Feb. 27, 1940. T. LINDSTROM 2,192,046

CIRCUIT BREAKER

Filed Jan. 16, 1936 3 Sheets-Sheet 1

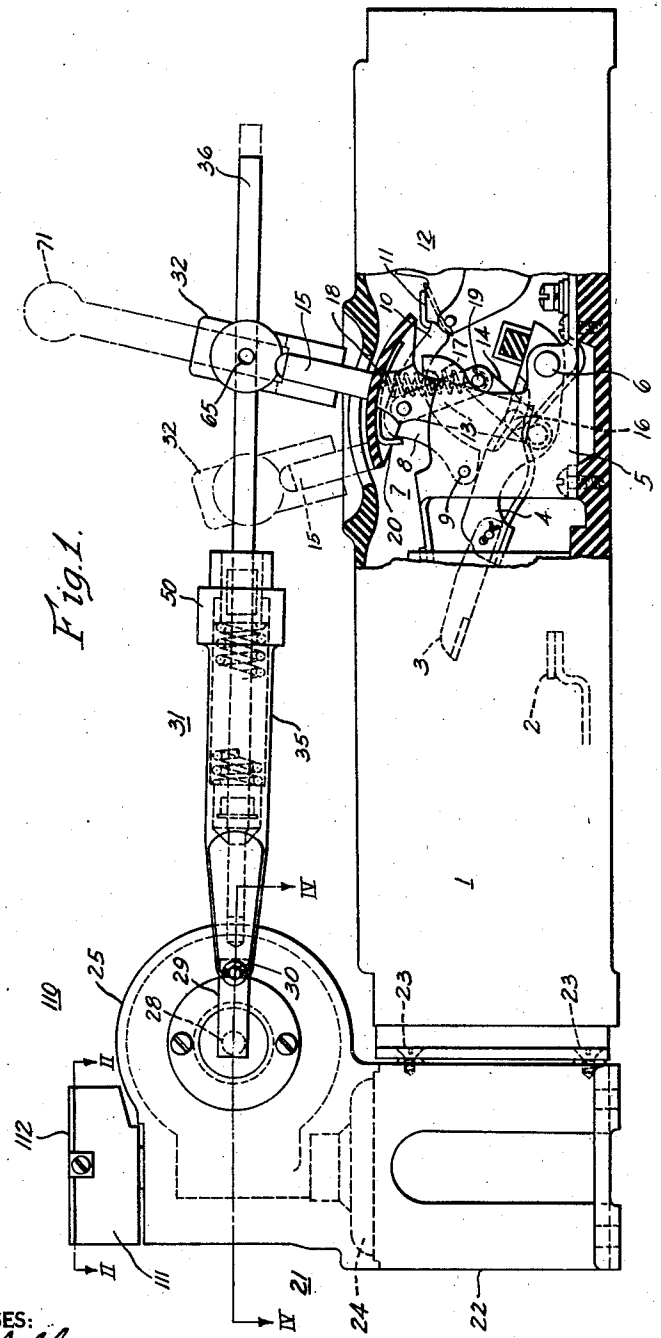


Fig. 1.

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Fig.2.

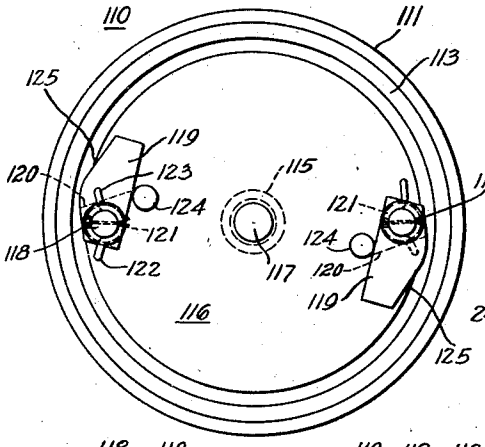
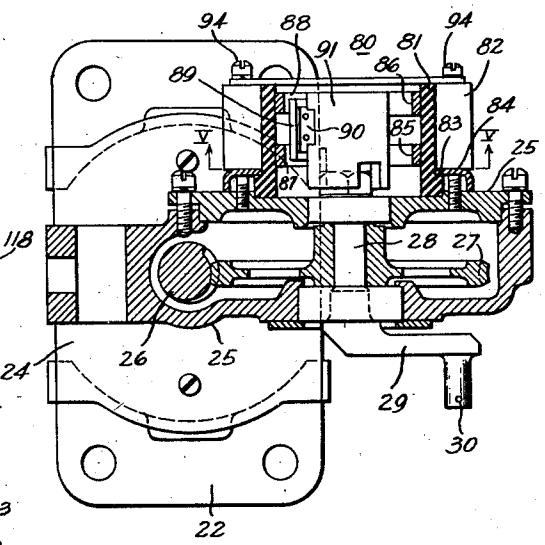


Fig.4.



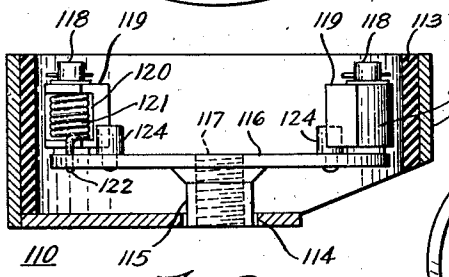
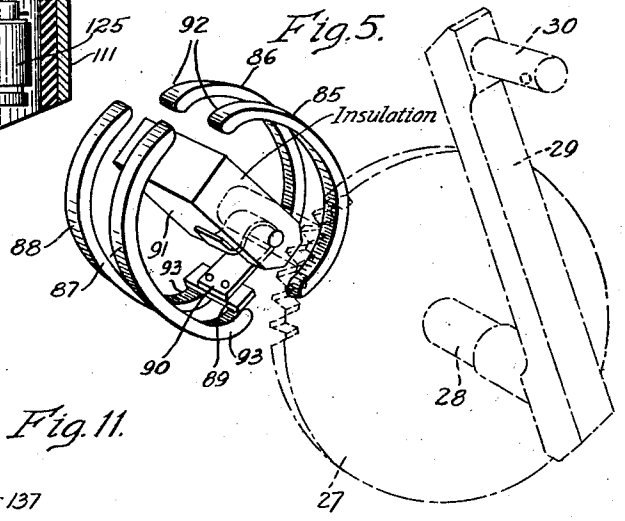


Fig.3.

