

Electronically Controlled Types KFE and KFVE; Three-Phase

KFE10001-E

DESCRIPTION

The Cooper Power Systems three-phase Types KFE and KFVE hydraulic/electronic-vacuum reclosers (Figure 1) provide minimum maintenance, long operating life, reliable and compact construction, proven and versatile solid-state electronics, and ground-fault tripping as low as five amps, and a maximum continuous current rating of 400 amps. The Type KFE provides 6000 amps symmetrical interrupting at 2.4-14.4 Kv and the Type KFVE provides 6000 amps symmetrical interrupting at 2.4-27 Kv.

COOPER POWER SYSTEMS COMPANY HISTORY

Fifty years ago, Kyle Corporation produced its first automatic circuit recloser. In 1947, Kyle became the distribution switchgear division of Line Material Industries, which then became part of McGraw-Electric Company in 1949. In 1957 the McGraw Electric Company merged with Thomas A. Edison Industries to become McGraw-Edison Company. In 1985 McGraw-Edison became a subsidiary of Cooper Industries.

Through all of these growing stages, Kyle reclosers have been refined and improved to their present reliable, basically maintenance-free state. In addition, Kyle became a leader in technology with the introduction of the solid-state electronically controlled recloser in the early 60s. Since then, the electronic control has added simplicity, accuracy, and flexibility to power distribution protection schemes.

In keeping with the tradition of McGraw-Edison's progressive development, the Type KF vacuum recloser was redesigned to include the time-proven technology of electronic control.

The Types KFE and KFVE reclosers combine the self-contained durability and simplicity of hydraulic control with the accuracy, reliability, and flexibility of solid-state electronics.

These reclosers use long-life, maintenance-free vacuum interruption, in combination with the latest solid-state electronic technology for current sensing and tripping. This combined technology produces a more compact (21% less volume), lighter (24% less weight) unit which requires 42% less oil.

The results are lower shipping costs, lower maintenance costs, and reduced handling and warehousing costs.

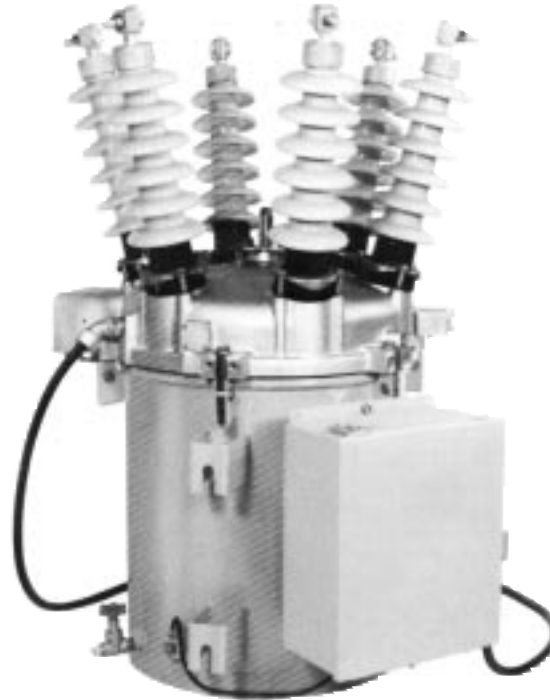


Figure 1. Cooper Power System's Type KFVE recloser combines interruption with hydraulic counting and electronic sensing and tripping.

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FEATURES

Both the Type KFE and KFVE are completely self-contained—no external power source or battery are required to operate the electronics. Power is obtained from the primary sources by means of bushing current transformers. A minimum of 5 amps primary-current flow is sufficient to power the electronics.

- Compactly designed in size and weight to conveniently mount to pole or substation structure.
- Plug-in trip resistors and trip-timing curves increase application flexibility. Plug-in components are easily installed into the electronic control—no longer a need to lower the recloser tank to change tripping and timing values.
- Ground-tripping as low as 5 amps is provided as a standard feature of the control. Ground-trip timing is available in both inverse and definite time curves.
- Long-life, maintenance-free, sealed vacuum interrupters provide safe, quiet current interruption without the oil contamination and contact wear associated with other interrupting media.
- Operating mechanism is designed to maximize recloser durability while simultaneously simplifying maintenance procedures.
- All external tank and head hardware is stainless steel, ensuring easy maintenance and durability.
- Electronic control circuitry is centralized on a single printed circuit board which is easily field replaceable. An easy-to-use electronic control tester is available.
- Electronic control design expands and simplifies the addition of accessories. Instantaneous phase- and ground-tripping and fault-indicating accessories now available add to application flexibility.

COOPER POWER SYSTEM'S KFE AND KFVE RECLOSERS = RELIABILITY

Minimum Maintenance

The Types KFE and KFVE reclosers encounter no oil contamination from current interruption because the fault-current arc is interrupted within the vacuum chamber rather than in oil. Thus recloser inspection and oil-test intervals can be extended over a considerably higher number of recloser operations.

Contact and interrupter life is several times greater than what is usual for oil interrupters. The duty cycle is four times that of comparably rated oil reclosers. Interrupters require no maintenance throughout their contact-life period.

Bushing replacement is easily accomplished without major disassembly of the recloser mechanism. The interrupter-support structure, mounted independently of the bushings, allows rapid bushing replacement, without removal or adjustment of the vacuum interrupters.

Oil is used in the Types KFE and KFVE reclosers for electrical insulation. It is also used in the operation-counting mechanism and to establish the timing of reclosing operations. Being a vacuum recloser, oil is not involved in arc interruption. Characteristics of the oil used and their significance are found in Cooper Power Systems *Reference Information R280-90-1*.

Long Operating Life

Low-energy arc interruption in a vacuum results in far less explosive shock when fault currents are cleared. Accordingly, reduced stress on the recloser mechanism extends the operating life of mechanism parts.

Vacuum interruption, with its inherently long duty cycle, allows maximum number of operations—yet has the least effect on recloser components. Hydraulic control systems are built into the operating mechanism to provide long, trouble-free operation, while reliable, solid-state electronics are built into the electronic control for versatility and ease in changing and selecting standard and accessory control settings.

Rugged, Reliable Construction

Drawing on experience gained over many years of successful design and manufacture, these reclosers employ operating principles and many components similar to those used in Cooper Power Systems Type D, and R&W family of reclosers for over 35 years.

The simple electromechanical design provides self-contained operation by movement of a solenoid plunger which loads springs, closes contacts, and releases springloaded mechanisms.

The complete internal mechanism is suspended from the head casting and can be removed from the tank as a single unit (Figures 2 and 3). Mechanism removal

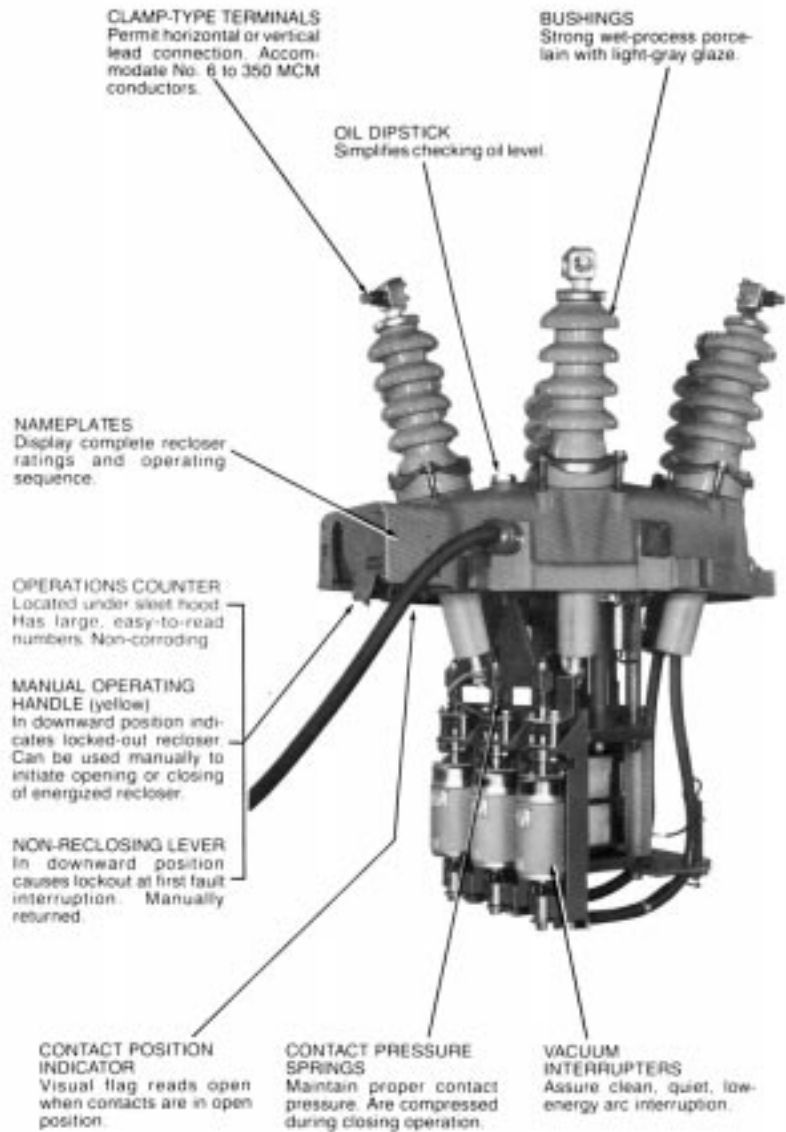


Figure 2.
Untanked Type KFE recloser (viewed from interrupter side).

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requires merely loosening and pivoting six captive bolts on the head flange. Six head flange clamping locations assure even and proper gasket compression. An oil-tight, weatherproof seal between head and tank is obtained by a nitrile gasket confined in a controlled compression clamping arrangement. The mechanism itself is secured to the head with four large bolts, easily removed in the event that work is required on mechanism parts (Figure 4).

External construction involves a rugged cast-aluminum head, sturdy well-anchored bushings, and a steel tank finished with a corrosion-resistant polyester base paint. Both finish and bushing glaze color is light gray, Munsell 5BG7.0/0.4.

Where additional operating and service flexibility is required, KFE and KFVE reclosers can be supplied with factory-installed accessories. Metering or relaying can be accomplished with integral bushing-current transformers. Remote-Trip, Remote-Close, and Remote-Lockout accessories permit remote operation. Recloser contact or mechanism position can be monitored with Auxiliary or Lockout-Indicating Switches. These and other accessories permit KFE and KFVE reclosers to fit even the most complex of system applications.

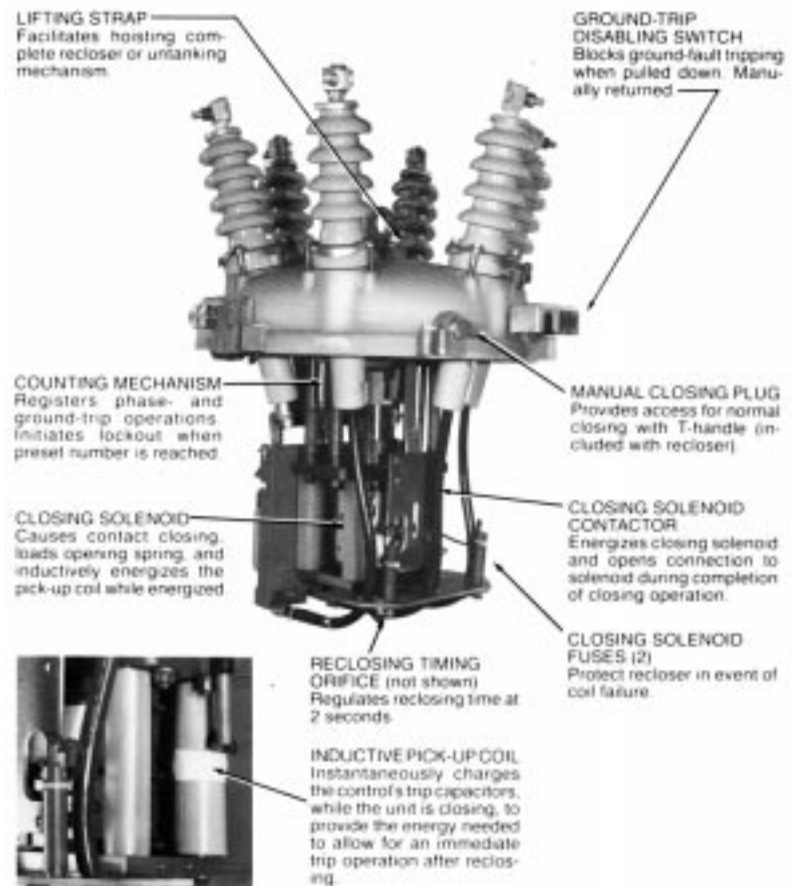


Figure 3.
Untanked Type KFE recloser (viewed from contactor side).

