Instructions for De-ion® Grid Oil Circuit Breakers Outdoor Type GS

5 Cycle Interrupting Time			
Type	MVA	KV	Amperes
460GS1500	1500	46	1200
460GS2500	2500	46	1200
690GS2500	2500	69	1200
690GS3500	3500	69	1200

All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

Westinghouse Electric Corporation
Power Circuit Breaker Division Trafford, Pa.

I.B. 33-255-2 Effective March, 1972

TYPE GS OIL CIRCUIT BREAKER

The oil circuit breaker is one of the most important units in power transmission systems. The protection, stability and continuity of service of the entire system depend largely on the efficiency of its operation.

This instruction book applies to breakers of 1200-ampere rating in the 46 to 69 KV voltage range. Each breaker consists of three pole units contained in a single-tank mounted on a supporting framework and connected mechanically to the operating mechanism. The stationary contacts and "De-ion" Grid interrupters (two per phase) are mounted on the lower ends of the condenser bushings. The moving contact crossbars are carried on the lower end of insulating lift rods that are suspended from the operating linkage. The three sets of operating linkages are connected to a horizontal pull rod which is operated through a bell crank lever by the operating mechanism.

Bushing-type current transformers, when ordered, are supported from the underside of the tank top around each bushing.

Important: **Proper installation and maintenance are necessary to insure continued satisfactory operation. The circuit breaker should not be installed where it must operate at voltages or currents greater than nameplate values. The short circuit conditions to be imposed upon the breaker must not exceed those specified at the time the breaker was purchased. In addition, certain physical conditions must be carefully surveyed and planned for as outlined under "Selecting the Location," Part II.**

SPECIAL INQUIRIES

When communicating with Westinghouse regarding the product covered by this Instruction Book, include all data contained on the nameplate attached to the equipment.* Also, to facilitate replies when particular information is desired, be sure to state fully and clearly the problem and attendant conditions.

*For a permanent record, it is suggested that all nameplate data be duplicated and retained in a convenient location.

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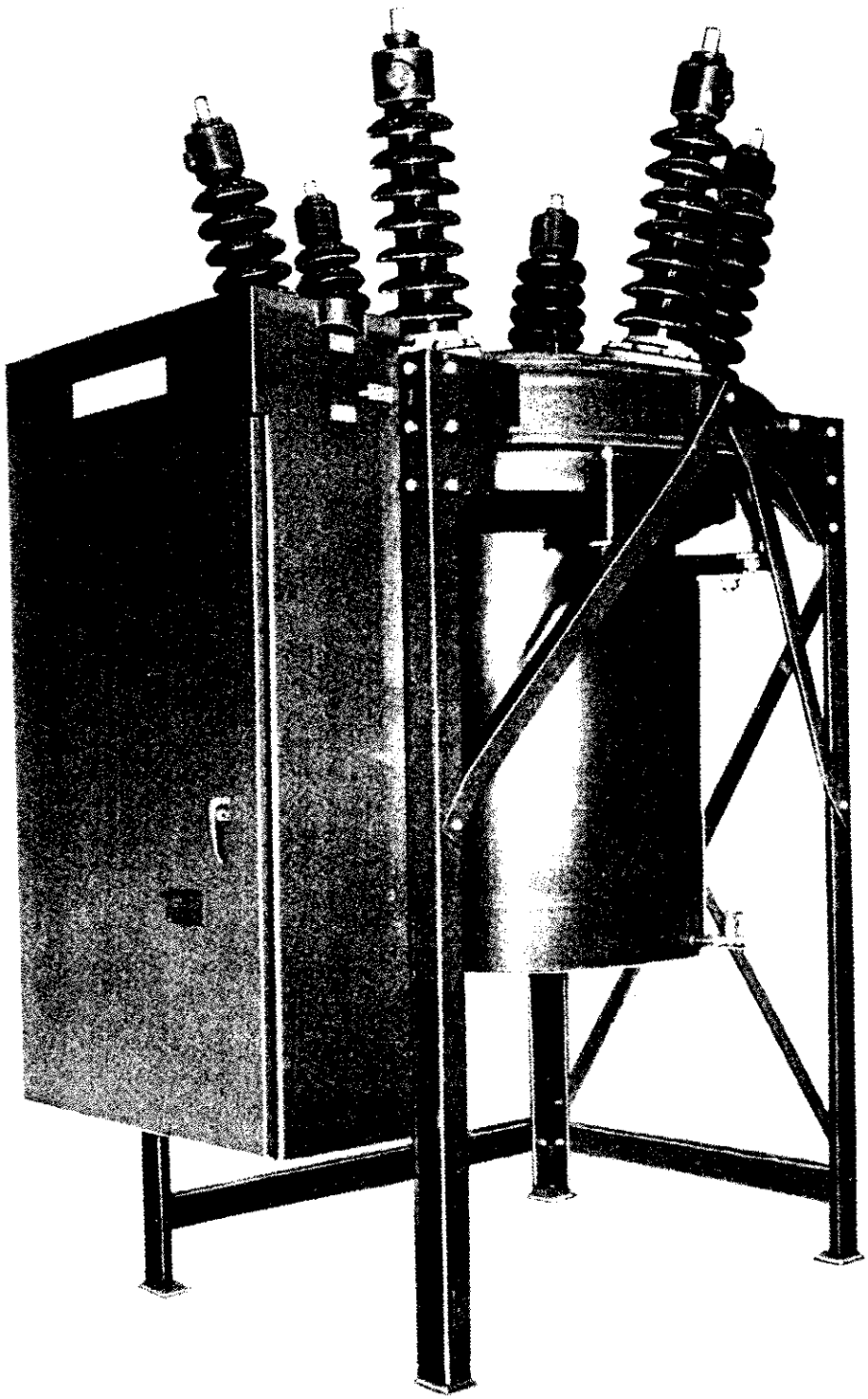


Frontispiece

PART I - RECEIVING, HANDLING AND STORING

Receiving the Shipment

All type GS breakers are assembled and tested commercially at the factory, after which they are carefully inspected and prepared for shipment. Breakers covered by this instruction book are normally shipped completely assembled, except for the sub-frame which is removed to facilitate shipment.

Important: **Upon receipt of a circuit breaker, it should be examined for any damage sustained in transit. Damage should be reported immediately to the carrier and the nearest Westinghouse Sales Office.**

Unpacking Parts and Accessories

Check all parts against the shipping list as they are unpacked and identified. Search the packing material carefully for bolts, nuts, screws, etc., which may have become loosened in transit. Instruction books, cards, or leaflets shipped with the breaker should be kept with the breaker.

Be sure to remove safety pin used to hold the mechanism trigger in place during transit.

Handling Procedure

The weight of the breaker without oil is listed on the nameplate. Breakers may be lifted without oil by hooking onto three lifting eyes on the breaker tank dome. Do *not* use the lifting eyes on the mechanism cabinet.

When using cable slings or chains take care to prevent slings from striking or bearing against the porcelain-clad condenser bushings as any unusual shock or strain may cause damage.

When moving breakers, do not lash the breaker down by the condenser bushings. The skids on which the breaker is mounted should not be removed until the breaker is installed. Avoid shocks or jars to prevent damage.

Caution: **These breakers have a high center of gravity. Care must be taken while handling to prevent them from tipping over.**

Storage of Breaker and Breaker Parts

Even though the breaker will not be placed into service immediately, installation in its permanent location is recommended. If this is not practicable, it should be stored in a place where it can be protected from mechanical damage. The following precautions should be taken:

All internal insulating parts must be protected from moisture. This can best be accomplished by filling the breaker tank with insulating oil. If this is undesirable, an alternate possibility for short term storage up to a few months is to place about 200 watts of heat or about 5 lb. of desiccant (Silica-Gel or Activated Alumina) inside the tank. Heaters should not be placed too close to insulating parts in order to avoid scorching. Filling tank with oil is considered a "must" for long term storage.

"De-ion" Grid Interrupters

The "De-ion" Grid interrupters must not be exposed to moisture at any time. The fibre in these stacks may absorb enough moisture, either from direct contact with water or from a humid atmosphere, to expand and warp out of shape. Spare interrupters should be stored under Wemco "C" oil in sealed containers.

Lift Rod and Guides

Store spare lift rods and guides on a level surface or hang them in a vertical position in a warm dry place to minimize the possibility of warping.

Condenser Bushings

It is permissible to store bushings in a vertical position in a warm, dry place for a short time. However, spare bushings in long term storage should be mounted in a vertical position with their lower ends immersed in Wemco "C" oil.

Operating Mechanism

Machined parts, pinned joints, etc. of the operating mechanism should be protected against corrosion. This is best accomplished by closing the cabinet doors and energizing the space heaters; this is recommended even if it requires the use of a temporary circuit to the heaters. An alternate possibility for short-term storage up to a few weeks is to

place about 5 lb. of desiccant (Silica-Gel or Activated Alumina) inside the cabinet. The use of desiccant is not suitable for long-term storage unless periodic inspection and replacement is done.

PART II - INSTALLATION

Note: **A convenient "Installation Check List" is included to insure proper procedure is followed during installation and to act as a permanent record for referral during maintenance checks.**

Selecting the Location

The breaker should be installed with sufficient space for cleaning and inspecting. Sufficient space must be provided to open doors and operate the hand-closing device. Space should also be provided for the operation of the pneumatic tank lifter, available as an accessory.

The breaker foundation should be high enough to prevent water from entering the housing.

The breaker should not be installed where salt water spray, sulphur, steam or other corrosive elements are in the atmosphere.

Mounting the Assembly

Circuit breakers should be level so that moving parts within the breaker can operate freely. Otherwise, friction may develop and undue strains may be imposed, leading to breakage and defective operation.

The foundation should be prepared before the breaker arrives. Consult the outline and drilling plan for necessary dimensions and foundation bolt locations.

Remove the breaker from its shipping skids and place on the permanent foundation. The precautions described under "Handling Procedure" should be observed. Note that the breaker must be lifted in order to assemble the sub-frame which is removed to facilitate shipment. Insert shims, if necessary, under the frame legs to plumb the breaker before tightening the foundation bolts.

Line Connections

Line connections should have sufficient flexibility and support to limit the strain on the condenser bushings to 100 lb. Clamp-type connectors are ordinarily used between the bushing stud and the line conductor. If tube conductors are used, they should be shaped and supported so that heavy expansion strains are not placed on the bushings. Conductor and connector should be of adequate current-carrying capacity to prevent heat transfer 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 tin plating and suitable corrosion resisting compound is used before the joints are clamped together. The galvanic action resulting from an unprotected joint will in time cause serious corrosion.

