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R. HAUSER ET AL
CIRCUIT BREAKER

3,072,765

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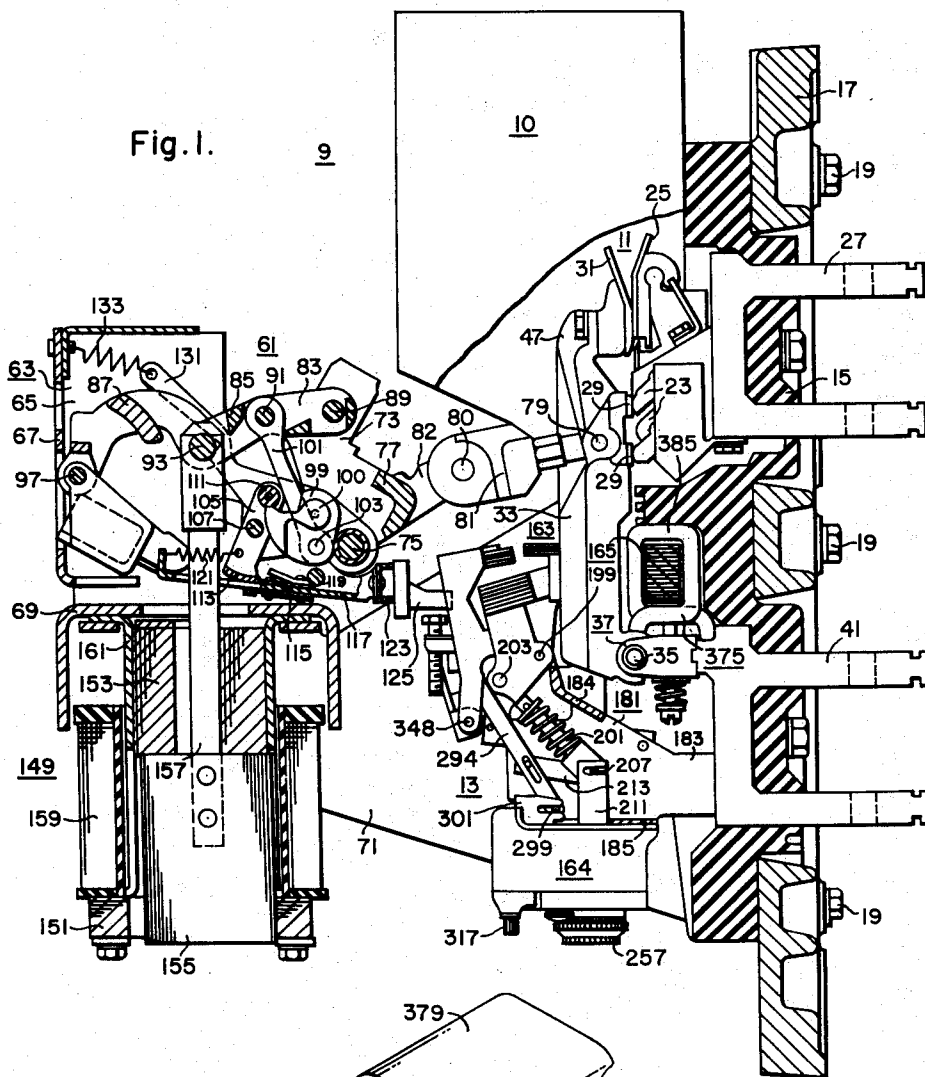
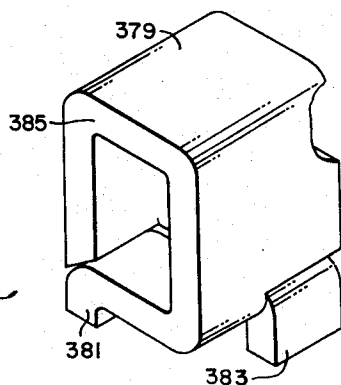


Fig. 6.



