PART 4 - GENERAL MAINTENANCE AND INSPECTION PROCEDURE

GENERAL

It has become the practice of operating companies to establish a system of regular inspection of their apparatus. Oil circuit breakers especially, due to the nature of function, should be given a general inspection at least once every six months. This inspection can consist of an inspection program in which the oil is not removed from the circuit breaker. At least once a year the oil should be drained and the breaker given a thorough inspection.

An operation counter is mounted on the operating mechanism to show the number of tripping operations on each breaker. However, neither the number of operations nor the length of time between inspections is to be taken as the only basis for determining the maintenance required. Short-circuit or heavy overload interruptions place mechanical strains upon the breaker, and also reduce the dielectric strength of the oil. After each interruption at or near the breaker rating, it is advisable that the mechanical operation should be checked, the condition of the contacts observed, and the oil tested. The breaker may be allowed a number of less severe interruptions before being inspected; operating experience will dictate the frequency of maintenance.

Maintenance and power-factor testing of condenser bushings should be given consideration during inspection. Refer to condenser bushing manual Technical Data 33-360 for complete recommendation on bushing maintenance. A copy of this manual may be obtained from any Westinghouse Sales Office.

INSPECTION PROCEDURE WHEN NOT DRAINING OIL

In preparing to make an inspection of a breaker the following steps should be taken:

1. Open the disconnecting switches to isolate the breaker from the system.

2. Ground the bushing terminals solidly and maintain this condition while work is going on.

3. Operate the breaker electrically to check mechanical operation.

4. Obtain oil samples and check dielectric strength of oil.

5. On routine inspections a reliable indication of the contact condition may be obtained by measuring the contact engagement using the technique which does not require draining the oil from the tanks as outlined under CONTACT ADJUSTMENT, Part 3.

6. The condition of the voltage dividing resistors, item 28, drawing 424-D-134 shunting the stationary contacts may also be checked conveniently without draining oil from tanks as outlined under GRID RESISTORS, Part 3.

7. Check the operating mechanism for loose nuts and bolts, and see that no cotter pins are missing. Lubricate bearings with drops of lubricating oil.

8. Check air system on pneumatic mechanism for leaks.

9. Check control wiring and current transformer junctions for loose connections.

10. Check gasket joints, conduit and tank fittings to make sure no water can enter breaker.

INSPECTION PROCEDURE WHEN DRAINING OIL FROM CIRCUIT BREAKER

In preparing to make an inspection of a breaker the following steps should be taken:

(a) Open disconnecting switches to isolate the breaker from the system.

(b) Ground the bushing terminals solidly and maintain this condition while work is going on.

(c) Close the breaker by hand.

(d) Drain oil from the tanks obtaining test samples if necessary.

Additional precautions should be taken before entering the tanks:

(a) When tank doors are opened the tanks should be thoroughly cleared of gaseous products. These may be explosive! Keep sparks and open flame away.

(b) Establish adequate ventilation preferably using a fan or blower to force air into the tanks.

(c) Ascertain that trouble lights and other electrical equipment to be used within the tank are adequately grounded.

(d) To preclude accidental closing by the mechanism, close the hand-operated valve in the air line between the mechanism and air reservoir, and open control circuits with the switch provided on the control panel.

(e) To preclude accidental tripping of the mechanism, insert the safety pin above the trigger, and be sure jack is tightened snugly against the mechanism spring housing. However, do not overtighten as mechanism should be just latched and not in overtravel.

Before disturbing any parts, check adjustments 1 to 3 below to give an indication of the condition of the breaker when removed from service.

1. Check clearance at over-travel stop above lift rod on the pole unit lever system. Check the pole unit lever system to make sure that there are no loose bolts and nuts and that there are no cotter pins missing. Pole unit lever system settings can be checked as described in the section on Pole Unit Lever System.

2. Check oil dashpots in each pole unit lever system to determine that they are working freely. (Item (5), drawing 891-D-795.)

3. Observe the condition of all parts that are now accessible. Check for loose bolts, nuts, springs, cotter pins, and damaged parts of any kind.

4. Open breaker with the hand jack and note the condition of the contact faces. A slight amount of burning on the contacts is not detrimental so long as the electrical conductivity or contact adjustment has not been changed. If the burning is severe, the contacts should be removed and reconditioned or replaced (see section Contact Removal, Part 3). The engagement of the contact fingers and the contact adjustment can

be determined by closing the breaker with the hand-closing jack. (For dimensions see section on Contact Adjustment, Part 3).

5. Reassemble all components carefully after inspection.

6. After the internal inspection is completed, clean the lower porcelains on the bushings with a clean, lint-free cloth dipped in clean breaker oil. Clean the surfaces of the wood Micarta lift rods and guides in the same manner. Clean all carbon from the stationary contact assemblies.

7. Check gasket joints, conduit and tank fittings to make sure no water can enter breaker.

8. Check dielectric breakdown strength of the oil.

9. Replace oil, remove safety pin and remove hand jack, open the hand valve between reservoir and mechanism, energize the control circuits, and check closing and tripping operation using all relays and circuits usually involved in the operation of the breaker.

10. Operate breaker several times after which check contact engagement by "Lighting Out" for reasons covered in "Operation and Timing Test".

11. Check tripping at reduced voltage to insure safety margin.

NOTE: If it is necessary to make any re-adjustments, it is recommended that a re-check of the operating speed be made as indicated in Part 2 under "OPERATIONS AND TIMING TESTS".

CARE OF OIL

WEMCO "C" oil is recommended for all circuit breakers. Westinghouse cannot assume responsibility for circuit breaker operation if an inferior grade of insulating oil is used, or if the dielectric strength of the oil is not properly maintained.

All oil used in circuit breakers is subject to deterioration in service due to carbonization and to the presence of water, even under the most favorable conditions. It is therefore essential to provide for periodic inspection and test, and to purify the oil whenever necessary to maintain its good condition. The more handling which insulating oil receives, the greater are the chances for it to become contaminated, unless adequate precautions are taken.

