Feb. 28, 1939. W. SATTLER 2,148,880

AUTOMATIC TOGGLE JOINT CUT-OUT SWITCH

Filed Sept. 14, 1937 2 Sheets-Sheet 1

Fig. 1.

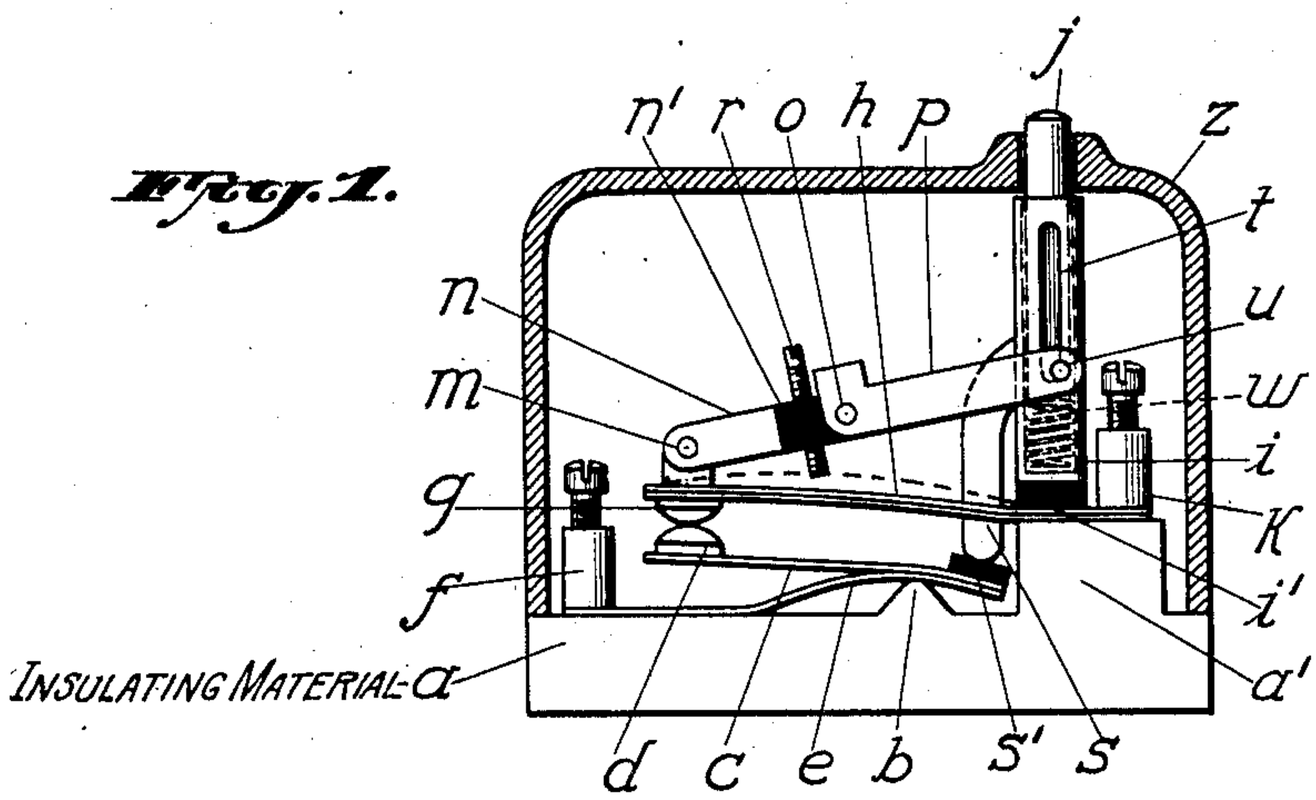

Fig. 2.

