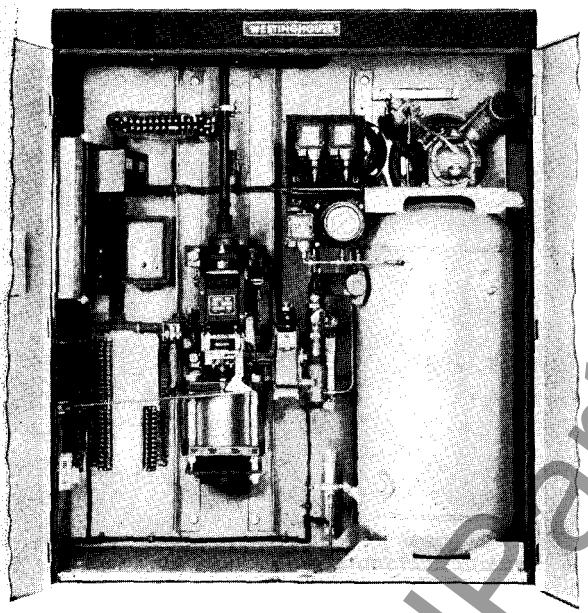
power circuit breakers

pneumatic operating mechanisms types AA-7, AA-10, and AA-14

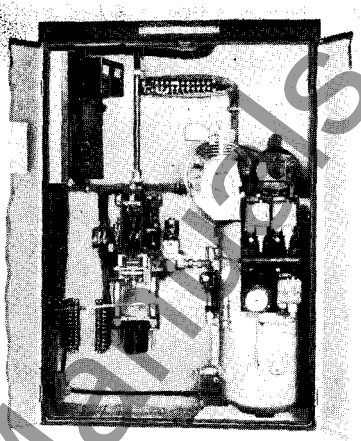
mechanically and electrically trip-free

descriptive bulletin 33-350

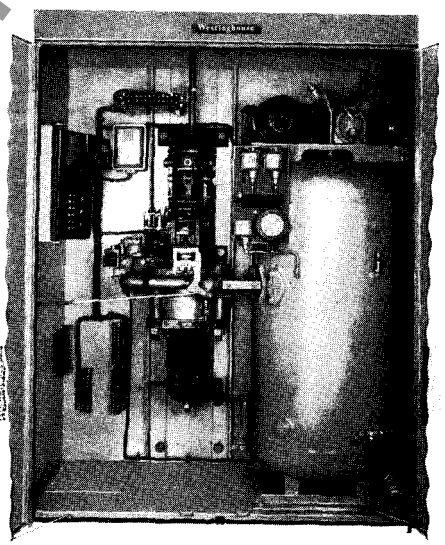
type AA-10



type AA-7



type AA-14



application

type AA pneumatic operating mechanisms provide high speed and ultra-high speed reclosing of large oil circuit breakers. They are also applicable for standard closing where station batteries either are not available or are limited in capacity. Low current requirements eliminate the necessity for heavy control cables.

Three sizes of pneumatic mechanisms are available: type AA-7 with a 7-inch operating piston, type AA-10 with a 10-inch operating piston, and type AA-14 with a 14-inch operating piston.

These three mechanisms are used for closing breakers ranging from 14.4 through 345 kv, and 500 through 25,000 mva. The type of mechanism used with each breaker is given on page 10.

advantages

mechanically and electrically trip-free: Unrestrained opening under all conditions.

pilot coil air control: Pilot valve controls inlet and exhaust.

roller-bearing latches: Speed up unlatching time.

ultra-high speed reclosing: 20 cycles or faster.

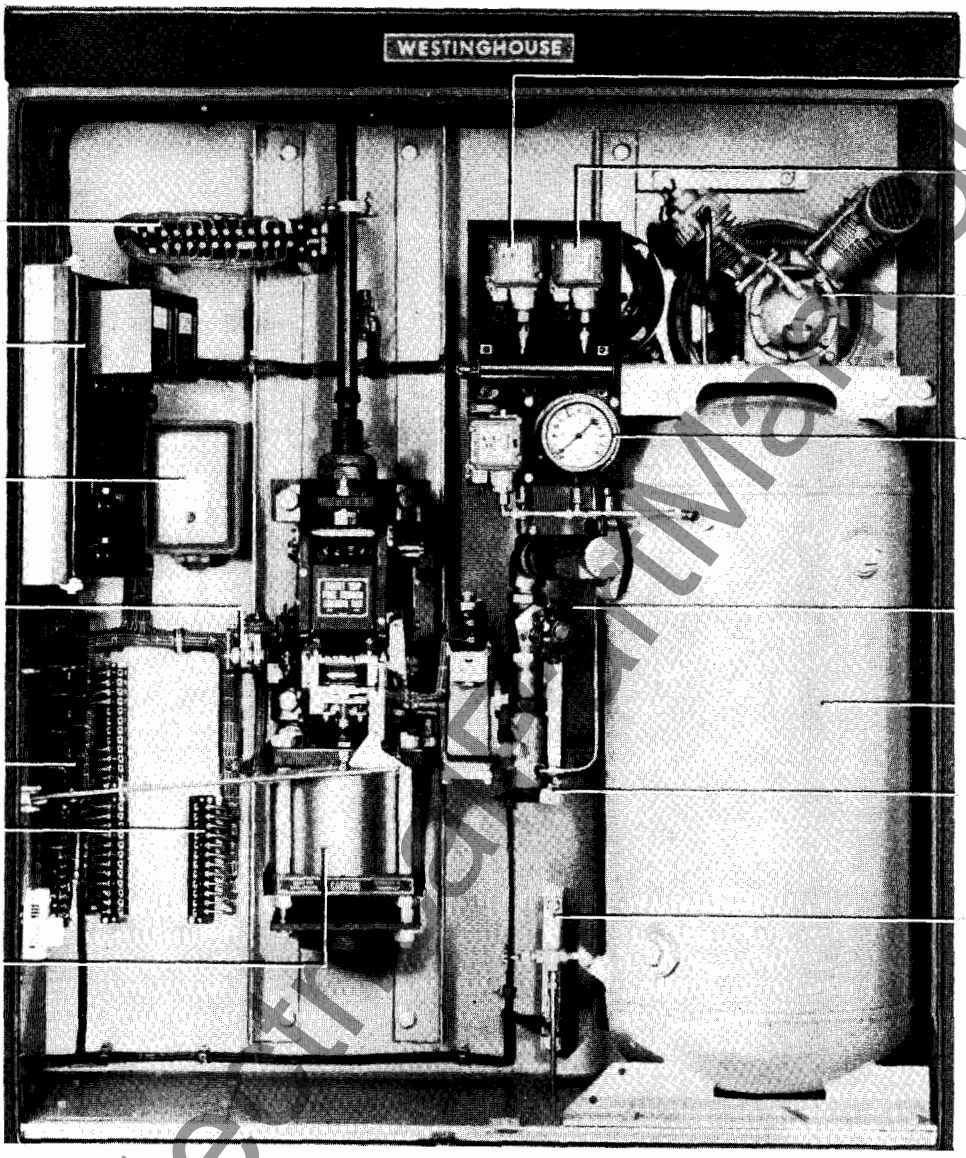
accessible major parts: All parts located for easy access with adequate space for maintenance. No critical adjustments are required. Mechanism factory adjusted and set.

