

April 27, 1965

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3,181,041

CIRCUIT BREAKER WITH MAGNETIC TRIP ADJUSTING MEANS

Filed Feb. 19, 1963

2 Sheets-Sheet 1

FIG. 1.

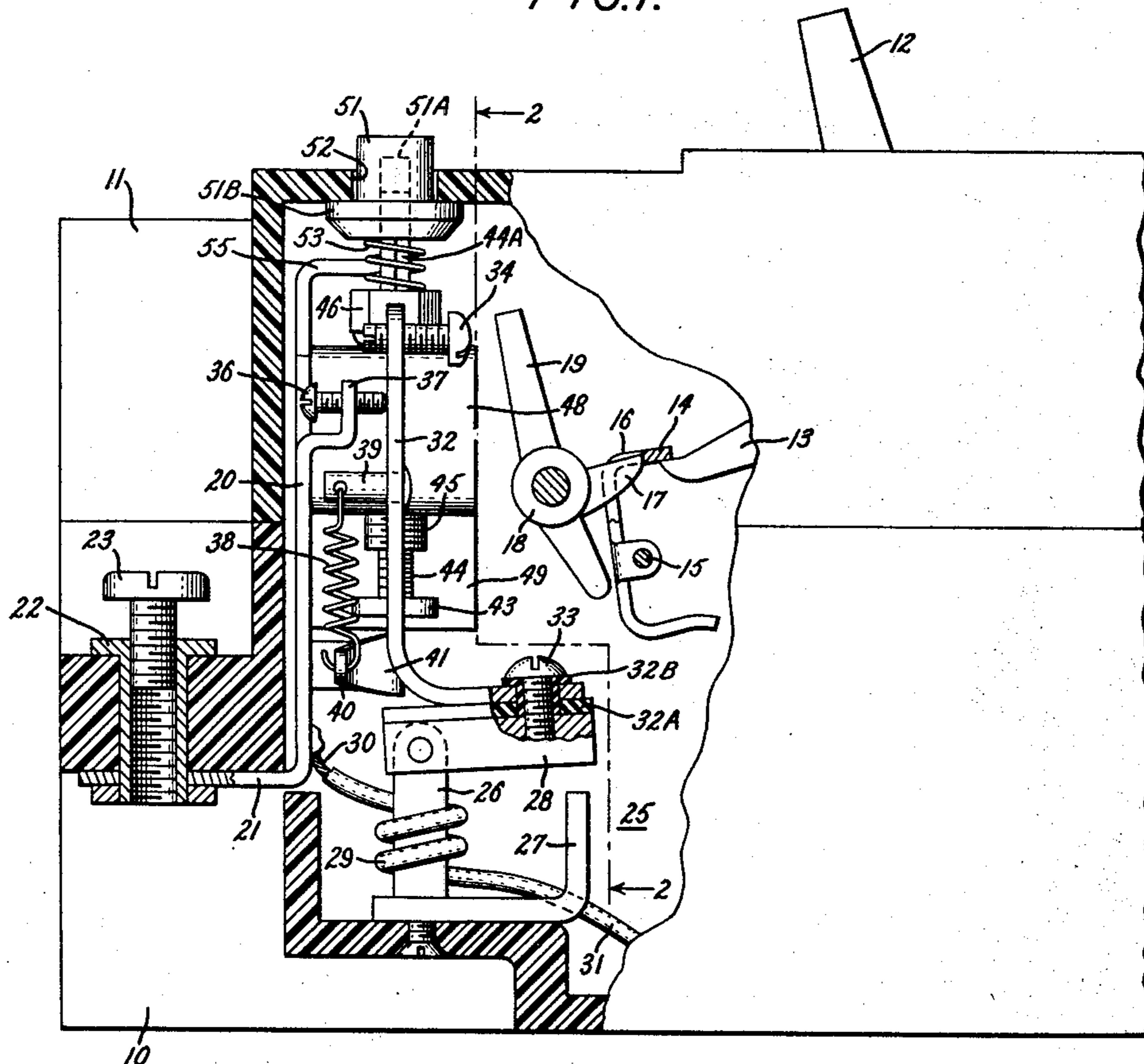


FIG. 3.