Grounding Connections

A grounding pad is supplied on the front left leg of the breaker frame. The grounding conductor should be capable of carrying 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, as 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 inside the tank dome around the condenser bushings. (See Fig. 1.)

Transformers are usually of the multi-ratio type with five leads to provide a wide range of ratios. These leads are carried into the mechanism housing through a gas-seal to terminal blocks. Each lead has an identification indicating the transformer tap to which it is connected lettered on the terminal block marking strips. Refer to the table on the current transformer nameplate, which is mounted on the inside of the housing door to determine the transformer taps required to obtain the desired ratio. Care must be exercised so as not to confuse the polarity of the transformers. If there is any question as to the proper method of connection, refer to the polarity, ratio and connection diagram.

Caution: **Be sure the correct transformer connections are made and a burden or short circuit is 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.**

Control Wiring

All control wires to the circuit breaker should be run in conduit when practicable. A control diagram located in the pocket on the inside of the door shows the proper connections for remote operating circuits and indicating lamps.

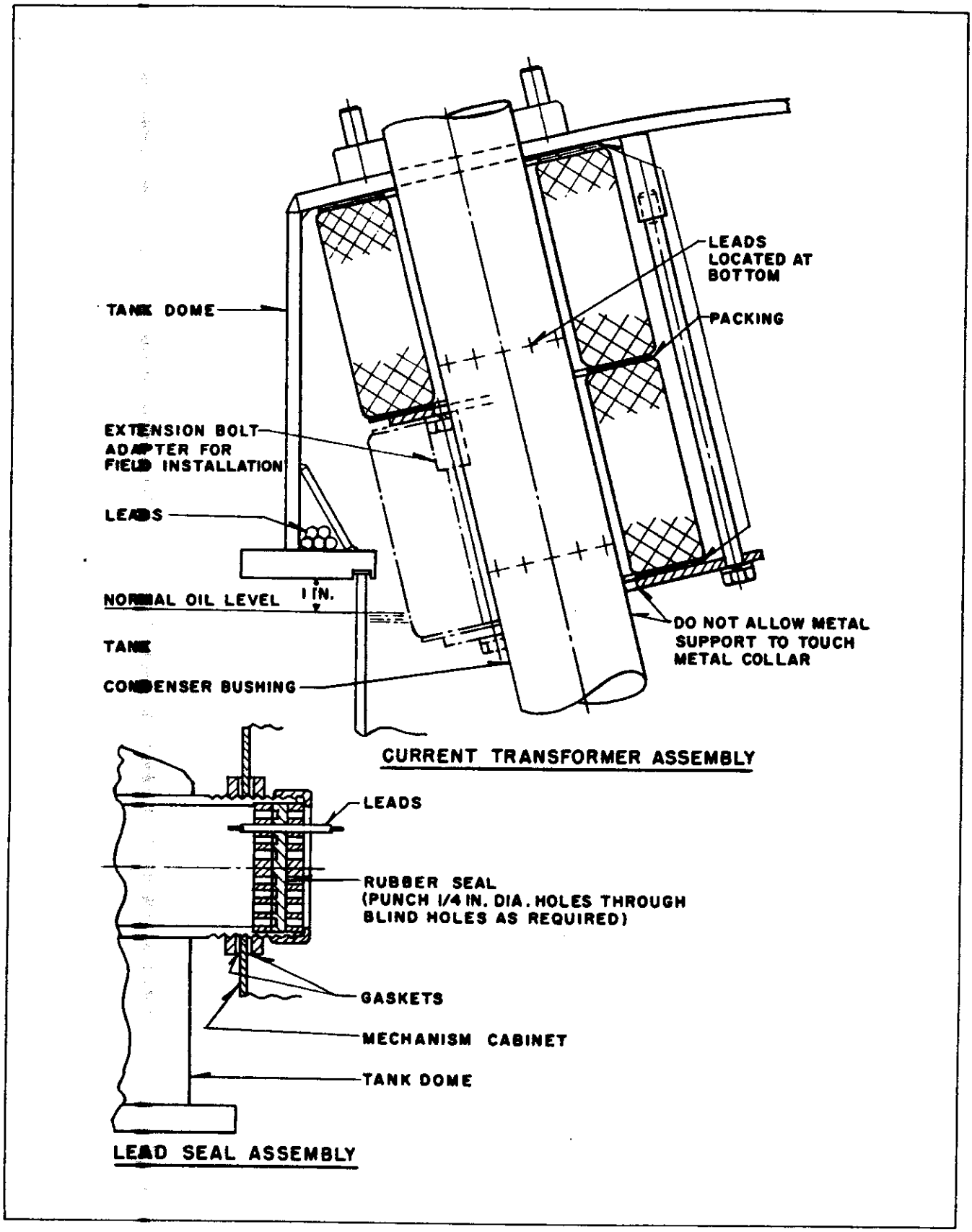


Fig. 1 *Current Transformer Assembly*

The control wiring should be so installed 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 in order not to slow up the tripping time.

Pneumatic Operating Mechanism

Read the Operating Mechanism Instruction Book (supplied with this book) for information on the operation and maintenance of the pneumatic mechanism. If lost or misplaced, Operating Mechanism Instruction Book number may be found on the mechanism nameplate inside the housing.

Final Installation Inspection and Tests

After the breaker has been installed and all mechanical and electrical connections completed the following inspection and tests should be made:

1. All insulation and parts within the tank, including the inside surface of the tank, must be wiped carefully to remove any dirt and moisture which may have collected. Do not use cotton waste because lint may contaminate the oil. Tank liners should be examined for mechanical damage.

2. See that all bearings of the operating mechanism are free of dirt and packing materials. Refer to the mechanism instruction book for lubrication of pins, bearings and latches, and check the oil level in the air compressor.

3. Close the breaker slowly by hand, checking to see that the lift rods and contacts are properly aligned and proper stationary contact engagement is obtained when the breaker is closed and just latched (no over-travel). The contact engagement should be .5" ± .060 from contacts touch to fully closed. Contact touch on both interrupters in the same phase must be within .030". Since the static friction on the multiple finger contacts encountered on hand closing is very great, it may be difficult to obtain .5" ± .060 engagement equalized between the two stationary contact assemblies. If the average of the engagement for both stationary contact assemblies is .5" ± .060, the adjustment is acceptable. This may be determined without removing the interrupters by "lighting out" between the contact feet on each pole and checking the travel on the moving contact lift rod. No check of contact touch between phases is necessary.

4. Check lever system overtravel stop for .031 ± .015 clearance. (Ref. Fig. 4.)

5. Open the breaker slowly by hand. The movement of the breaker on opening and closing should be without friction. See that binding does not occur in the movement of the lift rod through the guides or of the moving contact bayonettes into the "De-ion" interrupters.

6. Make a final check for tightness of hardware on stationary and moving contacts, shunts, lift rods, pole unit levers, foundation bolts, etc.

7. Check to see that all bushing gaskets are in place and have not been damaged. Check nuts on bushing flanges for tightness to prevent moisture from entering the breaker.

8. Check all pipe fittings and tighten if necessary.

9. Inspect all insulated wiring for damage. Test the wiring for possible grounds or short circuits.

10. Check all connections on terminal blocks, switches, and relays for tightness.

11. Raise tank with pneumatic lifter and secure tank bolts evenly.

12. Fill tank with clean, dry Wemco "C" oil and check dielectric breakdown of a sample taken from the bottom of the tank. (Follow detailed instructions under "Placing Oil in Service.")

13. Check electrical operation of the breaker a few times after the tank has been filled with oil and raised. It is recommended that the opening speed be checked with a graphic recorder. See detailed instructions under "Operation and Timing Tests."

Filling Tank with Oil

Precautions must be taken to insure absolute dryness and cleanliness of the apparatus before filling it with oil, and to prevent the entrance of water and dirt during the transfer of the oil to the apparatus.

The preparation and filling of outdoor apparatus should be done preferably on a clear, dry day. If this is not feasible, protection against moisture must be provided.

Precaution should be taken against the handling of oil at a temperature different from the tank into which the oil is being poured in order to avoid moisture condensation. Extra care must be taken if oil drums are stored in locations open to the weather.

Since the oil level will fluctuate somewhat with temperature change, the proper oil level depends on the ambient at the time of filling. The metal ring on the oil gauge is

calibrated for normal oil level at 25°C (78°F). The correct level for 50°C (122°F) is 3/4" above the ring, while the level for 0°C (32°F) is 3/4" below the ring. The correct level for the observed ambient may be estimated accordingly.

Oil which has a dielectric strength of less than 22,000 volts when tested by the usual methods should not be used. New oil may test considerably higher than this. However, unless tested under ideal conditions, the oil may appear to be worse than it really is, due to contamination of the sample when testing. (For proper methods of handling and testing the oil, see Instruction Book 45-063-100, "Wemco "C" Insulating Oil for Electrical Apparatus.")

Operation and Timing Tests

Caution: **Fill tanks with oil before tripping or power closing. Be sure the hand closing device and safety pin are removed from the mechanism.**

It is recommended that the settings be checked on the governor, low pressure alarm and cut-off switches before operating the breaker. Refer to mechanism instruction book for adjustments and to mechanism nameplate for settings.

Starting with normal air pressure (governor cut-off) on the pneumatic mechanism, check the breaker for the number of stored operations (run-down) with the compressor shut off. There should be at least 5 operations before the low-pressure cut-off switch opens the control circuit, and at least one operation below this. A jumper may be used to short out the cut-off switch (see control diagram) in order to count the operations below cut-off. If the number of operations is less than this, it may be due to any of the following reasons:

1. Excessive accelerating (tail) spring compression.
2. Binding due to improper contact alignment.
3. Excessive air loss in pneumatic mechanism.
4. Incorrect setting of bell crank lever.
5. Improper setting of mechanism auxiliary switch contact ("aa") which de-energizes the closing circuit.
6. Inaccurate pressure gauge on air reservoir, or improper setting of low-pressure cut-off switch.

In order to check the breaker timing properly, it is necessary to use a graphic recorder. The instrument most commonly used is the "Cincinnati Timer" made by the Cincinnati Clock and Instrument Co. which may be mounted on the breaker tank top as shown in Fig. 4.

The timing cap is removed and replaced with the timer mounting bracket which screws onto the threaded boss. The timer rod is inserted through this opening and screwed into a .190-32 insert located on the top of the lift rod. The timer is fastened to the bracket with a pair of heavy C-clamps.

