April 20, 1965 E. E. ZIEGLER, JR 3,179,769

CIRCUIT BREAKER WITH ADJUSTABLE TRIPPING MEANS

Filed Dec. 31, 1962 2 Sheets-Sheet 1

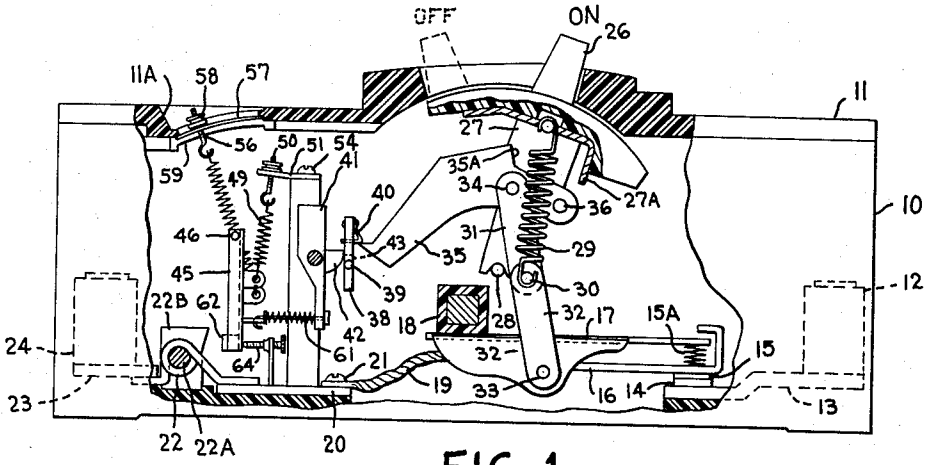


FIG. 1

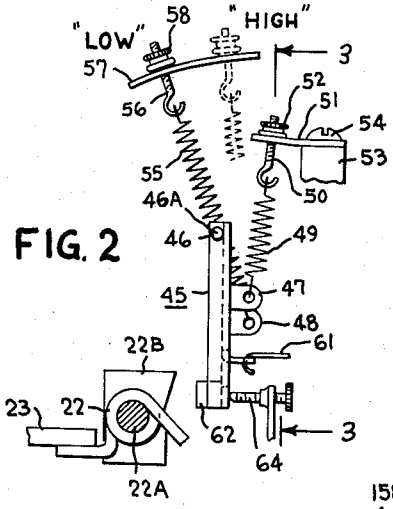


FIG. 2

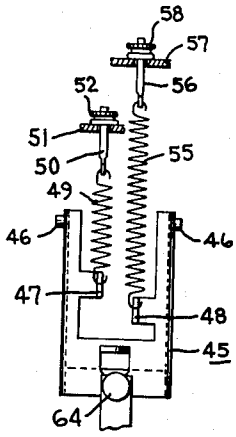


FIG. 3

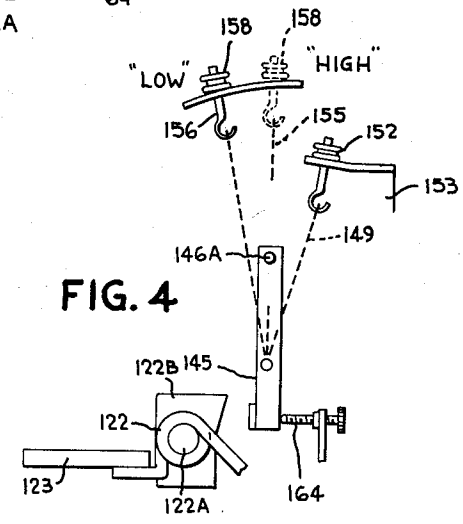


FIG. 4

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CIRCUIT BREAKER WITH ADJUSTABLE TRIPPING MEANS

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FIG. 5

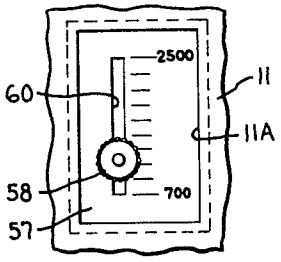


FIG. 6

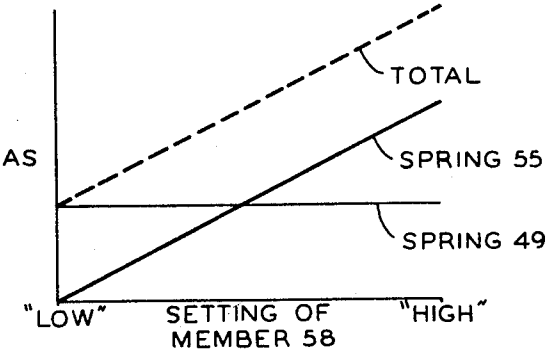
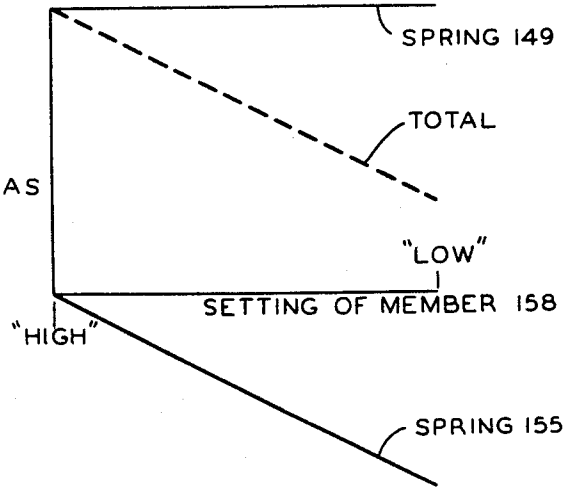


FIG. 7



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3,179,769

CIRCUIT BREAKER WITH ADJUSTABLE TRIPPING MEANS

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Filed Dec. 31, 1962, Ser. No. 248,484
8 Claims. (Cl. 200—95)

My invention relates to electric circuit breakers, and more particularly to circuit breakers of the type including adjustable magnetically operated means for causing automatic opening or "tripping" upon the occurrence of predetermined high current conditions.

In circuit breakers of the type described, it is usually desired that magnetic tripping occur when the current through the circuit breaker increases to a value of anywhere from three to ten times the normal continuous current rating of the circuit breaker, the exact current value at which such tripping occurs being selectable by the user.

Accordingly, such circuit breakers are ordinarily provided with means by which the user can selectively determine the current magnitude at which magnetic tripping will occur. Thus, for example, it is customary to provide such circuit breakers with an adjustable member, such as a knob or lever, which the user can set to cause tripping to occur anywhere in the aforementioned range, that is, from a "low" setting of three times normal current to a "high" setting of ten times normal current.

The circuit breaker is ordinarily provided with a molded insulating cover having a hole or slot, through which a trip adjusting member projects, which is movable between extreme positions corresponding to the aforesaid high and low settings. Adjacent the hole or slot, a graduated scale is provided, for use in conjunction with the movable adjusting member. It is very desirable that the scales used with each pole of a multi-pole breaker, and in fact, in different breakers should be uniform. If this were not possible, a different scale would have to be made for each adjusting member, requiring a great amount of time and corresponding expense.

