RECEIVING • INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

AUTOMATIC CIRCUIT RECLOSER

Type 400 PR
Type 560 PR

Ratings

Type	Voltage Rating Kv Maximum	Continuous Current Amperes	Maximum Interrupting Current RMS Symmetrical Amperes 4.8 Kv	8.32 Kv	14.4 Kv
400 PR	14.4	25 to 400	6000	5000	4000
560 PR	14.4	100 to 560	12000	10000	8000

WESTINGHOUSE ELECTRIC CORPORATION

DISTRIBUTION APPARATUS DEPARTMENT • BLOOMINGTON, INDIANA

SUPERSEDES I.B. 38-725-1C

OCTOBER, 1960

Printed in U.S.A.

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GENERAL INFORMATION

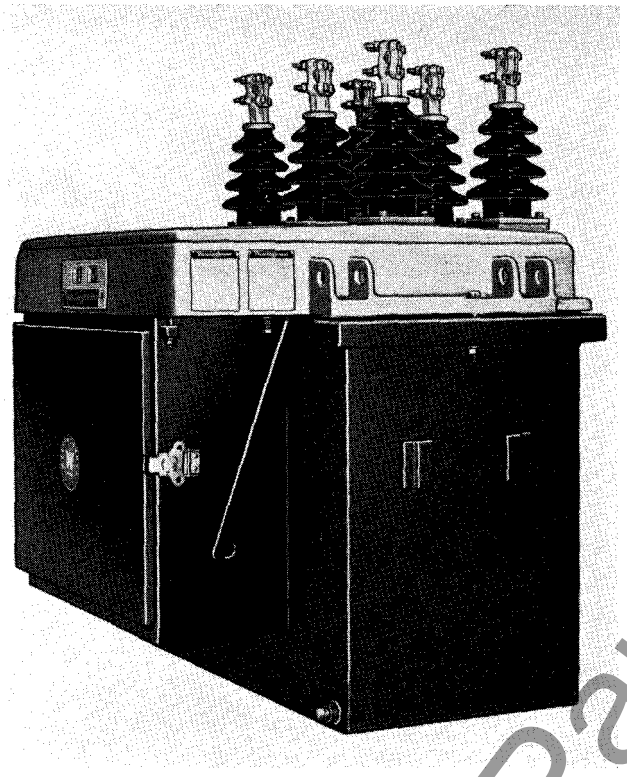


FIG. 1. PR Recloser

THE WESTINGHOUSE TYPE PR AUTOMATIC CIRCUIT RECLOSER Fig. 1 is a heavy duty three pole device designed for use in distribution substations and in main line feeders. On the occurrence of a fault, it interrupts the current to clear the circuit, and then automatically recloses to re-energize the line. If the fault has not been cleared it re-opens, repeating this a predetermined number of times up to four interruptions before locking open.

The basic components of the PR recloser are (1) a set of three power interrupters (one for each pole), (2) a set of three series solenoids and associated pneumatic timers which trip the recloser open on over current with an inverse time delay characteristic, (3) a motor operated mechanism which closes the contacts and at the same time compresses a spring to furnish opening power when needed, and (4) an integrator which is operated on each opening of the recloser and is adjusted to predetermine the total number of operations to lockout as well as the sequence of instantaneous and time delay openings.

Current flowing through any one of the three series trip coils will cause a force to pull its armature closed. The minimum trip spring restrains the armature unless a fault causes the current to exceed a value predetermined by the spring tension. When the armature starts to move an additional restraining action is exerted against the armature by a pneumatic timer causing the armature closing time to vary inversely with the magnitude of fault current. As the series trip coil armature reaches the end of its travel a trip bar is lifted by the operating rod of the pneumatic timer. Tripping is accomplished thru the action of a double toggle mechanism.

When this tripping bar is actuated, it applies a tripping force to the latch toggle and releases the main toggle, which allows the opening spring to snap the main interrupting contacts to the full open position. After the main contacts are opened, the latch toggle resets so that the main toggle can be closed when required.

During the open period of the recloser a small spring force is applied to the diaphram of a pneumatic reclosing timer. When the diaphram has moved sufficiently in response to this spring force, a switch is actuated to complete a circuit to the closing motor. The reclosing time is constant for any setting of the timer, and is completely independent of the magnitude of the fault current through the series trip coils.

The closing motor operates through a worm reduction gear, and applies a closing force to the main toggle. The main opening spring is also charged during the closing cycle.

Each operation of the recloser is counted by the lockout integrator and if the fault is not cleared by the first three operations of the unit, the integrator actuates a lockout switch on the fourth operation which opens the circuit to the closing motor. The recloser can be closed after lockout by using the manual closing handle or by energizing the closing motor from a remote switch.

The integrator mechanism is mechanically held so that it can not reset as long as the recloser is open. This assures that the integrator will be in position to lockout the recloser after only one operation if the device is reclosed on a faulted line. The lockout integrator rod resets after a time delay if the recloser remains closed.

The resetting of the integrator is accomplished electrically by use of a timer and solenoid energized by an auxiliary contact of the recloser.

The recloser may contain a set of bushing mounted current transformers for metering, ground fault protection, or other relaying functions. Other optional equipment which may be included are (1) a ground trip attachment, (2) demand ammeters, (3)

reclosing shunt trip, (4) non-reclosing switch, and (5) separately mounted auxiliary controls.

The high voltage components of the recloser are separated from the control components for convenience and safety. The interrupter assemblies, series solenoids, and bushing transformers are housed in an oil filled compartment. This tank may be unbolted from the head-casting and lowered when necessary, for inspection or maintenance. The motor mechanism, timers, integrator, and controls are housed in a weatherproof air filled compartment. The door on this smaller tank may be easily removed when it is desired to inspect or adjust the controls, or make operating tests.

It is recommended that the recloser be mounted on a concrete pad or a sturdy platform, and suitable substation type mounting frames are available for this purpose. However, the 400 PR may be pole mounted if desired, and a cross arm mounting frame is available for this purpose.

Satisfactory performance of the type PR recloser is contingent upon correct installation and adequate maintenance and servicing. The following instructions have therefore been prepared to help the user obtain the best and most economical usage from the device. This is a general instruction book and applies particularly to the basic PR recloser. Supplemental instructions are supplied for optional attachments and controls and for details of adjustment and servicing when required. Reference should be made to D.B. 38-725 for detailed description and application.

RECEIVING

It is important that the recloser be promptly inspected to insure that the correct material has been received, and so that a claim may be entered for any shortage or damage that may have been suffered in transit. If the device is not to be placed in service immediately, it is important that proper care be exercised in handling and storage so that the device will remain in good condition.

A. Inspection. The PR recloser should be inspected upon receipt to make sure no damage was suffered in transit. A damaged crate may indicate rough handling.

Check all parts against the shipping list as they are unpacked. Search the packing material for hardware or parts that may have been loosened. Instructions and literature packed with the recloser should be kept with the unit.

Remove the oil tank and the control tank and inspect the recloser mechanism. If the recloser is frame mounted when received, the tanks may be lowered for inspection. If the recloser is unmounted, the unit may be lifted by a crane and the tanks removed.

Caution: Lift only by the flanges at the side of the head casting. Do not lift by the bushings or terminal connectors.

Remove any blocks or wires used to hold moving parts in place during shipment.

Check the mechanism for loose screws or nuts, and damaged parts.

Any claim for damage should be filed at once with the carrier, and the local Westinghouse Sales Office notified.

B. Storage. If it is necessary to store the recloser for sometime before installation it is important to take certain precautions. The recloser is shipped without oil and it may be stored as received for a few weeks in a clean, dry, indoors location. If it is necessary to store the recloser outdoors or in a humid atmosphere, the oil tank must be filled at once to the proper level with Wemco C oil to prevent undue absorption of moisture by the insulating members in the recloser. The control compartment tank should be tightened firmly against its gasket seal.

INSTALLATION AND OPERATIONAL CHECKS

It is a good practice to check the recloser for correct mechanical and electrical operation before delivery to the site of installation. In installation, the recloser should be mounted securely by its mounting flanges, and be reasonably level. The line connections and control power connections should be carefully made and checked, the tank should be filled to the proper level with oil, and the installation should be carefully checked before energizing the recloser.

A. Operational Checks. If convenient, the recloser should be checked for correct operation before removal to the site of installation. It is preferable to do this indoors since a 240 volt, 60 cycle operating power source is necessary and tools and meters may be needed. The checking procedure is as follows, with components identified by number referring to Figs. 2 and 3.

1. Take off the door or remove the control tank by loosening four bolts that hold it to the head casting and lower it carefully to avoid damage to the control mechanism. This may be easily done if the recloser has been received mounted on a substation type frame, otherwise, the recloser should be set on the edge of a bench at least two feet off the floor and positioned so the control tank can be removed.

2. Try closing and tripping the recloser manually. To close, pull forward and upward on the long "Red"

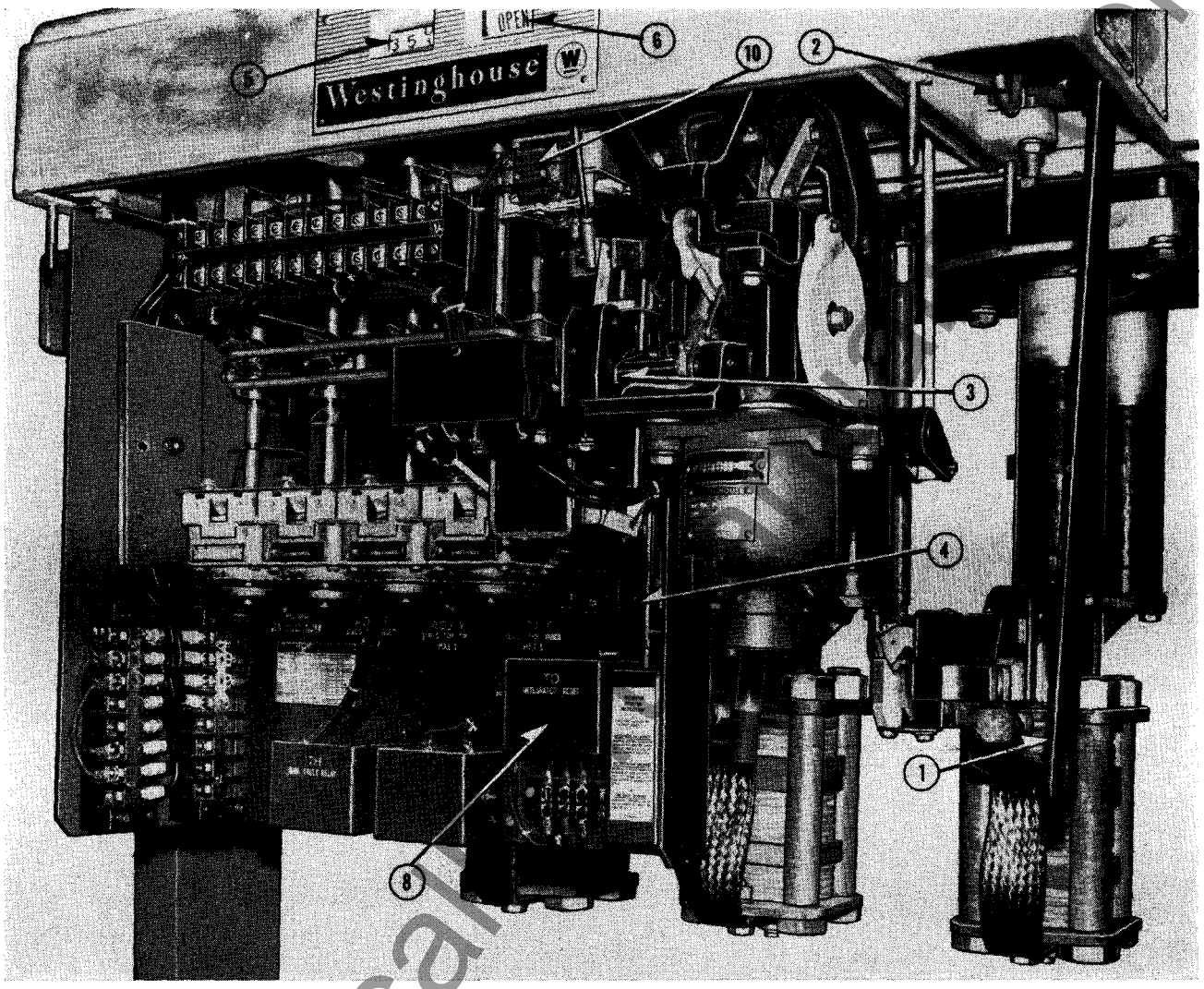


FIG. 2. Control Compartment Viewed from the Right Side

lever (1) at the right of the recloser. To trip, pull down lightly on the small "Green" lever (2). The unit can also be tripped by pressing lightly on the toggle link (3) extension just above and in front of the motor.

Each tripping operation should advance the integrator bar (4) upward one notch until it reaches the end of its travel. Each operation should also advance the counter (5) and operate the position indicator (6).

3. Connect a 240 volt, 60 cycle, single phase power source to the X_1 and Y_1 control terminals on the 12 point terminal block (7). If an auxiliary control panel is to be used, connect it to the recloser and make the operating power connections to the control panel terminals. (See connection diagram for auxiliary control panel in Part Three.

a. Operation Without Auxiliary Control. If the recloser is open, with the integrator advanced to the lockout position, it will have to be closed with the manual lever. Then, with the control circuit energized, wait approximately two minutes for the integrator to reset. The reset timer "TD" (8) will energize the reset solenoid (9) to permit the integrator rod to return to its starting position. Special timers mat be supplied for longer or shorter reset times. If the recloser is then tripped with the trip bar, it will reclose and this can be repeated until lockout occurs on the fourth operation or less depending on the setting.

b. Operation with Auxiliary Control. If the recloser is in the open position, close it electrically by means of the closing switch on the control panel. Set the non-reclosing switch "NR" on the control panel in the "Automatic" position. **The recloser will now automatically reclose if tripped by the trip bar,** the same as above. If the "NR" switch is set to "Non-automatic" the unit will not

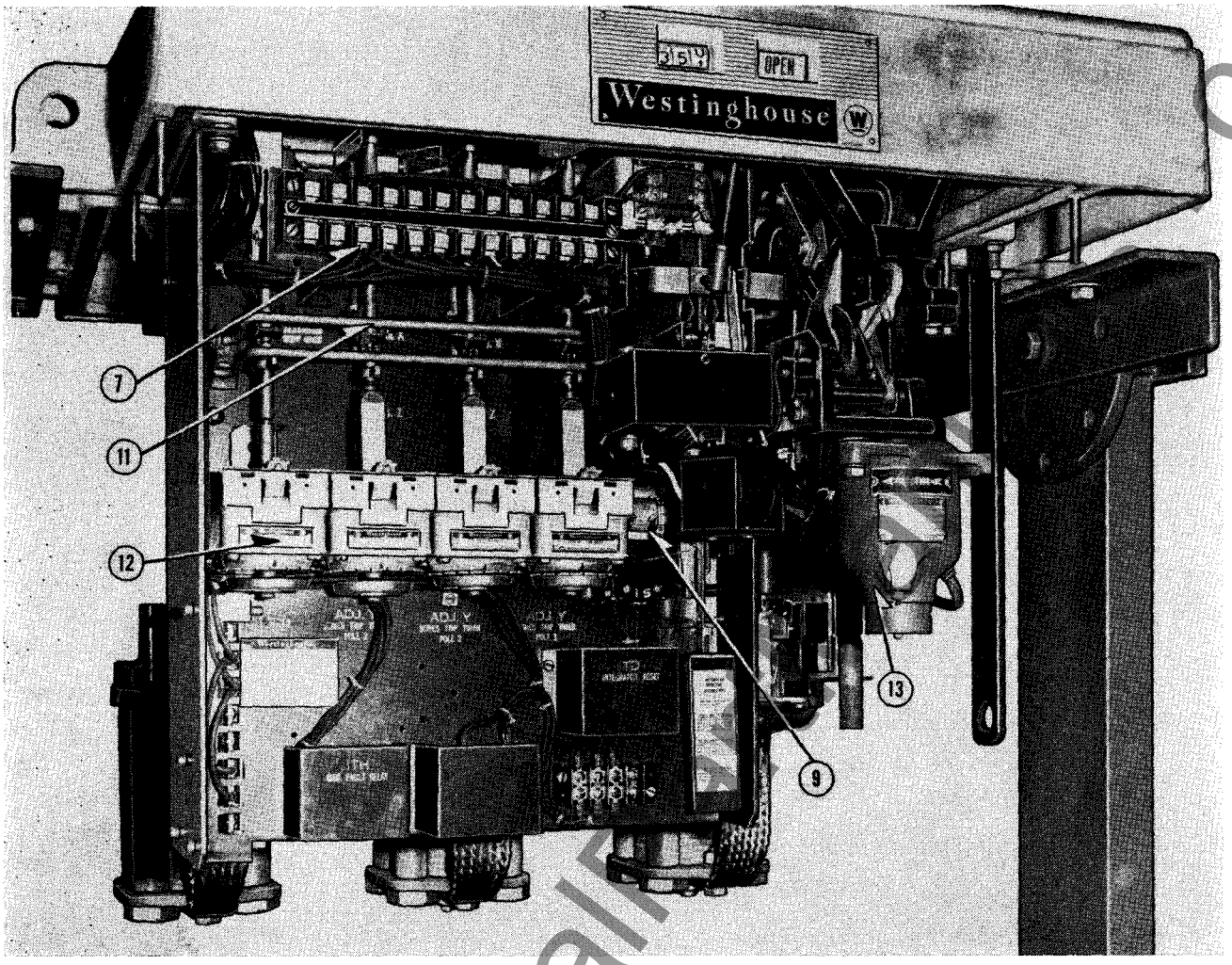


FIG. 3. Control Compartment Viewed from the Left Side

reclose. Also, if the recloser is tripped electrically from the control panel "trip" switch it will not reclose automatically.