Fig.5.



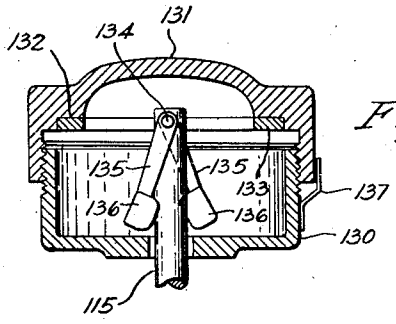
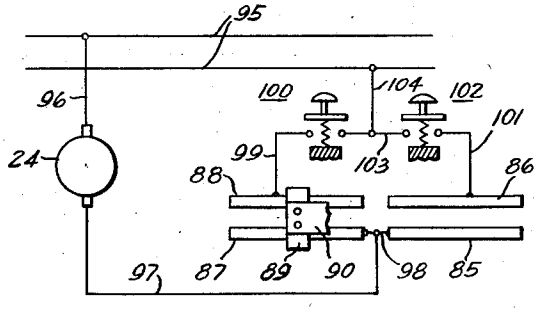


Fig.11.

Fig.6.



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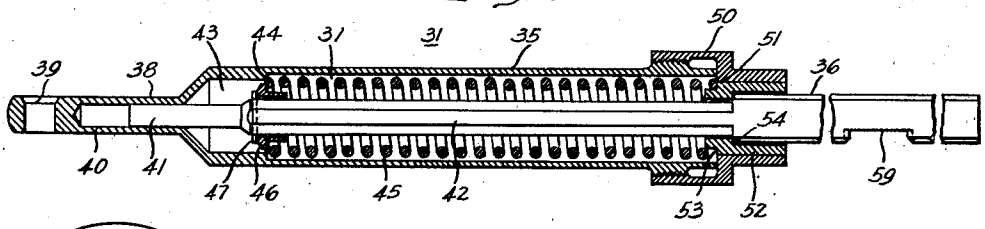
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CIRCUIT BREAKER

Filed Jan. 16, 1936 3 Sheets-Sheet 3

Fig. 7.



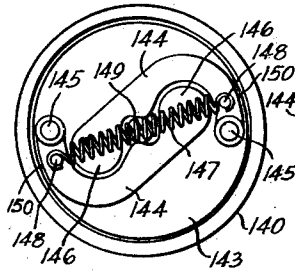


Fig. 12.

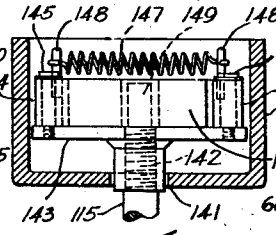


Fig. 13.

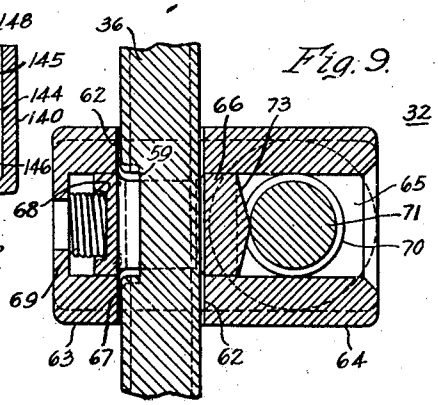


Fig. 9.

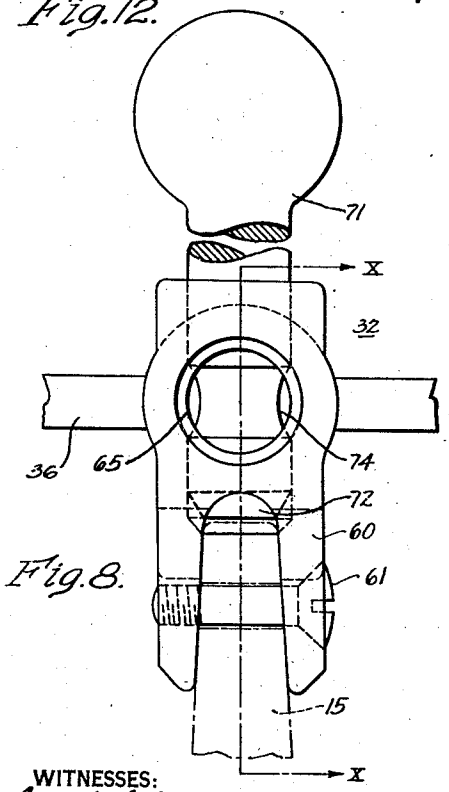


Fig. 8.

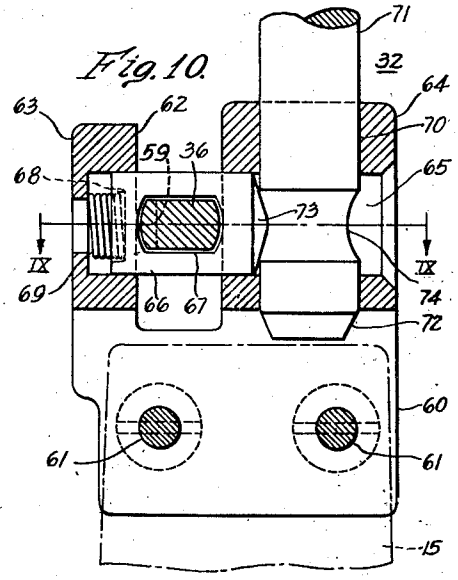


Fig. 10.

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Patented Feb. 27, 1940 2,192,046

UNITED STATES PATENT OFFICE

2,192,046

CIRCUIT BREAKER

Ture Lindstrom, Edgewood, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 16, 1936, Serial No. 59,387

20 Claims. (Cl. 200—92)

This invention relates to circuit breakers and more particularly to motor driven operating mechanisms therefor.

An object of the invention is to provide a simple and efficient operating mechanism for circuit breakers for controlling the operation thereof from a remote point.