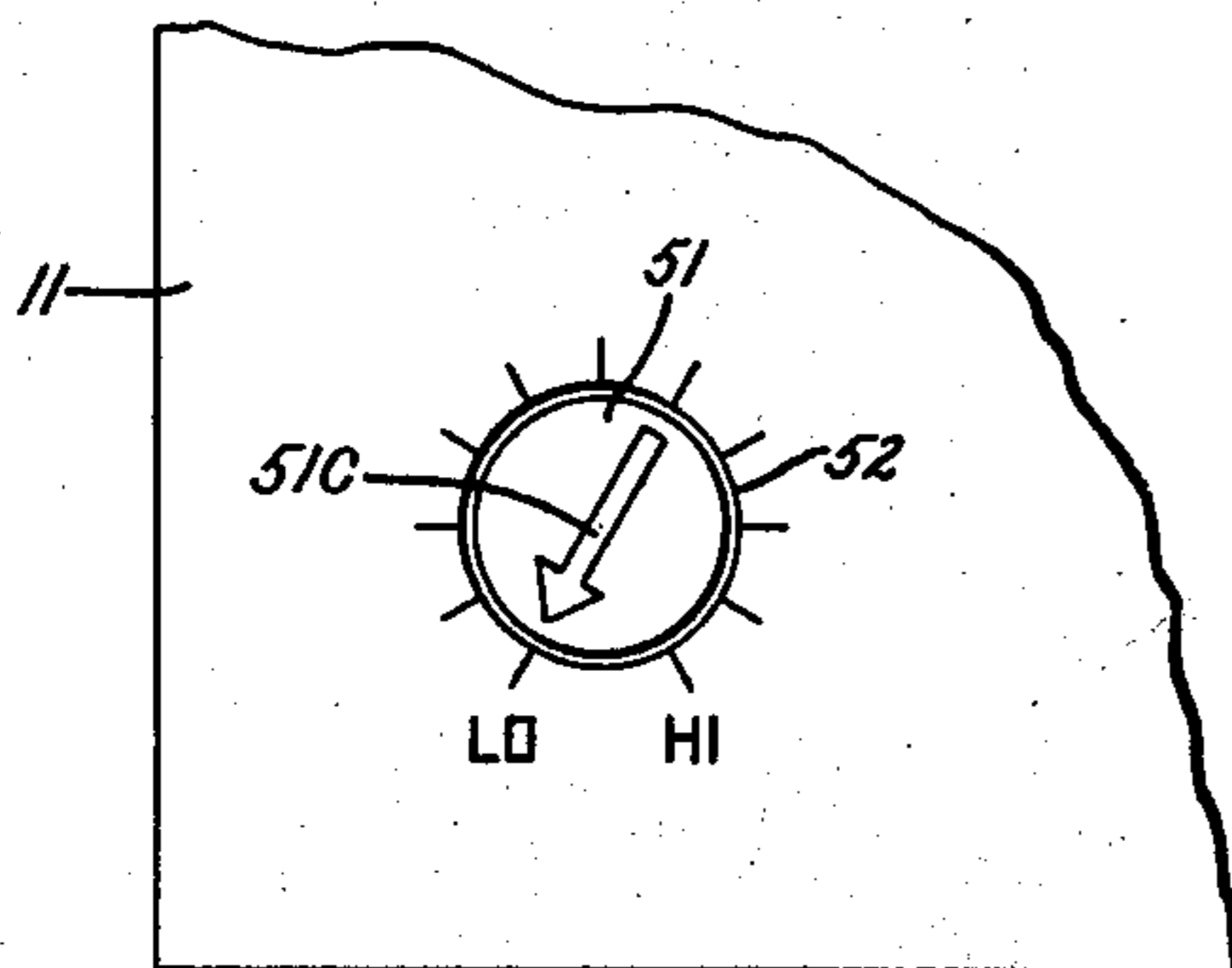
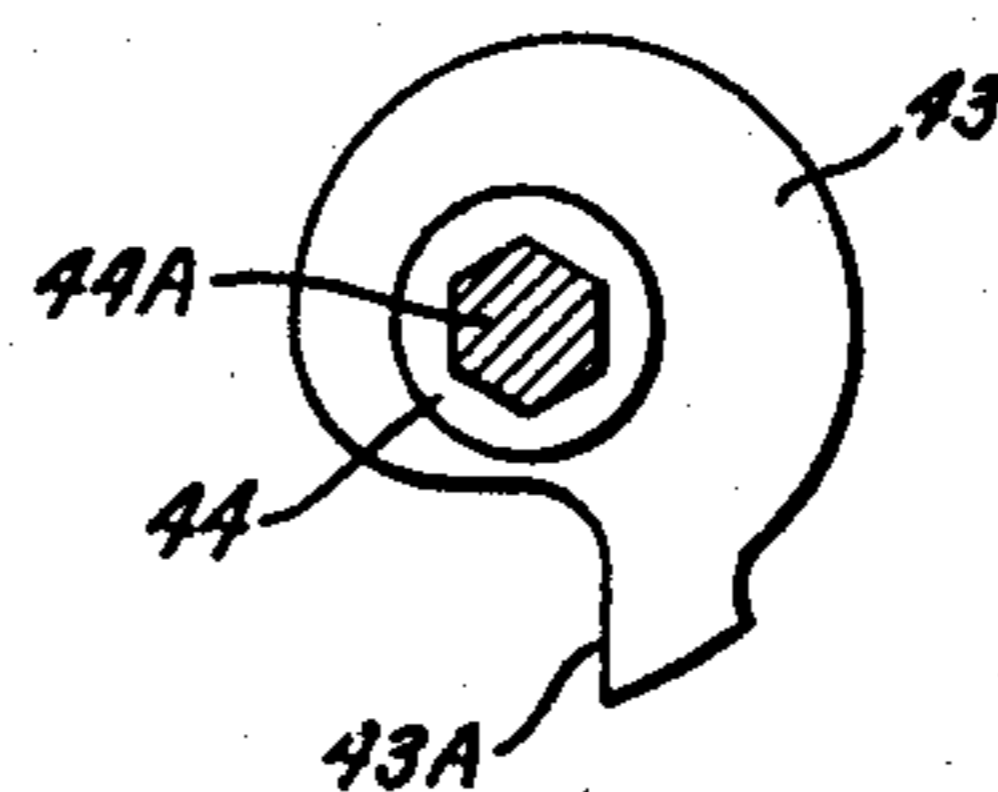


FIG. 4.



