Nov. 3, 1970 R. AUCHAPT ET AL 3,538,476

LOW-VOLTAGE ELECTRIC CIRCUIT-BREAKER

Filed April 30, 1969 4 Sheets-Sheet 1

Fig.1 Fig.2 Fig.3 Fig.4

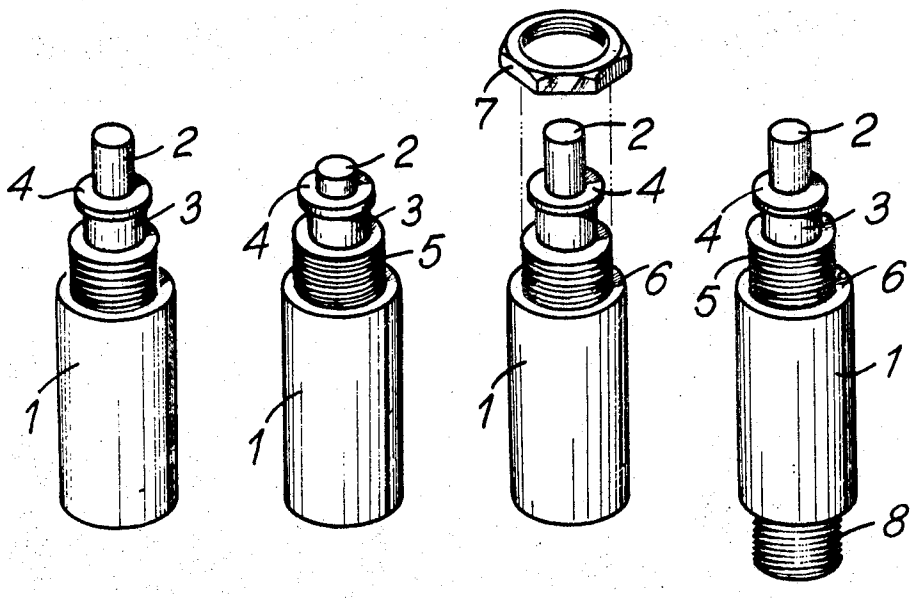
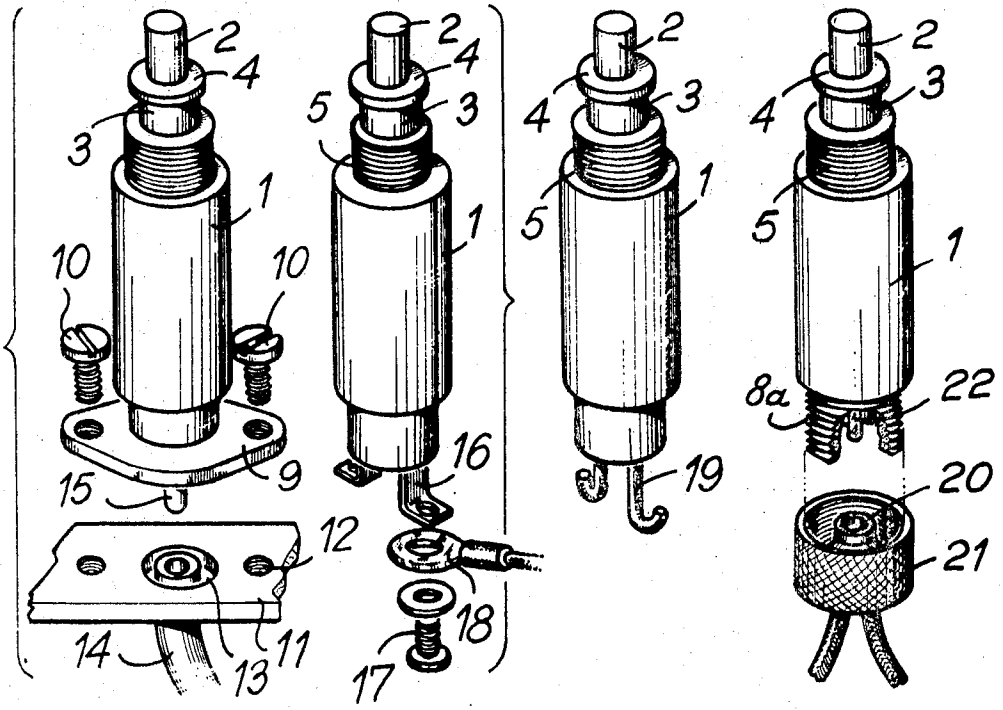


