever (3, Figure 4) to left, rotate racking crank approximately 1/4 turn clockwise, then release unlocking lever. Continue cranking until racking mechanism automatically stops at "TEST" position.

6. With the circuit breaker racked to "TEST" position, check for proper operation by operating all possible means of opening and closing. This includes control switches, relays, etc. Turn motor disconnect switch (1, Figure 2) to "ON" position to charge the closing springs, and operate the breaker as required. If motor disconnect switch (1, Figure 2) is not provided, springs will automatically charge when approaching "TEST" position.

FOR SAFETY: When racking circuit breaker to "CONNECTED" position, close compartment door (1, Figure 4) and insert racking crank (4, Figure 4) through sliding panel (2, Figure 4).

7. Push unlocking lever (3) to left and turn racking crank (4) approximately 1/4 turn clockwise, then release unlocking lever. Continue cranking until racking mechanism automatically stays at "CONNECTED" position.

CAUTION CAUTION CAUTION CAUTION

DO NOT ATTEMPT TO RACK ANY FURTHER.

The circuit breaker may now be put in service and be operated as required

Section 4. CIRCUIT BREAKER REMOVAL (See Figure 4)

4.1 REMOVAL FROM "CONNECTED" POSITION

To remove circuit breaker from "CONNECTED" position, open the breaker as required.

1. Open sliding door (2) in front compartment door (1).
2. Engage racking crank (4) and push racking unlocking lever (3) to left.
3. Rotate racking crank (4) counterclockwise approximately 1/4 turn, then release unlocking lever.
4. Continue cranking counterclockwise until racking mechanism automatically stops at "TEST" position.

4.2 "DISCONNECT" POSITION

Repeat same operation for "DISCONNECT" position.

4.3 REMOVAL FROM SWITCHBOARD

To position the racking mechanism for withdrawal of the circuit breaker from the switchboard, again push racking unlocking lever to the left and turn racking crank counterclockwise only until resistance to motion is felt. (Approximately 2-3 turns — DO NOT FORCE.)

NOTE: The closing springs, if charged, will automatically discharge when the racking mechanism is positioned for withdrawal from the switchboard.

The circuit breaker can now be removed from the compartment by pulling on the handle located at the bottom of the front barrier.

4.4 SAFE OPERATION RECOMMENDATIONS

1. It is recommended that any circuit breaker be withdrawn and stored in the test position whenever it is to be maintained in the open position with no planned switching.
2. It is recommended that a ground test device be connected to the proper compartment when any work is to be done on any bus or feeder circuit.

Section 5. MAINTENANCE AND ADJUSTMENTS

5.1 GENERAL INFORMATION

HK circuit breakers are designed for minimum maintenance and tested to insure that minimum maintenance will be required. Only one basic adjustment is normally required and that is contact adjustment. This should be checked to the dimensional values required as described in paragraph 5.2. Other adjustments are required only when operational check indicates a need. During maintenance checks, all accessible bolts, nuts and screws should be routinely checked to insure that they are tight.

It is recommended that circuit breakers normally be inspected after 2000 operations. These operations can be either no-load mechanical or load current switching where the power factor is relatively high. When circuit breakers are used for direct bulk capacitor or reactor switching operations or for motor starting applications, it is recommended that the circuit breakers be inspected after 1000 operations, because of the switching severity.

If, however, after the first inspection period, there is no indication of any problem, actual operating experience can dictate the inspection cycle.

Regarding maintenance recommendations following fault duty, reference is made to ANSI Standard C37.04 to which the circuit breakers have been tested. In accordance with this standard, a total of 400% asymmetrical fault duty can be accumulated. This is to be ten or less close-open operations at less than 85% of full fault duty; but it can be an accumulation over a long time period of lower currents. The condition of the breaker should be such that after this duty it is capable of one more close-open operation at full fault current. Inspection is to be made at this time to insure compliance with this requirement. Final operation can be made if everything is satisfactory. At this time, maintenance should be performed, reconditioning done and replacement made as indicated.

In accordance with the same standard, it is recommended that after a major fault duty cycle (CO-15 SEC.—CO), which is known to be between 85 and 100% of the circuit breaker rated asymmetrical short circuit current, the circuit breaker be inspected regardless of any time period or number of operations. Also, when the circuit breaker is applied on reclosing duty, it should be inspected immediately after the series of fault operations in the same range of currents.

The condition of the circuit breaker after interruption depends on circuit conditions regarding such things as power factor, X/R ratio and relay delay times. Experience with specific circuits will indicate the future amount of maintenance that will be required for the various breakers and then procedural modification can follow.

Where unusual service conditions exist, as covered by ANSI Standard C37.04, it must be assumed that these conditions were considered at the time of order; that the equipment supplied was designed for the special application; and that an appropriate supplemental maintenance program has been developed. These maintenance instructions cover only circuit breakers used under standard usual service conditions.

After normal service without major fault interruption, the following tests and adjustments should be made.

NOTE: The following tabulated tests and adjustments are all that are normally necessary for proper maintenance and operation of the HK circuit breaker. The remaining portions of the breaker—close coil assembly, shunt trip device, control relay, auxiliary switch and motor—require no maintenance during the standard life of the circuit breaker regardless of the operating duty.

5.2 CONTACT PRESSURE (See Figure 5)

(A) With the circuit breaker withdrawn from the switchboard, the following step-by-step procedure should be followed for properly checking and/or adjusting the contact pressure on "HK" type circuit breakers.

1. Remove interphase barriers and flux shunts and remove arc chutes as described in paragraphs 3.3 and 3.4

2. Turn racking screw clockwise approximately two to three turns until the racking-unlocking lever snaps into the first position corresponding to the "DISCONNECT" position.

3. Manually slow-close the circuit breaker as described in paragraph 3.7, but only to the point that arc contacts just touch. All arcing contacts should touch within 1/32", after all free play has been removed by pulling the bridge arm toward the open position.

4. Continue the slow-close operation to fully close the breaker. Each pole should have between 7/64" minimum and 3/16" maximum main contact compression measured at "A" between the EDGE of the metal stop plate and the main contact stop. (This dimension measured on either side is sufficient.) A rod or drill of these sizes can be used for measuring.

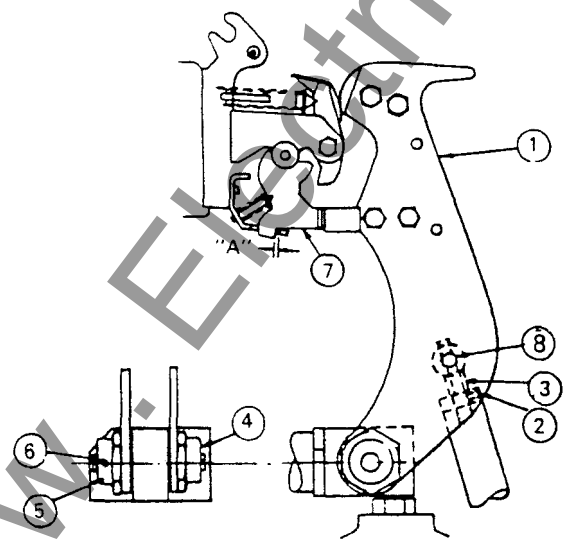


Fig. 5 — Contact Pressure and Bridge Pivot Pressure

At this point, if adjustments are correct, complete steps B6, B7, B8 and B9.

(B) If any adjustment is incorrect, use the following procedure to readjust contact pressure or to initially adjust when changes are made.

1. Completely slow-close the circuit breaker and set each pole for 7/64" main contact compression at "A". (A 7/64" rod or drill should fit tightly between the EDGE of the metal stop plate and the main contact stop.)

2. Open the circuit breaker, manually recharge closing springs, and partially slow-close the circuit breaker until the arcing contacts of any pole or poles just touch.

3. Advance the adjustment of lagging pole or poles so that the three arcing contacts touch simultaneously within 1/32". This adjustment is made by loosening locking nut (2) and rotating adjusting stud (3).

4. Complete slow-close operation to fully-closed position and check that main contact compression of the pole or poles that were advanced does not exceed 3/16". Also, arcing contact springs on these poles should not be fully compressed. If the 3/16" dimension is exceeded, the entire procedure should be repeated to obtain the correct gap at "A".

NOTE: Occasionally, center pole contact pressure may slightly exceed 3/16". However, if outer poles are within the 3/16" dimension, and arcing contact springs of the center pole are not fully compressed no readjustment need be made. When this condition exists, the center pole parts before outer poles on opening.