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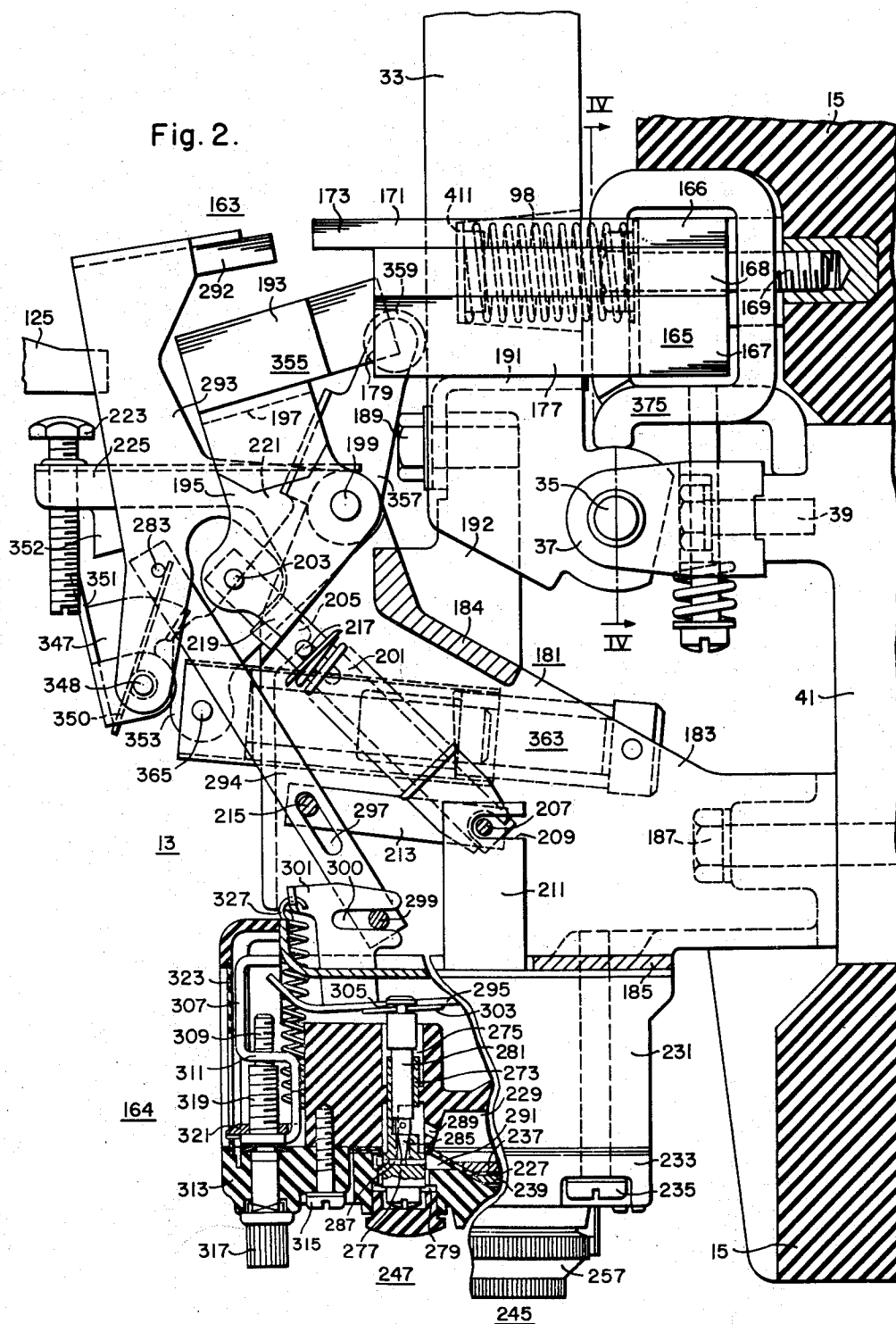
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Fig. 2.



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Fig.4.

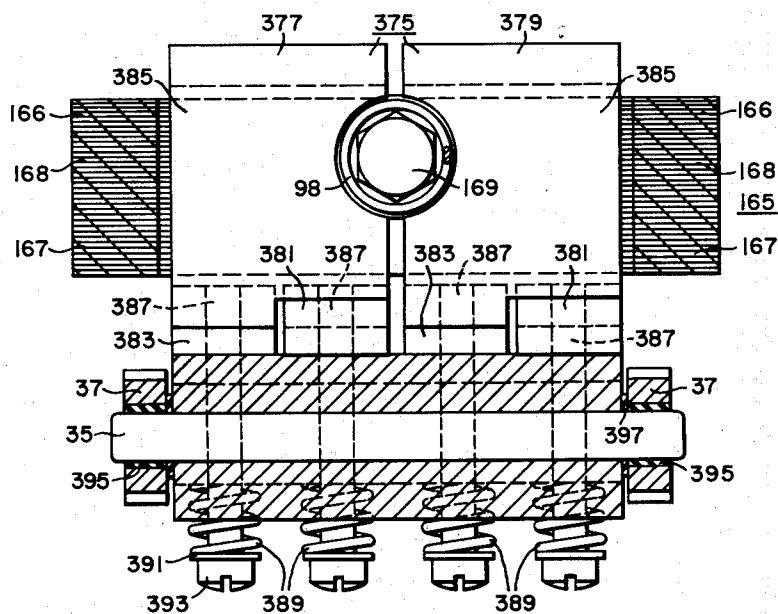
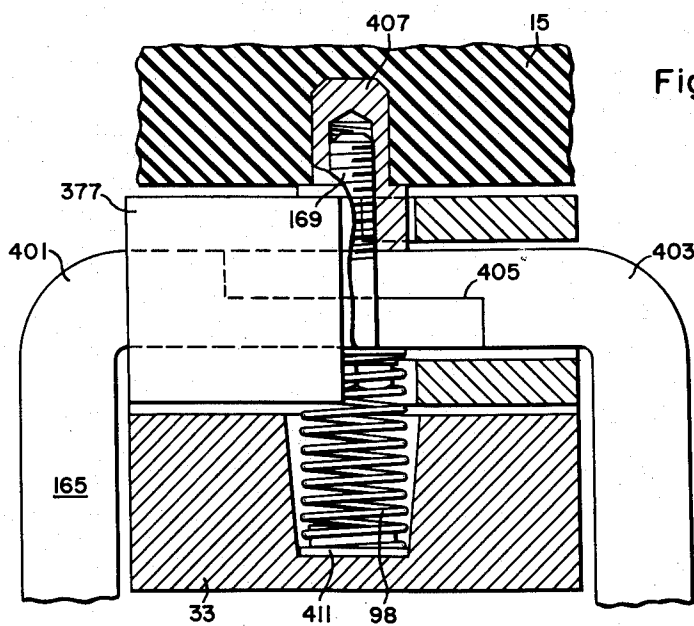


Fig.5.