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FIG. 2.

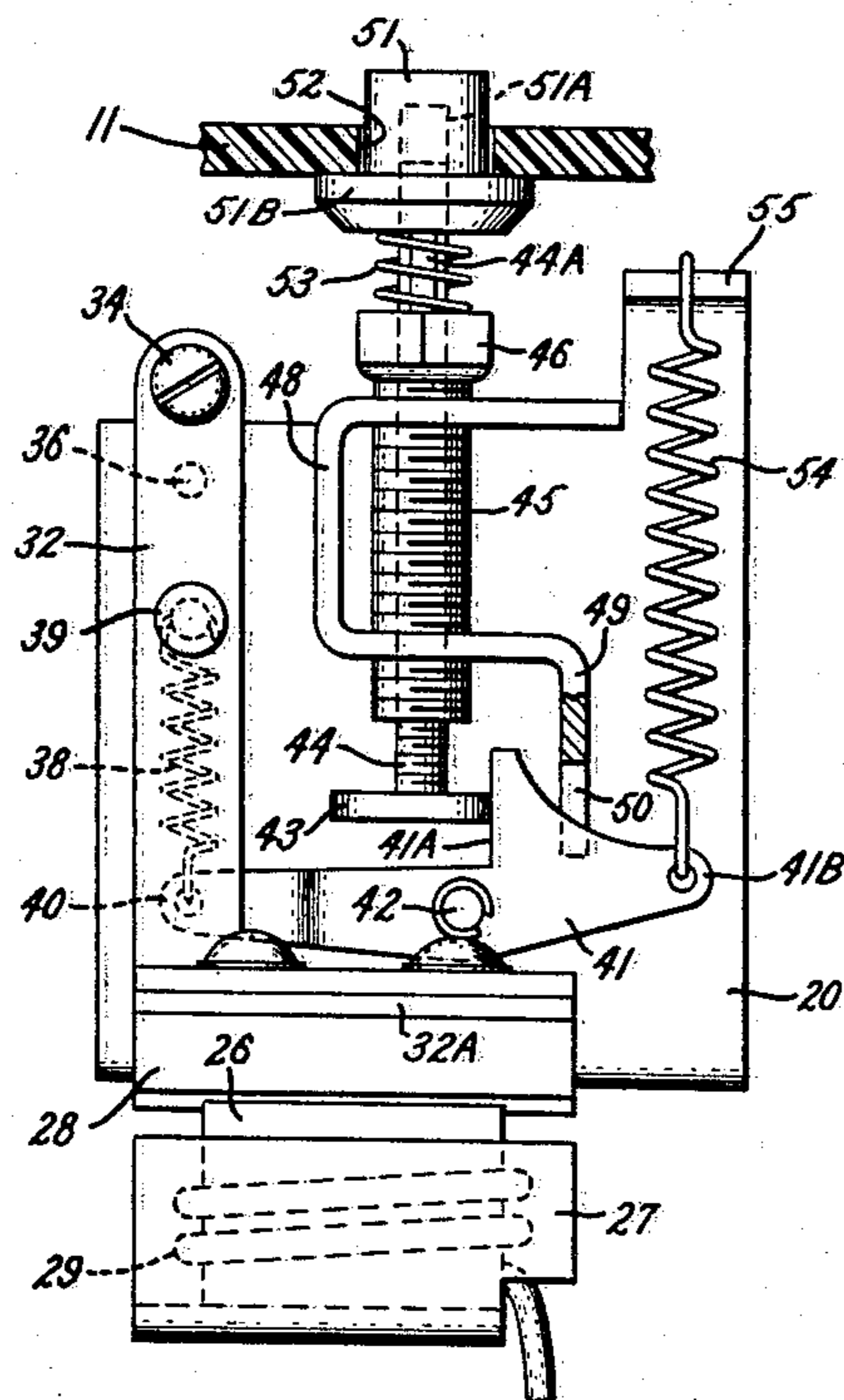
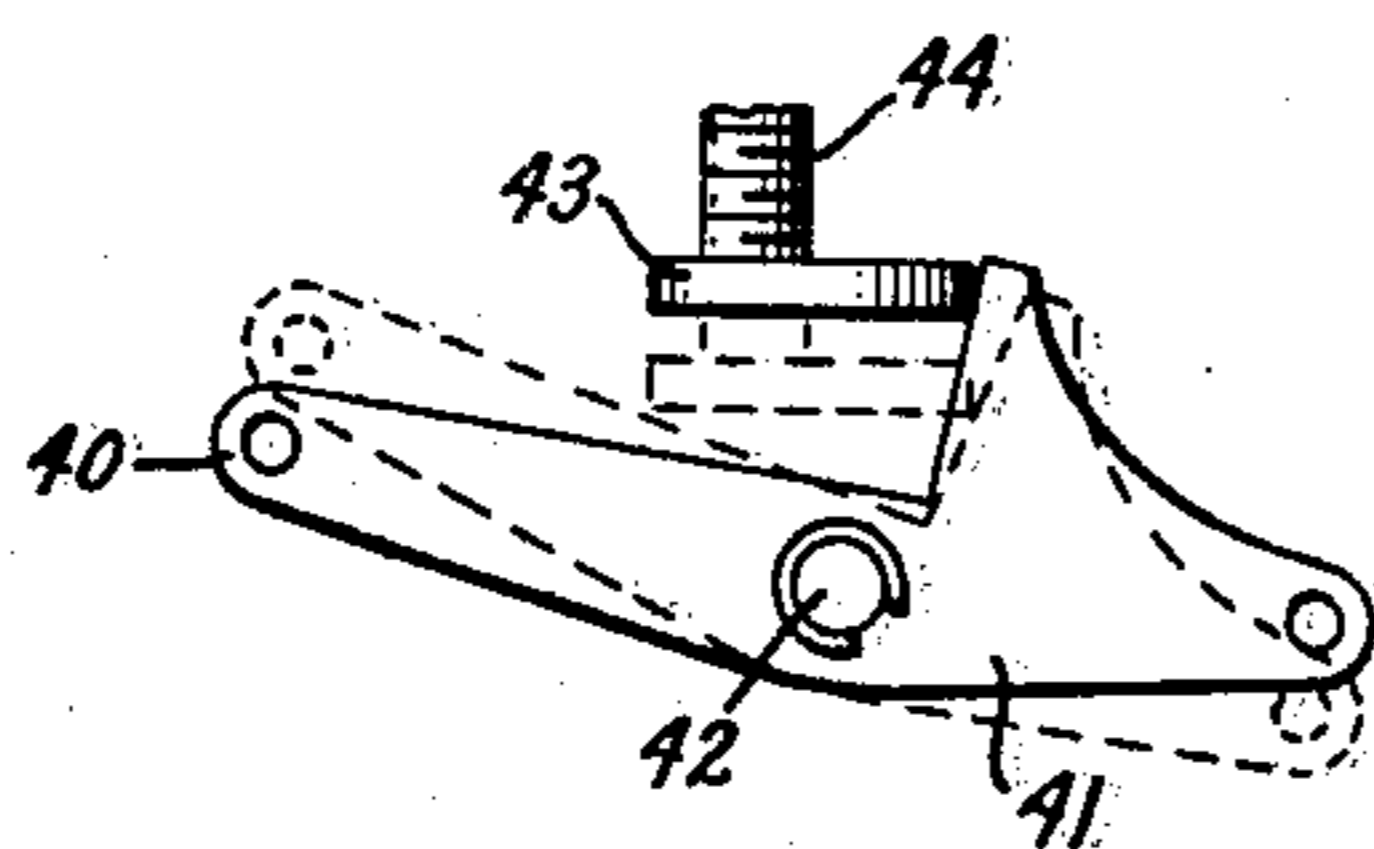