5. Open breaker, recharge closing springs, remove slow-close bracket, fast-close the breaker, recheck adjustments and trip open.

NOTE: Fast-closing the circuit breaker results in a slight increase in contact pressure over slow-closing.

6. Tighten locking nut (2) on each adjusting stud (3) to lock contact pressure adjustment stud in place.

7. Arc chutes can now be replaced, and interphase barriers assembly can now be reinstalled.

8. Return racking screw to its original position by turning counterclockwise approximately two to three turns until it stops.

9. The circuit breaker can now be replaced in its compartment and returned to service.

5.3 CONTACT AND INSULATION CLEANING

All dirt, soot or grease should be removed from circuit breaker contacts and surface of entire current-carrying structure, as well as all insulation surfaces,

with a cloth saturated with an oil-free OSHA-approved solvent. Cleaning of insulation is important because soot and dirt can accumulate and, with moisture, place the circuit breaker in jeopardy, dielectrically.

A degree of burning and pitting of circuit breaker arcing contacts is to be expected from normal operation; also, on highly inductive or capacitative circuits and after major interruptions, some pitting may occur on main contacts. A moderate amount of pitting will not interfere with operation of the contacts. When necessary to dress the contacts, cover the puffer nozzle (5, Figure 1) with a cloth, then follow the contour of the contacts with a fine file. Do not attempt to eliminate pitting entirely. After this maintenance, contact pressure (paragraph 5.2) and millivolt drop (paragraph 5.4) should be checked.

NOTE: Replacement of contacts is required when: after repeated dressing of any contacts, less than 50% of the original contact material thickness is left;* the tips of the stationary arcing contacts have been eroded away; any contact has been broken or cracked.

*Moving arcing contact can be inverted when working surface is reduced to less than 50%.

5.4 MILLIVOLT DROP TEST

During normal maintenance periods, the condition of the circuit breaker can easily be determined by performing a millivolt drop test. This test should be performed regardless of whether the circuit breaker had interrupted low or high currents or has minimum operations.

The following table lists the millivolt drop and resistance values for the circuit breakers, when manufactured, covered by this instruction book, from terminal to terminal, exclusive of the primary disconnects.

TABLE 1. MV DROP AND RESISTANCE VALUES

	Maximum MV Drop*	Maximum Micro-Ohms
7.5 HK 500, 15 HK 500, 15 HK 750 1200 Amperes	9	45
7.5 HK 500, 15 HK 500, 15 HK 750 2000-2500 Amperes	7	35
15 HK 750 3000 Amperes	6	30

Millivolt drop with 200 Amperes flowing.

Breakers operating with normal loading will require no maintenance if the millivolt drop does not exceed 150% of the listed values. If the millivolt drop does exceed 150% of the above values, the main and arcing contacts should be dressed with a fine file, cleaned and adjusted for proper contact pressure and then rechecked. If the values are still in excess of the 150% value, the bridge pivot pressure should be readjusted as outlined in paragraph 5.6.

NOTE: For optimum performance of the circuit breakers during periods of increased loading, it is recommended that the listed values be met.

After all above steps have been taken and the millivolt drop is still excessive, contact the district office for recommendations.

5.5 PUFFERS (5, Figure 1)

WARNING WARNING WARNING WARNING

KEEP CLEAR OF ALL MOVING PARTS.

The performance of the puffers should be checked during a normal maintenance interval. Each puffer should provide a moderate blast of air at breaker contacts, on opening of the circuit breaker. This can be detected by holding a piece of paper approximately 8-1/2" x 11" over the top of the contacts and opening the circuit breaker. All three poles must have puffing action or the circuit breaker must not be placed in service.

5.6 BRIDGE PIVOT PRESSURE (See Figure 5)

Bridge pivot pressure should be adjusted only when the millivolt drop test indicates a problem. When adjustment is necessary, adjust as follows:

1. Locking bolt (8) should be loosened on solid pushrod models. Spring-loaded pushrod models do not require disconnecting.
2. Bridge (1) should be disconnected from adjusting stud (3) on solid pushrod models.
3. Loosen one setscrew (6) in one pivot nut — either side.
4. Tighten bridge pivot nut (4 or 5) securely (approximately 75ft/lbs.). Then gradually back up pivot nut approximately 1/2 to 1-1/2 flats until bridge (1) motion is just free when bridge is removed by hand. On spring-loaded pushrod models, lift bridge against spring and then slowly release, insuring that it resets freely.
5. Tighten setscrew (6) in nut that was loosened, reinstall adjusting stud, if disconnected, and readjust contact pressure as described in paragraph 5.2.

5.7 CLOSING AND OPENING TIMES

After operation intervals noted previously or a change in bridge pivot adjustment, it is recommended that opening and closing times be checked

by use of a cycle counter, time-travel analyzer,* oscillograph, etc., to monitor the time from energizing to arcing contact touch or part.

Circuit breaker closing and opening times should be within the following time ranges for normal operation.

TABLE 2. CLOSING AND OPENING TIMES

	Closing Time Range ** MS	Opening Time Range** MS
7.5 HK 500, 15 HK 500, 15 HK 750, 1200 through 3000 Amperes	105-140	25-42

***At 125 VDC. Times at other voltages may vary slightly.*

NOTE: Table above also applies to 15 HK 500, 60 KA high-momentary and 15 HK 750, 80 KA high momentary.

NOTE: Below 0°C, the closing times will increase (but with no reduction in closing force); and opening times will be within the limits. Adjustments to correct speeds, if found to be outside limits, are critical and our district office should be contacted for recommendations.

5.8 ARC CHUTES

The arc chutes should be inspected internally to insure that no breakage occurred to liner plates or arc plates. Further, there may be a crust formed on the liner plates if local current interruptions were close to the continuous current rating of the breaker, or moderate faults were interrupted. This crust should be removed by carefully using a carborundum stone or scraper. The arc chute should then be blown out with compressed air to remove the resultant dust and particles.

After 400% accumulated current or major interruptions occur, the circuit breaker should be inspected immediately. All maintenance checks or tests noted above should be carried out, plus close examination of the arc chute. Arc plate and liner plate breakage should be carefully looked for, along with excessive erosion of the arc plates. Arc plates are made of ceramic material and perform the function of extracting heat from the arc as it is being forced into and elongated by them. The leading edges become coated with glass that comes to the surface from the extreme heat. Direct measure of use is the amount of glass beads evident.

When the entire leading edge and portions of the flat arc plate are heavily encrusted with glass beads the arc chute should be replaced. It should be noted that this condition will vary between arc chutes on the same breaker because of single-phase fault and asymmetrical current incidences.

5.9 OPERATING MECHANISM (See Figure 6)

The operating mechanism is adjusted at the factory for proper operation and should not be disturbed unless the circuit breaker does not close electrically on reclosing duty. This condition is caused when the latch check switch (2) at right side of breaker (when used) is not actuated. Circuit breaker should not close before trip latch (4) has reset.

Latch-check switch adjustments — made with latch (4) against stop pin (3):

1. Turn in adjusting screw (1) until contacts of switch (2) "break" as indicated by an audible click or check with bell ringer.
2. Retract adjusting screw until switch contacts "make".
3. Rotate adjusting screw one turn more. (Adjusting screw is self-locking.)

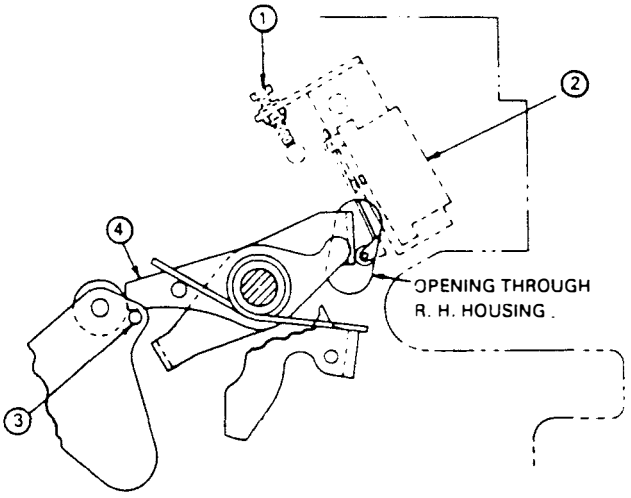


Fig. 6 — Latch Check Switch Adjustment

5.10 CONTROL RELAY ADJUSTMENT (See Figure 7)

The control relay does not normally require any adjustment in the field. However, if necessary, adjust the gap between the control device lever adjusting screw and the limit switch crank arm for a gap no less than 0.06" and no more than 0.09" with the closing springs charged.