Fig.5 Fig.6 Fig.7 Fig.8



LOW-VOLTAGE ELECTRIC CIRCUIT-BREAKER

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Fig. 9

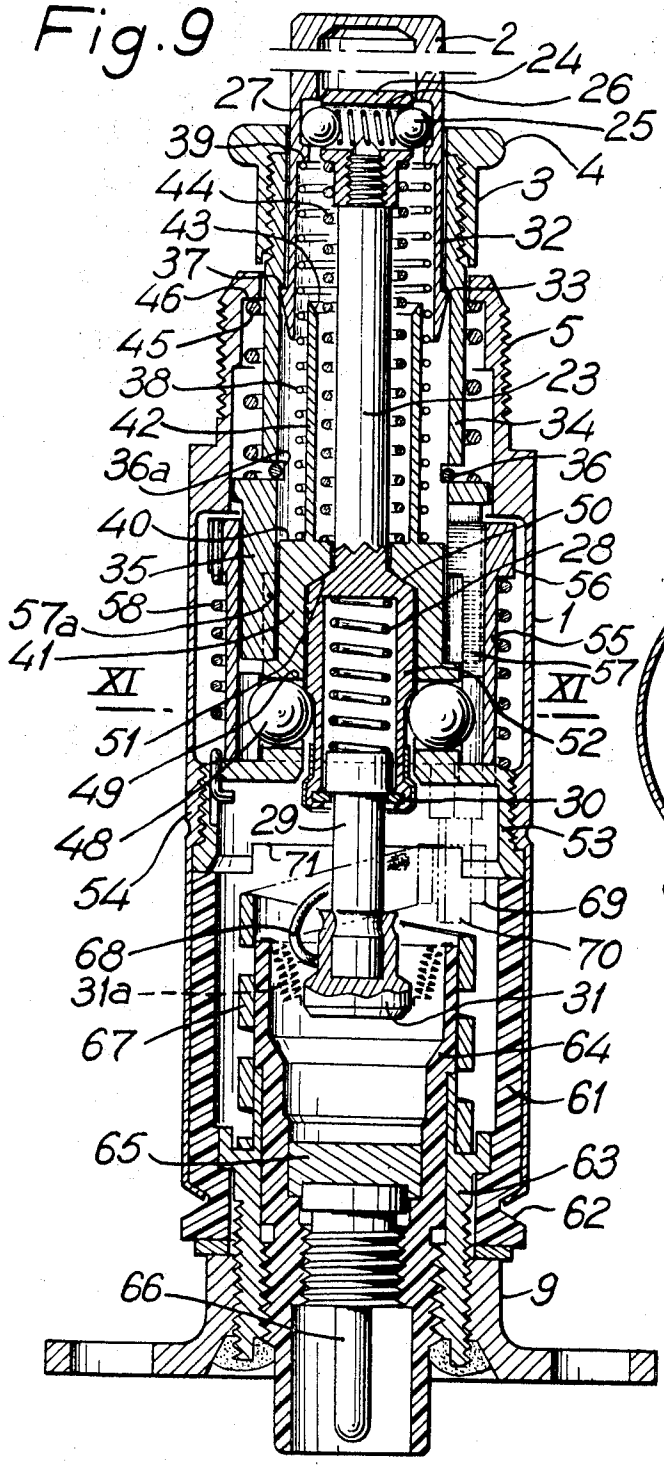
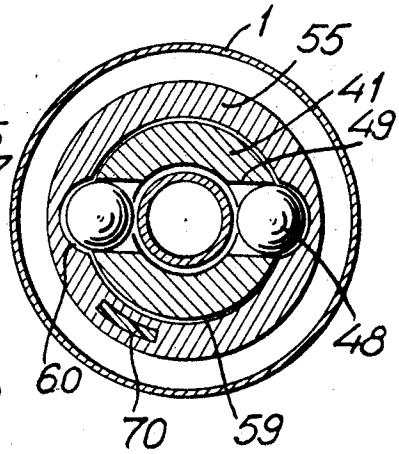