4. Now check the standard operating controls for correct functioning as follows:

a. Integrator Reset. Trip the recloser manually and allow to stay open for one minute. Then close the unit either electrically or by hand. The integrator should reset approximately two minutes after reclosing.

b. Reclosing Timer (10). Trip the recloser and observe the time interval before it recloses automatically. This is usually two seconds, but timer may have been set slower or faster if specified. If an instantaneous reset attachment has been supplied, the first one or two reclosings will be fast, and the balance slow.

c. Number of Operations to Lockout. With the integrator completely reset, trip the recloser repeatedly by the series trip bar until it fails to automatically reclose. This may take from one to four tripping operations depending on the factor setting specified.

d. Number of Instantaneous and Time Delay Operations. The time delay release shaft (11) located above the series trip timers (12) engages the integrator at its right end. If the shaft is raised, the series trip timers are uncoupled, and an instantaneous operation occurs. If the shaft is lowered a time delay operation is obtained when the series trips are actuated by fault current. The functioning of this may be observed by repeatedly tripping the recloser and observing the action of the release shaft as the integrator is advanced.

Checks on the timing and operation of the series trips and on ground fault and other relaying attachments may be done when desired, but require more elaborate equipment. Specific instructions are contained in Part Two for the series trip timer and Part Three for accessory relays.

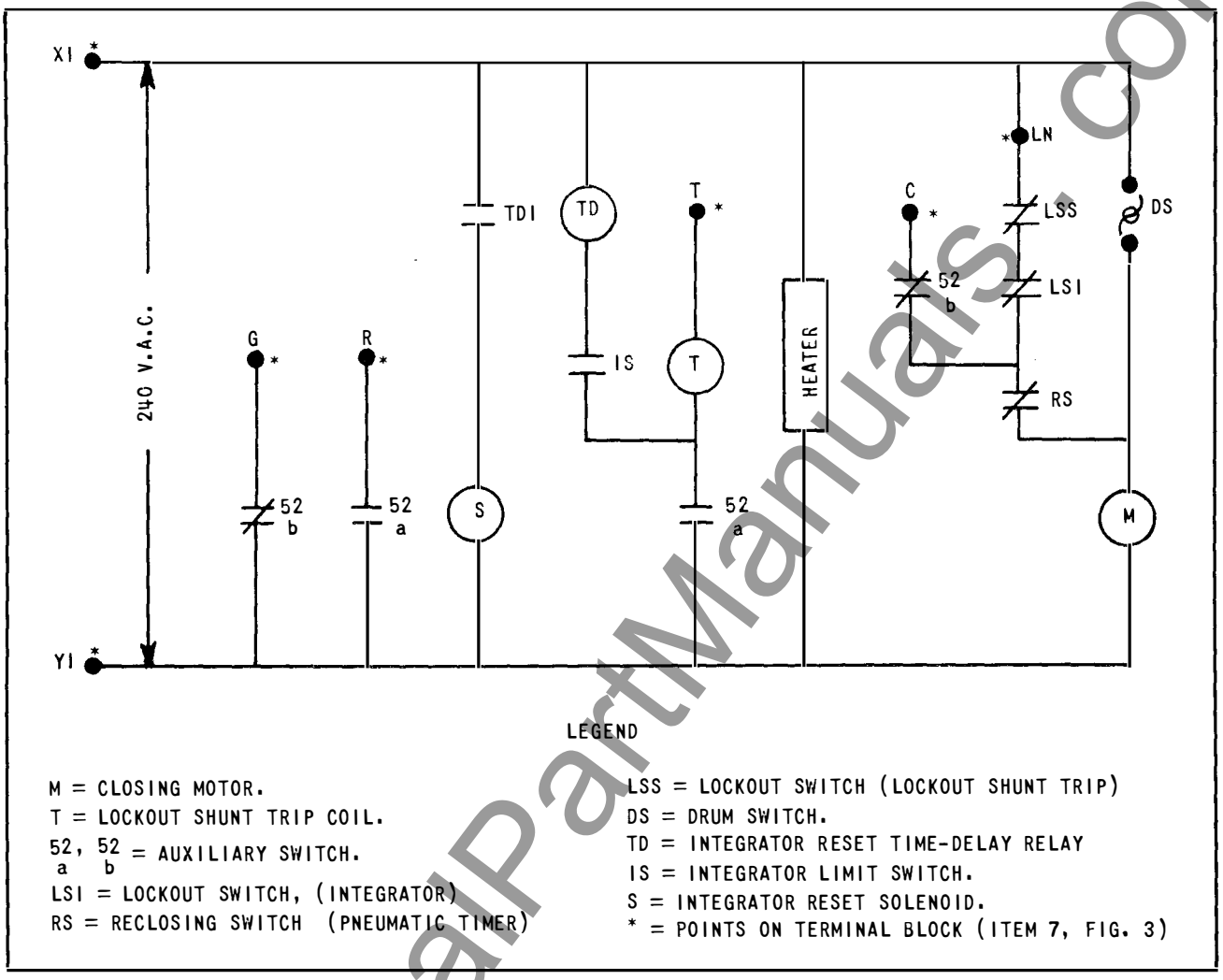


FIG. 4. Schematic Diagram

B. Recloser Mounting. The type PR recloser may be installed on a concrete pad, a platform, or pole mounted from crossarms. Suitable mounting frames are available. See enclosed D.B. 38-725 for description of standard frames.

It is important that the recloser be supported by the flanges projecting from the sides of the head casting, and securely, bolted to the support with four 5/8 inch bolts through the holes that are provided.

The recloser must be mounted reasonably level and particular note of this should be taken in the case of pole mounting.

C. Line Connections. The recloser is connected in series with the line. It may face in either direction as there is no distinction between line or load terminals.

The 400 PR recloser uses clamp type terminals that accomodate conductors from #2 to 350 MCM. The 560 PR uses a four bolt spade type terminal taking #2 to 800 MCM conductor.

A grounding terminal pad and parallel type clamp is welded to the base of the substation mounting frame, and will take #2 to #8 solid or #4 stranded conductor.

A small amount of slack should be allowed in the conductors attached to the bushing terminals in order to eliminate undue strain on the bushings.

D. Control Connections and Wiring. The basic connection and schematic diagrams for the PR recloser control circuit are shown by Figs. 4 and 5.

All control wires can be brought into the control compartment through a 1½ inch conduit entrance on the left side of the head casting. A twelve point terminal block is mounted inside the compartment, and contains the terminals for all external connections except current transformer tap leads. These are brought to separate terminal blocks when current transformers are provided.

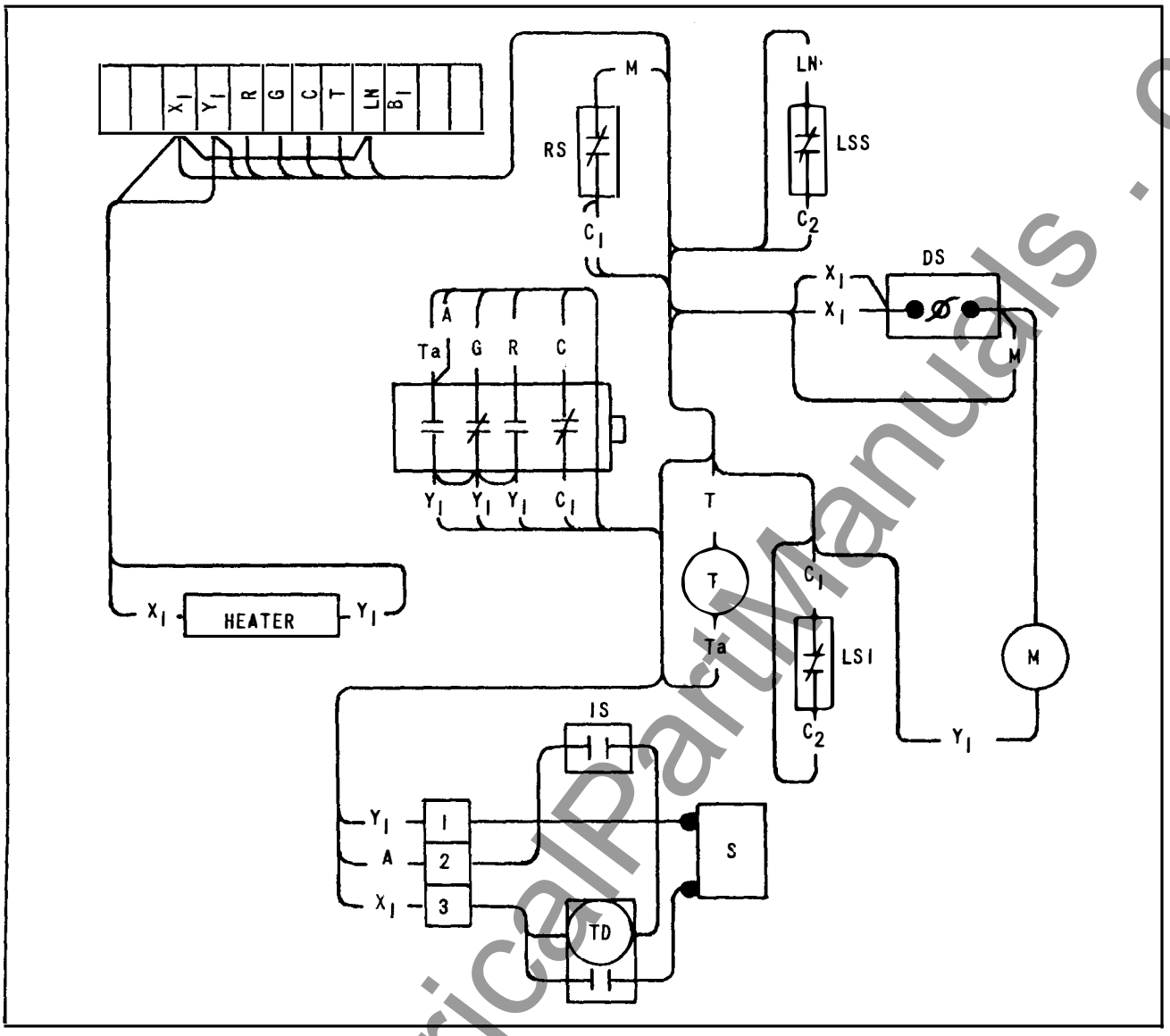


FIG. 5. Wiring Diagram

A 240 volt, 60 cycle, single phase source is required for operation of the recloser. This may be obtained from a secondary circuit on the line side of the recloser, or from an independent source. It should be capable of supplying 12 amperes without appreciable voltage drop.

The electrical connections to the control circuit should be made in accordance with the diagrams supplied for the specific recloser.

E. Final Inspection. When the recloser has been installed and all mechanical and electrical connections completed, EXCEPT ENERGIZING THE POWER LINE, the following points of inspection are recommended.

1. See that the inside of the tank and all insulating parts are clean and dry and that the tank liners are in position. **Do not** use cotton waste if any wiping is necessary.

2. See that bearings and operating mechanism are free of packing or foreign matter. Lubrication should not be required, and should be applied sparingly if at all.

3. See that the recloser is properly bolted in place and leveled.

4. Make a final check for tightness of hardware on stationary and moving contacts, shunts, lift rods, etc.

5. See that tank gaskets are in place and undamaged.

6. See that screws on bushing flanges are evenly tightened, and that terminal connections are tight.

7. Check pipe fittings for tightness.

8. Check control wiring insulation and see that connections are properly made.

F. Filling with Oil. When the inspection is complete, fill the tank with clean, dry Wemco C insulating oil to the required level, and bolt the tank firmly and evenly to the head casting, making sure that the tank lip is seated on the gasket.

Either inhibited or non-inhibited oil may be used in the recloser. The oil for the PR recloser is supplied but shipped separately in a 50 gallon drum.

The preparation and filling of outdoor apparatus with oil should be done on a clear, dry day if possible. In any case, protection must be provided against moisture and dirt.

The oil should be at about the same temperature as the tank into which it is being poured to avoid possible condensation of moisture.

Should the oil be at all questionable, dielectric strength tests should be made with a sample from the bottom of the drum.

MAINTENANCE AND STANDARD OPERATING DUTY

General Periodic Inspection. The PR recloser should be inspected completely at least once a year. The following check list is a minimum guide:

1. Inspect the bushings carefully for hairline cracks, and clean if contamination is evident.

2. Check the main and auxiliary tanks for rust and use a good grade of touch up paint if corrosion is found.

3. Open the control compartment door and inspect the control panel for loose connections.

4. The main operating tank should be removed. If the recloser has only operated a few times, the oil may be replaced without filtering. Otherwise, it should be filtered or new oil used.

5. Check the condition of the contacts by removing the moving contact for inspection. It may be removed by releasing the dowel pin from the Micarta lift rod, and lifting the contact rod from the interrupter.

If the moving contact is badly worn, it is necessary to remove the bottom casting of the interrupter for inspection of the stationary contact. However, if the moving contact is in good condition, it is a safe assumption that the stationary contacts are all right.

Caution: It is possible to dress the contacts, but do not file away good contact material unless deep pitting is evident. The contacts will carry their full rating even though somewhat mottled and uneven in appearance.

6. Check the interrupter grid plates externally for erosion of the parts. If the contacts were changed, it will usually be found necessary to change several grid plates.

7. The tank liners should be inspected carefully for breaks and cracks. If any are discovered, the liners should be replaced.

8. The operating mechanism and motor should be inspected for tightness and alignment.

9. Remove the bottom hub of the closing motor. The lock is held in place by two machine screws and covers the centrifugal over travel brake of the motor. Wipe the brake and hub clean of any oil or grease and replace the hub.

For placing the unit back in service after inspection, follow the general procedure outlined on pages 6 to 11 of this instruction book.

Standard Operating Duty. The PR reclosers are designed to provide an operating duty as set forth in ASA and NEMA Standards for Automatic Circuit Reclosers. The operating duty is determined by the maximum interrupting current rating corresponding to the frame rating as follows:

400 PR Power Class II Recloser

Current Interrupted	Number of Interruptions
600- 800 Amperes	40
1800-2200 Amperes	20
3600-4000 Amperes	12
Total Interruptions	72

560 PR Power Class III Recloser

Current Interrupted	Number of Interruptions
1200-1600 Amperes	24
3600-4400 Amperes	16
7200-8000 Amperes	12
Total Interruptions	52

When a recloser has completed an interrupting duty equivalent to the above, it should be removed from service at the earliest opportunity and serviced. It is expected that this will require at minimum, complete replacement of contacts, new oil, and replacement of all worn grid plates.