*For measuring circuit breaker speeds, analyzer mounting support and instructions are available on special order.

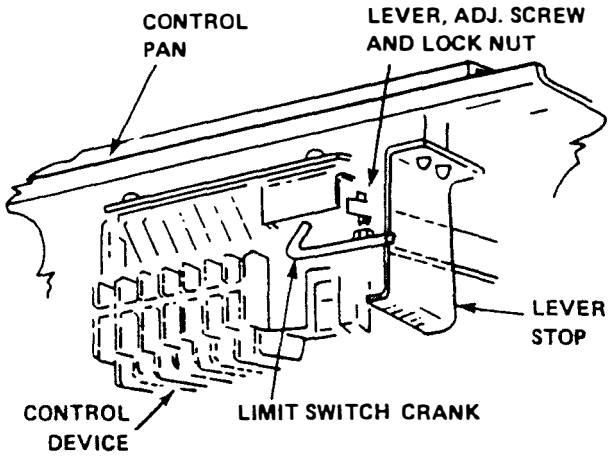


Fig. 7 — Control Relay

5.11 RACKING MECHANISM (See Figure 8)

The circuit breaker racking mechanism is adjusted for proper operation and should not be disturbed unless it becomes possible to close the breaker during a racking operation.

If it is possible to close breaker during a racking operation, it may be that interlocked blocking members are not positioned properly, which should be corrected as follows:

1. Remove the front mechanism coverplate.
2. With circuit breaker closed, make adjustments by regulating length of connecting rod (1) for 1/8" minimum to 3/16" maximum clearance at "A" between trip link (3) and blocking lever (2).

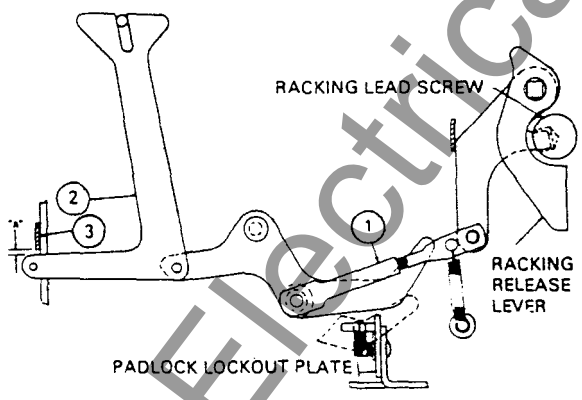


Fig. 8 — Racking Mechanism

5.12 LUBRICATION

The HK circuit breakers are lubricated during factory assembly as follows:

1. All mating surfaces of moving current-carrying joints have been lubricated with NO-OX-ID special grade "A" grease manufactured by Sanchen Company.
2. All other mechanism parts, bearings, pins, etc. have been lubricated with ANDEROL 757 manufactured by Tenneco Chemical, Inc., Intermediate Division.

In order to maintain reliable operations, it is important that all circuit breakers be lubricated at all times. All bearings and rolling surfaces that require lubrication have been properly lubricated at the factory during assembly and should not require any further lubrication during the life of the equipment. However, even the finest greases have a tendency to oxidize with age, as evidenced by hardening and darkening in color. In addition to lubricant oxidation, frequent operation of the breaker causes lubricant to be forced out from between the bearing surfaces. When these changes occur, regreasing is required to maintain reliable operation of the breaker. Elimination of the hardened lubricant is essential before regreasing is performed. A simple lubrication will often clear up minor misoperations which might be mistaken for more serious trouble.

If the grease should become contaminated or parts are replaced, lubrication should be done with NO-OX-ID or ANDEROL grease as applicable. Use of other greases have not been proven by test and are not recommended.

NOTES:

1. Do not use NO-OX-ID grease on any main and arcing contact surfaces.
2. It is recommended that the primary disconnects be maintained by renewing the NO-OX-ID grease during maintenance periods.
3. Do not use light oil to lubricate any mechanism parts.
4. The charging motor is sealed and no lubrication is required.

5.13 DIELECTRIC TESTS

If it is desired to make dielectric tests during maintenance periods, the following test values should be used. These are to be applied for a one-minute period.

TABLE 3. DIELECTRIC TEST VALUES

Circuit	60 Hz	DC
Primary Circuit	21.5 kV	30 kV
*Secondary Circuit (Control)	1100 V	1500 V

It is necessary that the charging motor be disconnected for this test by turning the motor disconnect switch to the "OFF" position. If a test is desired on the motor, then the motor disconnect switch should be turned to the "ON" position and the circuit retested at 540 V, 60 Hz or 760 V DC.

5.14 TROUBLESHOOTING

The following chart lists typical problems, their causes and corrective action required to remedy the malfunction.

TROUBLESHOOTING CHART

Problem	Probable Cause	Corrective Action
Breaker Fails to Close	Low or Incorrect Control Voltage	Adjust to Proper Level
	Closing Springs Not Charged	Adjust Per Section 5.10
	Control Relay Limit Switch Out of Adjustment	
	Breaker is not Racked into Test or Connected Position	Turn Operating Crank Clockwise until lever is locked into the desired position
	Latch Check Switch not Making (When Supplied)	Adjust Per Section 5.9
	Auxiliary Switch "b" Contact not Making	Determine Cause and Repair
	Racking Release Lever Linkage not properly adjusted	Adjust per Section 5.11
	Excessive Friction	Insufficient or Contaminated Lubrication (See Sec. 5.12)
	"Y" Contact not Making*	Defective "Y" Coil Circuit
	Undervoltage not operating (When Supplied)	Low or Improper Voltage Applied
	Defective Close Coil Assembly	Replace Close Coil Assembly
Breaker Fails to Trip	Low or Incorrect Control Voltage	Adjust to Proper Level
	Auxiliary Switch "a" Contact not Making	Determine Cause and Repair
	Defective Trip Coil Assembly	Replace Trip Coil Assembly
	Excessive Friction	Insufficient or Contaminated Lubrication (See Sec. 5.12)

**Caution — Improper "Y" circuit operation could permit the breaker to pump to destruction.*

5.15 ELECTRICAL CHARACTERISTICS OF CONTROL DEVICES

For operating voltage ranges for various nominal control voltages refer to Table 4, Operating Voltage Ranges.

For average current values at various nominal control voltages, refer to Table 5, Average Current Values. Current values given in this table are average, steady-state values and momentary inrush currents for all charging motors and AC coils are approximately six to eight times these values.

TABLE 4 — OPERATING VOLTAGE RANGE

Nominal Control Voltage	Spring Charging Motor	Close Coil	Trip Coil	Undervoltage	
				Pick Up Maximum	Drop Out
24 V dc	-	18-28	14-30	21	7-14
48 V dc	35-50	35-50	28-60	41	15-29
125 V dc	90-130	90-130	70-140	108	38-75
250 V dc	180-260	180-260	140-280	212	75-150
115 V ac	95-125	95-125	* 95-125	97	34-69
230 V ac	190-250	190-250	*190-250	195	69-138

TABLE 5 — AVERAGE CURRENT VALUES

Nominal Control Voltage	Spring Charging Motor	Close Coil	Trip Coil	Lockout Coil	Under-Voltage	N.E.C. Fuse
24 V dc	-	22.0	22.0	0.30	0.9	30
48 V dc	25.0	10.7	10.7	0.15	0.5	30
125 V dc	10.0	5.0	5.0	0.06	0.2	30
250 V dc	5.0	2.2	2.2	0.03	0.1	30
115 V ac	10.0	4.5	*4.5	0.40	0.2	30
230 V ac	5.0	2.3	*2.3	0.20	0.1	30

**Alternating current is never recommended because the control power is affected by the power system that it is protecting. A sufficient reduction in control power during a heavy fault condition could prevent the HK circuit breaker from opening, leading to loss of total load and/or equipment damage.*

Section 6. ELECTRICAL OPERATING SEQUENCE

Please refer to the specific schematic diagrams and other operational information furnished with your order.

Figure 9 is provided as a typical schematic for general information on electrical operation with DC closing.

Figure 10 is provided as a typical schematic for general information on electricial operation for HK breakers with AC closing. The following is the sequence of electricial operation with AC closing.

