June 28, 1960 D. C. MILLS 2,943,168

CIRCUIT BREAKERS

Filed Sept. 16, 1957 4 Sheets-Sheet 1

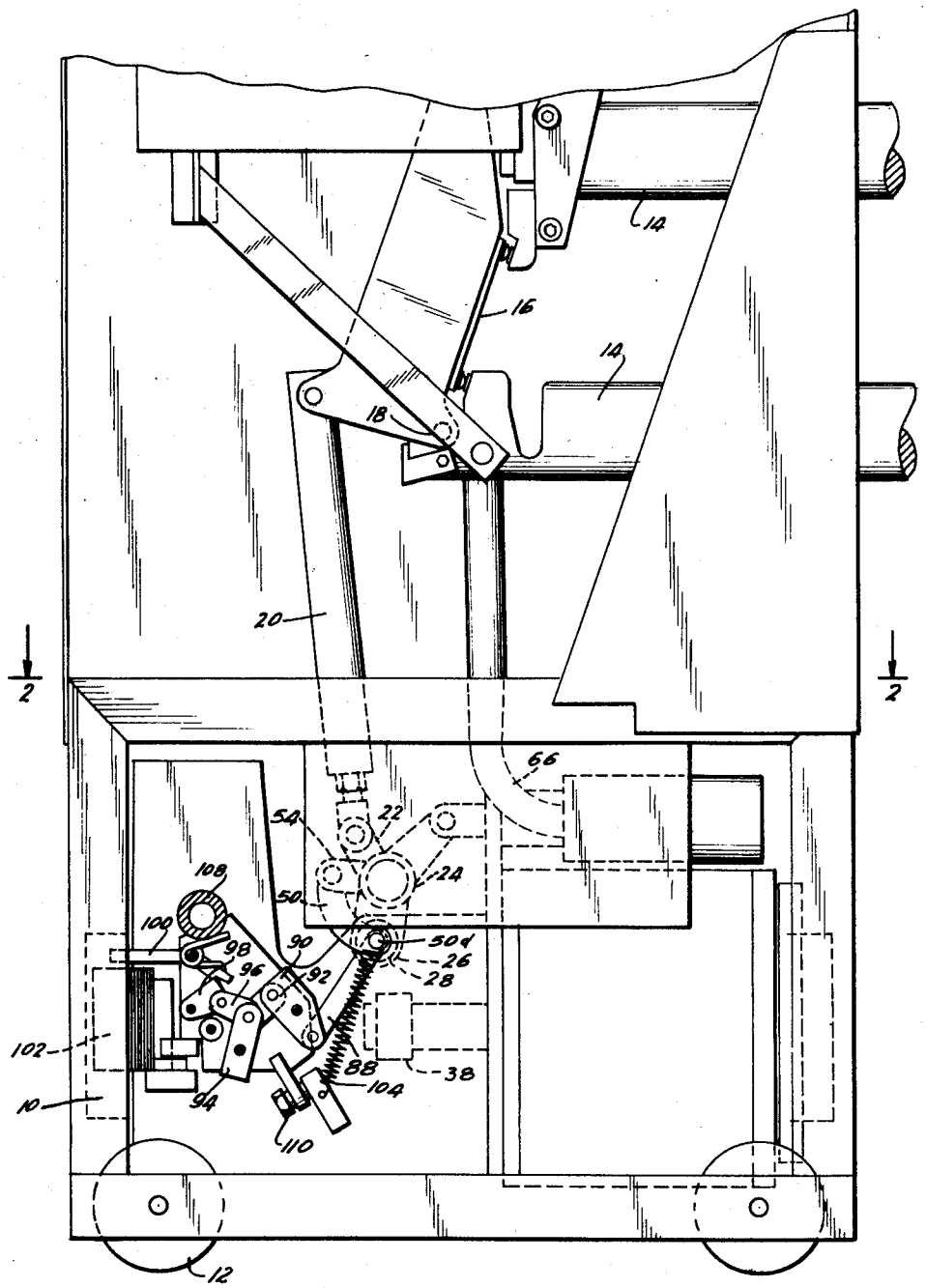


