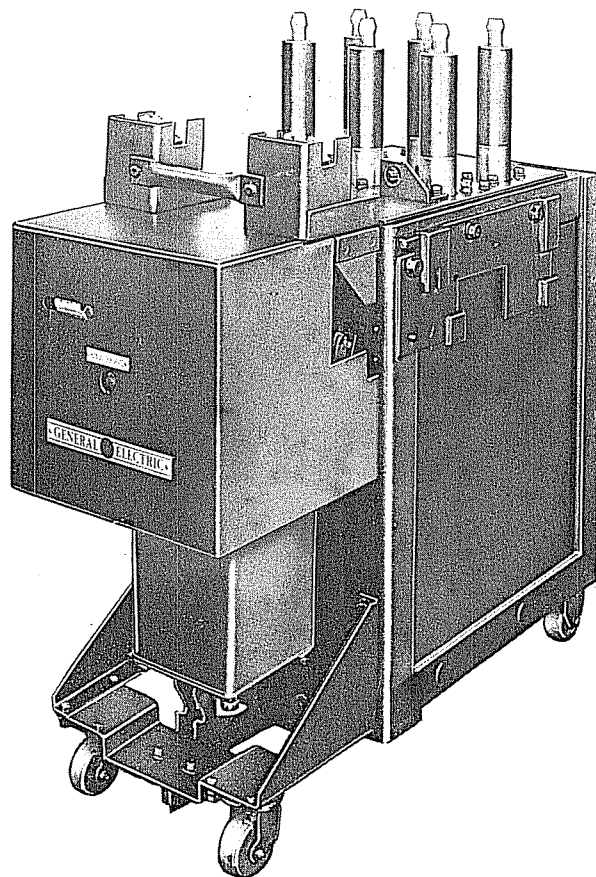


INSTRUCTIONS

Switchgear

POWER CIRCUIT BREAKERS

**Magne-blast Breaker
Types AM-5-50-4,
AM-5-50-5, and
AM-4.16-50-6 with
MS-9-1 Mechanism**



GENERAL  **ELECTRIC**

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MAGNE-BLAST AIR CIRCUIT BREAKER

TYPE AM-5-50-4, AM-5-50-5 AND AM-4.16-50-6 WITH MS-9-1 MECHANISM

INTRODUCTION

The Magne-blast Circuit Breaker is designed for installation in vertical-lift metal-clad switchgear, to provide reliable control and protection of power systems against faults. Among the many advantages of metal-clad switchgear are added protection to equipment and personnel, compactness, simplified installation and reduced maintenance. In keeping with these features the Magne-blast breakers are designed for interchangeability and maneuverability, together with reliability and low maintenance requirements.

The Magne-blast Circuit Breaker operates on the principle that an arc can be satisfactorily interrupted in air by rapidly and sufficiently elongating and cooling it. This is accomplished by means of a strong magnetic field that lengthens the arc and forces it into intimate contact with cool dielectric material. A sturdy, reliable operating mechanism assures low maintenance and long life, and the use

of flame retardant material reduces fire hazards to a minimum. The AM-5-50 and AM-4.16-50 magne blast breakers are in a number of current and voltage ratings. Refer to the breaker name plate for the complete rating information of any particular breaker. These breakers are designed for application at a maximum circuit voltage of 5000 volts. Within the published interrupting current range, these breakers have an interrupting capacity of 50,000 KVA on a duty cycle basis consisting of two closing-opening operations with a time interval of 15 seconds between them.

The breaker-mechanism combinations is designed only for electrical closing and the maintenance closing lever is supplied only for use in making adjustments. **NEVER ATTEMPT MANUAL CLOSING WITH THE BREAKER IN SERVICE**, for under such conditions, sufficient closing force and speed cannot be applied.

RECEIVING, HANDLING AND STORAGE

RECEIVING AND HANDLING

The breaker should be removed from the crating with sufficient care so that no damage will result from rough handling. Frequently "loose parts" associated with the apparatus are included in the crate. Care should be taken to make certain that these parts are not overlooked.

After the breaker has been removed from the crating, the brace and steel hooks, holding the box barrier in position, should be removed and discarded.

Each circuit breaker is carefully inspected and then is packed by workmen experienced in the proper handling of electrical switchgear.

Immediately on receipt of a circuit breaker, an examination should be made for any damage sustained during shipment. If injury or rough handling is evident, a damage claim should be filed at once with the Transportation Company, and the nearest General Electric Company's Sales Office should be notified promptly.

STORAGE

It is recommended that the breaker be put into service immediately in its permanent location. If this is not possible, the following precautions must be taken to insure the proper storage of the breaker:

1. The breaker should be carefully protected against condensation; preferably by storing it in a warm dry room, since water absorption has an adverse effect on the insulation parts. Circuit breakers for outdoor metal-clad switchgear should be stored in the equipment only when power is available and the heaters are in operation to prevent condensation.
2. The breaker should be stored in a clean location free from corrosive gases or fumes; particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a very corrosive effect on many parts.
3. Ground surfaces of bearings and latches of

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 General Electric Company.

the operating mechanism, etc., should be coated with heavy oil or grease to prevent rusting.