With the circuit breaker open, the closing springs uncharged, and the control power source energized across disconnects 5 and 02 and 01 and 6 and motor disconnect switch closed, operation occurs as follows:

1. Immediately upon the availability of control power at secondary disconnects "5" and "02" the spring charging motor (MOT) is energized, which, in turn, charges the closing springs. When the closing springs are charged, limit switch contacts "LSb" are opened, and limit switch contact "LSa" is closed. Also, upon availability of control

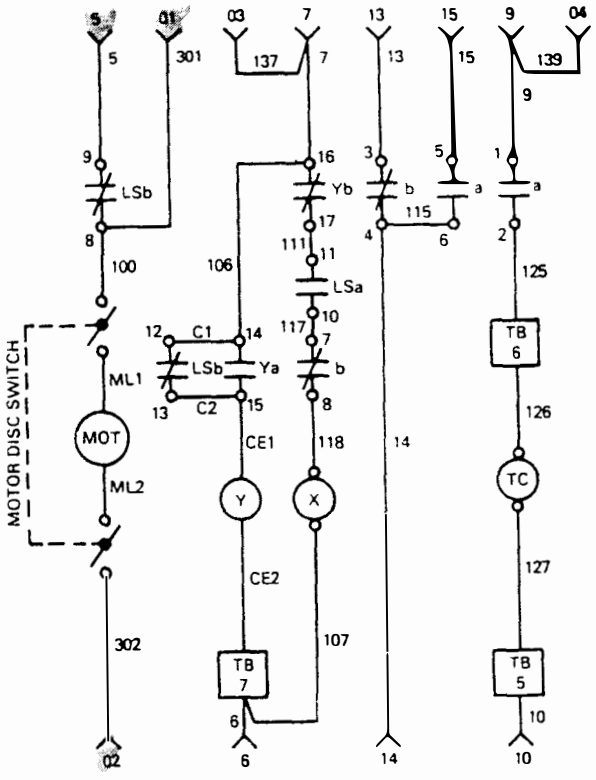


Fig. 9 — Typical Schematic Diagram of Control Circuit, DC Closing

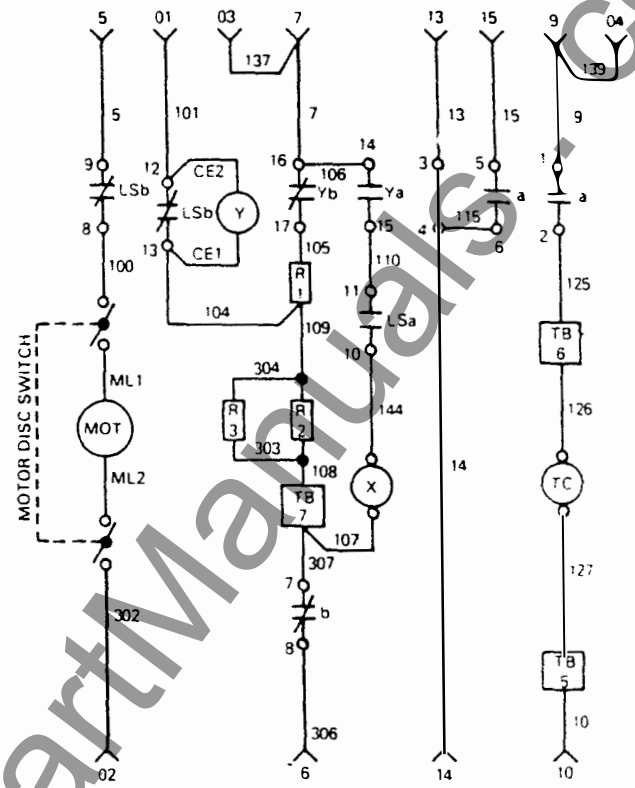


Fig. 10 — Typical Schematic Diagram of Control Circuit, AC Closing

LEGEND

REAR VIEW OF SECONDARY DISCONNECTS

6 >	< 5
9 >	< 7
10 >	< 13
15 >	< 14
04 >	< 03
02 >	< 01

a — Auxiliary Switch Contact Closed When Breaker Is Closed.
b — Auxiliary Switch Contact Open When Breaker Is Closed.
LCb — Latch Check Switch Contact Closed When Breaker Operating Mechanism Is Reset.
LSa — Limit Switch Contact Open When Springs Are Discharged, Closed When Springs Are Charged.
LSb — Limit Switch Contact Closed When Springs Are Discharged, Open When Springs Are Charged.
TC — Shunt Trip Coil
X — Closing Latch Release Coil.
Y — Control Relay Lockout Coil.
Ya — Normally Open Control Relay Contact.
Yb — Normally Closed Control Relay Contact.
TB — Terminal Block Point.
ML — Motor Lead.
CE — Coil Lead End.
C1, C2 — Terminal Jumper (Control Device).
^ — Female Secondary Disconnect Contact.
UV — Undervoltage Trip Device.
UVb — Normally Closed Undervoltage Trip Device Contact.
69 — Permissive Control Switch.
BL — Blocking Lever Switch (Open When Ground Switch Is Locked In Ground Position).

power at secondary disconnects "01" and "6" and after the closing springs have been charged, the lockout relay coil (Y) will be energized through the circuit breaker auxiliary switch "b" contact and the parallel resistors R2 and R3. The lockout relay will pick up and open contact Yb" and close contact "Ya".

2. Connecting secondary disconnects "03" or "7" to control via operation of the close control switch energizes the latch release coil (X) through the circuit breaker auxiliary switch "b" contact, the normally open lockout relay contact "Ya", and the limit switch contact "LSa". The latch release coil (X) releases the closing latch. The springs then discharge to close the circuit breaker.

3. When the springs discharge, limit switch contacts "LSb" close, and limit switch contact "LSa" opens.

4. When limit switch contact "LSb" in the motor circuit closes, the spring charging motor is energized, which, in turn, recharges the closing springs.

5. When the circuit breaker closes, all auxiliary switch "b" contacts open and all auxiliary switch "a" contacts close.

6. When limit switch contacts "LSb" close, the lockout relay coil (Y) is de-energized and opens lockout relay contact "YA", which de-energizes the latch release coil (X). Lockout relay contact "Yb" closes, which locks out the lockout coil (Y) as long as the "Close" contact is maintained. This is true because control power maintained on secondary disconnects "03" or "7" with "Yb" contact closed puts resistor R1 in parallel with the "Y" coil. The additional current flow through R2 and R3, and the associated increased voltage drop across R2 and R3 leaves insufficient voltage to pick up the lockout relay. The purpose of the lockout relay coil (Y) is to prevent pumping of the closing mechanism when closing against a faulted circuit.

7. After the breaker has closed and when the closing control switch is released by the operator, the lockout relay coil (Y) remains de-energized due to the auxiliary switch "b" contact in the closing circuit being open.

8. The circuit breaker can be tripped by operation of a remote trip switch, which energizes the circuit breaker trip coil (TC) through the auxiliary switch "a" contact.

9. The undervoltage device, if furnished, provides a direct acting lock-open and undervoltage tripping feature. This device must be energized to initially close the breaker, and also to maintain the breaker in a closed position.

10. The latch check switch, if furnished, insures that the operating mechanism must be reset prior to energizing the closing latch release coil (X).

11. The remote mounted capacitor trip feature, if furnished, provides an electrical energy storage network, whereby should a loss of control power occur at the instant of a tripping signal, sufficient energy will be furnished to insure an electrical tripping operation.

12. The stopping device switch, if applicable, prevents electrical reclosing of the circuit breaker after a manual trip until the stopping device switch has been manually reset.

When AC closing control power is supplied, the circuit breaker will not reclose unless the reclosing circuit has sufficient time delay to permit the "Y" coil to pick up.

Operation of accessories, when installed as ordered, can affect electrical/mechanical operations of the circuit breaker. When the circuit breaker is being tested electrically or mechanically, undervoltage devices should be energized or otherwise mechanically closed and mechanical interlocks, key or other, should be set in the "operate" position.

Section 7. GROUND AND TEST DEVICES

These devices are supplied when ordered and are basically three design types, with certain component variations such as test ports and interlocks.

- Simple, three-terminal, non-automatic.
- Simple, three-terminal, electrically operated.
- Complex, six-terminal, electrically operated with manual selector switch.

These devices are basically maintenance free for their normal operating life. Racking procedure is the same as for the basic circuit breaker as outlined previously, and all detailed operational instructions are attached to the individual devices.

Section 8. RENEWAL PARTS

Only those recommended renewal parts be stocked that will be required to insure proper and timely maintenance for normal operation of HK circuit breakers. Copies of the applicable Renewal Parts Bulletin for specific circuit breakers will be furnished on request to the nearest district office.