In order to insure that the recloser receives this attention when needed, a record of operations should be maintained, and a special note should be made of those interruptions at or near the maximum interrupting rating as the interrupter and contact wear is about in proportion to the current interrupted

Note: The maximum interrupting current rating for a specific recloser is determined by the series coil size. The interrupting rating is equal to 60 times the continuous current rating of the series coil, or to the maximum interrupting rating for the frame size—whichever is less.

DESCRIPTION OF COMPONENT PARTS

GENERAL

This part of the instruction book contains a detailed description of the component parts of the recloser which are supplied as standard equipment. For information regarding optional accessories, refer to Part Three.

This Part also contains detailed information for the adjustment of the series trip time-current characteristics of the PR recloser.

SERIES TRIP DEVICE

The basic tripping element of the recloser consists of three solenoids whose coils are in series with the line. Each solenoid is mounted on a bracket attached to the bottom of the bushings adjacent to the interrupter and are thus located in the main relcoser tank under oil. Refer to Fig. 6.

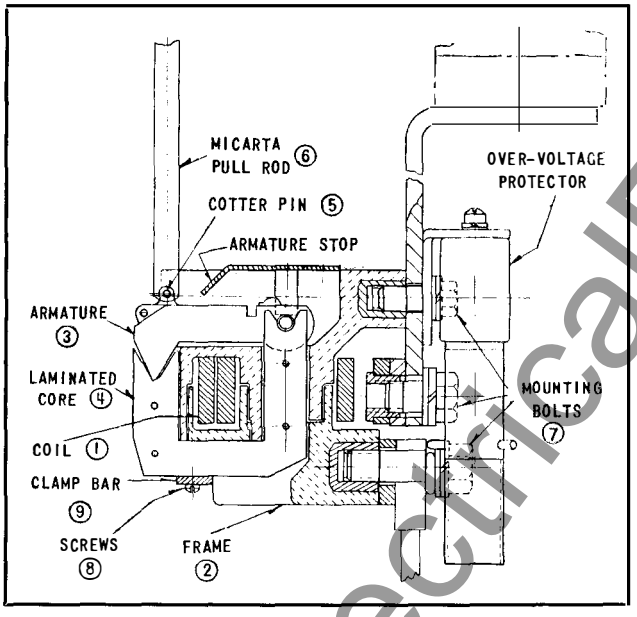


FIG. 6. Series Trip Device

The series coil, Item 1, is mounted in a moldarta frame, Item 2, which also contains the armature, Item 3, and core, Item 4. The armature is laminated and turns on bronze bushings.

The coil ratings are shown in Table 1 with identifying style numbers. The coils are mechanically interchangeable.

Procedure of Changing Coil Rating.

1. Remove the cotter pin, Item 5, which fastens the solenoid armature to the Micarta pull rod, Item 6, on Fig. 6.

2. Remove the entire coil and moldarta frame assembly by removing the three mounting bolts, Item 7.

3. Remove the two 1/4-20 filister head machine screws, Item 8. and the clamp bar, Item 9. Lift out the moldarta clamp base and the coil which is to be replaced.

4. Re-assemble the coil base using the desired replacement coil. Re-mount the frame and assembly to the mounting frame and reconnect the Micarta pull rod.

Caution: In re-assembling the series coil make sure that the armature bushings are fitted in the slotted bearings so as to be retained on the shaft by the flange.

5. After replacement of a trip coil even of the same current rating, it may be necessary to re-adjust the minimum trip current of the recloser. For this procedure check information on Adjustment of Series Trip page 17, of this instruction book.

Table 1.

AVAILABLE COIL RATINGS IN AMPERES	STYLE NUMBER
25	505D366G11
35	505D366G01
50	505D366G02
70	505D366G03
100	505D366G09
140	505D366G04
200	505D366G10
280	505D366G05
400	505D366G07
560	505D366G06

PNEUMATIC TIME DELAY UNIT FOR SERIES TRIPPING

The closing of the armature of the series trip coil is restrained for the time delay operations by a pneumatic time delay assembly shown in Fig. 7. Each series trip solenoid actuates its individual time delay unit to insure coordination on single phase faults. Each phase is calibrated to identical characteristics. The operation is as follows: Numbers in parenthesis refer to items in Fig. 7 unless otherwise designated.

When the current through the series coil exceeds the minimum trip value, the armature, Item 3, Fig. 6, exerts a downward pull on the Micarta pull rod, Item 6, Fig. 6. This pull is translated through the walking beam (7) to the timer and trip mechanism.

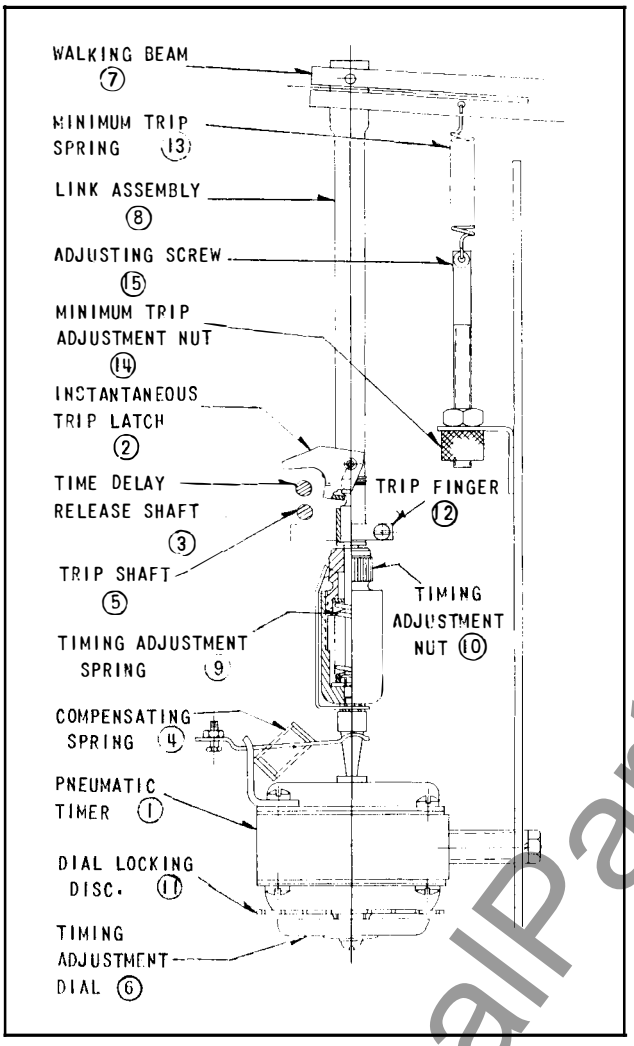


FIG. 7. Series Trip Time Delay

With the instantaneous trip latch (2) in the latched position, the link assembly, (8) acts as a solid member, exerting an upward force directly on timing adjustment spring (9). The timing adjustment spring in turn, by pushing against timing adjustment nut (10), causes the force exerted by the series solenoid to be transmitted to the diaphragm of the pneumatic timer(1). The pneumatic timer exerts a retarding force in the upward direction only. Time delay is achieved by the controlled flow of air into the timer through a valve which is operated by the timing adjustment dial, (6). The timing adjustment spring (9) being in series with the pull exerted on the time delay dashpot, will react in accordance with the magnitude of that pull. For low value of fault current, and hence, low values of exerted force, the compression spring is not appreciably deflected and the retarding motion is that exerted by the time delay dashpot alone. For higher values of current, however, the greater force will cause the compression spring to deflect thus permitting the upper portion of the linkage and trip finger (12) to move without regard for the time delay effect of the timer. Changing the initial compression of the adjustable spring changes the point at which collapse of the spring will occur in terms of fault current, thus a variation in the slope of the time current characteristic curve of the recloser can be obtained.

When the recloser main contacts open, the timer resets and the entrapped air is exhausted through a check valve.

An additional adjustment is possible by changing the position of the timing adjustment dial on the pneumatic timer. Turning the timing adjustment dial (6) to the right restricts the flow of air and increases the time delay of the device. Conversely, turning the dial to the left will permit more rapid tripping of the unit. Adjustment of the dial permits a large range in the tripping time at the lower current end of the time current curve.

Compensating spring (4) is included to insure that the minimum trip current will be the same on both instantaneous and time delay operations.

The minimum trip current is determined by the minimum trip spring (13) which restrains the movement of the walking beam (7). The tension of the spring (13) is changed by loosening the adjustment nuts (14) and raising or lowering the position of the screw (15). Increasing the spring tension increases the minimum current necessary to trip the recloser.

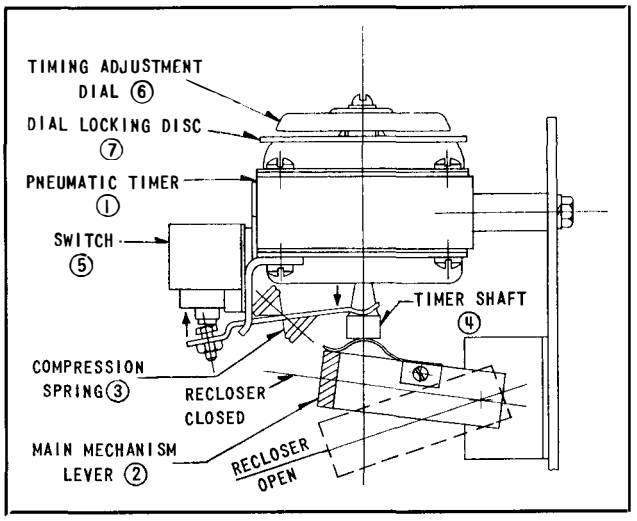


FIG. 8. Pneumatic Reclosing Timer and Switch

PNEUMATIC RECLOSING TIMER AND SWITCH

The delay between opening and subsequent reclosing operations is fixed by the pneumatic timer and switch assembly shown in Fig. 8. The timer is similar to that used for the series tripping time delay.

The timer, item 1, is controlled by movement of the main mechanism lever, item 2, which is shown with the recloser in the closed position. When the recloser opens, the lever moves away from the timer, and the compression spring, item 3, exerts a force against the time delaying mechanism of the timer. The movement of the timer shaft closes the contacts of a swith "RS" item 5, which completes the circuit to the closing motor.

The time between tripping and reclosing can be varied by means of the timing adjustment dial, item 6, which controls the orifice of the timer. Normally, the reclosing time delay is about two seconds. That is, after a series trip operation, two seconds will elapse before the unit will automatically reclose. If it is desired to change this reclosing time in the field, the locking disc, item 7, should be loosened, and the timing adjustment dial turned to the right to decrease the time or turned to the left to increase the time. Be sure to tighten the locking disc after making the adjustment.

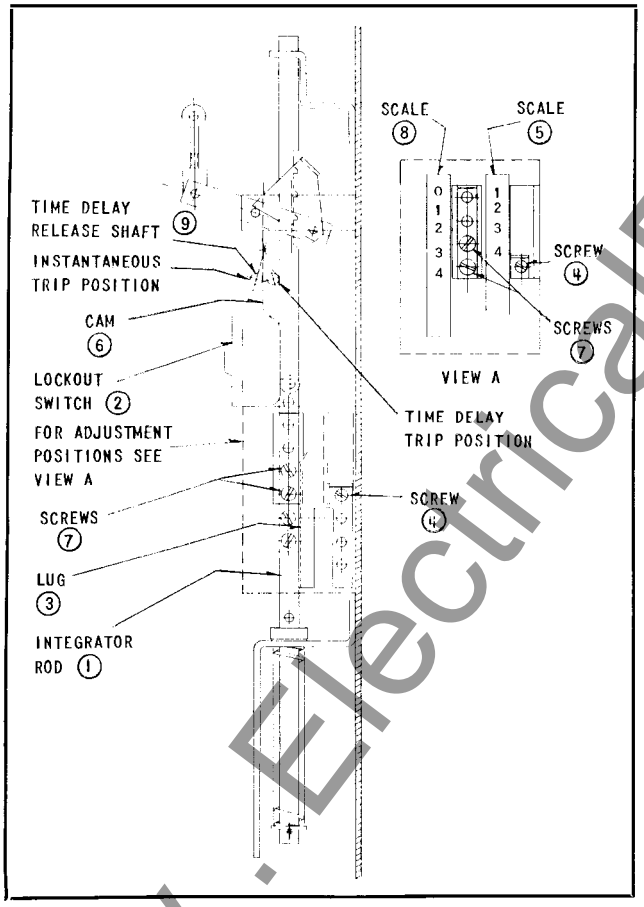


FIG. 9. Integrator and Lockout Switch

INTEGRATOR AND LOCKOUT SWITCH

The lockout integrator is a mechanically operated, electrically reset rod which counts the operations of the recloser. Refer to Fig. 9, to identify parts and determine operating sequence. Each opening operation of the recloser advances the lockout integrator rod, Item 1, one step. After a selected number of operations on a permanent fault, the lockout integrator is advanced sufficiently to operate the lockout switch "LSI" Item 2. This limit switch opens the circuit to the closing motor preventing automatic reclosing of the contacts, and effectively locking the recloser in the open position. The recloser may be closed after lockout by manually operating the closing handle, or by energizing the closing motor through an external control switch.

Resetting of the integrator mechanism is prevented mechanically until the main contacts of the recloser are in the closed position. During the closing cycle—after lockout—the integrator remains in a position corresponding to the operation preceding lockout. This means that the operation following lockout will be one time delayed operation, if the fault still persists. In addition, the recloser will over-ride high inrush currents which may result from a prolonged outage.

The number of operations to lockout can be varied by changing the position of the lug, item 3. When changing the number of operations to lockout, the integrator must be in the fully reset position. Remove the screw, item 4, which holds the lug to the integrator rod. This screw can be removed through the rear window in the right side of the control panel. Reposition the lug with the index opposite the desired number of operations as indicated on the scale, item 5, alongside the window.

The integrator rod also determines the sequence and number of instantaneous and time delay openings. The adjustable cam, Item 6, controls the position of the time delay release shaft, Item 9. As the integrator notches up, the release shaft will ride the cam. After the cam passes the release shaft position, the shaft moves and drops the instantaneous trip latch, Item 2, Fig. 7 to the latched position which engages the pneumatic timer. After this occurs any operation of the recloser will be a time delayed operation.

The number of instantaneous and time delay operations can be varied by changing the position of the cam. To change the position of the cam, remove the screw, Item 7, holding it to the integrator rod. These screws can be removed through the front window on the right side of the control panel. Reposition the cam with the index opposite the desired number of instantaneous operations as indicated on the scale, Item 8, alongside the window. This adjustment must be made with the integrator in the fully reset position.

CURRENT INTERRUPTERS

The interrupters used on the PR recloser are heavy, grid plate interrupters utilizing the basic Westinghouse De-ion flow method of interruption. As is shown in Fig. 10, a total of 21 vulcanized fibre plates are used in the interrupter stack. Heavy brass castings and steel plates serve as top and bottom plates respectively. Special high strength, fibre tie

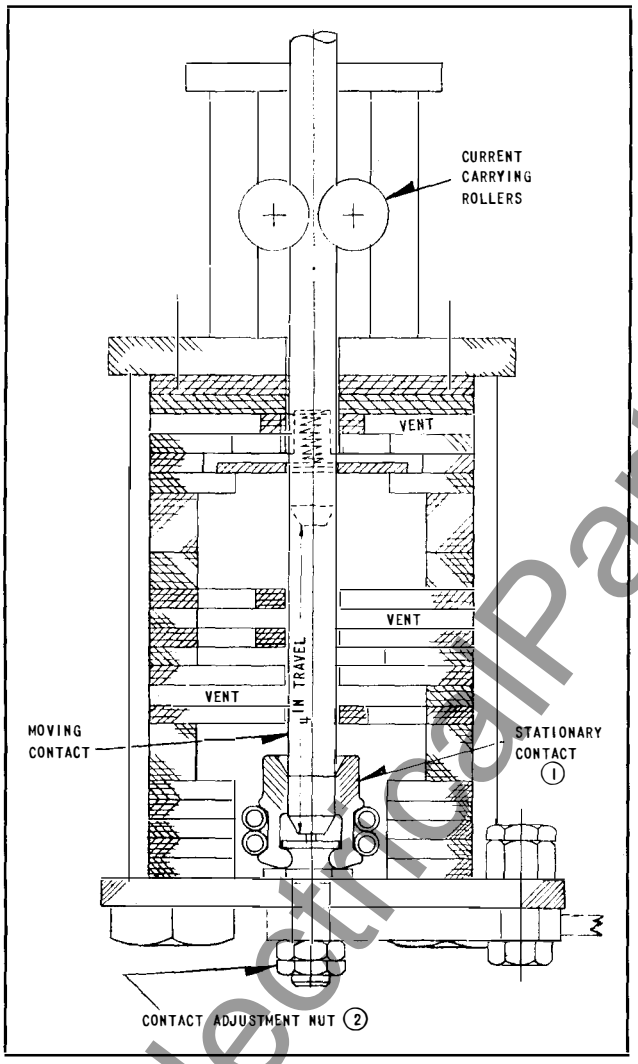


FIG. 10. Current Interrupter

rods hold the interrupter together in a compact unit. The stationary contact in each pole is a self-aligning nest of spring biased tulip contacts. Current is carried up the moving contact or contact rod through non-arc, spring biased rollers and thence to the other bushing of the recloser.