The opening and closing speed limits are shown on Typical Timer Record Fig. 3A. Note the 2.5-cycle limit on opening time. (Trip coil energized until contacts part.)

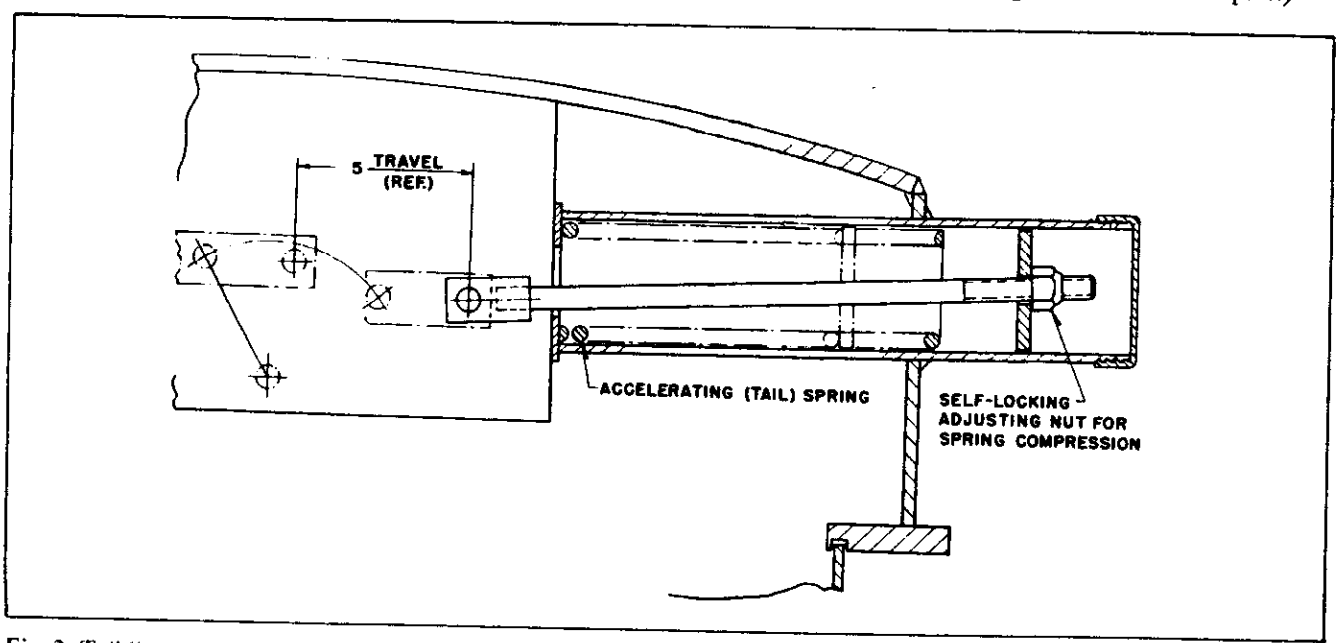


Fig. 2 *Tail Spring*

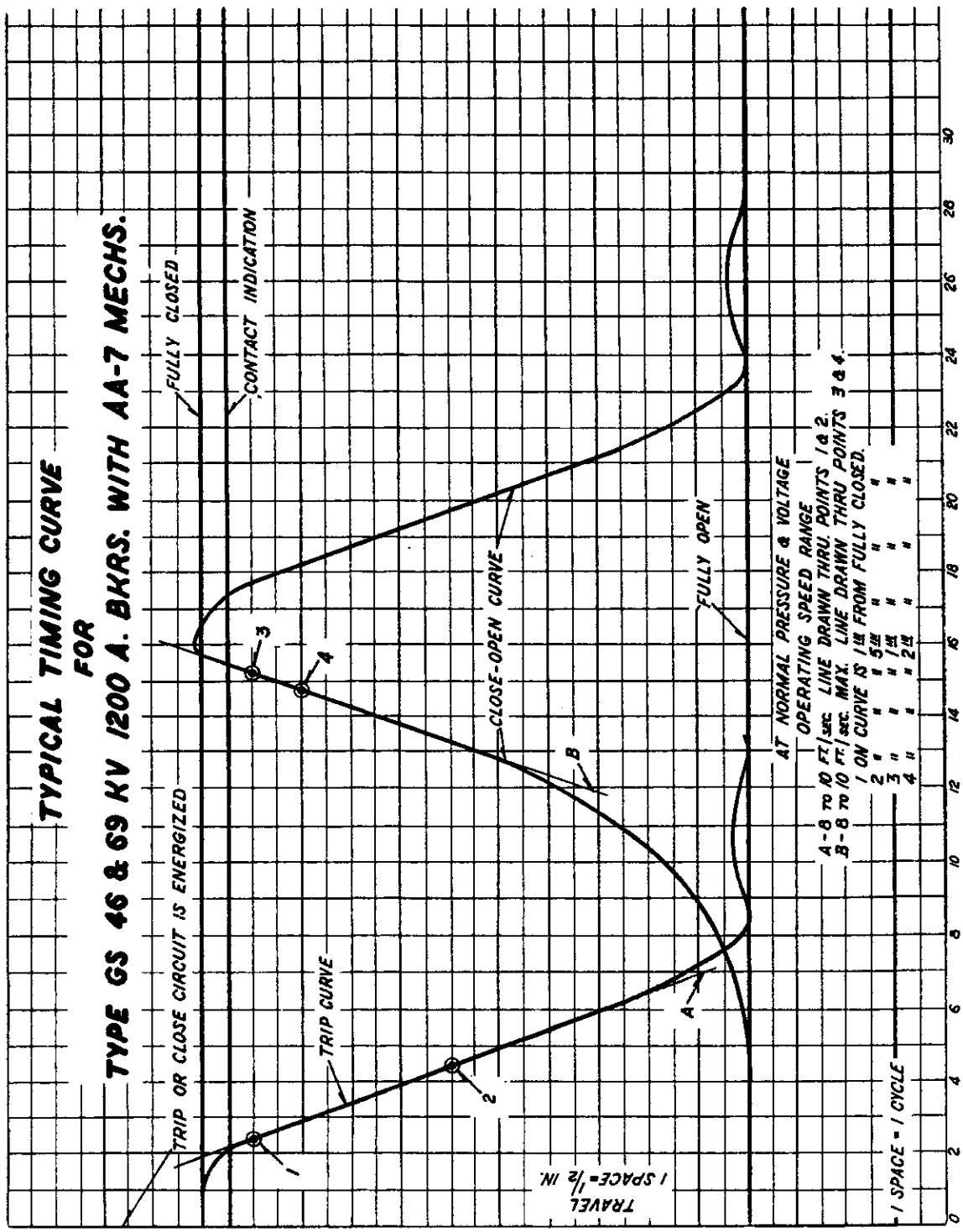


Fig. 3A *Typical Timing Curve*

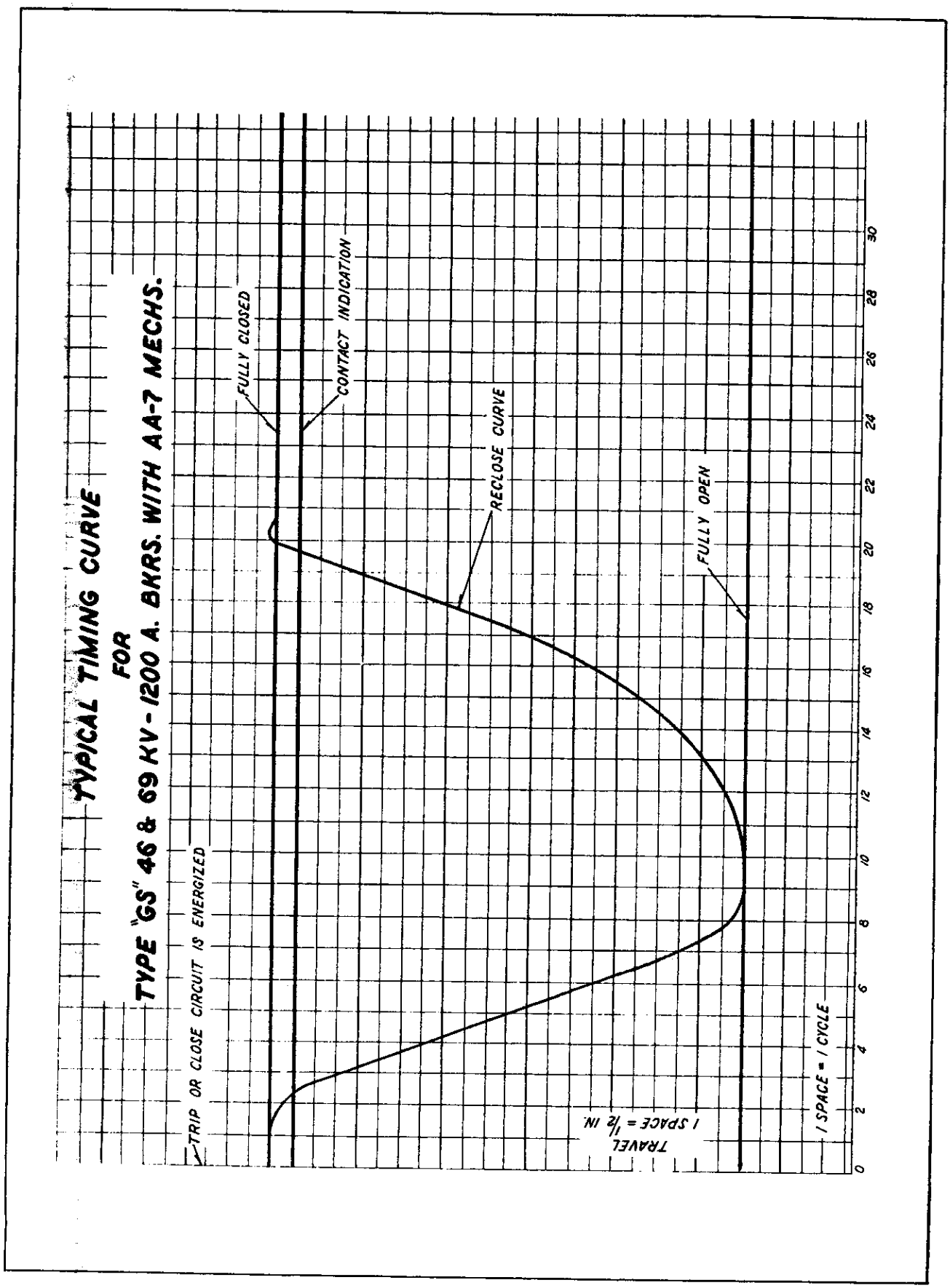


Fig. 3B *Typical Timing Curve*

The opening speed is controlled by adjustment of the tail spring compression, whereas the closing speed is controlled by throttle adjustment on the pneumatic mechanism. (See mechanism instruction book.) Normally the factory adjustments need not be disturbed.