dust-proof housing: Doors have molded rubber gasketing.

June, 1959
supersedes descriptive bulletin 33-125 dated May, 1952 and descriptive bulletin 33-125-A dated November, 1954
mailed to: E/280/DB; C26-5Z,b

www.ElectricalPartManuals.com

design features



air supply system

The air supply system provides compressed air at a pressure to meet the load requirements of the breaker on which the mechanism is applied.

The reservoir tank meets State Inspection Code requirements and all equipment is manufactured under close inspection to meet ASME requirements.

See page 3 for details.

auxiliary devices

Accessories essential to the proper functioning of the mechanism are arranged in convenient locations in the housing. These include control relays, switches, terminal blocks, heaters, hand closing device, and operation counter.

See page 3 for details.

www.ElectricalPartManuals.com

air supply system

1 **low pressure alarm switch** operates to sound a warning that normal operating pressure is not being maintained. It is set to operate at approximately 10% above the setting of the low pressure cutoff switch, but below normal starting pressure for the compressor.

2 **low pressure cutout switch** opens the control circuit at a pressure above the minimum satisfactory closing pressure.

A closing relay interlock also bypasses the low pressure cutout contacts during a breaker closing operation so that the cutout contacts will never try to interrupt the control relay coil current and insures completion of a closing operation once started.

3 **air compressor,** single-stage or two-stage depending on the size of the breaker, is driven by a 230/115-volt single-phase motor, although three-phase or d-c motors can be supplied on request. A pressure governor switch, operating on a low differential, controls the operation of the compressor. Compressor will charge the system from atmospheric pressure within one hour.

4 **pressure gauge** provides visual indication of air reservoir pressure.

5 **hand shutoff valve** in the piping between control valve and air storage reservoir provides a means for isolating the mechanism for maintenance work.

6 **reservoir tank** stores sufficient air for five closing or reclosing operations without recharging. Normally, however, the governor switch will start up the compressor to restore normal pressure before the mechanism has completed five operations. A safety valve prevents building up pressure to a dangerous level. A siphon-type drain valve for removing condensate protects the drain cock from freezing, even at very low temperatures.

---

7 **heaters** One heater, energized continuously, winter and summer, maintains a temperature differential between the inside and outside to prevent undesirable moisture condensation within the mechanism housing. Other thermostatically-controlled heaters (one in the AA-7, two in the AA-10 and AA-14) maintain this differential even in cold weather.

8 **pneumatic mechanism** See pages 4 and 5 for details.

9 **terminal blocks for control and transformer wiring** are mounted on the back and side of the housing. A plate in the bottom of the housing is removable to facilitate drilling for conduit entrance.

10 **cutoff switch** is operated by the piston rod and hence indicates position of the piston, even on trip-free operations.

11 **Linestarter** Compressor motor Linestarters are used only when higher operating pressure requires a two-stage compressor.

auxiliary devices

12 **control panel** X-Y non-pumping control relays and knife switches for control, motor, and heater circuits are mounted on a hinged panel for ready access to control wiring.

13 **eleven-pole auxiliary switch** with independently adjustable contacts is provided for use on interlocking, indicating, alarm, and trip circuits. This switch is connected to the vertical pull rod and hence indicates the closed or open position of the breaker.

high-speed auxiliary switch (not illustrated) available on request, mounts adjacent to eleven-pole switch and is operated from the vertical pull rod.

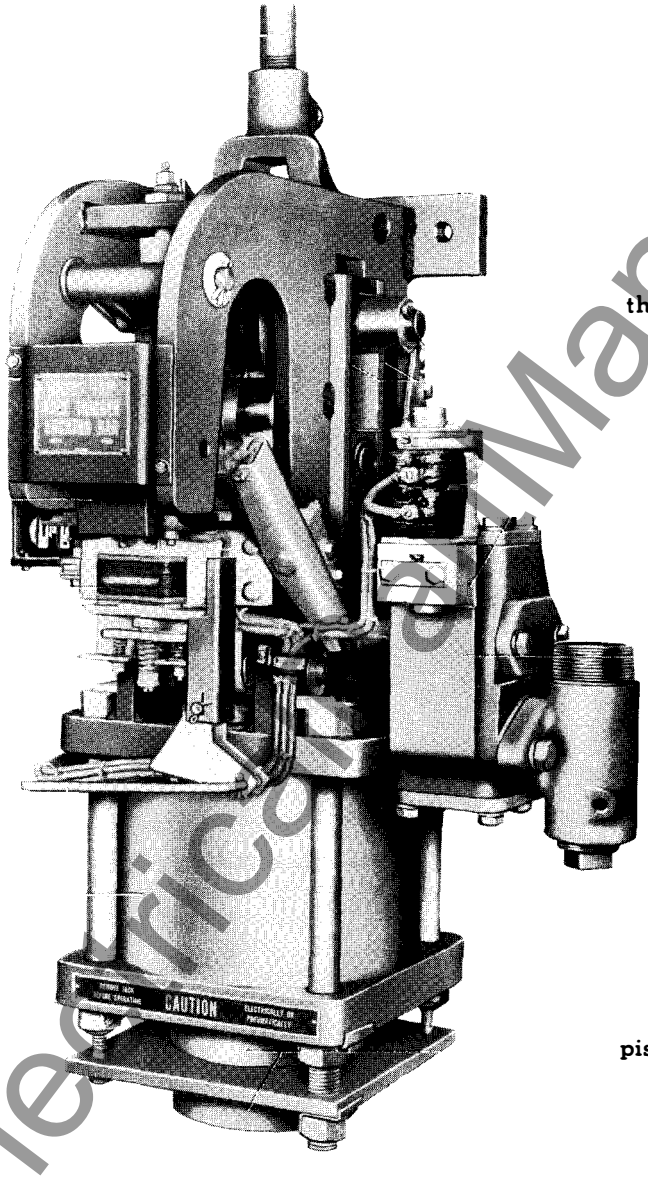
hand closing devices (not illustrated) On most breakers using the AA-7 mechanism, a club-type hand closing device is available to close the breaker during adjustment. The handle and socket can be removed easily for transfer from one mechanism to another. A screw-type jack device is provided for maintenance closing of the larger, more heavily loaded breakers.