Fig. 11



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Fig. 10

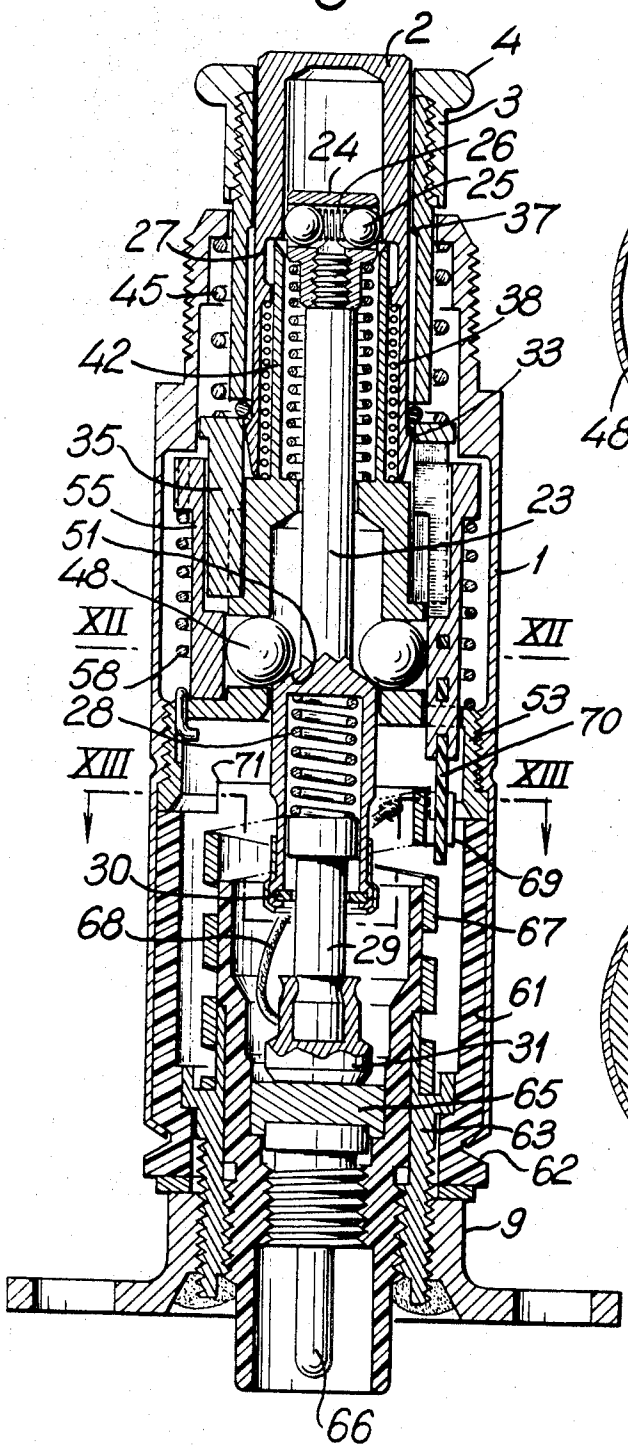


Fig. 12

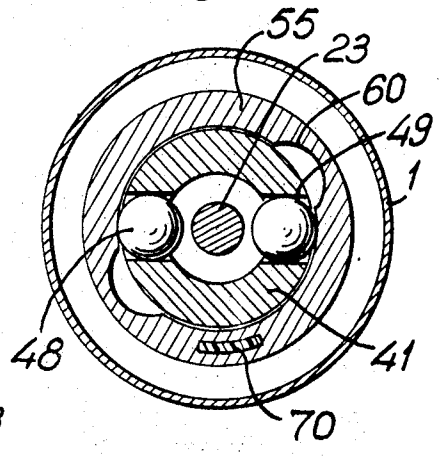
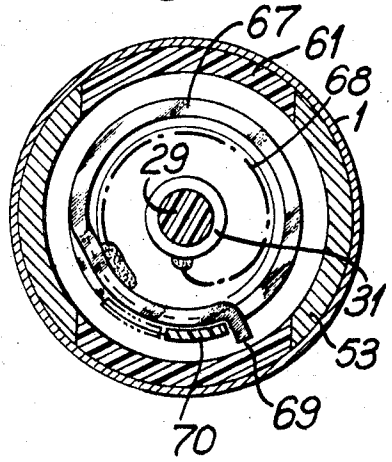