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3,072,765

CIRCUIT BREAKER

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5 Claims. (Cl. 200-109)

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

An object of the invention is to provide an improved over-current tripping device which can be utilized with circuit breakers of different current ratings.

Another object of the invention is to provide a circuit breaker with improved trip means embodying a magnet yoke and a multi-turn current path for energizing the magnet yoke.

Still another object of the invention is to provide a circuit breaker with improved trip means embodying a magnet yoke and multi-turn means for energizing the magnet yoke which multi-turn means also serves to decrease the amount of force required to close the breaker against an energized line.

A further object of the invention is to provide a circuit breaker with improved trip means embodying a magnet yoke that is energized by the current flowing through a multi-turn current path that includes a movable switch arm and a looped conducting member which electrically connects the switch arm to a conducting terminal member.

In accordance with one embodiment of the invention, a circuit breaker having a switch arm which is movable about a fixed pivot to open and close the breaker, is provided with an electromagnetic trip device operated by energization of a generally U-shaped magnet yoke. The switch arm passes through the opening defined by the legs of the U-shaped magnet yoke, and it is connected to a conducting terminal member by means of a looped conducting member that has one leg slidably engaging the movable switch arm and another leg engaging the terminal member. The movable switch arm and looped conducting member cooperate to form a multi-turn current path for energizing the magnet yoke. The main current path passes through the opening defined by the legs of the U-shaped magnet yoke a first time through the switch arm and a second time through the looped conducting member. The magnetic effect of the multi-turn energizing means serves to cancel part of the blow-off force operating against the movable switch arm to thereby decrease the amount of force required to close 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 of a preferred embodiment thereof, when read in connection with the accompanying drawings.

In said drawings:

FIGURE 1 is an elevational view, partly in section, of a circuit breaker having a trip device and a movable switch arm embodying the principles of the invention;

FIG. 2 is an enlarged elevational view, partly in section, of the trip device with the movable switch arm in the closed position;

FIG. 3 is a view similar to FIG. 2; but showing the switch arm in the opened position;

FIG. 4 is a view taken generally along line IV-IV of FIG. 2;

FIG. 5 is a plan view, partly in section, of the parts of the trip device shown in FIG. 4; and

FIG. 6 is a perspective view of one-half of the looped

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conducting member that electrically connects movable switch arm with one of the terminals.

Referring to FIG. 1 of the drawings, a circuit interrupter 9 shown therein is similar to the one shown and described in a patent to Merl E. Horn et al., Patent No. 2,813,170, patented November 12, 1957, and assigned to the assignee of the instant case. The circuit interrupter 9 includes a plurality of pole units each comprising a separable contact structure 11 positioned within an arc extinguishing structures 10. An overcurrent trip device 13 is provided for each pole unit. The contact structure and trip device for each pole unit of the circuit interrupter are mounted on separate insulating bases 15 which are rigidly secured to a metal panel 17 by means of screws 19. Since the pole units are alike, only one will be specifically described herein.

The contact structure comprises stationary main contacts 23 and a stationary arcing contact 25 all supported on the inner end of a U-shaped terminal conductor 27 (FIG. 1) the legs of which extend through suitable openings in the base 15 and panel 17. Cooperating with the stationary main contact 23 and the stationary arcing contact 25, respectively, are a movable main contact 29 and a movable arcing contact 31. The movable contacts 29 and 31 are supported by a channel-shaped main switch arm 33 that is pivotally mounted at its lower end on a pin 35 supported in a bracket 37. The bracket 37 is rigidly mounted by means of bolts 39 (only one being shown in broken lines in FIGS. 2 and 3) on a lower U-shaped terminal conductor 41.

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

The operating mechanism 61 includes a lever 73 pivotally mounted on a pivot pin 75 that is supported in the side members 65 of the frame 63. The lever 73 comprises a pair of spaced parts rigidly joined by an angle member 77 that extends across all of the poles of the interrupter. The angle member 77 is operatively connected to each of the movable switch arms 33 by means of an insulating connecting member 81 and a pivot pin 79 in each switch arm. The other end of each of the connecting members 81 is pivotally connected to the angle member 77 by means of a pivot pin 80 and a bracket 82 rigid with the angle member 77. There is a connecting member 81 for each pole unit of the circuit interrupter which connects the angle member 77 to the main moving contact member 33 for each pole unit so that, upon operation of the lever 73, the movable contact structures for all of the pole units move in unison.

An operating linkage comprising toggle links 83, 85 and 87, 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.