As the moving contact rod is withdrawn from the stationary contact assembly, the arc energy begins to vaporize some of the oil in the lower well surrounding the stationary contacts. As the moving contact retreats past the first vent, gas pressure generated in the lower well exerts a blast effect which, by means of the channel provided, tends to blow the arc out the vent and extinguish it as the gasses are expelled. Most circuit interruptions occur at this point in the operation. The moving contact continues to rise and should the arc persist, a second radial flow serves to extinguish the arc at the top vent. The biased seal, is designed to permit flow of fresh oil into the interrupter. Further, should the arcing under unusual conditions persist until the moving contact had completed or nearly completed its full travel, the oil in the top well would vaporize and expand causing a longitudinal flow down the length of the arc and out through the vents provided.

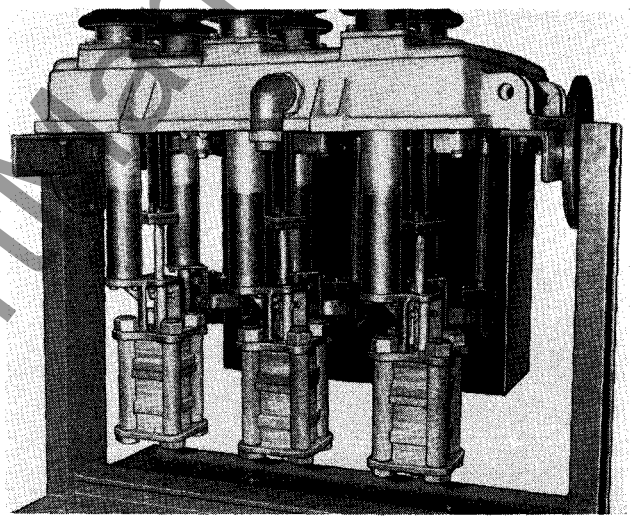


FIG. 11. Current Interrupters and Series Trip Coils

The entire stationary contact assembly, item 1, can be adjusted as a unit, by loosening the nut, item 2, and turning the stud extension by means of the slotted end. Proper adjustment procedure is as follows.

1. With recloser in closed position, turn stud to right with screw driver until moving contact rod bottoms in stationary contact assembly.
2. Back stationary contact assembly off by turning stud to left two turns. This will properly position the current carrying portions.
3. Replace locking nuts on stud.

The location of the three interrupters in the PR tank is shown in Fig. 11.

INTEGRATOR RESET TIMER AND SWITCH

If the recloser operates and does not lockout, or if reclosed manually after lockout, the integrator rod is left in an advanced position. Resetting of the integrator is accomplished by action of a timer and resetting solenoid.

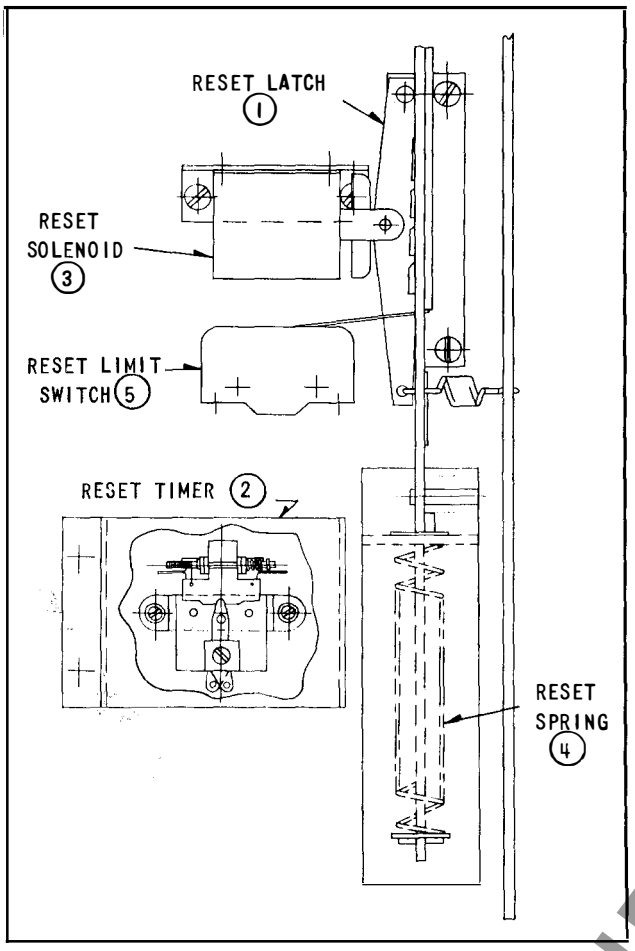


FIG. 12. Integrator Reset Components

As the integrator rod is stepped upward by action of the main mechanism it is held in position by a spring biased latch, item 1, on Fig. 12. The timer "TD" item 2, is energized by an "a" auxiliary contact of the recloser each time the unit is in the closed position. After a two minute time delay, the timer contacts close and energize the reset solenoids item 3. The solenoid releases the latch and allows the action of the reset spring, item 4, to restore the integrator rod to normal reset position.

Both the reset solenoid and timer are de-energized by a limit switch, item 5, which is operated by the travel of the integrator rod. The contacts of this switch are designated as "IS" on the control diagram, Fig. 4, page 9.

LOCKOUT SHUNT TRIP DEVICE

The lockout shunt trip coil "T" item 1, Fig. 13, is located to the left of the recloser closing motor, under the auxiliary switch. When energized through a remote contact, the lockout shunt trip coil trips the recloser directly by engaging the trip latch, item 2, with the shunt trip rod, item 3. At the same time, the lockout switch item 4, is operated which opens its

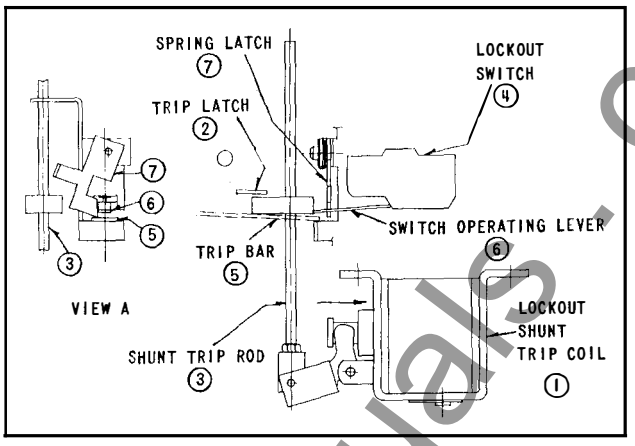


FIG. 13. Lockout Shunt Trip Device

contacts designated "LSS", and prevents the closing motor from being energized.

The lockout switch is opened when the shunt trip rod, item 3, releases the spring biased latch, item 7, as shown on view A.

The lockout switch remains open until a subsequent manual or remote control closing operation resets it. At that time, item 6, is raised by the operating lever of the auxiliary switch, which allows the latch, item 7, to reset and hold the switch closed and permit automatic reclosing. The switch will remain closed until a subsequent tripping through the lockout shunt trip coil, which will release the latch.

Tripping the recloser manually with the operating handle will result in the same operation as described above.

AUXILIARY SWITCH

The auxiliary switch is a mechanically driven rotary type switch equipped with four sets of contacts. Refer to Fig. 14. It is mounted to the left of the operating mechanism. Two of these contacts are normally open and the other two normally closed. Two of the contacts, one normally opened and one normally closed, are utilized in the operation of the recloser. The remaining two contacts are ordinarily used for red and green indicating light operation. This set of contacts may be used for other purposes if desired. The normally open or normally closed setting of the contacts is adjustable. The contacts can be set in the factory, per special instructions, or may be adjusted in the field. The contacts will carry 15 amperes continuously or 250 amperes for 3 seconds. Information on the interrupting ability of the contacts is contained in Table 2.

An additional 4 point auxiliary switch is available upon special order. The additional switch mounts atop the standard switch and can be adjusted for any combination of normally opened, or normally closed contacts requested.

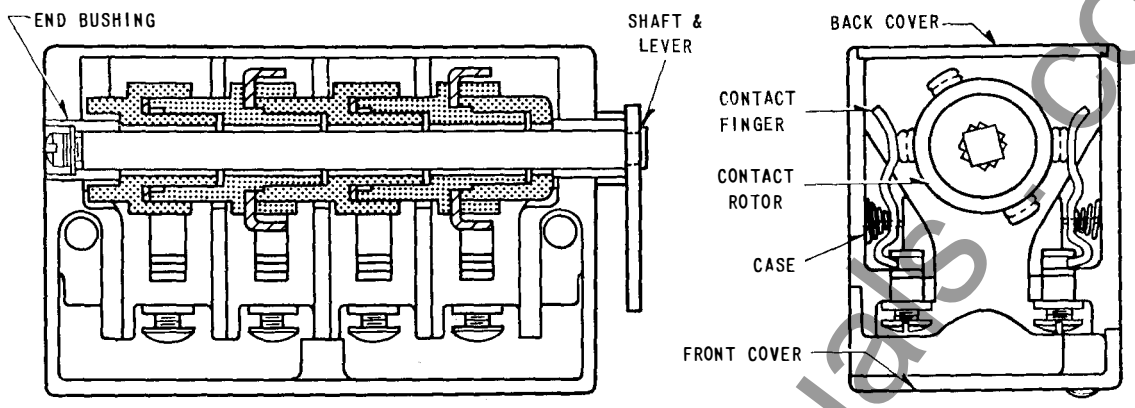


Table 2. Interrupting Capacity

VOLTS	INTERRUPTING CAPACITY IN AMPERES	
	Non-Inductive Circuit	Inductive Circuit
125 V. D-C	11	6.25
250 V. D-C	2	1.75
115 V. A-C	75	15
450 V. A-C	25	5

FIG. 14. Auxiliary Switch

CLOSING MOTOR AND OPERATING LINKAGE

The closing motor, item 13, Fig. 3, is a single phase commutator type, vertical shaft motor with ball bearings sealed with lubricant for the life of the motor. A single reduction of speed between the motor and the mechanism crank is accomplished by a worm gear mounted directly on the upper end of the motor shaft.

An oil seal on the motor shaft between the motor and the gear assembly prevents any oil or grease from running down the shaft into the motor. Since continuous operation of the closing mechanism is not required for any extended length of time, the motor is wound to develop an exceptionally high torque for its size and if operated too frequently for test purposes, may become overheated. A maximum of 25 consecutive operations may be applied without damaging the motor.

ADJUSTMENT OF SERIES TRIP TIME CURRENT CHARACTERISTICS

General. The time current characteristics of the PR recloser are set at the factory according to customer specifications. The characteristic curve of each recloser, as shipped, is included as a separate drawing with the instruction book.

The characteristic curve of any PR recloser can be altered in the field if necessary. The range through which the curve can be adjusted is shown in Fig. 15. The three adjustments are defined as follows.

X—Adjustment of minimum tripping current-obtained by varying the tension of the minimum trip spring item 14, Fig. 7.

Y—Tripping time at low currents—obtained by adjustment of the needle valve in the series trip timer, item 6, Fig. 7.

Z—Tripping time at high currents—obtained by varying the tension of the timing adjustment spring, item 9, Fig. 7.

Equipment Required. Before attempting to change the characteristic curve of the PR recloser, make sure the following equipment is available. Refer to Fig. 16 for connections.

1. An adjustable high current source with sufficient capacity to provide a stable current of ten to fifteen times the coil rating of the unit to be tested.

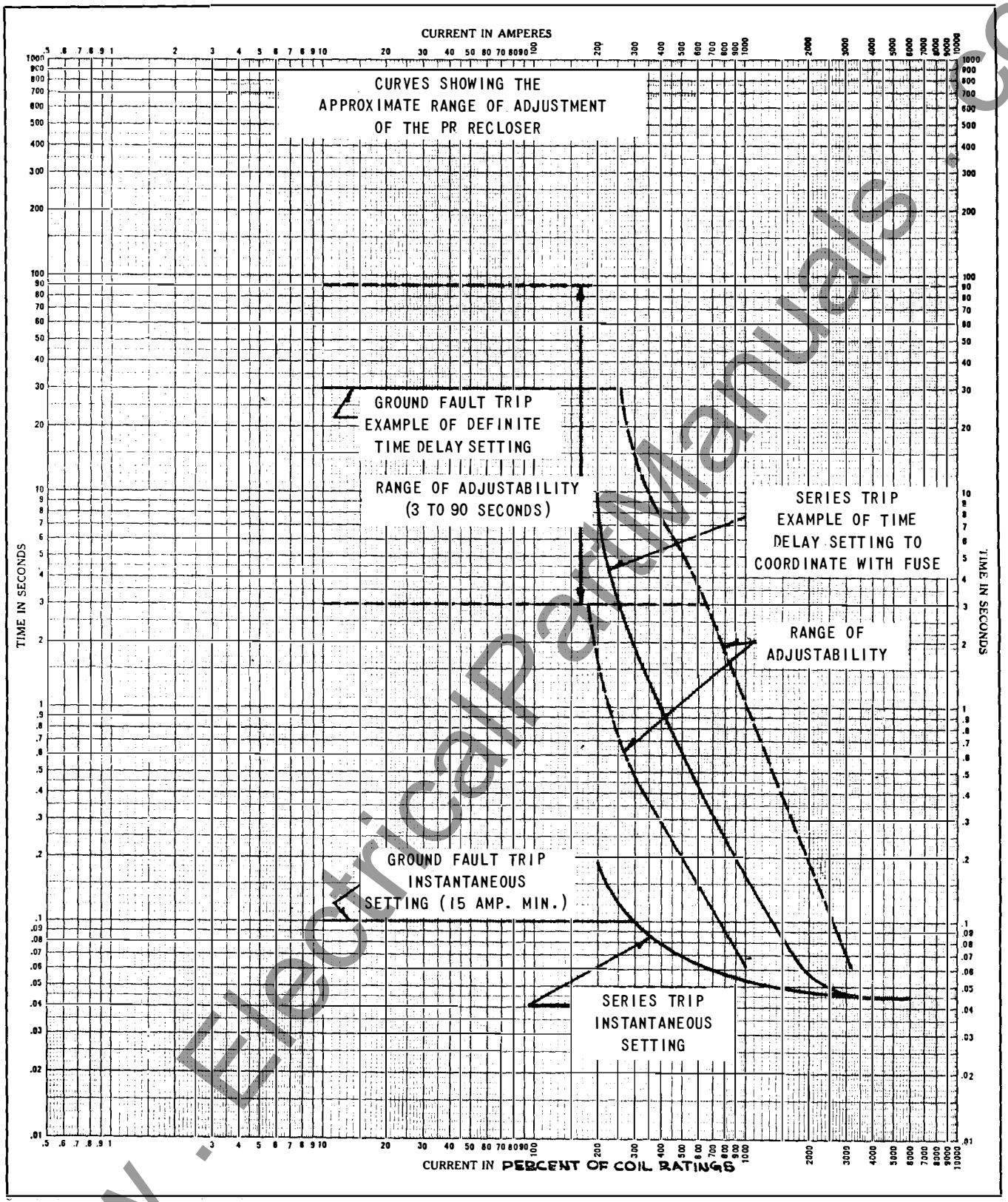


FIG. 15. Time-Current Characteristics Curves

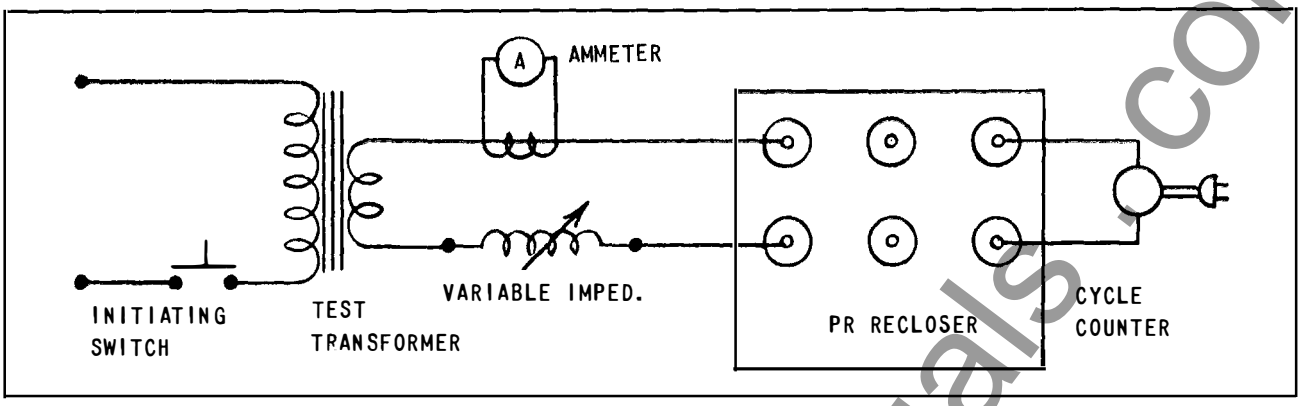


FIG. 16. Typical Test Set-up

Whether the current source has sufficient capacity is a function of the load impedance—in this case the recloser series trip coil impedance. It can be calculated approximately for any coil rating from the following formula:

$$Z_{coil} = \frac{K}{(I)^2}$$

where K is a constant equal to 75, I is the continuous current rating of the coil.

