Sept. 29, 1953 B. G. TREMBLAY ET AL 2,654,009

CIRCUIT BREAKER

Filed Feb. 11, 1950 2 Sheets-Sheet 1

Fig.1.

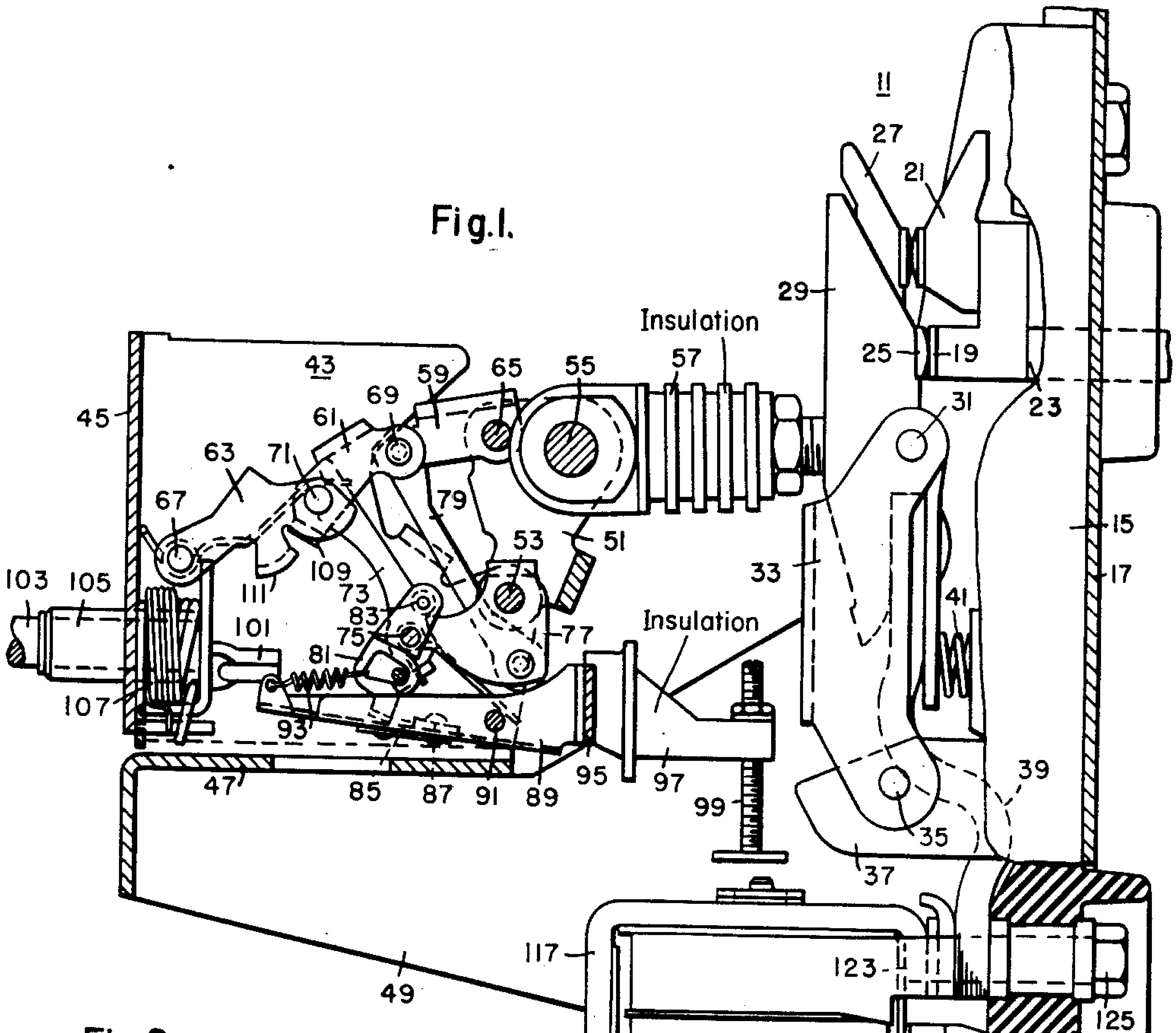
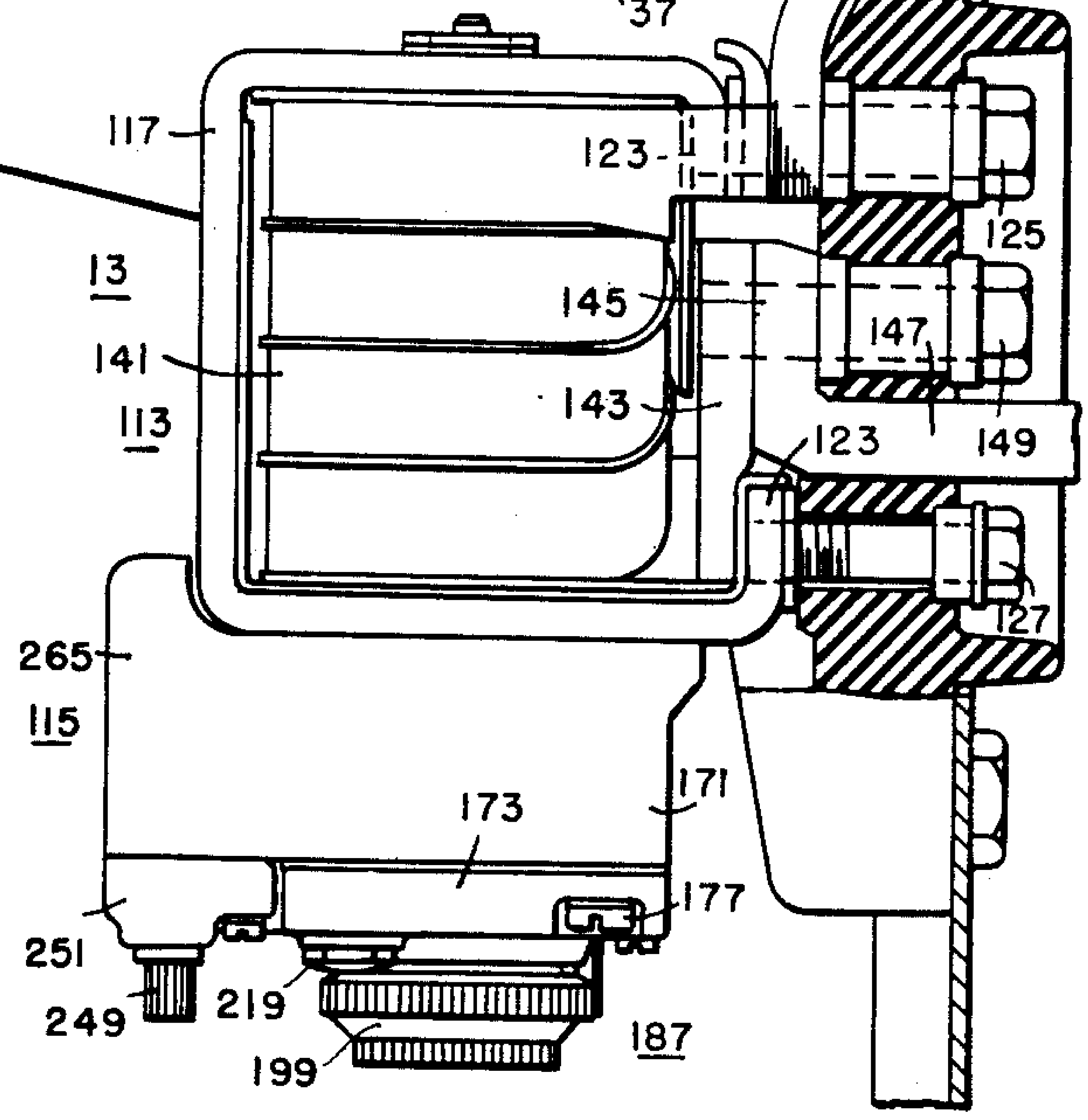
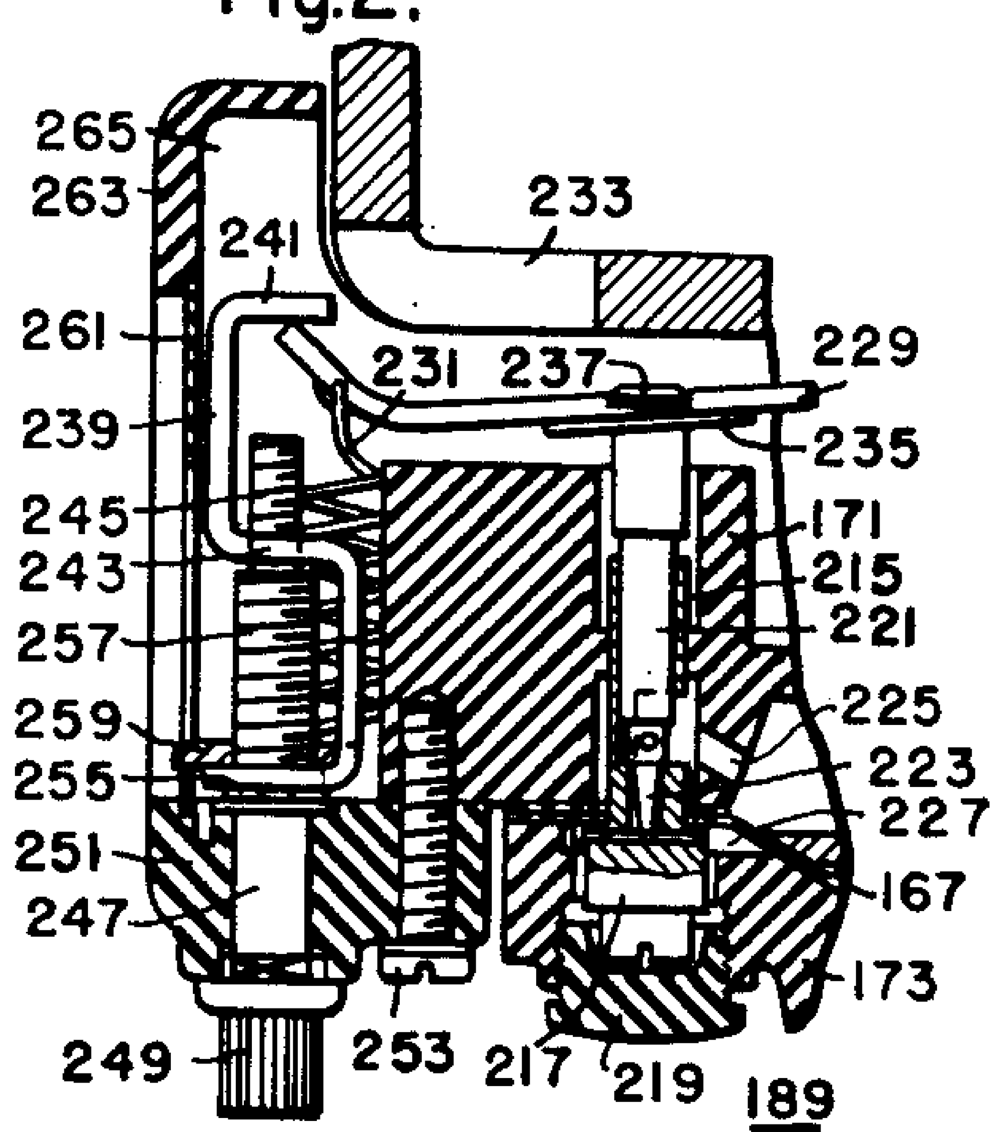



