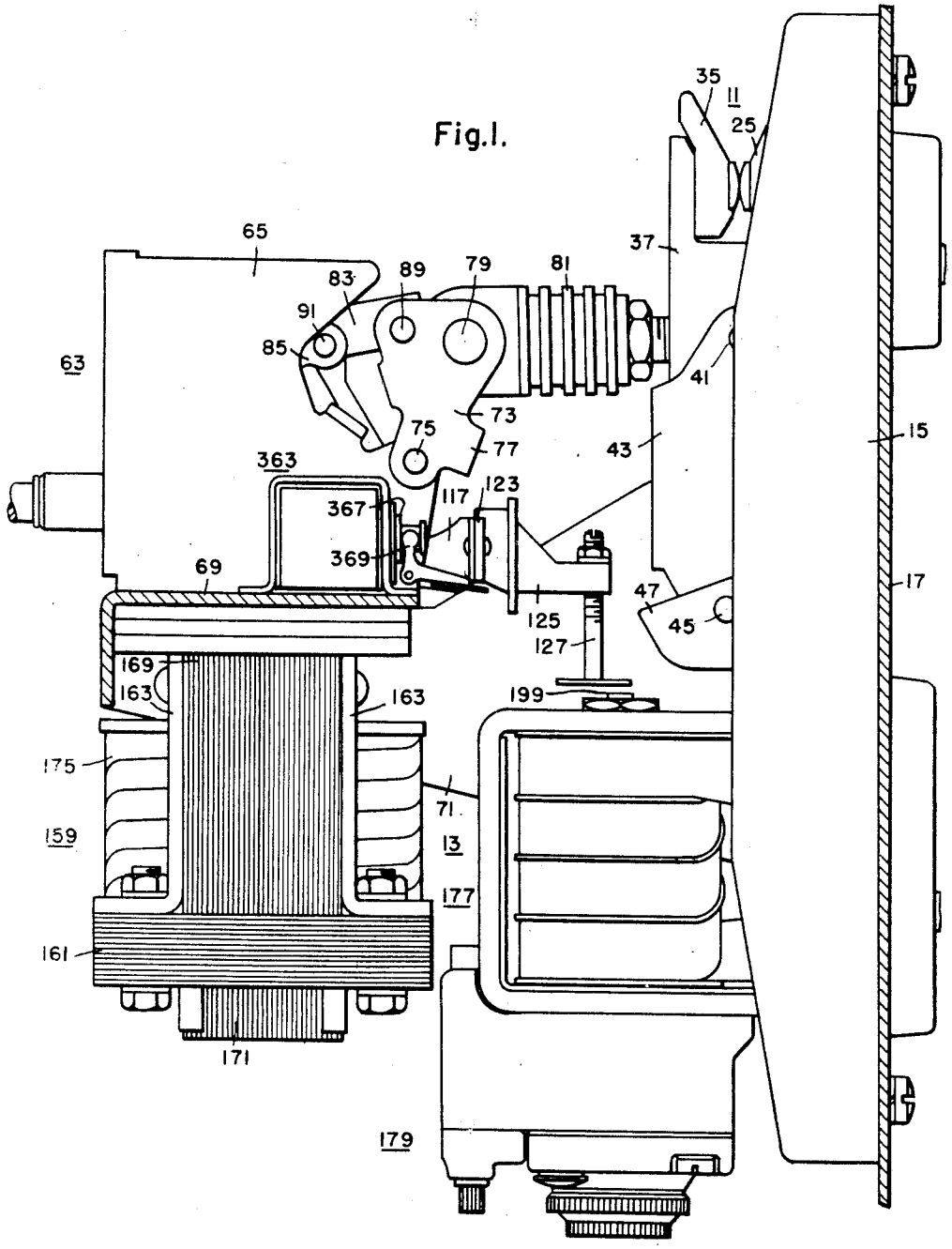
Jan. 18, 1955 H. J. LINGAL 2,700,082

CIRCUIT BREAKER

Filed Sept. 28, 1953

5 Sheets-Sheet 1

Fig. 1.



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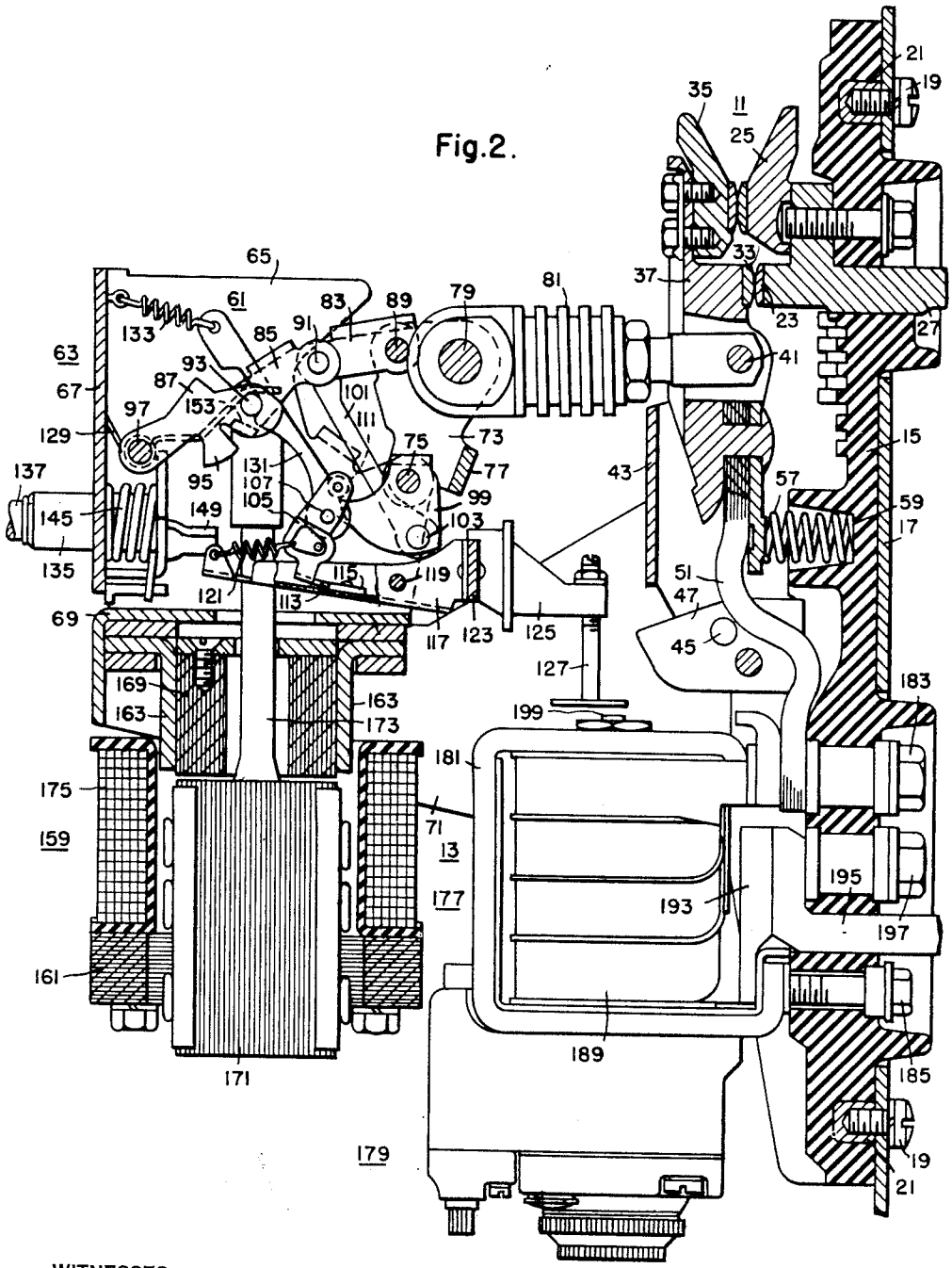
Jan. 18, 1955 H. J. LINGAL 2,700,082