FIG. 5.



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CIRCUIT BREAKER WITH MAGNETIC TRIP ADJUSTING MEANS

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Filed Feb. 19, 1963, Ser. No. 259,674
6 Claims. (Cl. 317-176)

My invention relates to electric circuits, and particularly to electric circuit breakers which include adjustable magnetically operated means for causing automatic opening or "tripping."

In accordance with the prior art, electric circuit breakers of the type described have been provided with adjustable magnetic tripping means including an adjusting member having a limited amount of movement, which the user can adjust to vary the tripping point of the circuit breaker between certain predetermined limits. Thus, for example, at one setting of such a "user's adjusting knob," the circuit breaker may trip at 5 times its normal current-carrying rating (designated at $5\times$). At the opposite limit of the movement of the user's adjusting knob, the same circuit breaker may trip magnetically at $12\times$.

Also, in accordance with the prior art, such circuit breakers have been provided with means which is adjustable at the factory, whereby not only the starting point, but also the span of the range of adjustment achieved by the user's adjusting knob may be varied. More particularly, with such adjusting mechanism, although the permitted range of movement of the user's adjusting knob remains constant, the "high" and "low" tripping points brought about by such movement can be set, independently of each other, by the manufacturer. Circuit breakers having adjusting mechanisms of this type are shown and claimed, for example, in prior application Serial No. 62,184, Klein and Powell, filed October 12, 1960, now Patent No. 3,084,236, issued April 2, 1963, and in Patent No. 3,053,954, Jencks and Murphy, issued September 11, 1962, both assigned to the same assignee as the present invention.