Fig.2.



WITNESSES:

E. A. McCloskey.

Paul O. Harlan.

INVENTORS
Bernard G. Tremblay and
William H. Stuellein.
BY
Ralph H. Swingle
ATTORNEY

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B. G. TREMBLAY ET AL

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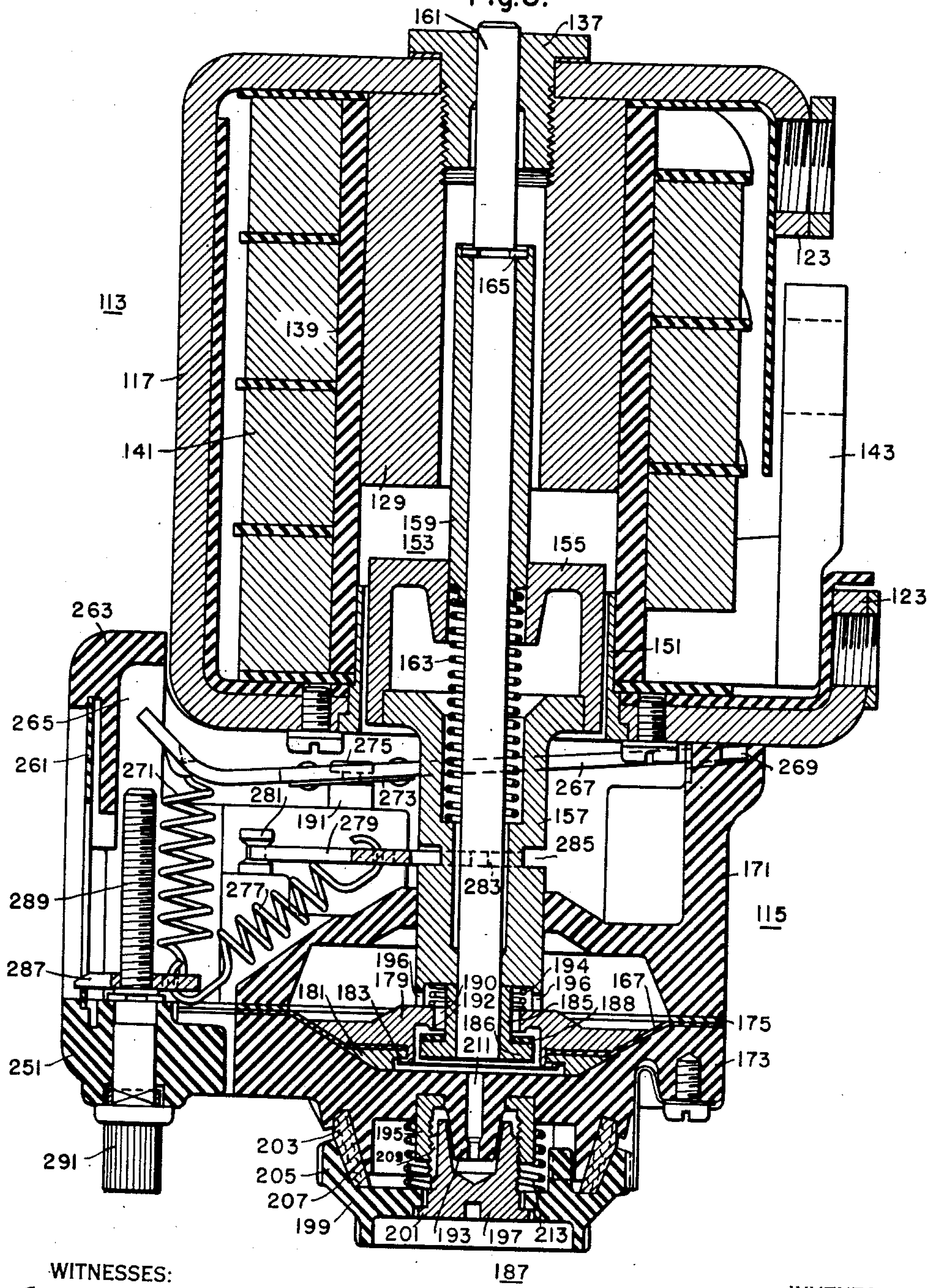
2 Sheets-Sheet 2

Fig.3.



WITNESSES:

E. A. McCloskey.

Paul D. Harlow.