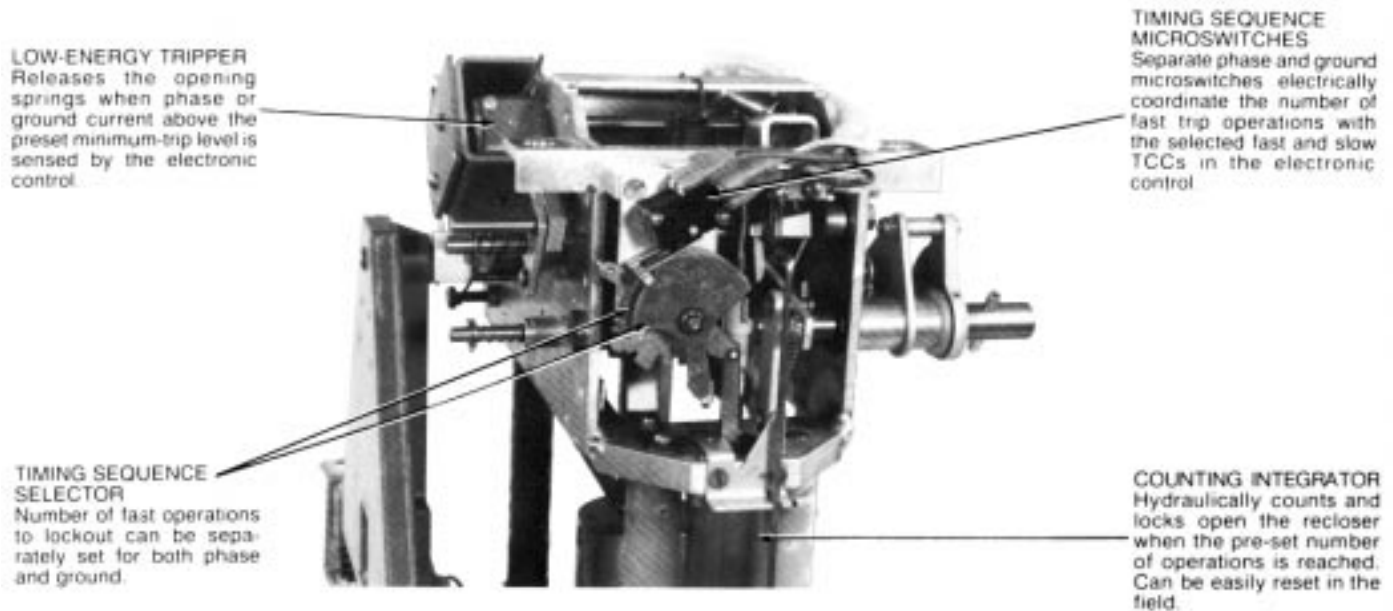


Figure 3.
Head mechanism for Type KFE recloser (head removed).

Reliable Operation

Connection of six recloser bushing terminals to the three-phase system prepares the recloser for operation. Raising the manual operating handle connects the closing solenoid across two phases and causes the closing solenoid plunger to be drawn into the solenoid. Through the recloser mechanism, this downward movement of the plunger closes the vacuum contacts, loads the contact pressure springs and the opening spring, and opens the phase-to-phase connection to the solenoid. The plunger is latched in the downward position after the vacuum interrupter contacts are closed.

Fault currents are sensed by six bushing current transformers mounted under the head of the recloser. Whenever any phase or ground current exceeds the minimum trip level and remains above that level for the selected timing period (as set in the electronic control), the low-energy tripper is energized by the energy-storage capacitor and releases the charged opening springs. The low-energy tripper provides simple and reliable operation, since energy to initiate the tripping operation is taken directly from the system.

Opening of the recloser contacts releases the closing solenoid plunger and allows it to travel upward to close the phase-to-phase connection to the closing solenoid. With the closing solenoid reenergized, a closing operation is accomplished in the same manner as described above.

Hydraulic control of recloser operations makes use of separate elements to regulate recloser sequence and reclosing time. A counting mechanism counts the number of operations to lockout.

Versatile Recloser Mounting

Any of three methods can be used to mount a Type KFE or KFVE recloser. Direct mounting by tank lugs to either a curved or flat surface (mounting lugs accommodate 16-mm (5/8-in.) diameter hardware); mounting by use of the pole extension hanger accessory; or substation mounting accessory.

Having a symmetrical head-to-tank clamping arrangement, the recloser may be placed in the tank in various positions. Thus optimum location of manual operating handles, indicators, and bushings can be easily accomplished.

Detailed Recloser Operation

The Types KFE and KFVE reclosers are completely self-contained, taking operating energy directly from the system. The electronic control signals the low-energy trip solenoid to initiate tripping operation. Reclosing and trip-spring energy is provided by a high-voltage closing solenoid. Dual timing of both phase-trip and ground-trip operations is provided by proper setting of the timing-sequence

selectors. Control of all recloser operations is hydraulic, except over-current sensing and trip timing which is controlled by the electronic control. Major components involved in operations are the closing solenoid; the low-energy tripper; the counting, sequencing, and lockout mechanisms; and the electronic control (Figure 5).

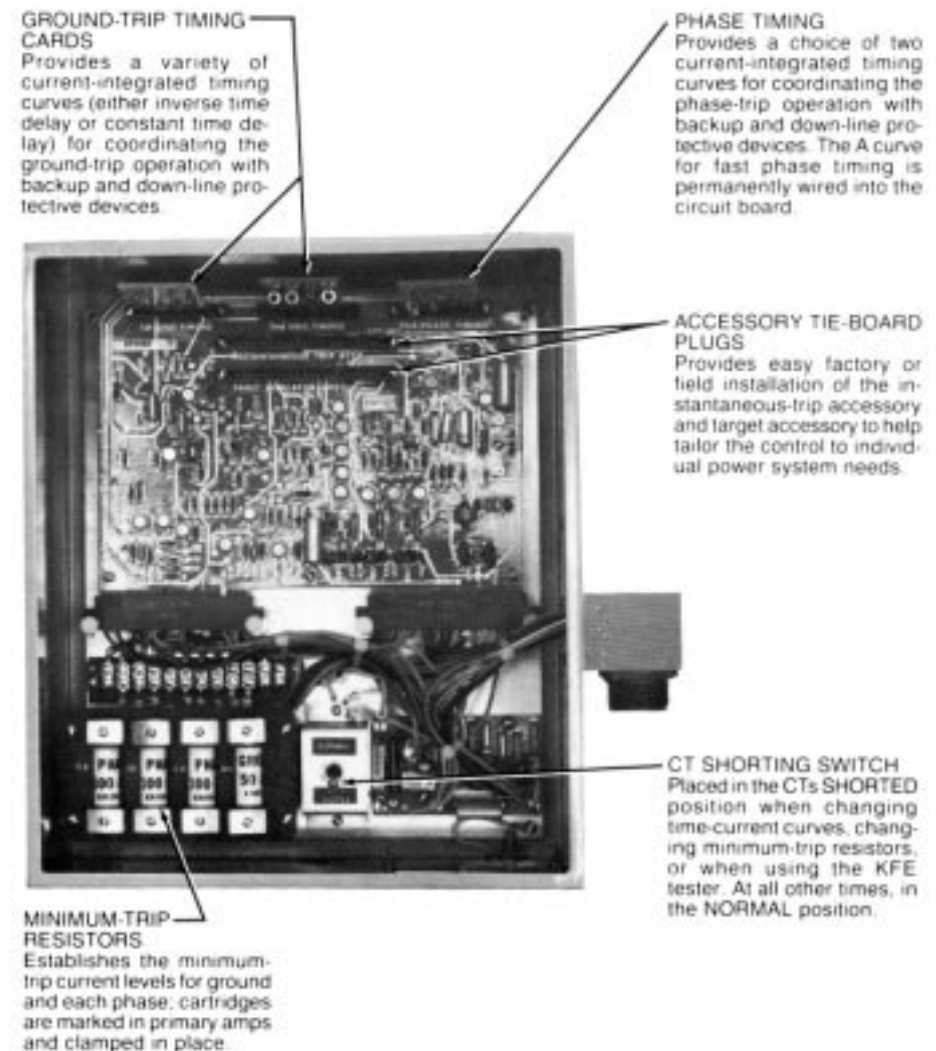


Figure 5.
Types KFE and KFVE electronic control.

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CLOSING SOLENOID

Energy that operates the recloser mechanism to close the vacuum interrupter contacts, compress the contact pressure springs, and charge the opening spring is obtained from the system through a high-voltage closing solenoid. As shown in Figure 6, this solenoid is connected phase-to-phase on the recloser's source side through a high-voltage contactor (switch). Selection of the closing solenoid voltage rating is based on the phase-to-phase voltage of the system on which the recloser is to be used. Low-voltage power can be employed for closing if the proper solenoid and a Low-Voltage Closing accessory are specified when the recloser is ordered.

The closing operation is best understood by considering the recloser to be connected to the line out but locked out (yellow manual operating handle in

downward position). To close from lock-out, the manual operating handle is raised to the closed position. This allows the closing solenoid contactor to close the phase-to-phase connection, thereby energizing the closing solenoid and imparting a downward acceleration to the solenoid plunger. Downward movement of the plunger causes the recloser operating mechanism to do the following:

- Contact-operating rods move downward to close vacuum interrupter contacts and compress contact-pressure springs.
- Closing-solenoid contactor opens.
- Opening spring is charged and recloser mechanism is set up for a tripping operation.
- Plunger is latched in its downward position, charging plunger-return springs.

While the recloser contacts are closed, the solenoid plunger remains latched in its downward position. Release of the recloser-opening spring (as in a trip operation) releases the plunger latch and allows the plunger to be drawn upward under action of the plunger-return springs. Oil flow into the chamber being vacated by upward movement of the plunger is regulated by a timing orifice in its base. This retards the plunger's upward movement to accomplish the recloser's two-second reclosing time (a four-second reclosing time is also available as an accessory). As the plunger reaches the top of its stroke, the closing solenoid contactor again closes, momentarily actuating the closing solenoid, and drawing the plunger back down to repeat the closing operation.