CIRCUIT BREAKER

Filed Sept. 28, 1953

5 Sheets-Sheet 2

Fig.2.



WITNESSES:

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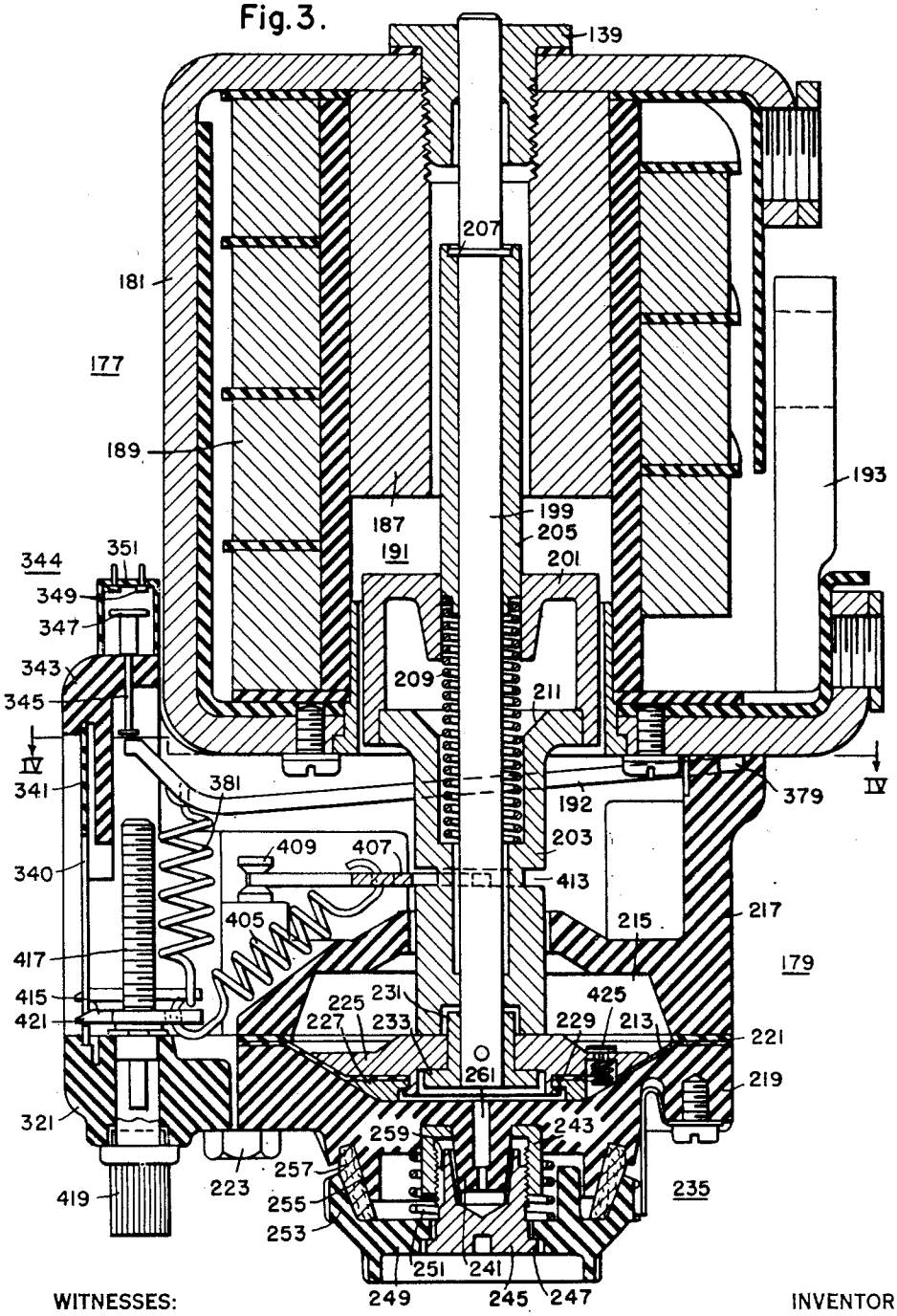
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Jan. 18, 1955 H. J. LINGAL 2,700,082

CIRCUIT BREAKER

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Fig. 3.



WITNESSES:

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Jan. 18, 1955 H. J. LINGAL 2,700,082

CIRCUIT BREAKER

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Fig. 4.