INVENTORS
Bernard G. Tremblay and
William H. Stuellein.
BY
Ralph H. Swingle
ATTORNEY

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UNITED STATES PATENT OFFICE

2,654,009

CIRCUIT BREAKER

Bernard G. Tremblay, Pittsburgh, and William H. Stuellein, East McKeesport, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 11, 1950, Serial No. 143,722

8 Claims. (Cl. 200—108)

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

Certain features disclosed but not claimed in this application are fully disclosed and claimed in copending application Serial No. 141,136, filed January 28, 1950, by J. B. MacNeill, F. E. Florschutz, T. Lindstrom, and B. G. Tremblay, and assigned to the assignee of this application.

An object of the invention is to provide a circuit breaker embodying an improved electromagnetic trip device provided with a novel time delay device.

Another object of the invention is to provide a circuit breaker having an electromagnetic trip device of improved construction embodying an air dashpot and a high-speed resetting valve to permit high-speed resetting of the trip device.

Another object of the invention is to provide a circuit breaker having an electromagnetic trip device and an improved time delay device of the air dashpot type embodying a high-speed reset valve which is operated directly by the electromagnet.

Another object of the invention is to provide a circuit breaker having an electromagnetic trip device including a trip rod and a time delay device of the air dashpot type with an improved high-speed reset valve operated directly by the trip rod.

The novel features that are considered characteristic of the invention are set forth in the appended claims. The invention itself, however, 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 fragmentary elevational sectional view showing one of the control valves for the time delay device and the adjusting means therefor, and

Fig. 3 is a vertical sectional view through the trip device and the time delay device therefor.

Referring to Fig. 1 of the drawings, the circuit breaker includes a plurality of pole units each comprising a contact structure indicated generally at 11, and an over-current trip device indicated generally at 13. The contact structure and the trip device for each pole unit are mount-

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ed on a separate insulating base 15 which is rigidly secured to a metal supporting panel 17. Since the pole units are alike, only the center pole unit is illustrated and described herein.

The contact structure 11 comprises stationary main and arcing contact 19 and 21 both secured on the inner end of a terminal conducting bar 23, and cooperating movable main and arcing contacts 25 and 27. The movable contacts are rigidly secured to a contact carrying member 29 pivotally mounted by means of a pivot pin 31 on a U-shaped switch arm 33 which, in turn, is pivotally supported by pivot means 35 on brackets 37 rigidly mounted on the insulating base 15.

The movable contact carrying member 29 is electrically connected by means of a flexible conductor 39 to the energizing coil of the trip device 13. A spring 41 compressed between the movable contact carrying member 29 below its pivot 31 and the insulating base 15 provides contact pressure in the closed position of the breaker and also biases the movable contact structure in opening direction.

The movable contact structure is normally maintained in the closed position by means of an operating mechanism indicated generally at 43 mounted in a U-shaped frame 45. The frame 45 is supported on a platform 47 which forms a cross member of a generally U-shaped main bracket comprising a pair of spaced side members 49 rigidly connected at their outer ends by the cross member or platform 47. The platform 47 extends substantially across the width of the breaker and the side members 49 are suitably secured to the metal panel 17 on the outside of the two outer pole units of the breaker.

The operating mechanism includes a lever 51 mounted on a pivot pin 53 supported in the side members of the frame 45. The lever 51 carries a rod 55 extending across all of the poles of the breaker and is connected by means of insulating connecting members 57 to the pivot pins 31 in the free ends of the switch arms 33 for the several poles of the breaker so that upon operation of the rod 55 the movable contacts of all of the poles move in unison.

An operating linkage comprising toggle links 59, 61 and 63 is provided to releasably hold the lever 51 and consequently the movable contacts in the closed position and to operate the movable contacts to open and closed positions. The toggle link 59 is pivotally connected to the lever 51 by means of a pivot pin 65 and the toggle link 63 is pivoted on a fixed pivot 67 supported in the frame 45. The toggle link 61 is pivotally connected to the links 59 and 63, respectively, by knee pivot pins 69 and 71.

The linkage 59, 61, 63 comprises two toggles, one of which 59—61 may be designated as the tripping toggle and the other 61—63 as the closing toggle. The tripping toggle 59—61 is normally slightly underset above a line drawn through the centers of the pivot pins 65—71 and the closing toggle 61—63 is normally underset below a line drawn through the centers of pivot pins 67—69. The closing toggle 61—63 is normally prevented from collapsing downward by a support member 73 pivoted on a pivot pin 75 supported in the frame 45 and having a shouldered portion engaging under the knee pivot pin 71.

The tripping toggle 59—61 is normally biased in a direction to cause its collapse by a component of the force of the springs 41 which bias the movable contact structures for the three poles of the breaker in opening direction and bias the connecting members 57 toward the left (Fig. 1). The tripping toggle 59—61 is normally prevented from collapsing by means of a main latch member 77 pivoted on the pin 53 and connected by means of a link 79 to the knee pin 69 of the tripping toggle.

The main latch member 77 is held in latching position by an intermediate latch lever 81 pivoted on the pin 75. The intermediate latch lever 81 carries at its upper end a latch roller 83 engaging the main latch 77 and at its lower end has a latching portion 85 normally engaging a latch member 87 on a channel-shaped latch 89 pivoted on a pivot pin 91 in the frame 45. A spring 93 serves to bias the latch lever 81 and the latch 89 to their latching positions.