FIG. 1

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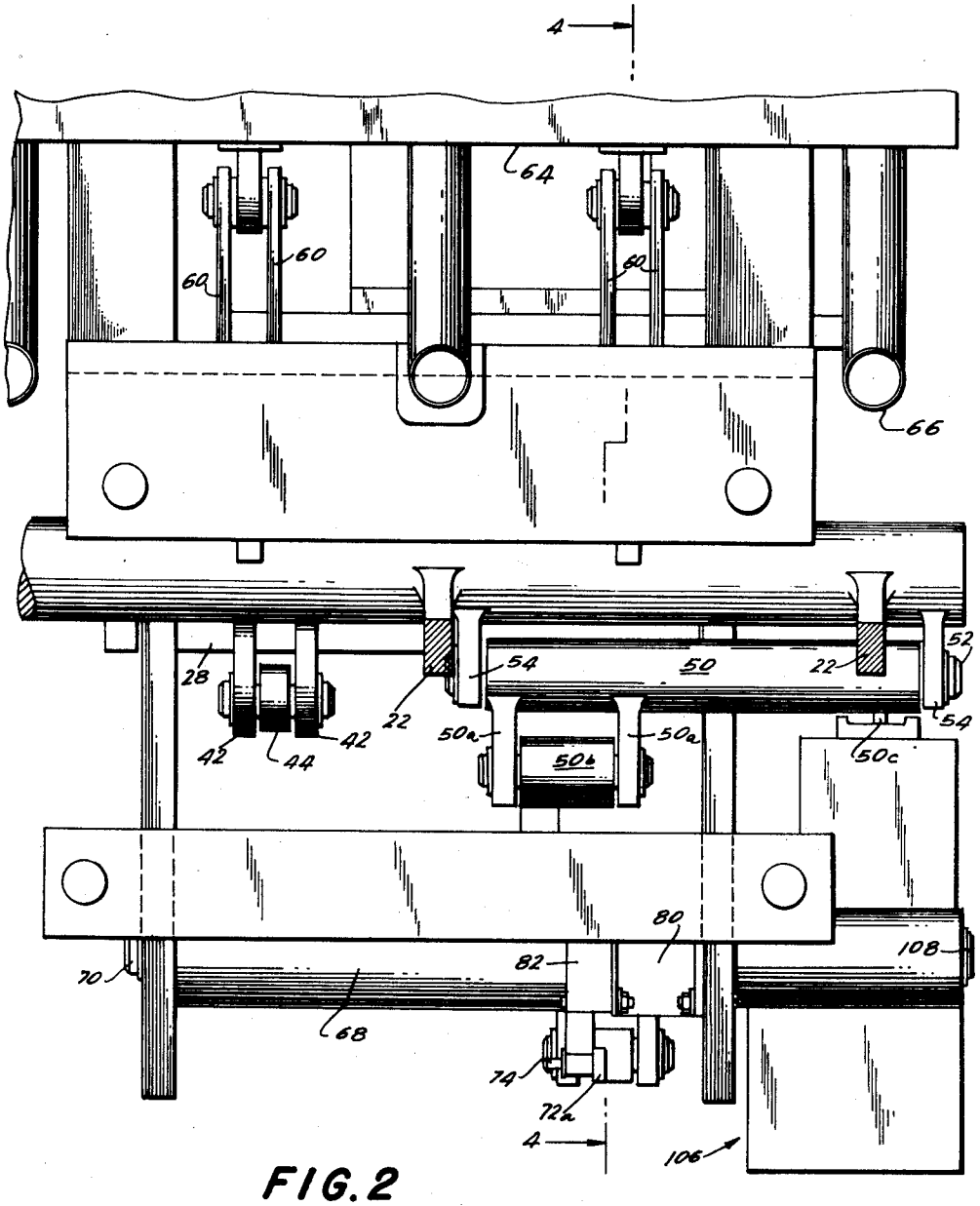