When the dielectric strength of the oil drops to 20,000 volts, the oil should be looked upon with suspicion, and in no case should it be allowed to drop below 16,500 volts when tested by one of the usual methods with electrodes 1 inch in diameter spaced 0.1 inch apart.

It is essential that the proper oil level be maintained in the circuit breakers. Considerable variation may be caused by changing temperature or possible leakage of oil. Low oil levels may cause flashover of bushings or failure to handle heavy interruptions properly. Oil bumpers may be uncovered and fail to provide proper cushioning effect.

CONDENSER BUSHINGS

Maintenance and power factor testing of condenser bushings should be given consideration during breaker inspection. Instruction Leaflet 33-354-1 is sent with each condenser bushing. This leaflet should be studied for complete recommendations on maintenance of bushings.

When placing bushings in breaker, do not permit the metal flange on the bushing to touch the metal support which holds the transformer in place. This has the effect of a short circuit turn around the transformer, and affects the ratio.

BUSHING CURRENT TRANSFORMER

If it should be necessary for any reason to replace a current transformer, first remove the stationary contact from the contact foot so that the transformer may be slipped down over the condenser bushing.

The transformer may be disconnected at the terminal box on top of the pole unit; however, before it can be removed, it is first necessary to loosen the compression seal inside the terminal box. This seal consists of a sandwich of two Moldarta pieces with a slice of Neoprene rubber in between, through which the transformer leads are threaded.

When replacing the transformer, make sure that the end of the transformer carrying the white polarity mark is facing upward. Also, see that the transformer is not thrown off ratio by allowing the case to touch the metal grounding band on the condenser bushing.

Tighten the compression seal inside the terminal box until the wires are held snugly. With this arrangement, it is not necessary to use any sealing compound as previously used on Type GM breakers.

CAUTION: Be sure that the proper transformer connections are made and a burden of short circuit placed across the terminals at the blocks in the mechanism housing before the breaker is closed on the line. Otherwise, dangerous voltage may appear across the open secondary terminals.

OPERATING MECHANISM

Complete instructions for operation and maintenance of the operating mechanism are given in a separate instruction book which accompanies this book. If the Operating Mechanism Instruction Book is lost or misplaced, the I.B. number may be found on the nameplate inside the housing.

RENEWAL PARTS

A list of renewal parts recommended to be maintained in stock will be furnished on request. When ordering renewal parts, specify the name of the part, using the name given in Fig. 1 of this book. Identify the breaker by including the type, amperes, volts and Shop Order (S.O.) number, as stamped on the nameplate.

PART 1 - RECEIVING, HANDLING & STORAGE

INTRODUCTION

The oil circuit breaker is a very important unit in the modern transmission system, being depended upon for flexibility of control. It should not be installed in places where it will be called upon to operate at voltages or currents greater than those given on the nameplate. The short-circuit conditions to be imposed on the breaker must not exceed those specified at the time the breaker was purchased.

Proper installation and maintenance are necessary to insure continued satisfactory operation of the circuit breaker. Procedures to be followed are given in this and related publications. Many of the instructions contained herein have been copied without change from NEMA Publication No. SG-4, "Standards for Power Circuit Breakers". A second publication, AIEE No. 64, "Guide for Maintenance for Insulating Oil" is cited as a valuable reference for the user of power circuit breakers which employ oil for insulating and arc interrupting functions.

GENERAL DESCRIPTION

The oil circuit breaker described in this instruction book consists of 3 individual pole units, mechanically connected together for gang operation. The three poles are welded to a common I-beam base which serves as a skid to facilitate rigging and unitizes the breaker to simplify installation. Closing and latching is accomplished with a pneumatic mechanism attached to the No. 1 pole unit. The accelerating force for opening is delivered by a large spring in a housing at the top of the No. 3 pole.

A numbering system has been adopted by convention for identifying pole units, terminals and terminal equipment. As previously mentioned, the pole to which the mechanism is attached is referred to as No. 1; the adjacent one is No. 2; and the most distant one is No. 3. Facing the mechanism on the No. 1 pole unit, the left-hand terminal is referred to as Terminal No. 1; the right-hand, as Terminal No. 2. In pole No. 2 the left-hand terminal is No. 3; the right-hand, No. 4. It follows in sequence that in Pole No. 3, the left-hand terminal is No. 5; the right-hand, No. 6.

Each pole unit is comprised of a 50-inch diameter tank, two outlet bushings, two stationary contact assemblies and a moving contact which bridges between these. The moving contact is attached to the lower end of an insulating lift rod which is actuated by a pole-unit lever system located in the top of the tank. Through-type current transformers as ordered are mounted beneath the dome of the tank around the ground flange portion of each bushing. These components are shown in the pole-unit drawings, e.g. numbers 891D794 and 891D795. More detailed descriptions are given on the pages which follow.

SHIPMENT AND STORAGE

Breakers of this type are usually shipped completely assembled. However, when shipping clearances or handling facilities do not permit shipment in this fashion, shipment is made with bushings and contacts removed and separately packaged. The contents of crates and boxes so shipped may be determined by checking each as identified against the shipping list.

Immediately upon receipt of a circuit breaker, it should be carefully inspected for damage sustained in transit. If damage or indications of rough handling is evident, a claim should be filed at once with the carrier (transportation company), and the nearest Electric Utility Sales Office of the Westinghouse Electric Corporation should be notified promptly.

Certain parts of the breaker are of insulating material and must be protected against moisture, dirt, and damage by rough handling or improper storage. Condenser bushings that have been shipped in boxes should not be removed until they can be placed into position in the breaker. The condenser bushings are sealed units imperious to moisture and hence require few precautions. However, if boxed bushings are to be stored, the cap end should be elevated at least 10 inches higher than the opposite end. This precaution maintains the internal oil level above the condenser structure. Instruction Leaflet number 33-354-1 accompanying the bushings describes this procedure.

The other insulating parts should not be allowed to become exposed to moisture at anytime. Excessive moisture, either from direct contact or from a humid atmosphere, can cause swelling and warping of parts. The stationary contact assemblies, when shipped separately, will be wrapped in an oil paper. However, if they are to be stored for any length of time, or if spare units are involved they should be kept in a container filled with WEMCO "C" insulating oil.