In each of the aforesaid inventions, the user's adjusting knob is fixedly attached to an adjusting member which is rotatably carried in the housing, the knob being mounted after the factory adjustment of the parts has been carried out. In order to provide an inexpensive non-rotatable mounting of this knob, and one which can be quickly assembled, it has been the practice to use interengaging flutes and ribs, or a flat-sided or non-circular shaft on which the knob is mounted. With such arrangements, the indicating knob cannot always be placed such that it points exactly to the "high" or "low" setting inscribed on the circuit breaker casing, since there are only a number of particular positions in which it may be mounted. Thus, for example, if an arrangement is used including teeth and corresponding notches 18 in number, the placement of the knob could involve a possible error of 10 degrees. Some error, of course, would also apply to all intermediate settings.

In addition, in accordance with the prior designs, the factory adjustment has required adjustment of certain parts which are not readily accessible, thus adding to the difficulty and slowing down the adjusting process.

It is an object of the present invention to provide a magnetic adjusting mechanism for adjusting the magnetic tripping point of an electric circuit breaker of the type described which permits positioning of the indicating knob to exactly correspond with the markings carried by the circuit breaker casing so that no substantial error is indicated either at the beginning or end of adjustment or any point intermediate these settings.

It is another object of the invention to provide an elec-

tric circuit breaker including an adjustable magnetic tripping means of the type described in which the initial or factory adjustment can be more readily accomplished.

In accordance with the invention in one form, an electric circuit breaker is provided including a member movable to initiate automatic opening of the circuit breaker, and a magnetic solenoid including an armature which is movable to engage the aforesaid tripping member upon the occurrence of predetermined current conditions. Means is provided for adjusting the tripping point of the solenoid including a pivotally supported cam follower whose position is adjusted by rotating a cam member between predetermined limits. The cam follower member has one position in which its working surface extends in a direction parallel to the axis of rotation of the cam member which works upon it. An initial adjustment is made in this setting to determine one end point of the operation of the solenoid. The cam member is also movable in a direction parallel to its own axis, to move it toward or away from the pivot of the cam follower member, and thereby to vary the mechanical advantage of the cam member on the cam follower. Such motion, however, does not change the position of the cam follower member when the parts are returned to their original condition in which the cam follower surface extends parallel to the axis of movement of the cam member. The two steps of adjustment, therefore, are (1) to set the parts so that the cam follower member surface is parallel to the axis of the cam member and then to adjust a characteristic of the solenoid, such as its gap setting; and (2) then to adjust the cam member in a direction parallel to its own axis to vary the mechanical advantage, until it is such as to give the desired amount of movement when the cam member is rotated to its opposite position.

In accordance with the invention, the cam member is supported on a threaded shaft which in turn extends through a bushing and has its upper end accessible to carry the user's adjusting knob. Rotation of the threaded bushing member moves the cam shaft upwardly or downwardly, the end thereof sliding within the user's adjusting knob. Initial adjustment may therefore be accomplished by simply holding the user's adjusting knob from rotating in the high or low position, and then rotating the adjusting bushing to move the cam member to the desired vertical position.

In accordance with another aspect of the invention, the threaded bushing referred to is itself threadedly carried by a supporting member by a reverse-direction thread so that rotation thereof causes vertical movement of the cam member equal to the sum of the pitches of the threads of the cam shaft and the bushing member.

The invention will be more fully understood from the following detailed description, and its scope will be pointed out in the appended claims.

In the drawings,

FIGURE 1 is a side elevation view of a position of the circuit breaker incorporating the present invention, a portion of the side wall being broken away;

FIGURE 2 is an elevation view of the tripping mechanism of FIGURE 1 taken substantially on the line 2-2 of FIGURE 1;

FIGURE 3 is a fragmentary view of a portion of the casing of the circuit breaker of FIGURE 1 showing the user's adjusting knob;

FIGURE 4 is a plan view of the adjusting cam of the mechanism of FIGURE 1, and

FIGURE 5 is an elevation view of the cam and cam follower member.

In the drawings, the invention is shown as incorporated in an electric circuit breaker including a molded insulating casing having a base 10 and a cover 11. The circuit breaker shown is of the three pole variety and

includes three pairs of relatively movable contacts, not shown, and manually operable operating mechanism, not shown, adapted to be actuated by the handle member 12 for moving all three sets of contacts simultaneously between open and closed circuit positions.

The operating mechanism includes a releasable member 13 which is normally held by an intermediate latch member 14 pivotally supported in the casing on a pivot pin 15. The intermediate latch member 14 has a central cutout portion 16 into which a primary latch member 17 extends so that it engages a portion of the latch member 14 and prevents counterclockwise rotation thereof as viewed. The primary latch 17 is rigidly carried by a common trip bar 18 extending across all three poles of the circuit breaker and having extensions 19 adapted to be engaged by the tripping mechanism in a manner to be described. Rotation of the trip bar 18 in a clockwise direction by the tripping mechanism causes release of the intermediate latch member 14 and therefore release of the releasable member 13, and automatic opening of the contacts of the circuit breaker.