2. Suitable ammeters and cycle counter.

Note: The Multi-Amp tester is a self-contained current source and measuring device, and is satisfactory for testing and adjusting the PR recloser. Table 3 shows suitable Multi-Amp. ratings.

Table 3.

COIL SIZE AMPERES	SOURCE CAPABILITY AMPERES	MULTI-AMP RATING
25	250	7.5 KVA
35	350	7.5 KVA
50	500	7.5 KVA
70	700	7.5 KVA
100	1000	7.5 KVA
140	1400	15 KVA
200	2000	15 KVA
280	2800	15 KVA
400	4000	45 KVA
560	4500	45 KVA

DETERMINATION OF DESIRED TIME-CURRENT CHARACTERISTICS

From system protective devices characteristics with which the PR recloser must coordinate, obtain the limits within which the recloser time current curve must fall.

Using the average of these limits construct a guide curve as follows:

1. Determine the minimum tripping current. Draw a vertical line on a standard sheet of curve paper at that current.

2. Select the desired tripping time at a current about 25% above the minimum tripping current and plot this point on the curve. (This point must be within the indicated range of the Y adjustment).

Through this point draw a curve similar in shape to the curves at low currents and parallel to them. Blend the upper portion of this curve into the vertical line representing minimum pick up of the recloser.

3. To complete the curve, select an appropriate point (from coordination limits) on the base line within the limits of the Z adjustment. Through this point draw a straight line parallel to the curves at high current. This line should intersect the curve drawn in Step 2.

Blend the intersections of the two curves and the straight line and base line together smoothly to form one continuous curve.

Any curve attained in the above manner should be used as a guide in setting the adjustments on the recloser. Do not expect to attain this exact curve since it is only a generalized shape. The final criteria is to compare the curve obtained, **after making adjustments**, with the coordination limits determined from system conditions.

One caution to be observed in sketching a guide curve is the advisability of staying as close to the center of the adjustment ranges as possible—on at least two of the three adjustment points. It is suggested that the limits of adjustment be traced from Fig. 15 onto the curve sheet on which the desired curve is drawn.

GENERAL INSTRUCTIONS— TO BE OBSERVED BEFORE MAKING ADJUSTMENTS

1. The recloser should be tanked, full of oil, and the tank bolts should be tight.

2. All adjustments must be repeated for each phase.

3. If the recloser is equipped with ground trip assembly, short the current transformer secondaires

before proceeding with test. This will prevent tripping the unit by residual current when the testing current is applied.

4. Disconnect integrator reset timer coil "TD" by removing lead from point 3 of terminal block in integrator reset assembly. This will prevent overheating and wear on reset timer while making adjustments.

5. If the recloser does not have an auxiliary control cabinet, connect a single pole, single throw switch to terminals X1 and C on the 12 point terminal block, item 7, Fig. 3. This will allow closing of unit after integrator has gone to lockout without waiting or forcing integrator reset.

6. If the recloser does not have an auxiliary control cabinet, connect 240 volt 60 cycle single phase source to X_1 and Y_1 and a jumper from LN to X_1 on terminal block, item 7, Fig. 3.

7. If the recloser is equipped with an auxiliary control cabinet, connect a 240 volt 60 cycle single phase source to X and Y on the terminal block in the auxiliary control cabinet.

PROCEDURE FOR ADJUSTING PR RECLOSER SERIES TRIP TIMERS

A. "X" Adjustment—Minimum Pick-Up Current.

1. Block time delay release shaft up so that all operations will be instantaneous. See Fig. 17 for suggested method.

2. Loosen minimum trip lock nut and rotate minimum trip adjusting nut to vary tension of minimum trip spring. If minimum trip current is to be raised, increase tension on spring, and if it is to be lowered, reduce spring tension.

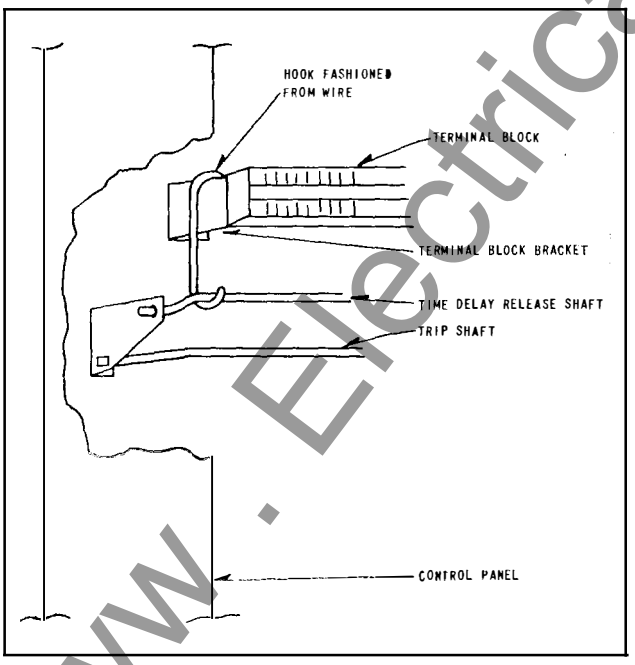


FIG. 17. Suggested Method of Holding the Time Delay Release Shaft while Adjusting Minimum Trip

3. Apply current to recloser increasing the magnitude gradually until recloser trips. Re-adjust spring tension until desired minimum tripping current is obtained.

4. Tighten lock nut to secure setting.

5. Unblock time delay release shaft before proceeding.

B. "Y" Adjustment—Tripping Time at Low Currents.

1. To establish the first point on the curve, we recommend a current setting at about 125% of minimum trip current. The curve at this point is flatter and consistent times will occur for any given current. (Do not expect consistent time of tripping at currents near minimum trip since the curve is nearly vertical at this point and actual tripping time is indeterminate).

Caution: To set current source to current above minimum trip of relcoser, energize source with recloser in circuit and hold down walking beam, Item 7, Fig. 7, with hand to keep recloser from tripping while setting current. We recommend de-energizing control voltage while setting current source for safety reasons.

2. Energize recloser and observe tripping time at this current. If adjustment is needed, vary the position of the timing adjustment dial on the series trip timer. Turning the dial to the right will increase tripping time at a given current.

As the desired time is approached tighten the locking disc at each point before checking time. Check final time with dial secured by the locking disc.

C. "Z" Adjustment—Tripping Time at High Currents.

1. Set current source at a current ten to fifteen times coil rating.

Caution: The unit must be prevented from tripping by holding down the walking beam as discussed previously. At these high currents, care should be taken that the recloser is not energized for more than four seconds at any one time. This is to prevent overheating of series components such as the series trip coil and bushings.

2. Energize recloser and adjust to desired time by rotating knurled nut. Rotating knurled nut to left will increase time of tripping and rotating to right will decrease time.

D. Development of Actual Recloser Time Current Curve.

1. Check minimum pick-up of recloser and plot as vertical line on curve sheet.

2. Set current source for several intermediate points such as 300, 500, 1000 percent of coil ratings. Plot these points and sketch in curve.

3. Determine if this curve meets coordination limits as originally determined from system operating conditions. If further adjustment must be made proceed as outlined in Steps A, B and C.

4. When satisfactory curve is obtained, reconnect reset timer coil and prepare recloser for service as outlined in Part I of the Instruction Book.

PART THREE

OPTIONAL ACCESSORIES FOR PR RECLOSERS

GENERAL

This part of the instruction book contains detailed description and adjustment information on optional accessories that may be purchased with the PR recloser. The recloser may or may not contain one or more of the accessories herein described.

The ground trip assembly consists of the three auxiliaries, the ground trip relay and timer, the bushing current transformers, and the reclosing shunt trip device. Any one of these three might appear separately for use with other auxiliary equipment.

Ground Trip Relay and Timer. The ground trip relay is a Westinghouse ITH instantaneous overcurrent relay mounted on the panel in the control compartment. It operates on residual current, and therefore, it must be used in conjunction with three bushing current transformers mounted internally. It would be possible to obtain a residual current from external current transformers if the transformer leads did not add excessive burden to the transformer.

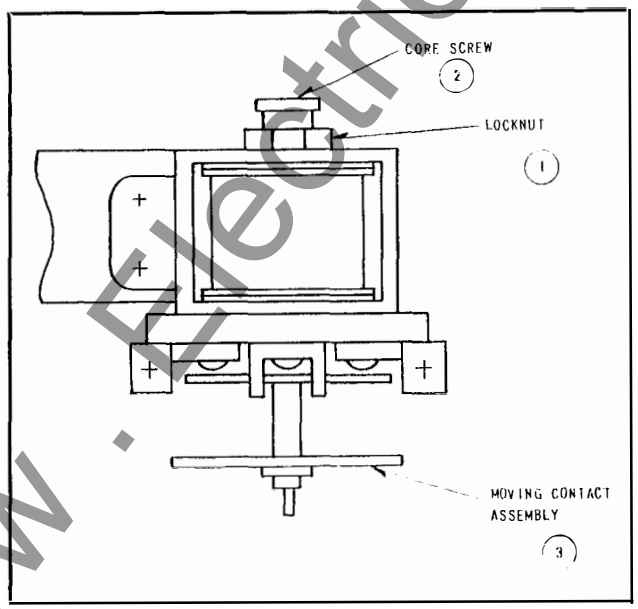


FIG. 18. Ground Trip Relay

The relay has a variable pick up, and by adjusting the pick up, the minimum ground trip current of the recloser can be changed. Fig. 18 is a sketch of the relay and method of mounting. The pick up is varied by loosening the nut, Item 1, and changing the position of the core screw, Item 2. Turning the core screw in will decrease the pick up current and backing it out will increase the pick up. The sensitivity may be increased by adjusting the moving contact assembly, Item 3. All desired pick up settings must be checked with a low current source.

Since the ground trip relay operates through bushing current transformers, the overall sensitivity will be a function of the BCT saturation characteristics and relay burden. The curves shown in Fig. 19 can be used to determine the proper setting of the ground relay for a desired ground fault sensitivity based on the various BCT taps.

The contacts of the ITH relay, when this scheme is used for ground tripping, energize the reclosing shunt trip coil described later. If instantaneous tripping is required for all four operations of the recloser, the reclosing shunt trip device operates directly on the tripping lever. If time delay is required, a pneumatic timer is installed on the panel which is operated by the shunt trip coil to trip the recloser. The adjustments, calibration, and operation of this timer are described under a previous section on Pneumatic Time Delay Unit for Series Tripping Page 12.

Bushing Current Transformers. Standard bushing current transformers can be mounted on the condenser bushings. Two 600/5 or one 600/5 and one 1200/5 multi-ratio current transformers can be supplied on the bushings nearest the control cabinet. (Bushings 1-3-5).

The bushing current transformer tap connections are brought to a separate terminal board in the control compartment of the recloser. See Fig. 20 for wiring directions. To change the ratio, use the shorting device on the terminal block and select the proper connection from Table 4.

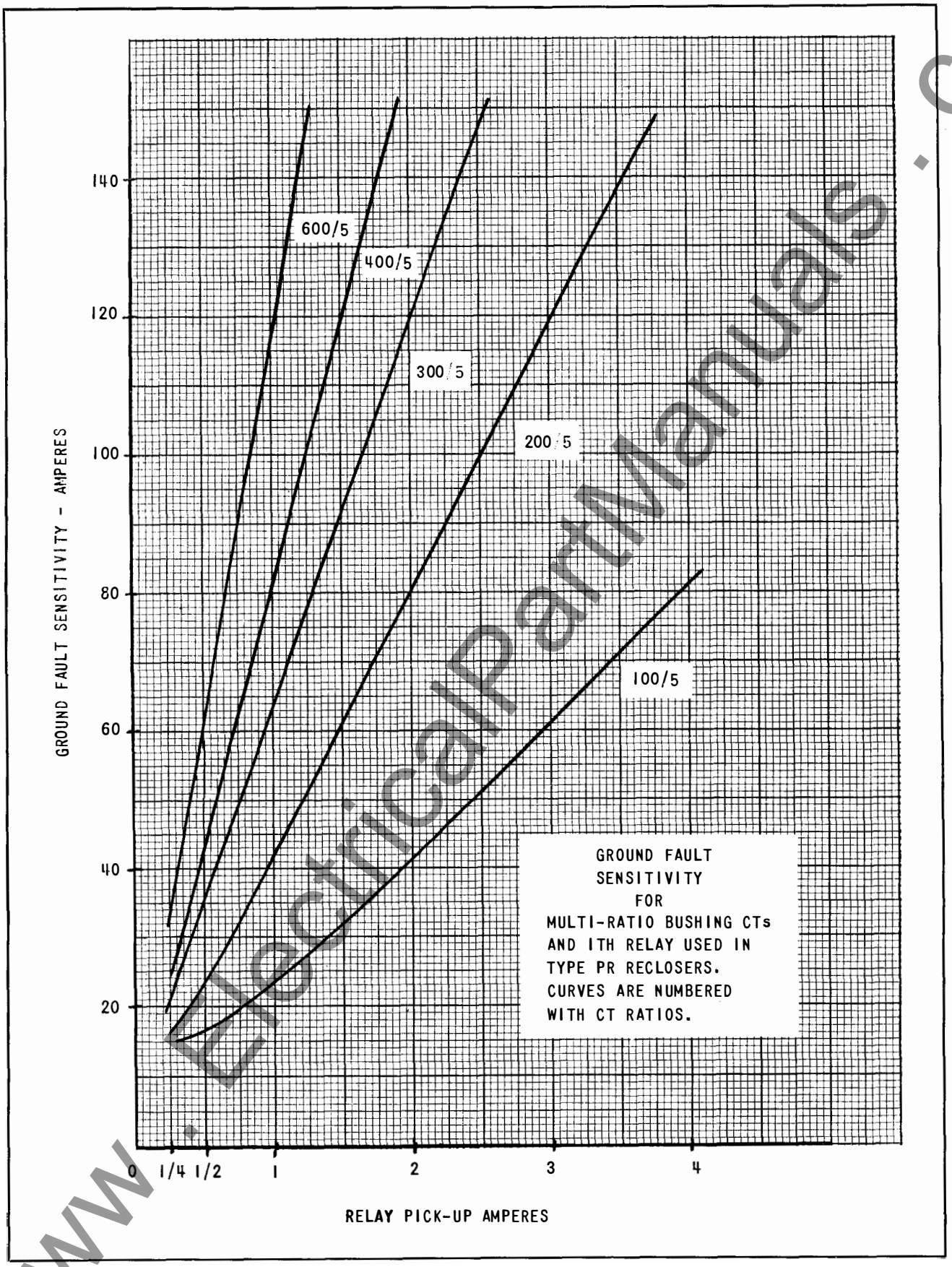


FIG. 19. Ground Fault Sensitivity

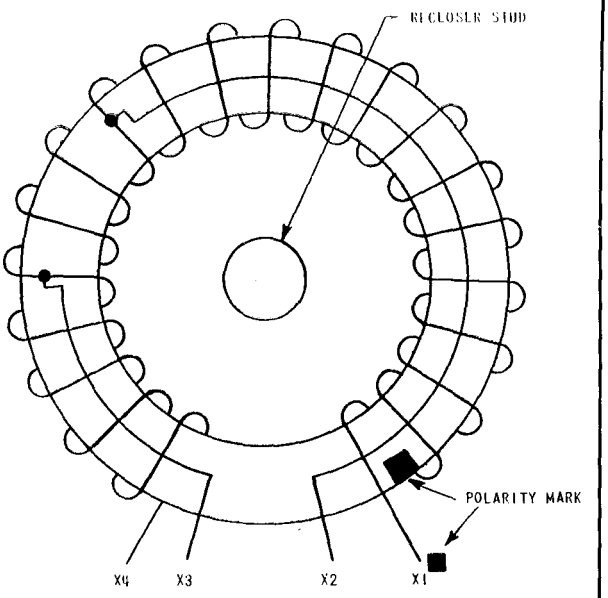


Table 4.

