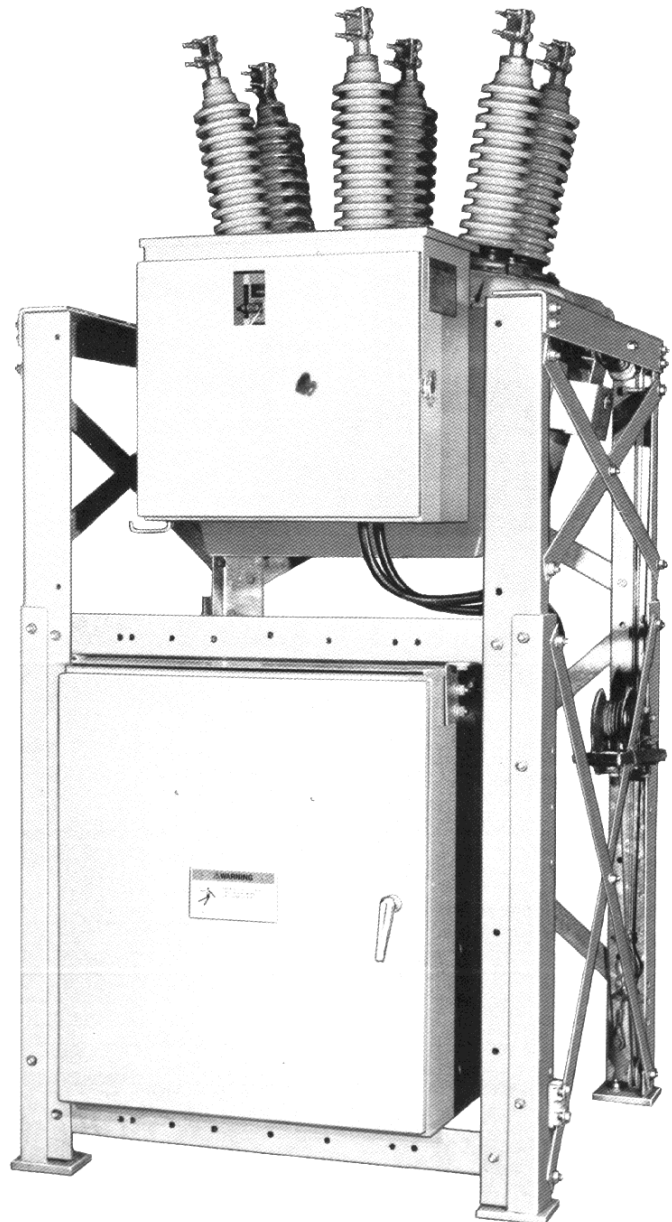


October, 1990
Supersedes Descriptive Bulletin 38-726
pages 1-8, dated February, 1990
Mailed to: E, D, C/38-000F

Relay, Static and Microprocessor Control
15.5-38 kV, 800 Amperes
110, 125, or 150 kV BIL
16 kA Interrupting Capacity Maximum

Three Phase Automatic Vacuum Circuit Reclosers Type ESV



ESV Recloser Substation Mounting

Type ESV Automatic Vacuum Circuit Reclosers

Application

The ESV recloser provides three phase fault protection for substation and line applications.

This recloser is capable of interrupting up to 16,000 amperes symmetrical fault current as shown in the table to the right.

Each recloser has a continuous current rating of 800 amperes. The duty cycle of each rating conforms to ANSI C37.60, Table 3A, where applicable.

The following data is applicable to all ESV reclosers:

- Temperature Range -30°C. to +70°C.
- Minimum Reclose Time—25 cycles
- Maximum Interrupting Time—2.7 cycles

Bushings 2-4-6, where the bushing current transformers are mounted, or bushings 1-3-5 may be used as line or load bushings and the recloser is operable regardless of current flow. This is especially important, and saves substation construction cost, where reverse power flow is desirable. The recloser under these conditions is operable without having to interchange the line and load bushing connections, saving the user several hours of labor costs.

The 800 ampere rating is based on a maximum temperature rise of 55°C.

The interrupting rating is not a function of phase or ground minimum trip. Trip values in the relayed ESV are achieved by changing tap settings on relays, or multi-ratio bushing current transformers. Trip values on static controlled ESV reclosers are changed by changing minimum trip resistors.

Basic Construction Benefits

Each recloser consists of the following major components:

- High Voltage Oil-Filled Compartment
- Mechanism Compartment
- Control Cabinet
- Substation or Pole Mounting Frame

A standard feature of the ESV recloser is that each unit is completely assembled at the factory into one package which minimizes the amount of time required for field installation.

In addition, every recloser is tested at the factory to insure that the control is functioning properly. Factory testing of minimum trip values, tripping times, reset and reclose times and contact resistance minimize the de-bugging problems that the user may encounter in the field. To correct these problems in the field, the user would most likely have to spend up to four hours of labor using over-pot equipment, timing devices, and a power supply. This design is intended to avoid these problems.