For the purpose of causing releasing movement of the trip bar 18 in response to predetermined current conditions through any one of the poles of the circuit breaker, current-responsive tripping mechanism is provided at each pole of the circuit breaker. Since the tripping mechanism in each pole is substantially identical, the mechanism of one pole only will be described. The tripping mechanism includes a metallic frame member 20 which is in the form of a plate, having portions thereof bent over or bent out of its general plane, including a bent-over mounting portion 21 which is rigidly attached to the insulating base 10 by means of the tubular member 22 to which it is attached by suitable means such as by brazing or spinning. The tubular member 22 also serves to receive a clamping screw 23 for attaching an electrical conductor.

The tripping mechanism includes a solenoid indicated generally at 25, including a core member 26, a pole piece 27 and a pivotally supported armature 28. A winding 29 is positioned on the core 26 and has one end portion 30 connected to the frame member 20 and thence to the terminal member 22. The other end 31 of the winding 29 is connected to the movable contact of the corresponding pole of the circuit breaker, not shown. The armature member 28 carries an operating extension 32 attached thereto by suitable means such as by screws or rivets 33. The extension 32 is insulated from the armature 28 by suitable means such as insulating sheet 32A, the screw 33 being insulated from the extension 32 by insulating washer 32B. The extension 32 carries an operating screw 32 which is adapted to engage the extension 19 of the trip bar 18 when the armature 28 is attracted to the pole piece 27.

The travel of the armature 28 in the opening direction is limited by engagement with a calibrating screw 36 at the outer end of the extension 32. The calibrating screw 36 is carried by an integral offset portion 37 of the frame member 20. The armature member 28 is biased constantly toward open or unoperated position by means of a tension spring 38 which has one end connected to a stud 39 carried by the extension 32 and has its other end carried by an end portion 40 of a pivotally supported cam follower member 41 pivotally supported on the frame 20 by pivot pin 42 (see FIGURE 2).

For the purpose of adjustably positioning the cam follower member 41, adjusting means is provided including a rotatable cam member 43 rigidly attached to the end of a threaded cam shaft 44. The cam shaft 44 is threadedly engaged in the bore of an adjustable sleeve member 45 having a non-circular head portion 46. The upper end portion 44A of the shaft 44, which is non-threaded, is also made non-circular, as shown for example in FIGURE 4.

The sleeve member 45 is threadedly engaged at two points in a generally C-shaped bracket 48 rigidly attached to the frame member 20. The bracket 48 includes an

integral downwardly projecting extension 49 having a slot 50 therein which is disposed and arranged to slidably receive the right hand portion 51 of the cam follower member 41.

The end portion 44A of the shaft 44 is slidably received within a correspondingly shaped blind hole 51A in the insulating knob 51. The insulating knob 51 is provided to enable the customer or user to adjust the tripping point of the breaker within a predetermined range, in a manner to be described. The knob 51 projects through an opening 52 in the top wall of the casing cover 11. The knob 51 which is slidable on the shaft portion 44A, is biased upwardly by a compression spring 53 surrounding the portion 44A of the shaft 44, which presses the flange portion 51B of the knob 51 against the inner surface of the top wall of the casing.

The cam follower member 41 has a linear cam follower surface 41A. The cam follower 41 is constantly biased in a counterclockwise direction against the cam 43 by a tension spring 54 having one end portion connected to the extension 41B of the member 41 and having its other end anchored to a bent-over portion 55 of the frame 20.

As shown in FIGURE 3, the portion of the user's adjusting knob 51 which projects through the opening 52 of the cover 11 is provided with a suitable indicator such as the arrow 51C, see FIGURE 3, and the casing cover 11 has a series of graduations marked off around the hole 52 between extreme positions designated as "LO" and "HI."

Operation

The adjustment or calibration of the circuit breaker in accordance with the invention may, for example, be carried out as follows. The user's adjusting knob 51 is turned to the "HI" position. In this position, the arrow 51C will point to the indicator "HI," and the cam 43 will be in the position which permits the cam follower member 41 to rotate to its most counterclockwise position under the influence of the tension spring 54, i.e., the position in which the surface 41A is closest to the shaft 44. Rotation of the cam member 43 in the "HI" direction is limited by the stop portion 43A of the cam member 43 as shown in FIGURE 4.

With the parts in this condition, the spring 38 will be elongated its maximum amount. In this connection, it should be noted that the spring 54 is made substantially stronger than the spring 38, so that the cam follower member 41 is always held against the surface of the cam member 43 at all times.

Since in the "HI" position being discussed, the spring 38 is elongated its maximum amount, there will be a maximum hold-open bias exerted on the armature 28, through the extension 32, by the spring 38. A relatively high amount of current will therefore be necessary to cause tripping. With the cam member and the cam follower in this position, the calibrating screw 36 is adjusted to vary the air-gap of the magnet or solenoid 25 until tripping occurs at the exact value desired for the "HI" setting of the user's adjusting knob.