Fig. 13



LOW-VOLTAGE ELECTRIC CIRCUIT-BREAKER

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Fig. 14

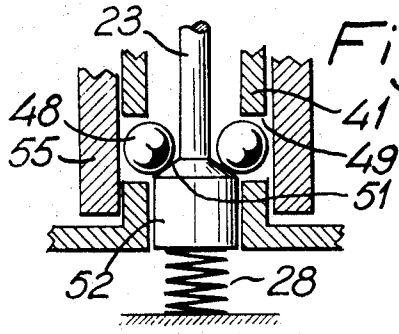


Fig. 15

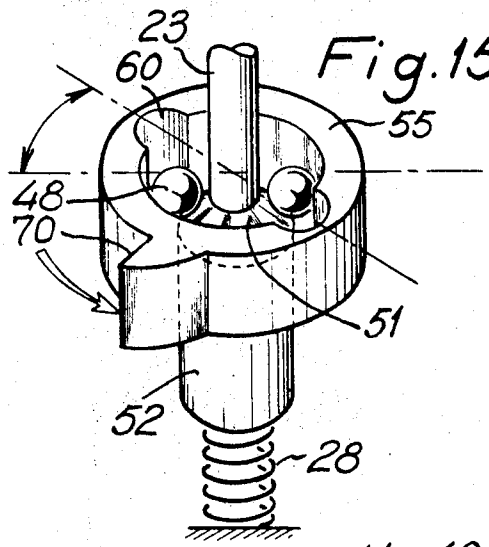


Fig. 16

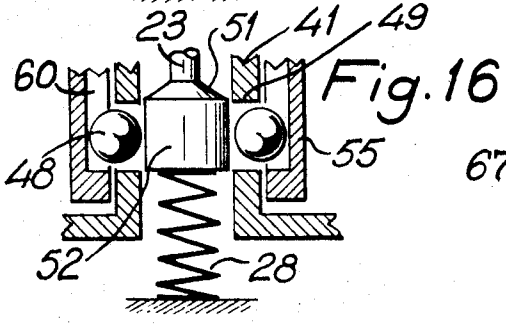


Fig. 17

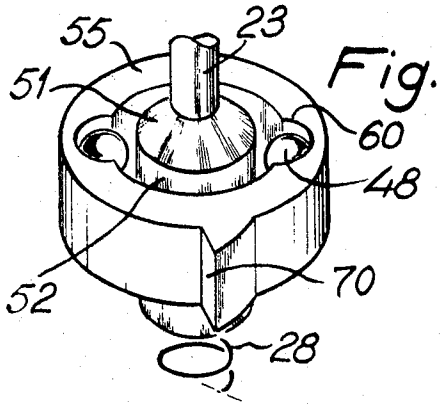


Fig. 18

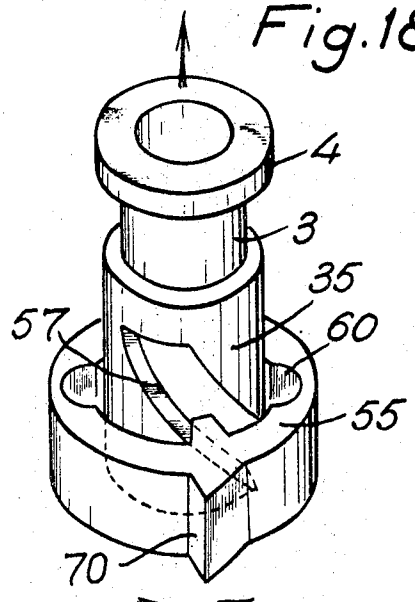
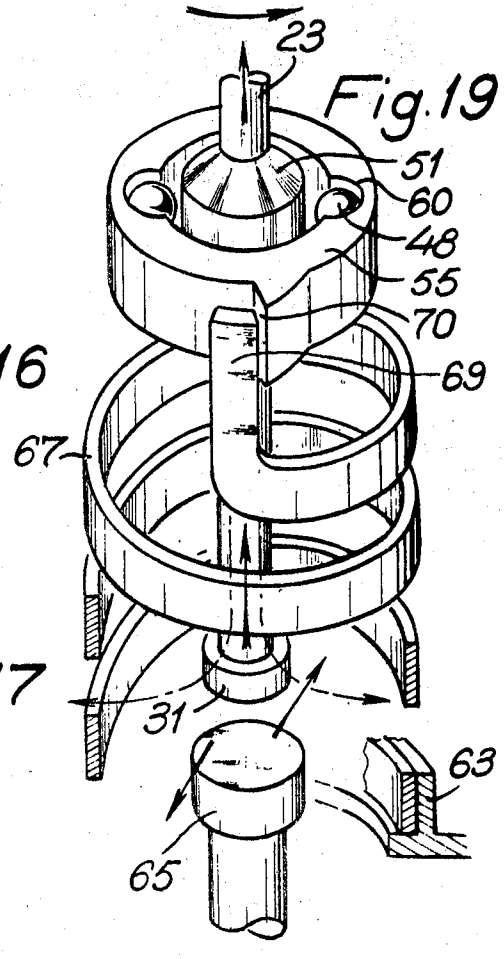


Fig. 19



United States Patent Office

3,538,476

Patented Nov. 3, 1970

3,538,476

LOW-VOLTAGE ELECTRIC CIRCUIT-BREAKER

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Filed Apr. 30, 1969, Ser. No. 820,504

Claims priority, application France, Oct. 2, 1968, 168,411

Int. Cl. H01h 71/16

U.S. Cl. 337—62

10 Claims

ABSTRACT OF THE DISCLOSURE

A circuit-breaker the contacts of which are held together against a countering device urging them into the open position and which includes a travelling-contact operating rod formed with a shoulder having a sloping operative surface, at least one pair of diametrically opposed balls capable of cooperating with said shoulder and, surrounding said balls, a balanced rotary latch formed with a retaining surface for the balls, which hold the circuit-breaker in the make condition, and with notches for receiving said balls clear of said shoulder, in the break position, said latch including actuating means operated by a trip-out factor sensing element against elastic countering means urging the same into the make position.