The minimum quantity of assemblies and items recommended in these bulletins are predicated on infrequent replacement of parts based on accumulated test and operating experience. Total assemblies are recommended for fast replacement, when necessary, to return the breaker to service as quickly as possible. Then certain replaced assemblies, such as the stationary upper terminals, can be returned to the factory for nominal reconditioning. The bulletins contain specific part-ordering instructions. Specific instructions regarding replacement of those part assemblies recommended are available if required.

INSTRUCTIONS FOR TYPE 5HK, 7.5HK, AND 15HK METAL-CLAD SWITCHGEAR 5000, 7500, AND 15000 VOLT

INTRODUCTION

Instructions for installation, operation and maintenance of metal-clad switchgear are furnished with each shipment.

These instructions should be read carefully and used as a guide during installation and initial operation.

File these instructions in a readily accessible place together with drawings and descriptive data of the switchgear. The use of these instructions will facilitate proper maintenance of the equipment and prolong its life and usefulness.

SCOPE OF INSTRUCTIONS

These instructions are general. They cover requirements for installation as applied to all metal-clad switchgear of the following classification:

5HK75	7.5HK250	15HK150
5HK150	7.5HK500	15HK250
5HK250		15HK500
5HK350		15HK750
		15HK1000

Specific information on particular applications is furnished in the form of general arrangement drawings.

1. Front view showing arrangement of relays and instruments.

2. Single line diagram showing power connections.

3. Floor plan indicating available space for power and control conduits.

4. Special construction details.

The first sheet of the Bill of Material indicates the application of the drawings.

TRANSPORTATION

Prior to shipment, the switchgear undergoes careful factory inspection. Each section is plainly marked at convenient places with its number and position. When size or other reasons make it necessary to divide the equipment for shipment, the unit number of the particular equipment is also marked on the section, along with its weight. The circuit breakers are shipped in individual cartons or crates.

Immediately upon receipt of the switchgear, examine for any damage or loss sustained during transportation. Check the contents against the packing list before discarding any packing material.

If there is any shortage, notify the nearest I-T-E representative at once.

The I-T-E Imperial Corporation is not responsible for damage after delivery of shipment to the carrier. However, if the company is notified of such claims, it will furnish forms to facilitate securing any adjustments. If damage to the shipment indicates rough handling, claim for damage should be filed at once with the carrier and the I-T-E Imperial Corporation promptly notified.

Indoor switchgear housings are shipped in groups of one to five units. Each group is mounted on heavy steel shipping bases. Unloading and handling at the site is usually done by placing rollers under the shipping bases. To avoid distortion to the switchgear, any force to move the structures should be applied to the shipping bases by means of crowbar, block and tackle, crane, etc.

STORAGE

Leave each switchgear group on its shipping base for subsequent moving. Remove circuit breakers and accessories from cartons or crates.

Observe the following precautions:

1. Check for missing or damaged parts.

2. Store in clean, dry place.

3. Cover parts susceptible to rust with heavy oil or grease.

4. Cover with heavy wrapping paper to keep dirt or dripping water from entering. Dirt or moisture may foul working parts or deteriorate contacts and insulation.

5. If the switchboard is to be stored for any length of time, or in any place where dampness may be present, then heaters should be used to keep the switchboard dry until it is placed in service. When outdoor switchboards equipped with heaters are stored, the power source for the heaters should be brought to the load terminals of the thermal circuit breaker or cutout device which controls the heater circuits.

UNLOADING AND HANDLING

The following is a recommended method for unloading and handling metal-clad switchgear housings.

INDOOR INSTALLATION

The switchgear should be unloaded as near to the installation site as possible. The operation may be completed by raising the switchgear shipping base with track jacks to allow rollers to be placed under the shipping bases.

Raising by Jacks

In most locations the practical way of handling the switchgear is by jacks.

1. After switchgear housings have been moved near site, raise the units by placing jacks under the shipping bases near the front and rear corners as shown in Fig. 1.

CAUTION: DO NOT APPLY JACKS TO THE HOUSINGS AT ANY OTHER POINTS.

Raise units evenly and just enough to position rollers. Repeat operation at other end of units so that rollers are equally distributed under units.

2. While a crew pushes the switchgear longitudinally towards its final position, one man should insert an additional roller under the forward end of the units. He should continue this operation by moving each roller that ...eed from the rear end to the forward end until the ... are in the desired position.

3. For lateral moving, raise the units by jacks and remove the rollers. Place the rollers laterally with steel channels resting on the rollers as shown in Figs. 3 and 4. Move the units until they are directly over the installation site.

4. When the units are in their final place, raise the units enough to just clear the rollers and any channels resting on the rollers, by placing the jacks under the side sheets, near but not under the shipping bases. Remove the bolts inside the units which hold them to the shipping bases. Remove all the rollers, steel channels and shipping bases and lower the units by means of the jacks onto the floor. Lower the units evenly so as not to distort any of the structure.

Raising by Slings

Where overhead lifting facilities are available, an alternate method of handling may be used for moving.

1. Holes are provided in the top of the units along the front and back which are spaced identically to those in the floor through which the shipping bases are bolted to the units.

2. Raise the units from the floor by placing the jacks under the side sheets near, but not under the shipping bases. Remove the bolts inside the units, which hold them to the shipping bases and withdraw the shipping bases. Lower the units to the floor evenly so as not to distort any of the structure.

3. Invert the shipping bases on top of the units and

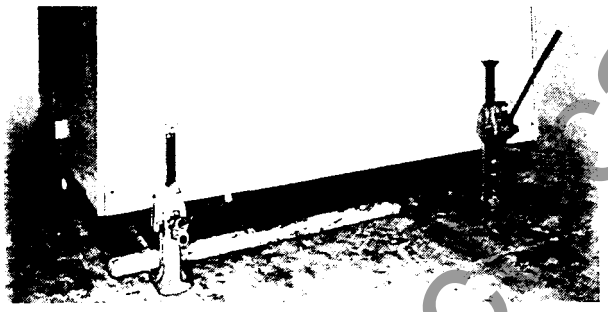


Fig. 1—Method of Raising Switchgear by Use of Jacks. Rollers in Place

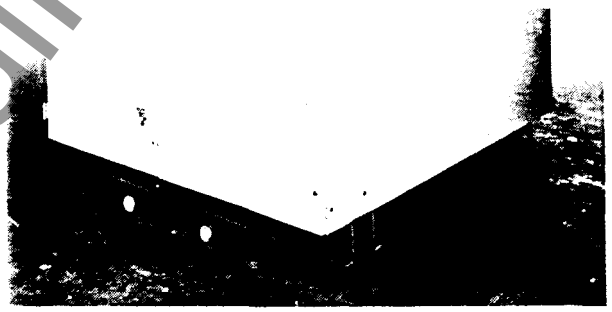


Fig. 2—Longitudinal Moving of Switchgear from Shipping Skid

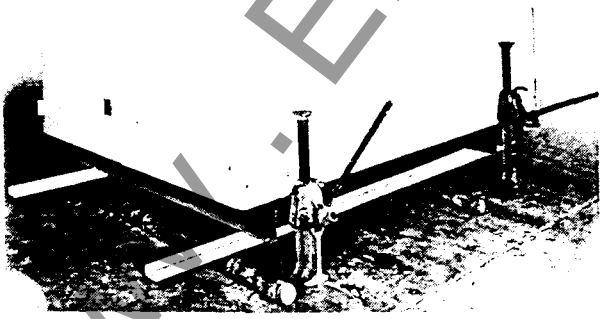


Fig. 3—Switchgear Raised, Rollers and Channels in Place Prior to Lateral Moving

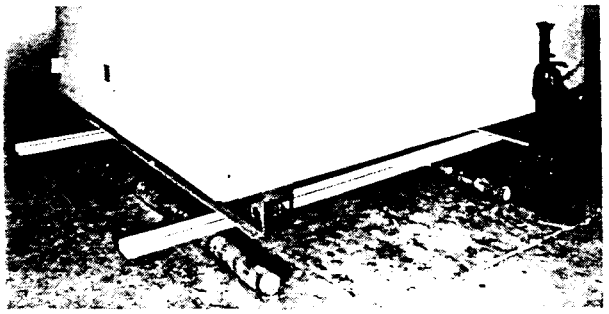


Fig. 4—Jacks Removed and Switchgear Ready for Lateral Moving

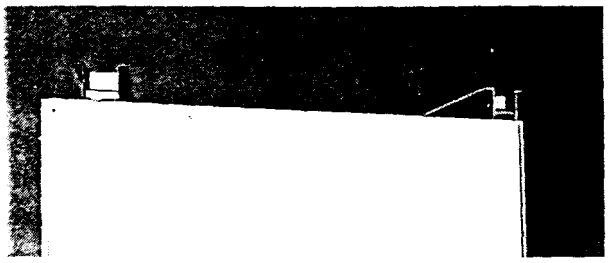


Fig. 5—Shipping Bases Bolted to Top of Switchgear

bolt to the top of the switchgear as shown in Fig. 5. All holes should be used to give uniform support to the housings and prevent distortion. Holes in the vertical webs of the shipping bases, equally spaced from each end, will permit the attaching of steel cable slings.