Table 1
Specific Ratings and Catalog Numbers

Catalog Number	ESV 1512	ESV 1516	ESV 2712	ESV 2716	ESV 3810	ESV 3812	ESV 3816
Rated Maximum Voltage, kV	15.5	15.5	27	27	38	38	38
Continuous Current, Amps	800	800	800	800	800	800	800
Basic Impulse Level Withstand Voltage, kV (BIL)	110	110	125/150 ^①	150	150	150	150
Maximum Interrupting Capacity, RMS Symmetrical Amps ^②	12,000	16,000	12,000	16,000	10,000	12,000	16,000
60 Hertz, One Minute Withstand, Dry, kV RMS	50	50	60/70 ^③	70	70	70	70
60 Hertz, Ten Second Withstand, Wet, kV RMS	45	45	50/60 ^③	60	60	60	60

^① BIL determined by bushing selected.

^② Interrupting capacity is not a function of phase or ground minimum trip selection.

^③ Higher values apply to 150 kV BIL design.

Duty Cycle

The ESV recloser is designed to conform to applicable sections of ANSI C37.60 with duty cycles as shown below.

Standard Operating Duty

Rated Maximum Voltage kV rms	Percent of Interrupting Rating						Total① Number of Unit Operations
	15-20		45-55		90-100		
	Minimum X/R	Number of Unit Operations	Minimum X/R	Number of Unit Operations	Minimum X/R	Number of Unit Operations	
15.5	4	44	8	56	15	16	116
27.0	3	44	7	56	14	16	116
38.0	4	44	8	56	15	16	116

^①This duty represents half life as measured by contact erosion.

Design Features of High Voltage Oil-Filled Compartment

• Tank

Welded steel construction of the high voltage tank minimizes the possibility of oil leaks which if not prevented are very costly to repair in the field. The oil is used as a dielectric only.

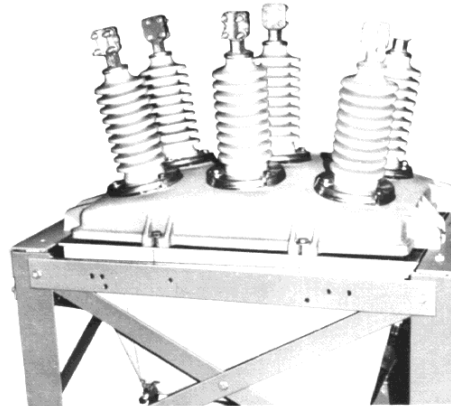
• Interrupters

The vacuum interrupters utilize a ceramic envelope that provides excellent thermal

properties as well as high strength characteristics.

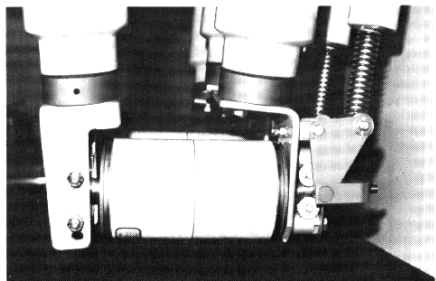
The interrupters are supported from the entrance bushings. The low mechanical shock during interruption simplifies the foundation requirements.

Vacuum interrupters eliminate the need for contact maintenance. The duty cycle of a vacuum recloser is at least four times that of an equivalent oil recloser. Compression overtravel springs maintain contact pressure and allow for contact wear.

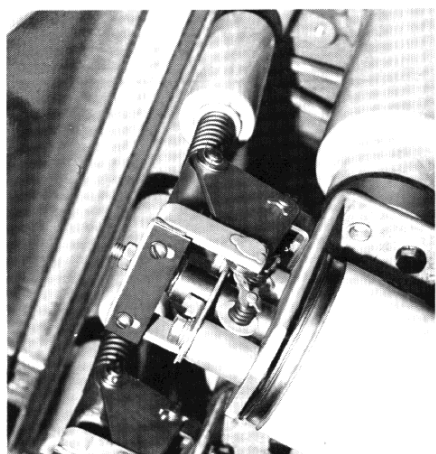


Recloser Tank, Head Casting, and Bushing Assembly

Type ESV Automatic Vacuum Circuit Reclosers



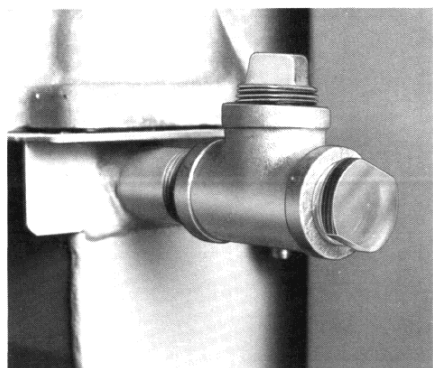
Vacuum Interrupters Supported From High Voltage Bushings



Operating Rod, Moving Stem, and Contact Rollers

• Oil Level Indicator

A visual floating ball oil level indicator is located on the tank wall next to the mechanism compartment to check the oil level during maintenance, saving the time that would otherwise have to be used in dropping the tank to check the oil level.