A further object of the invention is the provision of a motor driven operating mechanism for circuit breakers which, after being initially set into operation, is automatic to effect either opening, closing or resetting of the breaker contacts.

Another object of the invention is the provision of a motor driven operating mechanism for circuit breakers which readily permits manual operation of the breaker when desired.

A still further and more specific object of the invention is the provision of speed responsive means in motor driven circuit breaker operating mechanisms for controlling the rotation of the driving motor.

An ancillary object of the invention is the provision of resilient actuating means in circuit breaker operating mechanisms of the motor driven type.

Other objects and advantages relate to details and the arrangement of the various parts of the novel operating mechanism and will appear more fully in the following description, when taken in connection with the accompanying drawings, in which

Figure 1 is a side elevational view, partially in section, showing a circuit breaker embodying the motor driven operating mechanism of my invention;

Fig. 2 is an enlarged cross sectional view taken along line II—II of Fig. 1 showing a braking device for bringing the operating mechanism to rest after operation of the breaker contacts has been accomplished;

Fig. 3 is a side elevation of the brake mechanism illustrated in Fig. 2, and shows the casing and the brake lining in cross section;

Fig. 4 is an enlarged cross sectional view taken along line IV—IV of Fig. 1, showing the internal construction of the driving mechanism and the control switch for the driving motor;

Fig. 5 is a skeleton perspective view of the control switch for the driving motor;

Fig. 6 is a schematic wiring diagram of the motor control circuit;

Fig. 7 is a longitudinal section view of the resilient connecting rod for actuating the circuit breaker mechanism;

Fig. 8 is a side elevation view showing the coupling member for connecting the actuating rod to the switch lever;

Fig. 9 is a cross sectional view of the coupling member taken along line IX—IX of Fig. 10;

Fig. 10 is a cross sectional view of the coupling member taken along line X—X of Fig. 8;

Fig. 11 is a side elevation view partially in section showing a modified form of brake structure for bringing the operating mechanism to rest;

Fig. 12 is a top plan view of another form of brake structure; and

Fig. 13 is a side elevation view, partly in cross section, of the brake structure shown in Fig. 12.

Although the motor driven operating mechanism of this invention is applicable to the operation of circuit breakers of various types, it possesses numerous advantages adapting it particularly to the operation of circuit breakers employing a snap action mechanism controlled by an oscillatable lever for opening and closing the contacts. The advantage of the snap action mechanism, as is well known in the art, provides a quick make and break for the circuit contacts, which greatly reduces arcing and thus prolongs the life of the contacts. I have found that of the various remote controlled operating devices which have been devised for circuit breaker operation, the motor driven operating mechanism is by far better suited for circuit breakers of the snap action type, since these breakers are generally limited to low power applications. It is, therefore, desirable to keep the power requirement for remote control within reasonable limits. The snap action mechanism for effecting either the opening or closing operation of the breaker requires the application of a considerable force upon the actuating lever, which force must be applied over the greater portion of the path of movement of the lever, that is, at least up to the time the make or break of the contacts occurs. A solenoid operated mechanism would require an unwarranted expenditure of energy to effect the operation. Inasmuch as the speed of operation of the contacts is controlled by the snap action mechanism and is independent of the speed of operation of the actuating lever, a relatively low powered motor mechanically coupled in speed reducing relation to the operating mechanism may be employed, thereby effecting a considerable saving in power.

However, due to the fact that the load upon the actuating lever of the breaker is suddenly reduced after the snap action mechanism has gone into operation this will cause the driving

motor to speed up and unless some means are provided for bringing the motor to rest quickly after the circuit thereto has been broken and when the actuating lever has reached the end of its stroke, the motor will coast for a period of time sufficient to start the breaker actuating lever in its movement in the opposite direction. I have obviated this difficulty by providing the operating mechanism with a brake which is responsive to the speed of the motor. In one form of the invention the brake used is so designed that it is ineffective while the motor is under load, but as soon as the snap action mechanism of the breaker has completed its operation and the load upon the motor has been reduced, the resultant increase in speed renders the brake operative so as to bring the operating mechanism to rest.

It also becomes necessary in snap action breakers, particularly breakers employing a trip free mechanism which requires a definite amount of movement of the actuating lever in the open contact direction for resetting the mechanism after it has been tripped by an overload, to provide means whereby the requisite amount of movement of the actuating lever will always be insured. The means herein employed consists in providing a slightly greater path of travel of the motor driven actuating means than is required to actuate the breaker lever.

In order to prevent damage to the breaker mechanism which may result from forcefully bringing the actuating lever against its stops at either limit of its path of travel, I provide a resilient connecting rod between the motor driven actuating mechanism and the breaker actuating lever.

A further feature of the invention comprises means for releasing the operative connection between the motor operating mechanism and the breaker actuating lever in order to render the breaker manually operative. The releasable connection becomes necessary inasmuch as the driving connection between the motor and the reciprocating mechanism comprises a worm and worm gear, which combination is non-reversible in action, but has the advantage of a high speed reduction which is ideally suited for the particular use here employed.

In general, to accomplish the releasable connection, I provide a coupling member upon the breaker operating lever which slidably receives the motor driven actuating rod and which is normally latched to the rod. Means are provided for the insertion of a manually operable lever which, when inserted, unlatches the coupling member from the actuating rod and permits the breaker to be manually operated.

Having generally pointed out the main features of my invention, a more specific description thereof will now be given with particular reference to the drawings, in which the reference numeral 1 designates a snap action breaker having a fixed contact 2 and a movable contact 3. The contact 3 is carried by a switch arm 4 hinged to a suitable frame work 5 at 6. The snap action mechanism for actuating the contact arm 4 is generally designated at 7 and is of the same general construction as the mechanism more fully shown and described in Patent No. 1,918,232, issued to B. P. Baker and M. W. Brainard, July 11, 1932, and assigned to the assignee of this application.

The actuating mechanism 7 comprises a cradle 8 hingedly secured to the frame 5 at one end, as shown at 9. The other end of the cradle 8 designated at 10 is engaged by a latching member 11. The latching member 11 forms part of the tripping mechanism of the breaker generally designated at 12, which may be of a type more fully described in an application of Harry J. Lingal, Serial No. 600,624, filed March 23, 1932, and assigned to the assignee of this application, now Patent No. 2,047,739, issued July 14, 1936.