On breakers which use the AA-10 and AA-14 mechanisms, a screw-type jack with ratchet handle is used with either mechanism for closing the breaker during maintenance and inspection. It attaches to the lower end of the piston rod, threaded for this purpose.

www.ElectricalPartManuals.com

design features continued

pneumatic mechanism



breaker pull rod

guard plate

latch check switch

trip coil

hand trip device

main closing cylinder

throttle operating cam and roller

guide rails

manual closing button

pilot valve

inlet and exhaust valves

piston retrieving spring housing

The pneumatic mechanism consists of an air cylinder and piston, a lever system for connecting the piston rod to the pull rod of the breaker, a system of latches for rapidly disengaging the breaker pull rod from the piston, and a holding latch for maintaining the mechanism closed.

type AA-7, with 7-inch main air cylinder and piston, is electrically and mechanically trip-free at all times.

type AA-10, with 10-inch main air cylinder, is electrically trip-free at all times, and is mechanically trip-free when there is high-pressure air in the main closing cylinder, but non-mechanically trip-free when there is no high pressure air to retard the opening. Selective tripping is the choice of mechanically trip-free or non-mechanically trip-free opening and provides the benefits of both:

a. Fast opening speeds realized with mechanically trip-free operation when the breaker is closed against a fault, and

b. High-speed reclosing time inherent in non-mechanically trip-free operation without excessive stress on the breaker or mechanism.

type AA-14 is similar to the AA-10 but has twice the output.

www.ElectricalManuals.com

cylinder and closing piston: The cylinder, seamless brass tubing, is clamped by four studs between two steel plates. The main closing piston, a brass casting with bronze piston rings, is attached directly to the piston rod. The upper end of the piston rod carries a crosshead which serves both as an attachment to the lever system and as the engagement surface for the main holding latch, to maintain the mechanism in the closed position.

An adjustable packing gland around the piston rod, and piston rings on the main closing piston, minimize air loss during the closing operation. The lower end of the piston rod extends through the retrieving spring housing to provide the means of attaching the hand closing device.

closing piston snubber: A collar extension on the underside of the closing piston seals off the large opening in the bottom plate as the piston approaches the closed position. This traps air between the underside of the piston and the bottom plate, building up back pressure to cushion the shock by pneumatic dashpot action.

On the AA-10 and AA-14, additional snubbing action is obtained from two shock absorbing rubber rings placed in a recess in the top of the bottom plate.

retrieving spring assembly: Immediately below the bottom plate, and clamped to it by extensions of two of the studs on the main cylinder assembly, is a housing containing heavy retrieving springs. When the mechanism is closed, these springs are compressed. When the mechanism is tripped free, the springs retrieve the piston rapidly to the open position.

lever system: The piston is connected to the breaker pull rod through the closing link and thrust link, held in a toggle position by the trip-free lever and trigger. The AA-10 mechanism is held closed by the holding latch and non-trip-free trigger.

trip-free lever assembly: The trip-free latch is a roller bearing latch in the trip free lever held by a trigger with a Stellite surface. A machined stop on the trip-free lever eliminates adjustment of the trigger. A resilient rubber stop, designed so that the resisting force builds up slowly at first, then very rapidly, brings the trip-free lever to reset without bouncing. A catch prevents the shock of closing from releasing the trigger unintentionally.

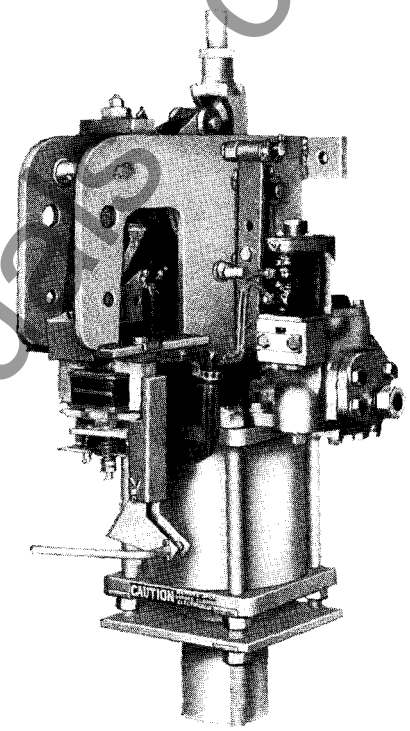
holding latch and trigger: To hold the mechanism closed after the closing air has been shut off, a holding latch engages on the crosshead. On the AA-10 this is a slip-off latch which is released either by action of the trip coil on the non-trip-free trigger, or by the movement of the trip-free levers. On the AA-7 mechanism, the holding latch engages the crosshead directly, and is released after the trip-free levers have moved a short distance.

trip selector: The AA-10 and AA-14 mechanisms are equipped with a trip selector. The selector bar is operated pneumatically so that the trip rod engages either the trip-free or the non-trip-free trigger, depending on whether or not there is high pressure air in the cylinder. When there is high pressure air in the cylinder that would retard opening the breaker, the ability to release the coupling between piston and breaker operating rods (mechanically trip-free opening) permits unrestricted opening. High speed reclosing is accomplished by keeping the piston coupled to the breaker operating rods (non-trip-free operation), permitting air to be admitted to the cylinder and the travel reversed at any point in the opening stroke.