If the breaker is stored for any length of time,

it should be inspected periodically to see that rusting has not started and to insure good mechanical condition. Should the breaker be stored under unfavorable atmospheric conditions, steps should be taken to dry out the breaker before it is placed in service.

DESCRIPTION

A Magne-blast Air Circuit Breaker, listed on the cover with MS-9-1 Mechanism may be seen in a cut-away view on Fig. 7.

It is composed of a solenoid operated mechanism bolted to a fabricated frame; six herkolite bushings with ball ends (for good contact and easy installation in Vertical Lift Metal-Clad Switchgear); three operating rods of insulating material; three

movable contact arms with primary and arcing contacts three stationary contact blocks and rear arc runner assemblies, containing the blow-out coils which are mounted on the back bushings; three front arc runners mounted on the arc chutes; three molded plastic "boosters" which supply air for aiding in the interruption of low currents; and three arc chutes of arc-resisting and insulating compound which segregate the three interrupting units.

INSTALLATION

Outline, wiring, and all other drawings relating to dimensions electrical connections and control should be on hand so that points in question are readily settled as they arise. Before any installation work is done, consult these drawings and the Instruction Book for the "Metal-Clad Switchgear".

The complete breaker mechanism unit has already been assembled, adjusted, inspected and tested at the factory in accordance with the detailed adjustments listed under the section OPERATION. It is possible, however, that unusually rough handling

or transportation may have caused some loosening or disturbance of the apparatus to warrant a re-checking and in some cases, readjustment.

Before proceeding, make certain that all control circuits have been de-energized and that the primary breaker circuits are open and effectively grounded.

Do not work on either the breaker or mechanism while in the closed position unless the prop and trip latch have been securely wired or blocked to prevent accidental tripping.

ADJUSTMENTS

Adjustments described herein should be referred to not only during placement of breakers in service, but also during periodic inspection of the breakers, and should be followed whenever it becomes necessary to repair or replace parts that have become worn or defective in service.

Instructions for the replacement of parts will be found under the later heading of "Maintenance".

PRIMARY CONTACTS

FIGS. 1 AND 7

With the breaker in the closed position, the top face of the primary contact fingers should be horizontal. This can be adjusted by means of the operating rod adjusting screw. To adjust, remove the pin fastening the adjusting screw to the mechanism crank and push the contact blade far enough closed so the adjusting screw can be turned. To increase the primary contact travel, turn the adjusting screw in the direction to lengthen the rod, and to decrease the primary contact travel, turn the screw to shorten the rod (1/2 turn gives approximately 1/32" change in contact travel). Reconnect the operating rod to the crank, and close the breaker manually to check the adjustment.

After the above adjustment has been made, the

travel of the contact surface of the primary contact should be measured on a manual closing operation. This travel or wipe should be 1/8" or over. If enough material has been removed from the primary contacts, to reduce this travel below 3/32", the primary contacts should be replaced.

ARCING CONTACTS

FIG. 1

Close the breaker until the arcing contacts just touch. The gap at the primary contacts should be 7/32" to 9/32". The arcing contacts should make within 1/16" of the other panels. To adjust, the following procedure should be followed: -

- (a) Remove the arc chute.
- (b) Loosen the lock nut on the arcing contact stop bolt.
- (c) With Allen wrench, turn the stop bolt until the arcing contacts just touch when the gap at the primary contacts is 7/32" to 9/32".
- (d) Lock the stop bolt in position with the lock-nut, and close the breaker manually to check the adjustment. SEE PRECAUTIONS ABOVE.
- (e) Replace the arc chute.

**CONTACT GAP
FIGS. 1 AND 7**

With the breaker tripped from the closed position, the minimum distance from the primary contact fingers to the contact surface of the contact blade should be 4-1/16" to 4-7/16". At the same time, the clearance between the underside of the contact blade and the top of the booster cylinder should be at least

3/8" to 3/4". To adjust for these conditions, remove the cotter pin from the mechanism stop nut and turn the stop nut to increase or decrease the contact gap. If the old cotter pin hole cannot be used for the cotter pin to positively lock the stop nut, a new hole should be drilled. After the cotter pin has been replaced, the breaker should be closed and tripped and the adjustment checked. Note: A change in this adjustment may require a change in the adjustment of the plunger rod in the mechanism as described later.

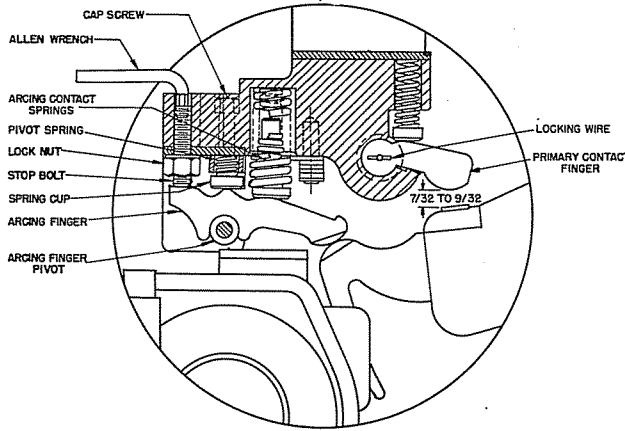


Fig. 1 Contact Assembly

LATCH WIPE (FIG. 2)

The wipe of the latch on the trip roller should be from 1/8" to 1/4". This can be determined easily by putting a film of grease on the latch, closing the breaker part way, and tripping. To adjust, add or remove washers under the head of the stop bolt located near the top of the latch on the trip coil frame.

rod adjustment is changed the rod must be spotted in the correct position and the set screws replaced.