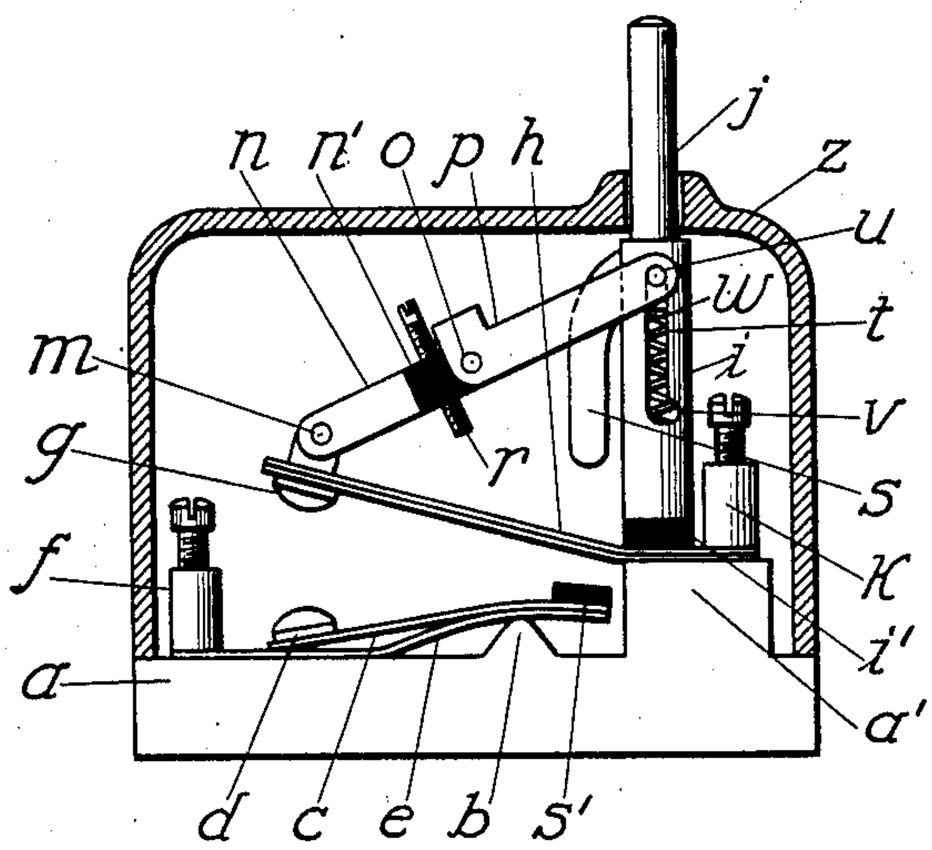

Fig. 3.

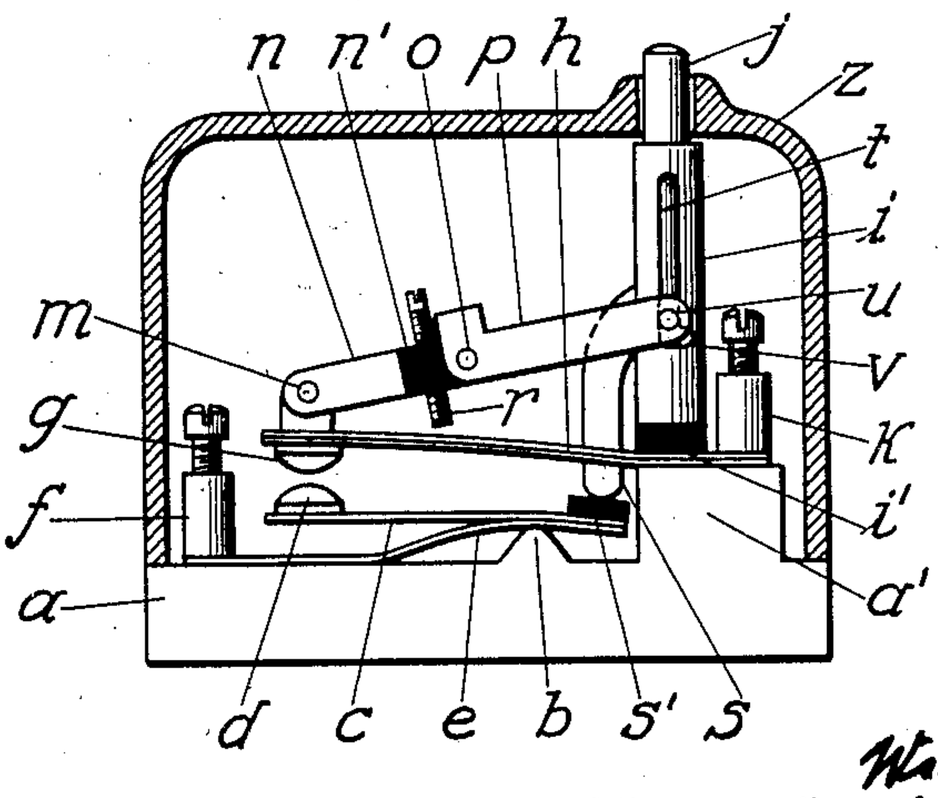

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Fig. 4.