If the opening speed is within limits but the contact parting time exceeds 2.5 cycles, it may be due to the following reasons:

1. Incorrect zero setting on graphic recorder.
2. Excessive voltage drop in D.C. control cable to breaker.
3. Improper adjustment of shunt trip unit refer to the mechanism I.B. for proper settings.

Note that the permissible rebound on the opening stroke is 5% of the total travel. This would amount to .5" as measured on the timer chart. If the rebound exceeds this amount, a defective speed regulator is indicated.

If the breaker is to be used for high speed reclosing duty, it is recommended that a timer record be made of this operation - Ref. Fig. 3B. The reclosing time may be adjusted to some extent by means of the "bb" auxiliary switch contact. If the reclosing time exceeds 20 cycles, it may be due to sluggish retrieving of the mechanism or faulty operation of the latch checking switch.

Before the final closing to place the breaker in service, make sure the control power and compressor supply switches are "ON," and that the hand valve between the compressor reservoir and the mechanism is wide open. DO NOT CLOSE THE BREAKER ON A LIVE LINE WITH THE HAND CLOSING DEVICE. This device is intended for breaker adjustment only.

INSTALLATION CHECK LIST

Station _____ Bus or Line _____

Installation Date _____

1. Nameplate Data

   a. Breaker - Type _____ Amp. _____ Serial - S.O. _____
      I.B. _____

   b. Mechanism Type _____ I.B. _____ Control Diagram _____
      Control Volt _____ Compressor and Heater Volt _____

2. General condition of breaker when received _____
   _____

NOTE

The following checks are to be made after the breaker has been set, leveled and bolted to its permanent foundation. Since the majority of breakers are shipped completely assembled, no attention has been given the erection of partially assembled breakers. When erecting a partially assembled breaker follow the detail instructions included in the instruction book text.

3. Remove blocking from

   a. Mechanism _____

4. Breaker Adjustments

   a. Jack breaker slowly toward the closed position and check: Pole 1 Pole 2 Pole 3

      1. Moving contact enters and moves into the grid stack without binding or friction. ____ ____ ____

	Pole 1	Pole 2	Pole 3
2. Place ohm meter or light out device between bushings on all three poles and mark lift rod or timing device rod when circuit is obtained.			
b. Jack breaker closed to the point where the AA-7 mechanism just latches, loosen jack to load mechanism and check.			
1. Contact engagement as determined by the difference in lift rod position from 4a2 to closed (.5 ± .060)			
2. Lift rod stop clearance (.032 ± .015)			
c. Mark full closed position on each lift rod and jack breaker to the open position.			
1. Lift rod travel (11" ± .25")			
5. Fill breaker tanks with oil and make dielectric test of oil (22 KV min.)			
6. Pneumatic Mechanism			
A. Oil level and proper rotation of air compressor			
B. Shunt Trip Assembly			
(1) Air Gap (3/16" Min.)			
(2) Free travel before kickoff spring is compressed (1/16" less than (1))			
(3) Trips with .032" shim on moving armature			
(4) Clearance between top of trip rod plunger and catch (.012" min.)			
C. Overtravel on closing piston (.125" min.)			
D. Pressure Switch Settings			
(1) Governor switch opens (150)			
(2) Low Pressure Alarm closes (120)			
(3) Low Pressure Cutoff opens (110)			
E. Leak Rate (5 psig/hr. max.)			
F. Operation Rundown starting at governor shut-off with compressor not running.			
(1) Number of operations before cutoff (5 minimum)			
(2) Number of operations after cutoff jumpered (1 minimum)			
G. Pump-up time of compressor 0 psig to 150 psig (60 min. max.)			
H. Clearance between trip free lever roller and trip free trigger. (.032" ± .005)			

_____ in.

_____ in.

_____ in.

_____ in.

_____

_____ psi

_____ psi

_____ psi

_____ psig/hr.

_____

_____

_____ min.

_____ min.

1.	Minimum operating voltages (see mechanism nameplate for voltage range)	Close _____ v.d.c.
		Trip _____ v.d.c.
7.	Timing Tests	
A.	Trip coil energized till contacts part (2.5 Hz. max.)	_____ Hz.
B.	Opening velocity on No. 2 phase - between 1 in. and 5 in. from full closed position (8 to 10 ft/sec)	_____ ft./sec.
C.	Close velocity on No. 2 phase - between 1 in. and 2 in. from full closed position (8 to 11 ft/sec)	_____ Hz.
D.	Reclose time (if required-) trip coil energized till contacts touch - (approx. 20 Hz.)	_____ Hz.
E.	Rebound on opening (.5 in. max.)	_____ in.

	Pole 1	Pole 2	Pole 3
8. Contact Resistance terminal to terminal measured with Ductor or equivalent (250 micro ohm max.)	____	____	____
9. Check voltage dividing resistors by jacking breaker open till contacts just part. Measure resistance terminal to terminal. (0.5 megohms + 15% - 10%)	____	____	____

PART III - OPERATION AND ADJUSTMENT

The Westinghouse "De-ion" Grid Interrupter Function - Fig. 5

The "De-ion" Grid Interrupters are laminated structures made up of a number of sections enclosed in a strong fibre-glass cylinder. Each section consists of parts of various shapes, designed to trap oil and direct gases from the oil through the arc in an efficient manner. Circular openings in the individual plates provide a path through which the moving contact passes to engage the stationary contacts in the closed position. One interrupter is assembled at the lower end of each condenser bushing which provides two interrupters per phase.

Even voltage distribution across the two breaks is obtained by the use of high ohmic resistors (250KΩ/ interrupter).

When the breaker opens, the moving contacts move downward and an arc is formed in the chambers of the interrupter between the moving and stationary contacts. The heat of the arc causes the surrounding oil to vaporize and disintegrate and the resulting gases pass along and around the arc in escaping through vents in the interrupter assembly. The efficient control of these gases results in a rapid deionization of the arc stream, especially at current zero, so that re-establishment of the arc on an ensuing half cycle is opposed. Interruption may take place at the first current zero after parting contacts, but if the rate-of-rise of recovery voltage is high, arcing may continue for one or two additional half cycles until contact separation is sufficient to withstand the recovery voltage.

The stationary contact fingers and the moving contact bayonettes are tipped with silver tungsten in order to resist contact erosion due to arcing. One of the six fingers on each interrupter is longer than the others in order to act as an arcing horn and protect the contact engagement area.

Operating Linkage - Fig. 4

The components of the operating linkage are as follows:

1. A vertical pull rod connecting the pneumatic operating mechanism to the bell crank.
2. A bell crank to convert vertical to horizontal motion.
3. A horizontal pull rod which connects the bell crank to the pole unit lever assembly.

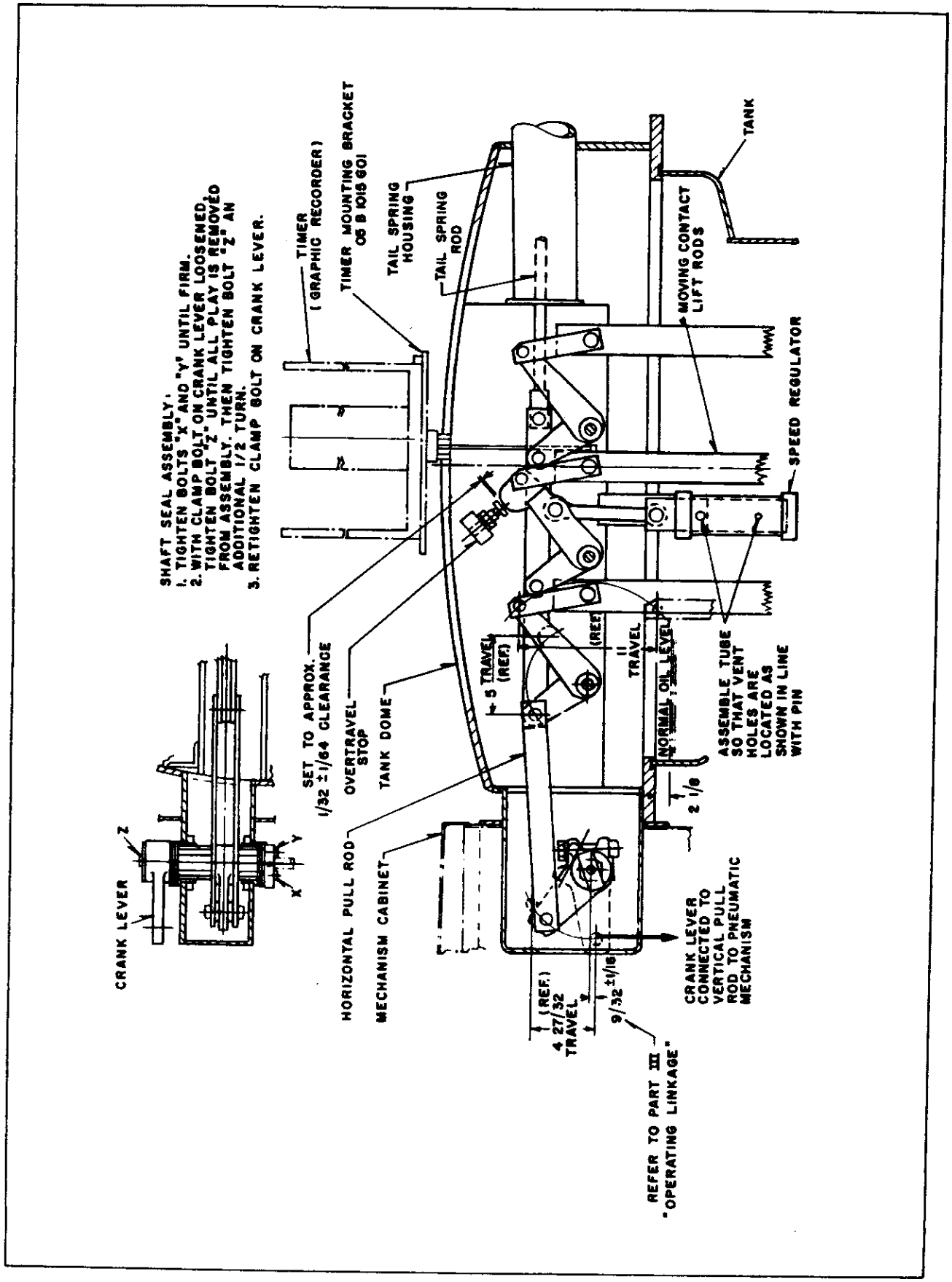


Fig. 4 *Pole Unit Linkage and Bell Crank Assembly and Graphic Recorder Mounting*

4. The pole unit lever assemblies which convert horizontal motion into straight-line vertical motion for the moving contact lift rod.