Components such as lift rods and lift rod guides, which are to be stored for more than a few days, should be transferred to a dry location, unpacked, and either laid on a flat surface or hung vertically to minimize the possibility of warping.

Breakers shipped completely assembled should have the internal shipping braces removed and should be filled with oil as soon as possible, or 200 to 300 watts heat applied in each tank, at a safe distance from insulation, so as to minimize condensation. The heaters provided in the mechanism housing should be energized to preclude condensation.

HANDLING

The weight of the breaker with oil is engraved on the nameplate located on the No. 2 tank manway. This information should serve as a guide to the lifting capacity of the crane or hoist to be used. The lifting lugs attached to the sides of the No. 1 and No. 3 tanks will bear the weight of the entire breaker (without oil). Do not attempt to lift or move the breaker with oil in the tanks, since this will place an undue stress on previously adjusted lever systems and settings.

The gallons of oil required is also shown on the nameplate. Oil weighs approximately 7-1/2 pounds per gallon, and the weight of the breaker without oil may be determined by subtraction or from the tabulation on the outline drawing.

IMPORTANT: When using cable slings for supporting the apparatus, do not allow them to strike the condenser bushings, since a strain on these may cause the porcelain sections to crack or break.

PART 2 - INSTALLATION

SELECTING THE LOCATION

The oil circuit breaker should be located so that it will be readily accessible for cleaning and inspecting. Sufficient space must be provided for opening the mechanism housing door and operating the hand closing device.

The breaker foundation should be sufficiently high so that water will not enter the operating mechanism housing during flood conditions.

The breaker should not be installed where salt water spray or sulfur steam is present.

See outline and drilling plan, supplied prior to shipment, for necessary clearance dimensions and foundation bolt locations.

MOUNTING THE ASSEMBLY

All circuit breakers must be set reasonably level so that the moving parts within can operate freely. Otherwise, friction will develop, and undue strains which may cause breakage or defective operation will be imposed upon the lift rods and other moving contact details.

The entire 3-pole I-beam mounted assembly may be leveled by shimming before clamping rigidly to foundation. Both fully assembled and partially assembled breakers (without bushings and contacts assembled) have tanks accurately aligned at the factory. In case of fully assembled breakers, all mechanical alignment and adjustments have been made at the factory also. Upon securing to foundation, the contact blocking in tanks should be carefully removed, and the 1/2" bolt, clamping bell crank lever, item 11, Dwg. 891D822, in closed position, should be removed from inside the mechanism housing. The breaker should be opened slowly by means of the hand closing device on the mechanism, and the entire assembly carefully inspected for loose hardware and any damage incurred in transit. All defects should be corrected and hardware tightened thoroughly. Check all settings including bell crank, lift rod stop clearances to make sure they are still correct. Refer to succeeding paragraphs. Contact alignment and adjustment should be checked per PART 3.

Partially assembled units, in addition to having tanks properly aligned, have interpole connecting pipes, operating rods, conduit, transformers and transformer leads already in place.

The bell crank assembly (Dwg. 891D822) is located on the No. 1 tank and extends into the mechanism housing. Its function is to convert the vertical movement of the operating mechanism into horizontal movement for the pull rod assembly (Dwg. 891D824). It has been properly set at the factory to the 1-3/8" to (+0.0, -1/8") dimension shown on Dwg. 891D822 and should not require readjustment.

The lift rod stop bolt (item 11 of Dwg. 891D795) has also been set at the factory to obtain 1/16" ± 1/64" clearance between the stop bolt and the main lever by adjusting the horizontal pull rods (Dwg. 891D824) with the breaker closed and just latched (no overtravel). This setting was made with normal accelerating spring load and contact loading, and the lever gauge (item 34, Dwg. 891D795), used to check the pole unit lever system toggle position, in place.

If for some reason the stop settings have been disturbed or there is any suspicion that they are not correct, first check the position of the pole unit levers with the lever gauge. If the toggle position on all three poles is correct, then the stop bolt should be reset to obtain 1/16" ± 1/64" clearance. If the toggle position on all three poles is off by approximately the same amount (this setting is not particularly sensitive), the correct procedure is to adjust the pull rod length from bell crank to No. 1 pole to correct the toggle position as measured in the No. 1 pole and then reset the stop bolts.

CAUTION: If the required direction of adjustment will raise the lift rod, then first check the 2-3/4" "A" travel dimension between the moving contact crossarm (item 59, Dwg. 424D134) and the lower contact (item 21) of the stationary contact assembly. This dimension should not be exceeded as it will produce undue strain on the stationary and moving contact assemblies. If necessary, loosen the moving contact crossarms to prevent any overtravel before shortening the horizontal pull rods.

Adjustment of the rod between the bell crank and the No. 1 pole (item 7, Dwg. 891D824) is made in half-turn steps (R.H. threads) by first opening the breaker by hand and removing pin, item 30, Dwg. 891D822, to free rod. One half-turn of the rod will raise or lower the lift rod approximately 1/32 of an inch. (It may be necessary to jack the breaker part way closed to obtain clearance to turn the rod.) Repin rod and close by hand to check effect of adjustment. When completed, be sure all cotter pins, friction washers and locking plates have been replaced.

Adjustment between No. 1 and No. 2 and No. 3 poles, if necessary, is made by turning the respective horizontal rod to shorten or lengthen it. These rods have R.H. and L.H. threads and are equipped with a hex section near the L.H. threaded end for turning. (See Dwg. 891D824) Shortening of rod will raise the lift rod approximately 1/16" for each half-turn. Tighten nuts and locking plates after adjustments are completed.

CONDENSER BUSHINGS

On completely assembled breakers the bushings are installed and properly positioned. In the case of partially assembled breakers, the bushings are normally crated and shipped in a vertical position. For handling of the bushing, follow directions of instruction leaflet 33-354-1 accompanying the bushings.