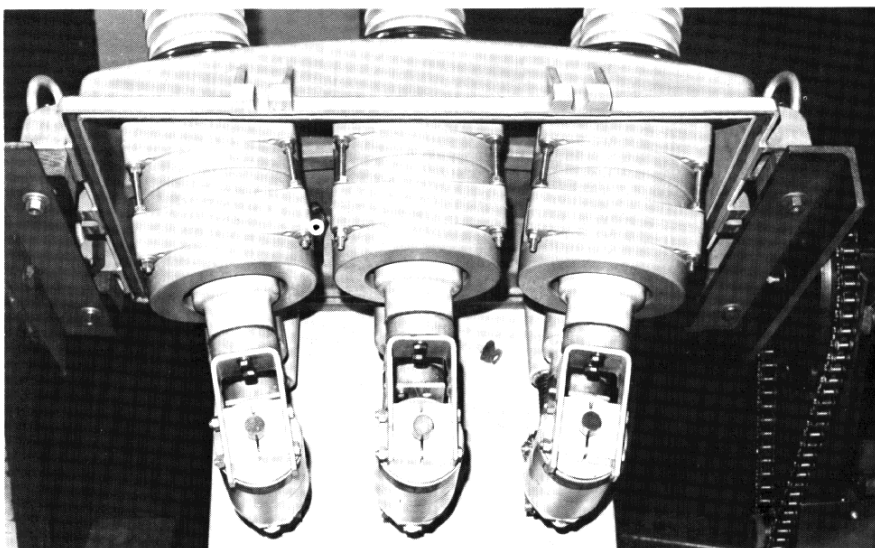
Oil Level Indicator

• Bushings

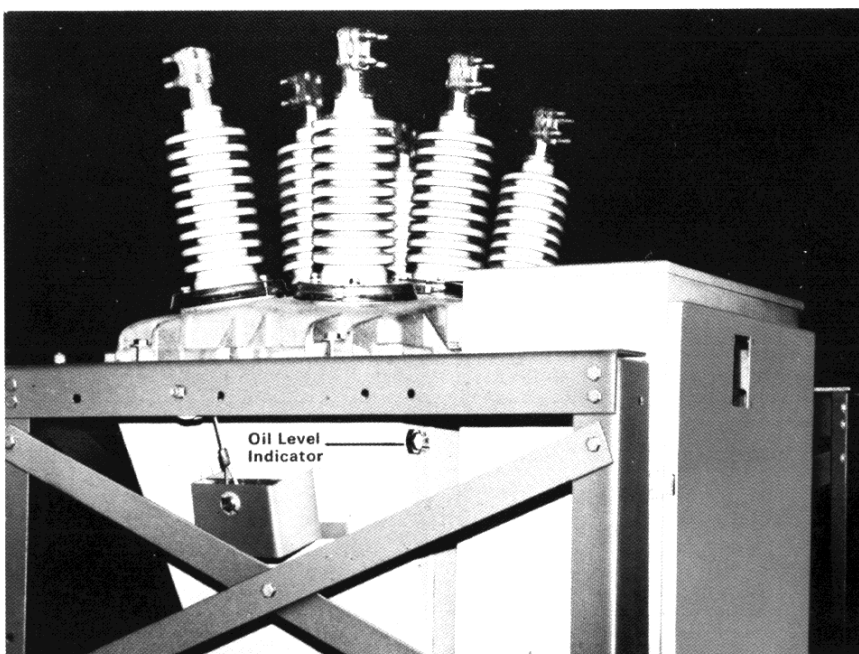
The recloser can be supplied with either a NEMA 4-hole pad or a 4-bolt clamp type connector to accommodate conductor sizes #2 through 800 mcm. This arrangement allows the purchaser to select the most suitable terminal, eliminating the need for special connectors at a possible savings of up to \$1000 per recloser.

• Multi-Ratio Bushing Current Transformers

BCT's with relay accuracy and a burden capacity of B2.0 allow the use of meters or the future addition of burden up to 50 volt amps without having to add extra current transformers. Multi-ratio current transformers let the user choose from at least 40 values of minimum pickup current on relayed reclosers providing more precise coordination.