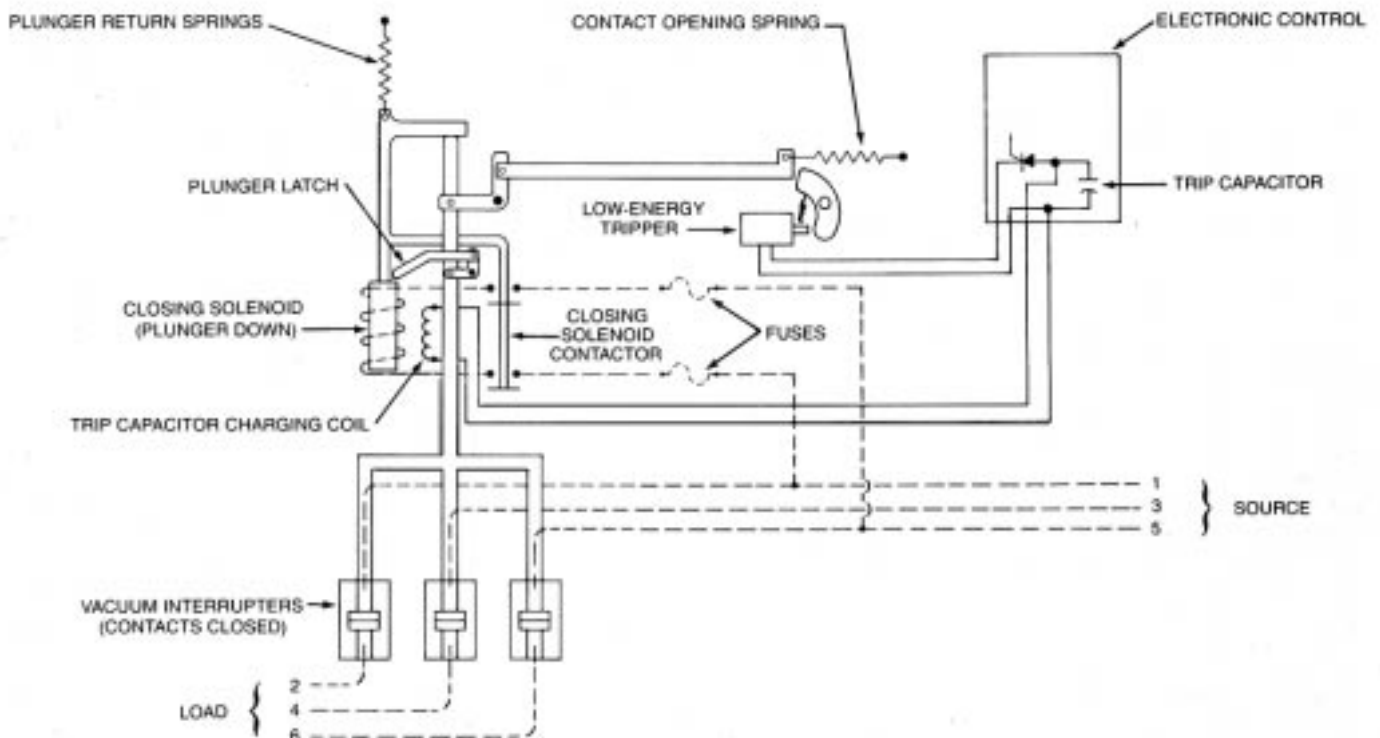


Figure 6.
Simplified diagram of recloser's major electrical and mechanical components.

LOW-ENERGY TRIPPER

The low-energy tripping mechanism, operated from the electronic control, initiates the overcurrent tripping operation. The mechanism consists of a permanent magnet and an armature and coil assembly which operate a trip lever (Figure 7).

During the closing operation, an electromagnetic charging coil instantaneously charges the trip capacitors — in the electronic-trip control—assuring that the recloser is armed and ready for an immediate trip operation if necessary. When the recloser is closed, the tripper-armature plunger is held in by the magnetic force of the permanent magnet. In this position, the armature spring is compressed and energized—ready to withdraw the armature when magnetically released.

During a trip operation, the stored energy in the trip capacitors energizes the solenoid coil in the low-energy tripper. This creates a counter-magnetic field which momentarily neutralizes the field of the permanent magnet—thus allowing the spring-driven armature to instantaneously operate the trip lever which in turn opens the recloser contacts. As the recloser contacts open, the precharged reset spring is released and returns the solenoid plunger to its de-energized position. This low-energy trip assembly is thus re-cocked and able to perform another trip operation as soon as a closing operation is completed.

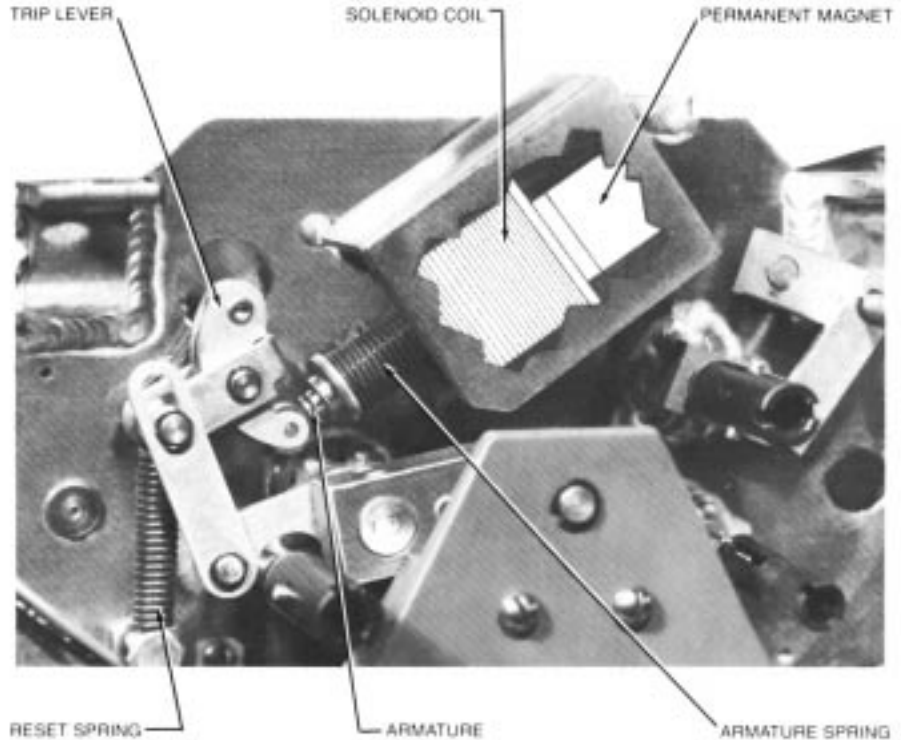


Figure 7.
Low-energy tripper.

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COUNTING AND SEQUENCING MECHANISMS

Each recloser operation is counted — phase and ground—by a ratchet-rod-and piston assembly mounted on the recloser mechanism. The counting mechanism in turn actuates the recloser's sequence mechanism and lockout mechanism.

COUNTING OPERATION

After each tripping operation, during the reclosing interval, a spring-biased pawl is moved upward by the pivoting mechanism linkage as shown by arrows in Figure 8. Being spring biased, the pawl engages the ratchet rod at the bottom of its stroke, raising the rod approximately 7,9-mm (5/16-in.). At the top of its stroke, the pawl disengages from the ratchet rod, returning to its starting position as the recloser closes.

The count is registered by a piston that is attached to the lower end of the ratchet rod and moves in an oil-filled housing. The piston is drawn upward with the ratchet rod and held there by oil trapped by a ball check valve; as the piston is drawn upward the valve opens, permitting the piston unimpeded upward travel, but downward movement only at a calibrated resetting rate. Each subsequent recloser operation further elevates the ratchet rod and piston.

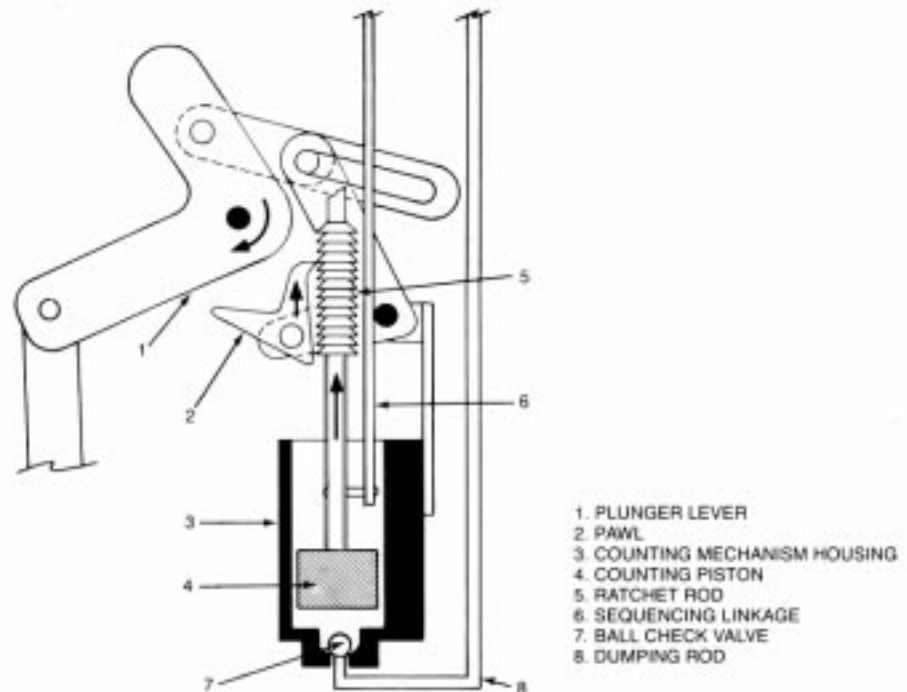


Figure 8.
Simplified diagram of counting mechanism.

The piston-and-ratchet-rod assembly begins resetting as soon as the pawl disengages from the ratchet rod as each count is completed. The reset time at 25° C is 75 to 175 seconds for each recloser operation counted. Following a lockout operation, the dumping rod raises the check valve, and results in a fast time (approximately 15 seconds), permitting the count to start from zero each time the yellow handle is raised.

NUMBER OF OPERATIONS TO LOCKOUT

The upper end of the ratchet rod contains a stepped spacer that can be indexed into three positions, providing 2, 3 or 4 operations to lockout (Figure 9). When the stepped spacer engages the lockout mechanism trip lever—after it has been raised the preset number of counts—it causes the recloser to lockout.

One operation to lockout can be set by moving the external non-reclosing handle, located under the sleet hood, to its downward position.

The counting mechanism registers all recloser phase- and ground-trip over-current operations. It will also register recloser operations initiated by externally controlled remote operating accessories.

SEQUENCING MECHANISM

A sequencing mechanism, consisting of a cam rod, a phase- and ground-trip cam, and a phase- and ground-sequencing switch connected to the electronic control determines on which characteristic the recloser will time its opening operations. The mechanism is actuated by movement of the ratchet rod (Figure 10).

When the recloser operates, the ratchet rod moves upward as previously described and causes a similar upward movement of the cam rod, causing a counterclockwise rotation of the cam assembly. As the recloser operates through its preset program, the sequencing switch rollers ride along the phase- and ground-trip cam edges. When the fast operations have been completed, the cam assembly will have rotated sufficiently to cause the sequencing roller to engage the sequencing switch. This switches the electronic control to its slow-timing characteristic. The sequencing mechanism will return to its reset position as the counting mechanism resets.

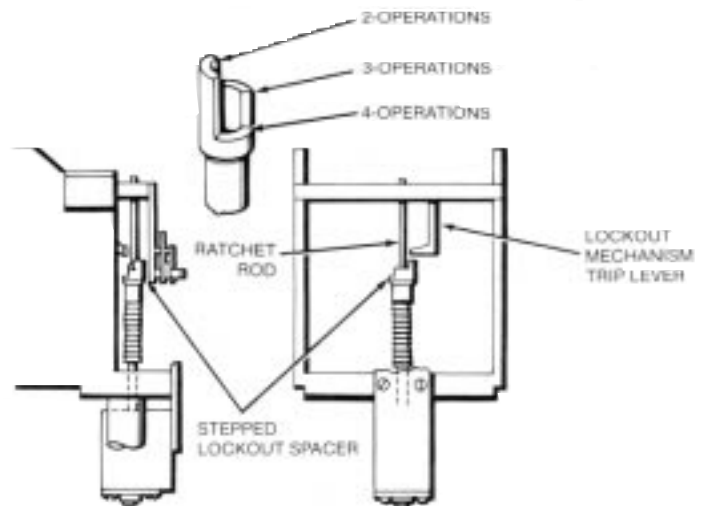


Figure 9. Simplified diagram showing operations to lockout settings on counting mechanism ratchet rod.