Before lowering a bushing into position, be sure the gasket on which it rests is cemented into place (items 40-41-42, Dwg. 891D794). Apply petrolatum liberally to the top surface of the gasket and to the bushing flange so that the gasket will not be damaged in moving the bushing laterally when positioning it properly.

Great care must be exercised in lowering a bushing into position to avoid damaging either the porcelain on the lower end or the current transformer insulation. Sufficient clearance has been provided but careful guiding is essential.

Before tightening the holding bolts, the bushing should be accurately aligned with respect to the center-lines of the tank, and the lower ends spaced the proper distance apart as indicated on Dwg. 891D794. Two eccentric bushings (item 33) per condenser bushing flange are provided to facilitate alignment as shown on 891D794 and located as per Dwg. 127A538.

There should always be clearance between the condenser bushing and the transformer support plate. In fact, it is essential that the metal flange on the bushing does not touch this plate. Contact between these parts would have the effect of a short-circuiting turn and would throw the transformer off ratio.

MOUNTING THE STATIONARY CONTACT UNITS

When the condenser bushings are in place, the stationary contact units should next be attached to the lower end of the bushing studs.

To do this conveniently, remove Micarta shield (item 28, Dwg. 891D794) and upper metal shield (item 27) in the order stated. Then remove the contact foot (item 20) with flange (item 24). The flange and foot assembly is held to interrupter assembly by three bolts (item 23). Screw the flange and foot assembly on the condenser bushing stud. Care must be taken to prevent cross-threading or damage to either threaded member. As indicated in the note on pole unit assembly, Dwg. 891D794, the flange (item 24) is to be screwed on the bushing stud so the lower surface of flange is flush with or higher than lower end of threads on condenser bushing stud to obtain a gap of 1/64" min. between flange (item 24) and contact foot (item 20) after final adjustment. The gap is necessary for locking the threads on flange and stud on pulling up the 8 bolts through the foot so the contact assembly cannot turn on the stud. Do not draw up bolts to final tightness as it may be desirable to shift the foot slightly in aligning the contact. The contact feet on the two bushings must be located at as nearly same height as possible. Assemble the stationary contacts on the feet. Do not tighten the bolt (item 23) or assemble the upper metal shields (item 27) until the moving contacts have been assembled and final adjustment made. However, the Micarta shields (item 28) must be shipped up over the contact assemblies and tied out of place on the lower end of the bushing.

MOVING CONTACTS

Before final alignment of the stationary contacts can be made, the moving contact must be assembled on the lift rod foot according to the procedure outlined below. It is advisable to complete the assembly of the moving contacts on all three pole units at the same time. See Dwg. 891D794.

Assembling and Adjusting the Moving Contact

The moving contact crossarm is assembled on the lift rod by first removing the lower two adjusting nuts and lock washers from the studs at the lower end of the lift rod. Slip the cross-bar over the studs and replace the lower nut on each stud. Adjust the upper and lower nuts to secure horizontal alignment of the crossarm. After all adjustments are complete, replace the shakeproof lock washer and lock nut below the lower adjusting nut.

NOTE: The adjusting nuts are also used for the purpose of tipping the moving contact slightly to obtain simultaneous contact on the closing stroke of the breaker. Refer to "Securing Alignment" section.

Adjusting Vertical Alignment of the Lift Rod

Oversize holes are drilled in the guide rod to provide for adjustment of the vertical alignment of the lift rod. To adjust, loosen the four bolts (item 17, Dwg. 891D794) and shift lower end of guide slightly to the left or right as desired. A series of holes in the lower horizontal guide pieces accommodates a variation in thickness of the lift rod, and permits forward or backward adjustment of the lift rod. Tighten bolts securely when required position is attained.

Disconnecting the Lift Rod

The lift rod may be disengaged from its operating lever by removing cotter pin, washer, and main pin assembly, items 28, 29, 30 of Dwg. 891D795.

When replacing the lift rod, be sure to have the projection (with No. 10-32 tap for travel recorder) on the upper end of the lift rod located beneath the small hole beside the lift rod stop.

After the final adjustments have been made, the fibre nuts on the guide assembly should be screwed in place, using shellac on the threads to prevent loosening.

SECURING ALIGNMENT

For the breaker to operate properly, it is absolutely essential that the moving contact crossbar be in alignment with the stationary contacts, and to engage them simultaneously. Refer to Dwg. 424D134 and note the horizontal alignment dimension of 1/4" ± 1/8" for the end of the moving contact crossbar (item 59) where it enters the lower metal shield (item 5). Several methods are available for securing alignment and simultaneous touching of contacts:

1. Slight shifting of stationary contact assembly on contact foot (item 3). Oversize holes in contact foot permit this adjustment.

2. By tipping crossbar on its lift rod to engage both lower stationary contacts simultaneously. This adjustment should be made only to compensate for small differences in height of the two stationary contact assemblies.

3. By slight shifting of the guide members to move the crossbar horizontally. If the alignment is still not correct, it may be necessary to shift the condenser bushings slightly.

CONTACT ADJUSTMENT

Refer to Dwg. 424D134 for contact adjustments. Adjustment note on drawing gives a condensed procedure which is more fully explained as follows:

1. Remove Micarta shield (item 4) and inside half of upper metal shield (item 6). (Already off for initial installation.)

2. With the breaker closed and 1/16" ± 1/64" clearance obtained at all lift rod stops, adjust moving crossbar (item 59) on its lift rod so that the lower contact (item 21) is raised the "A" travel dimension. The lower contact may be seen through a window in lower metal shield (item 5). It is suggested that the most accurate method of checking point of touching lower contact is by "lighting out" between it and crossbar (item 59).

3. Adjust nut (item 26) at lower end of operating rod is necessary to obtain 3/8" contact spring compression measured at "B", which is the amount the upper end of the operating rod projects through sleeve (item 36). Lock the nut (item 26) at lower end of operating rod with cotter pin (item 48).