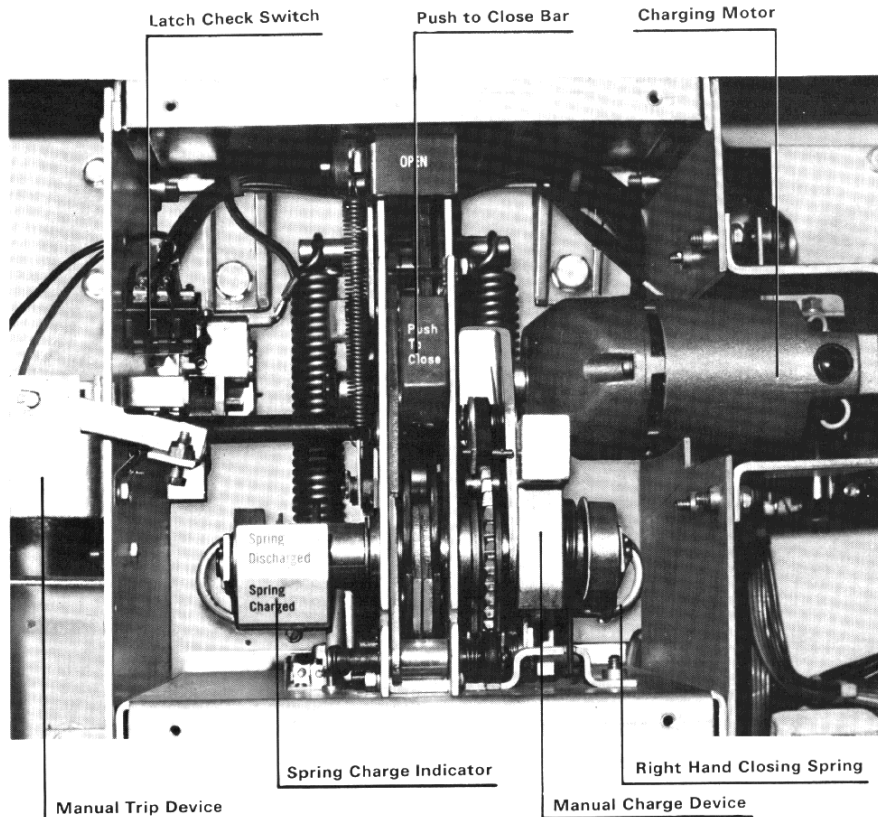


Bushing Current Transformers Mounted on Bushings 2-4-6

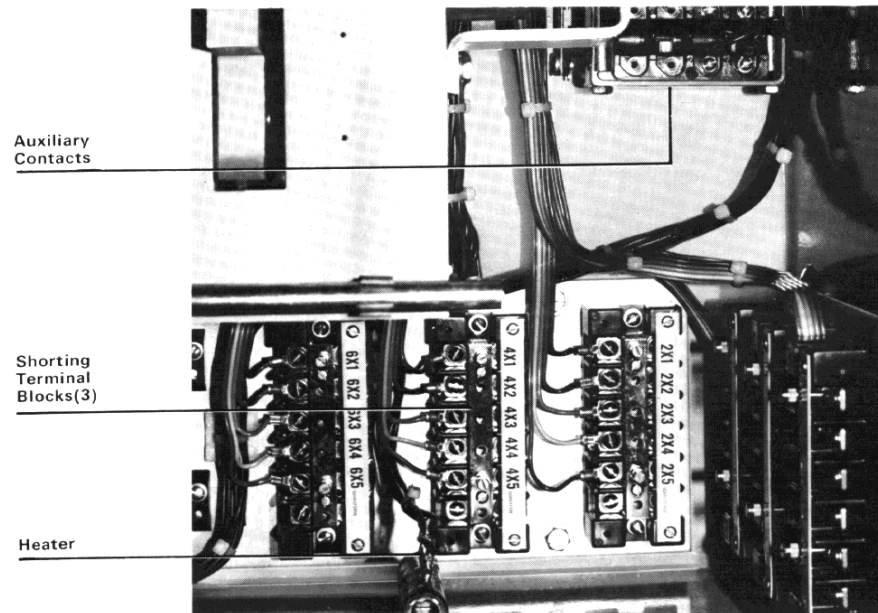


Overall View Showing Oil Level Indicator in Relation to other Components

Type ESV Automatic Vacuum Circuit Reclosers



Mechanism Details, Cover Removed, Front View

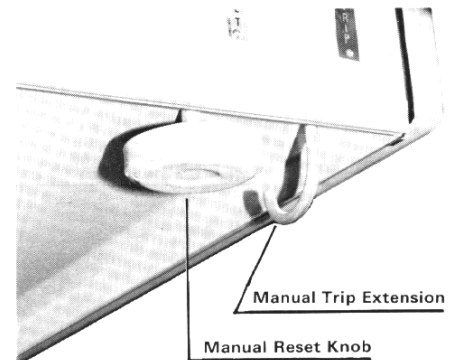


Control Circuit Details

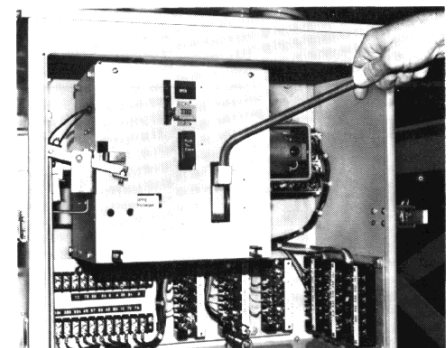
October, 1990

Other Features Incorporated in the Mechanism Compartment of the Recloser Include:

- Heaters are mounted in the weather-proof mechanism cabinet as well as in the control cabinet. Combined with gasketed doors, the heaters provide a climate that protects the control components from moisture.
- Shorting type terminal blocks located in the mechanism compartment permit ratio changing of the bushing current transformers under load. This design provides a safety feature to operating personnel and eliminates the need to by-pass and de-energize the recloser while ratios are being changed.
- Two spare auxiliary contacts are provided for the customer's use which eliminates the cost of purchasing a separate auxiliary switch when only one or two extra contacts are needed.
- Manual charging of the closing springs is accomplished by inserting the tool in the manual charging device and ratcheting approximately nine times. The tool is stored on the front of the mechanism in a set of clips.
- New motor cover bracket simplifies access to motor for maintenance or replacement.