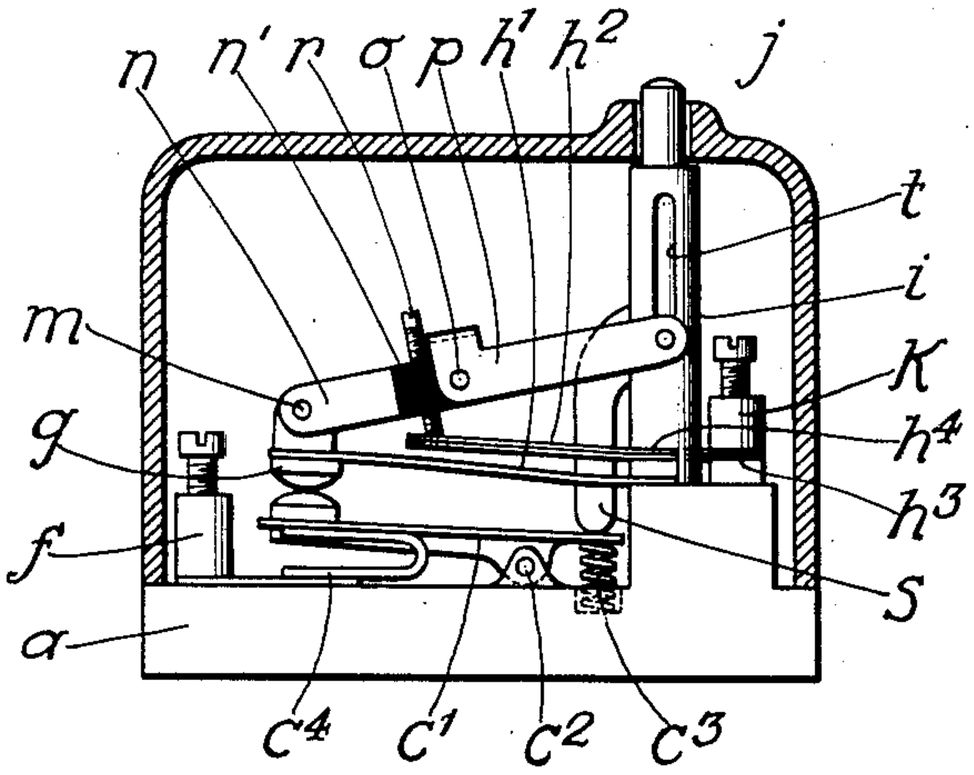


Fig. 5.

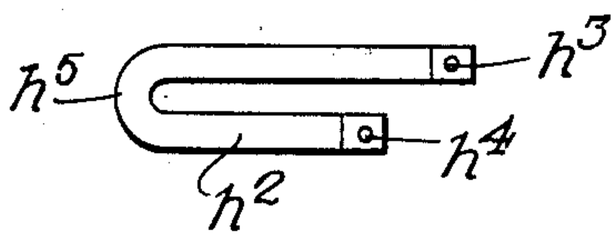
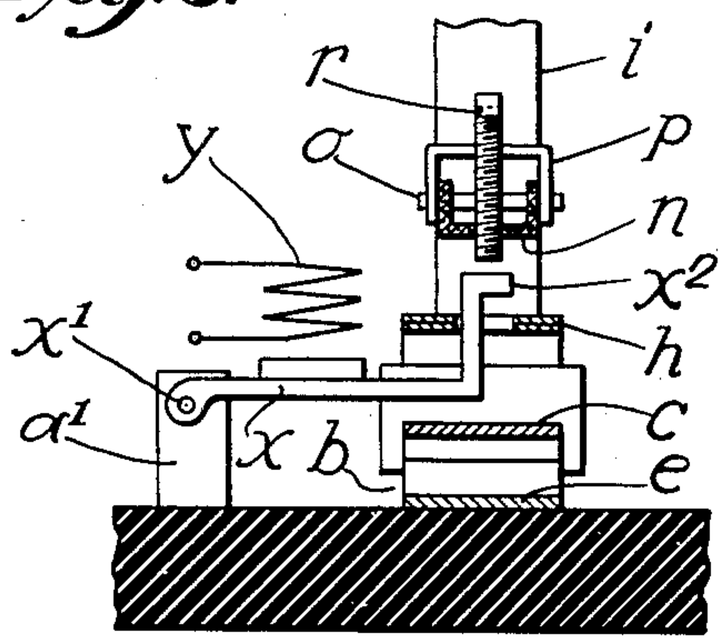