It is therefore very desirable that means be provided for adjusting the circuit breaker when it is manufactured so that the settings of the movable member which the user adjusts correspond to a predetermined scale. Thus, for example, when the breaker is manufactured, the structure should be so arranged that when the adjusting member is in the "low" position as indicated by the predetermined scale carried by the breaker housing, the breaker will trip at a predetermined current, and likewise, when the adjusting member is in the "high" position as indicated by the scale carried by the housing, the breaker will trip at a predetermined higher current.

A defect with prior art adjustable magnetic tripping constructions has been that when the circuit breaker is assembled at the factory so as to have the proper setting or sensitivity when the adjusting member is in one extreme setting, such as "high" or "low," according to the pre-set scale, and the adjusting member is then moved to the other extreme position and arranged at that position to have the desired sensitivity there, it is found, when the adjusting member is returned to the first extreme position, that the setting at that position has been changed, and is no longer accurate. In other words, it has been impossible to provide accurate settings at both the high and low positions without repeated re-adjustment at each extreme setting, because of interaction between the two.

In accordance with the invention of prior patent application, Serial No. 56,302, C. F. Hobson, Jr., filed September 15, 1960, now Patent No. 3,110,848 issued November 12, 1963, and assigned to the same assignee as

the present invention, a mechanism has been provided for achieving "independent" adjustment of the high and low settings of a magnetic tripping device, thereby remedying this defect of prior art constructions. The construction of the Hobson application, however, is relatively expensive since it requires a relatively large number of parts, assembled in a relatively expensive manner.