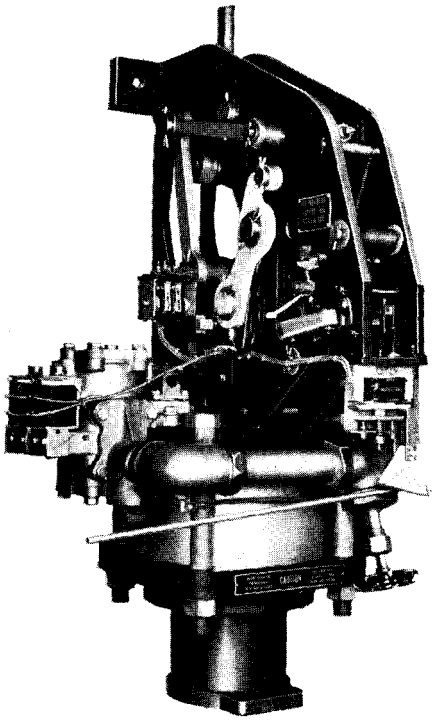
trip magnet assembly is located on the front of the mechanism where it is readily available for inspection. A resilient mounting prevents shock from accidentally operating the trip rod.

latch check switch remains open after mechanically trip-free operation until the latch and trigger have retrieved and the mechanism is ready to reclose.

type AA-7



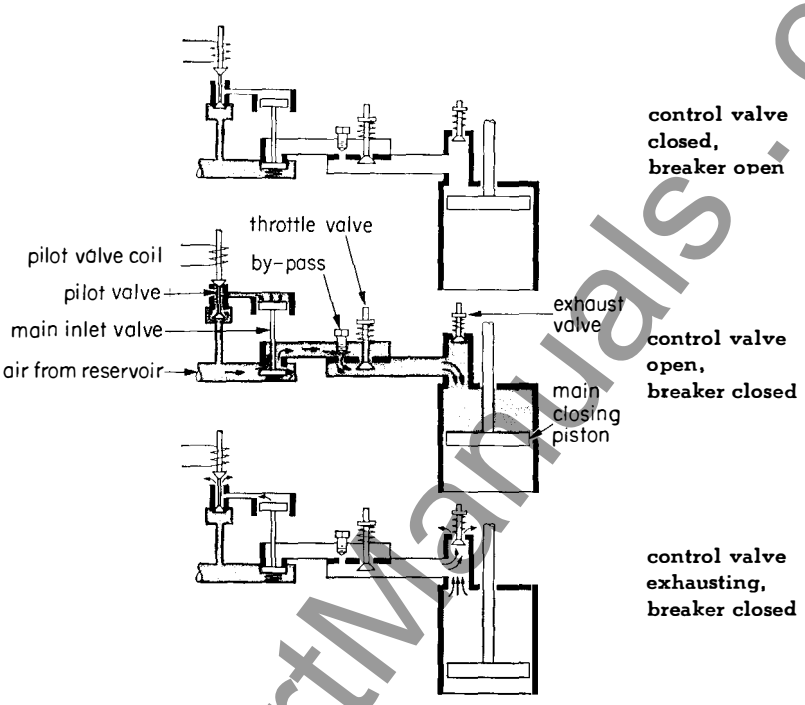
type AA-14



www.ElectricalPartManuals.com

design features cont'd

air control valve



The control valve combines both the inlet and exhaust functions in a single compact unit, controlled by a single solenoid-operated pneumatic pilot valve. Because of the wide range of functions which the mechanism may be called on to perform, the control valve assembly can be varied in these combinations:

a. For having a comparatively light starting load, a throttle and adjustable by-pass are required to prevent slamming.

b. For very high capacity breakers, the throttle and by-pass are eliminated.

c. For all breakers where multiple reclosures are required, the exhaust valve is fast-acting.

d. Where only one reclosure is required, a delayed exhaust is used.

pilot valve is double acting; that is, when the inlet seat is closed, the exhaust ports are open, and vice versa. The pilot valve inlet has a monel metal seat. The valve is operated either by energizing the pilot valve coil or by moving the pushbutton on top of the coil manually. The valve remains open only while the coil is kept energized or the button held down.

main inlet valve is a piston-operated valve with the piston located directly above the valve. Air pressure on top of the piston pushes down on the stem to open the valve. The valve has a metal-reinforced neoprene rubber seat to insure positive sealing

exhaust valves: Two types of exhaust valves are used. The AA-7 uses the high-speed valve while the AA-10 and AA-14 use the same for multiple high-speed reclosing. For standard reclosing the AA-10 and AA-14 use a delayed exhaust valve.

the high-speed valve is a free-floating valve piston normally resting on a seat which is undercut so that air pressure may act on the face of the valve to open it. During a breaker closing operation the valve held closed by air pressure on top of the piston, but at the end of the stroke, when the control pressure is cut off, the valve opens to quickly exhaust the high-pressure air from the cylinder.

the delayed valve is normally held open by a calibrated spring. When air is applied to the mechanism, the valve closes and prevents loss of air through the exhaust. At the end of the stroke, the delayed valve remains closed until the air remaining in the cylinder leaks down to a fairly low pressure, at which point the valve opens and exhausts the remaining air. Holding the air momentarily after the closing operation is completed does not impair the opening ability of the breaker, as the mechanism trips mechanically trip-free and there is no restraint on the opening.

throttle piston, when used, is controlled by a cam lever operated by the rod-end roller. For the start and early part of the closing operation, the breaker load is light for many breakers. In order to prevent the breaker lift rod from attaining unnecessarily high velocities during this lightly loaded portion of the closing stroke, the flow of air is restricted by having the throttle piston closed and the air forced to reach the cylinder via the by-pass port. Shortly before the breaker contact load is picked up, the large passage through the throttle valve is opened to provide maximum air flow to meet the rapid increase in load.