Bottom View of Mechanism Compartment

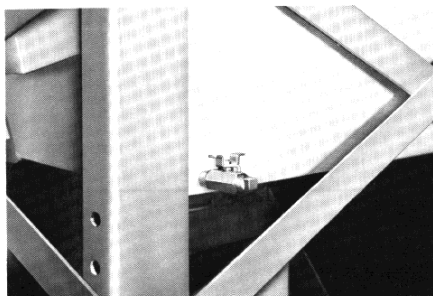


Manual Charging Tool in Place

Type ESV Automatic Vacuum Circuit Reclosers

• Oil Drain and Sampling Valve

This valve, which is mounted on the back wall at the bottom of the recloser tank, provides easy access for sampling or draining the oil without having to lower the high voltage tank. The location assures that the customer does not have to provide a sump pump to completely drain the oil, representing a significant savings in labor and equipment costs.

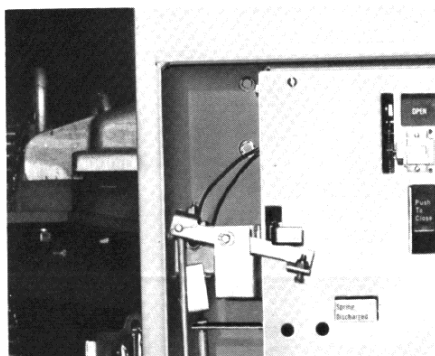


Oil Drain and Sampling Valve

Design Features of the Mechanism Compartment

The recloser is tripped by a low voltage shunt trip coil which receives its signal from current transformers and a static or electro-mechanical relay in lieu of tripping by a high voltage series trip coil mounted in the oil-filled compartment carrying full line current at high voltage.

The shunt trip design provides the user with a source of tripping that is not sensitive to the temperature or the condition of the oil.



Manual Trip Lever

• Mechanism

The operating mechanism is the stored energy type and is mounted in the low voltage compartment on the front of the recloser. Accessibility is gained through a quick release removable panel, and a removable top cover. This makes it possible for operating personnel to perform routine mechanism inspection without entering the high voltage oil-filled compartment.

A small motor driving through a ratchet mechanism is used to charge the main closing springs. The mechanism operates the recloser contacts by supplying a spring trip, spring close driving force to the crank-shaft operating all three phases simultaneously. This allows the user one trip-close-trip operation even if control power has been lost. To prevent the release of stored energy into a preloaded mechanism linkage, which could result in excessive stress, a mechanical safety interlock is provided so that the closing springs cannot be manually discharged when the recloser is in the "closed" position.

A latch check switch, located on the mechanism, is provided as a standard feature to permit electrical closing only when the mechanism is fully reset.

A visible flag on the mechanism front cover plate indicates the spring condition as "SPRING CHARGED" or "SPRING DIS-

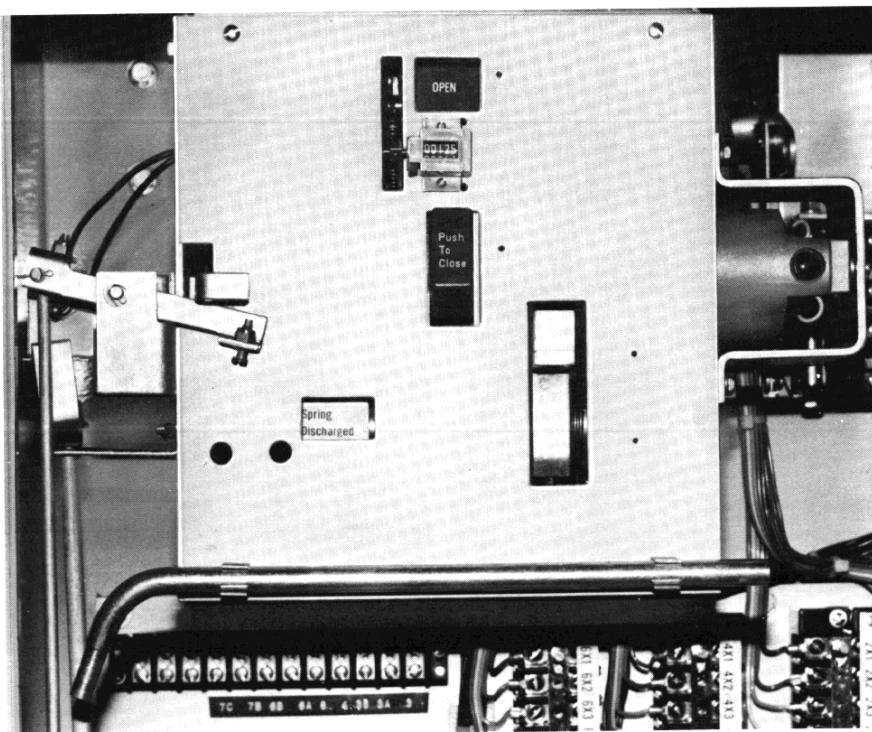
CHARGED." This positive indication tells operating personnel whether the mechanism has properly stored the energy required to close the recloser during maintenance operations.