After this has been accomplished, the user's adjusting knob is rotated to the "LO" position. In the "LO" position, the cam follower member 41 is forced away from the shaft 44 to its most clockwise position. This relaxes or shortens the tension spring 38, decreasing the hold-open bias on the armature. It will be noted, however, that the magnet air gap remains constant, since the extension 32 is still held against the calibrating spring 36. The breaker is then tested to discover at what value tripping occurs in this setting. If it is found that tripping occurs at too high a value, this would indicate that a lesser hold-open bias is needed. A decrease in the bias is provided, without changing the position of the user's adjusting knob, by lowering the vertical position of the cam member 43, moving it toward the pivot 42 of the cam follower member 41, as indicated in dotted lines in

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FIGURE 5. This raises the end 40 of the member 41, allowing the spring 38 to shorten.

If, on the other hand, it is found tripping occurs at too low a value, the cam member 43 is moved upwardly vertically, thereby moving it away from the pivot 42 and allowing the member 41 to move slightly further in the counterclockwise direction under the bias of spring 54, and further elongating the spring 38.

In accordance with the invention, the vertical movement of the cam member 43 is accomplished without rotational movement, by manually holding the user's adjusting knob 51 from turning, while the threaded sleeve member 46 is turned in one direction or the other. Since the shaft 44 is threaded in the bore of the sleeve 44, such rotation alone would cause vertical movement of the shaft 44 so long as the sleeve 45 is restrained from vertical movement.

In order to provide a greater amount of movement of the shaft 44 for a given amount of rotation of the sleeve 45, however, the sleeve 45 is itself threadedly supported in the bracket 48. The thread of the sleeve 45 in the bracket 48, i.e., the external thread on the sleeve 45, is made to run in one direction, such as a right-hand thread. The thread of the shaft 44 in the sleeve 45, i.e., the internal thread of the sleeve 45, is made to run in the opposite direction, such as a left-hand thread. Thus the sleeve member 46 is rotated so as to thread downwardly as viewed in FIGURE 2, the shaft 44, which is being held from rotation with respect to the sleeve 46, is also projected downwardly with respect to the sleeve 45, so that the total downward movement of the cam member 43 is equal to the sum of the threading movements of both the sleeve 45 and the shaft 44. This permits a substantial movement of the cam member 43 without a correspondingly great movement of the sleeve 45, so that a relatively small amount of adjusting movement is necessary. In practice, for example, it has been found that in a circuit breaker of the type illustrated, less than a full turn of the sleeve 45 is ordinarily required.

It will be appreciated that, if desired, other means for achieving the vertical adjustment of the cam member 43 without rotation may be utilized, such, for example, as that shown in the aforementioned application Serial No. 62,184.

It is a particular advantage of the applicant's present invention that the cam member 43 can be restrained from rotation during the initial adjusting stage by simply holding the user's adjusting knob from rotation.

It will also be observed that while the vertical position of the cam member 43 is varied, the position of the user's adjusting knob, with respect to the casing cover 11, remains unchanged, since it is constantly biased against the underside of the cover by the compression spring 53, while the upper end 44A of the shaft 44 moves slidably within the hole 51A. The required adjustment of the tripping point at the low setting can therefore be achieved while the cam and the user's adjusting knob are held exactly in the "LO" position as marked on the circuit breaker casing while the cam member 43 is being varied in its vertical position. Similar adjustment is possible in the "HI" position. Thus exact conformance of the end points of the adjustment with the high and low markings on the circuit breaker casing is assured.

While the invention has been shown in only one specific embodiment, it will be readily apparent that many modifications thereof can be made, and I therefore intend by the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric control device including:

- (a) an enclosure,
- (b) a cam follower member pivotally supported in said enclosure and including a cam follower surface,

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- (c) means operably connected to said cam follower member for varying the sensitivity of said device,
- (d) an elongated cam shaft,
- (e) a generally tubular supporting sleeve supporting said cam shaft in said enclosure,
- (f) said supporting sleeve being rotatable while said cam shaft is restrained from rotation to cause longitudinal shifting of said cam shaft with respect to said enclosure,
- (g) a cam member carried by said cam shaft adjacent one end thereof and disposed and arranged to engage said cam follower surface of said cam follower member,
- (h) an external adjusting knob supported by said enclosure and including a portion accessible for manual operation from outside said enclosure,
- (i) said cam shaft including a portion projecting through said supporting sleeve and into slidable and non-rotatable engagement with said external adjusting knob, and
- (j) said external adjusting knob being retained in position with respect to said enclosure by means independent of said cam shaft.

2. An electric control device comprising:

- (a) an enclosure,
- (b) a cam follower member pivotally supported in said enclosure,
- (c) means operably connected to said cam follower member for varying the sensitivity of said device,
- (d) said cam follower member having a generally linear cam follower surface,
- (e) an elongated cam shaft,
- (f) means supporting said cam shaft in said enclosure comprising a generally tubular supporting sleeve,
- (g) said supporting sleeve being rotatable to cause axial shifting of said cam shaft with respect to said enclosure while said cam shaft is restrained from rotation with respect to said sleeve,
- (h) a cam member carried adjacent one end of said shaft and disposed and arranged to engage said cam follower surface of said cam follower member,
- (i) an adjusting member having at least a portion thereof accessible for operation from outside said enclosure,
- (j) said enclosure having indicia on the outer surface thereof corresponding to different adjusted positions of said externally accessible adjusting member,
- (k) said cam shaft including a portion projecting through said supporting sleeve and into slidable and non-rotatable engagement with said externally accessible adjusting member,
- (l) said externally accessible adjusting member being movable to a position corresponding to a particular indicia carried by said enclosure and retainable in said position while said supporting sleeve is rotated to shift said cam shaft axially with relation to said enclosure to move said cam member linearly along said cam follower surface in a direction radially of said cam follower pivot to vary the mechanical advantage of said cam member on said cam follower member without varying the rotative position of said cam shaft or said external adjusting member.