www . ElectricalPartManuals . com

pneumatic operating mechanisms

types AA-7, AA-10, and AA-14

mechanically and electrically trip-free

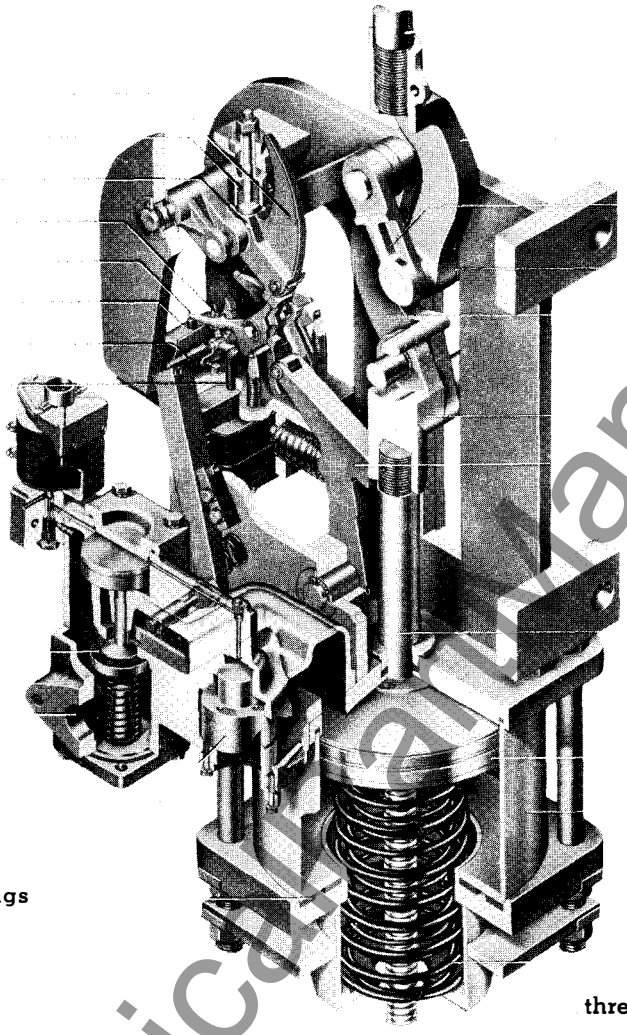
specifications

	type AA-7	type AA-10	type AA-14
main closing cylinder			
piston diameter	7 inches	10 inches	14 inches
piston material	brass	brass	brass
piston rings	bronze	bronze	bronze
cylinder	seamless brass tube	seamless brass tube	seamless brass tube
air control			
throttle valve	adjustable	adjustable	.....
inlet valve control	electro-magnetic pilot	electro-magnetic pilot	electro-magnetic pilot
exhaust valve	delay poppet or high-speed type	delay poppet or high-speed type	delayed poppet
heaters			
continuous heater	350 watts	350 watts	350 watts
thermostat controlled heater	350 watts	700 watts	700 watts
thermostat range	38°F to 70°F	38°F to 70°F	25°F to 60°F
thermostat setting ..... on	40°F	40°F	35°F
off	45°F	45°F	37°F
accessories			
terminal blocks ..... control	36 points	36 points	36 points
transformer	24 points	24 points	24 points
control relays	trip-free, non-pumping	trip-free, non-pumping	trip-free, non-pumping
auxiliary switches	one 11-pole, one 2-pole	one 11-pole, one 2-pole	one 11-pole, one 2-pole
hand closing device	lever or screw jack	screw jack	screw jack
control circuit protection	2-pole knife sw & fuses	2-pole knife sw & fuses	2-pole knife sw & fuses
compressor motor protection	2-pole knife sw & fuses & motor Thermoguard®	2-pole knife sw & fuses & motor Thermoguard	2-pole knife sw & fuses & motor Thermoguard
heater circuit protection	2-pole knife sw & fuses	2-pole knife sw & fuses	2-pole knife sw & fuses
sheet-steel housing			
number of hinged doors	2	2	2
door gaskets	moulded neoprene rubber	moulded neoprene rubber	moulded neoprene rubber
control currents			
closing ..... 24 volts d-c	17 amps	17 amps	.....
48 volts d-c	10 amps	10 amps	.....
125 volts d-c	9 amps	9 amps	18 amps
250 volts d-c	4 amps	4 amps	8 amps
tripping ..... 24 volts d-c	40 amps	40 amps	.....
48 volts d-c	22 amps	22 amps	.....
125 volts d-c	10 amps	20 amps (3 cycle) 10 amps (5 cycle)	30 amps .....
250 volts d-c	10 amps	10 amps	15 amps
air supply system*			
compressor	single-stage	single and two-stage	two stage
motor size	½ hp	¾ to 1½ hp	1½ hp
storage reservoir	19 gals.	‡	130 gals.
maximum operating pressure	175 psi max.	270 psi max.	280 psi max.
compressor control range	15 psi max.	15 psi max.	15 psi max.
breaker operations before low pressure cutout opens	5 minimum	5 minimum	5 minimum
charging time of air system			
a. Atmospheric to normal operating pressure	60 minutes	60 minutes	75 minutes
b. Minimum to normal operating pressure	30 minutes	30 minutes	30 minutes
relief valve setting	10% above operating pressure	10% above operating pressure	10% above operating pressure
air supply accessories			
Thermoguard motor	√	√	√
pressure gauge	√	√	√
drain valve	√	√	√
air strainer	√	√	√
shutoff valve	√	√	√
low-pressure alarm	√	√	√
low-pressure lockout	√	√	√
fused protection for motor control	√	√	√

*One per mechanism except for single pole reclosing.
‡60-gallon on all breakers except 10,000 mva and 230 kv; 80 gallon on 10,000 mva and 230 kv breakers.

www.ElectricalPortManuals.com

operation



closing

Closing is initiated by opening the pilot valve which in turn opens the main inlet valve. Air flows through the restricted bypasses into the main cylinder, closing the exhaust valve, and moves the piston downward towards the closed position of the breaker. As the contacts approach the closed position, the throttle valve opens, allowing maximum air flow to the cylinder and providing maximum closing force at the point needed.

When the contacts reach the closed position, the holding latch is engaged and the air flow cut off. The exhaust port then opens, dumping the high pressure air.

tripping

AA-7: The AA-7 is mechanically trip-free. Energizing the trip coil rotates the trigger so that the trip-free lever and linkage are disengaged and the breaker always opens mechanically trip-free.