The present invention relates to a low-voltage electric circuit-breaker which may be of the single-pole or multipole type and the function of which is primarily to provide automatic protection for one or more electric circuits against current overloads exceeding a predetermined nominal value.

The invention relates more particularly to a circuit-breaker which can be moved manually into the make or break position which may be considered also as a current cutout.

Devices of this kind normally include a sensing element responsive to the electrical overload, that operates on a latch mechanism which trips open the electrical contacts in the event of a fault, thus breaking the electric circuit in question.

Also known are devices in which a trip-out responsive to an overload is prevented if a durable force is applied to a manual "make" element, such a circuit-breaker being known as an "interdicted trip-out" type circuit-breaker, whereas in other devices trip-out unrestrained despite the application of such a force.

It is one object of the present invention to provide both these features without notable modification.

It is another object of the invention to make a circuit-breaker impervious to the effect of mechanical stresses, particularly vibration, irrespective of their direction.

It is still another object of the invention to provide simple arc blow-out means in such a circuit-breaker.

The present invention accordingly relates to a circuit-breaker in which the contacts are held together by a balanced latching mechanism which includes a ridged operating rod, at least one pair of diametrically opposed balls capable of cooperating with said ridge, and a balanced rotary latch for restraining and releasing said balls which is associated to actuating means activated by a trip-out factor sensing element, and a corresponding pair of lodgings for receiving said balls in their position clear of said ridge, which lodgings are separated from each other by bearing surfaces for retaining said balls on said ridge.

Preferably, the balls are associated to a guiding cage formed with openings therein inside which the balls remain partly engaged.

In one specific form of embodiment, in addition to the movement which it describes in order to shift said balanced latch, the sensing element responsive to the magnitude of the electric current being conducted generates a magnetic field which cooperates in blowing out the arc produced when the contacts open.

A possible example thereof is an expandable helicoid bimetallic strip arranged coaxially with the direction of motion of the travelling contact and around the latter.

The description which follows with reference to the accompanying non-limitative exemplary drawings will give a clear understanding of how the invention can be carried into practice.

In the drawings:

FIGS. 1 through 8 are perspective showings of various forms of embodiment of a circuit-breaker according to the present invention, notably in respect of the securing method and the connecting method.

FIG. 9 is a longitudinal sectional view of such a circuit-breaker in its tripped or break position.

FIG. 10 is a sectional view of the circuit-breaker in its make position.

FIG. 11 is a sectional view through the line XI—XI of FIG. 9.

FIG. 12 is a sectional view through the line XII—XII of FIG. 10.

FIG. 13 is a sectional view through the line XIII—XIII of FIG. 10.

FIGS. 14 through 17 show alternately in section and in perspective the mutual positions of the actuating rod, the balls, the ball cage and the balanced rotary latch, in the make position and in the break position respectively.

FIG. 18 is a detail view in perspective of the manual control of the balanced rotary latch.

FIG. 19 portrays diagrammatically and in perspective the magnetic effect of the field developed by the overload sensing thermal switch at the location where the breaking arc develops, whereby to blow out the same.

In its forms of embodiment shown in the accompanying drawings, the circuit-breaker includes a longish cylindrical body **1** from which projects a central make-button **2** surrounded by a bush **3** formed with a flange **4** that constitutes a break member likewise protruding from the body. FIG. 1 shows the break position in which button **2** protrudes considerably, while FIG. 2 shows the make position in which button **2** remains depressed and projects only very slightly above flange **4**.

As shown in FIG. 3, the body **1** is formed at the button end with a threaded reduced portion **5** projecting above a shoulder, whereby to enable the body to be secured in a panel hole by means of a nut **7**.

The body **1** may alternatively be formed with a further reduced portion **8** at its base to allow it to be fixed in a projecting position to the bottom of a housing, for example.

Other alternative securing methods are possible, notably by providing a base-plate **9** beneath the body **1** in order to enable the latter to be secured by screws **10** to a distributor rail **11** formed to that end with tapped holes **12** and with an intermediate hole **13** for passage therethrough of the insulating sheath **14** of a conductor terminating in a bush which engages over a central pin **15**, which pin forms one of the poles and the base-plate **9** the other.

FIG. 6 shows another embodiment which comprises brackets **16** on to which connecting taps **18** are secured by screws **17** and associated washers.

In FIG. 7 the connections are made by means of soldering terminals **19**.

Lastly, FIG. 8 shows a junction method utilizing a coaxial connector **20** provided with a knurled thumbscrew **21** adapted to cooperate with a bush and pin unit

22 at the base of body 1, the thumbscrew cooperating with the threaded portion 8*a* of said base.

In all cases the electrical connections and the insulations between poles and conductors external to the circuit-breaker are provided by any convenient means.