The linkage 83, 85, 87 comprises two toggles one of which 83, 85 functions as a tripping toggle. The other

toggle 85, 87 functions as a closing toggle. The tripping toggle is normally slightly underset above a line drawn through the center of the pivot pin 89, 93, and the closing toggle 85, 87 is normally slightly underset below a line drawn through the centers of the pivot pins 91, 97.

The tripping toggle 83, 85 is biased in a direction to cause its collapse by means of springs 98 (FIGS. 2, 3 and 5). The spring 98, there being one for each pole unit, bias the movable contact arms 33 in opening direction (to the left as viewed in FIG. 1), and this force is transmitted through the operating mechanism to the tripping toggle 83, 85. The tripping toggle 83, 85 is normally prevented from collapsing by means of a main latch member 99 pivoted on a pin 100 and connected by a link 101 to the knee pin 91 of the tripping toggle. The link 101 is connected to the main latch member 99 by a pin 103. The main latch 99 is held in latching position by an intermediate latch lever 105 pivoted on a pin 107 in the frame 63. The latch lever 105 carries a latch roller 111 which normally engages the main latch 99 to releasably hold the latter in holding position. The latch lever 105, at its lower end, carries a latch member 113 which normally engages a latch member 115 on a light-load latch member 117 which is pivoted on a pin 119 in the frame 63. The latch lever 105 and the member 117 are both biased to the latching position by a spring 121 tensioned between the lever 105 and member 117. Rigidly mounted on the right-hand end of member 117 is a trip bar 123 which extends across all of the poles of the interrupter and has secured thereto an insulating bracket 125 (FIGS. 1, 3 and 4) for each pole unit which cooperates with the trip device 13 for the corresponding pole unit.

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 closed position shown in FIG. 1.

The closing toggle 85, 87 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.

The circuit interrupter is tripped open by operation of the trip device 13, to be hereinafter described, for any pole unit of the interrupter. Operation of the trip device 13 actuates the trip bar 123 to effect release of the latch lever 105 which, in turn, releases the main latch 99. When the main latch 99 is released, the forces of the springs 98 (FIGS. 2, 3 and 5) are transmitted through the switch arm 33 and connecting members 81 to the lever 73, causing the tripping toggle 83, 85 to collapse upwardly to effect opening movement of the movable switch arms 33 for all of the pole units 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 member 131. During the unlatching movement of the main latch 99, a cam (not shown) thereon engages a part of the support member 131 and moves this member in a clockwise direction about its pivot 107 to disengage the shoulder thereon from beneath the pin 93 whereupon the closing toggle 85, 87, being no longer supported, collapses downwardly under its own weight and the weight of a moving armature of a closing solenoid which will be described later. Collapse of the closing toggle 85, 87 causes the tripping toggle 83, 85 to be reset to its thrust transmitting position and effects resetting of the latch mechanism to latching position. The operating mechanism is then in condition for a closing operation.

The circuit interrupter is closed electrically by energization, effected either manually or by automatic means, of a closing solenoid 149 (FIG. 1). The closing solenoid 149 comprises a fixed magnet yoke 151 and a fixed core member 153 mounted on the underside of the platform 69. A movable armature 155 is attached to the lower end of an operating rod 157 which extends up-

wardly and has its upper end pivotally connected to the knee pin 93 of the closing toggle 85, 87. An energizing coil 159 is supported on the lower end of a supporting bracket 161 which has its upper end fastened to the platform 69.

In the closed position of the interrupter, the armature 155 is held in its raised position (FIG. 1). When the breaker is tripped open, the closing toggle 85, 87 collapses downwardly permitting the armature 155 to assume its lower or unattracted position. Thereafter, upon energization of the coil 159, the armature 155 is attracted upwardly and acts through the rod 157 to straighten the closing toggle 85, 87 to effect closing of the contacts.

The action of the contact structure during a closing operation is generally the reverse of that during an opening operation.

The trip device 13 includes a tripping electromagnet 163 and a time delay device 164. The tripping magnet 163 comprises a U-shaped magnet yoke 165 which includes two separate magnet yokes 166 and 167 separated by a spacer 168 of non-magnetic material. The magnet yokes 166 and 167 and the spacer 168 are rigidly secured together and are rigidly secured to the base 15 of the corresponding pole unit by means of a bolt 169. The legs 171 of the magnet yoke 166 extend on opposite sides of the main current carrying switch arm 33 and terminate in pole faces 173 (FIGS. 2 and 3). The legs 177 of the magnet yoke 167 also extend on opposite sides of the switch arm 33 and terminate in pole faces 179. The U-shaped magnet 165, comprising the magnet yokes 166 and 167, is energized in a manner to be hereinafter specifically described.

The time delay device 164 and the elements of the trip device other than the magnet yoke are supported in a U-shaped frame indicated generally at 181 (FIGS. 2 and 3). The frame 181 comprises spaced side members 183 (only one being shown integrally joined by cross members 184 and 185). The lower portions of each of the side members 183 are rigidly supported on the base 15 by means of bolts 187. The upper end of each of the side members 183 is rigidly secured to the adjacent leg 177 of the magnet yoke 167 by means of a bolt 189 which passes through a bracket 191 rigidly secured to the leg 177 and which threadedly engages an upwardly extending portion 192 of the side member 183.