AA-10, AA-14: The AA-10 and AA-14 are equipped with a pneumatic selector which automatically selects non-trip free, if there is no air pressure on the piston, or trip-free, when the high pressure air is on the piston. If breaker is standing closed, the selector will be in the normal position and the trip coil will release the non-trip-free latch and breaker will open non-trip-free.

If the breaker is closed against a fault and tripped immediately, the selector will be in the trip-free position and breaker opens trip-free.

reclosing

AA-7: Since the AA-7 mechanism is mechanically trip-free, the breaker will essentially go to its full open position, the latches in the mechanism will reset, the latch check switch will close, and the closing circuit will energize to reclose the breaker.

AA-10, AA-14: If the AA-10 and AA-14 mechanisms trip out under non-trip-free conditions, the breaker contacts part, and the circuit is interrupted. This is well before the end of the stroke. After a short travel, the closing circuit is made and air admitted to the cylinder. This stops the closing stroke and reverses the contact travel and recloses the breaker. If opening under trip-free conditions, the operation is the same as the AA-7.

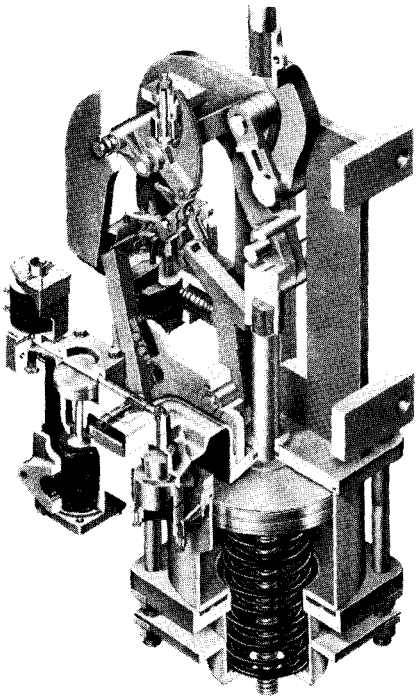
Automatic reclosing of the above mechanisms requires the use of a separately mounted reclosing relay.

www.ElectricalManuals.com

pneumatic operating mechanisms

types AA-7, AA-10, and AA-14

mechanically and electrically trip-free

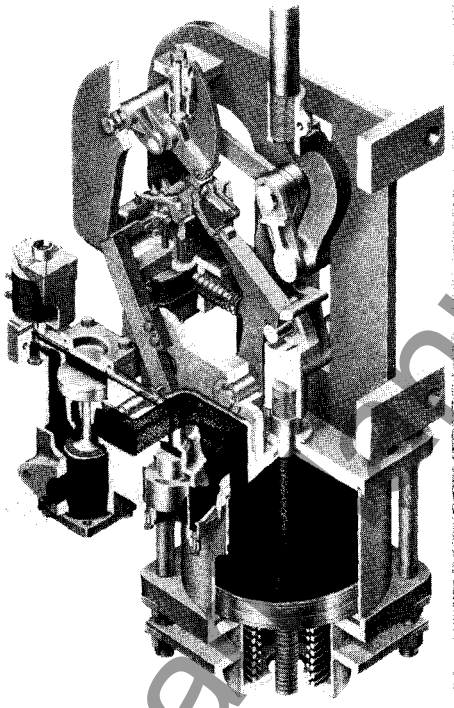


open position

The AA-10 mechanism is shown in the open position. To close, the inlet valve is opened, air forces the piston down and the piston pulls crosshead down, guided on each end by rollers running in hardened steel guides.

The crosshead pulls down closing lever and thrust link which pulls down the breaker pull rod and closes the breaker. Rod end rollers on pin also roll between the guides, which gives straight-line motion.

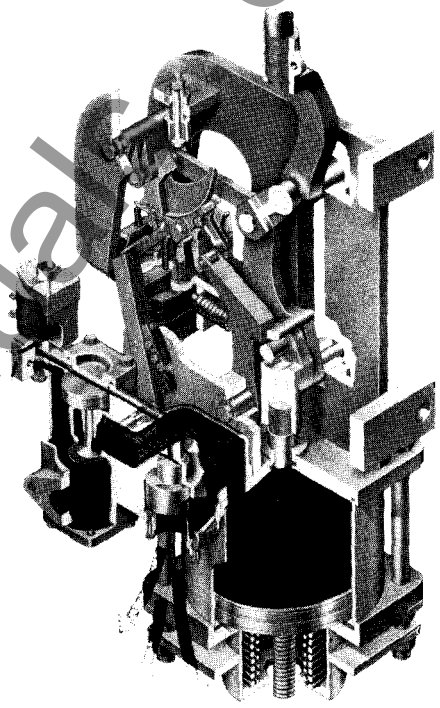
Crosshead pin moves down and holding latch drops over it to hold the breaker closed. The roller on the end of the holding latch is engaged by the non-trip-free trigger and prevented from rotating. The closing link and thrust link are prevented from unfolding by action of the intermediate link, which in turn is prevented from backing off by the trip-free lever and trip-free trigger.



closed position

The AA-10 mechanism is shown in the closed position with the trip-free and non-trip-free triggers engaged and holding latch holding the breaker closed.

The selector bar is under the non-trip-free trigger (no high-pressure air in the cylinder). To trip, the trip coil raises the trip rod, releases catches on the triggers, raises the selector bar, and rotates the non-trip-free trigger from under the roller bearing on the holding latch. The breaker load causes latch to be pushed back and the breaker contacts to open, and the piston moves to the upper position simultaneously. The closing link and thrust link do not unfold as they are held in toggle position by the intermediate link and the trip-free lever and trigger.



trip-free position

The AA-10 mechanism is shown in the trip-free position. This position results from tripping when there is high-pressure air in the cylinder. The high-pressure air operates the selector piston, which moves the selector bar under the trip-free trigger. The trip coil raises the trip rod, releases catches on the triggers, raises the selector bar, and rotates the trip-free trigger from under the roller on the trip-free lever. The breaker load causes intermediate link to back off and closing link and thrust link to unfold, allowing the breaker contacts to open independent of the piston.