It is best to make the adjustments on each pole independently; this may be done by dropping the lift rod in the other two poles. After the contacts in each pole have been adjusted in this manner, connect all lift rods and recheck the lift rod stop clearances. It will probably be found that the contact load has increased these clearances somewhat, and likely in differing amounts on each pole. Do not change stop settings to compensate for this condition. Instead, shorten the horizontal pull rod lengths, starting with No. 1 pole, as described under "Mounting the Assembly".

After readjustment of the pull rods, it will be necessary to recheck the 3/8" contact compression at "B" only. Small readjustment of the moving crossbar (item 59) on its lift rod may be necessary.

Open the breaker slowly by hand and check to see that the oil bumpers in each pole are struck simultaneously. The oil bumpers may be adjusted if necessary by adding or removing washers under the bolt head. A tolerance of ± 1/2" is permitted on moving contact travel in order to obtain simultaneous engagement of bumpers.

MAKING LINE CONNECTIONS

Line connections should be sufficiently flexible to prevent undue strains on the condenser bushings. Clamp type connectors are ordinarily used between the bushing stud and the line conductor. Cable conductors should be so supported that heavy loads will not be imposed upon the bushing. If tube conductors are used, they should be so shaped and supported that heavy expansion strains are not placed on the bushings. Conductor and connector should be of adequate current-carrying capacity to avoid heat being transmitted into the breaker bushing. All joints must be clean, bright, and free from burrs or surface roughness.

Do not connect an aluminum conductor to a copper alloy connector unless the latter has plating. The galvanic action resulting from a joint of aluminum to copper will in time cause considerable corrosion.

MAKING GROUND CONNECTIONS

Two ground pads are provided on the H-beam base. Each of these pads has two (1/2"-13) tapped holes located 1-3/4" apart according to AEIC (Association of Edison Illuminating Companies) specifications.

The ground conductor should be of sufficient size to carry the maximum line-to-ground current for the duration of the fault.

CAUTION: A permanent low resistance ground is essential for adequate protection. A poor ground may be worse than none, since it gives a false feeling of safety to those working around the equipment.

CONNECTING CURRENT TRANSFORMERS

Bushing type current transformers, supplied only when ordered, are mounted in the top of each pole unit tank.

Transformers are usually of the multi-ratio type, having five leads to provide a wide range of ratios. Short leads from all taps are carried in conduit through a lead seal plug to the weatherproof box on top of each unit.

The long leads provided are pulled through the conduit and connected to the terminal blocks inside the mechanism housing on No. 1 pole according to the connection diagram. The desired ratio may be selected at the terminal blocks inside the mechanism housing.

NOTE: Do not confuse the polarity of the current transformers. Refer to the polarity, ratio and connection diagrams sent with each breaker which show how to connect the transformer circuit. Ratios corresponding to various transformer taps are also reproduced on the transformer nameplate, located on the inside of the mechanism housing door.

CAUTION: Be sure that the proper transformer connections are made, and a burden or short circuit placed across the terminals at the blocks, before the breaker is closed on the line. Otherwise, dangerous voltages may occur across the open secondary terminals.

INSTALLING CONTROL WIRING

All control wires to the circuit breaker should be run in conduit where practicable. A diagram will be found in the pocket on the inside of the mechanism housing door. This diagram shows the proper connections for operating circuits and indicating lamps.

The control wiring should be installed so that trouble with one oil circuit breaker cannot be communicated to the control wiring on another breaker. The wire size should be selected to keep the voltage drop within reasonable limits. Excessive line drop will slow up the tripping time of the breaker, and hence, the interrupting time.

Check the control wiring to see that all connections are tight. Small nuts and clips may have become loose during transit and handling.

CHECKING THE OPERATING MECHANISM

Read carefully the Operating Mechanism Instruction Book which is supplied in conjunction with this book. Make sure the air compressor crankcase is filled with oil to the proper level. If the instruction book is lost or misplaced, Operating Mechanism I.B. number may be found on mechanism nameplate inside the housing.

FINAL INSTALLATION INSPECTION

After the breaker has been installed and all mechanical and electrical connections have been completed, before filling the breaker with oil, the following checks should be made and precautions taken:

1. Check that the breaker is properly set up, leveled, and clamped to its foundation.

2. Check that all bearings of the operating mechanism are free of dirt and have been properly lubricated. Excessive lubrication will pick up dirt and is not necessary. The latch faces should be coated with a thin film of rust inhibitor. This inhibitor should be carefully selected to be free-flowing at all anticipated temperatures, non-hardening, and self-healing (does not completely wipe off in one operation). Grease, S#1802395, (M9921-4) can be used for this purpose.

3. Close the breaker slowly by hand, noting that the operating rod and contacts are properly adjusted for correct alignment. With a "lighting out" circuit determine contact engagement for each pole and record. For this measurement just place breaker on latch - do not go into overtravel. Open the breaker by hand until "lighting out" circuit is broken. This should require approximately 1/4" travel of the lift rod. The movement of the breaker on opening and closing should feel free, with some friction noticeable when the moving contact is carrying the load of the stationary contact assemblies.

4. Check to see that all gaskets are in place and have not been damaged. All bolts and nuts on bushing flanges, tanks and connecting fittings must be properly tightened so that moisture cannot enter the circuit breaker thru any of these gasketed joints. Also be sure to check the large nuts which fasten the pneumatic mechanism to the No. 1 tank.

5. Pipe fittings may become loose because of vibration and shock received during handling, lifting and transportation. They should be checked immediately after the breaker is installed and tightened where necessary.

6. Inspect all insulated wiring to see that no damage has resulted during the process of installation.

7. Test the wiring for possible grounds or short-circuits.

8. Be sure that each current transformer is properly connected and a burden or short circuit is placed across the terminals at the blocks in the mechanism housing.

9. See that all current-carrying parts outside the oil tanks are correctly insulated in accordance with standard practice. See that all joints in the control circuits are made correctly.

10. Make a final check for tightness of hardware on stationary contact assembly (mounting hardware for shields, resistor-capacitor assembly, etc.) crossarm, lift rods, pole-unit levers, etc.