The embodiments shown in FIGS. 9 through 13 are similar in configuration to that of FIG. 5, and these figures depict the internal mechanism of the device. The circuit-breaker portrayed in the figures is of the free-tripping type, i.e. in which opening of the contact in the event of an overload is possible and effective even if the button 2 is kept depressed manually.

The button 2 can be made rigid with a central rod 23 through the cooperation, inside a blind hole formed in button 2, of a head-fitting 24 formed with a diametrical passage therethrough into which are inserted two balls 25 with a spring 26 therebetween. These balls are urged by spring 26 into a groove 27 formed within button 2, with the upper face of the groove bearing against said balls, over a substantially diametrical plane thereof.

The other end of rod 23 is formed with a housing for a contact-pressure spring 28 which reacts against the head of an insulating rod 29 slidably mounted in the housing of spring 28 and restrained therein by a keeper ring 30. The projecting end of rod 29 carries a travelling contact 31, and this compound forms the travelling pin of the circuit-breaker.

Button 2 is formed with a skirt 32 the bottom of which is formed with a catch portion 33. Skirt 32 is engaged into a guideway 34 on to the end of which is screwed bush 3 with flange 4. At the point where guideway 34 joins on to a reinforcement 35 which terminates it are recesses 36*a* which permit projection into said guideway and retention in position of an elastic ring 36 for temporarily restraining the catch portion 33 of button skirt 32, which portion, in its opposite position, is positively arrested against a shoulder 37 formed on the guideway.

A spring 38 is interposed between a shoulder 39 formed within button 2, beneath groove 27, and a shoulder 40 formed on a cage 41 to be described hereinafter. Spring 38 surrounds a break sleeve 42 the upper edge of which is formed with a bevel 43 capable of reaching the balls 25 by passing between the skirt 32 (with its base on the hollow portion of button 2, beneath the rectangular groove 27) and the edge of head 24.

Another spring 44 is interposed between head 24 and shoulder 40, but its reaction surface is within sleeve 42.

A third spring 45 is interposed between terminal shoulder 46 of threaded portion 5 of body 1 and the shoulder adjacent recesses 36, between guiding sleeve 34 and reinforcement 35.

Through the medium of matching splines 57*a*, reinforcement 35 cooperates with the said cage 41 of latching balls 48 assembled in diametrical pairs in associated housings 49.

At its top, cage 41 is bounded by a frusto-conical shoulder 50 formed with a passageway therethrough for rod 23 and against which bears a matching frusto-conical shoulder 51 which bounds the rod 23 and the reinforcement 52 forming the housing of spring 28, which reinforcement passes freely through cage 41.

Cage 41 comprises a threaded base 53 having an abutment rim, and this base is screwed into a suitably tapped reinforced portion 54 of the inside wall of body 1.

Cage 41 is surrounded by the reinforcement 35, and the latter is in turn surrounded by a cylindrical latch 55 the end section of which rests upon the bottom of base 53.

Externally, the other end of the latch 55 is formed with a head 56 opposite a corresponding shoulder on body 1. Latch 55 and reinforcement 35 of guiding sleeve 34 cooperate through the medium of associated helicoid ramps 57 (see also FIG. 18).

A return torsion spring 58 is interposed between the bottom 53 (to which the spring is fastened) and the head 56 (to which the spring is also fastened) whereby to tend to rotate latch 55 back into a latching position to be referred to hereinafter.

Internally latch 55 is formed on its cylindrical surface 59 with cylinder-sector shaped recesses 60 adapted to receive the balls 48 and thereby permit full disengagement of shoulder 51 on reinforcement 52.

Inside body 1, beneath the base 53, is an insulating sleeve 61 formed with a grove 62 into which the edge of body 1 is set without extending beyond the bottom of the groove. The bottom of sleeve 61 has set thereinto a threaded bush 63 on to which is secured the conducting base-plate 9 with interposed washers and suitable leak-profing between the various screwed parts. Internally, bush 63 receives a cup 64 at the bottom of which is a fixed contact 65 electrically connected to an axial connecting pin 66, said cup being made of insulating material.

A bi-metallic strip 67 rolled into a cylindrical coil is wound around the periphery of cup 64 and has one end electrically connected to bush 63 which is in turn connected to base 9, the free other end of bi-metallic strip 67 being electrically connected through a conductive flexible braid 68 to travelling contact 31.

This free end of the bi-metallic strip forms a hook 69 capable of cooperating with a tang 70 made of insulating material and set into a corresponding recess in latch 55, and this tang penetrates into the end section of the latch and passes through a notch in the bottom 53, the edges of said notch forming stops for the two directions of motion of latch 55.

A groove and tongue arrangement 71 prevents rotation between insulating sheath 61 and the base 23 which is securely screwed into body 1.

The electric circuit which is established passes through the pin 66 and the fixed contact 65 on the one hand, then through the travelling contact stud 31, the braid 68, the bi-metalic strip 67, the bush 63 and the base 9, on the other.