The trip device is actuated by a moving armature 193 rigidly mounted on a pair of spaced levers 195 (only one being shown) joined by a cross member 197 and pivotally supported on pins 199 in the side members 183. The armature lever 195 is connected to the time delay device 164 by means of a spring linkage 201 which is pivotally connected at its upper end by a pin 203 to the lever 195. In the unattracted position of the armature, the lever 195 rests against a fixed stop 205 formed on the side member 183 of the frame 181. The spring linkage 201 is connected at its lower end by means of a pin and slot connection 207, 209 to a member 211 which, in turn, operates the time delay device 164. The pin 207 is guided in its movement by means of a link 213 pivoted on a pin 215.

When the electromagnet 163 is energized in response to overcurrents, the armature 193 is attracted to the pole faces 179 applying an upward force on the spring linkage 201. The linkage 201 moves slowly upwardly under the restraining influence of the time delay device 164. During the upward movement of the linkage 201, a pin 217 therein engages one arm 219 of a bell-crank lever 221 and slowly rotates the latter in a clockwise direction. The bell-crank lever 221 is pivoted on the pin 199 and, during its clockwise movement, a headed screw 223 carried by the other arm 225 of the bell crank 221 engages the bracket 125 and actuates the trip bar 123 (FIG. 1) to trip the breaker in the previously described manner.

The linkage 201 is moved upwardly by the armature

193 to trip the breaker under the control of the time delay device 164 which comprises generally a flexible diaphragm 227 (FIG. 3) attached to the lower end of the member 211 and valve elements for controlling the rate of admission of air to the space below the diaphragm. The flexible diaphragm 227 is disposed in a chamber 229 formed in an upper housing member 231 and a lower housing member 233, both housing members being formed of molded insulating material. The outer edge of the diaphragm 227 is clamped between the housing members 231 and 233 with a sealing gasket to form an air-tight seal. The housing members are secured together and rigidly mounted on the cross member 185 of the frame 181 by means of bolts 235 (FIGS. 1 and 2). The central portion of the diaphragm 227 is suitably clamped between upper and lower clamp members 237 and 239 respectively to form an air-tight seal. The clamp members are rigidly secured together and to the member 211 by a screw 241 (FIG. 3).

Since the spaces above and below the diaphragm 227 are completely sealed off from each other and the space above the diaphragm is at atmospheric pressure, any force tending to raise the members 211 will be restrained by the partial vacuum below the diaphragm. In order to control the rate of tripping movement of the member 211 and the linkage 201, valve devices are provided to admit air to the space below the diaphragm at different rates. The valve devices comprise a long-time delay valve indicated generally at 245 (FIG. 3), and a short-time delay valve indicated generally at 247 (FIG. 2).

The long-time delay valve 245 (FIG. 3) will be described first. The central bottom portion of the lower housing member 233 is molded to form a valve seat 249 in the shape of an inverted truncated cone. Surrounding the valve seat 249 is a tubular metallic member 251 molded into the housing member 233 and threaded internally to receive a valve 253 having a conical opening therein for cooperating with the valve seat 249. The valve 253 is provided with a flange 255 which supports an adjusting knob 257 of molded insulating material which is biased against the flange by a spring 259. An air passage 261 in the form of a groove is provided along the threaded portion of the valve 253 and a passage 263 is provided axially through the valve seat 249. The flow of air into the chamber 229 below the diaphragm 227 is through a filter 265, the passage 261, the orifice defined by the valve 253 and the valve seat 249 and through the passage 263.

The inner surface of the knob 257 is provided with serrations which engage serrations on the valve 253 whereby rotation of the knob 257 rotates the valve 253 which, due to its threaded engagement with the fixed tubular member 251, moves the valve 253 axially of the valve seat 249 to vary the rate of admission of air to the space below the diaphragm and thereby vary the amount of time delay in the operation of the trip device.

The short-time delay valve device 247 (FIG. 2) controls a passage for admitting air from the chamber 229 above the diaphragm 227 to the space below the diaphragm at a rate to provide a very short time delay, in the order of alternating current cycles, in the operation of the trip device. The valve device 247 comprises a tubular valve element 273 disposed in an opening 275 in the upper housing member 231. The valve element 273 is provided with an enlarged head 277 at the lower end thereof which is seated in an opening 279 in the bottom housing member 233. The valve element 273 is also 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 the opposite sides of the diaphragm 227. The valve 273 has an axial passage therethrough in which is disposed a tapered projection 285 of the valve 281, the axial passage being normally closed by the valve 281. The head 277 of the valve element 273 has a horizontal passage 287

therein. A passage 289 in the housing member 231 communicates the chamber 229 above the diaphragm 227 to the opening 275 above the valve seat, and a passage 291 in the housing member 233 communicates the chamber 239 below the diaphragm to the passage 287.

It will be seen that upward movement of the valve 281 will open the passage comprising passages 289, 287 and 291 and establish a communication from the upper side to the lower side of the diaphragm 227.