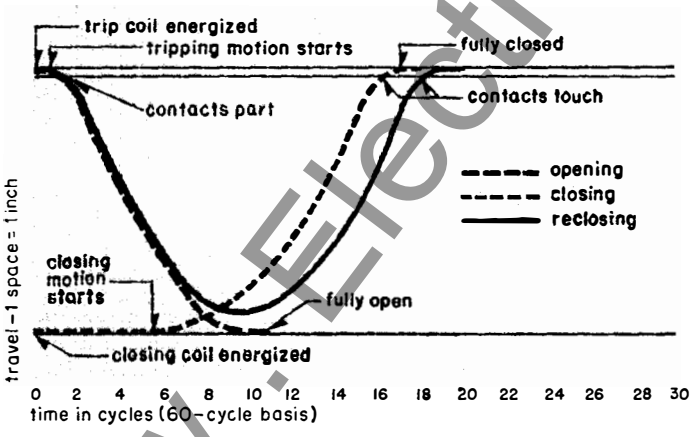
Closing link rotates on pin, and the kicker, which is part of this link, pushes the holding latch. The retrieving springs then push piston up, causing the closing link and thrust link back into toggle position. The intermediate link, moving forward, retrieves the trip-free lever and the trip-free trigger resets. Resetting the trigger allows the latch check switch to make contact. The mechanism is then ready for closing as in the open position.

www.ElectricalPartManuals.com

operation continued

application of type AA mechanisms on Westinghouse oil circuit breakers

rated kv	breaker type	amps	mva	interrupting time: cycles	mechanism
14.4	144G1000	1200	1000	5	AA-7
	144G1500	3000	1500	8	AA-10
	144G1500	4000	1500	8	AA-10
23	230G500	1200	500	5	AA-7
34.5	345G500	1200	500	5	AA-7
	345G1500	1200	1500	5	AA-7
	345G2500	2000	2500	8	AA-10
46	460G500	1200	500	5	AA-7
	460G1500	1200	1500	5	AA-7
69	690G1000	1200	1000	5	AA-7
	690G1500	1200	1500	5	AA-7
	690G2500	1200	2500	5	AA-7
	GO-5-A	1200	2500	5	AA-7
	GM-6-A	2000	3500	5	AA-10
	GM-6	2000	3500	5	AA-10
	690GM5000	2000	5000	5	AA-10
115	GM-3	800	1500	5	AA-7
	GM-6	1200	5000	3	AA-10
	1150GM10000	1600	10000	3	AA-10
138	GM-5	1200	5000	3	AA-10
	GM-7	1600	10000	3	AA-10
	1380GM15000	2000	15000	3	AA-14
161	GM-5	1200	5000	3	AA-10
	GM-7	1600	10000	3	AA-10
	1610GM15000	1600	15000	3	AA-10
230/196	2300GW5000	1200	5000	3	AA-10
	2300GW10000	1600	10000	3	AA-10
	2300GW15000	1600	15000	3	AA-14
	2300GW20000	1600	20000	3	AA-14
345	3450GW25000	1600	25000	3	AA-14



Typical opening, closing, and reclosing performance of high-voltage breakers using type AA-10 mechanisms.

www.ElectricalPartManuals.com

pneumatic operating mechanisms

types AA-7, AA-10, and AA-14

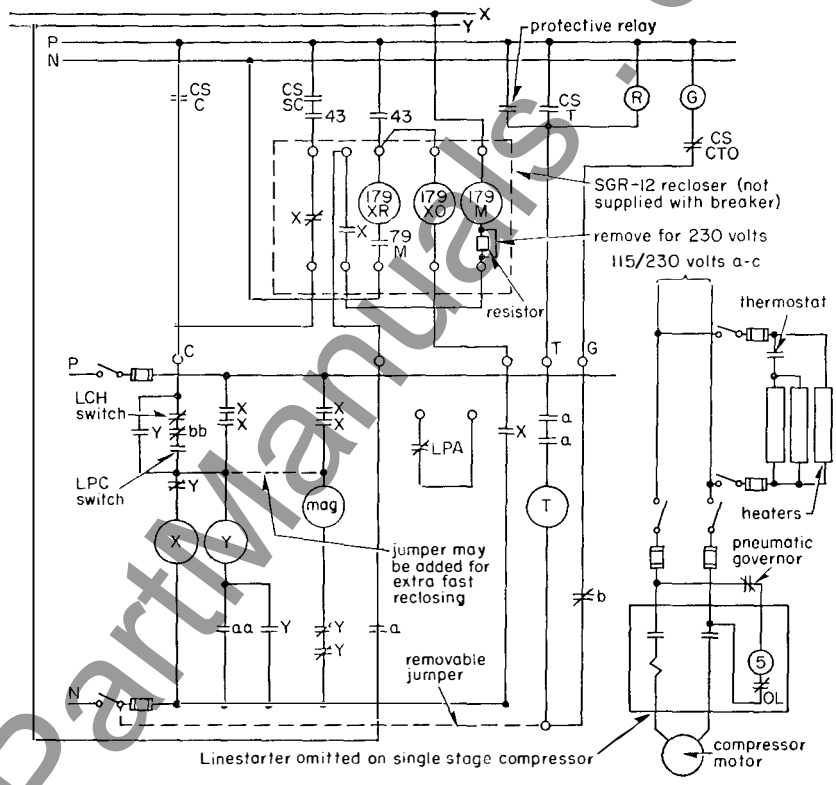
mechanically and electrically trip-free

Control scheme diagrams are shown with breaker auxiliary switch contacts in normal position for open breaker. Relays are shown in de-energized position Pressure contacts are shown for no pressure.