5. An accelerating spring (tail-spring - Fig. 2) which provides the force to open the breaker.

The operating linkage has been set at the factory so that new breakers should not require any field adjustment. However, the lever system overtravel stop clearance should be checked with the breaker closed and latched. This should be .032" ± .015" as shown.

The overtravel stop may show less than .032" clearance when the breaker has been power closed pneumatically. This occurs because the friction of the interrupter finger contacts tends to hold the moving parts in the overtravel position. Hence *all clearances and dimensional checks should be made after closing the breaker slowly with the manual closing device until the mechanism latch just snaps into place* (no overtravel).

If the stop bolt clearance is not correct, the stop bolt should not be disturbed until the .28" ± .031" bell crank lever setting has been checked as shown. This dimension is controlled by adjusting the length of the vertical pull rod inside the mechanism cabinet, and should be checked with the breaker closed and latched. After the bell crank lever has been set correctly, the overtravel stop bolt should be reset for .032" ± .015" clearance and locked.

There are no other adjustments for the operating linkage except the accelerating spring compression for speed control. When the two above adjustments are correct, the proper position of the pole unit levers and moving contact travel are assured.

Speed Regulator

A hydraulic speed regulator is connected to the lever system to control the speed during the opening stroke and to cushion the shock at the end of the stroke. The regulator is designed to provide proper contact travel and requires no adjustment.

The speed regulator depends on the presence of oil in the circuit breaker tank for proper operation and is ineffective when the breaker is tripped with the tank lowered or when the oil level is below normal. *Tripping the breaker under these conditions may cause damage and is not recommended.*

Condenser Bushings

If it is necessary to install or replace condenser bushings, refer to the instructions included with replacement bushings. Extreme care should be taken to prevent damage to the lower insulation of the bushings, and to prevent the bushing stud from striking the current transformer which may damage its insulation.

Make certain the flange gasket is placed properly in the recessed seat on the breaker top of the gasket. Clearance has been provided in the flange bolt holes to permit lateral adjustment of the bushings in order to facilitate contact alignment. Make sure the metal collar on the bushing does not touch the metal support plate for the current transformer; this would short circuit the transformer and affect its ratio.

After the moving and stationary contacts and "De-ion" interrupters are properly aligned, check the bushing flange bolts to be sure they are tightened uniformly around the flange. While inspecting the bolts, be sure the gasket is properly positioned to insure a moisture-proof seal between the flange and the breaker top.

Caution: **When working on a breaker which has just been in service, be sure the condenser bushing has been discharged by grounding the terminal end. The larger bushings can shock a workman seriously if they accidentally discharge through him.**

Interrupter Assembly - Fig. 5

The following procedure is given in the event that it is necessary to replace the entire contact foot and interrupter assembly.

Remove the contact foot from the interrupter before attempting to screw the foot onto the lower end of the condenser bushing. Care must be taken to avoid damaging the threads. The two contact feet for each phase should be assembled at the same height as checked by using a spirit level between the feet. The contact foot should be positioned so that the interrupter vents will face outward radially toward the tank wall. This will correspond to locating the split in the threads inward radially toward the center of the tank.

Disassemble the interrupter cylinder from the top casting by first loosening the locking set screw and then proceeding to unscrew the interrupter cylinder with the aid of a strap wrench.

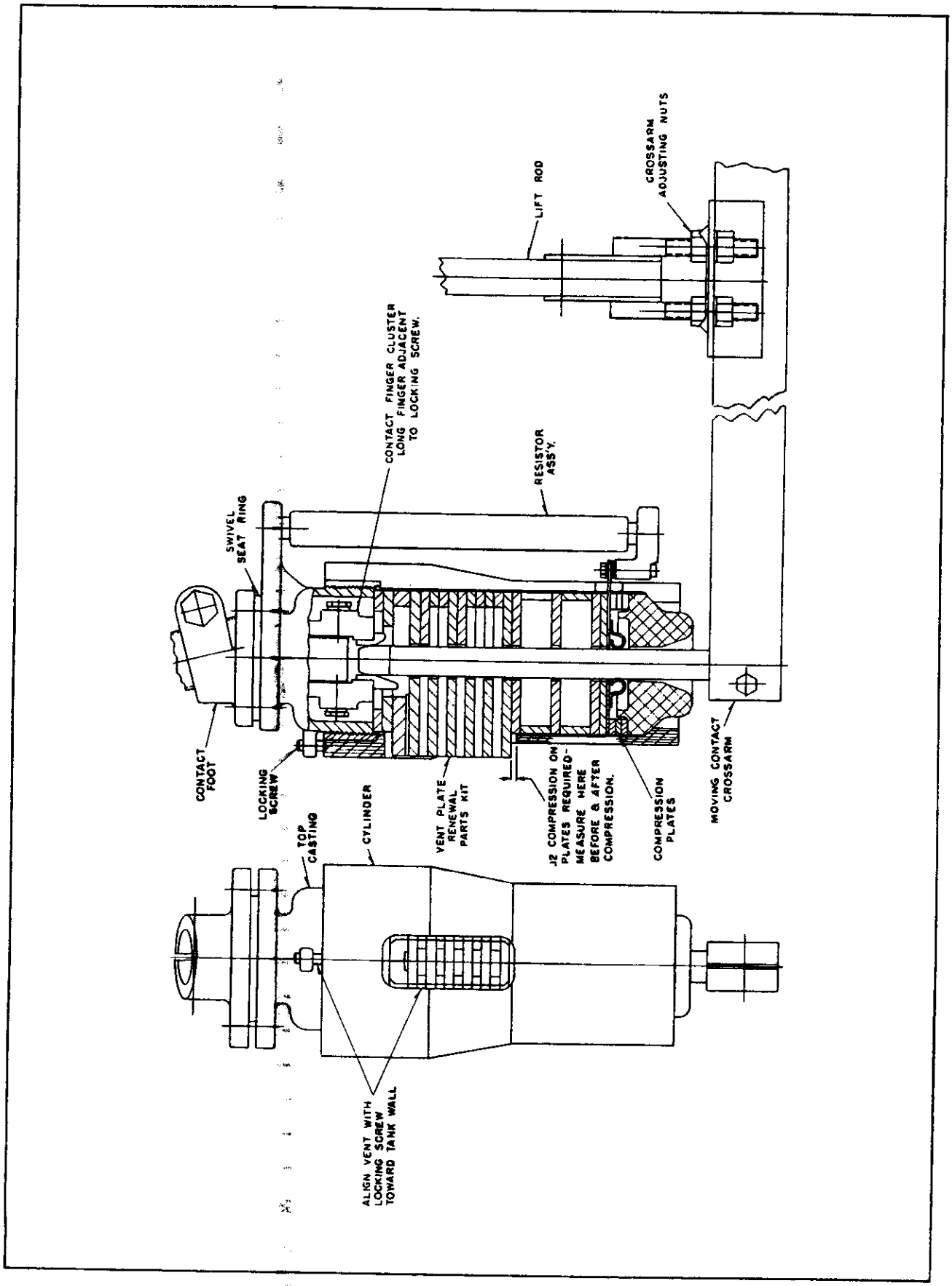


Fig. 5 *Interrupter and Contact Assembly*

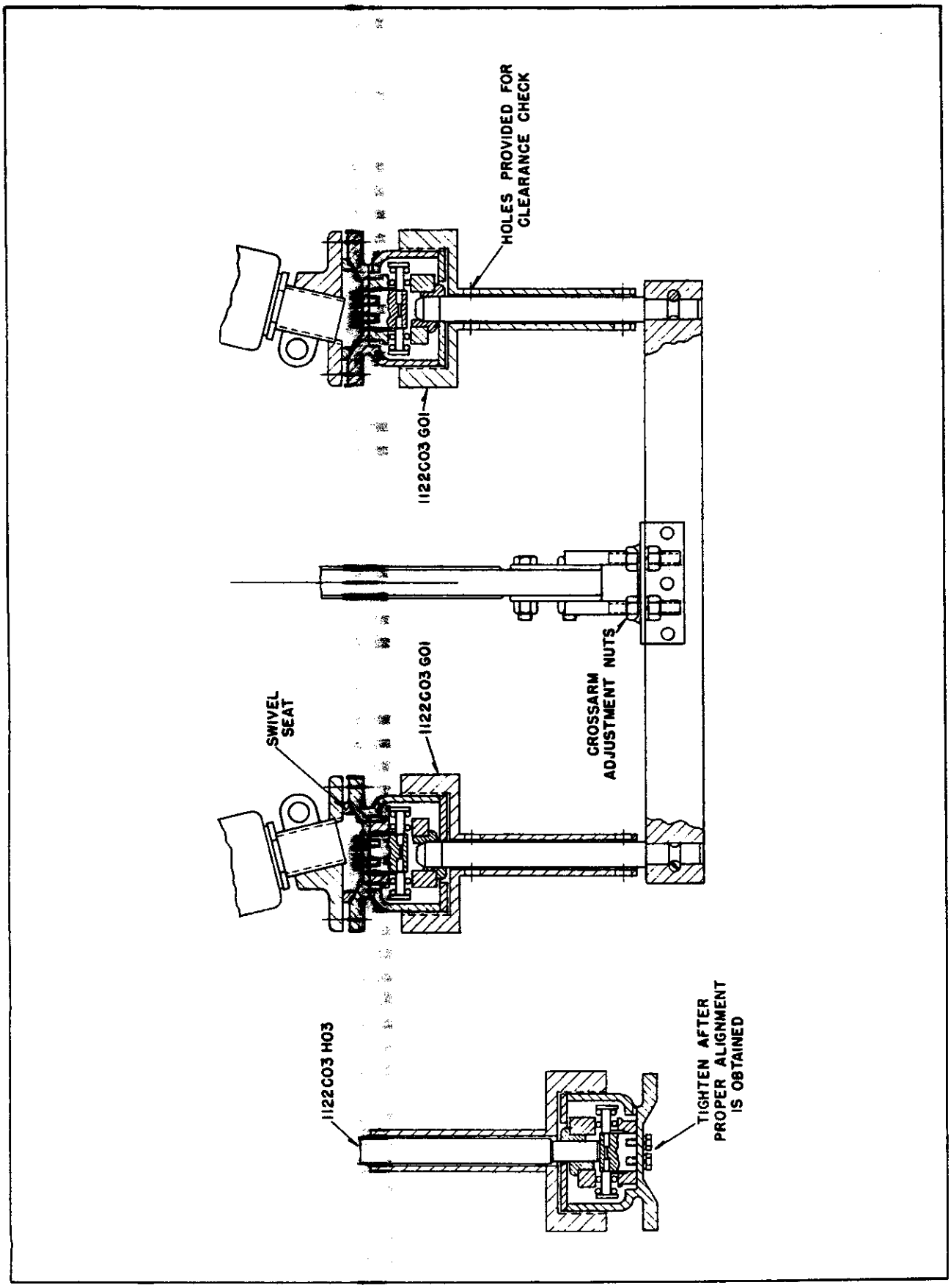


Fig. 6 *Stationary Contact Alignment*

When assembling the top casting to the contact foot, note that a swivel seat is provided for vertical alignment, and that the top casting has oversize holes to permit lateral alignment with the moving contact bayonettes. The bolts should be drawn up lightly, since final tightening will not be done until the adjustments are complete. The interrupter cylinder is reassembled after contact adjustment.