LATCH CLEARANCE (FIG. 3)

The clearance between the trip latch and roller with the breaker open should be approximately 1/32" to 1/16". This can be adjusted by means of the stop bolt in the front of the mechanism frame near the bottom. The lock nut should be fastened securely if any adjustment has been made.

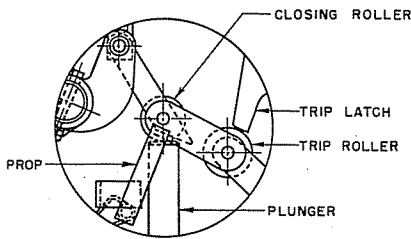


Fig. 2 Mechanism Linkage Closed Position

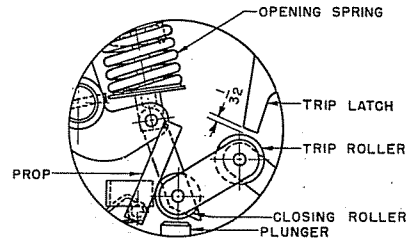


Fig. 3 Mechanism Linkage Open Position

PROP CLEARANCE (FIG. 3)

With the breaker closed as far as possible with the manual handle, the clearance of the pin through the closing roller over the prop should be 1/32" to 3/32" with a maximum variance of 1/32" between sides. This can be adjusted by dropping the closing coil and screwing the plunger rod into or out of the armature. Note: Two set screws are used to lock the plunger rod in position in the armature. If the

PLUNGER CLEARANCE

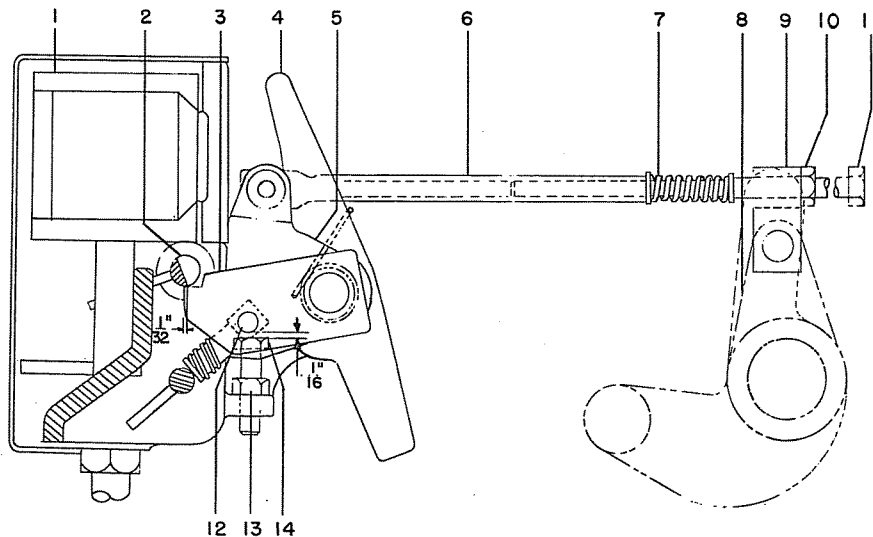
With the breaker in the open position, there should be at least 1/8" clearance between the plunger and closing roller. To increase this clearance, the brackets to catch the armature in the open position should be lowered by placing a shim between them and the coil bottom plate.

Fig. 1 (K-6496371)

Fig. 2 (K-6496373)

Fig. 3 (K-6496374)

ACP



- | | | |
|-----------------------|-----------------|---------------------|
| 1. Current Trip Unit | 6. Guide | 11. Adjustable Rod |
| 2. Trip Shaft | 7. Spring | 12. Pin |
| 3. Cam Latch | 8. Crank | 13. Locknut |
| 4. Breaker Trip Latch | 9. Spacer Block | 14. Adjusting Screw |
| 5. Latch Bracket | 10. Locknut | |

Fig. 4 Current Trip Assembly MS-9-1 Solenoid Mechanism

IMPACT CURRENT TRIP, CAPACITOR TRIP AND UNDERVOLTAGES TRIP DEVICES (FIG. 4)

When these devices are furnished with the breaker, the wipe of the impact current trip latch should be 1/32" to 1/16". This can be adjusted by the use of the small adjusting screw located behind

and near the right end of the current trip mounting bracket. Also, the adjusting screw (14) should be set 1/16" below the pin (12). This is to prevent the cam latch (3) from going over center. After the foregoing items have been checked and any adjustments that may have been required are completed, the breaker may be placed in service.