The operator can manually close the recloser by actuating the "PUSH TO CLOSE" button which discharges the closing springs. Stored energy makes the operating speed independent of operating personnel. This feature benefits the user in that the recloser can be manually closed into an energized circuit for load pickup when control power is not available.

A manual trip lever allows the recloser to be tripped quickly under emergency conditions.

As an added safety feature, a 69 device blocks automatic reclosing after manual trip by opening the electrical reclosing circuit. An external reset device is provided for restoring the normal reclosing function.

A cyclometer operations counter, which indicates the number of trip operations, is located behind the window in the mechanism cabinet permitting the user to determine if operations have occurred without having to incur the added labor cost of removing the housing door.



Mechanism Front View

Type ESV Automatic Vacuum Circuit Reclosers

Design Features of the Control Cabinet

A solid state or microprocessor overcurrent and reclosing package can be provided that typically performs all the functions associated with the electro-mechanical relay control.

ESV reclosers can also be provided with electro-mechanical overcurrent phase and ground relays as the typical panel shows. The reclosing relay is generally a solid state relay, type RCS-II although the electro-mechanical RC reclosing relay is available.

Among the many features of the relay control are the following:

- Optional mounting positions of the control cabinet provide flexibility in locating the recloser within the substation saving several feet of control cable, substation space, and substation bus. This savings is realized because in addition to the standard front recessed location, the control cabinet can be located on the rear or left hand side of the substation frame to accommodate special requirements as shown in Dimension Sheet 38-728.

- The hinged door of the control cabinet allows full access to the control panels and eliminates the time required to remove and replace a bolted cover every time access is needed. Provisions exist for padlocking the cabinet door to prevent entry or tampering by unauthorized personnel.

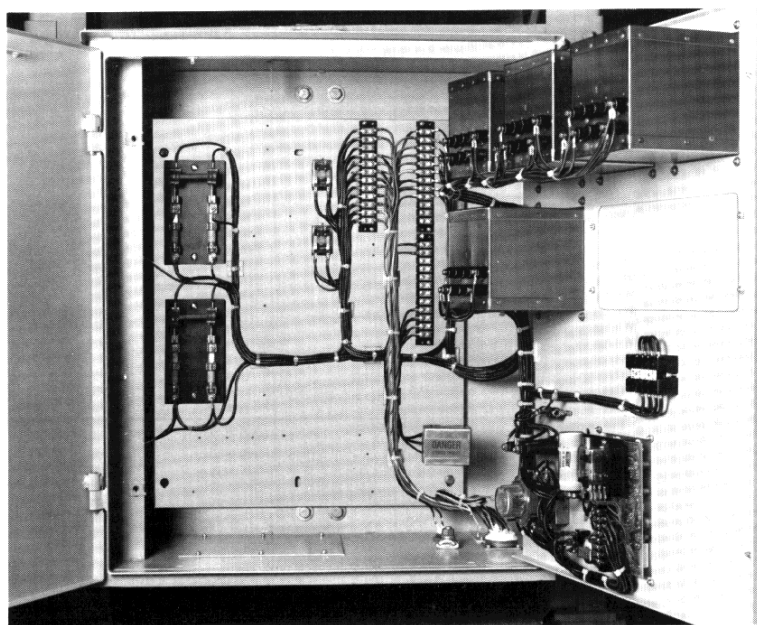
- A hinged panel is provided in the control cabinet in order to provide full access to all items mounted on and behind the panel. This decreases the time required to inspect or maintain control items mounted in the cabinet.

- Control wiring is installed at the factory by using a wiring harness that ensures uniformity of wiring and simplifies troubleshooting in the field.

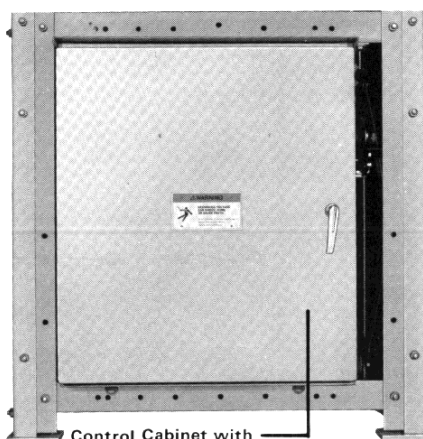
- A fused knife switch in the control circuit provides overcurrent fault protection for the control circuit and makes a visible disconnect readily available for maintenance.

- The spring charging motor and the close and trip coils can be supplied to operate on 115 or 230 VAC. The close and trip coils may also be supplied to operate on 48, or 125 VDC. 24 VDC tripping is also available. The various options of control voltages permit the user some flexibility by allowing the use of the most convenient source or existing station supply, saving the cost associated with providing a new or different source of control power.