It is an object of the present invention to provide an electric circuit breaker including adjustable magnetic tripping means, in which the trip value is adjustable at each of the "high" and "low" settings independently which does not require the use of expensive parts or assemblies.

It is another object of the invention to provide an electric circuit breaker including adjustable magnetic tripping means in which the "high" and "low" settings may be independently adjusted and in which the armature gap remains the same at both such "high" and "low" settings.

It is another object of the invention to provide an electric circuit breaker having magnetic tripping means which is adjustable in the manner described which is simple in construction and easy to assemble.

Other objects of the invention will in part be pointed out, and in part become apparent from the following detailed description, and the scope of the invention will be pointed out in the appended claims.

In accordance with the invention in one form, an electric circuit breaker is provided including magnetic tripping means having a magnetic field piece adapted to be energized by current passing through the circuit breaker, combined with a pivotally mounted armature member. Means is provided for adjusting the counter-bias on the armature member comprising a pair of spring members, each having one end attached to the armature. A first one of the spring members has its other end mounted so as to be adjustable axially of the spring member, to adjust the tension of the spring member. The second of the spring members has its other end supported so as to be slidably adjustable so as to vary the angular position of the spring, and also axially adjustable to vary the tension of the spring. The second spring member, in one extreme angular position; has its line of action passing through the pivotal support of the armature, and therefore in this position, its force does not act to affect the bias applied to the armature. In this position, therefore, the first spring is the only spring acting against the armature and its tension may therefore be adjusted to establish the "minimum" or "low" setting of the magnet.

When the second spring member is moved away from the aforesaid extreme angular position, toward the other extreme angular position, however, its line of action no longer passes through the pivotal axis of the armature. Its bias therefore acts in additive relation to the bias of the first spring, and it may therefore be moved to the other extreme position, in which its bias acts in addition to the bias of the second spring. When in the second extreme position, the tension of the second spring may be adjusted to obtain the desired operation of the magnetic tripping means at this setting. When the second spring is returned to the original angular position, the adjustment performed at the other position will be found to have no effect upon the first adjustment, because of the fact that the line of action of the spring is through the axis of the armature as previously mentioned.

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 an electric circuit breaker incorporating the invention, a portion of the side wall being broken away;

FIGURE 2 is a side elevation view of the magnetic

tripping and adjusting means of the circuit breaker of FIGURE 1;

FIGURE 3 is a view taken substantially on the line 3—3 of FIGURE 2;

FIGURE 4 is a view similar to FIGURE 3, showing another embodiment of the invention;

FIGURE 5 is a fragmentary view showing a portion of the top of the circuit breaker of FIGURE 1, and

FIGURES 6 and 7 are graphical representations of the bias force exerted on the magnetic device in the different settings of a control member.

In the drawings, the invention is shown as incorporated in an electric circuit breaker having a molded insulating casing including a generally box-like base 10 and a cover 11. The circuit breaker illustrated is a three-pole circuit breaker and includes three side-by-side line terminals 12 (only one shown) supported in recesses, not shown, at one end thereof and connected to one end of conductive straps 13, each having a stationary contact 14 at the other end thereof.

A movable contact 15 is also provided, carried by a contact supporting member 16. The movable contact supporting member 16 is carried by a generally channel-shaped contact arm 17, which in turn is rigidly attached to a contact cross-arm 18 serving to gang together the contact arms of all three poles of the circuit breaker. The contact supporting member 16 is connected by a flexible conductive member 19 to a conductive strap 20 by suitable means such as by screw 21. The contact strap 20 has one end of a coil 22 rigidly attached thereto by suitable means, such as by brazing, the other end of the coil 22 being similarly attached to a conductive strap 23, serving to support a load terminal connector 24. The coil 22 is wound about a coil member 22A having a pair of pole pieces 22B attached thereto at either end, only one shown.

The current path through each pole of the circuit breaker, is therefore as follows: entering at line terminal 12, to conductive strap 13, to stationary contact 14, to movable contact 15, to movable contact support 16, to flexible conductor 19, to conductive strap 20, to coil 22, to conductive strap 23, and finally to the output connector 24.