FIG. 2

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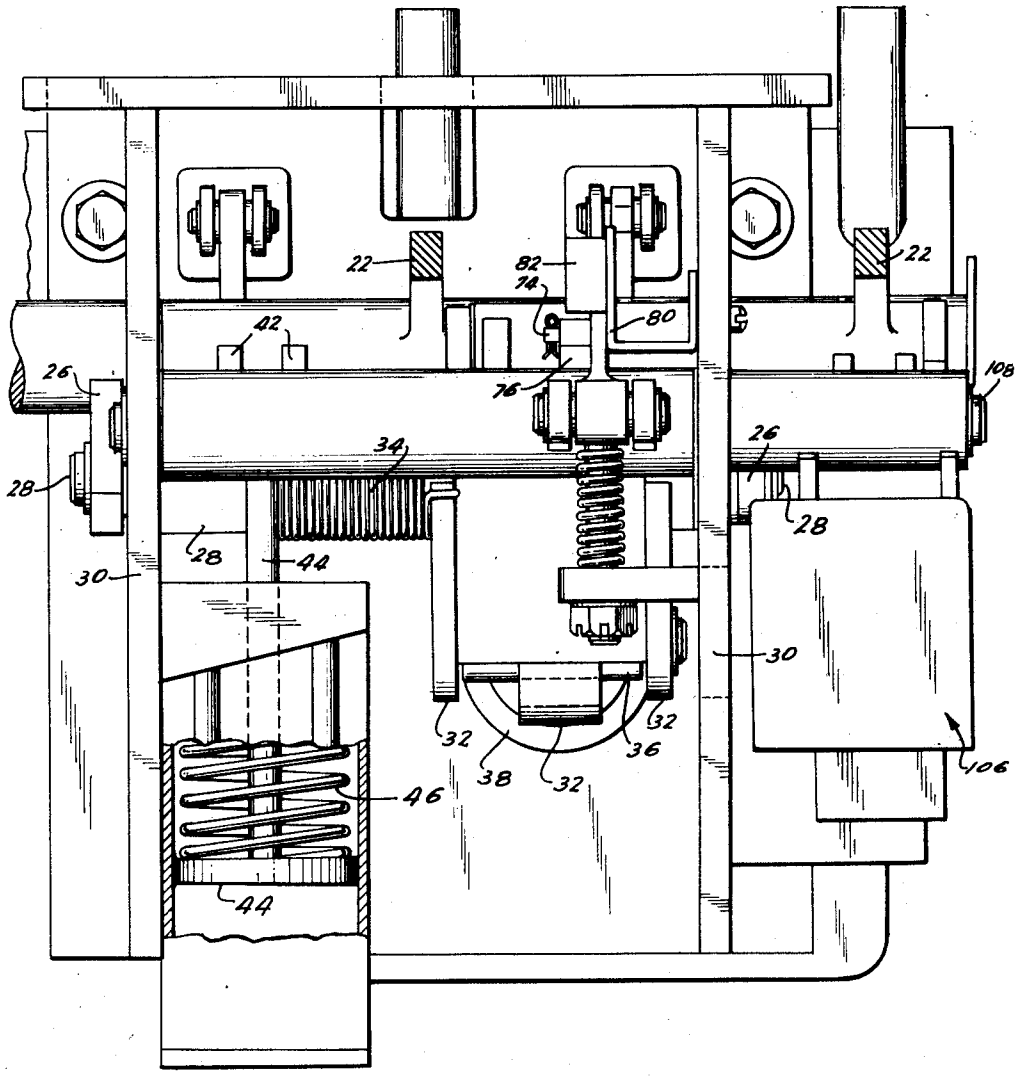


FIG. 3

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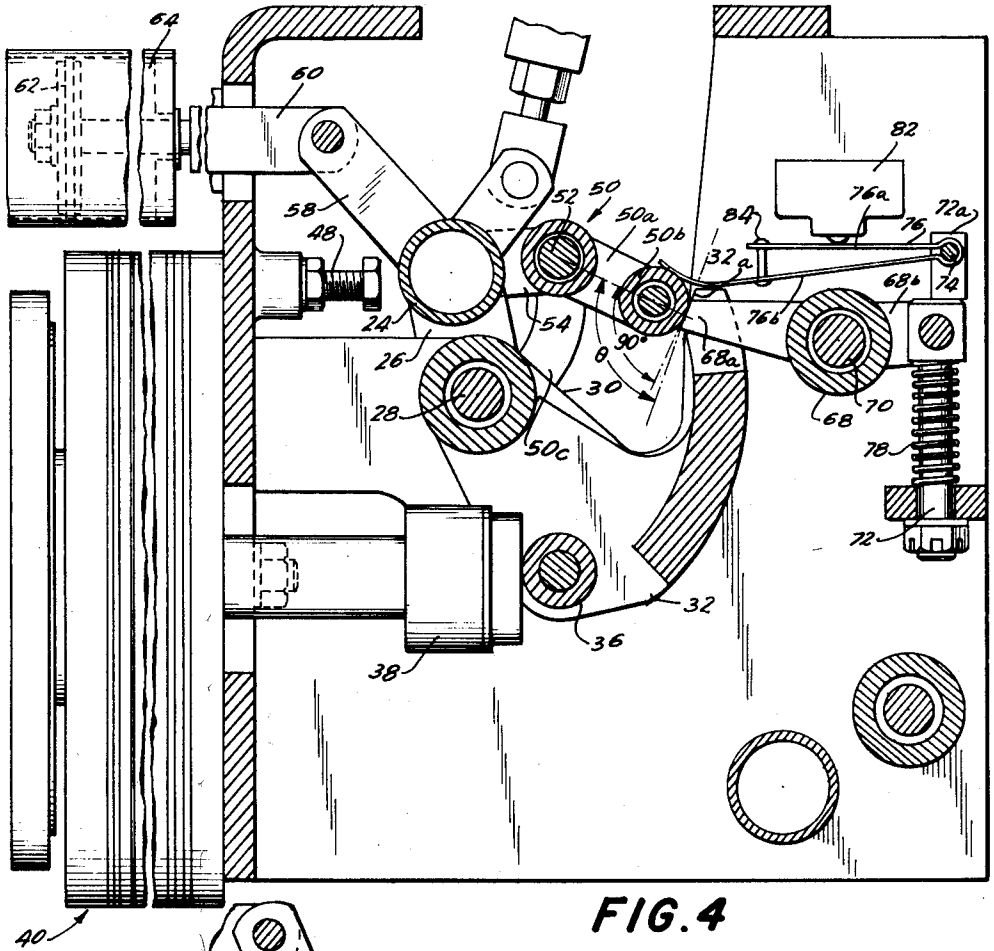