NOTE: Spreaders should be placed where necessary on the slings so that the cables rise vertically from the top of the units.

The switchgear should be raised high enough to clear projections above floor level, moved over the installation site and lowered into place. Then slings and shipping bases should be removed.

OUTDOOR INSTALLATION

Outdoor installation is handled similarly to the indoor type. Outdoor switchgear is constructed with a steel base that serves as a shipping convenience as well as a permanent support for the internal housings. Jacks may be placed under the shipping bases to raise the whole structure for positioning rollers. Slings may be passed through the large holes in the vertical webs of the shipping bases. Note that the shipping bases are not removable and cannot be placed on top of the switchgear as in indoor installations.

Before assembling a Walk-In structure read the drawing "Erection Procedure", listed on the front sheet of the Bill of Material, carefully and follow procedure indicated thereon.

For proper assembly of Outdoor Non-Walk-In switchgear, consult the drawing entitled "Gasket Application" which is listed on the front sheet of the Bill of Material.

INSTALLATION OF HOUSINGS

GENERAL

Before attempting any installation operations consult all drawings furnished by the I-T-E Imperial Corporation for the particular order. These drawings are in the form of floor plans, front views, primary and secondary wiring and a bill of material of the equipment furnished.

Sections of housings for 5HK equipment consisting of five indoor units or less and four units or less in the case of 7.5 or 15HK housings, are shipped on a single base. Larger switchboards are divided in sections for shipment and each section is on its own base.

A removable angle is bolted across the front floor of each breaker housing to provide reinforcement while moving the housings on rollers. After final installation this angle should be discarded.

PREPARATION OF FLOOR

Floor plan drawings are supplied for each installation. Typical floor plan drawings are not enclosed since they usually vary with each installation due to length and arrangement of housings.

The design of the floor may include channel iron sills embedded in the concrete. It is important that these sills be straight and level their full length, and correctly spaced. To insure this condition, it is recommended that ties be bolted between the sills at various intervals after which the lower flange of the sill be shimmed to proper height.

Where necessary, power and secondary (control) conduits should be installed before the installation of the housings. Available space for the conduits is given on the floor plan accompanying each order. These conduits should not extend more than one inch above the station floor level. Take precautions to plug conduit openings before pouring cement.

The concrete floor in front of the housings should be smooth to facilitate the handling of the circuit breakers. The finished floor level should be flush with the top of the channel sills so that the circuit breaker will roll evenly into the housing. The cement should be prepared in accordance with instructions issued by the Portland Cement Association, available at their offices in the large cities.

ASSEMBLING THE HOUSINGS

When the floor has been properly prepared, assembly of the switchgear may be started. Sections of the housings may be moved on their bases adjacent to final positions. They may be moved to final location by putting rollers under the shipping bases. Before moving shipping sections together, remove projecting bus support bolts.

If the switchgear consists of a number of sections, the center sections should be installed first, and the remaining sections added at each end. When the first section is in position, it should be checked for distortion in shipment. This may be done by dropping a plumb bob from the center of the front and rear doors. If the structures are not true, they should be straightened before proceeding. As each section is added, it should be checked for distortion, otherwise considerable pressure may be required to bring the sections into alignment.

Holes are provided in the floor for plug welding the housings to the channel sills.

When shipment is made in sections, the main bus, control wiring, and inter connections are dismantled at the point where the switchgear is separated. These should now be reassembled and all bolts and screws tightened. Bus support bolts should be reinserted through both side sheets. Incoming and outgoing connections should be made for both the main power circuit and all control circuits.

ering Bus Joints

us bars are covered with a flame retardant insulation having a sufficient thickness to stand full line voltage for the rating of the switchgear. Straight joints as well as connections to usual switchgear components are covered by a molded boot. After the bus has been re-assembled at a shipping split, the boot, which is flexible, should be spread apart and slipped over the joint in the same manner as those previously applied in the factory. The flanges should then be fastened together with nylon screws. With this cover no wrapping or filling compound is required, since it fits tightly over the bus insulation.

Tape and sealer are used where bus work runs into apparatus mounted in the switchgear such as flexible connectors, or equipment with irregularly shaped connections. Sufficient quantities of tape and sealer are provided for covering connections to be made in the field. The procedure for applying is as follows:

1. Tighten up hardware. For ½" hardware use a torque of 30 to 45 ft. lb.

2. Clean the area to be covered by removing grease, oil or dust.

3. Prepare the bare joint for taping by first providing a smooth, tapered surface for the tape. Use the sealer, carefully eliminating voids and covering bare parts. In no case extend the sealer more than ⅜" onto the bus insulation.

4. Wrap the joint using the tape furnished for the pose. On 7.5HK or 15HK switchgear wrap 13 half-ped layers; on 5HK equipment wrap 5 half-lapped layers. Wherever possible have the tape overlap the bus insulation by at least 1½". Half-lapped layers of tape should be "pencilled". Leave no voids between sealer and tape, or between layers of tape.

5. Taping should not cover more than 10% of porcelain bushings or insulators, nor should be carried beyond the first depression or petticoat.

CONNECTION OF PRIMARY CABLES

In general, there are three common methods of making primary cable entrance connections.

Synthetic Covered Cable with Clamps

For this type cable, prepare for entrance to connection lugs, and securely tighten lug clamps. The cable should be prepared as specified by the cable manufacturer. Use sealer and tape as described in previous section.

Lead Covered Cable with Wiping Sleeve

When cable diameters are specified on order, the wiping sleeves are furnished cut off to fit the cables. Uncut wiping sleeves are fitted to the cables as follows:

Wrap a cord (or tape) around the cable to obtain the circumference. Then wrap the cord around the wiping sleeve cone and mark the cone slightly above the cord. Saw off cone. Ream sharp edges of cone with round file.

iping sleeves are furnished untinned unless tinning ecified. Sleeves should be freshly tinned by applying flux and dipping in hot solder.

When installing the wiping sleeve, the lead sheath should extend into the sleeve fitting for one inch minimum. The end of the sheath should be belled over and if required by the operating voltage, a stress relief cone applied.

To wipe the joint, scrape the lead sheath clean approximately three inches beyond the end of the cone. Apply stearine flux to the cleaned sheath and to the cone. Then make the wiped joint in the usual manner. Fill wiping sleeve with the compound supplied.

Lead Covered Cable with Pothead

The same method of fitting as for wiping sleeves can be used to fit the pothead wiping sleeve to the cables. In the case of the pothead with wiping sleeve, the lead sheath should extend into the pothead for one inch minimum, bell over the end of the sheath, and add a stress relief cone if required. Clean the sheath about three inches beyond the end of the cone and apply stearine flux to end of the cone and the sheath. Wipe the joint in the usual manner.

On inverted potheads, the lead sheath should be extended down into the pothead body beyond the wiping sleeve flange joint so that the sheath will terminate below the level of the compound. To vent the top end of the inverted pothead sleeve while compounding, wipe the joint with a greased wire inserted between the sleeve and the sheath. Pull out the wire to provide a small hole to vent the air. After the pothead has been filled with compound, seal the hole with solder.

Shielded Cable

When shielded cable is connected to any terminator, proper stress relief cones must be applied.

If there is a ground sensor current transformer in the circuit, the cable, complete with shielding, must pass through it. This transformer will not operate properly if it surrounds the section of the cable from which the shield has been removed.

ROOF BUSHINGS

Roof bushings, for cable entrance, are shipped detached from the housing, and must be mounted in place when the switchgear is installed. Each bushing is furnished with a gasket that must be properly inserted between the roof and the bushing flange, using the adhesive as a binder between each of the parts. Cement the gasket to the roof using one layer of adhesive, then spread cement on the remaining flat surface of the gasket. Now put the bushing in place and bolt to the structure. Apply a bead of sealer to the exposed edge of the gasket to provide a weathertight seal.