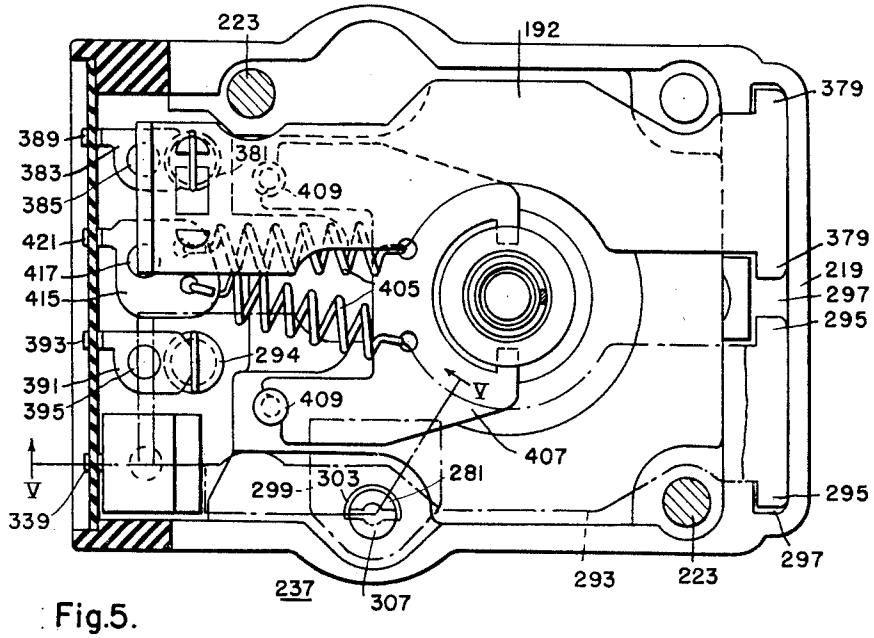


Fig. 5.

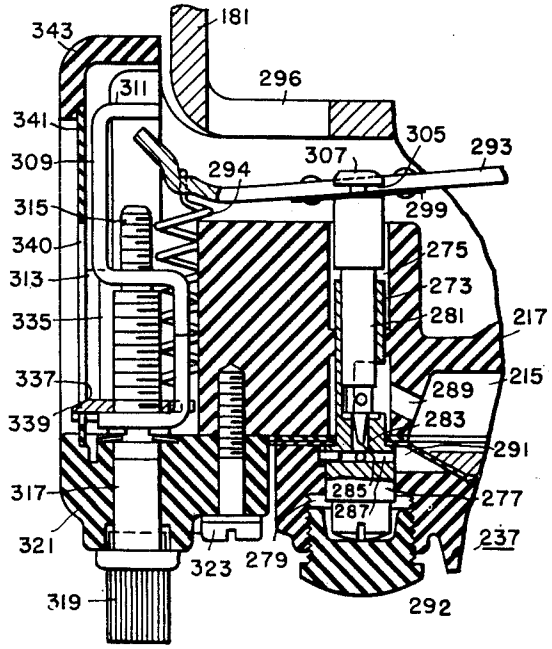
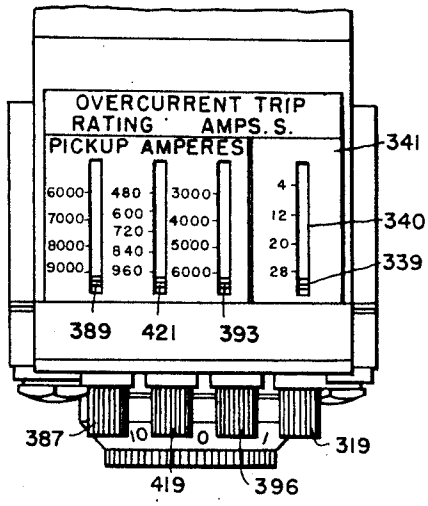


Fig. 6.



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CIRCUIT BREAKER

Filed Sept. 28, 1953 5 Sheets-Sheet 5

Fig.7.

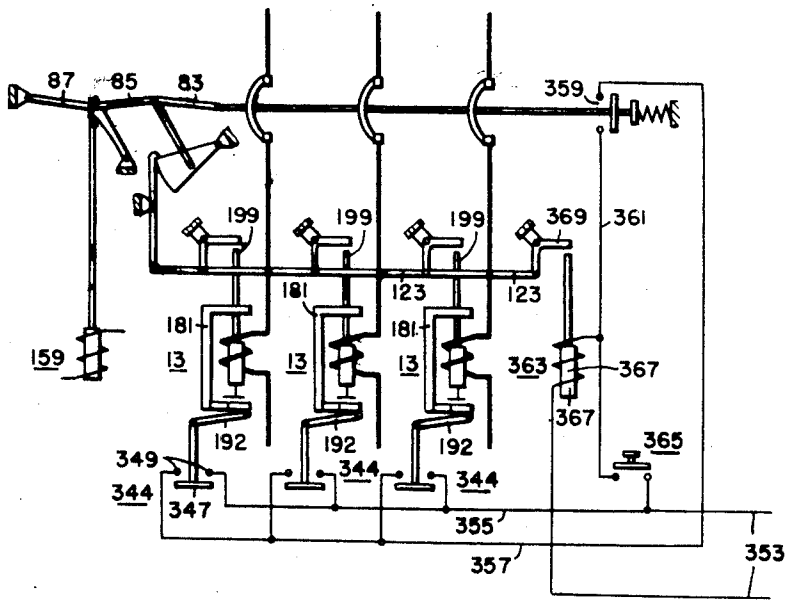
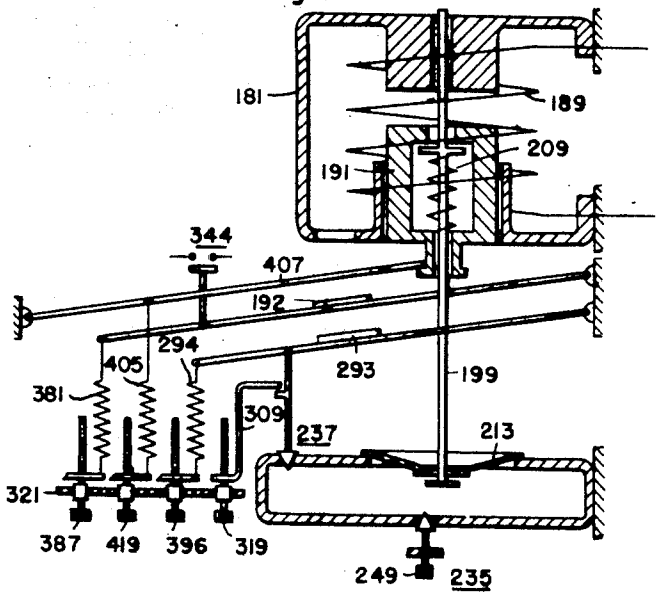


Fig.8.



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United States Patent Office 2,700,082 Patented Jan. 18, 1955

2,700,082

CIRCUIT BREAKER

Harry J. Lingal, Pittsburgh, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 28, 1953, Serial No. 382,748

7 Claims. (Cl. 200—98)

This invention relates to circuit breakers and more particularly to circuit breakers of the type used for controlling light to moderate power distribution circuits.

In certain circuit breaker applications, for instance, where a circuit breaker is to be applied in a selective tripping system as a source breaker or as a bus tie or group feeder breaker, the breaker is equipped with an overcurrent trip device which trips the breaker with a time delay on all values of overload currents up to the interrupting capacity of the breaker. With the breaker latched in the closed position, the breaker will carry such excessive overload currents for some time without damage to the breaker and will then interrupt the circuit.