FIG. 4

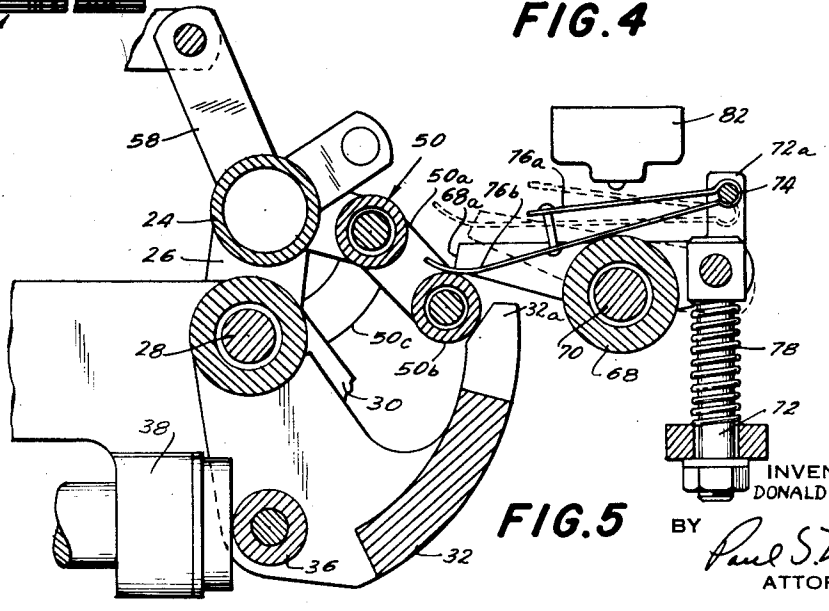


FIG. 5

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2,943,168

CIRCUIT BREAKERS

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15 Claims. (Cl. 200—87)

The present invention relates to means for operating and releasing the contacts of a circuit breaker, particularly of the heavy types used in metalclad switchgear.

An object of the present invention is to provide a novel trip-free operating mechanism for circuit breakers. A related object is the provision of a trip-free operating mechanism having a solenoid operator and in which a novel control for the solenoid is incorporated in the circuit breaker operating mechanism.

The illustrative embodiment of the invention will be seen to include a mechanism for operating the movable contact in a closing stroke, under drive impetus supplied by a solenoid or the like, this mechanism including a driving member, a driven member, and a controlled latch coupling the driving and driven members to each other. The driving and driven members are coaxial and the coupling latch has a controlled arm having a control link pivoted thereto at the common axis of the driving and driven members. The linkage which controls the coupling latch is unaffected by the closing operation of the contact-operating linkage because of the described coaxial relationship. Further, the coupling latch, in providing the coupling between the driving and driven members, is biased in a direction to supply the energy for the latching mechanism, which therefore needs only to be released for opening of the contacts to follow.

In the illustrative embodiment described below, the closing thrust of the solenoid must overcome the force represented by build-up of the contact pressure, and by the increasing storage of energy in a contact-opening spring, as well as the tension of a spring forming part of the external control for controlling the foregoing coupling latch mechanism. This latter spring acts to restore the latching mechanism to its normal condition that prevails before tripping occurs. Where a solenoid supplies the necessary driving effort for operating the contacts, it is important that this thrust should be available for as long as is required to complete the closing operation of the mechanism. When this is accomplished a prop moves into position to latch the operating mechanism "closed," and at that instant it is desirable for the solenoid to become deenergized. The solenoid should not continue to be energized beyond that point at which the contact-closing mechanism is fully operated both because of the heat-dissipation limitations of the solenoid itself and of its power supply, and because of the possibility of overcentering of any toggles included in the contact-operating linkage, as well as to avoid any mechanical blows that would result from striking of any mechanical limiting stop. A feature of this invention resides in the utilization of the contact closing linkage for operating a solenoid-control switch at the critical time when the solenoid should be deenergized, that is, at the time when the prop latches the contact mechanism in its "closed" configuration.

The illustrative embodiment of the invention, which has been outlined above as incorporating certain novel features forming part of the invention, is more fully described in the remainder of this specification, from which further novel features and objects and advantages will become apparent. In the following description reference is made to the accompanying drawings forming part of this disclosure, in which drawings:

Fig. 1 is a side view, with portions removed for clarity, of a circuit breaker embodying the various aspects of the invention;

Fig. 2 is a fragmentary plan view along the line 2—2 of Fig. 1;

Fig. 3 is a front elevation of the apparatus appearing in Fig. 2;

Fig. 4 is a cross-section along the line 4—4 of Fig. 2; and

Fig. 5 is a detail view of the mechanism in Fig. 4 in another operative configuration thereof, portions of the mechanism in Fig. 5 being shown in dotted lines in a still further operative position thereof.