The theory of operation of a circuit-breaker as hereinbefore described is as follows:

Starting with the open position of the contact shown in FIG. 9, if button 2 is then depressed, retention of the balls 25 in groove 27 causes rod 23 to be moved. The locking balls 48 are lodged partly in the notches 60. Inward movement of button 2 is continued until stud 31 meets fixed contact 65, the contact pressure being provided by the compression of spring 28.

In this configuration the locking balls 48 are free to move towards rod 23 by moving on to frusto-conical shoulder 51, and in this position the balanced rotary latch 55 can rotate responsively to spring 58 and move from the position shown in FIG. 11 to that shown in FIG. 12 As shown in FIG. 10, the balls 48 are kept proximate the rod 23 and prevent it from retracting, being then retained on the cylindrical inner surface of latch 55.

As button 2 is depressed further still, the catch 33 passes beneath the ring 36, which then holds button 2 in its depressed position (being required to overcome the compression of spring 38 only).

Prior to completion of the inward travel of button 2, balls 25 will have cooperated with the bevel 43 on the break sleeve 42 and will thus have left the groove 27 and be held closely together, with attendant compression of spring 26, within the internal bore of button 2. This disengages rod 23 from button 2, causing it to rise and to be arrested solely by the balls 48 resting against shoulder 51.

Should an electrical overload occur, bi-metallic strip 67 will undergo expansion by the Joule effect, causing its terminal hook 69 to meet the tang 70 and to make the latter rotate balanced rotary latch 55 against its countering spring 58. When this rotation causes the notches 60 to register with the passages 49, the slight

conicity of shoulder **51** drives the balls **48** into notches **60**, thereby freeing the rod and causing it to move outwards once more through relaxation of spring **28** in conjunction with relaxation of spring **44**. When the head **24** contacts the bottom of the bore in button **2**, the catch **33** beneath ring **36** gives way and, responsively to spring **38**, button **2** emerges once more from bush **3** until it is positively arrested when the catch **33** abuts against shoulder **37**, as shown in FIG. 9, whereupon the balls **25** cooperate once more with the groove **27** through the frusto-conical shoulder **51** meeting the corresponding shoulder **50** on cage **41**.

Manifestly, any pressure tending to maintain button **2** depressed will not prevent the circuit from being opened by reason of the freedom of travel now possessed by the head **24** in button **2**, balls **25** being then clear of groove **27** and encountering no obstruction.

Protrusion of button **2** further more indicates opening of the contacts.

Preparation for a fresh trip-in manoeuvre requires relieving the pressure on button **2** and a retraction of the latter in order to re-set the balls **25** in groove **27**.

In this situation the action of spring **44** is added to that of spring **38** so as to cause the catch **33** to disengage from ring **36**.

The latching effects are illustrated separately and more schematically, in perspective and in sectional view respectively, on FIGS. 14 through 17.

Starting from the make position shown in FIG. 10, if it is desired to deliberately open the circuit all that is necessary is to pull back bush **3** by gripping flange **4**. This action compresses spring **45** and causes head **35** to be guided by facing straight splines **57***a* formed in the head **41** of break sleeve **42** and in the reinforcement **35** of guiding sleeve **34**, thereby producing a rotation of latch **55** through the agency of helicoid ramps **57**. At the same time the balls **48** are released as a result of penetrating into the notches **60** in said latch when the latter has rotated sufficiently, and the effect on the rod is then identical to that hereinabove described in respect of trip-out obtained with the bi-metallic strip. FIG. 18 shows diagrammatically how the trip-out bush or button **3** cooperates with latch **55**.

It should be noted that the conjugate helicoid ramps **57** have sufficient clearance therebetween to permit rotation of the latch in response to the bi-metallic strip when button **3** is inoperative. Contact against one of the side of these ramps is obtained by the action of spring **58**, which takes up all play in the operation of button **3**, since the operative sides of ramps **57** are used when a pull is exerted on button **3**, so that response to such a pull is immediate.

It should likewise be noted that bi-metallic strip **67** is disposed after the fashion of a solenoid developing an axial field under the effect of the current flowing through it, and this field remains when the travelling and fixed contacts **31** and **65** separate, so long as the breaking are subsists. The effect of this field on the conductive ionized channels formed by the arc causes the same to distend radially, resulting in powerful and instant blowing out of the arc. The arrows in FIG. 19 depict these effects.

It will readily be appreciated that the above arrangements permit compact and lightweight construction offering great flexibility of utilization for a single type of core design, that the contacts can be placed in a sealed chamber in a gaseous atmosphere if need be, and that the latching mechanism is impervious to mechanical effects, notably vibration, for since the latch **55** is balanced it is unaffected by transverse vibration, and longitudinal vibration has no effect on it either. Being captive when latched, the balls **48** cannot be affected by longitudinal vibration, the more so since the angle subtended by the frusto-conical shoulder **51** can be very shallow, this angle being set, as a function of the desired response sensitivity in opening of the contacts upon release, to determine the magnitude of the radial forces on the balls **48** when this occurs.