Fig. 6.



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AUTOMATIC TOGGLE JOINT CUT-OUT SWITCH

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In Germany September 19, 1936

6 Claims. (Cl. 200—116)

My invention relates to automatic cut-out switches which respond to overload or short circuit conditions in electric circuits. In this type of switch, toggle joint devices are found by the art to be a practical means for locking the switch in closed position when the joint is in stretched position. Various means have been provided heretofore, such as solenoids, bimetallic strips and other devices, which, in responding to the predetermined excess current, act against the pivotal point of the joint and trip it, whereby the switch is unlocked and opened.

During the closing operation of the switch, and even from the first moment when the two contact elements touch, to the time when these elements are in full circuit-closing position, the central pivotal point of the toggle joint changes its position with respect to the tripping element. Since an overload or short circuit may occur or continue to exist while the switch is effecting its closing movement, it is of importance that the tripping element is so designed that it acts with its greatest force correctly against the tripping point not only after the switch has assumed its final closing position, but also during the closing operation of the switch.

To solve this problem, various auxiliary means have been suggested which however, so far as I am aware, are complicated and therefore add considerably to the expense in manufacturing the switch. Besides, many of such auxiliary means have a tendency to prolong the tripping period of the joint and thus the opening period of the switch.

The toggle joint operated cut-out switch according to the present invention overcomes the difficulties and disadvantages inherent to the prior art switches, by providing the switch with two spring-biased contact elements, one of which is actuated by a toggle joint tripping mechanism, while the other is designed to finally close the circuit after the toggle joint operated element has reached its contact closing position. The underlying idea, according to which the heretofore existing difficulties are overcome, is that a reliable and quick tripping of the joint is attained most effectively if in closing the switch the toggle joint is already set in tripping condition and its tripping point before the switch contacts are closed is brought into that position in which it is exposed to the most effective operation of the tripping element, in a manner which will be described later with reference to the drawings. Further, according to the invention the second switch contact is mounted on a separate lever disposed independently of the toggle joint mechanism, which lever is operated into switch-closing position by the main switch-operating elements only after the first contact is brought by the already set toggle joint into the position which it assumes when the switch is closed. In other words, the two contact elements are moved successively—and not simultaneously as in some prior art constructions—into and out of their final switch-closing positions. The independent arrangement of the second contact has the additional advantage that its mounting and motion can be arranged so that its operating path and speed may be considerably increased, so that even currents of considerable intensity can be interrupted safely and with certainty.

A switch according to my invention is illustrated in three operating positions in the three figures of the accompanying drawings in longitudinal sectional elevation, Figure 1 showing the switch in closed position ready to be tripped, Figure 2 showing the switch in open position, and Figure 3 showing the upper switch contact already in closing position and the independent lower contact partway lifted from its open position and about to be moved fully into closing position. Figure 4 illustrates another embodiment, and Figure 5 a detail thereof. Figure 6 shows a third modification in a cross section taken at a right angle with respect to the elevations shown in Figures 1 through 4.