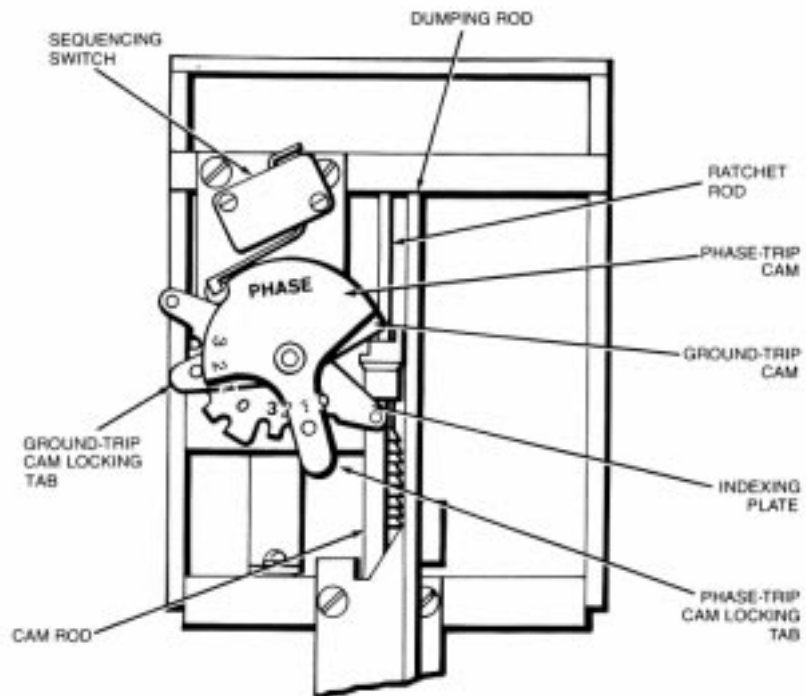


Figure 10. Sequencing mechanism and number-of-fast-operations settings.

NUMBER OF FAST OPERATIONS

The phase- and ground-trip cams are used to program the number of fast trip operations required in the recloser's operating sequence. As shown in Figure 10, the cam plates contain indexing numbers (0, 1, 2, 3) for both phase and ground. The operating sequence is set by simply lifting the locking tab on either the phase- or ground-trip cam and rotating it until it aligns with the desired number of operations on the fast curve. The number of slow operations will be automatically established—it will be the difference between the number of fast operations and the number of operations to lockout. In all cases, the total number of operations on both phase and ground must be the same. If four fast operations are desired, consult the factory.

ELECTRONIC CONTROL

The electronic control (Figures 11 and 12) utilizes solid-state circuitry and provides the intelligence for current sensing and trip timing. All the control electronics and electronic accessories are located in an external cabinet connected to the recloser with a 1,8-m (6-ft) long cable. The separate control cabinet is intended to be mounted to the recloser tank, although it can be mounted to the pole or other mounting structure at a distance equal to the cable length. The control cable is hard wired to the recloser and connected to the control with a threaded weatherproof connector.

CURRENT SENSING

KFE and KFVE reclosers have six 1000:1-ratio current-sensing transformers mounted on the bushings under the head—providing both phase- and ground- (zero-sequence) current sensing. The CTs are connected to the electronic control cabinet by the 1,8-m (6-ft) cable.

MINIMUM-TRIP SELECTION

The minimum-trip ratings, both phase (10-800 amps) and ground (5-400 amps) are established by plug-in resistor cartridges. The cartridges are labeled with their minimum-trip current values. The minimum-trip setting of the recloser can be changed by merely changing the trip resistors. A 1-amp ground minimum-trip rating is also available by connecting a jumper between Tabs X and Y on the main circuit board and installing a 5-amp ground minimum-trip resistor.

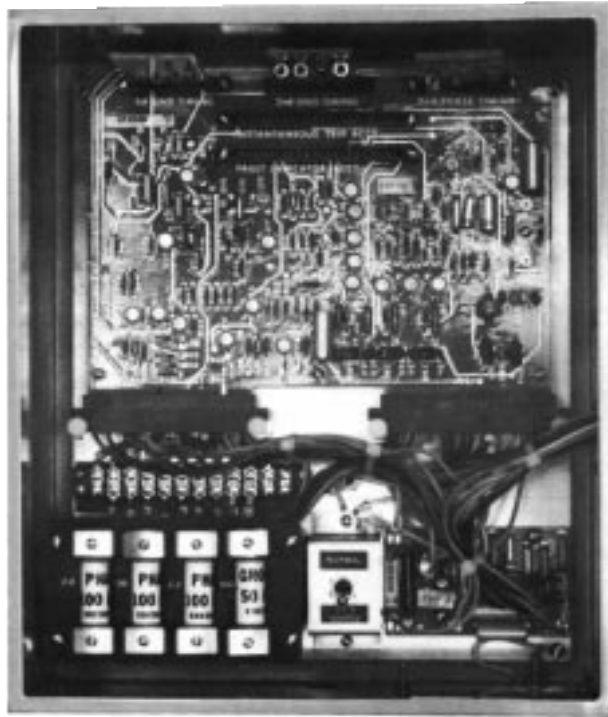


Figure 11.
Types KFE and KFVE recloser electronic control.

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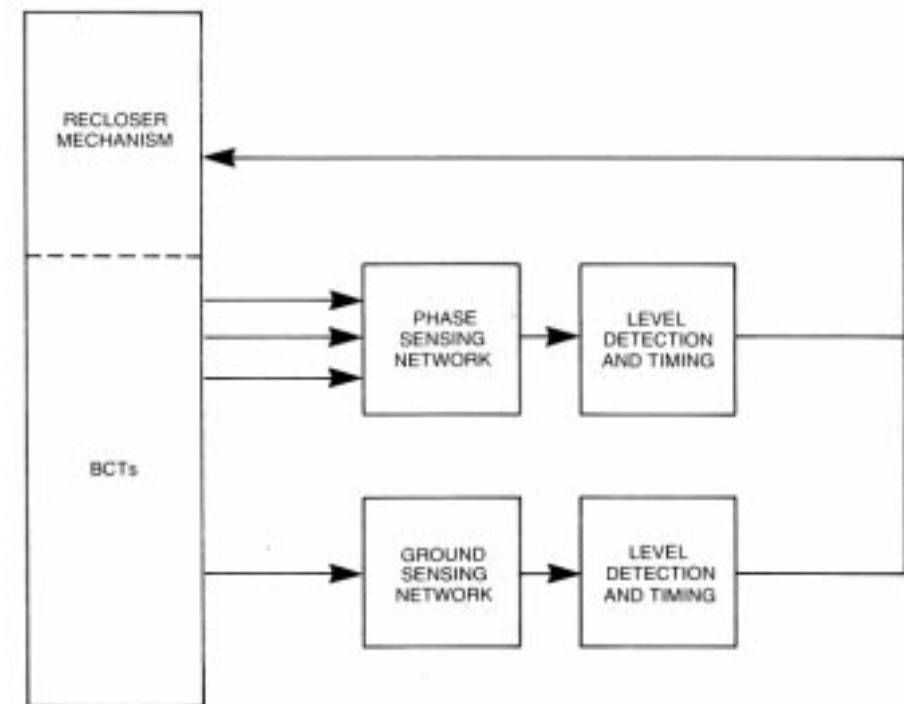


Figure 12.
Functional block diagram of electronic control.

PHASE- AND GROUND-TRIP TIMING

A variety of time-current characteristic curves allow the KFE and KFVE to fit specific power distribution systems. All timing starts at initiation of a fault, or when closing into a fault.

An A (fast), and B and C (delayed) phase-trip timing curves are available. For ground-trip timing, inverse curves 1 (fast) and 2 and 3 (delayed) and 9 constant time curves of from 0.1 to 15 seconds are available.

The A curve for phase timing is permanently wired on the control circuit board. The delayed phase-trip curves and all ground-trip curves are circuit cards which plug into the main control board. Phase and ground TCC circuit cards are not interchangeable. A typical set of curves is illustrated in Figure 13. For detailed coordination planning, complete sets of curves can be ordered; specify Cooper Power Systems bulletin *KFE10004-E*.

CONTROL POWER

The KFE and KFVE reclosers are completely self-contained; no external power source or battery is required to operate the electronics. The electronic circuitry is powered from the line by bushing-current transformers mounted under the head. A minimum of 5-amps primary current flow is sufficient to power the electronics and charge the trip capacitors which actuate the low-energy tripper. In addition, a pickup coil, wound on one leg of the closing solenoid frame, provides additional charge to the trip capacitors during each reclosing operation to insure that sufficient tripping power is available immediately following a closing operation, thus eliminating the necessity of a time delay to charge trip capacitors from load or fault current. Tabs are provided on Terminal Strip TB2 within the control cabinet for connecting a 15-18 Vdc voltage supply to charge the capacitors for test purposes.

VACUUM INTERRUPTION

Vacuum has proven to be an efficient medium for fault- and load-current interruption. It offers many advantages over other interrupting media:

- Deterioration of the medium is virtually non-existent.
- Its extremely rapid dielectric recovery makes the interrupter insensitive to the recovery-voltage rise rates usually encountered.
- Interrupter contact wear is minimal; consequently, contact life is considerably extended.

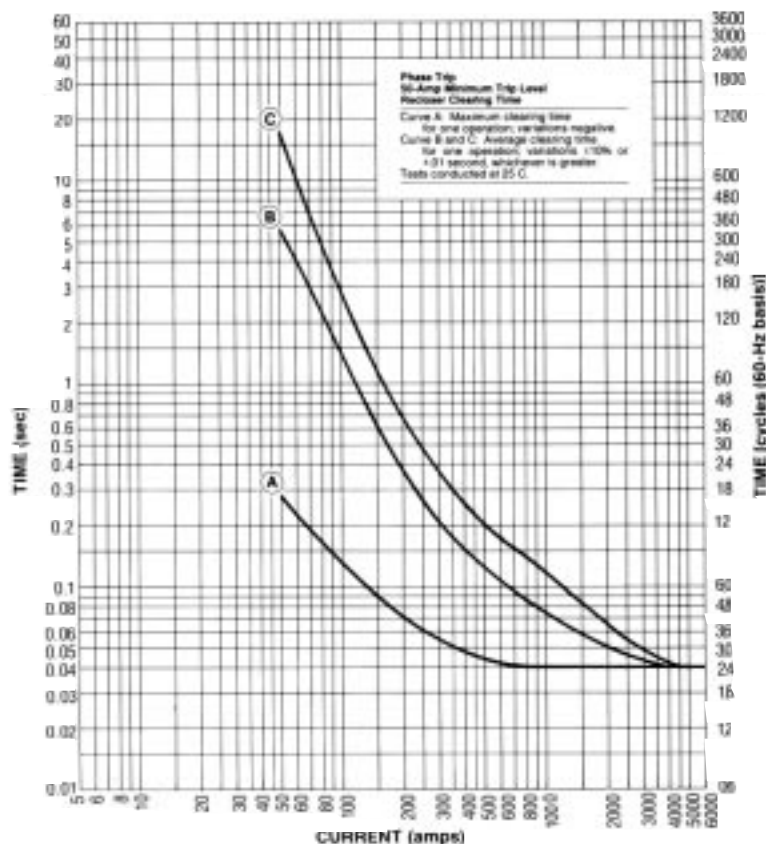


Figure 13.
Typical set of time-current curves for phase-trip operations.

- Shorter contact travel significantly reduces mechanism shock which results in less parts wear and longer operating life.
- Shorter contact travel results in faster opening time and fault clearing.
- The medium itself requires no service throughout the life of the interrupter.

Since the early twenties, designers of circuit interrupters have recognized the advantages of vacuum as an interrupting medium. But only during the last 35 years have two major technological advances enabled vacuum interrupters to become a commercial reality. These are developments in metallurgy growing out of the semiconductor industry and developments in modern vacuum techniques.

It was during this period that Cooper Power Systems, in conjunction with other research organizations, developed its first vacuum interrupter. Culminating over ten years of research, testing, and development, Cooper Power Systems (then Line Material Industries) announced in 1966 the Type VSA vacuum recloser, forerunner of what today is the industry's broadest line of vacuum reclosers.