A trip bar 95, extending across all of the poles of the breaker, is rigidly mounted on the right-hand end of the channel-shaped latch 89 and has insulating brackets 97 (only one being shown) secured thereto, there being a bracket 97 for each pole of the breaker. Each of the brackets 97 has a headed screw 99 adjustably mounted thereon for cooperating with the trip device 13 of its associated pole in a manner to be presently described.

The breaker is tripped open manually by means of a cam member 101 mounted on the inner end of a handle shaft 103 journaled in a bearing 105 mounted in the front piece of the frame 45. The handle is not shown in the drawings but is rigidly secured to the outer end of the shaft 103 and biased in both directions to a central position in a well known manner by means of a spring 107.

Rotation of the handle shaft 103 in tripping direction causes the cam member 101 to engage and actuate the latch member 89 in counterclockwise or unlatching direction to unlatch the intermediate latch lever 81, which, in turn, releases the main latch 77. This permits the tripping toggle 59—61 to collapse upwardly to effect opening of the breaker contacts. During the collapse of the tripping toggle a portion 109 of the toggle link 61 engages and actuates the support member 73 to a non-supporting position, thereby freeing the closing toggle 61—63. The closing toggle thereupon collapses downwardly and during its collapse resets and relatches the tripping toggle 59—61.

The breaker contacts may now be operated to the closed position by rotating the shaft 103 and the cam 101 in the direction opposite to the tripping direction. This causes the cam 101 to engage a projection 111 on the closing toggle link

63 and moves this link counterclockwise about its pivot 67 until the support member 73 resumes its supporting position below the knee pivot pin 71. During the closing operation the link 79 prevents collapse of the tripping toggle 59—61 which acts as a thrust transmitting means and moves the movable contact structure to the closed position.

The breaker is automatically tripped open by operation of the trip device 13 for any pole of the breaker. The trip device includes generally a tripping electromagnet 113 (Figs. 1 and 3) and a time delay device 115. The tripping magnet 113 includes a C-shaped magnet yoke 117. The ends 123 of the magnet yoke form mounting feet and are drilled and tapped to receive mounting bolts 125 and 127 as shown in Fig. 1.

The upper end of a stationary magnet core 129 is provided with an internal thread which cooperates with a threaded nipple 137 disposed in an opening in the magnet yoke to rigidly secure the stationary core 129 to the magnet yoke.

Surrounding the stationary core member 129 is an insulating tube 139 around which is disposed the energizing coil 141 of the magnet.

As shown in Fig. 1, the bolt 125 which secures the upper end of the magnet yoke to the base 15 also secures the flexible conductor 39 to the upper turn of the coil 141. The lower turn of the coil 141 is formed into a lug 143 which, together with the inner end 145 of a terminal 147 is secured to the base 15 by means of a bolt 149. A tubular member 151 (Fig. 3) of magnetic material is mounted in an opening in the lower portion of the magnetic yoke 117 and extends upwardly within the insulating tube 139. Disposed within the tubular member 151 is a movable core member or armature indicated generally at 153 comprising a cup-shaped upper portion 155 and a tubular lower portion 157 rigidly secured together by a suitable means such as brazing. The portion 155 is provided with a central opening through which extends a sleeve 159 surrounding a trip rod 161 extending axially through the movable armature 153, the sleeve 159 and an opening in the nipple 137. A spring 163 coiled about the trip rod 161 is compressed between a counterbore in the member 157 and the shouldered lower end of the sleeve 159. The upper end of the sleeve 159 is counterbored and engages a spring clip 165 seated in an annular groove in the trip rod 161.

The trip rod 161 is moved upwardly to trip the breaker under the control of the time delay device 115 which comprises, generally, a movable abutment or flexible diaphragm 167 (Fig. 3) cooperating with the lower end of the trip rod and several valve elements for admitting air to the space below the movable abutment or diaphragm at various rates to provide different amounts of time delay. The flexible diaphragm is disposed in a chamber formed in an upper housing member 171 and a lower housing member 173, both of said housing members being formed of molded insulating material. The outer edge of the diaphragm 167, together with a sealing gasket 175, is clamped between the housing members to form an airtight seal. The housing members 171—173 are secured together and rigidly secured to the magnet yoke 117 by means of bolts 177 (Fig. 1) (only one of which is shown). The central portion of the diaphragm 167 is clamped between upper and lower clamp members 179 and 181, respectively, the upper clamp 179 having an annular projection 183 extending downwardly through an opening in the lower clamp 181 and formed over against the lower face of the latter to form an airtight seal.

Secured to the lower end of the trip rod 161 is a sleeve 185 provided with a flange 186 to the upper face of which is suitably attached a facing 188 of a tough resilient material, the flange 186 and facing 188 forming a valve member. The sleeve 185 is disposed in a central opening or passage 190 in the upper clamp member 179. An annular valve seat 192 formed on the clamp member 179 about the passage 190 is provided to cooperate with the facing 188 to close the passage 190 upon upward or tripping movement of the trip rod 161. The lower portion 157 of the movable armature extends downwardly through an opening in the upper wall of the housing member 171 and is normally seated on the upper face of the upper clamp member 179 surrounding the opening 190. The lower end of the member 157 is counterbored and a coil spring 194 surrounding the sleeve 185 is compressed between the bottom of the counterbore and the upper face of the clamp member 179.