In the case of torsional vibration, moreover, the fact that latch **55** is balanced, together with the diametrical arrangement of the balls, cause this to remain without effect.

The device hereinbefore described is a free-tripping circuit-breaker. Using the same component parts, however, it is possible to devise an interdicted trip-out type circuit-breaker by eliminating the direct tie between rod **23** and button **2**, notably by eliminating the ring **36**, either of springs **38** or **44**, the head **24** and its balls **25**, and possibly also the sleeve **42**, provided that the springs have no tendency to warp.

Further, whereas the arrangements hereinbefore described relate to a single-pole circuit-breaker, the same components can clearly be used for a multi-pole circuit-breaker dependent on a single operating and latching system for all the poles, with each pole nevertheless remaining dependent on its own individual sensor, said sensors cooperating to act upon a single balanced latch so that a fault on any of the circuits should dependably result in all the circuits being opened.

It is furthermore manifest that changes could be made to the specific forms of embodiment described hereinabove, notably in respect of the trip-out triggering sensor, it being possible for such sensors to be responsive to factors other than the intensity of the current flowing, or to have a response mode other than heating by the Joule effect (for instance, by generating a magnetic effect), the only requirement being that the sensors be capable of causing a rotation of the balanced rotary latch in order to cause trip-out. In addition, the longish cylindrical body of the breaker may have any other convenient shape, or several pairs of latching balls could be used, or the major part of the components could be obtained otherwise than by turning operations.

With regard to the bi-metallic strip, the latter may be compensated or not and may utilize direct heating, as stated above, or indirect heating if necessary.

The blow-out field could furthermore be channelled by an appropriate magnetic circuit.

In order to facilitate adjustments, rotationwise clamping means may be provided between the bi-metallic strip and its attachment point.

The leaktightness of the contacts' envelope can be reinforced in respect of atmospheric or celestial space factors by means of at least one deformable wall such as bellows (depicted schematically at **31***a* in FIG. 9), which may be of the metallic variety with the necessary insulation being provided at the joints by means of glass or ceramic bonds.

What we claim is:

1. In a circuit-breaker having its contacts maintained abutting by latching means against countering means urging said contacts into the open position when said latching means are released, in combination, a pusher member, at least one travelling contact bearing rod mechanically connected to said pusher member, a shoulder on said rod formed with an operative surface inclined to the axis of said rod, at least one pair of balls on opposite sides of said rod apadted to cooperate mechanically with said operative surface in a first latching position wherein said contacts abut and to release said shoulder in a second position wherein said contacts are open, a balanced rotary latch surrounding said balls and said rod, thrust surfaces for said balls within said latch, notches for receiving said balls between said thrust surfaces, means for restoring the latch to said first position wherein the balls are restrained by said thrust surfaces, and a trip-out factor sensing means mechanically connected to said latch for moving the same towards said second position wherein said balls are engaged in said notches.

2. In a circuit-breaker as claimed in claim **1**, a fixed

cage for guiding said balls interposed between said latch and said rod proximate said shoulder.

3. In a circuit-breaker as claimed in claim 2, externally accessible actuating means operating through rotation of said latch and mechanically connected thereto for moving the same into said second position wherein said balls are engaged in said notches.

4. In a circuit-breaker as claimed in claim 3, latch actuating means formed by a bush, a pusher member formed by a button extending coaxially through said bush, and an outward bulge on said bush for exerting a manual pulling force thereon.

5. In a circuit-breaker as claimed in claim 1, sensing means for generating a directed magnetic field proximate said travelling contact, said magnetic field being used for blowing out the arc produced by the motion of said travelling contact.

6. In a circuit-breaker as claimed in claim 5, a sensing element formed by a bi-metallic strip shaped as a solenoid co-extensive with the path of travel of said travelling contact and crossed by the current flowing in a circuit established through operation of said contacts.

7. In a circuit-breaker as claimed in claim 1, a direct mechanical connection between said pusher member and said rod.

8. In a circuit-breaker as claimed in claim 1, a mechanical connection between said pusher member and said rod comprising retractable interconnecting means associated to release means rendered operative when said pusher member is pushed fully home.

9. In a circuit-breaker as claimed in claim 1, an enveloping housing of long cylindrical shape, a pusher member, a rod, a rotary latch and a travelling contact arranged coaxially within said housing.

10. In a circuit-breaker as claimed in claim 1, a flexible leaktight wall enveloping said contacts.

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U.S. Cl. X.R.

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