TRANS TURNS RATIO	TRANS MARKED RATIO	TRANS SEC TAPS
20/1	100/5	X1-X2
40/1	200/5	X3-X4
60/1	300/5	X2-X3
80/1	400/5	X1-X3
120/1	600/5	X1-X4

FIG. 20. Current Transformer Connections

Bushing Current Transformer Performance Data. ASA relaying accuracy class 10L100.

Short time thermal rating—90 times rated current for one second.

Short time mechanical rating—180 times rated current-momentary.

Typical excitation curves for the 600/5 unit with standard ratios are shown on Fig. 21. Refer to Table 5 for secondary resistance Figures.

Reclosing Shunt Trip Device. The reclosing shunt trip device is mounted on the panel in the control cabinet above and to the left of the series trip time delay units. It trips the recloser by activating the same trip shaft as the series trip coils through their pneumatic time delay units. Therefore, when the recloser is tripped from the reclosing shunt trip device, it will automatically reclose and go through its predetermined sequence to lockout. Fig. 22 indicates the physical position of the reclosing shunt trip device, Item 1, and Fig. 25, the electrical schematic where its coil is designated as TST.

The operating voltage of the coil, Item 1 on Fig. 22 is 240 volts a-c. The assembly may be removed by dis-engaging the guide spring, Item 4, and taking out the two bolts which hold the device to the control panel.

Auxiliary Control Cabinet. The auxiliary control panel in a weatherproof cabinet for remote control of the recloser is illustrated in Fig. 23.

Included in the auxiliary cabinet are two Westinghouse quick-lag breakers for control circuit protection, (item 1), a control switch, (item 2) for remote closing and tripping of the recloser, red and green operating lights, (item 3 and 4), a toggle switch, "NR" (item 5) for blocking the "RS" reclosing switch, and a by-pass switch "B" (item 6) for de-activating the ground tripping relay. The control switch trips the recloser through the lockout shunt trip device.

The cabinet has a 1½ inch conduit connector for interconnections between the control cabinet and the recloser. Source wires can be brought into the control cabinet through standard knockouts on the bottom of the cabinet. If the auxiliary control cabinet is mounted on a substation frame, the source circuits can be brought in through the 1½ inch conduit connector.

The schematic and wiring diagram for the PR recloser supplied with an auxiliary control cabinet is shown on Fig. 26.

Thermal Ampere Demand Meters. When a recloser is supplied with thermal demand ammeters, they are mounted on the substation frame as shown in Fig. 27.

Demand meters applied in this manner are supplied energy from the bushing current transformers in the PR recloser. We do not suggest using these meters for revenue purposes. Description and ratings available are listed in D.B. 38-725.

Instantaneous Reclosing Attachement. If instantaneous reclosing is desired, an additional snap acting switch is supplied with its contacts connected to short the RS contacts for the desired number of instantaneous operations.

When the desired number of instantaneous reclosing operations is reached (usually one) the integrator releases the snap acting switch, and the RS contact functions to reclose the unit through the action of the reclosing timer. A sketch of the location of the instantaneous reclosing attachment is shown in Fig. 24.

Table 5.

CURRENT RATIO	TURNS RATIO	SECONDARY RES OHMS
600/5	120/1	0.190
400/5	80/1	0.127
300/5	60/1	0.095
200/5	40/1	0.063
100/5	20/1	0.031

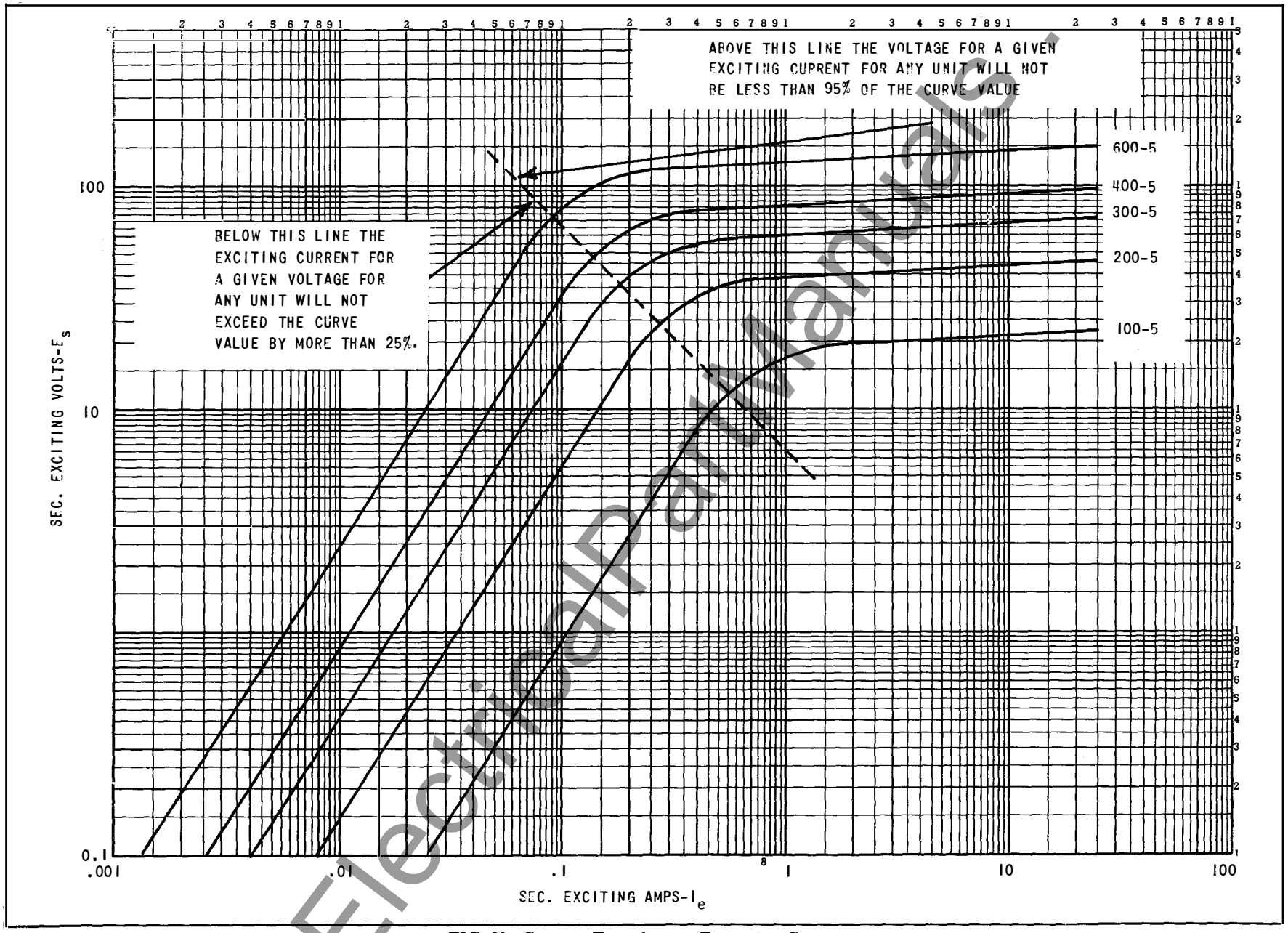


FIG. 21. Current Transformer Excitation Curves

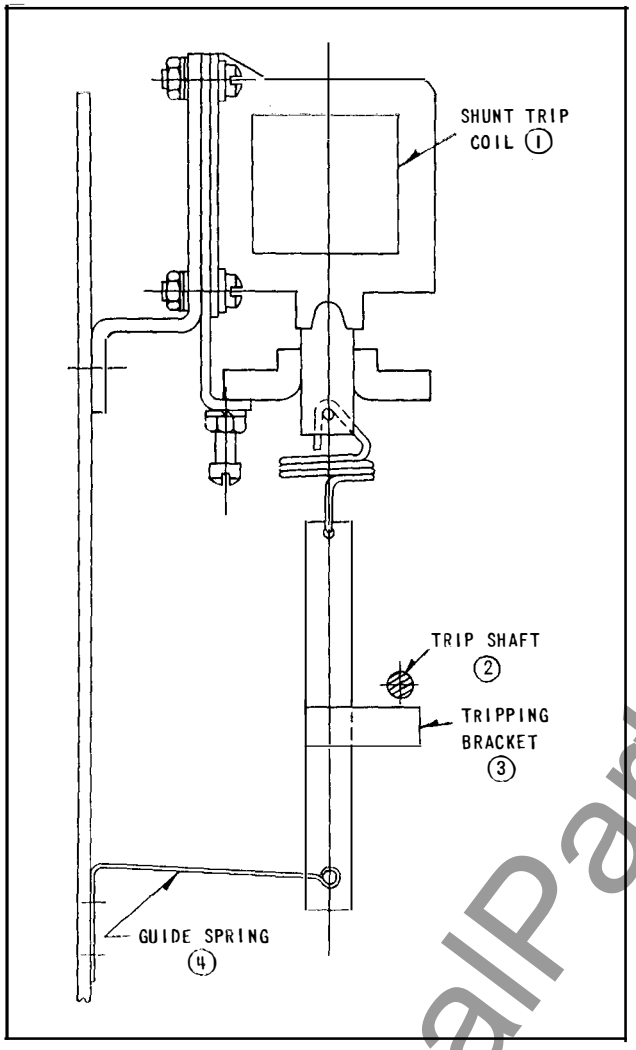


FIG. 22. Reclosing Shunt Trip Device

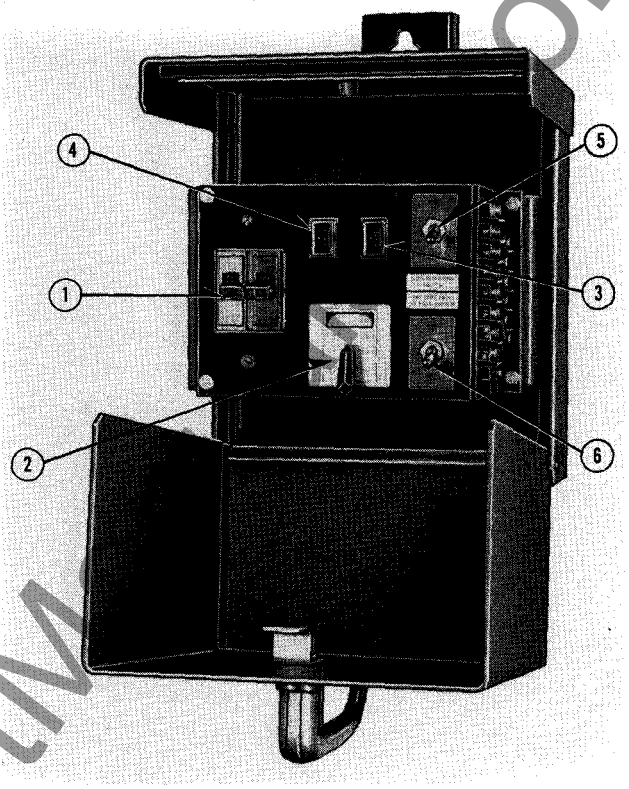


FIG. 23. Auxiliary Control Cabinet

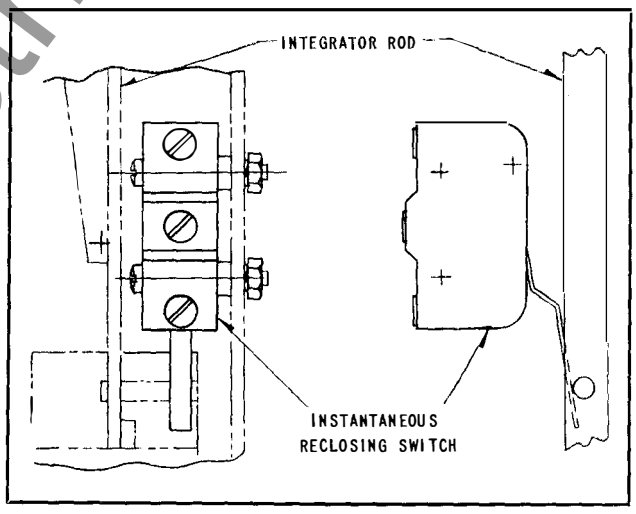
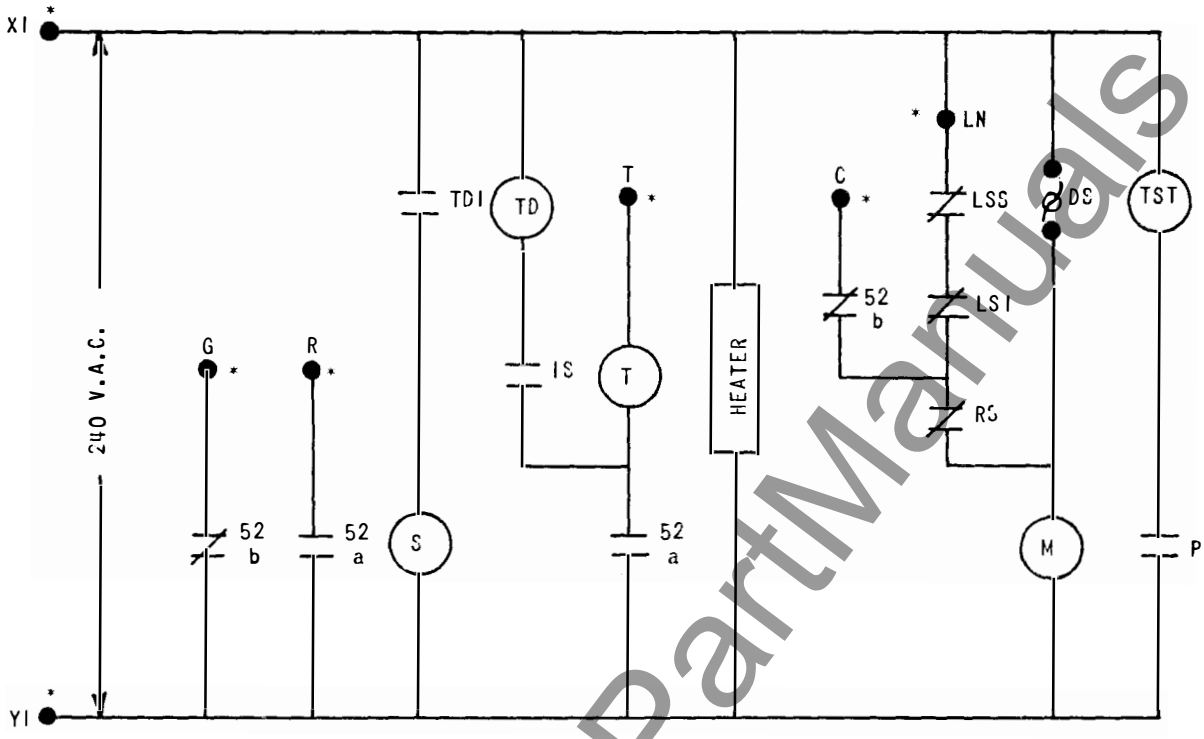