Moving Contact Assembly - Fig. 5

The moving contact cross-arm is fastened to 4 studs at the bottom of the lift rod as shown. Adjustment of the nuts permits vertical alignment in both directions, and also provides vertical adjustment for proper contact engagement.

The bayonettes are readily replaceable by removing the clamping bolts in the ends of the cross-arm. Note that the bayonette is not threaded, but is locked in place by the body of the clamping bolt which engages a groove. The bayonette shoulder should be seated firmly on the cross-arm before securing the clamping bolts.

Contact Adjustment

New breakers should not require any contact adjustment, but it is recommended that the alignment and engagement be checked as called for under "Final Installation Inspection and Tests," Part II.

The following adjustments are provided for vertical alignment (plumb) and lateral alignment of the interrupters in order to obtain proper entry of the moving contact bayonettes:

1. Swivel seat on the interrupter top casting. (plumb)

2. Oversize holes in the interrupter top casting. (lateral)

3. Four sets of nuts on moving contact cross-arm. (plumb)

4.* Amount of thread engagement on contact foot. (Height affects lateral spacing due to condenser bushing angle.)

5.* Oversize holes in condenser bushing flange.

The final adjustment is made in two steps as follows:

1. Determine that the bayonette contacts are plumb. If not adjustment may be accomplished by the cross-arm adjusting nuts (Fig. 6). The breaker is hand closed until the bayonettes touch, the top casting is then adjusted laterally until concentricity is obtained between the stationary contact fingers and the bayonette. The breaker is then opened and alignment tool S#1122C03G01 is screwed onto each contact foot (Fig. 6).

2. Vertical alignment, of the stationary contact assembly is obtained by manually closing the breaker to various positions while adjusting the four bolts in the top casting to maintain clearance between the i.d. of the alignment tool and the bayonette.

The following adjustments are provided for contact engagement:

1. Four sets of nuts on moving contact cross-arm.

2.* Amount of thread engagement on contact foot.

It will be noted that some of the adjustments for alignment and engagement are inter-dependent.

Check for .5" ± .06 contact engagement from contacts touch to fully closed and latched (no overtravel). This may be determined by "lighting out" between the contact feet on each pole and checking the travel on the moving contact lift rod. It is *not* necessary to adjust for simultaneous touching of all contacts.

After all adjustments are complete, the following items should be tightened securely: bushing flange bolts, contact feet clamping bolts, interrupter mounting bolts, and moving contact cross-arm nuts. Make a final check to make certain the adjustments have not been disturbed by tightening bolts and nuts, and then bend up the locking clip corners on the upper moving contact nuts.

The interrupter cylinder is then assembled to the top casting, by screwing it on until it is snug and then continue with the aid of a strap wrench until the 1/8" compression is obtained, as shown in Fig. 5, and the vents are aligned directly under the set screw. The required effort with a strap wrench is due to the fact that several compressible plates are used at the bottom of the interrupter. The cylinder is then locked in place with the set screw. Again, operate the breaker slowly by hand to make sure there is no binding in the interrupter or lift rod guides. The resistor assemblies are installed after all adjustments are complete.

*It is suggested that the bushing flange adjustment and contact foot thread engagement not be disturbed unless the other adjustments prove to be insufficient.

Tail Spring - Fig. 2

An accelerating spring is mounted in a housing extending from the rear of the tank top dome to accelerate the opening stroke of the contacts. This spring is set at the proper compression at the factory and should not be disturbed unless timing tests show the need for adjustment. Spring compression is controlled by the self-locking nut on the operating rod; adjustment should be made when the breaker is in the open position.

Pneumatic Tank Lifter

The pneumatic tank lifter is powered from the pneumatic mechanism air supply and is available as an accessory. Refer to I.L. 33-252-TL (supplied with lifter) for operating instructions.

PART IV - MAINTENANCE

It is recognized that the inspection and maintenance program will vary from one user to another. The important consideration is that a system of regular inspection be established, and the frequency determined by operating experience. The programming of maintenance can be scheduled with assurance by compiling operating data on individual breakers.

It is recommended that each new breaker be given a one-year "shake-down" period to prove the initial installation and to establish the duty to which it is likely to be subjected. After this period, a thorough inspection should be made as outlined under "General Inspection Procedure."

Subsequent inspection and maintenance procedures are normally divided into two categories. These procedures should be supplemented by frequent visual inspections by operators touring the switch yard.

Caution: **Before working on a breaker that has just been disconnected from the line, make sure that the condenser bushings have been discharged by grounding the terminal end. The bushings can retain an electrical charge which may cause serious shock to a workman.**

Routine Inspection Procedure

A routine inspection should be made yearly and used as an additional guideline in determining the necessity of a general inspection. A routine inspection includes checks which may be made externally.

The suggested routine inspection procedure is as follows:

1. Check mechanical operation of breaker. This should include checking for 5 stored closing operations (run-down) and checking pressure switch settings.

2. Check dielectric strength of oil.

3. Measure contact resistance across the bushings terminals. This should not exceed 250 micro-ohms.

Note: **The value given for contact resistance is the maximum limits for new breakers.**

The value given for contact resistance is the maximum allowable on new breakers to insure that the temperature rise of current carrying parts remains within limits. In no case shall the resistance be permitted to exceed 200 percent of this value. After the contacts have been serviced during normal maintenance, the resistance shall not exceed 150 percent of this value. The resistance shall be measured from terminal to terminal with 100 amperes dc in the circuit.

4. Measure contact engagement. This may be checked without lowering the tank by employing the graphic travel recorder connection through the tank top (Ref. Fig. 4) using a .19" dia. rod with .190-32 threads. Close the breaker slowly by hand until the contacts just touch ("Light Out" through terminals) and check the additional travel to close and just latch the mechanism (no over-travel). The difference between these two points represents the effective contact engagement which would be .5" ± .06" with new contacts. If engagement checks less than .31" the tank should be lowered for a thorough contact inspection.

5. Check the mechanical and electrical components of the operating mechanism as outlined in the Mechanism Instruction Book.

General Inspection Procedure

The following are some of the factors to be considered in determining the frequency of a general inspection procedure:

1. Time.

2. Number of switching and testing operations.

3. Number of overload and fault operations.

4. Severity of fault operations.

5. Condition of oil.

6. Cleanliness of atmosphere surrounding breaker.

7. Accumulated experience of breaker characteristics and duty.

8. Information received from routine inspections.

The following schedule is suggested as a basis for setting up a General Inspection program (whichever comes first):

1. Five years elapsed time.

2. Four times cumulative interrupting rating (4 rated faults, 8 half-rated faults, etc.).

3. 1000 mechanical operations.

The suggested General Inspection procedure is as follows:

Caution: **Open the control circuit at the breaker before starting breaker inspection to prevent accidental operation. Also close the hand valve between the compressor tank and pneumatic mechanism, and insert the safety pin to block the trip-free trigger.**

1. Lower the tank with the pneumatic lifter - Ref. I.L. 33-252-TL.

2. Close the breaker slowly by hand and check contact alignment and engagement. Engagement (as checked by "lighting out" and measuring moving contact lift rod travel) less than .31" is an indication of considerable contact erosion which may require contact replacement.

3. Check clearance of the lever system overtravel stop with the breaker closed and just latched (no overtravel). Ref. Fig. 4. Note that a clearance greater than .032" would affect the apparent contact erosion as checked in Step 2.

4. Open the breaker and examine the moving contacts. Recondition or replace bayonettes if necessary.

5. Inspect the stationary contact fingers for erosion by removing the interrupter cylinder. Ref. Fig. 5. Fingers suitable for reconditioning may then be dressed in place. If replacement is required, first remove the top casting from the contact foot and then remove the two bolts on top which hold the finger cluster in place.

Caution: **Renewal contacts are supplied as complete cluster assemblies only. If an attempt is made to replace individual finger contacts it should be noted that Loctite is used to retain the bolts which hold the fingers in place. For this reason it is necessary to apply heat to the bolt threads to facilitate removal. When assembling Loctite Grade B should be applied to the threads and the bolts torqued to 30 in.-lbs.**

When replacing the finger cluster, 1) make certain the long finger is positioned adjacent to the set screw used to lock the cylinder but do not tighten the two bolts which hold the finger cluster in place 2) screw the alignment tool 1122C03G01 onto the top casting, insert alignment tool 1122C03H03 fully to align the finger cluster with the top casting and then tighten the two holding bolts.

6. Remove the vent pieces from the top of the interrupter and examine for erosion. If the hole in the vent pieces exceeds 1.19" diameter, a vent plate replacement kit should be installed. This is a 8-piece kit which includes the two fibre plates and six vent pieces as shown in Fig. 5.

The fibre plates below the vent areas are not likely to require replacement in the life of the breaker unless there is unusually severe duty. Replacement should be made if the hole exceeds 1.19" diameter.

7. Check the pole unit linkages for excessive wear which may require parts replacement. Check bolts, nuts, cotter pins, etc. for tightness.

8. Check speed regulator to insure it is operating freely. (Remove bottom plate and inspect piston, cylinder, and spring-biased valve).

9. Clean the lower ends of the bushings and the lift rods and guides with a clean cloth dampened with clean oil. Remove carbon from the interrupters.