11. Wipe out the interior of the breaker carefully with lintless material to remove any dirt and moisture which may have collected.

12. Apply petrolatum to the gasket face of the manhole cover which presses against the tank flange so that the door will open easily without damaging the gasket at the next inspection. Close the door and draw down all bolts evenly until reasonably tight.

PLACING OIL IN SERVICE

The most careful precautions must be taken to insure the absolute dryness and cleanliness of any oil-insulated apparatus before filling it with oil, and to prevent the entrance of water and dirt during the transfer of the oil to the apparatus. When returning a circuit breaker to service, thoroughly clean all carbon from the interior so that the new oil will not be contaminated. This may be done by flushing and swabbing with clean insulating oil and wiping with clean, dry lintless material. Cotton waste is undesirable on account of the residual lint which may be introduced into the oil. The preparation and filling of outdoor apparatus should preferably be done on a clear, dry day. If this is not practicable, protection against moisture must be provided.

Precaution should be taken against the handling of oil at a temperature different from the container into which the oil is being poured, as condensation may occur and moisture may be introduced into the oil. Extra care must be taken in case oil drums are stored in locations open to the weather. Sufficient clearance from ground is essential to permit circulation of air to prevent condensation.

Oil which has a dielectric strength of less than 22,000 volts when tested by the usual method should not be put into the circuit breaker. New oil should test considerably higher than this. However, unless tested under proper conditions, the oil may appear to be worse than it really is due to contamination of the sample when testing. See Westinghouse Instruction Book 45-063-100 for proper method of testing and handling.

Fill the oil tanks to the proper level with WEMCO "C" oil. Since there is a common connection between tanks slightly below the minimum oil level, only one float type oil gauge mounted on the No. 1 tank top is supplied. Filling should be made thru the No. 2 tank either by pumping through its drain valve or thru its filling connection (1-1/2" tapped hole in the 4" pipe cap located at R.H. rear of tank top). As soon as No. 2 tank is filled to the common connection pipe, overflow to No. 1 and 3 occurs, the No. 2 tank will easily handle overflow of up to 100 gallons per minute, and when the gauge on No. 1 tank moves half way to normal level, filling should be stopped momentarily to allow gauge to reach a steady level and then continued if necessary.

When removing oil from any tank for maintenance inspection or processing of oil, a small amount of oil will also be removed from the other two tanks until the level falls below the common connecting pipe. If all three tanks are separately drained and refilled, it is recommended that the first two tanks be refilled to just below the common connection pipe (easily seen by removing the 4" pipe cap on tank top), and third tank filled until gauge on No. 1 tank indicates correct level.

OPERATION AND TIMING TESTS

CAUTION: <u>Fill tanks with oil before tripping or power closing.</u>

Interrupters are equipped with oil dashpots and may be damaged by high-speed operation dry.

Before power closing, the hand closing jack must be removed from the operating mechanism piston rod and the safety pin removed from the mechanism.

Starting with normal air pressure (marked on the mechanism nameplate) on the pneumatic mechanism, operate breaker several times after which contact engagement should be checked by "lighting out". This will give good indication that there has been no mechanical failure due to mal-alignment or mechanical defects. Engagement should be approximately 1/4" as pointed out under FINAL INSTALLATION INSPECTION. Check the breaker for number of operations per tank of air with the compressor shut off. If all adjustments are correct, there should be at least five operations before the low-pressure cut-off switch on the pneumatic mechanism opens the close circuit. If the number of operations is less than five, it may be due to any of the following reasons:

1. Too much accelerating spring compression (located at top of pole #3).

2. Improper contact alignment.

3. Excessive air loss in pneumatic mechanism.

4. Incorrect setting of pole-unit lever system or bell crank assembly.

5. Improper setting of the mechanism auxiliary switch contact which de-energizes the closing valve.

6. Inaccurate pressure gauge on air reservoir, or improper setting of the low pressure cut-off switch.

Check the opening time and reclosing time (if required) of the breaker with a graphic recorder. In order to be sure of getting 3 cycle arc interruption, the moving contact lift rod should have moved 3 to 3.5 inches, 3 cycles after the trip coil is energized. Contact parting time on all three poles should be checked. If the breaker is slower than this, it may be due to any of the following reasons:

1. Too much contact compression.

2. Insufficient accelerating (tail) spring compression.

3. Incorrect setting of pole-unit lever system.

4. Incorrect trip armature setting on operating mechanism (See operating mechanism instruction book.)

The average velocity on opening operation of the moving contact through the arcing zone can readily be determined by the slope of the line of the graphic recorder, through points 1" and 5" out from the full closed position and should be 11.5 to 14 feet per second.

In addition to showing time and travel characteristics, the opening curve gives a good indication of the efficiency of the oil dashpots which cushion the breaker moving contacts at the end of the opening stroke.

The velocity of the moving contact on closing should be from 5.5 to 6.5 feet per second at point of contact touch.

The graphic recorder may be connected to the lift rod through the tank top by removing the small pipe plug beside the lift rod stop bolt. A projection on the upper end of the lift rod is provided with a 10-32 tap, so that a 3/16" diameter rod with 10-32 threads on one end may be passed through the tank top and screwed into this tapped hole. Typical mounting arrangement is shown on Dwg. 702C577.

If the breaker is to be used for high speed reclosing duty, the reclosing time may be adjusted by means of the "bb" contact on the 2-pole auxiliary switch. See control diagram and pneumatic mechanism instruction book for further explanation.

Before the final closing to place the breaker in service, make sure the switches on the pneumatic mechanism control panel for the control power and compressor supply are in the "ON" position. and that the hand valve between the compressor reservoir and the mechanism is wide open. Check for normal operating pressure and power and close the breaker. Do not close the breaker on a live line with the hand closing jack. This device is intended for breaker adjustment only, and operates much too slowly for closing the breaker on a live line.

PART 3 - OPERATION AND ADJUSTMENT

In case of trouble with any part of the circuit breaker, it is necessary to understand thoroughly the construction and adjustment of the individual parts. In general, it is advisable to work only on a part which needs attention and not disturb the rest of the apparatus. The various parts and adjustments are described in the approximate order in which they are assembled at the factory.