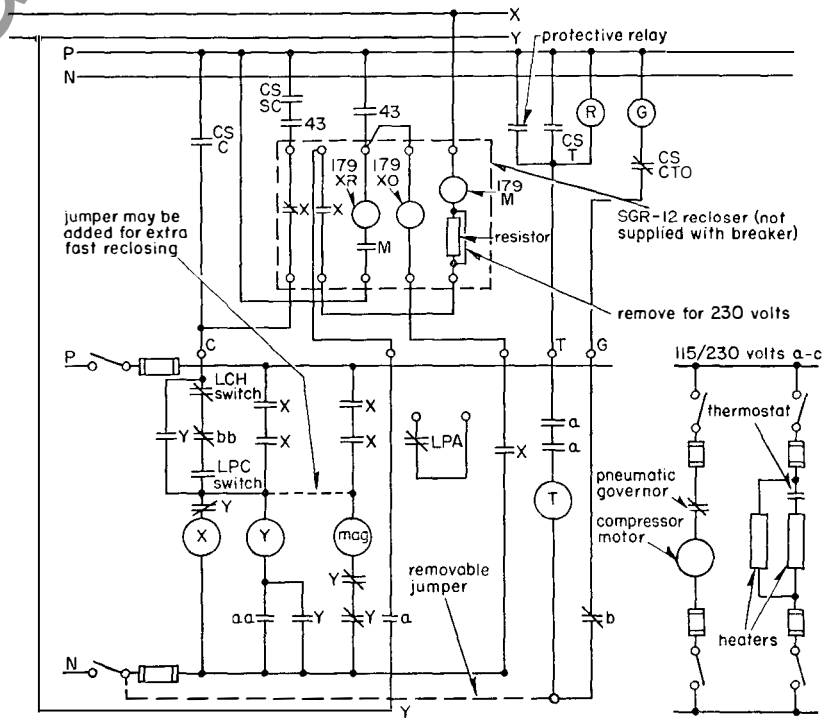
legend

⊣⊢	open contact
⊣/⊢	closed contact
○	coil
▭	heater or resistor
mag	pilot valve coil
179	reclosing relay
CS	control switch
43	toggle switch
LPA	low pressure alarm (closed for low pressure)
LPC	low pressure cutout (open for low pressure)
LCH	latch check switch
5	Linestarter

type AA-10



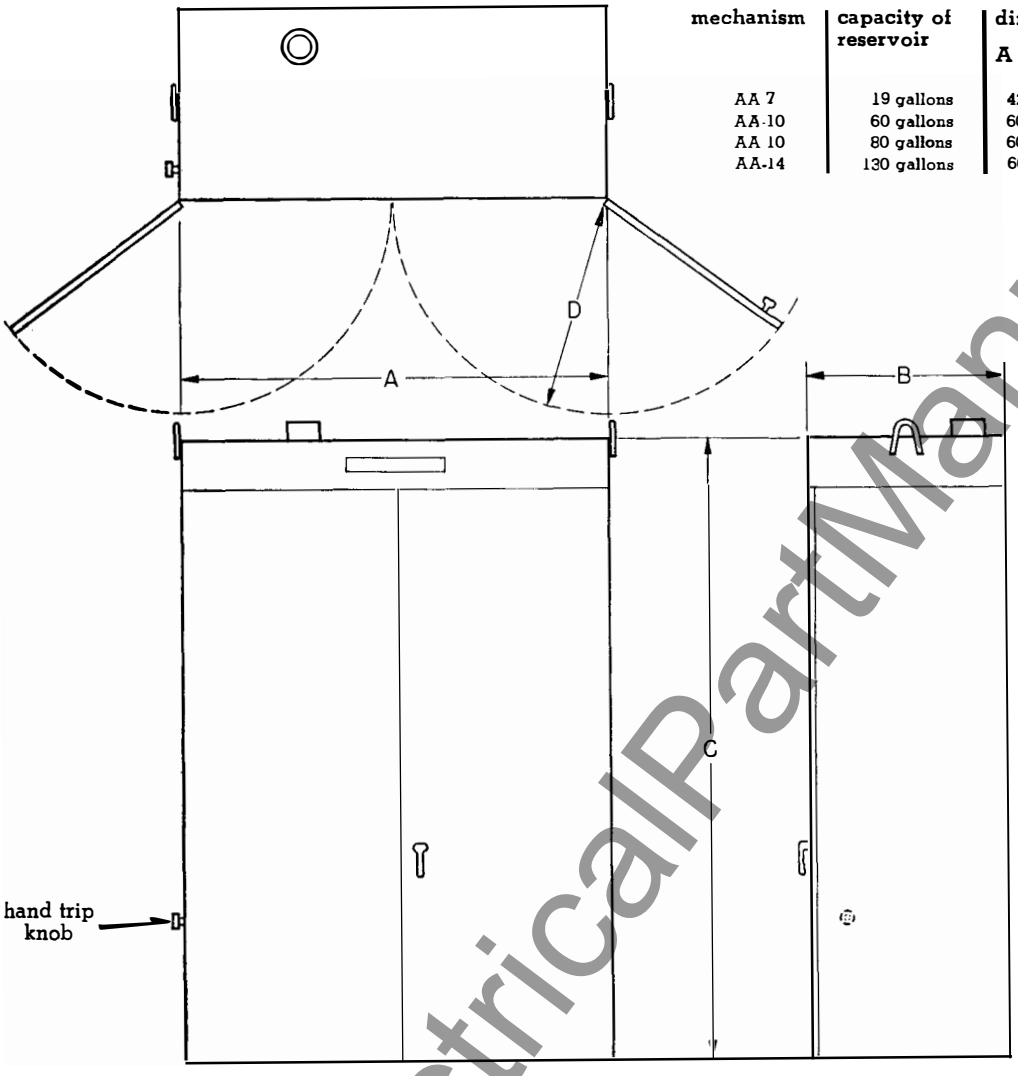
type AA-7



www . ElectricalPartManuals . com

pneumatic operating mechanisms
types AA-7, AA-10, and AA-14

dimensions in inches



mechanism	capacity of reservoir	dimensions: inches A	B	C	D
AA 7	19 gallons	42	18½	64½	23½
AA-10	60 gallons	60½	24	75½	32⅜
AA 10	80 gallons	60½	24	88	32⅜
AA-14	130 gallons	66⁵⁄₁₆	30	92	34⅜

further information

prices	refer to Westinghouse	
description	type G breakers	descriptive bulletin 33-252
	type GM breakers	descriptive bulletin 33-253
	type GW Watch-Case breakers	descriptive bulletin 33-254

Westinghouse Electric Corporation
Power Circuit Breaker Department: East Pittsburgh Division • East Pittsburgh, Pa.
printed in U.S.A.

www.ElectricalPartManuals.com