Since the spaces above and below the diaphragm 167 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 161 will be restrained by the partial vacuum below the diaphragm. In order to control the rate of tripping movement of the trip rod 161, several valve devices are provided to admit air to the space below the diaphragm. The valve devices comprise a long-time delay valve indicated generally at 187 (Fig. 3), a short-time delay valve indicated generally at 189 (Fig. 2) and an instantaneous valve 191 (Fig. 3).

The long-time delay valve device 187 comprises a valve seat 193 molded integral with the bottom housing member 173, a tubular metal insert 195 molded in the housing member 173 surrounding the valve seat 193 and having an internal thread therein, a valve member 197 cooperating with the valve seat 193 and threadedly engaging the tubular insert 195 whereby it may be adjusted and an insulating adjusting knob 199 supported on a flange 201 on the valve member 197. The air entering the space below the diaphragm is filtered by means of a suitable filtering material 203 supported between an annular flange 205 on the knob 199 and a cooperating annular projection 207 formed integral with the housing member 173. An air passage 209 in the form of a groove is provided along the threaded surface of the valve 197 and a passage 211 is provided axially through the valve seat 193. The flow of air into the chamber below the diaphragm 167 is through the filter 203, the passage 209, the orifice defined by the valve 197 and the valve seat 193 and through the passage 211.

The knob 199 is provided with serrations (not shown) which engage corresponding serrations (also not shown) in the flange 201 of the valve 197 so that rotation of the knob also rotates the valve to vary the orifice and thereby vary the amount of time delay. The valve device 187 is calibrated by pushing upward on the knob 199 to disengage it from the valve member 197. The knob is then set to zero, the valve member rotated to closed position and the knob released. The knob is restored to engagement with the valve by means of a spring 213 compressed between the bottom of the housing 173 and the knob.

The short-time delay valve 189 (Fig. 2) con-

trols a passage for admitting air from the space above the diaphragm 167 to the space below the diaphragm at a rate to provide for tripping the breaker with a very short time delay in the order of alternating current cycles. The valve device 189 comprises a tubular valve member 215 (Fig. 2) disposed in an opening in the housing member 171 and having an enlarged head portion 217 seated in an opening in the housing member 173, the valve member 215 being held in position by a plug 219 screwed into the opening in the housing member 173. A valve 221 slidable in the tubular valve member 215 normally cooperates with a valve seat formed in the tubular valve member to close a communication with opposite sides of the diaphragm. The valve element 215 is provided with an axial passage in which is disposed a tapered projection 223 of the valve 221 and which is normally closed by the valve 221. The head 217 of the valve element 215 is provided with a passage, and passages 225 and 227, respectively, in the housing members 171 and 173 communicate the space above the diaphragm to the area above the valve seat and the space below the diaphragm to the area below the valve seat.

Upward or opening movement of the valve 221 opens the passage through the valve element 215 and establishes communication from the upper to the lower side of the diaphragm. The valve 221 is actuated to the open position by means of a valve operating armature 229 which is biased by means of a spring 231 to its unattracted position and is attracted upwardly by the tripping magnet 113. When this magnet is energized by overloads in the intermediate range of overloads of, for instance, 200% to 1000% of normal ratio current, the armature 229 is shown in Fig. 2 broken away, but is suitably pivotally mounted at its right hand end. The magnet yoke 117 has an opening 233 therein as shown in Fig. 2 to provide an air gap for operating the valve operating armature 229. A bracket 235 secured to the armature 229 engages under a head 237 on the valve 221 upon operation of the armature to actuate the valve to open position.

The rate of flow of air to the space below the diaphragm and consequently the rate of tripping movement of the trip rod 161 is controlled by the amount of opening of the valve 221. The opening movement of the valve 221 is adjustably controlled by means of an adjustable S-shaped stop member 239 (Fig. 2). The upper portion 241 of the S-shaped member comprises an adjustable stop and is disposed in the path of the upturned end of the armature to be engaged thereby and thus limit the upward movement of the armature 229 and limit the extent of opening of the valve 221. The center cross bar 243 of the S-shaped member has a threaded portion 245 of an adjusting screw 247, so that upon rotation of the screw 247 the S-shaped member 239 will be moved up or down, depending upon the direction of rotation, to provide for greater or lesser movement of the armature 229 and, hence, greater or lesser opening movement of the valve 221.

The lower end of the adjusting screw 247 has a reduced fluted portion molded into an insulating knob 249. The knob 249 is rotatably mounted in an insulating cross bar 251 secured to the underside of the housing member 173 by screws 253 only one of which is shown. A spring washer 255 seated in an annular groove in the adjusting screw **247** biases the screw upwardly and presses a flange on the knob **249** against the underside of the cross bar **251**.

The adjusting screw **247** has an enlarged threaded portion **257** which passes through a clearance opening in the lower horizontal portion of the S-shaped member and threadedly engages a pointer **259**. The lower vertical portion of the S-shaped member has cut-away portions on opposite edges thereof which are engaged by projections on the pointer **259** so that the latter will travel up and down without rotating. The outer end of the pointer **259** is reduced and extends through a vertical slot in an index plate **261** supported at its lower end on the cross bar **251** and having its upper end secured to a cross member **263** molded integral with side members **265**, which in turn, are integral with the housing member **171**.

The thread on the portion **257** of the adjusting screw has approximately twice the lead on the thread on the portion **245**, hence, for one rotation of the adjusting screw the pointer **259** will move twice the distance as the S-shaped member **239**. This makes possible an expanded dial on the index plate **261** and provides for more accurate setting of the short time delay device.