10. Check the operating mechanism for loose nuts and bolts and for missing spring cotters.

11. Check latches to see that faces are in good condition and are properly adjusted. (See Instruction Book for Operating Mechanism.) Apply rust inhibitor to latch faces. The inhibitor should be free flowing at all anticipated temperatures, non-hardening and self-healing (so that it will not wipe completely off in one operation). A light lubricant similar to Westinghouse 55213-AG or Beacon 325 is suggested.

12. Check air system on pneumatic mechanism for excessive leakage. Leak rate should not exceed 5 psig/hour.

13. Check control wiring for loose connections.

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

15. Check dielectric breakdown strength of the oil. See "Care of Oil" below.

16. Raise and secure tank and refill with oil. Check closing and tripping operations, using all usual relays and circuits involved in the operation of the breaker. Be sure all relay and pressure switch contacts are clean. Check operation at reduced voltage to insure safety margin.

17. Make timing test with graphic recorder to check opening speed and reclosing time (if required). Also check number of stored closing operations. Ref. "Operation and Timing Tests" Part II.

18. Check setting of compressor governor, low pressure alarm, and cutoff switches. Pressure settings are tabulated on mechanism nameplate.

Care of Oil

Wemco "C" oil is recommended for use in all circuit breakers. Westinghouse cannot assume responsibility for circuit breakers 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 due to oxidation and contamination with carbon and water, even under the most favorable conditions. It is essential to make periodic inspections and tests, and purify the oil whenever necessary. The more handling the insulating oil receives, the greater the chances for it to become contaminated, unless adequate precautions are taken.

Operators should prepare a schedule for inspection based on operating conditions. Reference to the station log with the record of dielectric oil tests should determine the frequency of inspection and tests. When the dielectric strength of the oil drops to 20,000 volts, the oil should be regarded with suspicion. In no case should it be allowed to drop below 16,500 volts when tested in a standard test cup with electrodes spaced 0.1 inch apart. It is essential that the proper oil level be maintained. Considerable change may be caused by varying temperature or possible oil leaks. Low oil levels may cause flashover of bushings or breaker failure. Also the speed regulator may be uncovered and fail to provide proper cushioning effect.

Refer to Westinghouse Instruction Book 45-063-100 which covers the care and maintenance of oil. It should be studied before any attempt is made to test or purify the oil.

Condenser Bushings

Maintenance and power factor testing of condenser bushings should be given consideration during breaker inspection. Technical Data Section 33-360 (available on request) should be studied for complete recommendations on maintenance.

Note: **For bushing replacement with those other than Westinghouse, concentricity between bolt circle of bushing flange and diameter of bottom stud must be .12 in.**

Important: **When installing bushings, do not permit the metal flange on the bushing to touch the metal support which holds the current transformer in place. This will set up a short circuited turn around the transformer and affect the ratio.**

Bushing Current Transformer

In order to replace or add a current transformer, it is necessary to remove the interrupter so that the transformer may be slipped down over the condenser bushing. Reassembly will be facilitated by marking the position of the contact foot on the bushing stud before removal. It is also necessary on No. 1 and 3 poles to remove the lift rod guide and swing the lift rod out of the way.

The gas seal assembly (Ref. Fig. 1) must be loosened in order to remove the transformer leads. When mounting additional transformers, the lead seal may be reused by punching 1/4" diameter holes for each lead in the remaining blind holes in the rubber piece.

If a transformer is removed so that some of the punched holes are not used, a new rubber seal piece must be obtained in order to insure a gas-tight seal.

Be certain the insulating washers at the top and bottom of the transformer are in place before securing the transformer.

Be sure to place the end of the transformer carrying the white polarity mark upward. See that the transformer is not thrown off ratio by allowing the case to touch the metal grounding band on the condenser bushing.

Caution: **Be sure that proper transformer connections are made and a burden or 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.**

Oil Gauge

A float-type gauge in the tank top is marked with a metal ring for normal oil level at 25°C (78°F). Fluctuation in oil level recording to ambient temperature is covered under "Filling Tank with Oil," Part II.

The gauge glass is gasketed to insure weather tightness. Should it be necessary to replace a gauge glass, remove the old glass, clean the guard thoroughly, assemble the gasket at top and bottom of the glass, and fasten cap so that the glass is held in proper position. Use Westinghouse Cement No. 32230-CA or equivalent on the threads if the gauge has been removed from the breaker, so that water will not enter the tank.

RENEWAL PARTS

A list of renewal parts recommended for stock will be furnished on request. When ordering renewal parts, identify by style number if possible, or by description using the illustrations and nomenclature in this book. Identify the breaker by including the type, amperes, volts and Shop Order (S.O.) Number, from the nameplate.

SERVICE ASSISTANCE

If a breaker fails to operate properly and the trouble cannot be found or corrected, notify the nearest Westinghouse Electric Utility Sales Office for assistance.

Printed in U.S.A.

WESTINGHOUSE

INSTRUCTION BOOK SUPPLEMENT FOR OIL CIRCUIT BREAKERS WHICH USE COMPOUND FILLED TYPE "S" AND "ES" BUSHINGS

TYPICAL Contemporary Instruction Books Are:

Type "GS" Breaker	Type "G" Breaker
I.B. 33-255-1A (34.5 kV & Below)	I.B. 33-252-1 (1200 Amperes)
I.B. 33-255-2 (46 kV & Above)	I.B. 33-750-4 (Hi-Amperes)

As an aid to assuring satisfactory performance of the COMPOUND FILLED type "S" and "ES" Bushing over its life expectancy, it is suggested that a time zero reference hot collar power factor test be made on the bushings at time of breaker installation.

Type "S" and "ES" Bushings are supplied in "G" and "GS" breakers at ratings of 14.4, 23, 34.5 and 46 kV. These hot collar tests apply to compound filled bushings and are NOT APPLICABLE TO OIL FILLED OR OTHER TYPE BUSHINGS. The hot collar method of test is a practical and sensitive method for testing localized zones of the bushing for evidence of contamination which could lead to failure.

A bushing should be replaced, if a test reading of any point on that bushing varies by (50%) or more from the readings of other points on that bushing, or the readings on any other bushing. Test results should be retained for comparison with subsequent test results.

If a bushing tests satisfactorily initially, it is suggested that it be retested one year later and the test results compared with previous test readings. If the test readings are 50% different when compared to the average reading from the previous year, the bushing should be replaced immediately. If the test readings are within limits (50% of the average of the previous year) the bushing is suggested to be retested every three years and test results compared with initial test readings as stated above.

If a user does not have the capability to make or interpret the hot collar power factor test, it is suggested that the nearest Westinghouse Engineering Service Office be contacted. Westinghouse will provide this service on a charge customer basis.

OIL CIRCUIT BREAKER DEPARTMENT
POWER CIRCUIT BREAKER DIVISION
WESTINGHOUSE ELECTRIC CORPORATION
TRAFFORD, PENNSYLVANIA 15085

July, 1976

SUPPLEMENT TO I.B. 33-255-2

covering:

460GS1500

460GS2500

690GS2500

690GS3500

Instruction Book I.B. 33-255-2 contains instructions for "Operation and Timing Tests" which identify that timing tests are to be performed with the timer mounted on the breaker tank top and the timer rod attached to a boss on the lift rod. Changes have been made which now require the timer be mounted on the accelerating spring assembly as shown in Figure 1 below. The spring housing cap is removed and replaced with the timer mounting bracket which screws onto the housing. The end of the exposed operating rod is provided with a #10-32 tapped hole for the timer connection. The timer is fastened to the bracket with a pair of heavy "C" clamps.

The opening and closing speed limits are shown on the typical timing charts attached. Note that the open and closed positions are reversed from usual timer records. The speed limits are related to the 5" travel on the accelerating spring rod which will give the correct speed for the 11" moving contact travel. Note also the 2.8 cycle limit on opening time (trip coil energized until contacts part).

The opening speed is controlled by adjustment of the tail spring compression, whereas the closing speed is controlled by throttle adjustment on the pneumatic mechanism. (See mechanism instruction book.) Normally the factory adjustments need not be disturbed.

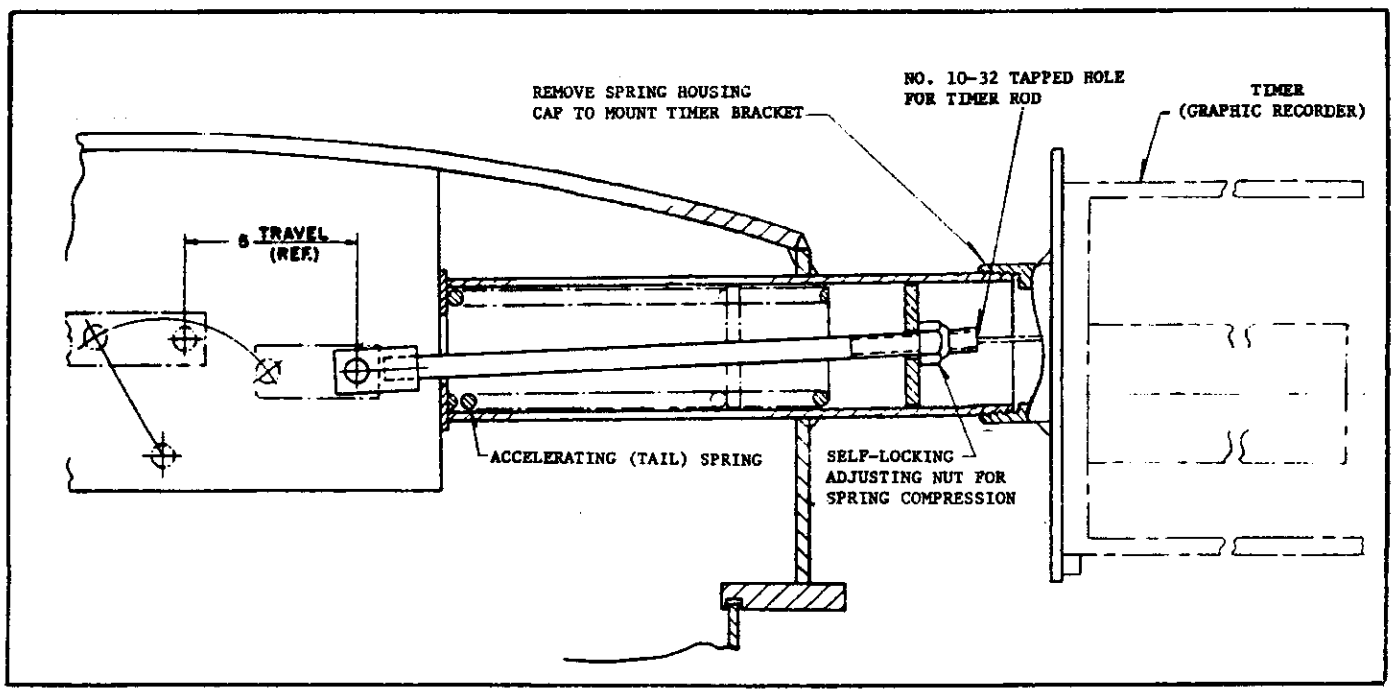
If the opening speed is within limits but the contact parting time exceeds 2.8 cycles, it may be due to one of the following reasons:

1. Incorrect zero setting on graphic recorder.
2. Excessive voltage drop in D.C. control cable to breaker.

Note that the permissible rebound on the opening stroke is 5% of the total travel. This would amount to 1/4" as measured on the timer chart(9/16" actual rebound referred to 11" contact travel). If the rebound exceeds this amount, a defective speed regulator is indicated.