INSPECTION AND TEST

1. For ease in reviewing the adjustments, the following are recapitulated:
 - a. Primary contact wipe: 1/8" or greater.
 - b. Arcing contact wipe: 7/32" to 9/32".
 - c. Primary contact gap: 4-1/16" to 4-7/16".
 - d. Trip latch wipe: 1/8" to 1/4".
 - e. Prop clearance: 1/32" to 3/32" with a maximum variance of 1/32".
 - f. Trip latch clearance: 1/32" to 1/16".
 - g. Plunger clearance: 1/8" or greater.
 - h. Impact trip wipe: 1/32" to 1/16".
 - j. Impact cam latch clearance: 1/16".
2. Check all nuts, bolts, screws, and cotter pins to make certain that they are properly tightened.
3. Inspect all wiring and make certain that no damage was done during installation. Check all terminals, screws, and connections and test the circuits for possible short circuits or grounds.
4. Check the operating voltage for both the closing coil and trip coil to determine if with line drop it is within the limits specified on the nameplate. In the case of a rectifier operated mechanism, the DC voltage across the coil terminals with full closing coil current flowing should be 105-110 volts. (For applications of repetitive operations, the DC voltage across the closing coil should not exceed 110 volts). Adjustment is possible by means of the tap resistor in the rectifier AC line. For detailed description of this adjustment refer to Instruction Book on Copper Oxide Rectifiers for Circuit Breaker Closing Service.

HI-POTENTIAL TEST

If the breaker has been stored for a long period of time, it is recommended that the insulation be checked before the breaker is placed in service. A standard 60 cycle high potential test at 14,000 volts RMS will normally indicate whether the breaker is

satisfactory for service. With the breaker contacts in the fully opened position, apply the high potential to each terminal of the breaker individually for one minute with all other terminals and the breaker frame grounded. After high potential tests are made on organic insulating materials, these materials should be inspected for visible leakage current paths, and necessary action must be taken to replace insulation that may have been affected by moisture absorption. The high potential test is also recommended for breakers which have been removed from service and stored over an extended period of time under unfavorable atmospheric conditions.

AUXILIARY DEVICES

On breakers that are equipped with auxiliary devices such as current trip, undervoltage trip or capacitor trip, the device should be checked for proper electrical operation. The current trip device should trip the breaker at 3 amperes. The undervoltage device should trip the breaker when the control voltage drops below 40 to 60% of rated voltage, and it should pick-up at 80% of the control voltage or less. An adjustment plate is provided on the front of the undervoltage trip device as an aid in obtaining the desired setting.

Voltage applied to the undervoltage device should be brought up to the pickup value within a period of 20 seconds, to avert damaging the pickup coil.

The capacitor trip should be capable of tripping the breaker as late as 25 seconds after the control voltage is removed. If the auxiliary devices do not perform in accordance with these specifications, a careful examination should be made for defective parts. The latch checking switch is used to insure that the mechanism latch has been reset after a tripping operation. The latch checking switching contacts are connected in the control circuits in the metal-clad unit to prevent the closing coil from being energized until the latch is reset. The contacts in the switch should "make" at the end of the reset stroke of the tripping latch. See Fig. 5. The point at which the switch contacts "make" may be adjusted by adding or removing shims.

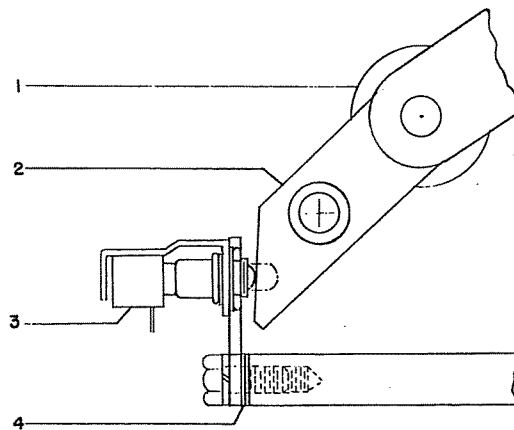
The MS-9-1 solenoid mechanism is trip free and will operate satisfactorily over the standard ranges for closing and tripping voltages as discussed below.

For electrical operation, control power may be from either an alternating or direct current source. In the case of alternating current, a copper oxide rectifier, mounted in the metal-clad unit, is used to supply the direct current required by the closing coil.

Operating ranges are given on the mechanism nameplate. Ordinarily, standard ranges apply and are as follows:

STANDARD CLOSING AND TRIPPING VOLTAGE RANGE

Nominal Voltage	Closing Range	Tripping Range
125 V. DC	90-130 V. DC	70-140 V. DC
250 V. DC	180-260 V. DC	140-280 V. DC
230 V. AC	190-250 V. AC	190-250 V. AC



1. Closing Roller 2. Linkage 3. Latch Checking Switch 4. Shims

Fig. 5 Latch Checking Switch

Fig. 5 (383A911)

ACP

OPERATION

The Magne-blast Circuit Breaker utilizes magnetic forces produced by the load current through the blowout coils to interrupt the arc. These magnetic forces together with an air stream from the "boosters" drive the arc from the contacts out along the diverging arc runners into the "interleaving" arc chutes. The tapered fins that project alternately from the two opposite inner surfaces of the chute deflect the arc into a gradually deepening serpentine path. This lengthening and consequent cooling action rapidly increases the resistance of the arc to cause interruption. Hot exhaust gases are cooled while passing through the muffler at the end of the arc chute. Easily removable box barriers encase each phase separately, segregating the interrupting units and providing insulation between phases and from each phase to the grounded frame.