The valve 281 (FIG. 2) is actuated upwardly to the open position by means of an armature 292 which is rigidly mounted on one end of a lever 293 that is pivoted on the pin 199. The lever 293 is connected by a link 294 to a lever 295 pivotally supported at 296 (FIG. 3) on the housing member 231. The link 294 is connected by a pin 283 to the lever 293 and is provided with a slot 297 which cooperates with the pin 215 to guide the link in its movement. The lower end of the link 294 has a pin 299 therein which cooperates with a slot 300 in a bracket 301 that is rigidly mounted on the lever 295. A bracket 303 secured to the lever 295 engages in a notch 305 in the upper end of the valve 281 so that upon actuation of the lever 295 by the armature 292 acting through the lever 293 and link 294, the valve 281 is instantaneously moved upwardly to the open position. This opens the previously described communicating passage-way permitting air to pass from the chamber 229 above the diaphragm 227 to the space below the diaphragm to control the rate of tripping movement of the member 211 and the linkage 201.

The amount of opening of the valve 281 and, hence, the rate of flow of air to the space below the diaphragm is controlled by an adjustable S-shaped stop member 307 (FIG. 2). The upper portion of the stop member 307 is disposed in the path of tripping movement of the up-turned end of the lever 295 to be engaged thereby and thus limit the extent of opening of the valve 281.

The stop member is adjustable to vary the amount of short-time delay by means of an adjusting screw 309 which threadedly engages the center cross bar 311 of the S-shaped member 307. The adjusting screw 309 is rotatably mounted in an insulating cross bar 313 supported on the under side of the housing member 233 by means of screw 314, only one of which is shown. A knurled knob 317 is mounted on the lower end of the screw 309 below the cross bar 313 whereby the adjusting screw 309 may be rotated to provide the proper setting of the stop 307.

A portion 319 of the screw 309 also engages a pointer 321, an end of which projects outward through a slot in a scale plate 323 to give an indication of the setting of the adjustable stop 307 for the short-time delay valve 281.

The pickup point, that is the magnitude of overload current required to actuate the armatures 193 and 292, may be varied by varying the tension respectively of springs 325 (FIG. 3) and 327. The spring 325 has one end attached to a yoke 329 which has its legs pivotally supported in spaced grooved studs 331 (only one being shown) supported in the housing member 231. The right-hand end of the yoke 329 is provided with inwardly extending projections 333 which engage in an annular groove 335 in the cylindrical member 211. The other end of the spring 325 is attached to a pointer 337 which is threadedly engaged by an adjusting screw 339 that is rotatably mounted in the cross bar 313. The adjusting screw 339 is provided with an adjusting knob 341 on the end thereof below the cross bar 313. Rotation of the screw 339 varies the tension of the spring 325 to thereby vary the pickup point of the armature 193. The tension of the spring 327 for the armature 292 is similarly adjusted by means of a screw and pointer (not shown) like the adjusting means for the spring 325.

The magnet yokes 166 and 167 are separated from each other by the non-magnetic member 168 in order that

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operation of armature 193, upon energization of its magnet yoke 167, will not shunt part of the flux from the magnet yoke 166 as would be the case if the yokes 166 and 167 formed a single magnet yoke. This prevents a change of calibration of the short-time delay armature 292 when the armature 193 is attracted to the pole faces 179.

The trip device functions with time delays of different durations in response to overload currents of different magnitudes. For instance, the device may function with a relatively long time delay in the order of seconds in response to overload currents up to approximately ten times normal rated current and with a relative short-time delay in the order of alternating current cycles in response to greater overload currents.

The parts are shown in the closed circuit position in FIG. 2. Assuming the occurrence of an overload current below ten times normal rated current, the tripping electromagnet becomes energized, in a manner to be hereinafter described, sufficiently to attract the armature 193 upwardly. The armature 193 acts through the lever 195 and the spring linkage 201 to produce an upward thrust on the member 211, the movement of the member 211 being retarded by the partial vacuum below the diaphragm 227. The linkage 201 moves slowly upwardly in tripping direction as air is drawn into the space below the diaphragm through the long-time delay valve 245. The slow upward movement of the linkage 201 acts through the pin 217 to slowly rotate the bell crank 221 in a clockwise direction until the screw 223 in the arm 225 of the bell crank 221 engages and actuates the bracket 125 of the trip bar 123 and effects release of the latch mechanism and opening of the interrupter in the previously described manner.

As soon as the interrupter contacts have opened, the tripping electromagnet is deenergized and the armature 193 and the member 211 are restored to their normal positions by the spring 325 (FIG. 3). A spring biased reset or bypass valve 343 (FIG. 3) controls a passage through the diaphragm 213 to provide quick dumping of the air in the space below the diaphragm and quick restoration of the parts.

Energization of the electromagnet in response to overload currents above ten times normal rated current attracts both of the armatures 193 and 292. The short-time delay armature 292 is attracted to the magnet yoke 171 and it acts through the link 294 to move the lever 295 upwardly opening the short-time delay valve 237 an amount determined by the adjustment of the stop 307. This admits air to the space below the diaphragm 227 at a higher rate than the long-time delay valve 245 alone and provides a short-time delay in the order of cycles in the tripping operation of the device.