Referring now to the drawings, a frame 10 is shown having typical wheels 12 of drawout switchgear. Frame 10 carries main conductors 14 that are bridged by the moving contact unit 16 having a pivotal mounting 18. A link 20, pivoted to contact unit 16 and having its lower end pivoted to an arm 22 on a bar 24, is vertically reciprocated for swinging the contact assembly 16 between closed and open position, and reversely. As shown in Figs. 2 and 3, there are three sets of contacts and three operating links 20 and three arms 22 carried by a common bar.

Bar 24 is rigidly carried by a pair of arms 26 that swing about end extensions of a main shaft 28 in fixed frame members 30. Bar 24 is part of a multi-armed driven member which is operated by a driving member 32 on shaft 28, the driving and driven members thus having coaxial pivots. Torsion spring 34 (Fig. 3) biases member 32 clockwise as viewed in Fig. 4, thus maintaining an anti-friction roller 36 carried by driving member 32 in engagement with the head 38 of the operating solenoid 40. All of the parts, including the solenoid, the driven member 24 and the driving member 32 are illustrated in Figs. 1 to 4 in the position they assume at the instant when the solenoid is at the extreme end of its contact-closing stroke. Immediately after completion of this stroke the solenoid is deenergized in a manner to be described and members 32 and 38 are withdrawn, to the left in Fig. 4.

A pair of arms 42 (Figs. 2 and 3) extend from bar 24, for applying contact-opening bias of compression spring 46 via link 44 to bar 24. This spring tends to operate bar 24 on its supporting arms 26 in the direction to open the contacts; and the operation of the contact-closing linkage by solenoid 40 overcomes this bias and compresses the spring so as to be in condition to open the contacts upon release.

The contact closing mechanism includes a toggle that is very nearly straight at the time that the contacts are closed. One link is found in the unit 22—24—26 which is joined, at the knee of the toggle, to the links 20 of the three poles. It is important that this toggle should not be over-centered and in order to prevent this an adjustable mechanical limit stop 48 is provided. The solenoid conceivably might continue energized beyond the critical moment of completion of the contact-closing stroke. In that event bar 24 would strike stop 48. However, as will be seen, even this limited excess travel of the operated member 22—24—26 is avoided by precisely timed deenergization of the solenoid.

Driving member 32 and driven member 24 are coupled to each other by a latch 50 having an arm 50*a* that bears a roller 50*b*. Latch 50 also has an arm 50*c* that is pro-

vided (see Fig. 1) with a pivot 50*d* that is coaxial with shaft 28 and with the axes of the driving member 32 and the driven member 24.

Roller 50*b* of the drive-coupling latch 50 engages a slant face 32*a* of the driving member 32. Member 50 is carried by driven member 24—26—54 that is biased by spring 46 in the direction to resist this drive. The driving face 32*a* is at such an angle (Fig. 4) to arm 50*a* as to bias member 50 in the clockwise direction about the pivot 52 on arm 54 carried by bar 24. In Fig. 2 roller 50*b* and arms 50*a* are seen at the left side of member 50, while arm 50*c*, only a portion of which shows in Fig. 2, appears near the extreme right side of member 50.

The operation of the operating linkage may now be described. It is accepted that pivot 50*d* is restrained by a control mechanism to be described.

The energizatiton of the solenoid 40 projects its operating head 38 to the right, thereby operating the driving member 32 counterclockwise, as viewed in Fig. 4. Engagement of surface 32*a* against roller 50*b* transmits counterclockwise driving thrust for member 24 (via arms 50 and 54) about the pivotal axis of shaft 28. This same driving thrust of member 32 causes arm 50*a* to be biased about its pivot 52 in the clockwise direction (Fig. 4) but such motion is prevented by restraint of pivot 50*d* (Fig. 1) as detailed below. Operating of member 24 operates the links 20 in the contact closing direction and compresses contact-opening spring 46. Additionally, by means of arms 58 projecting from bar 24 and links 60 connected thereto, the single piston 62 of a "puffer" 64 is given a driving stroke. This develops a volume of compressed air that is delivered by three tubes 66 to the region of the contacts, in order to interrupt low-current arcs.

In order to hold the mechanism that operates the contacts in the closed-contact position represented in Fig. 4, after members 32 and 38 are withdrawn by spring 34 and by the internal spring of the solenoid, the following mechanism is provided. A prop 68 is carried pivotally on shaft 70 having an arm formed with a slant face 68*a*, the same slant angle in relation to arm 50*a* of the latch 50 as previously described for surface 32*a*. Thus, latch 50 is biased in the release direction by action of the contact-opening spring 46 both before deenergization of the operating solenoid at which time driver 32 acts on roll 50*b* and after deenergization of the solenoid at which time prop 68 furnishes like reaction.