FIG. 24. Instantaneous Reclosing Attachment

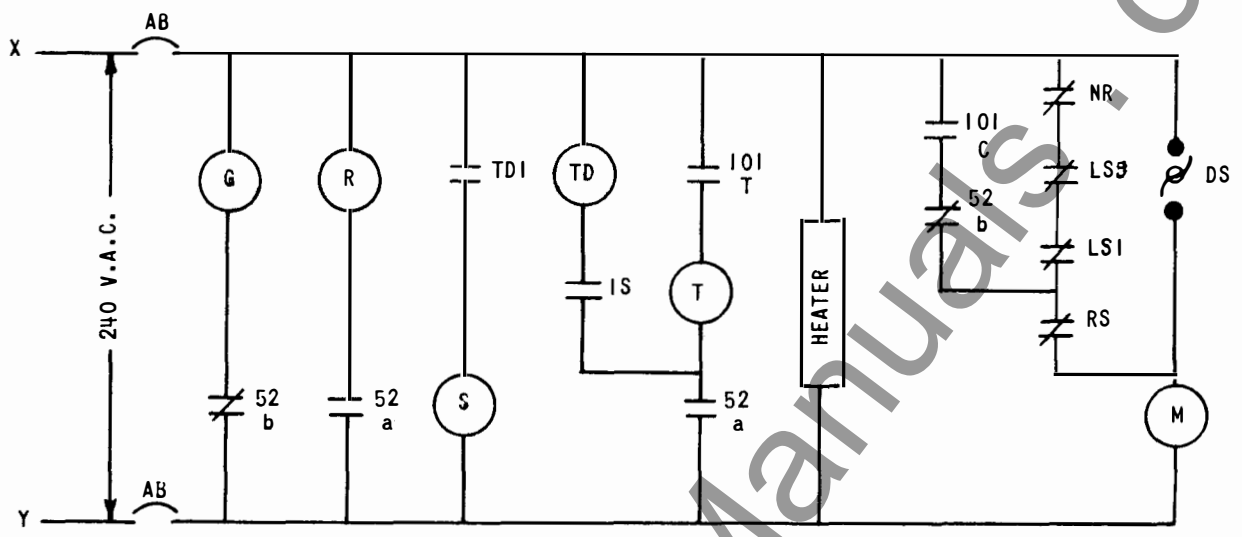


LEGEND

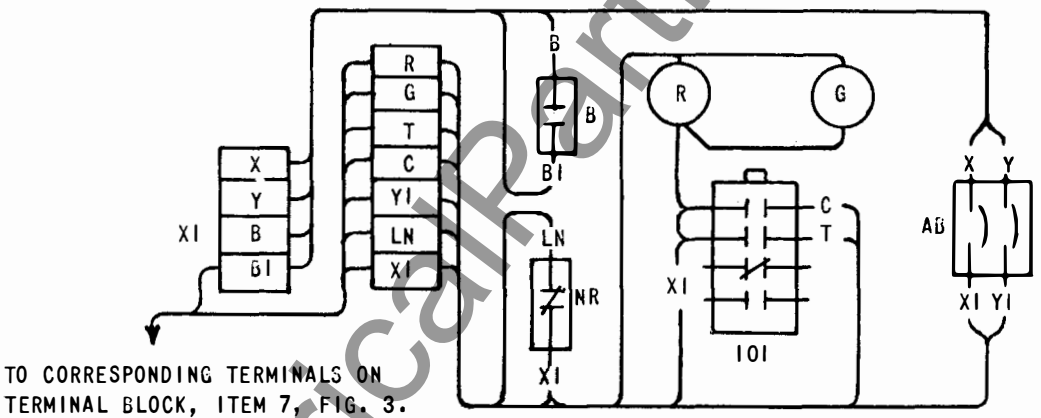
M = CLOSING MOTOR.
T = LOCKOUT SHUNT TRIP COIL.
52a, 52b = AUXILIARY SWITCH.
LSI = LOCKOUT SWITCH (INTEGRATOR)
RS = RECLOSING SWITCH (PNEUMATIC TIMER)
LSS = LOCKOUT SWITCH (LOCKOUT SHUNT TRIP)
DS = DRUM SWITCH.
TD = INTEGRATOR RESET TIME-DELAY RELAY
IS = INTEGRATOR LIMIT SWITCH.
S = INTEGRATOR RESET SOLENOID.
TST = RECLOSING SHUNT TRIP COIL.
P = PROTECTIVE RELAY CONTACTS.
* = POINTS ON TERMINAL BLOCK (ITEM 7, FIG. 3)

NOTE: WHEN THE RECLOSING SHUNT TRIP COIL IS SUPPLIED WITHOUT GROUND TRIP OR OTHER RELAYS THE LEADS ARE CONNECTED DIRECTLY TO POINTS ON TERMINAL BLOCK.

FIG. 25. Schematic Diagram with Reclosing Shunt Trip



SCHEMATIC DIAGRAM WITH AUXILIARY CONTROLS



TO CORRESPONDING TERMINALS ON TERMINAL BLOCK, ITEM 7, FIG. 3.

AUXILIARY CONTROL WIRING DIAGRAM

LEGEND

M = CLOSING MOTOR.
T = LOCKOUT SHUNT TRIP COIL.
101 = CONTROL SWITCH.
52, 52 = AUXILIARY SWITCH.
a b
LSI = LOCKOUT SWITCH (INTEGRATOR)
RS = RECLOSING SWITCH.
R = RED INDICATING LAMP.
G = GREEN INDICATING LAMP.
NR = NON-RECLOSING SWITCH.
LSS = LOCKOUT SWITCH (LOCKOUT SHUNT TRIP)
DS = DRUM SWITCH.
TD = INTEGRATOR RESET TIME-DELAY RELAY.
IS = INTEGRATOR LIMIT SWITCH.
S = INTEGRATOR RESET SOLENOID.
B = GROUND FAULT TRIP BYPASS SWITCH.
AB = AB BREAKER.

FIG. 26. Electrical Diagrams for a PR Recloser with Auxiliary Controls

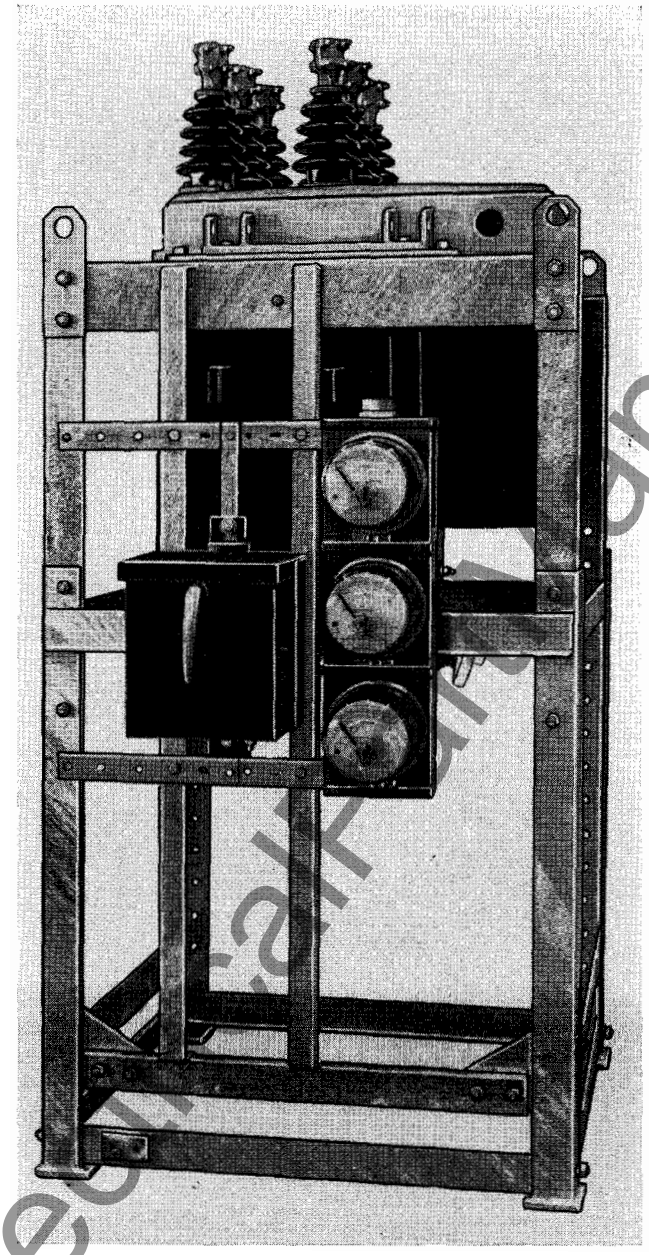


FIG. 27. Recloser on Substation Frame with Meters and Controls

RELAYED TYPE PR AUTOMATIC CIRCUIT RECLOSERS

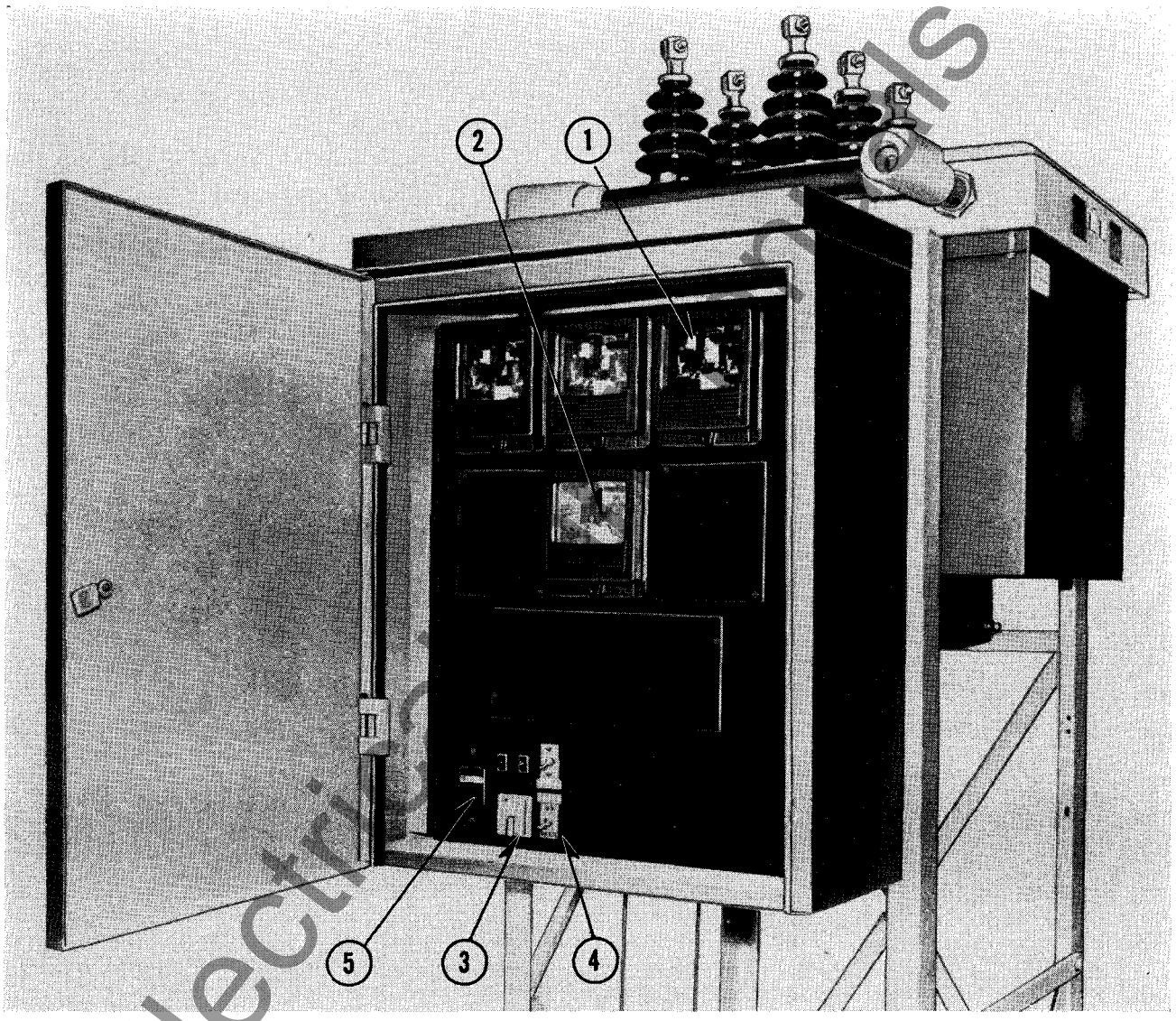


FIG. 28. Relay Cabinet and Mounting Location

GENERAL INFORMATION

Normal use of the PR recloser includes three series trip coils for phase fault protection and an instantaneous over-current relay and timer for ground fault sensing. These units are described in the preceding sections of this instruction book. Because the ground relay utilizes a reclosing shunt trip coil, which is supplied as an auxiliary to the PR recloser, many utilities have gone to a complete relayed unit, replacing the series trip coils with overcurrent relays. The relays are housed in a cabinet mounted on the recloser frame with current transformer and control leads brought over to the recloser mechanism cabinet through conduit. The reclosing is accomplished through the integral mechanical reclosing mechanism of the standard unit, this feature distinguishing it from a reclosing circuit breaker which uses a synchronous motor driven reclosing relay. The relay cabinet and mounting location is illustrated in Fig. 28.

CONTROL COMPONENTS

Complete protection using a relayed PR recloser consists of the following items. For detailed description of these components refer to instruction leaflet listed. For items described previously in this instruction book, only a page number is listed.

IN RECLOSER MECHANISM TANK—SEE FIG. 29.

Item 1-reclosing shunt trip coil, 24, -48-125^{V} DC, 120-240^{V} AC (page 23).

Item 2-reclosing timer (page 13).

Item 3-integrator rod with adjustments (page 14).

Item 4-integrator reset timer (page 15).

Item 5-integrator reset solenoid and latch (page 16).

Item 6-four or eight contact auxiliary switch (page 16).

Item 7-240 volt reclosing motor (page 17).

Item 8-lockout shunt trip coil (page 16).

Item 9-3-600/5 milti-ratio BCT's (Leads brought from main tank) (page 21).

Item 10-Instantaneous reclosing attachment (page 23).

IN RELAY CABINET—SEE FIG. 28.

Item 1-type CO overcurrent relay for phase portection (I.L. 41-101).

Item 2-type CO overcurrent relay for ground protection (I.L. 41-101).

Item 3-control switch and associated indicating lights.

Item 4-recloser non-reclosing switch.

Item 5-multi-breaker for control circuit protection.