For the purpose of operating the movable contact arm 17, together with the movable contact member 15, between open and closed circuit positions, operating mechanism is provided including a manually operable handle member 26 supported on and carried by a generally U-shaped operating member 27 pivotally supported on pivot pins 28 in the base 10. The operating member 27 serves to move one end of each of a pair of operating springs 29 (only one shown) the other end of which is connected to a knee pivot pin 30 interconnecting a pair of toggle links 31 and 32. The lower toggle links 32 are connected by a pivot pin 33 to the movable contact arm 17, while the upper toggle links 31 are connected by a pivot pin 34 to a releasable support member 35 pivotally supported in the base 10 on a pivot pin 36.

In operation, as the operating handle 26 is moved from "on" toward "off" position, the tension springs 29 are moved across the pivot pin 34, causing the upper toggle links 31 to rotate in clockwise direction, collapsing the toggle linkage 31–32, and moving the movable contact arm 17 to open circuit position.

As the operating handle member 26 is moved from "off" toward "on" position, the process is reversed. The tension spring 29 is moved across the pivot pin 34, moving the toggle links 31 in the counterclockwise direction to straighten the toggle links 31–32, moving the contact arm 17 to closed-circuit position, applying contact closing force to the movable contact member 15 through contact pressure spring 15A.

The releasable member 35 is normally restrained in the position shown in FIGURE 1 by current responsive latching means including a primary latch member 38 pivotally

supported at 39 in the base 10, and carrying a latching projection 40 disposed and arranged to engage the end of the releasable member 35. A common-trip bar 41 is also provided, pivotally supported in the base 10 and including a retaining latch member 42 adapted to engage and normally restrain the primary latch member 38 from counterclockwise rotation in response to the force exerted thereon by the releasable member 35. The primary latch member 38 has a cut-out or aperture 43 into which the retaining member 42 is adapted to enter when the trip bar 41 is rotated a small amount in clockwise direction as viewed in FIGURE 1.

For the purpose of causing rotation of the trip bar 41 and release of the operating mechanism upon the occurrence of predetermined current conditions, current responsive means is provided, including a stationary magnetic assembly comprising the coil 22, the core 22A, and pole pieces 22B. In addition a movable armature member 45 is pivotally supported in the base 10 on pivot pins 46. The armature member 45 is generally U-shaped and includes a pair of offset lug members 47 and 48 for the purpose of providing means for connecting to bias springs as shown.

A first or "fixed" bias means is provided, comprising a first tension spring 49 having one end connected to the lug 47 and the other end connected to a hook member 50 supported on supporting member 51 by means of a retaining and adjusting nut 52. The supporting member 51 is rigidly mounted on a projecting boss portion 53 of the base 10 by suitable means, such as by a screw 54.

A second "adjustable" bias member is also provided, comprising a second tension spring 55 having one end thereof attached to the lug 48 and having the other end attached to a hook member 56 supported on an arcuate support member 57 by means of an adjustable nut 58. The arcuate member 57 is supported between spaced arcuate boss portions (only one shown) 59 of the base 10. The arcuate support member 57 has an elongated slot 60 located centrally thereof, to permit longitudinal shifting of the hook member 56 and the retaining nut 58 to adjust the angle of the spring 55.

The armature member 45 is connected to the trip bar 41 by suitable means such as by a connecting rod 61, see FIGURE 1. The armature member 45 carries a magnetic armature 62 at its lower end which is adapted to be attracted to the pole pieces 22B upon the occurrence of predetermined current conditions in the circuit.

The action of the springs 49 and 55 is such as to bias the armature member 45 counterclockwise, against an adjustable stop member 64.

Upon the occurrence of predetermined current conditions through the circuit breaker, the armature 45 is attracted to the pole pieces 22B, causing rotation of the trip bar 41 through the agency of the connecting rod 61. This rotates the retaining latch 42, allowing counterclockwise rotation of the primary latch member 38 and releasing the releasable member 35.

The releasable member 35 moves in a clockwise direction under the action of the springs 29, thereby opening the contact arm 17, and causing counterclockwise rotation of the cross-bar 18 and therefore simultaneous opening movement of the contact arms of the other two poles of the breaker. As the releasable member 35 moves in a clockwise direction, it carries the pivot point 34 upwardly and to the right as viewed, thereby carrying it across the line of action of the springs 29, causing collapse of the toggle 31–32 and movement of the pivot point 30 to the left as viewed. Movement of the pivot point 30 to the left causes the line of action of the springs 29 to move across the pivot point 28 of the operating member 27. This reverses the bias exerted upon the handle member 27, and moves it in a counterclockwise direction until the extension 27A of the operating member 27 engages a portion 35A of the releasable member 35, at which point the parts come to rest.