The cradle 8 and the switch arm 4 are joined by means of a pair of toggle links 13 and 14. The mechanism is actuated by a lever 15 hinged to the frame 5 at 16 and connected through a coil spring 17, the upper end of which is joined to the lever 15 at 18 whereas the lower end is connected to the knee 19 between the toggle links 13 and 14. It will be apparent that when the actuating lever 15 is in the position shown in Fig. 1 that the action of the spring 17 tends to collapse the toggle links 13 and 14 to maintain the contact arm 4 in the open position. As the lever 15 is moved to the left or to the on position, and as the point 18 crosses the center line between the pivotal point of the toggle link 13 with the cradle 8 and the knee joint 19, the spring 17 will cause the toggle links to straighten out thereby forcing the switch arm 4 downwardly to cause the contact 3 to engage the contact 2.

In opening the contacts, the foregoing operations and movements of the various parts occur in the reverse order and are well known and need not be further described. In the event that the contacts 2 and 3 have been opened due to overload, the tripping mechanism 12 comes into play releasing the latch member 11 allowing the end 10 of the cradle 8 to move upwardly under the action of the spring 17, which also raises the switch arm 4 through the toggle connections 13 and 14.

In order to reset the breaker, the actuating lever 15 is provided with an offset extension 20 adapted to engage the cradle 8 so as to move the cradle downwardly when the lever 15 is moved in the off position. By permitting the lever 15 to be moved a short distance in addition to that required to normally open the breaker contacts, the end 10 of the cradle 8 is made to engage the latching mechanism 12 to again reset the cradle.

The operating mechanism suitable for actuating the breaker from a remote point is generally indicated at 21, and comprises a frame 22 which may be secured to one end of the circuit breaker casing by means of screws 23. Within the frame 22 is mounted a driving motor 24. Secured to the upper end of the motor 24 and the frame 22 is a gear case 25 into which an extension of the armature shaft of the motor 24 extends. Upon this extension is mounted a worm 26 adapted to engage a worm gear 27 secured in any well known manner to a shaft 28. The shaft 28 is journalled in suitable bearings in the sides of the gear case 25 and is provided at one end with a crank arm 29. The crank arm 29 has a crank pin 30 journalled in aperture 39 of a resilient actuating rod generally designated at 31. The actuating rod 31 is releasably connected to a coupling member 32 which, in turn, is secured to the switch actuating lever 15. It will thus be seen that as motor 24 is rotated, the worm 26 in mesh with the worm gear 27, will impart rotation to the crank pin 30, which, in turn, will oscillate the connecting rod 31 and

consequently the switch lever 15 for opening, closing and resetting the breaker.

As was pointed out above, the resilient connecting rod 31 is desirable in order to prevent injury to the mechanism 7 due to the fact that, for satisfactory operation, it is necessary to insure the maximum movement of the lever 15 along its path of travel. This maximum movement is obtained by making the throw of crank arm 29 slightly greater than what would theoretically be required. In order to provide the requisite resiliency, the connecting rod 31 is constructed of two parts, namely, a tubular portion 35 (Fig. 7) and a cylindrical portion 36 adapted to be telescopically received by the former portion. The tubular portion 35 has a bore 37 and a reduced end portion 38, which end portion also has a bore 40 but of less diameter than the bore 37. The bore 40 is adapted to receive and serves as guiding means for the end portion 41 of the member 36. The member 36 also has an intermediate portion 42 of somewhat greater diameter. The bore 37 has a portion 43 of reduced diameter which forms an annular shoulder or stop 44 for one end of a coil spring 45 positioned within the bore 37 and surrounding the cylindrical portion 42. The other end of the spring 45 is maintained in contact with an offset collar 50 which in this instance may be screw-threaded onto the outer surface of the tubular portion 35. The offset portion of collar 50 provides an annular shoulder 51, the depth of which corresponds to the depth of the shoulder 44 and is adapted to contact substantially the outer half of the end convolution of the spring 45. The inner half of the left end convolution of the spring 45 is adapted to be engaged by a flanged collar 46 mounted upon the end portion 42 and secured in place by means of a key or pin 47. The inner half of the right-hand end convolution of the spring 45 is engaged by an annular shoulder 53 of an offset collar 52. The greater diameter of the collar 52 is adapted to be received by the smaller diametrical portion of the collar 50 and is slidable coaxially therein. The collar 52 also has an outwardly facing annular shoulder 54 against which the enlarged end portion of the shaft 36 is adapted to be held in engagement.

From the foregoing description, it will be apparent that when a force is applied to the end portion 38 in a right-hand direction, that is, in a direction tending to compress the rod 31, such force will be transmitted to the tubular portion 35, the shoulder 44, through the spring 45 to the shoulder 53 of the collar 52 which, in turn, engages the portion 36 and transmits the resultant movement to the releasable connection 32. In the event that the force applied to the portion 38 is in the opposite direction, that is, to the left, the shoulder 51 will engage the spring 45 which, in turn, transmits the force to the flanged collar 46 and since the latter is secured to the portion 42 of the shaft 36 will cause the latter to move to the left. In the particular arrangement described, the coil spring 45, regardless of the direction of the force applied at the portion 38, will always work in compression so as to provide a resilient connection between the end portions 36 and 38.

The coupling member 32 (Figs. 8, 9 and 10) comprises a lower saddle portion 60 adapted to be secured to the breaker operating lever 15 by means of screws 61. The upper portion of the coupling member 32 is divided by a slot 62 into two upright portions 63 and 64. The upright portion 64 is provided with a transversally extending bore 65, which bore also extends partially through the upright portion 63. The bore 65 is adapted to receive a cylindrical clutch member 66 which is slidable axially therein and has a diametrical substantially rectangular opening 67 therethrough. The opening 67 is for the purpose of slidably receiving the end portion 36 of the operating rod 31. The clutch member 66 is also provided at one end with a recess 68 in which may be nested a compression spring 69 for biasing the clutch member toward the actuating rod 36.