A latch or interposer 347 is provided to effect an instantaneous tripping operation if the breaker is operated to close against an excessive fault current or a short-circuit current. The interposer 347 is pivotally supported, by means of a pin 348, on the lower end of the lever 293 which lever carries the armature 292. A spring 350 biases the interposer 347 to its effective position shown in FIG. 3 in which position a portion 351 thereof is disposed directly beneath a projection 352 on the arm 225 of the bell crank lever 221.

The interposer 347 is biased to its ineffective position, when the breaker is in the closed position shown in FIG. 2, by engagement of a portion thereof with one arm 353 of a lever indicated generally at 355. The lever 355 is pivoted on the pin 199, and the other arm 357 of the lever 355 carries a roller 359 which engages the switch arm 33. The lower end of the arm 353 of the lever 355 is pivotally connected to a dash-pot device indicated generally at 363, by means of a pin 365.

The occurrence of an overload current greater than ten times the rated current or a short-circuit current when the breaker is in the closed position causes in-

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stantaneous operation of both of the armatures 193 and 292, and opening of the short-time delay valve 281 (FIG. 2) to provide a short-time delay in the tripping operation. Since, at this time, the interposer 347 is in its ineffective positions, it will not engage the projection 352 and, therefore, it will not directly operate the lever 221 to instantaneously trip the breaker. It can be understood that when the breaker is in the closed position, the interposer will never operate from this position to instantaneously trip the breaker.

The interposer will, however, be positioned to effect an instantaneous tripping operation during closing operations if the breaker is closed against a fault. As seen in FIG. 3, when the breaker is open the switch arm 33 engages the roller 359 of the lever 355, and biases the arm counterclockwise about the pivot 199 clearing the arm 353 of the lever 355 from engagement with the interposer 347 whereupon the interposer is moved clockwise under the bias of the spring 350 until the portion 351 of the interposer is positioned directly under the projection 352 of the lever 221.

During a closing operation, the switch arm 33 travels at a relatively high speed and spring means (not shown) causes the lever 355 to follow the switch arm. However, due to the retarding action of the dash-pot 363, the lever 355 moves clockwise at a slower speed than the switch arm 33. If the breaker closes on normal current or on a low overload below ten times normal current, the tripping magnet 165 will not be energized sufficiently to attract the armature 292, and the breaker will go to the fully closed and latched position. In this event, the lever 355 will, after a time delay of, for example, approximately $\frac{1}{2}$ to 1 second, engage and move the interposer 347 to its ineffective position (FIG. 2) thus defeating instantaneous tripping from the closed position of the breaker.

If, however, the breaker is closed on a fault current greater than ten times normal rated current or a short circuit, the tripping magnet 165 will be energized sufficiently to attract the short-time delay armature 292. In this event, the time delay in the clockwise movement of the lever 355 effected by the dash-pot 363 is sufficient to insure that the lever 355 does not disengage the interposer 347 from the projection 352 before the armature 292 acting through the interposer 347 moves the arm 225 of the bell-crank lever 221 to move the screw 223 to instantaneously trip the breaker.

Improved means are provided for energizing the magnet yoke 165 to effect a more sensitive tripping operation of the circuit breaker. A looped member of conducting material 375 comprising two similar parts 377 and 379 (FIG. 4) electrically connects the switch arm 33 (FIGS. 1, 2 and 3) with the terminal conductor 41. As best seen in FIG. 6, each of the parts 377 and 379 of the looped conducting member 375, comprises a first leg 381, a second leg 383 and a looped portion 385. The looped portion 385 of each of the looped parts 377 and 379, surrounds the closed portion of the U-shaped magnet yoke 165. Each of the looped parts 377 and 379 is supported by the bracket 37 by means of two screws 387 (FIG. 4) which pass through openings in the legs of the bracket 37 and threadedly engage the looped members 377 and 379. The members 377 and 379 are biased in a direction wherein the legs 381 engage a portion of the switch arm 33 and the legs 383 engage a portion of the terminal member 41, by means of springs 389 (FIG. 4). The springs 389 fit over the bolts 387 and are supported between the bracket 37 and washers 391 that are held in place by the bolt heads 393. As best seen in FIG. 4, the supporting pin 35 is insulated from the bracket 37 by means of two tubular shaped insulating members 395.

The magnet yoke 165 is formed of mating parts 401 and 403 (FIG. 5) which have stepped mating portions that engage to form a stepped plane 405 (shown in FIG. 5 partially in broken lines and partially in full lines)

when the parts are in place. When the breaker is being assembled, the magnet yoke is mounted after the looped conducting device 375 is in place. The parts 401 and 403 are brought together and the bolt 169 is passed there-through to threadedly engage an insert 407 that is supported in the insulating base 15 to thereby support the magnet yoke 165 in place. The spring 98 is disposed between the magnet yoke 165 and the switch arm 33, and it biases the switch arm to the open position and operates to force the breaker open when the latched operating mechanism 61 (FIG. 1) is released for an opening operation. An insulating member 411 (FIG. 5) serves to insulate the switch arm 33 from the spring 98.