The mechanism may be reset by manually moving the operating handle **26** and the operating member **27** in the counterclockwise direction to the "off" position as shown. This causes the releasable member **35** to rotate in a counterclockwise direction until the latching end thereof is once again under and in latched engagement with the latch **40** of the primary latch member **38**.

Magnetic adjusting operation

Referring particularly to FIGURES 2 and 3, the cover **11** of the insulating enclosure is provided with a generally rectangular opening **11A** through which the arcuate member **57** and the adjusting member **58** are visible and accessible, as shown in FIGURE 5.

It will be observed from the drawings that the total amount of possible movement of the adjustable member **58** is determined by the length of the slot **60** in the arcuate member **57**.

It is desirable that the circuit breaker should, during manufacture, be adjusted so that when the adjustable member is set in the "low" position, the circuit breaker will trip at a particular desired current value. It is likewise desirable that the circuit breaker when manufactured be adjusted so that when the knob **58** is in the "high" position, the circuit breaker will trip at a particular higher value of current. In accordance with the invention, this is accomplished in the following manner.

When the circuit breaker is initially assembled, the adjustable member **58** is set in the "low" position, as shown in FIGURE 2. The adjustable stop member **64** is then adjusted until the line of action of the spring **55** extends directly through the axis **46A** of the supporting pivot pin **46**. It will be observed that, under these conditions, the spring **55** does not tend to cause rotation of the armature member **45** in either direction. At the same time, however, the tension spring **49** tends to cause rotation of the armature **45** in counterclockwise direction, that is, toward unattracted position and against the stop **64**. In this condition, the tension of the spring **49** is adjusted until the armature member **62** is attracted to the pole members **22B** at the desired low setting of current. When this has been achieved, the adjusting member **58** moved to the "high" position, as shown in dotted lines in FIGURE 2. It will be observed that in this position, the force of the spring **55** is added to the force of the spring **49**. With the parts in this position, the nut **58** is then adjusted to adjust the tension of the spring **55** until tripping occurs at the desired current value corresponding to the "high" setting.

It will now be observed that when the adjustable member **58** is again returned to the "low" position, there will be no change in the value at which tripping occurs in the "low" condition, because the change made in the tension of the spring **55** when adjusting the "high" position does not have any effect on the tripping in the "low" position since in this position the line of action of spring **55** passes through the axis **46A** of the armature member **45**. At intermediate positions, the spring **55** will have an added effect, increasing the current at which tripping will occur, in proportion to its position, until the high position is reached.

In other words, the invention provides (*a*) an adjustable fixed bias, and (*b*) means for adding a portion only of an additive bias, such portion varying smoothly and continuously from zero to one hundred percent of the additive bias, together with (*c*) means for adjusting the 100% value of the additive bias. This is shown graphically in FIGURE 6. It will be observed that the starting point of the "Total" curve is determined solely by spring **49**, and the difference between start and finish of the "Total" curve is determined solely by spring **55**. Thus the starting point of the system may be chosen or adjusted irrespective of the value of the additive bias, and the end point or high may be adjusted without affecting the starting point.

In FIGURE 4 there is shown another embodiment of the invention, in which a subtractive instead of an additive bias is provided. This form of the invention is generally similar to that illustrated in FIGURE 2, excepting that the line of action of the spring **155** passes through the axis **146A** of the pivotal support of the armature **145** when the spring **155** is in the "high" position, rather than in the "low" position. Accordingly, when this form of the invention is assembled, the adjustable member **158** is placed in the "high" position and the stop **164** is adjusted until the line of action of the spring **155** passes through the axis of rotation of the armature **145**. With the parts in this position, the tension of the spring **149** is adjusted, by means of the nut **152** until tripping occurs at the desired "high" setting. The adjustable member **158** is then moved to the "low" setting, and the tension of the spring member **155** is adjusted until tripping occurs at the desired "low" setting.

Since the spring **155** functions in a subtractive manner at all settings except the "high" setting, the spring **155** must be selected and the adjusting hook **156** and nut **158**, designed so that the tension of the spring **155** is such as to exert a force on the armature **145** when in the "low" position a force which is less than the force of the spring member **149**. If this were not so, the spring **155** would overcome the spring **149** and cause tripping movement of the armature. The operation of this form is shown graphically in FIGURE 7.