If an attempt is made to close the breaker against a fault current on the line the breaker would likely be severely damaged. The reason for this is that the large magnetic forces which tend to blow the contacts apart are greater than the force applied by the closing mechanism to close the contacts. Merely providing greater closing force does not solve the problem because the greater closing force would, when closing the breaker with a normal current on the line, cause damage to the breaker.

An object of the invention is to provide a circuit breaker having a trip device embodying time delay tripping means and means for tripping the breaker instantaneously only when the breaker is closed with a fault on the line.

Another object of the invention is to provide a circuit breaker embodying time delay and instantaneous tripping means with means for energizing the instantaneous tripping means only during a closing operation.

Another object of the invention is to provide a circuit breaker having a normally ineffective instantaneous trip means with means for rendering the instantaneous trip means effective only during a closing operation of the breaker.

The invention, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description thereof when read in conjunction with the accompanying drawings.

In said drawings:

Figure 1 is an elevational view, partly in section, of a circuit breaker embodying the principles of the invention.

Fig. 2 is a vertical sectional view through the center pole of the breaker.

Fig. 3 is a vertical sectional view through the trip device.

Fig. 4 is a sectional plan view of the time delay device taken substantially along line IV—IV of Fig. 3.

Fig. 5 is a fragmentary sectional view taken on line V—V of Fig. 4 showing the short-time delay valve device and the adjusting means therefor.

Fig. 6 is an elevational view of a part of the time delay device showing the scale plate and the several adjusting knobs.

Fig. 7 is a schematic view of the circuit breaker including a diagram of the control circuit for energizing the instantaneous trip means.

Fig. 8 is a schematic view of the trip device illustrating the several adjusting means for the time delay device.

The invention is illustrated as applied to a circuit breaker of the type fully disclosed in copending application Serial No. 141,136, filed January 20, 1950, by John B. MacNeill, Fritz E. Florschutz, Ture Lindstrom and Bernard G. Tremblay and assigned to the assignee of this application.

Referring to Fig. 2 of the drawings, the circuit breaker includes a plurality of pole units each comprising a contact structure indicated generally at **11**, and an overcurrent trip device indicated generally at **13**. The contact structure and the trip device for each pole unit are mounted on a separate insulating base **15** which is rigidly secured to a metal panel **17**.

The insulating base **15** for the center pole unit (Fig. 2) is secured to the panel **17** by means of screws **19** threadedly engaging metal inserts **21** molded integral with the insulating base **15**.

The contact structure **11** comprises a stationary main contact **23** and a stationary arcing contact **25**, both of which are secured on the inner end of a terminal conductor **27** which extends through suitable openings in the insulating base **15** and in the metal panel **17**.

Cooperating with the stationary main and arcing contacts **23** and **25**, respectively, is a movable main contact **33** and a movable arcing contact **35**. The movable main contact **33** is mounted on a pivoted contact carrying member **37** and the movable arcing contact **35** is suitably mounted on the contact carrying member **37**.

The contact carrying member **37** is pivotally mounted by means of a pivot pin **41** on the upper or free end of a generally channel-shaped switch arm **43** having its two sides pivoted by means of separate pivot pins **45** on spaced brackets **47** mounted on the base **15**.

The contact carrying member **37** is electrically connected by means of a flexible conductor **51** to the energizing coil of the trip device **13** to be later described. A spring **57** compressed between the lower end of the contact carrying member **37** and a spring seat **59** in the insulating base **15** provides contact pressure in the closed position of the breaker and also biases the contact structure in opening direction.

The movable contact structure is normally maintained in the closed position by an operating mechanism indicated generally at **61** (Fig. 2) mounted in a U-shaped frame **63**. The frame **63** comprises spaced side members **65** (Figs. 1 and 2) and a connecting cross member **67**. The frame **63** is supported on a platform **69** which forms the cross member of a main bracket comprising a pair of spaced side members (only one being shown) joined at their outer ends by the cross member or platform **69**. The platform extends across the width of the breaker and the side members **71** are rigidly secured to the metal panel **17** on the outside of the two outer pole units.

The operating mechanism includes a lever **73** pivotally mounted on a pivot pin **75** supported in the side member **65** of the frame **63**. The lever **73** comprises a pair of spaced levers joined by a cross member **77** and between them support a rod **79** which extends across all three poles of the breaker. The rod **79** is operatively connected by means of an insulating connecting member **81** to the pivot pin **41** in the free end of the switch member **43** on which the movable contact member **37** is mounted. There is a connecting member **81** for each pole of the breaker connecting the rod **79** to the moving contact structure for each pole unit so that upon operation of the rod **79** the movable contact structure for all three poles move in unison.

An operating linkage comprising toggle links **83**, **85** and **87** (Fig. 2) is provided to hold the lever **73** and consequently the movable contacts in the closed position and to operate the movable contacts to open and closed positions. The toggle link **83** is pivotally connected to the lever **73** by a pivot pin **89** and the toggle link **85** is connected by a knee pivot pin **91** to the toggle link **83** and by a knee pivot pin **93** to the toggle link **87**. The toggle link **87** is pivotally mounted on a fixed pivot **97** in the frame **63** and has a cam member **95** thereon.

The linkage **83**, **85**, **87** comprises two toggles, one of which **83**, **85**, functions as a tripping toggle and the other **85**, **87** as a closing toggle. The tripping toggle **83**, **85** is normally slightly underset above a line drawn through the pivot pins **89**, **93** and the closing toggle **85**, **87** is normally underset below a line drawn through the pivots **91**, **97**.

The tripping toggle 83, 85 is normally biased in a direction to cause its collapse by a component of the springs 57 which bias the movable contact structures for the several poles of the breaker in opening direction and bias the connecting members 81 toward the left (Fig. 1). The tripping toggle 83, 85 is normally prevented from collapsing by means of a main latch member 99 pivoted on the pivot pin 75 and connected by a link 101 to the knee pin 91 of the tripping toggle, the link 101 being connected to the latch member 99 by a pivot pin 103.

The main latch 99 is held in latching position by an intermediate latch lever 105 pivoted on a pin 107 supported in the frame 63. The latch lever 105 carries a latch roller 111 which normally engages the main latch 99 to releasably restrain the latter in holding position. The latch lever 105 at its lower end carries a latch member 113 engaging a light-load latch 115 mounted on a channel-shaped member 117 pivotally mounted on a pin 119 supported in the frame 63. The latch lever 105 and the member 117 are biased to their latching positions by a spring 121 tensioned between the parts as shown in Fig. 2. Rigidly mounted on the right hand end of the channel-shaped member 117 is a trip bar 123 which extends across all of the poles of the breaker and has secured thereto an insulating bracket 125 for each pole of the breaker. Each of the brackets 125 has a headed screw 127 adjustably mounted therein for cooperating with the trip device 13 for the corresponding pole unit in a manner to be later described.