The actuating rod 36 is provided with a notch 59, the length of which is preferably slightly greater than the diameter of the clutch member 66 so that when the notch 59 and the clutch member 66 are in registration, the spring 69 will urge the clutch member into engagement with the notch to thereby latch the operating rod 31 to the coupling member 32.

The upright portion 64 is also provided with a vertical bore 70 for the reception of a hand operated lever 71. The lever 71 has its lower end tapered, as shown at 72, which in cooperation with the tapered portion 73 of the clutch member 66 forces the clutch member to the left when the lever 71 is inserted in the bore 70. The movement of the clutch member 66 to the left by the hand operating lever 71 is sufficient to unlatch the operating rod 31 from the coupling member 32 and thus permits the coupling member to be rocked back and forth with the break lever 15.

In order to prevent accidental displacement of the lever 71 from its socket within the coupling member 32, an annular groove 74 is provided, which is adapted to register with the beveled end 73 of the clutch member 66, thereby releasably holding the hand operated lever in place.

In order to interrupt the circuit of the driving motor 24 by the time the mechanism actuates the breaker contacts, I provide a cutout switch generally designated at 80 (Figs. 4 and 5). The switch 80 in this instance comprises a cylindrical insulating member 81 surrounded by an annular housing 82. The inner end of the member 81 has an outwardly projecting flange 83, the end face of which is seated in a circular depression in the side of the gear case 25 positioned in concentric relation with respect to the shaft 28. Positioned between the flange 83 and the housing 82 is a flanged ring 84 which serves to cooperate with screws 94 passing therethrough and through the housing 82 to clamp the assembly to the side of the gear case 25. Upon the inner circumferential surface of the insulating member 81 are mounted four substantially semi-circular contact segments 85, 86, 87 and 88. The segments 85 and 87 are paired in axially spaced parallel relation with the segments 86 and 88 respectively.

The two segments of each pair are adapted to be bridged by a metallic brush 89 secured to a spring arm 90, which is mounted upon an insulating brush holder 91. The brush holder 91 is mounted upon the end of the shaft 28 and is adapted to rotate therewith. It will be apparent that as the shaft 28 revolves, the brush 89 will wipe across the contact segments to establish in turn an electrical connection between the pairs of contacts 85, 86 and 87, 88 respectively.

The function and operation of the switch 80 will be more fully understood when considered

with the wiring diagram of Fig. 6. In this diagram, the numeral 95 designates a suitable source of current. One of the lines of the source 95 is connected by conductor 96 to one terminal of the motor 24. The other terminal of the motor 24 is connected by conductor 97 to a conductor 98, which joins the contact segments 85 and 87. The segment 88 is connected by a conductor 99 to one terminal of a push button switch generally designated at 100. The contact segment 86 is connected by conductor 101 to one terminal of a similar push button switch 102. The other terminals of the push button switches 100 and 102 are joined by a conductor 103 which, in turn, is connected by conductor 104 to the other line of the source 95.

The brush holder 91 is so positioned on the shaft 28 with respect to the crank arm 29 that when the crank arm 29 is in the position as shown in Fig. 1, that is, with the switch lever 15 in the open position, the brush 89 will be in engagement with the leading edges of the contact segments 87 and 88. Thus, when the push button switch 100 is closed, current will be established from the source through the conductor 96, motor 24, conductor 97, conductor 98, segment 87, brush 89, segment 88, conductor 99, switch 100, conductor 103, and conductor 104 back to the source 95. The motor circuit being complete will cause the motor to rotate the crank arm 29, thus causing the connecting rod 31 to be moved to the left and consequently moving the circuit breaker lever 15 toward the closed position.

When the lever 15 has reached the overcenter position of the spring 17 where the contact actuating mechanism 7 will automatically close the contacts, the circuit to the motor 24 may be interrupted. By the time the contacts have been closed, brush 89 will have reached the ends of the contact segments 87 and 88 and as soon as the brush leaves these contacts, the motor circuit established through the push button switch 100 will be automatically broken. It will be noted that the trailing ends 93 of the contact segments 87 and 88 as well as the ends 92 of the contacts 85 and 86 are bent inwardly from the surface of the insulating member 83 and form projections substantially in radial alignment with the leading ends of the contact segments adjacent thereto. The purpose of the respective projections 92 and 93 is to provide a quick break as the brush 89 travels over the ends thereof and also to insure a positive contact between the brush and the leading ends of the adjacent pair of contacts. In other words, with the particular construction shown, it is impossible to have the operating mechanism stop at a time when the brush 89 is not in engagement with either pair of contact segments.

From the previous description it will be understood that the operating mechanism, following the closing operation of the breaker contacts, was made to come to rest with the brush 89 in contact with the segments 85 and 86. Now, in order to open the breaker, push button 102 is actuated, which establishes the circuit from the source 95 through conductor 96, motor 24, conductor 97, conductor 98, contact segment 85, brush 89, contact segment 86, conductor 101, switch 102, conductor 103 and conductor 104 to the other line of the source 95. Upon the initiation of this circuit, motor 24 will drive the crank arm 29 in the same direction as previously described, but since the arm has moved 180° from its initial starting point and is now on its return movement to the starting point, it will move the connecting rod 31 to the right and consequently the breaker lever 15 to the open position. Prior to the time when the lever 15 reaches the open position, that is, after the mechanism 7 has opened the contacts 2 and 3, the brush 89 leaves the projecting ends 92 of the segments 85 and 86 thereby breaking the motor circuit.

In the event that the breaker trips out when it is under load, say due to an overload condition, it will be necessary, as pointed out above, to move the breaker lever 15 slightly beyond the open position which relatches the cradle 6 thereafter enabling the contacts 2 and 3 to be closed in a normal manner. When remote control operation is desired for resetting the breaker, it will be necessary to first actuate the opening push button 102 and after the full open position has been reached, to then actuate the push button 100 to effect closing of the breaker. It will, of course, be understood that the push button switches 100 and 102 may be of the self-holding type, that is, after being initially actuated, a suitable holding circuit is energized for maintaining the contacts closed which automatically releases and restores the contacts to the open position at such time when the circuit is opened by the cutoff switch 80. Inasmuch as push button switches of this type are old and well known in the art, it is deemed not necessary to further illustrate or describe the same.