THE WESTINGHOUSE DE-ION GRID UNIT

The contact assembly consists of one interrupting unit per terminal (2 per pole) and a moving contact to bridge the two interrupters and complete the circuit.

NOTE: The numbers in the text refer to items shown on Dwg. 424D134.

The interrupting unit (grid) is made up of fibre plates to form passages for the desired oil flow, with two contact breaks per unit. A pressure generating arc is formed between the crank arm contact (19) and the intermediate contact (20), and the main arc is drawn between the intermediate contact and the lower contact (21). On an interrupting operation the contacts are rapidly opened by the breaker accelerating springs which act on the moving contact lift rod; by the spring (23) acting on the operating rod (22); and by the three springs inside the oil piston. The pressure arc and the main arc are drawn practically simultaneously. The function of the pressure arc is to build up a gas pressure in upper chamber "D" and force an oil flow into the interrupting break.

The oil is forced into chamber "E" through passages (not shown) in the thick grid plate which guides the intermediate contact, and from there down either side of the grid into inlets on each side of the arc path. The oil flow along the arc path deionizes the arc, and the arc products pass out of the grid through vents on either side of the grid. The position of the vents is staggered in height with respect to the inlets and are located 90 degrees around the grid. The name of this interrupter "Multi-Flow De-ion Grid" is readily apparent from this description - the interruption is due to the flow of fresh, un-ionized oil along the arc path through a multiple orifice arrangement. After the main arc is extinguished, the circuit is interrupted and hence the pressure arc can no longer be maintained.

In order to insure 3-cycle operation on low currents, an auxiliary oil flow piston is included, since the pressure generating arc is relatively less effective on low current interruptions. When the contacts open, the lower spring seat is released and the springs behind it force it downward to pick up the piston. There is no spring operating on the piston itself -- this delayed action is intentional to permit the contacts to have sufficient break distance before the oil flow is started in order to reduce the probability of re-strikes or charging current interruptions. In connection with this, the interrupting gap reaches about 3/4" before the pressure generating gap is started. (This was called "practical simultaneously" previously, since this sequence of contact parting is not important on heavy current interruptions.)

Downward movement of the piston forces oil from chamber "F", up the oil passages on either side of the grid and into the inlets. Upward movement of the piston when the breaker closes tends to reduce the pressure in chamber "F" which allows refilling of oil through valve (12). Although the lower shield (5) appears to form a closed chamber in the section shown, actually it is freely vented to the breaker tank. Chamber "C" on the inside of the piston also communicates freely with the tank through a passage not visible, in order to permit unrestrained movement of the piston.

The auxiliary oil flow piston also functions to flush out the grid after a heavy interruption. In this case the operation is a little different -- the pressure generated by the pressure arc is communicated to chamber "F" through chamber "E" and passages down either side of the grid. This pressure holds the piston up until the interruption is completed, and then operates by its own spring pressure to flush out the grid. To assist in refilling the grid with oil, the check valve in the top of the pressure chamber "D" provides a vent for any residual gas left inside, and also permits circulation of oil to keep the temperature rise down on normal flow. This valve closes automatically when the pressure in chamber "D" builds up. As a protective feature, the spring biased relief valve above the check valve opens if the pressure in chamber "D" becomes too high. Arcing horn (9) serves to control the length of pressure arc.

Two other features on the interrupter are worthy of mention. The resistors (28) are shunted across each grid in order to distribute the voltage equally between the two interrupters in each pole. The resistance of these units is very high, they are 500,000 ohms each, or a parallel resistance of 250,000 ohms per grid, 500,000 ohms per pole. Thus, the resistor current is but a fraction of an ampere which is broken within one cycle after the main interruption takes place. The large springs at the lower end of each stack tie rod shown in small partial section allow for expansion or contraction of the stacks, while still clamping the fibre plates firmly together. The length of the stack may change a small amount according to the moisture content absorbed by the fibre plates.

The mechanical operation of the contacts may best be observed by examining a closing operation. The moving contact (59) first picks up the lower contact (21) to establish the resistor circuit, and also picks up the lower spring seat. Further movement picks up the operating rod (22) and piston in that order. As the operating rod moves upward, the hinged crank arm contact (19) moves downward until it touches the intermediate contact (20). At this point the intermediate contact is in its extreme upper position (closed position dimension of 1/4" is zero here), and there is a gap of approximately 3/4" between the lower end of the intermediate contact and the lower contact (21). The crank arm contact continues to move downward, pushing the intermediate contact ahead of it, until the latter touches the lower contact coming up thus completing the circuit through the grid. The final 1/4" of moving contact travel reverses the movement of the intermediate and crank arm contacts to their final position and at the same time compresses the contact compression spring to the 3/8" dimension at "B". This reversal of movement is possible because the crank arm contact is not rigidly connected to the operating rod (22). Instead, it is connected through a pair of links (18) to the sleeve (36) which is spring biased to the operating rod.

Contact Inspection

On routine inspections, a fairly good idea of the condition of the contacts may be obtained by measuring the contact compression without draining oil from the tanks. Referring to Dwg. 891-D-795 connection may be made to the lift rod through the tank top by removing the small pipe plug beside the lift rod stop bolt. A projection on the upper end of the lift rod is provided with a No. 10-32 tap which is ordinarily used for a time-travel recorder rod. However, this arrangement may also be used to measure contact compression by screwing a 3/16" diameter rod with No. 10-32 threads on one end into the top of the lift rod. Close the breaker slowly by hand until the contacts just touch as checked by "lighting out" between the bushing terminals. Check the position of the 3/16" diameter rod and measure the travel between this point and the latched position of the breaker. A travel of 1/4" on this rod corresponds to 3/8" contact spring compression measured at "B" on Dwg. 424-D-134. When the breaker is first set up, all 3 poles should check 7/32 to 9/32" contact compression measured on the lift rod as described. If any pole shows less than 3/16" compression on routine inspections measured in this manner, the oil should be drained from the tanks for a more complete inspection, and the necessary adjustments.