As long as the main latch 99 is held in latching position by the latching mechanism just described, the tripping toggle 83, 85 will, through the link 101, be held in the position shown in which the breaker contacts are held in the closed position. The closing toggle 85, 87 is normally biased in a direction to cause its collapse by a spring 129 but is normally prevented from collapsing by a shouldered support member 131 pivoted on the pin 107 and biased by a spring 133 into supporting engagement with the knee pin 93 of the closing toggle.

Rigidly secured to the front plate or cross member 67 of the frame 63 is a bearing member 135 in which is rotatably mounted a handle shaft 137 to the outer end of which is secured an operating handle (not shown). Secured to the inner end of the shaft 137 is a cam member 149 which has the dual function of engaging the free end of the channel-shaped member 117 to manually trip the breaker upon movement of the handle in one direction and of engaging the cam 95 on the closing toggle 85, 87 to manually close the breaker upon movement of the handle in the opposite direction. The cam member 149 and the handle are biased in both directions to a central position in a well known manner by means of a spring 145.

Assuming the circuit breaker to be in the closed and latched position (Fig. 1) with the support member 131 supporting the closing toggle 85, 87 in its extended thrust transmitting position, the breaker is tripped open by manually rotating the handle shaft 137 in the proper direction. During this movement the cam member 149 engages and actuates the channel-shaped member 117 to disengage the latch member 115 from the latch 113 whereupon the force exerted by the springs 57 biasing the switch arms 43 in opening direction and transmitted through the connecting members 81, the rod 79 and the lever 73, causes the tripping toggle 83, 85 to collapse upwardly and effects opening movement of the movable contacts for all of the poles of the breaker.

The closing toggle 85, 87 does not immediately collapse following release of the latch mechanism since it is held by the support 131. During the collapsing movement of the tripping toggle 83, 85 the toggle link 85 rotates counterclockwise about the pivot pin 93 causing an ear 153 formed on the link 85 to engage and move the support member 131 to disengage the shoulder thereon from beneath the pin 93 whereupon the toggle 85, 87 collapses downwardly under the bias of the spring 129 and the weight of the moving armature of a closing solenoid, which will be described later. Collapse of the closing toggle 85, 87 causes resetting of the tripping toggle 83, 85 to thrust transmitting positions and resetting of the latching mechanism to latching positions. The mechanism is now in condition for a closing operation.

The contacts are closed either manually by operation of the shaft 137 by the handle or by operation of a closing solenoid indicated generally at 159. In order to

close the contacts manually, the shaft 137 is rotated in the direction opposite to the direction it is rotated to manually trip the breaker. This operation of the shaft 137 engages the cam member 149 with the cam 95 on the closing toggle link 87 and straightens the closing toggle 85, 87. Since, at this time, the knee of the tripping toggle 83, 85 is restrained by the latching mechanism, the thrust of straightening the closing toggle 85, 87 is transmitted through the tripping toggle to rotate the lever 73 in a clockwise direction to close the contacts. As the knee pin 93 of the closing toggle 85, 87 arrives at the fully closed position the support 131 is moved by the springs 133 into supporting engagement with the knee pin 93 to maintain the contacts closed.

The circuit breaker is closed automatically by energization of the closing solenoid 159 (Figs. 1 and 2) which is effected either manually or automatically by closing a suitable switch (not shown). The solenoid 159 comprises a fixed magnet yoke 161 and a fixed core member 169 supported on brackets 163 secured to the underside of the platform 69. A movable armature 171 is attached to the lower end of an operating rod 173 which extends upwardly and has its upper end pivotally connected to the knee pivot pin 93 of the closing toggle 85, 87. An energizing coil 175 wound on an insulating spool is supported on the fixed magnet yoke 161.

In the closed position of the breaker the armature 171 is held in its raised position as shown in Fig. 2. When the breaker is tripped open the closing toggle 85, 87 collapses permitting the armature 171 to assume its lower or unattracted position. Thereafter, upon energization of the coil 175, the armature 171 is attracted upwardly straightening the toggle 85, 87 and closing the breaker contacts.

The circuit breaker is automatically tripped open by operation of the trip device 13 for any pole of the breaker. The trip device includes a tripping electromagnet indicated generally at 177 (Figs. 1, 2 and 3) and a time delay device indicated generally at 179. The tripping electromagnet 177 comprises a C-shaped magnet yoke 181 rigidly secured to the base 15 by means of bolts 183 and 185 (Fig. 2), a fixed core member 187 (Fig. 3), an energizing winding 189, a movable armature 191 and an instantaneous tripping armature 192. The bolt 183 (Fig. 2) which secures the upper end of the magnet yoke 181 to the base 15 also secures the lower end of the flexible conductor 51 to the upper turn of the winding 189. The lower turn of the winding 189 has a conducting lug 193 electrically and mechanically secured thereto and this lug is secured to a conducting terminal 195 and to the base 15 by means of a bolt 197. The energizing winding 189 is thus electrically connected in series relation in the circuit through the breaker which circuit extends from the terminal 27, the main and arcing contacts 23, 33 and 25, 35, the contact member 37, flexible conductor 51, energizing coil 189 of the trip magnet to the terminal 195. Upon energization of the tripping magnet the armature 191 is attracted upwardly and actuates a trip rod 199 which engages the headed screw to operate the trip bar 123 and trip the breaker.

The movable armature 191 comprises an upper cup-shaped member 201 and a lower tubular member 203 both of magnetic material and rigidly secured together. The member 201 has a central opening therein and is adapted to slide over a sleeve 205 surrounding the trip rod 199. The sleeve 205 is limited in its upward movement relative to the trip rod 199 by means of a spring clip 207 seated in an annular groove in the trip rod. A spring 209 coiled about the trip rod 199 is compressed between the lower end of the sleeve 205 and the bottom of a counterbore 211 in the lower element 203 of the movable armature.

The fixed core member 187 (Fig. 3) is clamped to the upper leg of the magnet yoke 181 by means of a thimble 139 the bore of which acts as a guide for the trip rod 199.