As was pointed out above, it is characteristic of snap-action switches to allow the contacts to close or open under the action of the snap-action mechanism prior to the time the actuating lever reaches the end of its stroke. It will be apparent that immediately after the actuation of the snap-action mechanism 7 the load upon the motor 24 will be greatly reduced. When the switch 80 is arranged to deenergize the motor slightly after the spring 17 has been moved over center, the marked reduction of the load on the motor will cause it to materially increase its speed. Even after the cutoff switch 80 has disconnected the motor from the source of supply 95, the coasting effect without motor speed reducing means would be sufficient to carry the operating mechanism into the beginning of the next sequence of breaker operation. In order to bring the motor to rest promptly at the end of the breaker operation, I provide a centrifugally controlled brake mechanism generally indicated at 110. This mechanism (Figs. 2 and 3) comprises a cylindrical housing 111 mounted in coaxial relation with the armature shaft of the motor 24 upon the frame 22. The housing 111 is provided with a cover plate 112, and has a brake lining 113 on its inner wall, the purpose of which will appear hereinafter. A concentric opening 114 in the lower wall of the housing 111 provides an entrance for the shaft 115, which shaft is an extension of the motor armature shaft and is coaxial with the worm 26. Upon the end of the shaft 115 is mounted a circular brake shoe supporting plate 116 and is secured for rotation therewith by means of a screw 117. Placed near the outer periphery of the plate 116 are a pair of diametrically opposed pins 118. A brake shoe 119 of elongated form, as shown in Fig. 2, is pivotally mounted at one end upon each pin 118 and may be retained in position by means of a washer and retainer key, as illustrated. The brake shoes 119 are each provided with a U-shaped recess 120 at their pivotal ends for the reception of a coil spring 121 which is adapted

to encircle the pin 118 and have one of its ends anchored into the plate 116 at 122 and the other end in engagement with the shoe 119 for the purpose of urging the brake shoes 119 in a clockwise direction and normally maintain them in contact with stop members 124. Thus, as the motor 24 rotates the plate 116 in a counterclockwise direction, the brake shoes 119 will tend to pivot about their pins 118 in a counterclockwise direction toward the brake lining 113 positioned on the interior of the housing 111. When the motor is under load, that is, during the operation of the lever 15 prior to the time the snap action mechanism 7 automatically actuates the contact arm 4, the speed of the motor will not be sufficient to bring the brake shoe surfaces 125 into engagement with the brake lining 113. However, as soon as the mechanism 7 actuates the contact arm 4, the load on the motor will be greatly reduced causing it to speed up, which increase in speed and the resultant centrifugal force acting upon the brake shoes 119, will bring the braking surfaces 125 into engagement with the lining 113, thereby causing the motor to decelerate which, after its speed has been reduced considerably, will come to rest as a result of the frictional forces of the operating mechanism.

In Fig. 11, a modified form of braking mechanism is shown. In this instance, the cylindrical brake housing 130 is provided with a cap member 131 which is preferably screw threaded onto the housing. The inner upper wall of the cap member 131 is provided with a flanged annular recess 132 in which is seated an annular brake lining 133. The extension 115 of the motor shaft projects upwardly through the bottom of the housing 130 and has a pin 134 passing diametrically therethrough near its upper end. Hinged to the pin 134 is a pair of brake arms 135, the free ends of which carry brake shoes 136. It will be apparent that as the shaft 115 is rotated, the centrifugal force acting upon the shoes 136 will cause them to move outwardly and upwardly toward the brake lining 133. The cap member 131 is adjusted with respect to the brake shoes 136 so that during normal load conditions upon the driving motor 24, the brake shoes 136 will be adjacent, but not in contact with, the lining 133. Then, as the motor 24 speeds up as a result of the load thereon being reduced following the automatic actuation of the switch actuating mechanism 7, the brake shoes 136 will be thrown into engagement with the brake lining 133 to thereby retard the rotation of the motor. The side of the casing 130 may also be provided with an index finger 137 which, in connection with a suitable index placed upon the outer side wall of the cap member 131 and calibrated in revolutions per minute or other suitable units, greatly facilitates the adjustment of the cap member with respect to the housing.

In Figs. 12 and 13 is shown another form of brake mechanism, particularly adapted for the purpose at hand. The reference number 140 designates a cylindrical brake housing closed at the bottom except for a concentric opening 141 for receiving the extension 115 of the armature shaft of the motor 24. The shaft 115 has a threaded portion 142 adapted for threaded engagement with a circular brake shoe supporting plate 143 which plate is similar in construction to the plate 116 shown in Figs. 2 and 3. A pair of non-symmetrical U-shaped brake shoes 144 are pivotally mounted at one end upon pins 145, the lower ends of which have a threaded portion of reduced diameter for threaded engagement with the supporting plate 143 at diametrically opposed points.

The configuration of the brake shoes 144 is such that when mounted, as shown in Fig. 12, the free or longer end 146 of each shoe is normally interposed between the two legs of the other shoe. A coil spring 147 engaging a pin 148 seated in the body of each shoe 144 at a point adjacent the pivotal pins 145 normally maintains the shoes in a collapsed position and in engagement with the reduced end portion 149 of the shaft 115. It will be noted that the end portion 146 of each shoe 144 normally extends inwardly beyond the line joining the centers of the pivotal pins 145, thus when the supporting plate 143 is rotated, the centrifugal force acting upon the end portions 146 on one side of the line joining the pivotal points 145, will have a tendency to rotate the brake shoes 144 in a counterclockwise direction about their pivotal points 145, as viewed in Fig. 12, and to maintain the shoes in engagement with the shaft 149. The centrifugal force acting upon the main portion of the shoes 144 on the other side of the line joining the pivotal points 145 will tend to rotate the shoes in a clockwise direction.

The shoes 144 are designed with respect to shape and mass so that the centrifugal force tending to cause rotation thereof in the clockwise direction will predominate. The spring 147, is, therefore, one of relatively low tension but sufficient to prevent an appreciable movement of the brake shoes outwardly in a clockwise direction at normal load speed of the driving motor 24. Then as the motor 24 speeds up as a result of the load thereon being reduced following the automatic actuation of the switch mechanism 7, the centrifugal force acting upon the brake shoes 144 will overcome the force exerted by the spring 147 to cause the braking surfaces 150 of the shoes 144 to engage the inside wall of the casing 140 and to thereby cause the motor to come to rest.