The recloser can also be tripped from a capacitor trip device located in the control cabinet. This device stores DC that is available for tripping when close-in faults could drop the station AC control voltage below the level required for AC tripping. This device has the reliability of a battery, but eliminates the



Typical Control Cabinet with Hinged Panel Open



Control Cabinet with Hinged Door

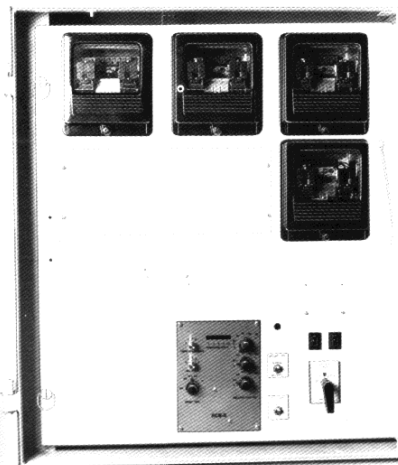
maintenance normally associated with batteries as well as the cost of a small station battery.

- Overcurrent relaying can be supplied either with electro-mechanical relays or static relays. The extended range HI-LO overcurrent relays provide the user with a wider range of built-in current settings which may permit standardization on one control package minimizing application problems.

- The reclosing relay provided on most ESV reclosers is the RCS-II which is located on the hinged panel. The RCS-II utilizes solid state timing to control reclosing. Dial settings allow selection of reset time, reclose time for each operation, number of instantaneous trips, and the number of trips to lockout. This

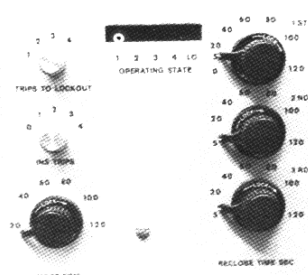
design feature eliminates the need to purchase new components to change any of the reclosing settings saving the cost of material, labor, and inventory carrying charges. A version of this relay utilizing electro-mechanical timing to control reclosing can also be provided.

Both reclose relays have the reset-after-successful-reclose feature. The reset timer begins after reclose as shown on the opposite page. This feature allows a shorter reset time. Reset time need only be coordinated with maximum trip time at minimum trip setting. This feature also provides cold load pickup.



Typical Hinged Panel

Type ESV Automatic Vacuum Circuit Reclosers



RCS-II

RCS-II Relay

To understand how the reset after reclose feature works, assume the recloser is locked out and the fault still exists. Operate the control switch to close recloser. The recloser will operate on the last selected trip curve. In most cases this will be a time delay operation. After the reset time, the control will reset to its programmed operational sequence. Reset time begins at the end of the time selected for the recloser to reset to a pre-programmed sequence.

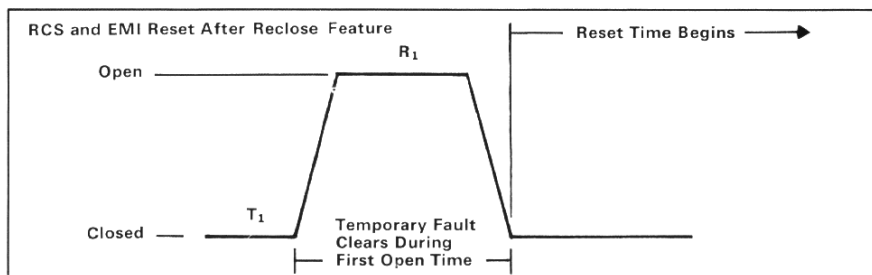
Control reset times can be reduced as a result of this standard feature since there is no cumulative timing effect. Shorter reset times minimize the possibility of a recloser lockout during a series of temporary faults. An unnecessary outage caused by lockout means customer inconvenience.

The second reclose time should not be set for less than six seconds due to charging time.

- Another standard design feature located in the control cabinet is an anti-pump scheme (X-Y) that prevents repeated closing into faults if the electrical close switch is held in the closed position. Danger to station personnel and equipment is reduced and the need for maintenance normally associated with pumping is eliminated.

Design Features of the Substation Frame

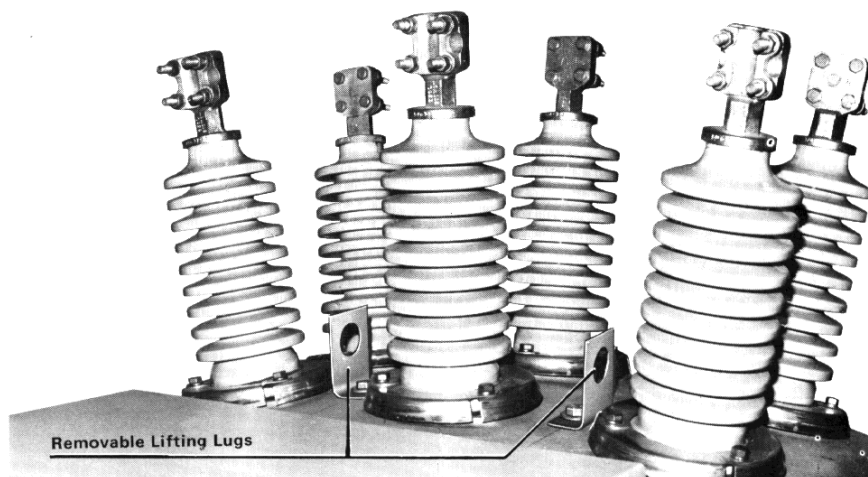
The substation frame for ES and ESV reclosers are interchangeable. The substation mounting frame is adjustable and can be field adjusted without special tools in 3-inch increments. This feature makes it possible for the user to match the recloser to the height of the existing substation bus resulting in a significant savings in phase connection labor and material. This feature also eliminates the cost of purchasing and assembling a frame extension. See Dimension Sheet 38-728 for details.