Regardless of the condition of the contacts as indicated by the above method, the breaker should be given a thorough inspection at least once a year, and even more often if the breaker is subject to several heavy interruptions or a large number of operations. The condition of the moving contact (59) and the lower side of lower contact (21) may be easily observed when the breaker is open. The burning of these surfaces will ordinarily be very slight. The condition of the crank arm contact (19) and the upper side of the intermediate contact (20) may also be observed by removing upper metal shield (6). The condition of these contacts will be an indication of the condition of the lower side of the intermediate contact and the upper side of lower contact (21).

All of the contacts, except moving contact (59) and lower side of (21), are faced with tungsten-alloy. This alloy is especially resistant to arcing, so that deterioration will not be very rapid. It is expected that the contact faces may be smoothed off with a file a good many times before replacement is necessary.

When making general inspections, the following points should also be checked on the contact assembly:

1. Check all nuts and bolts for tightness.

2. Try check valve in chamber "D" and valve (12) for freedom of movement. Valve (12) may be reached by removing lower metal shield, while the check valve may be reached by removing upper metal shield.

3. The 13/16" dimension for compression of the heavy springs at the lower end of the four stack tie rods should be maintained as shown in small section view on Dwg. 424-D-134.

Contact Removal

If there is enough burning to warrant removal of the contacts, this may be done rather easily. The crank-arm contact (19) may be removed as an assembly with shunts and operating rod as shown on Dwg. 424-D-134 by first removing the nut (26) and spring (23) at the lower end of the operating rod, and then removing the four bolts in the bearing plate at the upper end.

The intermediate contact (20) is a floating piece which is restrained by spring seat and insulating screw (52) in heavy top plate of the grid stack. After the screw is removed, rotate the intermediate contact 90° after which contact may be pushed up from below and pulled out through the opening in one end of the pressure chamber box. To replace same use reverse procedure. Be sure that slot in the intermediate contact lines up with hole in heavy top plate before replacing the screw. In tightening down the screw use care so as not to snap it off.

The lower contact (21) may be removed, with its driving spring (10), by removing lower metal shield (5), which is fastened to the lower casting by four bolts.

It is expected that it will rarely be necessary to completely disassemble a grid stack. Extremely heavy interrupting duty, such as encountered in laboratory testing, would be required before it would be necessary to replace any of the fibre plates. However, a piston spring compression tool is provided with each breaker order which will facilitate this operation. This tool consists simply of a long threaded stud, a heavy steel washer, and a nut. With the lower contact (21) removed and the nut run down to the lower end of the tool, the upper end of the tool may be screwed into the upper spring seat. The nut (with washer on top) may now be advanced to pick up the lower spring seat. It is only necessary to raise the spring seat a small amount in order to relieve any pressure (transmitted through piston on the lower casting). The nuts and heavy springs on the four large stack tie rods may now be removed to allow the lower casting to be taken off. The tool with springs and spring seats may now be removed as a unit from the upper side of the lower casting. The piston now may be removed.

Grid Resistors

The condition of the voltage dividing resistors (28) may be conveniently checked without draining oil from the tanks. Merely open the breaker with the hand closing jack just far enough to part contacts and measure the resistance between top of bushing terminals. This will give the reading of two parallel sets of resistors in series. Since part of the resistor circuit is through the oil pump piston, there is a possibility of an oil film causing an open circuit on a low voltage test circuit. Jacking the breaker in or out a small amount will usually re-establish the circuit. Proper resistance value is 500,000 ohms. This value is per pole as well as per resistor, since there are two parallel sets in series. Plus or minus 15 percent variation from these figures is permissible -- greater variations should be cause for draining oil and making thorough investigation.

If it should be necessary to replace damaged grid resistor (28), care should be taken to match the resistance of the other units in the same pole so that the voltage will be distributed equally between the two grids. The resistance may differ from the nominal values considerably (due to aging) but, the two pairs in each pole should be matched within 10 percent. The resistor is made up of a number of individual blocks, so that a new unit may be made to match an old unit by interchanging the blocks.

POLE UNIT LEVER SYSTEM

The pole unit lever mechanism (Dwg. 891-D-795), located on the top of each tank, operates the lift rod which carries the moving contact. This is simply a lever system designed to give a straight line motion with the proper mechanical advantage at the end of the closing stroke. Included as part of the lever system is an oil bumper which cushions the opening stroke over the last portion of the stroke. The oil bumper fills automatically when the breaker tanks are filled with oil.

Adjustments.

When the breaker is properly adjusted and has been closed by hand, there should be 1/16" ± 1/64" at the lift rod stops (See Dwg. 891-D-795). This clearance is necessary to permit the operating mechanism to overtravel and latch, and to make sure that the closing movement is stopped by the operating mechanism without undue strain on any of the pole unit parts. If the toggle lever were permitted to go too far forward, the tripping speed would be slow. Conversely, if the toggle lever were too far back, the breaker would be difficult to close.

NOTE: The stops have been carefully set at the factory and should not be changed unless there is a reasonable suspicion that they have been disturbed. Be sure lock-nuts and locking plates are securely tightened after adjustment has been completed.

ACCELERATING SPRING

To provide sufficient opening speed through the arcing zone, an accelerating spring is mounted on No. 3 pole. When the pneumatic operating mechanism is used, this spring operates on the horizontal pull rod over a large part of, and in some cases, over the entire opening stroke. See Dwg. 702-C-526. Thus this mechanism, which can exert as much force in the open position as in the closed position, picks up some accelerating spring load comparatively early in the closing stroke.

Adjustments

If it is necessary to adjust the acceleration of the breaker, remove 6" pipe cap at end of accelerating spring housing on rear of #3 tank, and tighten or loosen the adjusting nut to establish correct opening time as indicated by timer test described under "Operation and Timing Tests". Be careful when tightening spring adjustment; too much compression may cause spring to run "solid", or make the breaker hard to close. It is advisable to check by hand closing before operating breaker electrically. Lock nut in place after completion of adjustment.