Manufactured at its Kyle Products Plant, Cooper Power Systems vacuum interrupters have established a superb field record for long life and high reliability. This stems from superior design, materials, and processing, plus thorough testing to confirm that high-quality standards have been met. The interrupters used in the Types KFE and KFVE reclosers (Figure 14) employ the same materials and are similarly processed and tested.



Figure 14.
Vacuum interrupters installed in Type KFE recloser.

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Interrupter Design and Construction

In the Types KFE and KFVE reclosers interrupter (Figure 15), a symmetrical interrupting chamber, placing contacts near the center of the interrupter insulation, makes most efficient use of its dielectric capabilities. This assures a more reliable interrupter and optimum electrical design of the interrupter support structure.

Major interrupter insulation is provided by a high-alumina ceramic cylinder. Ceramic is used, rather than glass, because it is far stronger and withstands the extremely high vacuum-bakeout temperature. High bakeout temperature insures the interrupter purity level required for long vacuum life.

End caps are made of a vacuum-melted alloy having thermal expansion closely matching that of the ceramic. They are joined to the metallized ends of the ceramic using a unique butt-seal brazing method. Experience has proven this to be a highly reliable means of achieving the enclosure integrity required to maintain the very high vacuum level -10^{-7} to 10^{-9} mm of mercury—required for interrupter operation.

A stainless-steel bellows completes the vacuum enclosure. Sealed to the moving-contact shaft, the bellows withstand the short but rapidly accelerating contact motion without fatigue, over a long mechanical life.

The copper-alloy contact materials, that are used in the contact assemblies, are processed in specialized vacuum equipment. The contacts are designed for antiwelding and high current-interruption capabilities.

Processing and assembly of Cooper Power Systems vacuum interrupters is accomplished under carefully controlled manufacturing conditions. Vacuum-melted alloys—essentially pure to start with—are further decontaminated, then assembled in a contaminant-free clean room. Further purification is accompi-

shed under elevated temperature in the bakeout process. Automatic equipment insures proper vacuum processing while the purification cycle is completed. Full sensitivity leak tests—possible because the ceramic has an extremely low helium permeability—confirm enclosure integrity. Assurance that exact manufacturing specifications have been met is provided by electrical tests of the interrupter before and after assembly in the recloser.



Figure 15.
Cutaway of typical vacuum interrupter.

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RATINGS AND SPECIFICATIONS

TABLE 1
Voltage Ratings

Description	KFE	KFVE
Nominal operating (Kv)	2.4-14.4	2.4-24.9
Maximum design (Kv)	15.5	27.0
Impulse withstand (BIL) 1.2 x 50 microsecond wave, crest (Kv) ...	110*	125*
60-Hz withstand (rms)		
Dry, 1 min (Kv)	50	60
Wet, 10 sec (Kv)	45	50
RIV at 1000 kHz, at 9.41 Kv KFE, 16.4 Kv KFVE (microvolts max) .	100	100
Operating frequency (Hz)	50-60	50-60

*In accordance with ANSI standard C37.60—1981.

TABLE 2
Current Rating

Description	KFE	KFVE
Maximum continuous current (amps)	400	400
Overload capability (4 hr) (amps)	500*	500*
(2 hr at 40°C) (amps)	600*	600*
Interrupting current (amps)	6000	6000
Magnetizing interrupting current (amps)	14	14
Cable charging current at 8.94 Kv KFE, 15.5 Kv KFVE (Ø and gnd) (amps)	5	5
Three-second current (rms sym amps)	6000	6000
Momentary current (rms sym amps)	9000	9000
Surge current (amps)	65000	6500
Make current (peak asym amps)	16200	16200

*After level-off at rated continuous current

TABLE 3
Interrupting Rating

Minimum Trip Current (amps)		Maximum Interrupting Current (rms symmetrical amps)	
Phase	Ground	KFE	KFVE
—	5	6000	6000
10	10	6000	6000
20	20	6000	6000
30	30	6000	6000
50	50	6000	6000
70	70	6000	6000
100	100	6000	6000
140	140	6000	6000
200	200	6000	6000
280	280	6000	6000
320	320	6000	6000
400*	400*	6000	6000
450*	—	6000	6000
560*	—	6000	6000
800*	—	6000	6000

*Continuous current rating 400 amp

TABLE 4
Operating Times

Normal reclosing time (sec)	2*
Resetting time at 25°C (min per recloser operation)	1.5

*A four-second reclosing time is available.

TABLE 5
Duty Cycle

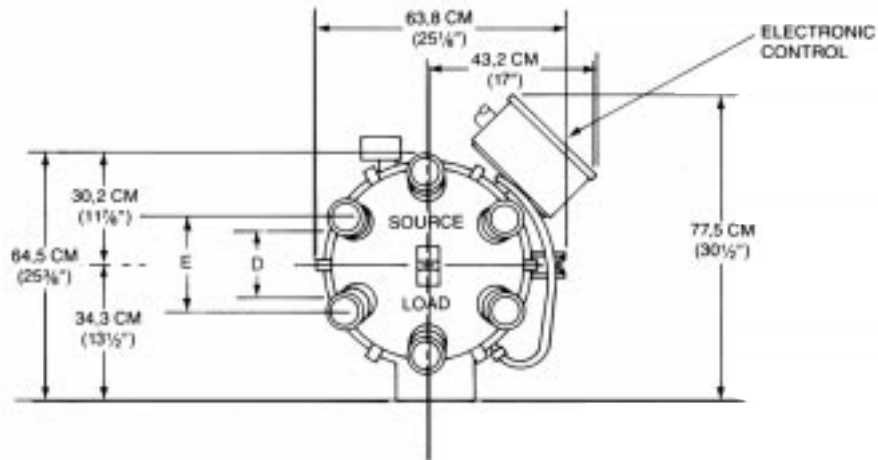
% of Interrupting Rating	Max Circuit X/R Ratio	Number of Operations
KFE 15-20	3	96
15 Kv 45-55	7	120
6 KA* 90-100	14	<u>32</u>
		248 Total
KFVE 15-20	4	96
27 Kv 45-55	8	120
6 KA* 90-100	15	<u>32</u>
		248 Total

*Maximum interrupting current (rms symmetrical amps).

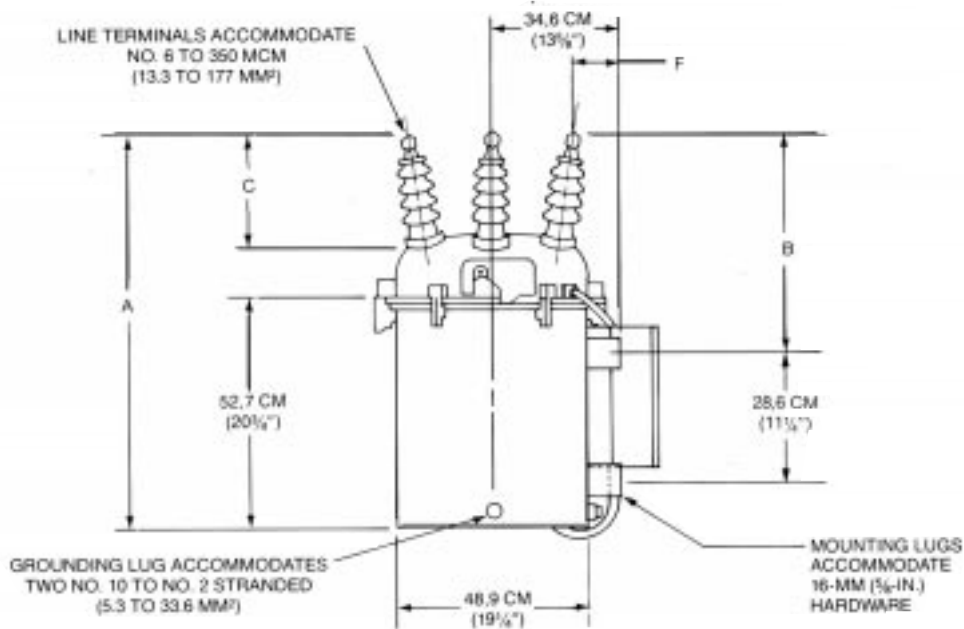
TABLE 6
Mechanical Specifications

Operating temperature (°C):	
Minimum	-30
Maximum	50
Close mechanism	Solenoid close
Open mechanism	Spring operated
Contact close time (cycles)	0.75
Contact gap cm (in.)	0,95 (0.375)
Contact open time (cycles)	0.50
Interrupting time (cycles)	1.50
Allowable contact erosion cm (in.):	
KFE	0,32 (0.125)
KFVE	0,16 (0.062)
Resetting time, integrator, sec (at 25°C) per trip operation (Quick reset after lockout)	75-175
Resistance, nominal (micro-ohms):	
Bushings, terminal-to-terminal	400
Reclosing time (sec at 25°C)	1.5-2.5
Mechanical life (minimum operations):	
Mechanism	2500
Vacuum bottle	2500
Creepage distance cm (in.)	
KFE	29.5 (11-5/8)
KFVE	63.3 (26-1/2)

DIMENSIONS, WEIGHTS, OIL CAPACITY



Dimension	KFE	KFVE
A	93,7 cm (36 ⁷ / ₈ "	107,8 cm (42 ⁷ / ₈ "
B	54,8 cm (21 ⁵ / ₈ "	68,7 cm (27 ¹ / ₈ "
C	28,3 cm (11 ¹ / ₈ "	42,4 cm (16 ⁷ / ₈ "
D	20,3 cm (8"	23,2 cm (9 ¹ / ₈ "
E	27,3 cm (10 ³ / ₈ "	31,4 cm (12 ³ / ₈ "
F	11,1 cm (4 ³ / ₈ "	7,5 cm (2 ⁷ / ₈ "

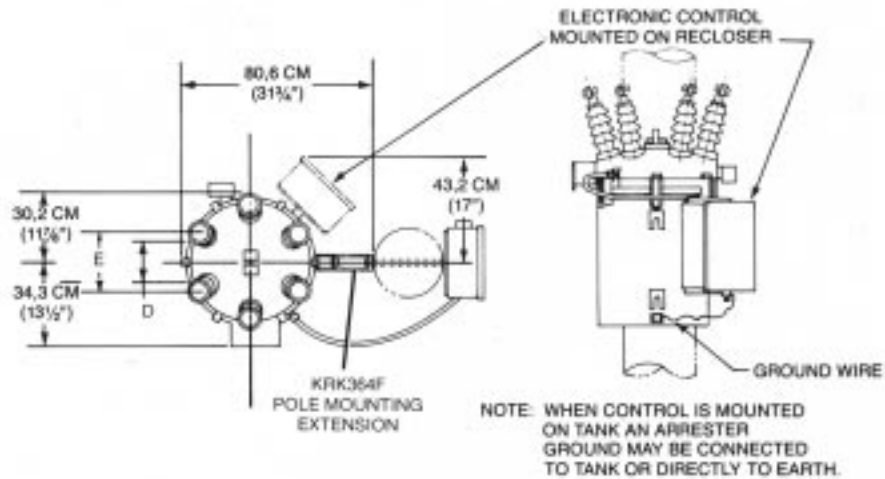


Dimensions and Weights

Description	KFE	KFVE
Recloser weight with oil kg (lb)	172 (380)	189 (416)
Recloser weight with pole-top frame kg (lb)	181 (400)	198 (436)
Recloser weight with substation frame kg (lb)	240 (530)	257 (566)
Recloser oil capacity liters (gal)	71,9 (19)	71,9 (19)
Standard bushing creepage cm (in.)	29,53 (11 ⁵ / ₈)	67,3 (26 ¹ / ₂)

Figure 16. Types KFE recloser top and front view dimensions.