OPERATION AND ADJUSTMENTS

Indexing the number of operations to lockout and the type of tripping, i.e. instantaneous or time delay, is a function of the integrator and its associated limit

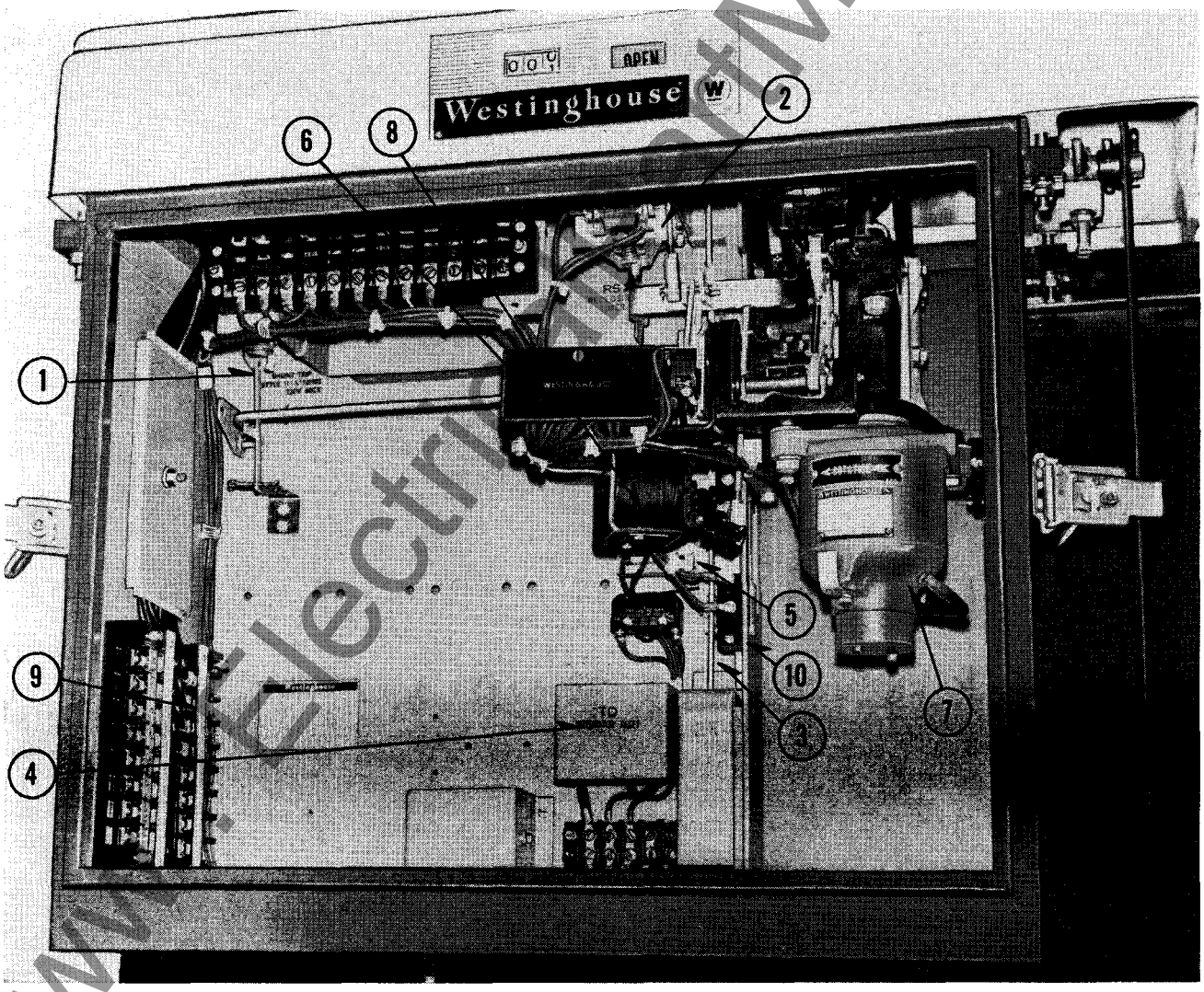


FIG. 29. Recloser Mechanism Tank

switches. Any combination of from one to four operations to lockout or one to four instantaneous operations can be obtained. The adjustments are independent and selection is made on the recloser mechanism panel. Each setting is indexed and marked.

The reclosing time is adjustable from 2 to 60 seconds; although once set, it must remain the same for all operations. For instantaneous reclosing the reclosing timer is bypassed. Two instantaneous reclosings can be obtained if desired, although this may upset coordination as will be explained later. Reclosing time is independent of tripping time.

In the event of the successful clearing of a temporary fault, which leaves the integrator in an intermediate position, the reset timer is energized by a recloser auxiliary contact. After a fixed time delay, the integrator is reset through action of an unlatching solenoid. The rest time is fixed at the factory and cannot be changed in the field except by replacement of the timer. The reset timer is obtainable with preset time delays of from 10 seconds to 2 minutes. This is total time regardless of the number of reclosings which occured before fault clearing.

The functional requirements and method of obtaining them are detailed in Fig. 30.

A typical schematic and wiring diagram for a relayed PR recloser is shown in Figs. 31 and 32.

Note: These are for reference only. Do not use for your unit. Refer to specific drawings enclosed with each unit.

RECLOSING SEQUENCE INFORMATION

The number of operations to lockout and reclosing time are operating decisions, based on system practices and load characteristics. The recloser is not derated for one or two instantaneous reclosings.

As with circuit breakers, the reset time of the overcurrent relay determines the minimum reclosing time which can be used and still obtain a full time delay operation on a subsequent tripping. This is subject to some compromise which depends on the setting of the instantaneous trip attachement. The fundamental points to remember are:

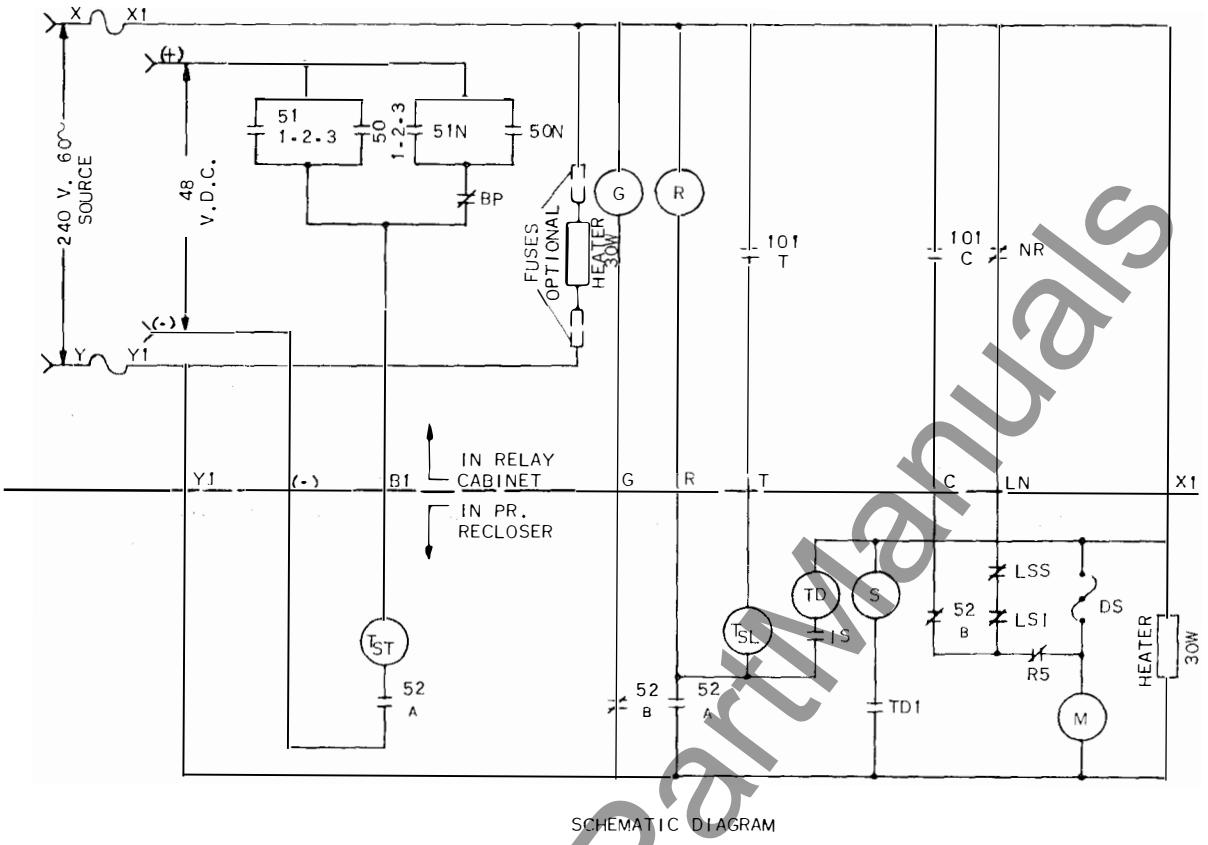
1. If all tripping is to be time delay, **no** instantaneous reclosing should be used. The minimum reclosing time should be determined by the reset time of the over-current relay. The reset time of the relay is a function of the time dial setting.

2. If the instantaneous trip element is locked out after one or two operations, a single instantaneous reclosing followed by two time delay reclosings, will give a fully coordinated sequence, providing the first operation is instantaneous as described in 3 and 4.

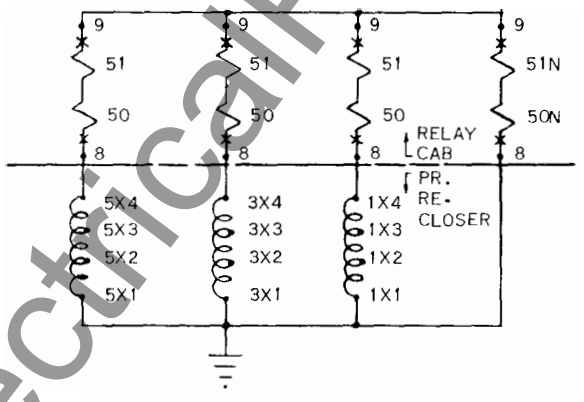
3. If the range of fault currents is such that time delay operations can occur on 50 percent of the faults, it is doubtful that instantaneous reclosing would be satisfactory. In many cases, reclosing would occur before the overcurrent tripping contact as opened and a retripping will occur. The coordination scheme will then miss one complete time delay operation.

FUNCTION	FIXED	FIELD ADJUSTABLE		FACTORY SET		DEPENDENCY
		ITEM	RANGE	ITEM	RANGE	
1. Tripping Time						
A. Instantaneous	IIT, 4-5					Independent
B. Time Delay		CO Relay	See I.L. 41-101			Independent
2. Reclosing Time						
A. Instantaneous				Limit Switch	1, or 2 IR's	Dep. on 1B
B. Time Delay		Reclosing Timer	2-60 sec.			Independent
3. No. Inst. Trips		Limit Switch	1,2,3 or 4			Dep. on 4
4. No. Time Delay Trips		Limit Switch	4 minus IT's			Dep. on 3
5. No. Operations to LO		Limit Switch	1,2,3 or 4			Independent
6. Reset Time				Reset Timer	10 sec to 2 min	

FIG. 30. Functional Requirements and Method of Obtaining



SCHEMATIC DIAGRAM



THREE LINE AC DIAGRAM

LEGEND

51	= CO8 RELAY	52, 52 A B	= AUXILIARY SWITCH
50	= INSTANTANEOUS CONTACTS, CO8 RELAY	T_{SL}	= SHUNT LOCKNUT SOLENOID
51N	= CO9 RELAY	TD	= INTEGRATOR RESET TIME DELAY RELAY
50N	= INSTANTANEOUS CONTACTS, CO9 RELAY	IS	= INTEGRATOR RESET SWITCH
BP	= GROUND FAULT TRIP BYPASS SWITCH	S	= INTEGRATOR RESET SOLENOID
G	= GREEN INDICATING LIGHT, OPEN	LSS	= LOCKOUT SWITCH, SHUNT LOCKOUT
R	= RED INDICATING LIGHT, CLOSED	LSI	= LOCKOUT SWITCH, INTEGRATOR
101	= CONTROL SWITCH	RS	= RECLOSING SWITCH
NR	= NON-RECLOSING SWITCH	DS	= DRUM SWITCH
T_{ST}	= SHUNT TRIP SOLENOID	M	= CLOSING MOTOR

FIG. 31. Schematic Diagram

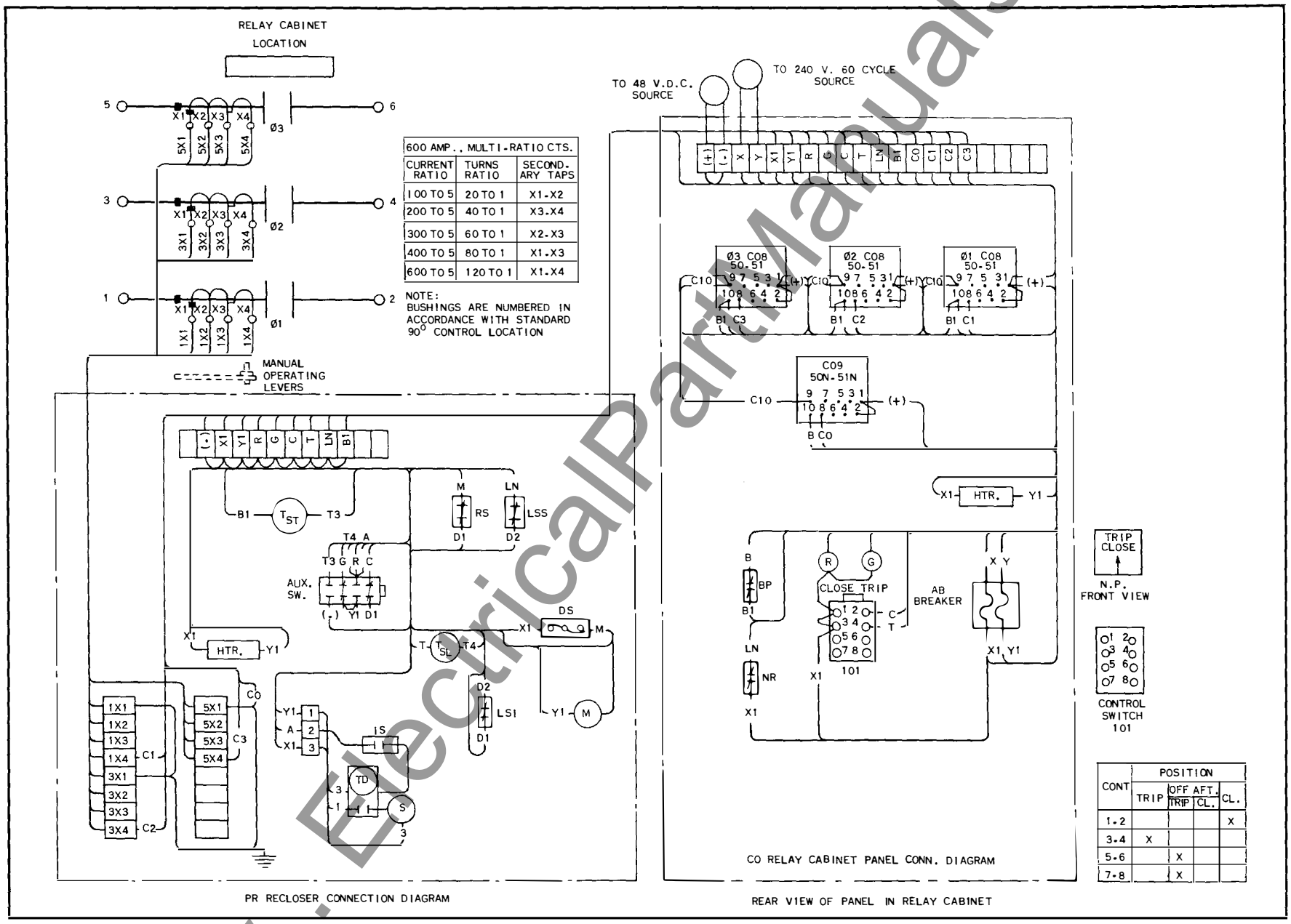


FIG. 32. Wiring Diagram

4. If the range of fault currents is such that instantaneous tripping will occur on 85 to 90 percent of all faults, one or two instantaneous reclosings (depending on number of instantaneous trips) could be used, and reasonable coordination can be expected.

5. This problem is no different than that encountered with reclosing relays and circuit breakers.

The selected reset time of the integrator also requires some knowledge of system conditions. It normally is set for compromise between the following criteria.

1. The maximum tripping time for any fault which the recloser is supposed to clear. This determines minimum reset time.

2. The minimum time allowable to prevent unnecessary lockout on repetitive faults. This determines the maximum reset time.

Fundamentally, the reset time should be set as low as possible so that full sequencing is available on subsequent faults. Experience has shown that two minutes is satisfactory for most conditions on series trip PR reclosers. On relayed units, it is very likely that this time can be reduced to a lower value, providing it does not fall beneath the maximum tripping time for the over-current elements. As pointed out previously, the reset time is pre-set at the factory.

MEMORANDUM