CONNECTION TO GROUND BUS

Ground bus bars are bolted to the frames of the housings at the factory before shipment. When housings are shipped separately, it is necessary to bolt the ground bus to the framing. Ground bus bars should be solidly

and permanently connected to the station ground by means of a cable or bus of crass section not less than that of the housing ground bus.

Cable or bus should not be in conduit, and should take the most direct path.

CONNECTION TO CONTROL SOURCE

The control source wiring to the switchgear should be of larger cross section than the balance of the control wiring in order to reduce the voltage drop, particularly when this source is some distance from the switchgear. Provision is made in the switchgear, in the form of heavy duty terminal blocks, for the connection of these control source leads. The leads should first be checked for proper electrical sequence before the connection is made.

Secondary and Control Connections

All secondary and control connections on metal-clad switchgear are factory wired in accordance with the connection diagrams applying to the installation. The secondary and control connections for all outgoing connections are wired to terminal blocks accessible to the conduit connections.

Control connections between housings are provided through openings in the side sheets of the switchgear. When shipment is made in groups of several units each, the cross connections between groups are installed at the factory, one end of each of the group connectors is then disconnected and tagged. Care should be taken to insure that all these connections between groups are securely remade when the groups are placed together again.

INSTALLATION OF BUS BAR CONNECTION BETWEEN GROUPS

The main bus in each group is assembled in the factory complete, ending at the tap connections located at either end of the group. Sections of main bus for connection between groups are provided for installation in the field.

All contact surfaces at all bolted joints in the bus are silver plated. These contact surfaces should be cleaned and then bolted together. Conductivity of a bolted or clamped joint depends upon the pressure applied. The contact surfaces may be cleaned by first rubbing lightly with fine steel wool, then wiping with cloth saturated with carbon tetrachloride. Take care not to remove silver plating.

After bolting the sections of the main bus at junction point of shipment groups, insulate the connections by taping or installing a molded boot over the joint.

For instructions on taping, see section titled "ASSEMBLING THE HOUSINGS."

TESTING AND INSPECTION

With the housings erected, assembled, and connected, observe the following precautions:

1. Remove all extraneous matter and see that all internal parts are free of dirt, grease, and moisture. If moisture has penetrated, dry out with air or heat.

2. Remove all blocks in relays used for protection in shipment.

3. Apply potential tests to check for any damaged insulation.

60 CYCLE, RMS, WITHSTAND VOLTAGES (1 MINUTE)		
Rated	Factory Test	Field Test
60 volts	500 volts	375 volts
61 to 220 volts	1500 volts	1100 volts
221 to 600 volts	2200 volts	1650 volts
4800 volts	19,000 volts	14,600 volts
7200 volts	36,000 volts	27,000 volts
13,800 volts	36,000 volts	27,000 volts

CAUTION: IF PHASE TO PHASE TESTS ARE MADE IN ADDITION TO PHASE TO GROUND TEST, CARE MUST BE TAKEN THAT NO SHUNT CONNECTED COILS SUCH AS POTENTIAL TRANSFORMERS ARE CONNECTED DURING THE TESTS.

4. Check continuity of all circuits. A great deal of this work can be done after the circuit breakers are installed by energizing the control source and operating the equipment with the main circuit dead. Indicating instruments check the continuity of current transformer and potential transformer circuits after the main circuit is energized.

5. Set all relays, regulators, and other devices for proper operation of loads. No relays are set at the factory. Remove screws from short circuiting strip on terminal blocks in current transformer circuits. Screws should be stored in tapped holes in corners of the blocks.

6. If finish has been marred during shipment or installation, apply touch-up paint (which may be secured from the factory).

IMPORTANT: PROPER PHASING OF ALL MAIN CIRCUITS SHOULD BE CHECKED ACCORDING TO DIAGRAM.

FINAL INSPECTION

After the switchgear together with the apparatus which it is to control has been installed and all interconnections made, it should be given a final check and test before being put into service. This is necessary to insure that the equipment has been correctly installed and that all connections are completed. Extreme care must be exercised to prevent the equipment to be controlled from being connected to the system while the preliminary tests are being conducted.

If disconnecting switches are not part of the apparatus or switchgear, the line leads should be disconnected to accomplish this. The testing equipment required will depend entirely on the type of installation. Portable voltmeters both a-c and d-c with a wide range of scales will usually be required. If the equipment to be put into service is quite extensive and complicated, both a-c and d-c ammeters should be available in case unexpected trouble develops.

Some simple portable device for ringing or lighting out circuits should be included in the testing equipment.

STANDARD CONSTRUCTION

SHUTTERS

Shutter arrangement shown in Fig. 6 is the means of covering the live terminals of the primary circuit of the switchgear when the circuit breaker is removed from the housing.

The shutters open when the circuit breaker is installed in the housing. The breaker going into the housing engages the arm connected to one of the shutters, and actuates it, opening the shutters as the element continues into the housing toward the "CONNECTED" position.

Check shutter operation by actuating the arm connected to the shutters to see that it does not bind.

BUS INSULATION

All primary bus work in the housing, with the exception of the ground bus is covered either with I-T-E standard insulation or sealer and tape. The insulation with boots over the joints is used for the main bus, risers and most connections. Sealer and tape are used for joints where boots are not adaptable.

PRIMARY DISCONNECT DEVICE

Each primary terminal of a drawout circuit breaker is equipped with a disconnect device consisting of a circle of fingers compressed by a garter spring (see Fig. 7). The mounting of these fingers on the circuit breaker permits inspection of them when the circuit breaker is withdrawn. This is a high pressure, self-aligning device, whose parts are silver plated to reduce the resistance to a minimum. The springs are outside the current path.

The tubular stationary element is rigidly mounted in an insulating molding located in the primary housing of 5HK switchgear and in a porcelain insulator in that of the 7.5 and 15HK switchgear.

SECONDARY DISCONNECTING DEVICES

All circuit breakers are provided with separable disconnecting devices of the self-aligning pressure-type as shown in Fig. 8. These devices are amply proportioned for carrying the required amount of current. The flexible member of the device is mounted on the breaker frame to facilitate inspection and maintenance. These devices make contact in the fully connected and test position, and no test jumper is needed.

GROUND BUS AND CONTACTS

The extension of the ground projecting toward the front of the housing, between the floor guides, is shown in Fig. 6. The ground bus contacts are located on the bottom of the rear structure of the circuit breaker and engage the ground bus extension when the breaker is in the connected, test, and any intermediate position.