While the invention has been shown in only two embodiments, it will be readily apparent that many modifications thereof may readily be made. Thus, for example, instead of the slidable member **58**, a rotatable operating knob may be provided, together with a suitable operating arm, for adjustably positioning the movable end of the spring **55**. 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 electrical control device comprising:
   (*a*) a relatively stationary magnet,
   (*b*) an armature rotatably supported for rotation about a predetermined axis of rotation,
   (*c*) first biasing means acting on said armature and biasing said armature for rotation in a direction away from said magnet,
   (*d*) stop means limiting rotation of said armature away from said magnet,
   (*e*) second biasing means for said armature,
   (*f*) means for adjusting the line of action of said second biasing means between a first position in which said line of action passes through said axis of rotation of said armature and a second position in which said line of action passes to one side of said axis of rotation,
   (*g*) means for adjusting the magnitude of said second biasing means without affecting said line of action of said second biasing means, and
   (*h*) means for adjusting the magnitude of the force of said first biasing means.

2. An electrical control device comprising:
   (*a*) a relatively stationary magnet,
   (*b*) an armature supported for pivotal movement about a predetermined axis of rotation toward and away from said magnet,
   (*c*) first biasing means for said armature biasing said armature away from said magnet,
   (*d*) stop means limiting movement of said armature away from said magnet,
   (*e*) second biasing means for said armature,
   (*f*) means for adjusting the line of action of said second biasing means between a first position in which said line of action passes through said axis of rotation of said armature, and a second position in which

said line of action of said second biasing means is at one side of said axis of rotation such as to cause said second biasing means to bias said armature away from said magnet,

(*g*) means for adjusting the magnitude of said first biasing means when said second biasing means is in said first position, and

(*h*) means for adjusting the magnitude of said second biasing means when said second biasing means is in said second position.

3. An electrical control device comprising:

(*a*) a relatively stationary magnet,

(*b*) an armature supported for pivotal movement about a predetermined axis of rotation toward and away from said magnet,

(*c*) first biasing means for said armature biasing said armature away from said magnet,

(*d*) stop means limiting movement of said armature away from said magnet,

(*e*) second biasing means for said armature,

(*f*) means for adjusting the line of action of said second biasing means between a first position in which said line of action passes through said axis of rotation of said armature, and a second position in which said line of action of said second biasing means is at one side of said axis of rotation of said armature such as to bias said armature toward said magnet,

(*g*) means for adjusting the magnitude of said first biasing means when said second biasing means is in said first position, and

(*h*) means for adjusting the magnitude of said second biasing means when said second biasing means is in said second position.

4. An electrical control device comprising:

(*a*) a relatively stationary magnet,

(*b*) an armature supported for pivotal movement about a predetermined axis of rotation toward and away from said magnet,

(*c*) first biasing means for said armature biasing said armature away from said magnet,

(*d*) stop means limiting movement of said armature away from said magnet,

(*e*) second biasing means for said armature comprising at least one tension spring having one end thereof connected to said armature,

(*f*) means for adjustably positioning the other end of said tension spring so as to shift the line of action of said spring between a first position in which said line of action passes through said axis of rotation of said armature and a second position in which said line of action of said spring is at one side of said axis of rotation of said armature,

(*g*) means for adjusting the magnitude of said first biasing means when said tension spring is in said first position, and

(*h*) means for adjusting the tension of said tension spring when in said second position.

5. An electric control device comprising:

(*a*) a relatively stationary magnet,

(*b*) an armature supported for pivotal movement about a predetermined axis of rotation toward and away from said magnet,

(*c*) a first tension spring having one end thereof connected to said armature, and having the other end thereof attached to a relatively stationary anchor means and biasing said armature away from said magnet,

(*d*) stop means limiting movement of said armature away from said magnet,

(*e*) a second tension spring having one end thereof connected to said armature and having the other end thereof connected to a movable anchor means,

(*f*) means for adjustably positioning said first spring anchoring means whereby to vary the tension of said first tension spring,

(*g*) first means for adjustably positioning said movable anchor means so as to shift the line of action of said second tension spring between a first position in which said line of action passes through said axis of rotation of said armature and a second position in which said line of action of said tension spring passes to one side of said axis of rotation of said armature, and

(*h*) second means for adjustably positioning said movable spring anchor means whereby to vary the tension of said second tension spring.