For the following closing, tripping and trip-free operations Fig. 7 may be consulted.

When the solenoid coil is energized, the armature is driven upwards and the plunger rod threaded into the armature raises the roller carried by the set of links fastened to the operating crank. This action rotates the crank and closes the breaker contacts. After the armature and linkage have reached the end of their travel, the prop rotates into position under each end of the pin through the roller and the

mechanism is held in the closed position. The solenoid coil is de-energized by a relay which is actuated by the cutoff switch at the end of the armature stroke, and the armature is returned by gravity to its original position.

When the trip coil is energized, the plunger forces the latch off the roller causing the linkage to collapse which allows the opening spring to rotate the main crank and open the contacts. During the opening stroke, auxiliary switch contacts open to interrupt the trip coil circuit. After the breaker is open, the mechanism linkage returns to its normal position, and a spring resets the trip latch.

In case the trip coil is energized while the breaker is closing, the trip plunger forces the latch off the trip roller allowing the mechanism linkage to collapse and the breaker to reopen. The armature completes its closing stroke, however, and the coil is de-energized as in a normal closing operation.

When the breaker is tripped under load or short circuit conditions, the opening springs act to swing the contact arms downward, parting first the primary contacts, and then the arcing contacts. The arc is then transferred to the arc runners and, as described before, into the arc chutes where it is interrupted.

MAINTENANCE

Dependable service and safety of power distribution equipment is based on the unfailing performance of the circuit breaker.

To maintain such service, it is recommended that a definite schedule be set up and adhered to for the purpose of properly lubricating the wearing parts. A dependable and observing attendant can be expected to forestall mishaps by reporting loosened nuts, scored surfaces, and other evidences of possible trouble.

In addition, but at less frequent intervals, periodic inspection should be made at which time the apparatus should be given such servicing as may be found desirable or necessary. In case of highly repetitive operation it is recommended that the first Periodic Inspection be made after not more than 500 operations to determine whether there has been any loosening up of parts. The interval between later Periodic Inspections should depend on operating conditions and should be determined by experience.

PERIODIC INSPECTION

At this time a thorough inspection should be made of all parts of the breaker and mechanism.

CONTACTS

After removing box barrier, the contacts on the two outside phases can readily be inspected. The contacts on the center phase can be seen with the aid of a mirror and flashlight. If the contacts are

in good condition, there is no need of removing the arc chute. If, however, the surface of the contacts needs smoothing up with a fine file or sand paper, the arc chutes can be removed as described under the heading REPLACEMENT OF PARTS.

ARC CHUTE

If the arc chutes are removed for contact maintenance, and are for any reason disassembled for inspection, the following points should be noted:

1. Scale formed over the surface of the chute must not be removed but loose particles collected in the muffler should be blown out.
2. Cracks which have formed in the fins of the arc chute are to be expected in ceramic materials of this type when subjected to the severe heat of an arc. These cracks do not interfere with the operation of the device in any way and should be disregarded. If the chute has had any mechanical injury due to dropping or accidental striking which has resulted in actual breaking off of fins, replacement of the arc chute is necessary.

INSULATION PARTS

The insulation parts on the breaker should be kept clean and dry. Smoke or dust collected between inspection periods should be wiped off, and if dampness is apparent, heaters should be installed to insure dryness.

BUSHINGS

The surface of the bushings should be smooth and unscratched. If the insulation surface should become damaged, it should be well cleaned, and then re-touched with either GE-1170 clear varnish or GE-1202 (clear) or GE-1210 (brown) *Glyptal. Allow to dry smooth and hard.

MECHANISM

Careful inspection should be made to check for loose nuts or bolts and broken cotter pins. The latch surface should be inspected for wear and the surface of the rollers should be inspected for chipping or other evidences of damage. Lubrication should be done in accordance with the instructions under the heading LUBRICATION.

LUBRICATION

During assembly at the factory, all wearing parts, bearing surfaces and all machined surfaces on both the breaker and mechanism have been coated with a film of medium soft lubricating and rust-resisting greases. At regular maintenance periods, apply a few drops of machine oil SAE-20 or 30 to bearings. Ground surfaces such as cams and rollers should be wiped clean and a thin coat of General Electric Lubricant D50H15 applied.

When the breaker is given a general overhaul or is disassembled, or when operation becomes sluggish the following procedure should be followed: On bearings, the pins should be removed and all old oxidized grease cleaned off of parts by soaking in kerosene or similar cleaner. Do not use carbon-tetrachloride. If the grease in the bearings has become badly oxidized, it may be necessary to use alcohol (the type used for thinning shellac) to remove it. Ordinarily, by swishing the bearing around and removing solid particles with a stiff brush, the bearings can be satisfactorily cleaned. After the bearings have been thoroughly cleaned, spin them in clean, light machine oil until the cleaner or solvent is entirely removed. Allow this oil to drain off and then repack immediately with General Electric Lubricant D50H15, being certain that all metal parts are greased.