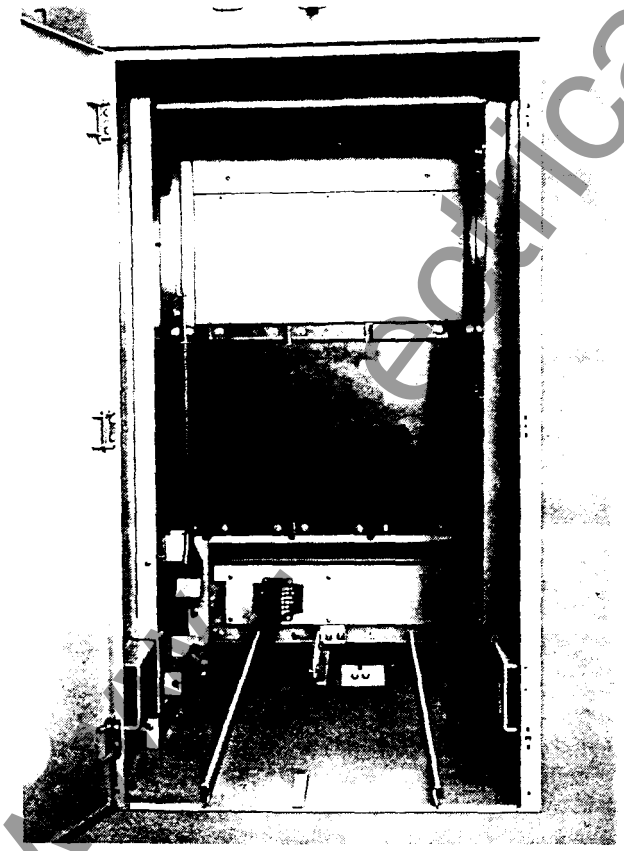


Fig. 6—Front View of Housing

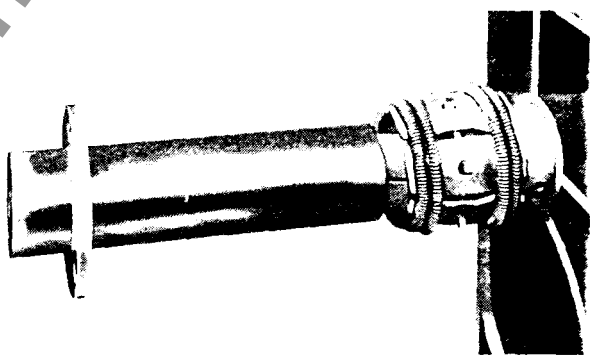


Fig. 7—Primary Disconnect Device

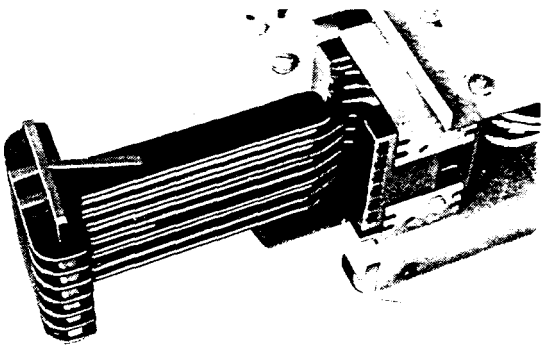


Fig. 8—Secondary Disconnecting Device

CONTROL WIRES

The main control leads ore mounted in the rear of the metering comportment. All electrically operated equipment is connected to these control wires through a suitable control circuit protective device. See Fig. 9.

CIRCUIT BREAKERS

GENERAL

Circuit breakers are boxed and shipped seporately and without parts of the breakers being blocked or wired for shipping protection.

On each switchboard all circuit breakers of like rating ore interchangeable unless the secondary (control) circuit requires otherwise. In these cases interlocking will be used to prevent interchangeability.

Circuit breakers and housing are each set in a jig at the factory.

Circuit breakers have three positions in the housing. In the "DISCONNECT" position the main disconnecting devices on the breaker are disengaged and separated a safe distance from the stationary part of the devices located on the housings. An insulating shutter covers the openings to the stationary part. In this position, all control contacts are disengaged. In the "TEST" position, also, the main disconnecting devices are disengaged and the shutters are closed, but certain of the control contacts are connected so that the circuit breaker may be operated.

In the third or "CONNECTED" position, the main disconnecting devices are engaged, the shutters are open and all control contacts, except those connected to the push buttons on the breaker, are connected.

Interlocks prevent moving a circuit breaker from one position to another unless the breaker is open, and prevent closing the breaker between positions.

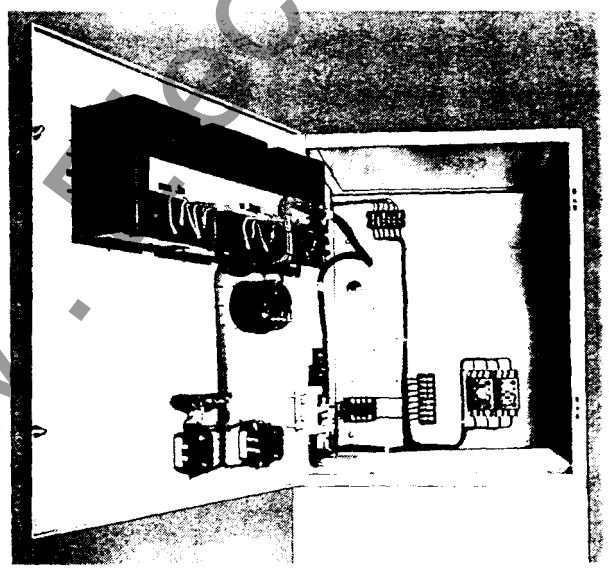


Fig. 9—Control Wires Mounted in Rear of Compartment

For handling of circuit breakers, for the procedure of inserting them into the switchgear comportment and removing them, refer to the separate bulletin covering the breakers.

HOW TO PUT THE SWITCHGEAR IN SERVICE

GENERAL

Before energizing the switchgear observe that:

1. The board is completely assembled with all barriers in place, all joints toped and all extroneous material has been removed.

2. Potential tests hove been mode to determine that all insulation is in good condition.

3. All outgoing cables ore either permanently connected or thoroughly insulated so as not to cause a fault, especially at end remote from switchboard.

4. All screws are removed from short circuiting strips on current transformer circuit terminal blocks, and relays ore not blocked.

5. All circuits ore properly phased.

6. There is a backup circuit breaker which is in operating condition and set so as to clear any fault that inadvertently may occur.

SAFETY PRECAUTIONS

THE CIRCUIT BREAKERS SHOULD BE IN TEST POSITION WHEN PRACTICABLE. WHEN A THOROUGH INSPECTION OR WORK IS REQUIRED ON A BREAKER, IT MUST BE REMOVED FROM THE HOUSING. THE BUS SHOULD BE DE-ENERGIZED AND GROUNDED WHENEVER POSSIBLE WHEN WORK IS TO BE DONE ON SWITCHGEAR.

PROCEDURE

All circuit breakers should be in the disconnect position initially. Then first energize the control circuit with the main power circuit de-energized. Rack one circuit breaker into the test position. The charging of the closing springs will indicate that the control power is connected. Then rack the remaining circuit breakers into test position, one at a time.

With the circuit breaker in the test and connected position, open and close the breaker by push buttons when provided on the breaker, or from the control switch, or any remote operating point that may be provided. The breaker may be tripped by manually manipulating all relays and protective devices. Interlocks and special controls may be checked for proper operation.

The main power may now be applied to the switchgear after all circuit breakers hove been placed in the test position. Close all doors to the switchgear as a safety measure. Those breakers necessary to energiz the main bus should be moved to the connected position and closed. Observe undervoltoge relays or other devices that should function properly when the main bus is energized. Next move each circuit breaker in turn to the connected position and close. Observe that all relays and instruments are functioning properly. Improper readings of wattmeters, power foctor meters, and watthour meters usually indicate improper phasing of meter wiring.

When a switchgear installation is fed from one or more generators, it is usual to bring each generator up to speed and connect it to the bus so as to make adjustments on it for speed and voltage. The generators are then synchronized and adjusted for load division.

When a switchgear installation contrals synchronous or induction motors, there may be special adjustments of relays and control devices that must be made for the proper operation of the motors.

MAINTENANCE

GENERAL

All switchgear installations should be given a general inspectian at frequent intervals. Perform a visual inspection, front and rear, to see that there is no evidence of loose parts, warping or undue vibration. Take steps to remedy any deficiencies of this nature that may appear. Keep the assembly dry at all times. If leaks from overhead pipes and dripping from condensation or other sources cannot be eliminated, prevent the moisture from falling on the gear.

SEMI-ANNUAL INSPECTION

At least twice yearly, a thorough inspection of the oard must be performed. Prior to this inspection, de-ergize all circuits. The following checks in particular re emphasized:

1. Inspect all bolted connections, nuts and screws for tightness.
2. Inspect all cables for tight connections and ample support.
3. Inspect control wiring for signs of wear and damage. Replace wires wherever doubtful.
4. Examine resistors and other devices prone to overheating.
5. Open all hinged panels and remove all bolted panels.
6. Clean all insulation thoroughly.
7. Withdraw all drawout components and clean. (Refer ta Circuit Breaker Instruction Bulletin before cleaning circuit breakers.)
8. Clean the stationary portion of the switchgear by wiping with a clean cloth. A compressed air hose will be useful in the relatively inaccessible areas.
9. Remove covers of all panel devices where practicable. Check wiring for secure connections. Clean contacts on relays and switches wherever necessary. Replace covers.
10. Replace all panels and components.

CARE OF FINISH

The exterior finish used on I-T-E Switchgear is of the highest grade baked synthetic enamel. The interior frame work is also bonderized and finished with oven baked enamel. The switchgear should be kept clean at all times. Wiping with a clean dry cloth will usually suffice. To remove oil and grease marks, use warm water and soap, wiping dry with a soft cloth.

To touch up the interior finish after final erection, use DuPont Air Dry Gray Enamel. The color finish furnished on the exterior varies, and this information is stated on the front sheet of the Switchgear Bill of Material. To touch up the exterior, use DuPont Duco of the corresponding color.

RENEWAL PARTS

The quantity of renewal parts to be stocked varies with the installation. Previous experience and the number of units in service are the best guides available. To order replacement parts, contact the nearest Sales Office of the I-T-E Imperial Corporation. Give a complete description of the parts and the nameplate data of the device requiring these parts. Specify the quantity required.