The trip rod 199 is moved upwardly to trip the breaker under the control of the time delay device 179 which comprises a flexible diaphragm 213 (Fig. 3) attached to the lower end of the trip rod 199 and valve means for admitting air to the space below the diaphragm at various rates to provide different amounts of time delay in the operation of the trip rod. The flexible diaphragm 213 is disposed in a chamber 215

formed in an upper housing member **217** and a lower housing member **219**, both of the housing members being formed of molded insulating material. The outer edge of the diaphragm **213** is clamped between the housing members **217** and **219**, together with a sealing gasket **221** to thereby form an air-tight seal. The housing members are secured together and rigidly secured to the lower leg of the magnet yoke **181** by means of bolts **223** (Figs. 3 and 4). The central portion of the diaphragm **213** is clamped between upper and lower clamp members **225** and **227** respectively, the upper clamp member **225** having an annular projection 229 extending downwardly through an opening in the lower clamp member **227** and formed over against the lower face of the latter to form an air-tight seal.

Secured to the lower end of the trip rod **199** is a sleeve **231** having a flange **233** thereon rigidly secured to the upper clamping member **225**. The lower portion **203** of the movable armature extends downwardly through an opening in the upper wall of the chamber **215** above the diaphragm **213** and is seated on the upper face of the clamping member **225** being biased thereagainst by the spring **209**.

Since the spaces above and below the diaphragm **213** are completely sealed off from each other and the space above the diaphragm is at atmospheric pressure, any force tending to raise the trip rod **199** will be restrained by the partial vacuum below the diaphragm. In order to control the rate of tripping movement of the trip rod **199** valve devices indicated generally at **235** (Fig. 3) and **237** (Fig. 5) are provided to admit air to the space below the diaphragm **213** at different rates to provide a long time delay and a short time delay respectively in the operation of the trip rod.

The central bottom portion of the housing member **219** is molded to form a valve seat **241** in the shape of an inverted truncated cone. Surrounding the valve seat **241** is a tubular metallic member **243** molded into the housing member **219** and threaded internally to receive a valve **245** having a conical opening therein for cooperating with the valve seat **241**. The valve **245** is provided with a flange **247** for supporting an adjusting knob **249** of insulating material which is biased thereagainst by a spring **251** coiled about the tubular member **243** and compressed between the bottom of the housing member **219** and the upper surface of the knob **249**, a flange **253** on the knob **249** cooperates with a flange **255** on the housing member **219** to support a filter **257** for filtering the air admitted to the chamber **215** below the diaphragm. A passage **259** is provided along the threaded surface of the valve **245** and a passage **261** extends axially through the valve seat **241** to admit air to the chamber **215** below the diaphragm. Rotation of the knob **249** rotates the valve **245** which moves the valve axially of the valve seat **241** to vary the rate of admission of air to the chamber below the diaphragm thereby varying the amount of time delay provided in the operation of the trip device.

The short time delay device **237** (Fig. 5) controls a passage for admitting air from the chamber **215** above the diaphragm **213** to the space below the diaphragm at a rate to provide a short time delay in the order of alternating current cycles in the tripping of the circuit breaker. The valve device **237** comprises a tubular valves element **273** (Fig. 5) disposed in an opening **275** in the housing member **217** and having an enlarged head portion **277** seated in an opening **279** in the housing member **219**. The valve element **273** is provided with a valve seat and a valve **281**, slidable in the tubular valve element **273** normally cooperates with the valve seat to close a communication with opposite sides of the diaphragm. The valve element **273** is provided with an axial passage **283** in which is disposed a tapered projection **285** on the valve **281** and which is normally closed by the valve **281**. The head **277** of the valve element **273** is provided with horizontal passages **287** disposed at right angles to each other. A passage **289** in the housing member **217** communicates the chamber **215** above the diaphragm **213** with the opening **275** above the valve seat and a passage **291** in the housing member **219** communicates the chamber **215** below the diaphragm **213** with passages **287** in the portion **277** of the valve element **281**. The valve element **273** is held in place by a plug **292** threaded into the opening **279** in the housing member **219**.

It will be seen that upward or opening movement of the valve **281** will open the passage **283** and establish a communication from the upper side to the lower side of the diaphragm **213** through the passage **289**, **283**, **287** and **291**. The valve **281** is actuated to open position by means of an armature **293** (Figs. 4 and 5) which is biased to unattracted position by a spring **294** and which is attracted upwardly by the tripping magnet **177** when the magnet is energized by overload circuits in an intermediate range of overloads of, for instance, 200% to 1000% of normal rated current. An opening **296** (Fig. 5) in the lower leg of the magnet yoke **181** provides an air gap for the magnetic circuit through the armature **293**. The armature **293** is provided with laterally extending projections **295** (Fig. 4) which are seated in recesses **297** in the upper portion of the housing member **217** to pivotally support the armature. A bracket **299** (Figs. 4 and 5) secured to the armature **293** has a semi-circular opening **303** (Fig. 4) therein which engages in a notch **305** in the upper end of the valve so that upon actuation of the armature **293** the bracket **299** engages a substantially semi-circular head **307** on the valve **281** and moves the valve to open position. This opens the previously described communication and permits air to pass from the chamber **215** above the diaphragm **213** to the space below the diaphragm to control the tripping movement of the trip rod **199** (Fig. 3). The rate of flow of air to the space below the diaphragm, and consequently the rate of tripping movement of the trip rod, is controlled by the amount of opening of the valve **281**.

The extent of opening movement of the valve **281** is adjustably controlled by means of an adjustable S-shaped stop member **309** (Fig. 5). The upper portion **311** of the S-shaped member **309** comprises an adjustable stop disposed in the path of tripping movement of the free end of the armature **293** to limit the upward movement of the armature **293** and the extent of opening of the valve **281**. The center cross bar **313** of the S-shaped member **309** has a threaded opening therein which is engaged by a reduced threaded portion **315** of an adjusting screw **317**, so that upon rotation of the screw the S-shaped member **309** will be moved up or down, depending on the direction of rotation of the screw, to provide for greater or lesser movement of the armature **293** and, hence, greater or lesser opening movement of the valve **281**.

The screw **317** extends through an opening in a cross member **321** of insulating material and has an insulating knob **319** secured to its lower end. The cross member **321** is secured to the underside of the housing member **217** by means of screws **323** only one of which is shown. An enlarged threaded portion **335** of the adjusting screw **317** passes through a clearance opening in the lower portion of the S-shaped member and threadedly engages an indicating member **337**. A pointer **339** at the outer end of the member **337** extends through a vertical slot **340** in an index plate **341** supported at its lower end on the cross member **321** and having its upper end secured to a cross member **343** integral with the housing member **217**.