General Electric Lubricant D50H15 is available only in cartons containing twelve collapsible tubes of grease. There is a total of three pounds of grease to the carton. It is so packaged to insure cleanliness and to prevent oxidation.

When the breaker is disassembled, the booster cylinders should be wiped clean and a thin film of General Electric Lubricant D50H15 applied to the inner surface of the cylinders. The pivot points of all contacts should also be lubricated when the breaker is disassembled.

REPLACEMENT OF PARTS

All wearing parts, bearings and machined surfaces on both the breaker and the mechanism should be lubricated with a film of General Electric Lubricant D50H15 before re-assembling.

* Reg. U.S. Patent Office.

Before maintenance or replacement of contacts, the arc chutes must be removed.

ARC CHUTE REMOVAL (FIG. 7)

To remove the arc chutes, first loosen the two arc chute supporting bolts (one on each side of the chute) and remove the arc runner connection bolt. The arc chute is then free to be pulled away from the mechanism.

PRIMARY CONTACTS (FIG. 7)

The primary contacts are designed to carry the normal load current with a minimum amount of heating and are provided with an inlaid block of silver to minimize the effects of wear. The stationary primary contacts consist of 4 fingers for the 1200 ampere breaker and are mounted along with the associated springs on the support casting carried by the rear bushing. The fingers may be replaced after removing the locking wire through the pivot end.

The movable primary contact is carried on the blade hinged at the front bushing. The arc chute must be removed (see section Arc Chute Removal) and the following steps should be followed for replacement of the contact blade: -

- (a) Remove the bolt fastening the arc chute supporting the bracket to the lower end of the front bushing, and remove the bracket.
- (b) Disconnect the puffer tube and operating rod from the contact blade.
- (c) At the blade hinge, remove the bolt, springs, spacers (only on 600 amp. breaker) and thimbles, see Fig. 6.
- (d) Slip the contact blade off the end of the bushing and withdraw.

Reassemble the replacement parts making certain that all cotter pins are replaced. If a new hinge bolt has been used, or if it seems desirable for any other reason, the pressure at the hinge joint should be checked by measuring with a spring balance the force required to swing the contact arm. For both the 600 and 1200 ampere breakers, this force should be between 40 and 60 pound-inches.

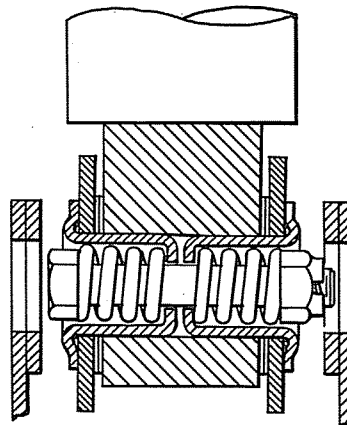


Fig. 6 Contact Blade Hinge

Magne-blast Air Circuit Breaker Type AM

ARCING CONTACTS

The movable arcing contact is bolted on the front of the contact block on the primary contact blade and is more convenient to replace with the contact blade removed.

The stationary arcing contact (see Fig. 1) is carried by the bracket fastened to the lower side of the rear bushing. To remove, take out the two Allen head cap screws from the top. To replace, the following steps should be followed:

- (a) Remove lock nut and stop bolt.
- (b) Place arcing finger on pivot pin.
- (c) Place fibre spring cut on top of the arcing finger.

- (d) Place pivot spring guide block in position on the underside of the top of the bracket.
- (e) Insert spring through the top of the bracket, spring block and into the spring cup.
- (f) Place the assembly on the underside of the bushing, and engage the cap screws one turn in the spring guide block.
- (g) Insert the arcing contact springs and guide.
- (h) Tighten the cap screws, and reassemble the stop bolt and lock nut.

The contacts should be adjusted as described previously under the section ADJUSTMENTS.

RENEWAL PARTS

A complete list of renewal parts is contained in Renewal Parts Bulletin GEF-3391. Those parts subject to wear in ordinary operation and to damage or breakage due to abnormal conditions are marked as recommended renewal parts.

When ordering renewal parts, address the nearest General Electric Sales Office, specifying the quantity required and give the catalog number from the Renewal Parts Bulletin.

It is recommended that sufficient Renewal Parts be carried in stock to enable the prompt replacement of any worn, broken or damaged parts. A stock of such parts minimizes service interruptions caused by breakdowns, and saves time and expense. When continuous operation is a primary consideration, more renewal parts should be carried, the amount depending upon the severity of the service and the time required to secure replacements.