Installation and Maintenance Features

There are several ESV recloser features that make it easier for the user to install the recloser and perform routine maintenance.

- The head casting is sealed to the high voltage oil filled tank with a cork neoprene gasket that is cemented in the gasket seating grooves of the casting. These grooves control the gasket compression and ensure proper alignment thus providing a positive seal. A major benefit of this design is that the gasketing technique allows the recloser to be shipped with oil, saving the user the time required to fill the recloser in the field.
- The substation and pole mounting frames and hardware are hot dipped galvanized which provides the user with a big savings by eliminating periodic repainting.
- A tank lifter with better than a 4:1 gear ratio and a quick release brake can be provided, if specified. The lifter makes it possible for one person to lower the tank. As a safety feature, the quick release brake prevents the tank from falling if the handle is accidentally released during operation. This feature eliminates special winching equipment and a second person is not needed.



- Lifting brackets are installed to allow easy installation and reduce possibility of damage during installation. The lugs are painted red and must be removed after installation.
- The rugged construction of the recloser minimizes the possibility of damage during shipment or handling. The frame is constructed of galvanized angle iron and the high voltage compartment is made of welded steel which is covered by a strong aluminum head casting. This construction could save the user the time and expense of repairing a recloser damaged in shipment before installation.
- Every recloser is provided with a manual trip lever. The recloser can be tripped by an external trip lever to perform maintenance and/or inspection with the high voltage circuit energized and without having to open any compartments to gain access to the lever. The lever provides a back-up tripping system in the event that control power is lost and, most importantly, the lever minimizes the time required to trip the recloser under emergency conditions.
- Eyelet terminal connectors are used on the control wiring in order to provide more secure connections. This minimizes receiving inspection expense in that connections do not shake loose during shipment.

Type ESV Automatic Vacuum Circuit Reclosers

Options and Accessories

- Three Type GA-332 mini-ammeters with a 0.5 amp scale can be mounted on the hinged control panel. This feature provides built-in indication of instantaneous load current. Each hinged panel is punched to mount these meters either at time of purchase or at a later date by the user. This benefits the user since it eliminates the need for separate installation which adds labor cost and material expense.

If required, thermal demand ammeters instead of mini-ammeters can be added either at time of purchase or at a later date by the customer. This flexibility is available to the user because the panel punching is standardized and will accept either set of ammeters at any time.

- Instead of electro-mechanical relay control, microprocessor overcurrent and reclosing relaying, plus demand metering can be provided in a package that mounts on the hinged panel. All the features of this control are described in other bulletins, but listed below are a few of the major features:
 - + Three Phase Overcurrent Protection (Time and Instantaneous)
 - + Ground Overcurrent Protection (Time and Instantaneous)
 - + Multi-Shot (5-Shot) Reclosing
 - + High-Set Instantaneous
 - + Three Single Phase Ammeters – Demand and Peak
 - + Multi-Event Recording
 - + Accumulation of Breaker Interrupting Duty

- + Continuous Self-Checking with Alarm Light and Contacts
- + RS-232C Communications Port for Remote Terminal Connection
- + Zone Sequencing
- + Cold Load Pickup

Five selectable time current curves, wide current tap ranges and a fully programmable reclosing relay provide the ultimate in feeder protection flexibility.

Display ammeter and demand ammeter functions display phase currents in primary amperes.

An event recorder stores fault data for up to sixteen reclosing events in memory. This record, which includes data and time of trip, phase and ground currents in primary amperes, and tripping element, can be recalled through the keypad on the front of the unit, or remotely through a terminal connected to the RS-232C port on the back of the unit.

A continuous self-diagnostic program ensures the ultimate in equipment availability. There are eight self check/self test functions:

- Read-Only Memory (ROM)
- Random Access Memory (RAM)
- Input Supply Voltage
 - +5V, $\pm 15V$
- Analog Offset
- Trip Circuit Continuity
- Analog to Digital Converter
- Analog Gain

Cumulative interrupting duty is stored in the Distribution Protection Unit and is accessible either via the keypad or the RS-232C port. This allows a comprehensive maintenance program to evaluate required maintenance as well as document the wear of a particular recloser.

The microprocessor control operates from standard 5 Ampere secondary current transformers and circuit breaker auxiliary contacts. Each control operates on DC. If 24, 48 or 125 VDC power is not available, the control can be provided with a 24 VDC Uninterruptible Power Supply.

Other accessories that are available:

- Remote trip and close
- Oversize control cabinet
- Surge arresters
- CBT control power transformers
- Ground wire monitoring scheme.

Further Information

PL 38-720	DB 38-721
AD 38-723	AD 38-727
DS 38-722	DS 38-728
SA 38-729-A	SA 38-729-B