Referring to these drawings, *a* represents the base plate on which the switch and its protecting casing *z* are mounted and which consists of insulating material appropriate for such purposes. Base *a* is provided with a ridge *b* which serves as free fulcrum for the two-armed switch lever *c*. These arms are of unequal length, the longer arm carrying the switch contact *d* at its outer end, and the end of the shorter arm being fixed to the free end of an opening spring *e* which also rests on ridge *b* intermediate its ends and which tends to keep lever *c* and its contact *d* in open position shown in Figure 2. Lever *c* may be connected to one of the switch binding posts *f* either directly by way of spring *e* or by a separate lead, not shown here. The other switch lever *h* consists of a leaf spring and is fixed at one end to an elevated portion *a'* of base *a*, for instance by means of the switch operating post *i*, insulated at *i'* from lever *h*, and the latter may be connected on base *a'* directly to the other switch binding post *k*. The other switch contact *g* is fixed to the free end of lever *h*.

For actuating lever *h* the following means are

provided. Operating post *i* is tubular and serves as a slide for push rod *j* which is supported on a compression spring *w* disposed in the interior of post *i* and tends to eject rod *j* from the post into the position shown in Figure 2. The wall of tubular post *i* is provided with an elongated slot *t* through which rod *j* is pivotally connected at *u* to one end of toggle joint *n,p*, the other end of which joint is pivotally attached at *m* to the free end of switch lever *h*. The tripping joint between the toggle joint elements *n* and *p* is shown at *o*. Some insulation should be provided somewhere between switch contact *g* and operating post *i* and thus for instance a portion *n'* of lever element *n* may consist of insulating material as shown, or if desired this entire element may be made of insulating material. An adjustable set screw *r* is threaded into the insulated portion *n'* closely adjacent to the tripping joint *o* and serves as the actuating point for the toggle joint *n,p*.

For actuating the toggle joint, various means may be employed. In the present example switch lever *h* consists of a bimetallic strip as shown, of a cross section commensurate with the magnitude of the current at which the cut-out switch should open, so that when this magnitude is attained the strip is sufficiently heated so that it buckles as shown in dotted lines in Figure 1, thereby striking in the most effective manner the tripping screw *r* of the toggle joint and tripping the latter upwardly.

It should be stated here first that the relative longitudinal dimensions of toggle joint *n,p* and lever *h* are such that the toggle joint normally remains stretched and thus its constituent elements *n* and *p* in straight alignment and set condition when the lever is in normal closed or open position shown in Figures 1–3. If now the actuating member of the switch, namely, push rod *j*, which in Figure 2 protrudes far out of casing *z*, is depressed against the tension of spring *w* into the position shown in Figure 1, the toggle joint *n,p* is tilted in stretched and set condition into the position shown in that figure, in which its pivot pin *u*, due to the longitudinal pressure in the joint from *m* toward *u*, drops into a recess *v* provided at the lower end of slot *t* shortly after lever *h* has attained its contact closing position, whereby push rod *j* is locked with switch lever *h* in contact-closing position. To push rod *j* is also attached a downwardly extending detent *s* of such length that when rod *j* has sufficiently descended, the end of the detent engages the short arm of the other contact lever *c*, preferably by way of an insulating plate *s'*, and on further descent raises contact *d* against the tension of spring *e* close to contact *g* into the position shown in Figure 3. Now only a further short push on rod *j*, during which pivot pin *u* is snapped into recess *v*, as previously mentioned, suffices to close the two contacts *d*, *g* entirely and to lock the entire cut-out switch in operative position shown in Figure 1.

If now, as stated hereinbefore, due to an excessive current load, the bimetallic strip lever *h* is sufficiently heated so that it buckles upwardly, the toggle joint is tripped upwardly, whereby lever *h* is released and moves upward while the distance between pivot pins *m* and *u* is temporarily shortened sufficiently to pull pivot pin *u* out of recess *v*, so that now the upward pressure of springs *e* and *w* throws the right-hand end of toggle lever *n,p* upwardly into the position shown in Figure 2. At the same time, the pressure of detent *s* against the short end of two-armed lever *c* is released and spring *e* quickly throws this lever into the position shown in Figure 2. This double action separates the contacts *g* and *d* very rapidly far apart. As soon as the toggle joint has been thrown upwardly, its two elements *n* and *p* immediately reassume the stretched and set position as shown in Figure 2. The entire cut-out switch is now again ready to be closed by depressing rod *j*. If an excessive overload occurs at the circuit-closing moment, the switch is tripped in the same effective way as in case of a later occurring overload, because the joint *o* has always assumed its best suitable position before the circuit is actually closed.