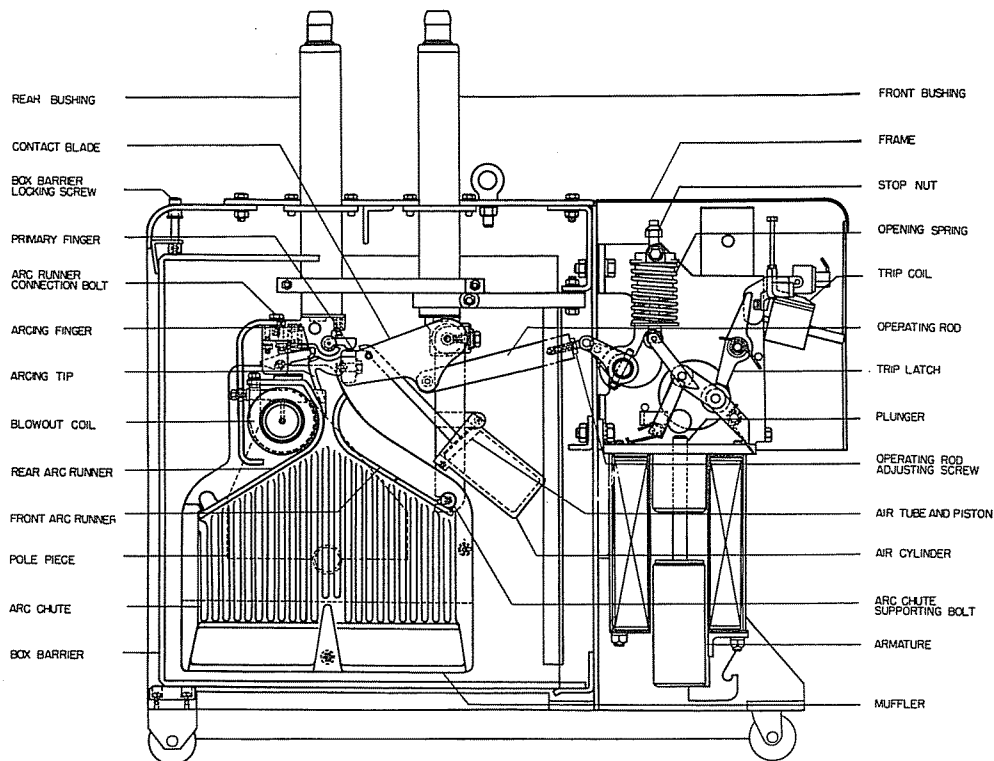


Fig. 7 Typical Magne-blast Air Circuit Breakers Type AM-5-50 and AM-4.16 With MS-9-1 Mechanism

WHEN YOU NEED SERVICE

IF YOU NEED TO REPAIR, recondition, or rebuild any electric apparatus, a G-E service shop near you is available day and night, seven days a week, for work in the shops or on your premises. Latest factory methods and genuine G-E renewal parts are used to maintain the original performance of your G-E equipment. For full information about these services, contact the nearest service shop or sales office listed below:

APPARATUS SERVICE SHOPS

Allentown, Pa. 672-676 E. Highland St.
 Appleton, Wisc. Midway Industrial Area,
 County Trunk, "P"
 Atlanta—Chamblee, Ga. 4639 Peachtree
 Indus. Blvd.
 Baltimore 30, Md. 920 E. Fort Ave.
 Boston—Medford 55, Mass. Mystic Valley Pkwy.
 Buffalo 11, N. Y. 318 Urban St.
 Charleston 28, W. Va. 306 MacCorkle Ave., S.E.
 Charlotte, N. C. 2328 Thrift Road
 Chicago 32, Ill. 4360 W. 47th St.
 Cincinnati 2, Ohio 444 W. Third St.
 Cleveland 4, Ohio 4966 Woodland Ave.
 Columbus 23, Ohio 2128 Eakin Rd.
 Corpus Christi, Texas 115 Busse St.
 Dallas 19, Texas 3202 Manor Way
 Davenport—Bettendorf, Ia. 1039 State St.
 Decatur, Ill. 2225 E. Logan St.
 Denver 5, Colo. 3353 Larimer St.
 Detroit 2, Mich. 5950 Third Ave.
 Houston 20, Texas 5534 Harvey Wilson Drive
 Indianapolis 22, Ind. 1740 W. Vermont St.
 Johnstown, Pa. 841 Oak St.
 Kansas City, Mo. 3525 Gardner Ave.
 Los Angeles 1, Calif. 6900 Stanford Ave.
 Louisville, Ky. 2014 New Main St.
 Midland, Tex. 3404 Bankhead Hwy.
 Milwaukee 3, Wisc. 940 W. St. Paul Ave.
 Minneapolis 12, Minn. 2025 49th Ave., N.
 New Orleans, La. 2815 N. Robertson St.
 New York—N. Bergen, N.J. 6001 Tonnelle Ave.
 Oakland, Calif. 1525 Peralta St.
 Philadelphia 24, Pa. 1040 E. Erie Ave.
 Pittsburgh 6, Pa. 6519 Penn Ave.
 Portland 10, Oregon 2727 N.W. 29th Ave.
 Richmond 24, Va. 1403 Ingram Ave.
 Roanoke, Va. 115 Albermarle St.
 Sacramento, Calif. 99 N. 17th St.
 St. Louis 10, Mo. 1115 East Road
 Salt Lake City 4, Utah. 301 S. Seventh West St.
 San Francisco 3, Calif. 1098 Harrison St.
 Seattle 4, Wash. 3422 First Ave., S.
 Southington, Conn. 53 Railroad Ave.
 Spokane 3, Wash. S. 155 Sherman St.
 Tampa 1, Fla. P.O. Box 1245,
 Naval Indus. Res. Shipyard
 Toledo 4, Ohio. 1 So. St. Clair St.
 Wheeling, W. Va. 2050 National Rd.
 York, Pa. 54 N. Harrison St.
 Youngstown 5, Ohio 272 E. Indianola Ave.