The instantaneous valve device **191** (Fig. 3) is of the same construction as the short-time delay valve device with the exception that the tapered end which extends into the passage controlled thereby is omitted to permit instantaneous full opening of the passage permitting substantially unobstructed flow of air to the space below the diaphragm and instantaneous operation of the trip rod. Referring to Fig. 3, the instantaneous valve **191** is operated to the open position by means of an armature **267** similar to the armature **229** for the short time delay valve. The armature **267** is provided with projections **269** (only one being shown) which pivotally support the right hand end of the armature **267** in suitable recesses in the housing member **171**. The armature **267** is biased to unattracted position by means of a spring **271** and when operated, a bracket **273** secured to the armature engages a head **275** on the valve **191** and operates the valve to open position.

The main movable core member **153** (Fig. 3) is biased to unattracted position by means of a pair of springs **277** (only one being shown) having one end attached to a member **279**. One end of the member **279** is pivotally supported in notched studs **281** (only one being shown) and the other end of this member **279** is provided with inwardly extending projections **283** (only one being shown) which engage in an annular groove **285** in the tubular member **157** of the movable core. The other ends of the springs **277** are attached to a pointer **287** which is threadedly engaged by an adjusting screw **289** rotatably mounted in the cross member **251** and having an adjusting knob **291** secured to the lower end thereof below the cross member. The pointer **287** is provided with a reduced portion extending through a vertical slot in the index plate **261** to prevent rotation of the pointer when the adjusting screw is turned and to indicate the setting of the spring adjustment.

The springs **231** (Fig. 2) and **271** (Fig. 3) for the short time delay valve armature **229** and the instantaneous valve armature **267** are attached to pointers like the pointer **287** (Fig. 3) and are provided with adjusting screws and knobs like

those associated with the main movable core member. By adjusting the tension of the springs **277**, **231** and **271**, the pick-up point or the amount of overload current required to operate the associated armatures may be varied. That is, the pick-up point for long time delay tripping, short-time delay tripping and instantaneous tripping may be varied.

The trip device operates with time delays of different durations in two distinct ranges of overcurrents below a predetermined magnitude, and instantaneously in response to overcurrents above the predetermined magnitude, or in response to short circuit currents. The ranges of overcurrents may be arbitrarily defined as, for example, a low range up to 500% or 600% of normal rated current, an intermediate range between 500% or 600% and 1000% of normal rated current, and instantaneous 1000% or more of normal rated current.

Assuming an overcurrent within the low range of overcurrents, the trip device will operate as follows: Upon the occurrence of an overcurrent in the low range the tripping electromagnet becomes energized and attracts the armature **153** upwardly. The armature acts through the spring **163** and the sleeve **159** to produce an upward thrust on the trip rod **161**, the movement of the trip rod being retarded by the partial vacuum below the diaphragm **167**. The initial upward movement of the trip rod **161** causes the valve facing **188** to engage the annular valve seat **192** on the clamp member **179** to thereby close the passage **190** and completely seal off the spaces above and below the diaphragm **167**. On very low overload currents the pressure of the facing **188** on the valve seat may not be sufficient to establish a perfect seal. It is for this reason that the spring **194** is provided. On such low overloads the spring **194** provides sufficient pressure to effectively close the valve **188**—**192**.

The trip rod **161** moves slowly upwardly in tripping direction as air is drawn into the space below the diaphragm through the long time delay valve **187** until the upper end of the trip rod engages the headed screw **99** (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 device **187** is in the order of seconds and may be varied by adjusting the valve **193**—**197** as set forth previously.

As soon as the breaker contacts are opened the tripping magnet **113** is deenergized and the armature **153** and the trip rod are restored by the springs **277** and the force of gravity to their Fig. 3 position. Immediately upon deenergization of the tripping magnet **113**, the armature **155**—**157** drops into engagement with the upper face of the clamp member **179**. The lower end of the armature member **157** also engages the sleeve **185** and opens the valve **188**—**192** permitting equalization of air pressure above and below the diaphragm through the passage **190** and openings **196** in the lower end of **157** to thereby effect high-speed return of the parts of their normal lower positions as shown in Fig. 3.

When an overcurrent in the intermediate range of overcurrents occur, the electromagnet **113** is energized sufficiently to attract the short time delay armature **229** (Fig. 2) upwardly against the adjustable stop **241** opening the short time delay valve **189** an amount determined by the adjustment of the stop **241**. This admits air to the space below the diaphragm 167 at a higher rate than the long time delay valve above and provides a relatively short time delay in the order of alternating current cycles in the tripping operation.

Energization of the tripping magnet 113 in response to an overcurrent in the intermediate range is not sufficient to attract the armature 267 (Fig. 3) for the instantaneous valve 191, however, upon the occurrence of an overcurrent of 1000% or more of rated current, both the short time delay armature 229 (Fig. 2) and the instantaneous armature 267 (Fig. 3) are attracted and open both the short time delay valve 189 (Fig. 2) and the instantaneous valve 191 (Fig. 3), thereby admitting air to the space below the diaphragm 167 at a rate sufficient to permit substantially instantaneous tripping movement of the trip rod.

On short time delay and instantaneous tripping operations, the spring 163 limits the force applied by the moving armature 153 to the time delay device. On such operations the armature 153 is attracted immediately against the fixed core member 129 compressing the spring 163 which then supplies the force necessary to actuate the trip rod. Thus the pull exerted in the time delay device is limited to the maximum force exerted by the spring 163 when it is compressed. This prevents damage to the time delay device and also provides a uniform pull on the time delay device.