Further advantages of this switch as compared with prior art switches of this type are its great simplicity due to the small number of parts and its simple construction. Consequently, in quantity production it can be rapidly assembled and is therefore very cheap to manufacture. Further, the few operating parts required may be of very light weight which considerably lowers the inertia of these parts and permits rapid starting. Due to the compactness of the construction, the parts may be assembled within a very small compass, which renders the switch particularly useful for portable power plants such as exist in motor vehicles and aircraft. Moreover, its certainty, rapidity, and reliability of operation and the wide spacing of its open contacts renders it particularly adapted also for domestic installations.

Several obvious modifications of the switch here shown and described may be made within the scope of the idea underlying the present invention. For instance, the contact lever *h* itself need not be constructed as a bimetallic strip and may only serve as a conductor for the current to the contact element *g*. This may be desirable where the cut-out switch is to respond at very small overloads, where the bi-metallic strip would not be strong enough to serve as operating lever for contact *g*. In that case, a separate bimetallic strip, electrically connected in series with the contact lever *h*, may be arranged on the contcat lever in a position in which, when responding to excess current, it strikes the tripping point of the toggle joint most effectively. Further the bimetallic strip may be replaced by electromagnetic means designed to respond to given excess currents. In that case switch lever *h* would be designed as a bronze spring, provided with a longitudinal slot in which an armature extension of the responding electromagnet moves and by which extension the toggle joint is tripped in case of overload. Lastly also the double-armed lower contact lever *c* and its actuating spring *e* may be modified by designing this lever *c* as a rigid double-armed lever controlled by a separate spring tending to hold it in open position. Modifications of the above kind are illustrated by Figures 4, 5 and 6.

Figure 4 shows an overload switch having in general the same construction as the embodiment of Figures 1–3 except for the following details. Instead of a bimetallic strip *h* and the first-described switch, a simple bronze spring h_1 is used, serving only as contact lever but having no tripping function. An additional bimetallic strip h_2 have the U-shape shown in Figure 5, is connected with one end h_3 to terminal *k*, and with its other end h_4 to lever h_1. The central portion of bimetallic strip 2 rests against the tripping screw *r*. When beign heated by an excess load, the strip h_2 bends its free portion h_5 in the upward direction and effects tripping. In this em-

bodiment, lever c_1 consists of a rigid element and is journalled by means of a pin c_2, a separate spring c_3 being inserted and tending to move lever c_1 into contact opening position. Lever c_1 and terminal f are connected by a flexible wire c_4. The operation of lever c_1 is the same as that of lever c of the preceding figures.

Figure 6 illustrates an overload switch according to the invention, the tripping mechanism of which is operated magnetically. This switch also has in general the same construction as that of Figures 1–3 except for the following details, the similarity being recognizable from the coinciding reference characters. Instead of the bimetallic strip h indicated in Figure 1, the corresponding contact lever shown in Figure 6 consists of a bronze spring. The tripping mechanism has a tripping member x which is journalled at x_1 to a support a_1 and passes through an aperture of spring h so as to have its free end x_2 located below the tripping screw r. Member x forms the armature of a tripping magnet y which is connected in the circuit to be controlled. In case of an excess load, magnet y attracts the armature and x_1 hits against screw r and effects the tripping.

I claim:

1. A toggle joint operated automatic cut-out switch, having a spring-biased, first contact lever fixed at one end and carrying one switch contact at its other end, an operating post mounted at the fixed lever end and a toggle joint pivotally attached at one end to the contact end of said lever and having its other end slidingly disposed on said post whereby the toggle joint is normally held in stretched and set condition, closing members on said post for operating said sliding joint end to bring said contact lever into contact-closing position, means on said post tending to throw said toggle joint into contact-opening position, means for locking said toggle joint in contact-closing position, and means responsive to a given overload current for tripping said toggle joint when the contact lever is in closing position to release said locking means, a second contact lever carrying a second switch contact at one end and being pivotally mounted independently of said first lever and means tending to normally hold said second lever in contact opening position, and an actuating element connected with said switch-closing means and arranged to actuate said second contact lever shortly before said first lever has arrived in closing position and to close the two switch contacts after the first lever has arived in closing position.