6. An electric circuit breaker comprising:

(*a*) an insulating casing,

(*b*) at least one pair of relatively movable contacts between open and closed circuit positions, said operating mechanism comprising a member releasable to cause automatic opening of said contacts,

(*d*) means for initiating release of said releasable member in response to predetermined current conditions through said contacts comprising a relatively stationary magnet having an energizing coil connected electrically in series with said contacts,

(*e*) an armature supported for pivotal movement in said casing about a predetermined axis of rotation toward and away from said magnet,

(*f*) first adjustable spring means biasing said armature away from said magnet,

(*g*) second adjustable spring means comprising an elongated spring member having one end thereof connected to said armature,

(*h*) means for adjustably positioning the other end of said second spring means so as to shift the line of action of said second spring means between a first position in which said line of action passes through said axis of rotation of said armature and a second position in which said line of action of said spring passes at one side of said axis of rotation of said armature, and means for adjusting the magnitude of said second biasing means.

7. An electric circuit breaker comprising:

(*a*) an insulating casing,

(*b*) at least one pair of relatively movable contacts supported in said insulating casing,

(*c*) operating mechanism for operating said relatively movable contacts between open and closed circuit position comprising a member releasable to cause automatic opening of said contacts,

(*d*) means for initiating release of said releasable member in response to predetermined current conditions through said contacts comprising a magnet supported in said casing and including an energizing coil connected electrically in series with said contacts,

(*e*) a generally U-shaped armature member having the arms of said U supported for pivotal movement about a predetermined axis of rotation adjacent the ends thereof toward and away from said magnet,

(*f*) said insulating casing comprising a generally box-like base and a cover therefor,

(*g*) a first tension spring having one end thereof connected to said armature member and having the other end thereof connected to a first spring anchor member,

(*h*) a second tension spring having one end thereof connected to said armature member and having the other end thereof connected to a second spring anchor member,

(*i*) means for adjustably positioning said first spring anchor member in a direction axially of said first tension spring, said adjusting means being accessible only when said cover is removed from said casing,

(*j*) second adjusting means for adjustably positioning said second spring anchor member axially of said second tension spring, said second adjusting means

being accessible for operation when said cover is in place on said casing,

(*k*) said second adjusting means also being adjustably movable along a path of movement between a first position in which the line of action of said second tension spring passes between said arms of said U and through the axis of rotation of said armature member and a second position in which the line of action of said second tension spring passes at one side of said axis of rotation of said armature member.

8. An electric circuit breaker comprising:

(*a*) an insulating casing having a base and a removable cover,

(*b*) at least one pair of relatively movable contacts supported in said base,

(*c*) operating mechanism supported in said base for operating said relatively movable contacts between open and closed circuit positions, said operating mechanism including a member releasable to cause automatic opening of said contacts,

(*d*) means for initiating release of said relatively separable contacts in response to predetermined current conditions therethrough comprising a relatively stationary magnet supported in said base, and an energizing coil connected electrically in series with said contacts,

(*e*) a generally U-shaped armature pivotally supported in said base for movement about a predetermined axis of rotation passing through the legs of said U adjacent the outer ends thereof, said armature being movable about said axis toward and away from said magnet,

(*f*) a first tension spring having one end thereof connected to said armature and having the other end thereof attached to a first spring anchor member,

(*g*) means accessible only when said cover is removed

from said base for adjustably positioning said first spring anchor member in a direction axially of said first spring means whereby to vary the force of said first spring means,

(*h*) adjustable stop means for limiting movement of said armature away from said magnet, said adjustable stop means being accessible only when said cover is removed from said casing,

(*i*) second tension spring means having one end thereof connected to said armature and having the other end thereof connected to a second spring anchor member,

(*j*) means for adjustably positioning said second spring anchor member in a direction axially of said second tension spring, and

(*k*) means for adjustably positioning said second spring anchor member selectively along a path between a first position in which the line of action of said tension spring passes through said axis of rotation of said armature and a second position in which said line of action of said spring passes at the opposite side of said axis of rotation of said armature from the line of action of said first tension spring,

(*l*) said adjusting means for said second tension spring being accessible through an opening in said circuit breaker cover.

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