If the breaker is to be used for high speed reclosing duty, it is recommended that a timer record be made of this operation. The reclosing time may be adjusted to some extent by means of the "bb" auxiliary switch contact. If the reclosing time exceeds 20 cycles, it may be due to sluggish retrieving of the mechanism or faulty operation of the latch checking switch.

Before the final closing to place the breaker in service, make sure the control power and compressor supply switches are "ON," and that the hand valve between the compressor reservoir and the mechanism is wide open. DO NOT CLOSE THE BREAKER ON A LIVE LINE WITH THE HAND CLOSING DEVICE. This device is intended for breaker adjustment only.



Tail Spring and Graphic Recorder Mounting

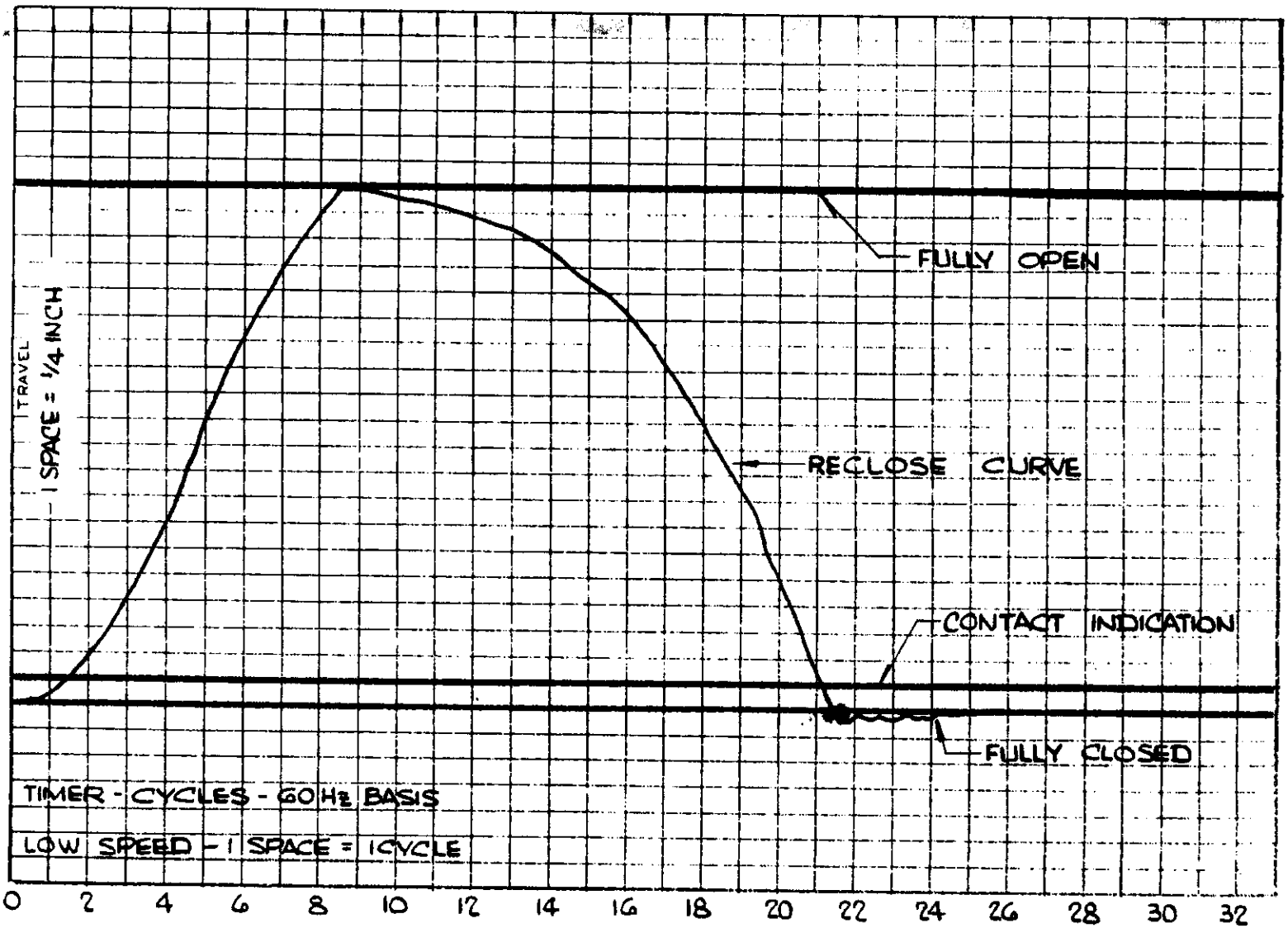
TYPICAL TIMING CURVE

FOR

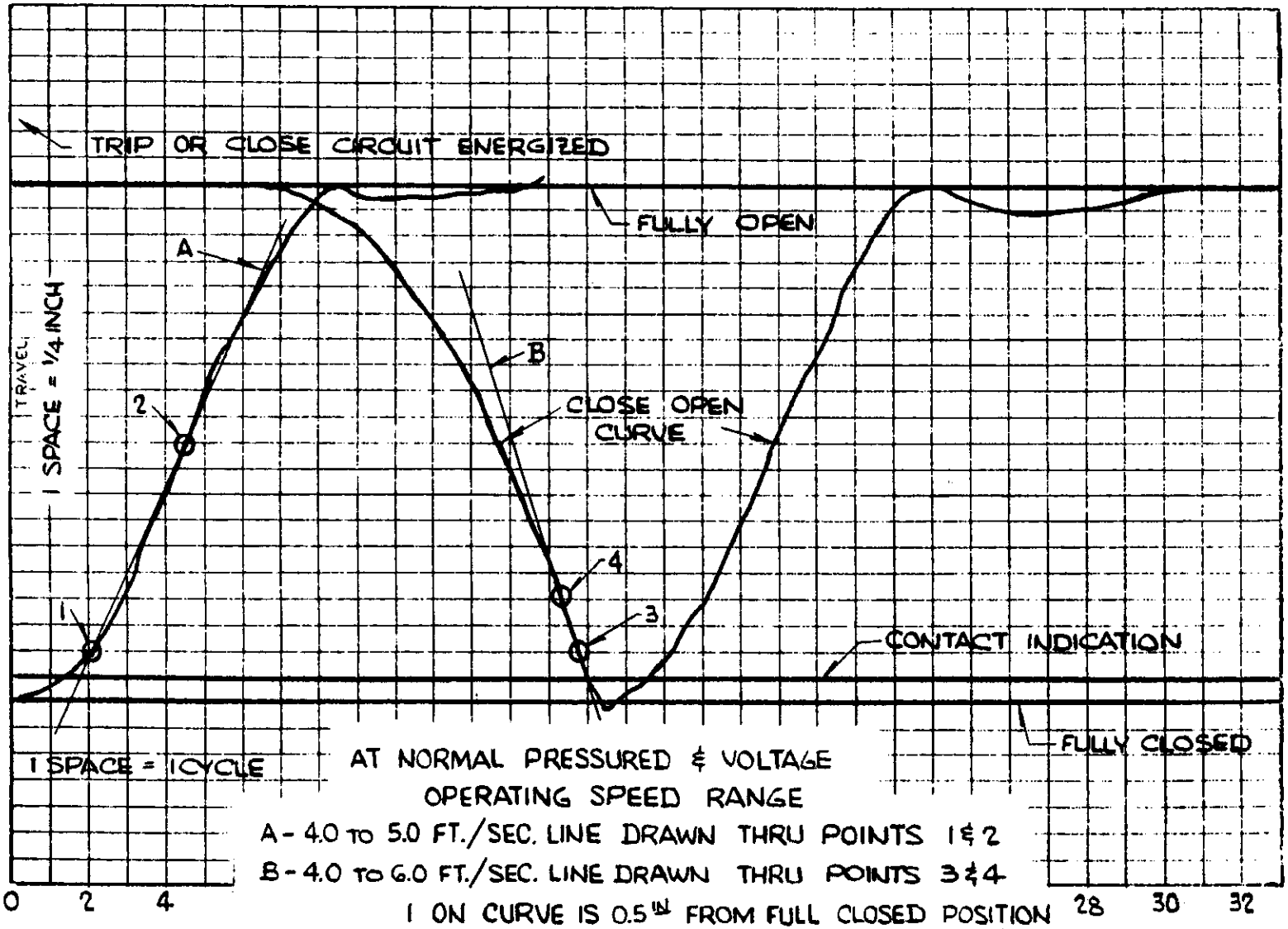
TYPE 460GS1500 - 460GS2500 - 690GS2500 - 690GS3500

OIL CIRCUIT BREAKER

(TIMING PERFORMED FROM ACCELERATING SPRING ROD)



TYPICAL TIMING CURVE
FOR
TYPE 460GS1500 - 460GS2500 - 690GS2500 - 690GS3500
OIL CIRCUIT BREAKER
(TIMING PERFORMED FROM ACCELERATING SPRING ROD)



AT NORMAL PRESSURED & VOLTAGE

OPERATING SPEED RANGE

A - 4.0 TO 5.0 FT./SEC. LINE DRAWN THRU POINTS 1 & 2

B - 4.0 TO 6.0 FT./SEC. LINE DRAWN THRU POINTS 3 & 4

1 ON CURVE IS 0.5 IN FROM FULL CLOSED POSITION

2 ON CURVE IS 2.5 IN FROM FULL CLOSED POSITION

3 ON CURVE IS 0.5 IN FROM FULL CLOSED POSITION

4 ON CURVE IS 1.0 IN FROM FULL CLOSED POSITION