The pickup point, that is, the magnitude of overload current required to actuate the armature **293** may be varied by varying the tension of the spring **294**. The upper end of the spring **294** is attached to the armature **293** and the lower end of the spring is attached to a movable member **391** (Fig. 4) which threadedly engages an adjusting screw **395**. The screw **395** is rotatably mounted in the cross member **321** and has an adjusting knob **396** (Fig. 6) on the lower end thereof below the cross member **321**. Rotation of the screw **395** will move the member **391** up or down to vary the tension of the spring **294**, thus varying the pickup point of the armature **293**. The movable member **391** is provided with a pointer **393** extending through a vertical slot in the index plate to prevent rotation of the movable member and to indicate the setting of the device.

Similarly the pickup point for the movable armature **191** (Fig. 3) of the tripping electromagnet **177** may be adjusted. The armature **191** is biased to its unattracted position by means of springs **405** (Figs. 3 and 4) having their upper ends attached to a U-shaped yoke **407** which has its two legs pivotally supported in spaced, grooved studs **409** supported on the housing member **217** substantially as shown in Figs. 3 and 4. The right

hand end of the yoke 407 engages an annular groove 413 (Fig. 3) in the lower member 203 of the armature 191. The lower ends of the springs 405 are attached to a movable member 415 which is threadedly engaged by an adjusting screw 417. The lower end of the adjusting screw 417 is rotatably mounted in the cross member 321 and has an insulating knob 419 secured to its lower end below the cross member 321. A pointer 421 on the movable member 415 extends through a slot in the scale plate 341 to prevent the movable member from turning and to indicate the setting. It will be understood that the scale plate 341 bears indicia adjacent the several pointers indicating the settings of the several adjusting devices.

The trip device operates with time delays of different durations in two ranges of overcurrents below a predetermined magnitude. These ranges of overcurrents may be arbitrarily defined as, for example, a low range up to 500% or 600% of normal rated current, and a high range between 500% or 600% and 1000% of normal rated current. The circuit breaker will also trip open instantaneously in response to excessive currents above 1000% of normal rated current, or short circuit currents, but only during a closing operation when the breaker closes in against such a fault current, since means, to be hereinafter described, is provided to render the instantaneous tripping means effective only during a closing operation of the breaker.

Upon the occurrence of an overcurrent in the low range the tripping electromagnet becomes energized and attracts the armature 191 (Fig. 3) upwardly. The armature acts through the spring 209 and the sleeve 205 to produce an upward thrust on the trip rod 199, the movement of the trip rod being retarded by the partial vacuum below the diaphragm 213. The trip rod 199 moves up slowly in tripping direction as air is drawn into the space below the diaphragm through the long time delay valve 235 until the upper end of the trip rod engages the headed screw 127 (Fig. 1) and actuates the latch mechanism to effect tripping of the breaker in the manner previously described. The time delay provided by the long time delay valve device 235 is in the order of seconds and may be varied by adjusting the valve 241, 245 as set forth previously. A spring biased bypass valve 425 (Fig. 3) controls a passage through the diaphragm 213 to provide for quick restoration of the armature 191, the trip rod 199 and the diaphragm 213 to their normal positions following a tripping operation.

An overcurrent in the high range of overcurrents, but below 1000% of normal rated current, energizes the tripping electromagnet 177 sufficiently to attract the valve actuating armature 293 (Fig. 5) upwardly against the adjustable stop 311 opening the short time delay valve 281. This admits air to the space below the diaphragm 213 at an increased rate and provides a relatively short time delay in the order cycles in the operation of the trip device.

As previously set forth the armature 192 is provided to effect instantaneously tripping of the breaker in response to excessive fault currents or short circuit currents. It was also pointed out previously that the circuit breakers in certain locations in a selective tripping system are capable of carrying excessive currents for a certain length of time without damage to the breaker, the length of time the circuit breaker will carry such excessive overload currents being determined by the setting of the short time delay device. The critical time in the operation of the breaker when damage is most likely to occur is in closing the breaker in against an excessive fault current or short circuit current. For this reason the instantaneous armature will function to effect instantaneous tripping of the breaker only during a closing operation of the breaker and then only when the breaker contacts close against an excessive fault current.

The armature 192 is similar to the armature 293 and is provided with projections 379 (Figs. 3 and 4) for pivotally supporting the armature 192 in the recess 297 in the upper face of the housing member 217. The free end of the armature 192 is biased by means of a spring 381 to its unattracted position. The magnet yoke 181 is provided with an opening (not shown) similar to the opening 296 (Fig. 5) which provides an air gap for the magnetic circuit through the armature 192.

The pickup point, that is, the magnitude of overload current required to actuate the armature 192 may be varied by varying the tension of the spring 381. The upper end of the spring 381 is attached to the armature 192 and the lower end is attached to a movable member 383 (Fig. 4) which is threadedly engaged by an adjusting screw 385. The lower end of the adjusting screw 385 is rotatably mounted in the cross member 321 and has an adjusting knob 387 secured to its lower end below the cross member 321. A pointer 389 on the movable member extends through a slot in the scale plate 341 to prevent the member 383 from turning and to indicate the setting.

When the electromagnet 177 (Fig. 3) is energized by a fault current of, for instance, ten times normal rated current, as a short circuit current, it attracts the armature 192 upwardly during which movement the free end of the armature engages and actuates a switch indicated generally at 344. A plunger 345 is slidably mounted in the cross member 343 of the housing member 217 and, at its upper end, the plunger 345 carries a bridging contact member 347 for cooperating with spaced stationary contacts 349 in the switch 344 which is enclosed in an insulating housing 351.

Referring to Fig. 7, which comprises a schematic illustration of the circuit breaker, there is a switch 344 associated with the trip device 13 for each pole of the breaker. The switches 344 are connected in parallel relation in a circuit which extends from one side of a source of electrical energy 353, a wire 355, any one of the switches 344, a wire 357, an auxiliary switch or contacts 359 on the circuit breaker which are open when the breaker is closed and closed when the breaker is open, a wire 361, the coil of a shunt trip device 363 (see also Fig. 1) to the other side of the source 353. A switch 365 is provided for manually energizing the shunt trip device 363 to trip the breaker.

The armature 192 (Figs. 3, 4, 7 and 8) will function to close the switch 344 whenever an overload current of ten times normal rated current or a short circuit occurs. However, when the breaker is standing closed, the auxiliary contacts 359 (Fig. 7) are open, so that closure of one or more of the switches 344 will not energize the shunt trip 363. If the breaker is closed in against a fault of sufficient magnitude, the switch 344 will close at the instant the arcing contacts 25—35 (Figs. 1 and 2) touch and, since at this time, the auxiliary contacts 359 (Fig. 7) have not opened, the shunt trip coil will be energized and its armature 367 (Fig. 1) will actuate a bell crank 369 which, in turn, actuates the trip bar 123 to trip the breaker open instantaneously.