A rod 72, pivoted to an arm 68*b* of prop 68 has an upstanding projection 72*a* carrying a pin 74. A leaf spring 76 having two arms 76*a* and 76*b* is pivoted on pin 74 (see Figs. 2 to 5). Compression spring 78 biases prop 68 counterclockwise as viewed in Figs. 4 and 5.

A mounting bracket 80 (Figs. 2 and 3) carries a solenoid-control switch 82 of the snap-acting type, operated by arm 76*a* of the leaf-spring member 76. The two arms of the leaf spring have a double headed rod 84 that confine the arms to a maximum degree of separation. These arms are biased to separate much farther than that and therefore they are restrained under a substantial initial bias. Lifting of the lower arm 76*b* of the member 76 against switch 82 applies a very substantial pressure against the button of switch 82 right from the start. Nevertheless the elevation of lower member 76*b* beyond the limit of operation of switch 82 results only in arm 76*b* approaching the arrested arm 76*a* with no resulting damage to the switch.

The operation of this mechanism may now be described in reference particularly to Fig. 5. In that figure the solenoid has only approached its extreme operating limit of Fig. 4, arm 50*a* being in its partially raised condition and being engaged by leaf-spring arm 76*b*. Prop 68 has also been engaged by the roller 50*b* of the latch. Continued operation of member 32 counterclockwise raises arm 76*b* and it also swings members 68 and 76 into the dotted-line position indicated.

In the solid-line configuration of the parts in Fig. 5, switch 82 is in its unoperated condition. When the parts shift to their dotted-line positions, the shaft 74 lowered so that, even though the left-hand extremity of arm 76*b* is elevated, member 76 as a unit is tilted about the operating button of switch 82.

Ultimately, when member 50 has ben lifted to that critical position which indicates the operating linkage of the contact-closing mechanism is in its full contacts-closed configuration, prop 68 drops into latching position in relation to roller 50*b* as represented in Fig. 4. At this instant, the left-hand end of member 76 being lifted by roller 50*b* and the right-hand extremity being lifted by pin 74, switch 82 is operated. By any convenient wiring detail, not illustrated, solenoid 40 is deenergized at this instant and members 32 and 38 are allowed to return under spring impetus. Suitably switch 82 may be closed to operate a relay having contacts that open to break a series circuit from a D.-C. source to the solenoid. When this occurs solenoid head 38 and drive member 32 retract while prop 68 holds the contact operating linkage "closed."

It was mentioned earlier that pin or shaft 50*d* is restrained, when the mechanism is latched so as to be coaxial with shaft 28. This evidently allows member 50 to move as a unit with member 24 that also has its pivot coaxial with shaft 28 without disturbing the linkage which restrains pin 50*d* in that fixed position.

The latching linkage that controls pin 50*d* includes a link 88 (Fig. 1) that operates on a member 90 having a fixed pivot at its center. At the opposite end of member 90 a link 92 forming one part of a toggle, the other link 94 of the toggle having a fixed lower pivot. The knee of the toggle 92—94 carries a further link 96 as one part of a second toggle, the other part 98 of which is restrained against buckling by the latching arm of an armature 100 operated by electromagnet 102.

Member 50 tends to be operated in the clockwise direction in Fig. 4 by virtue of the pressure that drives it against the slant surfaces of members 32 and 68. This is counterclockwise bias as viewed in Fig. 1. Member 88 is accordingly tensioned, link 90 is biased counterclockwise, and toggle 92—94 tends to collapse. This is restrained by the toggle 96—98 which, itself tending to collapse, is biased against armature-latch 100. When this armature is attracted, the entire linkage thus described releases member 50 and the circuit breaker is released. Spring 46 becomes effective to drive the entire mechanism in the contact-opening direction. When this occurs, a tension spring 104 reverses the operation of the latching linkage just described for latching pivot 50*d* of member 50. Subsequently, when the circuit breaker is being closed by the solenoid 40, the thrust applied by spring 104 is reversed by the bias applied to member 50 and member 88 is again in tension. One of the forces developed by the operating solenoid 40, accordingly, is to tension spring 104 which resets the latching mechanism.

The latching mechanism is generally indicated in Figs. 2 and 3 by the arrow and numeral 106. This mechanism is carried on a pivot 108, the entire latching mechanism being fixed in adjusted position as a unit by bolt 110 for properly orienting member 50*d* at the axis of shaft 28.

While there has been disclosed above an exemplary embodiment of the invention which is presently preferred, nevertheless it will be apparent to those skilled in the art that various modifications and varied applications may be made of the novel features; and consequently the invention should be broadly construed in accordance with its full spirit and scope.