It is apparent that as soon as the brake shoes 144 begin to move outwardly and the mass of the end portions 146 begin to shift to the opposite side of the line joining the pivotal points 145, the centrifugal forces tending to maintain the shoes in the collapsed position are reduced whereas the forces causing the shoes to rotate outwardly are amplified to a high degree. Since the tension of the spring 147 is relatively low, the restoring action of the brake shoes to their collapsed or non-braking position is materially delayed, thus permitting the braking action to continue until the speed of rotation of the motor is substantially zero.

The particular design of the brake shoes 144 also affords an advantage in that the distance between the braking surfaces 150 and the pivotal axis 145 of the shoes is small as compared with the effective length of the brake shoes beyond the braking surfaces, thereby making it possible to obtain a relatively high brake contact pressure.

From the foregoing description, it will be apparent that I have provided a simple and efficient operating mechanism for circuit breakers of moderately low power thereby affording remote control for these breakers at a moderate cost. The provision of a centrifugally operated brake which is positive in action and free from trouble for reducing the coasting period of the

motor in motor driven operating mechanisms, has greatly advanced the commercial value of such mechanisms in the field of remote control operation of circuit breakers. It is also apparent that I have overcome a number of difficulties peculiar to the remote control of circuit breakers employing snap action mechanisms for actuating the breaker contacts. The assurance of the requisite amount of movement of the breaker actuating lever to positively operate the breaker contacts has been provided for by the resilient operating rod of the mechanism. A further desirable feature which I have made possible through this invention and as described in the foregoing is the provision of means whereby the motor driven connection to the breaker operating lever can be quickly and conveniently released so as not to impair the manual operating facilities of the breaker.

As has previously been pointed out, the circuit to the motor 24 may be interrupted when the lever 15 has reached the position where the contact actuating mechanism will automatically close the contacts of the breaker, i. e., when the spring 17 passes over center. In such instance the motor will not speed up after actuation of the contacts as it has been deenergized. Obviously under these conditions the centrifugal brake mechanism would be arranged to be actuated by the increase of speed of the motor before the motor circuit is deenergized, i. e., before the spring 17 passes over center.

Although I have shown and described a particular structure for accomplishing motor driven operation of a snap action type breaker, it is to be understood that the same is for illustrative purposes and that changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In combination, a pair of separable contacts, a snap action mechanism for opening and closing said contacts, an oscillatable lever for actuating said mechanism, means for actuating said lever comprising an operating member, driving means for oscillating said operating member, means controlled by the position of said driving means for controlling the operation of said driving means, and means responsive to the load conditions on said operating member for bringing said driving means to rest following actuation of said mechanism.

2. In combination, separable contact means, a snap acting mechanism for opening and closing said contact means, an oscillatable lever for actuating said mechanism, means for actuating said lever comprising an operating member, driving means including an electric motor for oscillating said operating member, means for automatically deenergizing said motor following actuation of said snap acting mechanism, and means responsive to a reduction in load on said motor for retarding rotation of said motor.

3. In a circuit breaker, separable contact means, a mechanism for opening and closing said contact means, an oscillatable lever for actuating said mechanism, means including an electric motor for oscillating said lever, means for automatically deenergizing said motor when said lever reaches predetermined positions following actuation of said mechanism, and a brake operable in response to the occurrence of a predetermined speed condition of said motor for retarding rotation of said motor.

4. In combination, a pair of separable contacts, a snap action mechanism for opening and closing said contacts, an oscillatable lever for actuating said mechanism, said mechanism being adapted to actuate said contacts before said lever reaches the ends of its normal path of travel and to effect a decrease in the operating effort required to move said lever on to the end of its path of travel following actuation of said contacts, driving means including an electric motor for oscillating said lever, and means operable following actuation of said contacts for automatically stopping said driving means immediately after said lever reaches the end of its path of travel and before its direction of movement is reversed by said driving means.

5. In combination, a pair of separable contacts, actuating mechanism for said contacts including an oscillatable lever for normally opening and closing said contacts, a member releasable to cause opening of said contacts irrespective of the position of said lever, means operable in response to predetermined conditions to effect release of said member, said member being resettable following its release by movement of said lever in one direction, means for actuating said lever to open and to close said contacts and to reset said releasable member comprising a rotatable crank arm, a motor rotatable in one direction only for driving said crank arm and resilient coupling means for operatively connecting said crank arm and said lever.

6. In combination, a pair of separable contacts, a mechanism for opening and closing said contacts including an oscillatable lever for normally actuating said mechanism to open and to close said contacts, a member releasable to cause said mechanism to open said contacts irrespective of the position of said lever, means operable in response to predetermined conditions to effect release of said member, said member being resettable following release thereof by movement of said lever in one direction, means for actuating said lever to open and to close said contacts and to reset said releasable member comprising a motor driving means for oscillating said lever, and means including a brake responsive to a predetermined change in speed of said driving means for bringing said driving means to a stop following actuation of said mechanism by said lever.

7. In combination, a pair of separable contacts, a snap action mechanism for opening and closing said contacts including an oscillatable lever for normally actuating said mechanism to open and to close said contacts, a member releasable to cause said mechanism to open said contacts irrespective of the position of said lever, means operable in response to predetermined conditions to effect release of said member, said member being resettable following release thereof by movement of said lever in one direction, means for actuating said lever to open and to close said contacts and to reset said releasable member comprising a motor driving means for oscillating said lever, means for automatically deenergizing said motor means following each actuation of said mechanism by said motor means, and means including a centrifugally actuated brake for said motor means operable in response to a predetermined change in speed of said motor means for causing said motor means to stop immediately after said lever reaches either end of its path of travel and be-

fore the direction of movement of said lever is reversed.