2. A toggle joint operated automatic cut-out switch, having a first contact lever fixed at one end and carrying one switch contact at its other end, an operating post mounted at the fixed lever end and a toggle joint pivotally attached at one end to the contact end of said lever and having its other end slidingly disposed on said post whereby the toggle joint is normally held in stretched and set condition, closing means on said post for operating said sliding joint end to bring said contact lever into contact closing position, means on said post tending to throw said toggle joint into contact-opening position, means for locking said toggle joint in contact-closing position and means responsive to a given overload current for tripping said toggle joint when the contact lever is in closing position to release said locking means, a second, two-armed contact lever of unequal arm lengths, carrying the second switch contact at the long arm end and being pivotally mounted independently of said first lever and means for tending to normally hold said second lever in contact-opening position, and an actuating element connected with said switch-closing means, arranged to actuate the short arm of said second lever shortly before said first lever has arrived in closing position and to close the two switch contacts after the first lever has arrived in closing position.

3. A toggle joint operated automatic cut-out switch, having a first current-carrying spring-biased contact lever fixed at one end and carrying one switch contact at its other end, an operating post mounted at the fixed lever end and having a push bar slidingly disposed in it, a toggle joint pivotally attached at one end to the contact end of said lever and having its other end pivotally attached to said push bar, whereby the toggle joint is normally held in stretched and set condition and the contact lever can be moved into closing position, a spring tending to hold said push bar in opening position and means on said post for locking said bar in contact-closing position, and means on said contact lever responsive to a given overload current for tripping said toggle joint when the contact is in closing position to release said locking means, a second contact lever carrying a second switch contact at one end and being pivotally mounted independently of said first lever and a spring tending to normally hold said second lever in contact-opening position, and a detent fixed on said push bar and arranged to actuate said second lever shortly before said first lever has arrived in closing position and to close the two switch contacts after the first lever has arrived in closing position.

4. A toggle joint operated automatic cut-out switch, having an insulating base, a first current-carrying contact lever mounted at one end to said base and carrying one switch contact at its other end, an operating post mounted at said base and having a push bar slidingly disposed in it, a toggle joint pivotally attached at one end to the contact end of said lever and having its other end pivotally attached to said push bar, whereby the toggle joint is normally held in stretched and set condition and the contact lever can be moved into closing position, a spring tending to hold said push bar in opening position and means on said post for locking said bar in contact closing position, said first contact lever consisting of a bimetallic leaf spring deforming at a given overload current and disposed, when in contact-closing position sufficiently close to the tripping point of the toggle joint, to trip the joint by such deformation to release said locking means, a second contact lever carrying a second switch contact at one end and being pivotally mounted independently of said first lever and a spring tending to normally hold said second lever in contact-opening position, and a detent fixed on said push bar and arranged to actuate said second lever shortly before said first lever has arrived in closing position and to close the two switch contacts after the first lever has arrived in closing position.

5. An electric cut-out switch comprising an insulating base, two spring-biased contact levers counter-movably mounted to said base so as to coact in closing and opening the switch contact, said spring bias tending to move said two levers into contact opening position, a toggle joint mechanism operatively connected with one of said levers for moving when in stretched condition said lever into contact closing position and locking said lever in said position, said mechanism in-

cluding a switch-closing member for actuating said toggle joint, overload-responsive releasing means for tripping said toggle joint, and means operatively connected with said mechanism for actuating said other lever so as to finally close the contact by said other lever after said toggle joint has arrived in closing position and to release said other lever upon the tripping of said toggle joint.

6. An electric cut-out switch comprising an insulating base, two spring-biased contact levers counter-movably mounted to said base so as to coact in closing and opening the switch contact, said spring bias tending to move said two levers into contact opening position, a toggle joint for moving the first of said two levers into contact closing position and locking said first lever in said position, a movable actuating member for closing the switch, said toggle joint being arranged between said actuating member and said first lever so as to operatively connect when in stretched condition said member and said first lever, overload-responsive releasing means for tripping said toggle joint, and a stop connected with said actuating member and being disposed to move the second of said two levers against said spring bias into contact closing position at the end of the closing movement of said actuating member and to release said second lever at the beginning of the opening movement of said member.

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