What is claimed is:

1. A circuit breaker having a contact-operating linkage including spring means biasing said linkage in the opening direction, a pivoted member forming part of said linkage, a releasable element pivoted to said pivoted member and having two arms including a coupling arm and a control arm, a control linkage normally engaging a part

of said control arm at the pivotal axis of said pivoted member and restraining said part of said control arm from displacement from said axis and thereby establishing a normal relationship between said pivoted member and the releasable element pivoted thereto, and means providing a slant reaction surface for engagement by said coupling arm effective to transmit spring bias for said spring means tending to operate said two-armed member away from said normal relationship, thereby to operate said releasable element out of said normal relationship when said control linkage releases its said restraint.

2. A circuit breaker having a contact-operating linkage including spring means biasing said linkage in the opening direction, a pivoted driven member forming part of said linkage, a drive member pivoted coaxially with said driven member, a releasable drive coupling element pivoted to said driven member and having a drive-coupling arm and a control arm, said drive member having a slant bearing surface engaged by said drive-coupling arm, said bearing surface being disposed at a small angle relative to the tangent at the point of contact of said drive-coupling arm to a circle about the pivot of the coupling element, a prop also engageable with said drive-coupling arm when the circuit breaker contacts have been closed and said prop having a similarly slanted bearing surface, said prop acting via said drive-coupling arm to retain the linkage in its contacts-closed configuration, and release means normally acting on the other arm of said coupling element to retain said drive-coupling arm in engagement with one of said bearing surfaces during and after closing operation of said linkage.

3. A circuit breaker having a contact-operating linkage including a pivoted driven member, a driving member pivoted coaxially therewith, a releasable drive coupling element pivoted to one of said members and having a portion engaging a surface on the other of said members, the engaged surface being slanted to bias the coupling element about its pivot, and release means engaging a part of said coupling element on the axis of said driving and driven members and effective for normally retaining said element and the member to which it is pivoted in a predetermined drive-coupling relation during the contact-closing operation of said driving and driven members.

4. A circuit breaker having a contact-operating linkage including a pivoted driven member, a driving member pivoted coaxially therewith, a releasable drive coupling element pivoted to one of said members and having a roller engaging a surface on the other of said members, the engaged surface being slanted to bias the coupling element about its pivot, and release means normally retaining said element in drive-coupling relation.

5. A circuit breaker having a contact-operating linkage including spring means biasing said linkage in the opening direction, a pivoted driven member, a drive member pivoted coaxially with said driven member, a two-armed releasable drive coupling element pivoted to said driven member and having a roller on an arm thereof, said drive member having a slant bearing surface engaged by said roller, said bearing surface being slanted at a small angle relative to the tangent at said roller to a circle about the pivotal axis of the coupling element, a prop also engageable with said roller when the circuit breaker has been closed and having a similarly slanted bearing surface, said prop normally acting via said coupling element and after closing operation of the linkage to retain the linkage in its contacts-closed configuration, and release means normally acting on the other arm of said coupling member to retain said roller in engagement with one of said bearing surfaces during and after closing operation of said linkage.

6. A circuit breaker having a contact-operating linkage including a spring biasing the linkage in the contact opening direction, a pivoted driven member, and control means for the driven member, said control means

including a latch pivoted to the driven member with the pivotal axes of said latch and said member separated from each other, a driving member operable about the axis of the driven member and engageable with said latch to drive the linkage in the contact-closing direction, a prop engageable with said latch to restrain the contact-operating linkage in the contacts-closed position, and means to retain said latch in position to be engaged by said driving member and said prop successively, said driving member and said prop each having a surface for engaging said latch, said surfaces being disposed to react against said latch and this reaction providing bias to urge said latch about its pivot in the releasing direction.

7. A circuit breaker having a contact-operating linkage including a spring biasing the linkage in the contact opening direction, a pivoted driven member in said linkage, and control means for the driven member, said control means including a latch pivoted to the driven member with the pivotal axes of said latch and said member separated from each other, a driving member operable about the pivotal axis of the driven member and engageable with said latch to drive the linkage in the contact-closing direction, a prop engageable with said latch to restrain the contact-operating linkage in the contacts-closed position, and means to retain said latch in position to be engaged by said driving member and said prop successively, said driving member and said prop each having a surface for engaging said latch, said surfaces being disposed to react against said latch and this reaction providing bias to urge said latch about its pivot in the releasing direction, said retaining means having pivotal engagement with a portion of said latch that is coaxial with said driven member and is thereby effective to maintain a predetermined relationship between said driven member and said latch during and after contact-closing operation of said driven member, said restraining means upon release thereof allowing change of said predetermined relationship between said driven member and said latch for contact-opening operation of said linkage.