APPARATUS SALES OFFICES

Abilene, Texas. 442 Cedar St.
 Akron 8, Ohio. 335 S. Main St.
 Albany 7, N. Y. 90 State St.
 Albuquerque, N. Mex. 323 Third St., S.W.
 Alexandria, La. 720 Murray St.
 Allentown, Pa. 1132 Hamilton St.
 Amarillo, Texas. Amarillo Bldg.
 Appleton, Wisc. 531 W. College Ave.
 Atlanta 3, Ga. 1860 Peachtree Rd., N.W.
 Augusta, Ga. Masonic Bldg.
 Augusta, Me. 152 State St.
 Baltimore 1, Md. 111 Park Ave.
 Bangor, Maine 77 Central St.
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 Binghamton, N. Y. 19 Chenango St.

Birmingham 3, Ala. 1804 Seventh Ave., N.
 Bismarck, N. Dak. 418 Rosser Ave.
 Bluefield, W. Va. 704 Bland St.
 Appalachian Bldg.
 Boise, Idaho 1524 Idaho St.
 Boston 1, Mass. 140 Federal St.
 Buffalo 3, N. Y. 535 Washington St.
 Butte, Mont. P.O. Box 836, 103 N. Wyoming St.
 Canton 2, Ohio. 700 Tuscarawas St., W.
 Cedar Rapids, Iowa 210 Second St., S.E.
 Charleston 28, W. Va. 306 MacCorkle Ave., S.E.
 Charlotte 1, N. C. 112 S. Tryon St.
 Chattanooga 2, Tenn. 832 Georgia Ave.
 Chicago 80, Ill. P.O. Box 5970A, 840 S. Canal St.
 Cincinnati 2, Ohio 215 W. Third St.
 Cleveland 4, Ohio. 4966 Woodland Ave.
 Columbia 1, S.C. P.O. Box 1434, 1420 Lady St.
 Columbus 15, Ohio 40 S. Third St.
 Corpus Christi, Texas 205 N. Chaparral
 Dallas 2, Texas. 1801 N. Lamar St.
 Davenport—Bettendorf, Ia. 1039 State St.
 Dayton 2, Ohio 11 W. Monument Bldg.
 Dayton 9, Ohio. Avia. & Def.,
 2600 Far Hills Ave.
 Denver 2, Colo. 650 Seventeenth St.
 Des Moines 9, Iowa 505 W. Fifth Ave.
 Detroit 2, Mich. 700 Antoinette St.
 Duluth 2, Minn. 14 W. Superior St.
 Elmira, N. Y. Main and Woodlawn Aves.
 El Paso, Texas. 215 No. Stanton
 Erie, Pa. 1001 State St.
 Eugene, Ore. Cascade Bldg., 1170 Pearl St.
 Evansville 19, Ind. 123 N.W. Fourth St.
 Fairmont, W. Va. 310 Jacobs Bldg.,
 P.O. Box 1626
 Fergus Falls, Minn. 108 N. Court Ave. P.O. Box 197
 Flint 3, Mich. 653 S. Saginaw St.
 Fort Wayne 6, Ind. 3606 So. Calhoun St.
 Fort Worth 2, Tex. 408 W. 99th St.
 Fort Worth, Tex. Avia. & Def.,
 6200 Camp Bowie Blvd.
 Fresno 1, Calif. 407 Patterson Bldg.
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 Lubbock, Texas. 3302 Avenue "A"
 Macon, Ga. 682 Cherry St.
 Madison 3, Wisc. 16 N. Carroll St.
 Manchester, N. H. 875 Elm St.

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 New Orleans 12, La. 837 Gravier St.
 New York 22, N. Y. 570 Lexington Ave.
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 Niagara Falls, N. Y. 253 Second St.
 Norfolk 10, Va. 229 W. Bute St.
 Oakland 12, Calif. 409 Thirteenth St.
 Oklahoma City 2, Okla. 119 N. Robinson St.
 Omaha 2, Nebr. 409 S. Seventeenth St.
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 Peoria 2, Ill. 309 Jefferson Bldg.
 Philadelphia 2, Pa. 1405 Locust St.
 Phoenix, Ariz. P.O. Box 4037, 303 Luhrs Tower
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 Syracuse 6, N. Y. 3532 James St.
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 Tulsa 3, Okla. 320 S. Boston Ave.
 Utica 2, N. Y. 258 Genesee St.
 Washington 5, D. C. 777-14th St., N.W.
 Waterloo, Iowa 206 W. 4th St.
 Wenatchee, Wash. 328 N. Wenatchee Ave.
 Wheeling, W. Va. 40 Fourteenth St.
 Wichita 2, Kan. 200 E. First St.
 Williamston, N. C. 115 E. Main St.
 Worcester 5, Mass. 288 Grove St.
 York, Pa. 56 N. Harrison St.
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