DIMENSIONS (Continued)



Dimension	KFE	KFVE
A	93,7 cm (36 7/8")	107,8 cm (42 1/8")
B	54,8 cm (21 5/8")	68,7 cm (27 1/8")
C	28,5 cm (11 1/8")	42,4 cm (16 7/16")
D	20,3 cm (8")	23,2 cm (9 1/8")
E	27,3 cm (10 3/4")	31,4 cm (12 3/8")
F	27,9 cm (11")	7,5 cm (2 5/8")

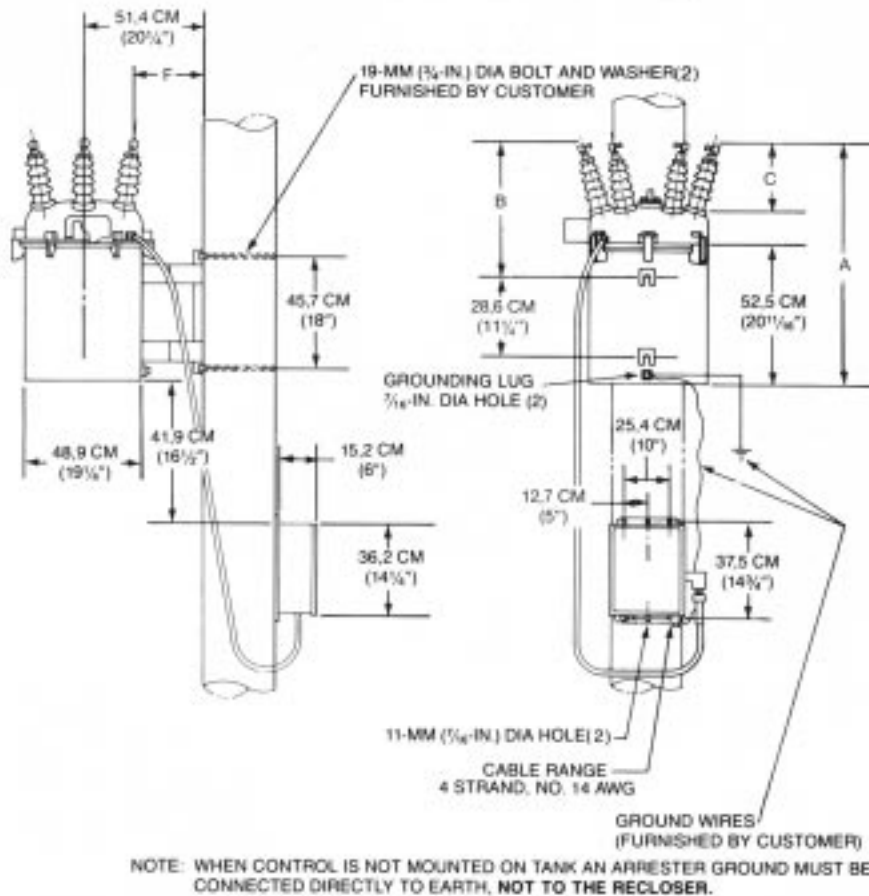
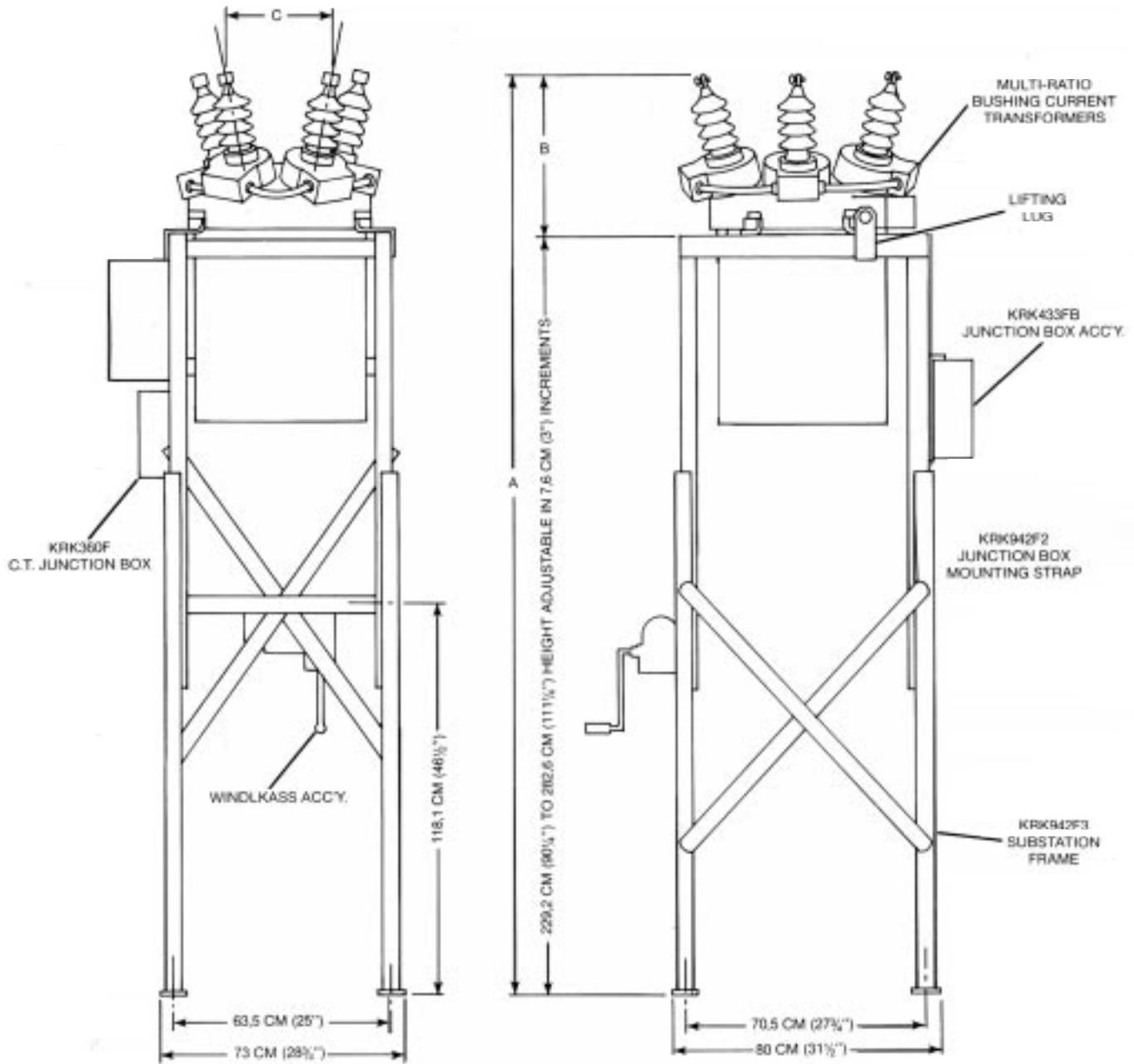


Figure 17. Mounting and clearance dimensions for pole-mounting extension hanger.



Dimension	KFE		KFVE	
	No BCT's	With BCT's	No BCT's	With BCT's
A	271,3 cm (106 ¹³ / ₁₆ "	283,3 cm (111 ³ / ₁₆ "	286,5 cm (112 ³ / ₁₆ "	298,6 cm (117 ¹ / ₁₆ "
B	42 cm (16 ¹ / ₄ "	94,1 cm (21 ³ / ₁₆ "	57,3 cm (22 ³ / ₁₆ "	71 cm (27 ⁷ / ₁₆ "
C	27,3 cm (10 ³ / ₄ "	31,4 cm (12 ³ / ₁₆ "	31,4 cm (12 ³ / ₁₆ "	34,3 cm (13 ¹ / ₂ "

Figure 18. Mounting and clearance dimensions for substation elevating structure.

RECLOSER ACCESSORIES

The Types KFE and KFVE reclosers can be tailored to meet a variety of application requirements by including factory-installed accessories. Ordering information for all accessories is found at the end of this bulletin.

Extra-Creepage Bushings

When Type KFE reclosers are to be installed where extensive salt spray, smog, smoke, or other atmospheric contaminants reduce the effectiveness of porcelain insulation, extra-creepage bushings can be supplied. Standard Type KFE recloser bushings provide 29,5 cm (11-5/8-in) of creepage; extra-creepage accessory bushings provide 43,2 cm (17-in.).

ORDERING INFORMATION	
Extra-creepage bushings	KRK288FC

Bushing-Current Transformers

A set of three 600:5 multi-ratio bushing-current transformers can be factory-installed externally on source-side bushings (Figure 19). The accessory includes three current transformers, conduit and fittings between the current transformers, and 1,5m (5-ft) of factory wiring to a terminal block mounted in a weather-proof junction box. Although the ratio to be connected— 50:5, 100:5, 150:5, 200:5, 250:5, 300:5, 400:5, 450:5, 500:5 or 600:5—must be specified when this accessory is ordered, it can be changed at the installation site (Figure 20).

NOTE: Current transformer cannot be installed over bushing #4 when KRK414FB remote close accessory is used.



Figure 19.
Bushing-current transformer accessory mounted on recloser bushings.

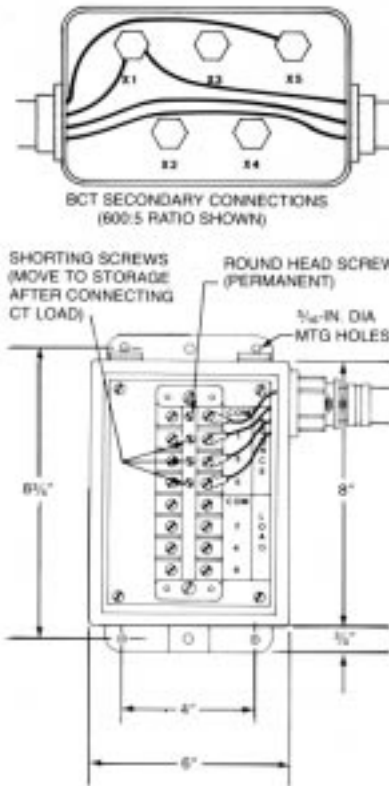


Figure 20.
Bushing-current transformer connections.

ORDERING INFORMATION

Three 600:5 multi-ratio BCTs on source-side standard creepage bushings, KFE	KRK50F3X
Three 600:5 multi-ratio BCTs on source-side extra-creepage bushings, KFE	KRK51F3X
Three 600:5 multi-ratio BCTs on source-side, KFVE	KRK63F3X
600:5 multi-ratio slip-on BCT field-installation kit (one transformer per kit)	KA712L2

Accessory-Connection Junction Box

The Accessory-Connection Junction Box (KRK433FA) must also be specified when recloser is to be furnished with one or more of the following accessories.

- Auxiliary switch.
- Lockout-indicating switch.
- Remote trip.
- Remote lockout.
- Remote close.
- Low-voltage closing.

When reclosers are to include remote closing in addition to one of the above accessories, the KRK433FB (Figure 21) junction box must be specified.

The junction box provides a convenient single location for connection of customer remote operating and indicating circuits. The KRK433FA junction box includes a 1,8-m (6-ft) cable for interconnection of recloser and junction box. The KRK433FB includes an additional cable for connection to the remote closing accessory. Figure 22 shows the dimensions and accessory connection locations in the KRK433FA and KRK433FB junction boxes.

ORDERING INFORMATION

Accessory-connection junction box	KRK433FA
Accessory-connection junction box (if remote-closing accessory ordered)	KRK433FB



Figure 21.
Accessory-connection junction box (KRK433FB) with cable receptacles for connection to recloser and remote-closing accessory.

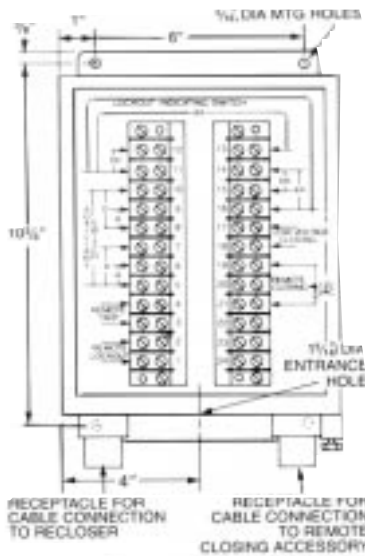


Figure 22. Dimensions and accessory-connection locations in the KRK433FA and KRK433FB accessory junction boxes.