8. An electrically operated circuit breaker including a contact-operating linkage, a contact-opening spring for said linkage, an operating solenoid, a prop for retaining said linkage in the contacts-closed configuration, and a solenoid-controlling switch to deenergize the solenoid as soon as the linkage has been actuated sufficiently by the solenoid to be latched closed by the prop, said prop being spring-biased to a normal position which it assumes both when the circuit breaker is closed and when fully open, and the prop being operated out of that normal position by said latch during the contact-closing stroke of the solenoid, said switch having a control member which is operable jointly by said prop and by said linkage for operating said switch to deenergize said solenoid at the instant that both the linkage and the prop are in contacts-closed position, said linkage being operable to drive said switch control member and to remove said prop from said normal position during contact-closing operation and then to cause return of the prop when the linkage has completed its contact-closing stroke, and said prop thereupon being effective to operate the switch control member upon return of this prop to normal contacts-closed position.

9. An electrically operated circuit breaker including a contact-operating linkage, a contact-opening spring for said linkage, an operating solenoid, a prop for retaining said linkage in the contacts-closed configuration, and a solenoid-controlling switch to deenergize the solenoid as soon as the linkage has been actuated sufficiently by the solenoid to be latched closed by the prop, said prop being spring-biased to a normal position which it assumes both when the circuit breaker is closed and when fully open, and the prop being operated out of that normal position by said latch during the contact-closing stroke of the solenoid, said switch having a two-ended operating lever one end of which is operable by said prop and the other end of which is operable by said linkage, an intermediate por-

tion of said lever engaging and operating said switch at the instant that both the linkage and the prop are in contacts-closed position, said linkage being operable to remove said prop from said normal position during the contact-closing stroke and then to release the prop at the end of the contact-closing stroke, and said prop operating its end of the switch lever upon its return to normal contacts-closed position.

10. An electrically operated circuit breaker including a contact-closing linkage, a contact-opening spring for said linkage, an operating solenoid, a prop for retaining said linkage in the contacts-closed configuration, and a solenoid-controlling switch to deenergize the solenoid as soon as the linkage has been actuated sufficiently by the solenoid to be latched closed by the prop, said switch having a two-ended operating lever one end of which is engageable by said linkage and the other end of which is operable by said prop, and an intermediate portion of said lever engaging and operating said switch at the instant that both the linkage and the prop are in contacts-closed position.

11. An electrically operated circuit breaker including a contact-operating linkage, a contact-opening spring for said linkage, an operating solenoid, a prop for retaining said linkage in the contacts-closed configuration, and a solenoid-controlling switch to deenergize the solenoid as soon as the linkage has been actuated sufficiently by the solenoid to be latched closed by the prop, said switch having a two-ended operating lever one end of which is engageable by said linkage and the other end of which is operable by said prop, and an intermediate portion of said lever engaging and operating said switch at the instant that both the linkage and the prop are in contacts-closed position, said operating lever being formed of a reversely bent leaf spring providing two roughly parallel portions held under predetermined initial bias by a spacing limiter and one of said portions being cooperable with said prop and said switch and the other said leaf spring portion being cooperable with said prop and said linkage.

12. A switch and an actuating lever therefor including a leaf-spring having spaced portions doubled back about a pivot, a separation limiter engaging and retaining the double-back portions under initial bias, one of said leaf-spring portions being arranged to bear against the switch, and an actuating device operable against the other of said leaf-spring portions at the side thereof to urge it toward the first-mentioned leaf-spring portion, whereby the initial force of the actuating lever against the switch is high and yielding of the lever precludes damage to the switch with continued operation of the lever after bottoming of the switch.

13. A circuit breaker having a contact-operating linkage including a driven member having a fixed pivot, a pivoted coupling arm thereon, said coupling arm having a control part coaxial with the pivot of said driven member, release means normally restraining said control part for retaining said coupling element in fixed predetermined augular relationship with respect to said pivoted driven member despite angular operation of the latter, and a driving member having predetermined bearing relationship against said coupling element during the contact closing stroke of that driving element with the coupling element restrained.

14. An electrically operated circuit breaker including a contact-closing linkage, a contact opening spring for said linkage, an operating solenoid for said linkage, a prop for retaining said linkage in the contact-closed configuration, said prop having a normal position which it assumes both when the circuit breaker is open and when the prop retains the linkage in the contacts-closed configuration, the linkage acting to deflect the prop during the contact-closing operation of the circuit breaker, and a solenoid-controlling switch to deenergize the solenoid as soon as the linkage has been actuated sufficiently by the solenoid to be retained closed by said prop, said switch having respective control connections to said prop and to said linkage for operating the switch to deenergize the solenoid only when the prop is in said normal position and said linkage is in its contacts-closed configuration.

15. An electrically operated circuit breaker including a contact-closing linkage, a contact opening spring for said linkage, an operating solenoid for said linkage, a prop for retaining said linkage in the contact-closed configuration, said prop having a normal position which it assumes both when the circuit breaker is open and when the prop retains the linkage in the contacts-closed configuration, and the linkage acting to deflect the prop during the contact-closing operation of the circuit breaker, and a solenoid-controlling switch operated by said prop to deenergize the solenoid as soon as the linkage has been actuated sufficiently by the solenoid to be retained closed by said prop.

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