3. An electric control device comprising:

- (a) a pivotally supported cam follower member,
- (b) means operably connected to said cam follower member for varying the sensitivity of said device,
- (c) an elongated cam shaft,
- (d) a cam member carried by said cam shaft adjacent one end thereof and disposed and arranged to engage said cam follower member,
- (e) said cam follower member having a linear cam follower surface extending substantially radially of the pivot point of said cam follower member,
- (f) a generally tubular supporting sleeve for said cam shaft,

- (g) support means threadedly supporting said sleeve in said device, said cam shaft being threadedly engaged in said supporting sleeve,
- (h) manually engageable means for restraining said cam shaft from rotation,
- (i) means carried by said supporting sleeve for facilitating rotation of said supporting sleeve while said cam shaft is restrained from rotation,
- (j) said threaded engagement of said shaft in said sleeve being opposite in direction from said threaded engagement of said sleeve in its support, whereby said cam shaft moves with respect to said support means for said sleeve member at a rate determined by the sum of the pitches of the threads of said sleeve member and said cam shaft member,
- (k) whereby to move said cam member substantially radially of said pivoted cam member to vary the mechanical advantage of said cam member on said cam follower member.
4. An electric control device comprising:
- (a) a support,
- (b) a cam follower member pivotally supported on said support,
- (c) means operably connected to said cam follower member for varying the sensitivity of said device,
- (d) said cam follower member including a linear cam follower surface extending in a direction generally radially of the pivot of said cam follower member,
- (e) an elongated cam shaft,
- (f) a generally tubular supporting sleeve threadedly carried by said support,
- (g) said cam shaft being threadedly received within said supporting sleeve,
- (h) a cam member carried by said cam shaft adjacent one end thereof and disposed and arranged to engage said cam follower surface of said cam follower member,
- (i) said cam shaft including a portion projecting through said tubular supporting sleeve and having its other end portion projecting beyond said tubular supporting sleeve and accessible for engagement to prevent rotation of said cam shaft when desired,
- (j) a rotation of said supporting sleeve while said cam shaft is restrained from rotation serving to move said cam shaft axially with respect to said support at a rate equal to the sum of the pitches of the threads of said cam shaft and said tubular supporting and moving said cam member along said cam follower surface radially of said pivot of said cam follower member to vary the mechanical advantage of said cam member on said cam follower member.
5. An enclosed electric control device comprising:
- (a) an enclosure,
- (b) a cam follower member pivotally supported in said enclosure, and including a linear cam follower sur-

- face extending substantially radially from the pivot of said cam follower member,
- (c) means operably connected to said cam follower member for varying the sensitivity of said device,
- (d) an elongated threaded cam shaft in said enclosure,
- (e) means supporting said cam shaft in said enclosure comprising a generally tubular supporting sleeve threadedly supported with respect to said enclosure by means of external threads thereon,
- (f) said cam shaft being threadedly engaged in the bore of said supporting sleeve,
- (g) a cam member carried by said cam shaft adjacent one end thereof and disposed and arranged to engage said cam follower surface of said cam follower member,
- (h) an adjusting member carried by said enclosure and including a portion accessible externally of said enclosure,
- (i) adjusting indicia carried by an external surface of said enclosure adjacent said externally accessible portion of said adjusting member,
- (j) said cam shaft including a portion projecting through said tubular member and into slidable and non-rotatable engagement with said adjusting member,
- (k) means retaining said adjusting member in position with respect to said enclosure independent of said cam shaft,
- (l) and means carried by said supporting sleeve for facilitating rotation of said supporting sleeve while said cam shaft is restrained from rotation by means of said adjusting member, whereby to shift said cam shaft axially and to move said cam member substantially radially of said pivot of said cam follower member to vary the mechanical advantage of said cam member on said cam follower member while said adjusting member is retained in a predetermined position with respect to said external indicia on said enclosure.
6. An electric control device as set forth in claim 5 wherein said device also comprises:
- (a) an electromagnetic armature movable to initiate actuation of said device, and
- (b) a tension spring having one end operably connected to said armature and having the other end operably connected to said cam follower member whereby variation in the rotated position of said cam follower member causes variation in the tension of said spring.

References Cited by the Examiner

UNITED STATES PATENTS

3,084,236 4/63 Klein et al.

BERNARD A. GILHEANY, *Primary Examiner*.ROBERT K. SCHAEFER, *Examiner*.