8. In combination, a circuit breaker having a pair of separable contacts and a snap action mechanism for opening and closing said contacts and an oscillatable lever manually operable for actuating said mechanism, means for oscillating said lever to actuate said mechanism including a rotatable crank arm, a motor for driving said crank arm, and coupling means including a clutch for releasably connecting said crank arm with said lever, said clutch being disengageable to permit said lever to be moved manually independently of said crank arm.

9. In combination, relatively movable contacts, a snap action mechanism for opening and closing said contacts including an oscillatable lever movable between two limiting positions for actuating said mechanism, said mechanism being adapted to actuate said contacts during the movement of said lever in either direction before it reaches the end of its path of movement, the force required to move said lever being decreased after it has been moved a predetermined distance, means for oscillating said lever to actuate said mechanism comprising a rotatable crank arm, an electric motor for driving said crank arm, means connecting said lever to said crank arm, means for automatically deenergizing said motor when said lever approaches either of its limiting positions, and means including a brake associated with said motor operable in response to a predetermined increase in speed of said motor for retarding the speed of said motor, said brake comprising at least a pair of centrifugally actuated braking members biased to a non-braking position which are moved to braking position in response to said predetermined increase in speed of said motor.

10. In a circuit interrupter, a pair of separable contacts, a snap action mechanism for opening and closing said contacts, an oscillatable lever for actuating said mechanism, said mechanism being adapted to automatically actuate said contacts prior to the time said lever reaches the ends of its normal path of travel, driving means including a motor for actuating said lever, means actuated in timed relation with said lever for said motor when said lever reaches predetermined positions, and speed responsive means associated with said motor for retarding the rotation thereof following the actuation of said lever to cause movement of said contacts by said mechanism.

11. In a circuit interrupter, a pair of separable contacts, a snap action mechanism for opening and closing said contacts, an oscillatable lever for actuating said mechanism, said mechanism being adapted to automatically actuate said contacts prior to the time said lever reaches the end of its normal path of travel, driving means including a motor for actuating said lever, means actuated in timed relation with said lever for the motor when said lever reaches predetermined positions, and a centrifugally actuated brake responsive to an increase in speed of said motor to actuate said lever to cause the actuation of said contacts by said mechanism for retarding the rotation of said motor and bringing said lever to rest at the end of its stroke.

12. In combination, with a circuit breaker having a pair of separable contacts and a mechanism including an oscillatable lever manually operable for opening and closing said contacts, means for actuating said lever comprising rotary driving means, said rotary driving means including a crank arm, coupling means connecting said crank arm and said oscillatable lever, said coupling means including a clutch, and means for disengaging said clutch to release the operative connection between said crank arm and said lever to thereby render said lever operative manually independently of said crank arm and said rotary driving means.

13. In combination, with a circuit breaker having a pair of separable contacts and a mechanism including an oscillatable lever manually operable for opening and closing said contacts, means for actuating said lever comprising an oscillating mechanism, means operatively connecting said oscillating mechanism and said lever, and means operable to release the operative connection between said connecting means and said lever and to render said lever manually operative independently of said oscillating mechanism and connecting means.

14. In combination, a circuit breaker having a pair of separable contacts and an oscillatable lever manually operable for opening and closing said contacts, power driven means for actuating said lever comprising a motor, a crank arm driven by said motor, a member connecting said crank arm and said lever, releasable connecting means between said member and said lever adapted to receive a manually operative removable member, said connecting means normally providing a driving connection between said member and said lever, said manually operative member when in engagement with said connecting means being adapted to release the said driving connection and render the circuit breaker manually operative by said oscillatable lever without moving said power driven means and member.

15. In combination, a circuit breaker having a pair of separable contacts and an oscillatable lever for opening and closing said contacts, power driven means for actuating said lever comprising a motor, a crank arm driven by said motor, a rod connected to said crank arm, means for connecting said rod and said lever, said connecting means comprising guide means secured to said lever for slidably receiving said rod, means for latching said guide means to said rod for movement thereby and a manually operable member for engaging said latching means for releasing the driving connection between said rod and said guide means thereby to render the switch lever manually operative.

16. In combination, a circuit breaker having a pair of separable contacts and an oscillatable lever for opening and closing the contacts, means for actuating said lever comprising a crank arm, a motor for driving said crank arm, an actuating rod connected to said crank arm, connecting means secured to said lever including guide means for slidably receiving an end portion of said rod, said end portion having a notch therein, latch means associated with said connecting means normally biased into engaging relation with said notch, and a manually operative handle removably associated with said connecting means adapted to engage said latching means for rendering said connection and said lever movable relative to said rod.

17. In combination, a circuit breaker having a pair of separable contacts and an oscillatable lever for opening and closing the contacts, means for actuating said lever, and means including a

resilient link for operatively connecting said actuating means and said lever, said resilient link having a force transmitting spring means which transmits the force for operating the lever and which is always worked in compression irrespective of the direction in which said lever is moved.

18. In combination, a circuit breaker having a pair of separable contacts and an oscillatable lever for opening and closing the contacts, means for actuating said lever comprising a crank arm, a motor for driving said crank arm, means for operatively connecting said crank arm and said lever, said connecting means including a pair of members movable relative to each other and connected respectively to said crank arm and said lever, and a spring means which is always worked in compression for transmitting the force for operating said lever, said spring means yieldingly opposing such relative movement of said pair of members.

19. In combination, a circuit breaker having a pair of separable contacts and an oscillatable lever for opening and closing the contacts, means for actuating said lever comprising a crank arm, a motor for driving said crank arm, means for operatively connecting said crank arm and said lever, said connecting means including a pair of members each having a cylindrical portion, said portions being adapted for telescopic arrangement and limited relative axial movement with respect to each other, the respective ends of said portions having opposed bearing surfaces, and resilient means interposed between said opposed bearing surfaces, for yieldingly opposing relative movement between said portions.

20. In combination, a pair of separable contacts, an oscillatable lever for opening and closing said contacts, means for oscillating said lever to actuate said contacts comprising a driving means, means for operatively connecting said driving means and said lever said connecting means including a pair of members mounted for limited telescoping movement with respect to each other and having opposed bearing surfaces, a spring interposed between said bearing surfaces for yieldingly opposing relative movement between said members, said connecting means being capable of transmitting both compressional and tensional loads with said spring always working in compression.

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