Auxiliary Switch

Remote indication of recloser contact position can be accomplished with the Auxiliary Switch accessory (Figure 23). The contacts of the auxiliary switch also can be used to switch other circuits in accordance with the opening and closing of the recloser contacts. Table 7 shows the interrupter ratings of the auxiliary switch.

TABLE 7
Interrupting Ratings of Auxiliary Switch

Volts	Current (amps)
120 ac	15
240 ac	15
24 dc	2
48 dc	0.75
125 dc	0.5
250 dc	0.25

A two-stage switch is provided; each stage contains one single-pole doublethrow isolated set of contacts—*a* and *b*. When the recloser contacts are open, the *a* contacts are also open and the *b* contacts are closed. How auxiliary switch and recloser contacts are related is tabulated below. The contacts cannot be changed.

When recloser contacts are closed: Auxiliary switch contacts a are closed; auxiliary switch contacts b are open.
When recloser contacts are open: Auxiliary switch contacts a are open; auxiliary switch contacts b are closed.

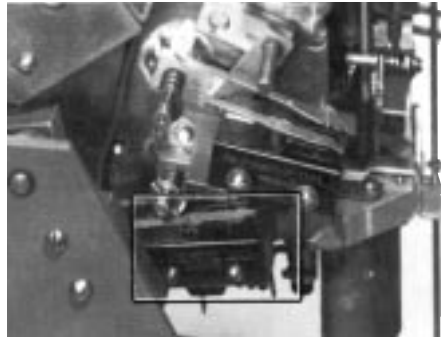


Figure 23. Auxiliary switch mounted on side of recloser mechanism frame.

Customer connections to auxiliary switch contacts are made in the accessory-connection junction box (Figure 22). One stage (Terminals 8, 9, and 10 in Figure 22) is employed in the switching of the remote-trip accessory; however, the second stage of the auxiliary switch (Terminals 5, 6, and 7 in Figure 22) is available for customer use.

The accessory-connection junction box must be ordered separately unless the remote-trip accessory is specified; in this case, the auxiliary switch is automatically included, and need not be specified separately.

ORDERING INFORMATION

Accessory auxiliary switch (2 normally open/normally closed contacts),.....	KRK411FA*
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* Requires accessory junction box KRK433FA. If remote-trip accessory is ordered, auxiliary switch accessory need not be ordered separately.

Lockout-Indicating Switch

A Lockout-Indicating Switch accessory (Figure 24) can be included on reclosers to provide a facility for remote indication of recloser lock out. This accessory is particularly useful in load-transfer schemes or other applications where lockout of one recloser may initiate the closing of another. Table 8 shows the interrupting ratings of the lockout-indicating switch.

TABLE 8
Interrupting Ratings of Lockout-Indicating Switch

Volts	Current (amps)
120 ac	15
240 ac	15
24 dc	2
48 dc	0.75
125 dc	0.5
250 dc	0.25

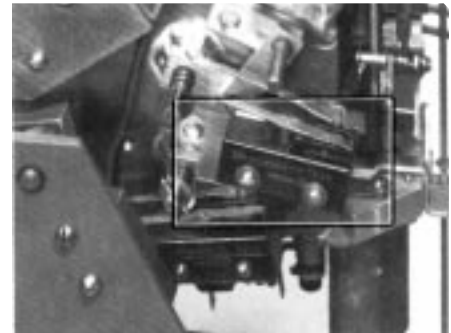


Figure 24. Lockout-indicating switch mounted on side of recloser mechanism.

A two-stage switch is provided; each stage contains one single-pole, doublethrow isolated set of contacts—*aa* and *bb*. When the recloser is locked out, the *bb* contacts are closed and *aa* contacts open. See tabulation below for relationship of recloser and indicating switch contacts. The contacts cannot be changed.

When recloser is	locked out	not locked out
Indicating switch <i>aa</i> contacts are	open	closed
Indicating switch <i>bb</i> contacts are	closed	open

Customer connections to lockout-indicating switch contacts are made in the accessory-connection junction box as shown in Figure 22. One stage (Terminals 14, 15, and 16 in Figure 22) is employed in the switching of the remote-lockout accessory; however, the second stage of the lockout-indicating switch (Terminals 11, 12, and 13 in Figure 22) is available for customer use.

The accessory-connection junction box must be ordered separately unless the remote-lockout accessory is specified; in this case, the lockout-indicating switch is automatically included, and need not be specified separately.

ORDERING INFORMATION

Accessory lockout-indicating switch	KRK412FA*
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* Requires accessory junction box KRK433FA. If remote-lockout accessory is ordered lockout-indicating switch need not be ordered separately.

Remote-Trip Accessory

Recloser trip operations can be triggered from a remote location by energizing the Remote-Trip accessory (Figure 25) through an external supply circuit. Automatic reclosing will occur, the recloser will count the operation, and sequencing will occur in the same manner as if the electronic control had operated. Table 9 lists the remote-trip accessory ratings.



Figure 25. Remote-trip accessory mounted on side of recloser mechanism.

TABLE 9
Remote-Trip Accessory Ratings

Catalog No.	Rated Voltage (volts)	Current Required (amps)
KRK53FA	24 ac	7.0
	24 dc	2.0
KRK53FB	48 ac	3.5
	48 dc	1.0
KRK53FC	120 ac	1.8
	125 dc	0.5
KRK53FD	240 ac	0.9
	250 dc	0.25

Total time to open recloser contacts using the remote-trip accessory is 0.033 seconds (or 2 cycles on a 60-Hz basis).

A two-stage auxiliary switch is provided as part of the remote-trip accessory. One stage is employed in the switching of the remote-trip accessory; the second stage—to which connections are made at Terminals 5, 6, and 7 in the junction box accessory—is available for customer use. Operation and ratings of the auxiliary switch are the same as described earlier for the auxiliary switch accessory. External circuit connections to the remote-trip accessory are made in the accessory-connection junction box as shown in Figure 22.

ORDERING INFORMATION

Remote-trip accessory:	
24 Vac or 24 Vdc	KRK53FA*
48 Vac or 48 Vdc	KRK53FB*
120 Vac or 125 Vdc	KRK53FC*
240 Vac or 250 Vdc	KRK53FD*

* Requires accessory junction box KRK433FA. Also includes lockout-indicating switch accessory KRK412FA.

Remote-Lockout Accessory

When energized from an external source, the Remote-Lockout accessory (Figure 26) will cause the recloser to trip and its mechanism to lockout. The recloser's yellow manual operating handle will drop to its lockout position, providing a visual indication that the recloser is locked out. Table 10 lists the remote-lock out accessory ratings.



Figure 26. Remote-lockout accessory mounted on side of recloser mechanism.

TABLE 10
Remote-Trip Accessory Ratings

Catalog No.	Rated Voltage (volts)	Current Required (amps)
KRK409FA	24 ac	7.0
	24 dc	2.0
KRK409FB	48 ac	3.5
	48 dc	1.0
KRK409FC	120 ac	1.8
	125 dc	0.5
KRK409FD	240 ac	0.9
	250 dc	0.25

Total time to open recloser contacts and lockout the mechanism using the remote-lockout accessory is 0.05 seconds (or 3 cycles on a 60 Hz basis).

Closing from lockout can be accomplished manually by moving the yellow handle up to its closed position, or remotely with the remote-closing accessory. Remote-lockout and remote-closing accessories are often applied on the same recloser to enable remote control of lockout and closing. External circuit connections to the Remote-Lockout accessory are made in the accessory-connection junction box (Figure 22).

A two-stage lockout-indicating switch is provided as part of the remote-lockout accessory. One stage is employed in the switching of the remote-lockout accessory; the second stage—to which connections are made at Terminals 11, 12, and 13 in the junction box accessory—is available for customer use. Operation and ratings of the lockout-indicating switch are the same as described earlier for the lockout-indicating switch accessory.

ORDERING INFORMATION

Remote-trip accessory:	
24 Vac or 24 Vdc	KRK409FA*
48 Vac or 48 Vdc	KRK409FB*
120 Vac or 125 Vdc	KRK409FC*
240 Vac or 250 Vdc	KRK409FD*

* Requires accessory junction box KRK433FA. Also includes lockout-indicating switch accessory KRK412FA.

Remote-Close Accessory

When energized from an external source, the Remote-Close accessory (Figure 27) initiates a closing operation by moving the recloser's yellow manual-operating handle to its closed position. This actuates the closing-solenoid contactor to energize the solenoid and close the recloser.

The remote-close solenoid is rated for intermittent duty, and accordingly should

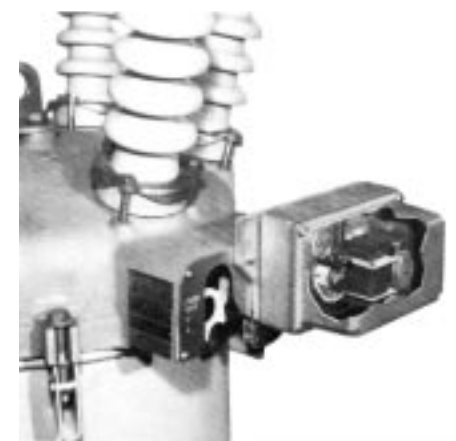


Figure 27. Remote-close accessory mounted on recloser sleet hood.

be energized only with a three-wire supply including a normally open momentary contact. When the contact is closed, a relay is energized which closes the circuit to the accessory motor. On completion of the closing operation, switches restore the accessory circuits in preparation for the next closing signal. External circuit connections are made in the accessory junction box (Figure 22) when the remote close accessory is on a recloser that also includes one or more of the following accessories:

- Auxiliary switch.
- Lockout-indicating switch.
- Remote-trip.
- Remote-lockout.
- Low-voltage closing.

When none of the above listed accessories are included on the recloser, the accessory junction box is not required and customer connections for the remote-close accessory are made directly to the accessory.

Electrical ratings of the remote-close accessory are:

- Voltage (Vac) 120
- Current (amps)
- Inrush 1.25
- Steady state 0.5
- Operating time (sec) 2

ORDERING INFORMATION

Remote close, 120 Vac.	KRK414FB*
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* Requires accessory junction box KRK433FA, if any of the following accessories are ordered: auxiliary switch, lockout-indicating switch, remote trip, remote lockout, or low-voltage closing.

Low-Voltage Closing

When the proper closing coil is specified and a Low-Voltage Closing accessory (Figure 28) is included, the Type KFE recloser can employ low-voltage ac closing. The proper coil is specified by code number in the recloser catalog number; the low-voltage closing accessory provides the alternate closing-solenoid contactor and the factory-installed wiring to accommodate the low-voltage closing power. Also a separate step-down transformer is utilized to insure that enough voltage is present to charge the trip capacitors under low-voltage closing. Customer low-voltage power is connected in the accessory-connection junction box (Figure 20). Reclosing time using the low-voltage closing accessory is:

- Normal reclosing time (see) 2
 - Resetting time at 25°C
(min per recloser operation) 1.5
- (A 4-second reclosing time is available.)



Figure 28. Type KFE low-voltage closing accessory, mounted on side of recloser mechanism.

82085KM-A

TABLE 11
Low-Voltage Closing Accessory Ratings

Rated Voltage (Vac)	Current Required (amps)	Closing Coil Code No.*
120	40	26
240	25	28

*Specify as final two digits in recloser catalog number.

ORDERING INFORMATION

Low-Voltage Closing Accessory

120 Vac	KRK54FA
240 Vac	KRK54FB

CONTROL ACCESSORIES

Instantaneous-Trip Accessory

The Instantaneous-Trip accessory (Figure 29) extends the range of recloser coordination with source-side devices at higher fault levels. Above a predetermined fault level, the accessory bypasses the programmed time-current characteristics to cause the recloser to trip immediately without intentional time delay. For fault currents below this actuation level, the control operates according to its normal programmed trip characteristics.