If there is no fault of sufficient magnitude on this line when the breaker closes the mechanism will go to the fully closed and latched position. Between the time the breaker contacts touch and the mechanism is latched, the auxiliary contacts 359 (Fig. 7) opens so that a short circuit current occurring thereafter will cause tripping of the breaker with a short time delay and with a long time delay in the case of an overload current in the previously described manner.

The invention provides a circuit breaker having trip means and time delay means for providing long and short time delay in the operation of the trip device and also means for instantaneously tripping the breaker, there being also provided means for rendering the instantaneous trip means effective only when the breaker is closed with a fault on the line.

Having described the invention in accordance with the provisions of the Patent Statutes, it is to be understood that various changes and modifications may be made in the structural details and combination of elements disclosed without departing from some of the essential features of the invention.

I claim as my invention:

1. In a circuit breaker having relatively movable contacts, operating means for opening and closing said contacts, a movable member movable to effect automatic opening of said contacts, a first tripping electromagnet comprising an energizing winding and an armature operative upon energization of said winding by overload currents below a predetermined value to move said movable member, time delay means for effecting a time delay in the operation of said movable member by said armature, a second tripping electromagnet operative when energized for moving said movable member, a

second armature operative instantaneously upon energization of the energizing winding for said first tripping electromagnet by overload currents above said predetermined value, contact means operative by said second armature of said first tripping electromagnet for effecting energization of said second tripping electromagnet to thereby cause instantaneous movement of said movable member, and auxiliary contact means positioned according to the positions of said breaker for effecting energization of said second tripping electromagnet only during closing operations of said breaker.

2. In a circuit breaker having relatively movable contacts, operating means for said contacts, a movable member movable to effect automatic opening of said contacts, a first tripping electromagnet operative when energized by overload currents below a predetermined value to move said movable member, time delay means for effecting a time delay in the movement of said movable member by said first tripping electromagnet, a second tripping electromagnet operative when energized to instantaneously move said movable member, contact means instantaneously closed by said first tripping electromagnet when said first tripping magnet is energized by overload currents above said predetermined value to effect energization of said second tripping electromagnet and instantaneous movement of said movable member, and an auxiliary switch controlled by said circuit breaker for effecting energization of said second tripping electromagnet only during closing operations of said breaker.

3. In a circuit breaker having relatively movable contacts, operating means for said contacts, a movable member movable to effect automatic opening of said contacts, a first tripping electromagnet operative when energized by overload currents below a predetermined value to move said movable member, time delay means for effecting a relatively long time delay in the movement of said movable member by said first tripping electromagnet, means for controlling said time delay means to effect a relatively short time delay in the movement of said movable member by said first tripping electromagnet, a second tripping electromagnet operative when energized to instantaneously move said movable member, contact means instantaneously closed by said first tripping electromagnet when said first tripping magnet is energized by overload currents above said predetermined value to effect energization of said second tripping electromagnet and instantaneous movement of said movable member, and an auxiliary switch controlled by said circuit breaker for effecting energization of said second tripping electromagnet only during closing operations of said breaker.

4. In a multi-pole circuit breaker having relatively movable contact means in each pole of said breaker, operating means for said movable contact means, a movable member common to all of the poles of said breaker movable to effect automatic opening of said contact means, an overcurrent trip device in each pole of said breaker operative when energized by overcurrents below a predetermined value to move said movable member, a time delay device for each of said overcurrent trip devices for effecting a time delay in the movement of said movable member by said overcurrent trip devices, electroresponsive means operative when energized to instantaneously move said movable member, contact means on each of said overcurrent trip devices operative upon energization of any one of said overcurrent trip devices to effect energization of said electroresponsive means, and auxiliary contact means on said operating means for effecting energization of said electroresponsive means only during a closing operation of said operating means.

5. In a multi-pole circuit breaker having relatively movable contact means in each pole of said breaker, operating means for said movable contact means, a movable member common to all of the poles of said breaker movable to effect automatic opening of said contact means, an overcurrent trip device in each pole of said breaker operative when energized by overcurrents below a predetermined value to move said movable member, a time delay device for each of said overcurrent trip devices for effecting a relatively long time delay in the movement of said movable member by said overcurrent trip devices, means on each of said overcurrent trip devices for controlling the associated time delay device to effect a relatively short time delay in the movement of said movable member by said overcurrent trip device, electroresponsive means operative when energized to instantaneously move said movable member, contact means on each of said overcurrent trip devices operative upon energization of any one of said overcurrent trip devices to effect energization of said electroresponsive means, and auxiliary contact means on said operating means for effecting energization of said electroresponsive means only during a closing operation of said operating means.

6. In a circuit breaker having relatively movable contacts, operating means for opening and closing said contacts, a movable member movable to effect automatic opening of said contacts, a first tripping electromagnet comprising an energizing winding, an armature operative upon energization of said winding by overload currents below a predetermined value to move said movable member, a time delay device for effecting a time delay in the operation of said movable member by said armature, a second tripping electromagnet operative when energized for moving said movable member, a second armature operative instantaneously upon energization of said energizing winding for said first tripping electromagnet by overload currents above said predetermined value, switch means operative by said second armature of said first tripping electromagnet for effecting energization of said second tripping electromagnet to thereby cause instantaneous movement of said movable member, means adjustable to selectively determine the minimum overload current required to actuate said second armature, and auxiliary contact means operated by said circuit breaker for effecting energization of said second tripping electromagnet only during a closing operation of said breaker.

7. In a circuit breaker having relatively movable contacts, operating means for said contacts, a movable member movable to effect automatic opening of said contacts, a first electromagnetic means for moving said movable member, time delay means comprising a fluid dashpot for effecting a time delay in the operation of said movable member, a first valve for admitting fluid to said dashpot at a predetermined rate for effecting a long time delay in the operation of said movable member, a second valve for admitting fluid to said dashpot at a greater rate than said first valve for effecting a short time delay in the operation of said movable member, a valve operating armature operative when said electromagnet is energized in response to overload currents below a predetermined value for actuating said second valve, a second electromagnetic means operative when energized to instantaneously move said movable member, switch means for effecting energization of said second electromagnetic means, a switch actuating armature operative when said first electromagnet is energized in response to overload currents above said predetermined value for actuating said switch means to effect energization of said second electromagnetic means, and auxiliary switch means operative according to the position of said breaker to effect energization of said second electromagnetic means only during a closing operation of said breaker.

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