We claim as our invention:

1. In a circuit breaker, the combination of a trip device operable to effect automatic operation of said breaker comprising a trip member, electromagnetic means for operating said trip member, a time delay element having a passage therein for retarding tripping movement of said trip member, a chamber enclosing said time delay element, means defining a second passage communicating with said chamber on one side of said time delay element, valve means controlling said second passage to admit fluid to said chamber to retard tripping movement of said trip member, and a valve member on said trip member operable upon energization of said electromagnet to engage said time delay element to close the passage in said time delay element, said valve member being movable upon deenergization of said electromagnet to open said passage.

2. In a circuit breaker, the combination of a trip device operable to effect automatic operation of said breaker comprising a trip rod, an electromagnet energized in response to overload currents for operating said trip rod, a time delay element having a passage therein for retarding tripping movement of said trip rod, a chamber enclosing said time delay element, means defining a second passage communicating with said chamber on one side of said time delay element, valve means controlling said second passage to admit fluid to said chamber to retard tripping movement of said trip rod, said trip rod having a portion extending through said passage, a valve seat on said time delay element, and a valve member on said portion of said trip rod cooperating with said valve seat upon tripping movement of said trip rod to close the passage in said time delay element.

3. In a circuit breaker, the combination of an electromagnetic trip device operable to effect automatic opening of said breaker, said trip device comprising a trip rod, an energizing winding, an armature operable upon energization of said winding to actuate said trip rod, a time-delay element comprising a flexible diaphragm for retarding tripping movement of said trip rod, a member secured to said time delay element and having a passage therethrough, a chamber enclosing said flexible diaphragm, means defining a second passage communicating with said chamber on one side of said flexible diaphragm, valve means controlling said second passage to admit fluid to said chamber on one side of said diaphragm to retard tripping movement of said trip rod, a valve seat on said member, and a valve member on said trip rod for engaging said valve seat to seal the passage through said member upon tripping movement of said trip rod, and said armature upon deenergization of said winding engaging and moving said valve member to open said passage.

4. In a circuit breaker, the combination of a trip member movable to effect automatic operation of said breaker, a trip device comprising electroresponsive means operable when energized in response to overload currents to move said trip member, time delay means comprising a fluid dashpot, a movable abutment in said dashpot for retarding tripping movement of said trip member, said movable abutment having a control passage therein, an annular valve seat formed on said abutment, a valve member on said trip member movable into engagement with said valve seat upon tripping movement of said trip member to seal said control passage, means forming a second passage communicating with said dashpot on one side of said movable abutment and valve means controlling said second passage to admit fluid to said dashpot to permit retarded tripping movement of said trip member, said valve member being movable upon deenergization of said electroresponsive means to open said control passage and permit resetting movement of said trip member and said movable abutment.

5. In a circuit breaker, the combination of a trip rod movable to effect automatic operation of said breaker, electroresponsive means operable when energized in response to overload currents to effect tripping movement of said trip rod, time delay means comprising a fluid dashpot, a movable abutment disposed in said dashpot and provided with a control passage communicating the opposite sides of said abutment, said trip rod having a portion extending through said passage, a member fixed to said portion of said trip rod for engaging said abutment to close said control passage and to move said abutment upon tripping movement of said trip rod, means forming a second passage communicating with said dashpot on one side of said movable abutment and valve means controlling said second passage operable to admit fluid to said dashpot at a predetermined rate to control the rate of tripping movement of said trip rod, said member moving to open said passage upon deenergization of said electroresponsive means to permit resetting of said abutment and said trip rod.

6. In a time delay device, a magnet, an armature mechanism actuated in one direction by attraction of the magnet, a normally open dashpot having a movable member connected to the armature mechanism, said dashpot being substantially closed during actuation of said armature mechanism by said magnet to retard movement of the mechanism in the direction in which it is actuated by the magnet, a valve communicating with the dashpot and normally open when

the armature mechanism is in unattracted position, and a connection between the armature mechanism and the valve positively moving the valve to closed position at the beginning of the movement of the armature mechanism when attracted by the magnet.

7. In a time delay device, a movable element, a magnet, an armature actuated by the attraction of the magnet to move said movable element in one direction, a normally open dashpot having a movable member connected to the movable element, said dashpot being substantially closed during movement of said movable element by said armature when said armature is actuated by said magnet to retard movement of said movable element in the direction in which it is actuated by the magnet, a valve communicating with the dashpot and normally open when the armature is in unattracted position to permit exhaust of fluid from said dashpot, and a connection between the movable element and the valve positively moving the valve to closed position early in the movement of the armature when attracted by the magnet.

8. In a time delay device, an electromagnet, a mechanism actuated in one direction by energization of said electromagnet, a normally open dashpot having a movable member connected

to said mechanism, said dashpot being substantially closed during actuation of said mechanism by said electromagnet to retard movement of the mechanism in the direction in which it is actuated by the electromagnet, a valve communicating with the dashpot and normally open in the deenergized condition of said electromagnet, and a connection between said mechanism and said valve positively moving said valve to closed position at the beginning of the actuation of said mechanism upon energization of said electromagnet.

BERNARD G. TREMBLAY.
WILLIAM H. STUELLEIN.

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