The main current path through each pole unit of the circuit interrupter is from the upper terminal 27 (FIG. 1), through the stationary contacts 25, 33, the movable contacts 31, 29, the switch arm 33, the looped conducting member 375, to the lower terminal 41. The current path through the looped conducting member 375 extends through the legs 381, looped portions 385 to the legs 383 of the looped conducting members 377 and 379.

The electromagnetic forces generated by the current flowing through the looped conducting member 375 will tend to expand this member. The looped conducting member 375 is composed of a flexible material such, for example, as copper. The magnetic forces will act to force the legs 381 and 383 of each of the parts 377 and 379 of the looped member 375 downwards as viewed in FIGS. 1-4 and 6, and since upward movement of the looped member 375 is prevented by the insulating base 15, the magnetic forces will act to increase contact pressure between the legs 381 and the switch arm 33 and between the legs 383 and the terminal 41. This increase of contact pressure enables the breaker to function properly upon the occurrence of excess current conditions.

It can be seen that the current passes through the opening defined by the legs of the magnet yoke 165 at least twice forming a multi-turn energizing path. Because the current passes through the adjacent parts of the switch arm 33 and looped conducting device in the same direction, i.e. downward through the magnet yoke, the magnetic effect tends to draw these devices together. Since the looped conducting device is stationary, this magnetic effect will draw the movable switch arm 33 towards the closed position when current is passing through the breaker, thus reducing the amount of force required to close the breaker against an energized line.

Having disclosed 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 thereof without departing from the spirit of the invention.

We claim as our invention:

1. In a circuit interrupter, a stationary contact, a movable contact, a current carrying switch arm supporting the movable contact, operating means operable to move the switch arm to open and close the interrupter, a tripping electromagnet comprising a generally U-shaped magnet yoke, the switch arm in the closed position passing through the opening defined by the legs of the generally U-shaped magnet yoke, a looped conducting member cooperating with the switch arm to form a multi-turn current path for energizing the U-shaped magnet yoke, and upon the occurrence of a predetermined amount of overload current through the multi-turn current path the magnet yoke becoming energized sufficiently to operate the tripping electromagnet to effect opening of the circuit interrupter.

2. In a circuit interrupter, a stationary contact, a movable contact, a current carrying switch arm supporting the movable contact and movable about a fixed pivot to open and close the contacts, a tripping electromagnet including an armature and a U-shaped magnet yoke, a relatively stationary conducting member looped around a portion of said magnet yoke, a portion of said conducting

member slidably engaging a portion of said switch arm to electrically connect said conducting member to said switch arm, and said armature being attracted to said magnet yoke upon the occurrence of an overload current above a predetermined amount to effect opening of said contacts.

3. In a circuit interrupter, a stationary contact, a movable contact, a current carrying switch arm supporting the movable contact, operating means operable to move the switch arm to open and close the interrupter, a tripping electromagnet comprising a generally U-shaped magnet yoke, the switch arm in the closed position passing through the opening defined by the legs of the generally U-shaped magnet yoke, a relatively stationary conducting member looped around a portion of said magnet yoke, said switch arm and looped conducting member cooperating to form a multi-turn current path for energizing said magnet yoke, and said magnet yoke being energized sufficiently upon the occurrence of a predetermined amount of overload current through said multi-turn current path to operate the tripping electromagnet to effect opening of the circuit interrupter.

4. In a circuit interrupter having a main current carrying path therethrough, a stationary contact, a movable contact, a current carrying switch arm supporting the movable contact, operating means operable to move the switch arm to open and close the interrupter, a tripping electromagnet including an armature and a generally U-shaped magnet yoke, the switch arm in the closed position passing through the opening defined by the legs of the generally U-shaped magnet yoke, a terminal member of conducting material, a conducting member having a looped portion a first leg and a second leg, said looped portion surrounding a portion of said magnet yoke, spring means biasing said conducting member in a direction to engage said first leg with said switch arm and said second leg with said terminal member, said main current path passing from said switch arm through said looped conducting member to said terminal member, and an overload current above a predetermined amount energizing said magnet yoke sufficiently to cause said magnet yoke to attract said armature to effect opening of the interrupter.

5. In a circuit interrupter having a main current carrying path therethrough, a stationary contact, a movable contact, a current carrying switch arm supporting the movable contact, operating means operable to move the switch arm to open and close the interrupter, a tripping electromagnet comprising an armature and a generally U-shaped magnet yoke, the switch arm in the closed position passing through the opening defined by the legs of the generally U-shaped magnet yoke, a terminal member of conducting material, a conducting member having a looped portion a first leg and a second leg, said looped portion surrounding a portion of said magnet yoke, spring means biasing said conducting member in a direction to engage said first leg with said switch arm and said second leg with said terminal member, said main current path passing from said switch arm through said looped conducting member to said terminal member, the forces created by the current in said looped portion being such that they cooperate with said biasing action of said spring means to hold said conducting member in engagement with said switch arm and said terminal member, and an overload current above a predetermined amount energizing said magnet yoke sufficiently to cause said magnet yoke to attract said armature to effect opening of the interrupter.

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