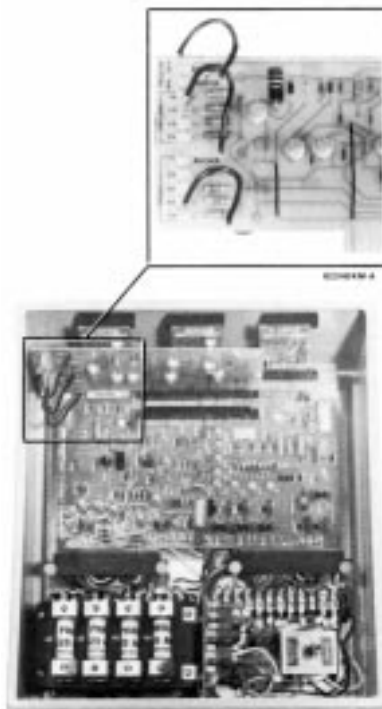


Figure 29. Instantaneous-trip accessory.

82249KM-A

Actuating levels are based on multiples of the minimum-trip current settings of the control—2, 4, 6, or 8 times the normal trip level. Separate phase and ground multiple selections are made by push-on tabs located on the accessory circuit board.

The instantaneous-trip accessory is operational on all shots in the operating sequence, unless the Block feature is selected. The phase and ground Block selection cancels all accessory operations. Phase or ground may be separately blocked, or they may both be blocked at the same time. The Block feature is operational on all shots in a sequence when it is selected.

The instantaneous-trip accessory consists of a plug-in circuit board that mounts on the back panel inside the electronic control. There are no connections external to the control.

Coordination of a recloser equipped with instantaneous trip and a source-side fuse is shown in Figure 30. With the recloser operating normally on its delayed TCC curve, coordination with the primary fuse will be lost at fault levels above approximately 2000 amps. However, with the instantaneous-trip accessory set for a multiple of 4, the recloser will trip instantly at any fault level above 1600 amps and extend recloser-fuse coordination up to the maximum interrupting level of the recloser.

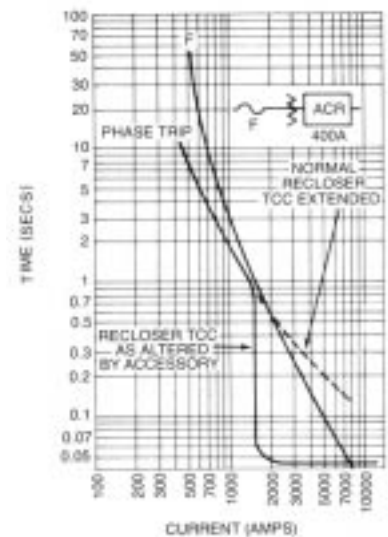


Figure 30. Instantaneous-trip coordination with a high-side fuse.

Another application of the instantaneous-trip accessory is diagrammed in Figure 31. With the accessory set for a multiple of 4, a fault at F1 would initiate instantaneous tripping for fault currents above 1600 amps. The fault would be sectionalized by the sectionalizer which requires only momentary current interruption to achieve its counting mechanism.

A fault at F2, however, will not activate instantaneous tripping because the maximum available fault level is below 1600 amps. The recloser will operate on its programmed 2A2C sequence and the delayed curve will allow the fuse to clear the fault.

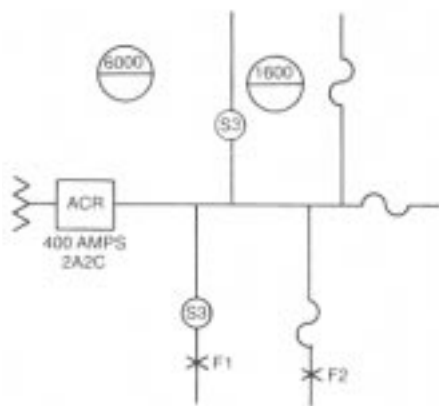


Figure 31. On a load-side fault, instantaneous tripping occurs at high-current fault (F1) with normal coordination at F2 to allow the fuse to sectionalize.

ORDERING INFORMATION

Instantaneous Trip Accessory . . .	KRK55F
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Fault-Indicator Target Accessory

Fault indication of phase-to-ground, phase-to-phase, or three-phase faults is provided with the Fault-Indication Target accessory (Figure 32). The accessory consists of a plug-in circuit board that mounts on the back panel of the control and an annunciator circuit board that mounts inside a window on the bottom of the control cabinet.

The annunciator-type target shows an orange dot in the appropriate phase or ground window visible through the bottom of the control cabinet when the control trips due to an overcurrent. The targets reset when the fault condition is cleared, or when recloser occurs.

ORDERING INFORMATION

Fault-indication target accessory . .	KRK52F
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Figure 32. Fault-indication target accessory.

86761KM-A

KFET Tester

The KFET tester (Figure 33) is a portable field/shop unit designed to verify correct operation of the Type KFE or Type KFVE recloser control.

The KFET tester injects a signal into the control to simulate a fault condition and then displays the control response time or recloser clearing time.

ORDERING INFORMATION REQUIRED

To order, include recloser description and catalog number. In addition, recloser accessories, electronic and mounting equipment may be required; order these by description and catalog number.

ORDERING INFORMATION

KFET control tester	KRK-11F
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Figure 33. Type KFE, KFVE control tester.

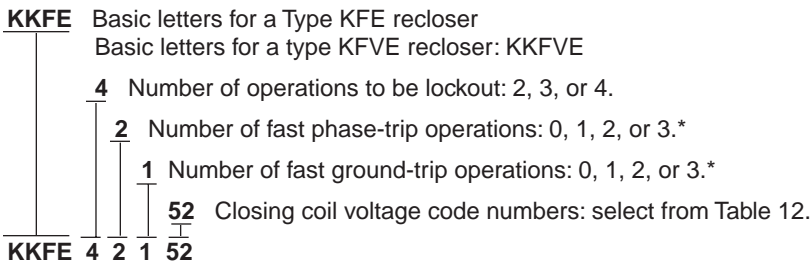
87900KM-A

Construction of Basic Catalog Number

1. Use the chart below and Table 12 to construct a catalog number that describes the basic recloser.
2. From Table 13, specify the catalog numbers that describe the plug-in operating settings.
3. From Tables 14 and 15, specify the catalog numbers that describe the desired accessories.
4. From Table 16, specify the catalog numbers that describe the mounting equipment (if required).

Example:

To order a basic 11 -Kv Type KFE recloser with 2 fast, 2 delayed on-phase trip and 1 fast, 3 delayed on-ground trip operations for service on a 50-Hz system, the catalog number would be constructed like this:



*Remaining operations to lock out will be on delayed curve.

KKFE42152 is the catalog number for a basic Type KFE recloser with 2 fast, 2 delayed on-phase trip and 1 fast, 3 delayed on-ground trip operations; for service on an 11 Kv, 50-Hz system.

TABLE 12
Closing Coil Voltage Code Numbers

Phase-to-Phase Closing Coil Operating Voltage $\pm 15\%$	Code No.
5-Hz Coils (Kv)	
6.0	51
11.0	52
13.2	53
14.4	54
20.0	55**
22.0-24.9	56**
6-Hz Coils (Kv)	
2.4	21
4.16-4.8	22
6.0	31
12.0-13.2	30
14.4	27
20.0	29**
22.0-24.9	33**
Low-Voltage Coils* (Vac)	
120	26
240	28

* Require low-voltage closing accessory (KRK54F) to operate. Order separately.
 ** KFVE reclosers only.

TABLE 13
Plug-In Operating Settings

Description	Catalog No.
Minimum-trip current	
Phase minimum-trip resistors _amps (set of 3)	KRK597F_
(Select from 10, 20,30,50,70, 100,140, 200, 280, 320, 400, 450, 560, or 800 amps)	
Ground minimum-trip resistor _amps	KRK596F_
(Select from 5, 10, 20, 30, 50, 70, 100, 140, 200, 280, 320, or 400 amps)*	
Trip timing characteristics	
Phase-trip timing plug _	KRK592F_
(Select phase-trip curve B or C)	
Ground-trip inverse time delay	
Ground-trip timing plug ___ in first socket**	KRK590F_-1
Ground-trip timing plug ___ in second socket**	KRK590F_-2
(Select from curves 1, 2, or 3***)	
or	
Ground-trip constant time delay	
Ground-trip timing plug ___ in first socket**	KRK673F_-1
Ground-trip timing plug ___ in second socket**	KRK673F_-2
(Select from curves 1, 2, 3, 4, 5, 6, 7, 8, 9***)	

* One amp ground minimum-trip is available by connecting a jumper between Tabs X and Y on the main circuit board and installing a 5-amp ground minimum-trip resistor.
 ** If single timing of ground-trip is desired, order basic recloser with 0 number of fast ground-trip operations and specify 0 in catalog number for ground-trip timing plug in first socket.
 *** Apply faster curves (smaller number plug) to first ground socket.

**TABLE 14
Recloser Accessories**

Description	Catalog No.
Three 600:5 multi-ratio bushing-current transformers on standard creepage source-side bushings, KFE only	KRK50F3X*
Three 600:5 multi-ratio bushing current transformers on extra-creepage source-side bushings (Includes the extra-creepage bushings), KFE only	KRK51F3X*
Three 600:5 multi-ratio bushing current transformers on source-side bushings, KFVE only	KRK63F3X*
600:5 multi-ratio slip-on bushing-current transformer field installation kit (one transformer per kit)	KA712L2
Auxiliary switch (2 no-nc contacts)**	KRK411FA***
Lockout indicating switch	KRK412FA***
Remote trip (includes auxiliary switch accessory)	
24 Vac or 24 Vdc	KRK53FA***
48 Vac or 48 Vdc	KRK53FB***
120 Vac or 125 Vdc	KRK53FC**
240 Vac or 250 Vdc	KRK53FD***
Remote lockout (includes lockout-indicating switch accessory)	
24 Vac or 24 Vdc	KRK409FA***
48 Vac or 48 Vdc	KRK409FB***
120 Vac or 125 Vdc	KRK409FC***
240 Vac or 250 Vdc	KRK409FD***
Remote close, 120 Vac	KRK414FB
Low-voltage closing, KFE only	
120 Vac	KRK54FA***
240 Vac	KRK54FB***
Accessory junction box	
For one or more of the triple asterisk (***) accessories	KRK433FA
For remote close accessory, and in combination with (X) accessories	KRK433FB
Extra-creepage distance bushings, KFE only	KRK288FC
Oil-sampling-and-drain valve	KA809R
Bushing terminals for 1/0 to 500 mcm cable, KFE only	KRK525F

* Replace X in catalog number with ratio to be connected: 600, 500, 450, 400, 300, 250, 200, 150, 100, 50.

** If remote trip is also being specified, auxiliary switch need not be ordered separately.

*** Requires accessory junction box KRK433FA; order separately.

If remote lockout is also being specified, lockout indicating switch need not be ordered separately.

Requires accessory junction box KRK433FB if the auxiliary switch, lockout-indicating switch, remote trip, remote lockout, or low-voltage closing accessories are ordered; order separately.

Recloser must be ordered with Code 26 (120 Vac) or Code 28 (240 Vac) closing coil; see constructing a catalog number for basic recloser.

**TABLE 15
Electronic Trip Control Accessories**

Description	Catalog No.
Instantaneous trip	KRK55F
Fault-indicator target	KRK52F

**TABLE 16
Mounting Equipment**

Description	Catalog No.
Pole-mounting extension hanger	KRK364F
Substation-mounting structure	KRK942F3
Windlass accessory, for use with substation—mounting structure	KRK942F5
Control and junction box mounting accessory, for use with substation - mounting structure	KRK942F4
Auxiliary junction box mounting accessory, for use with substation—mounting structure	KRK942F2
Meter-trough mounting for substation structure	KRK398FA



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