July 18, 1950 J. F. O'BRIEN ET AL 2,515,258

ELECTROMAGNET WITH SPLIT CORE ARMATURE

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FIG. 1

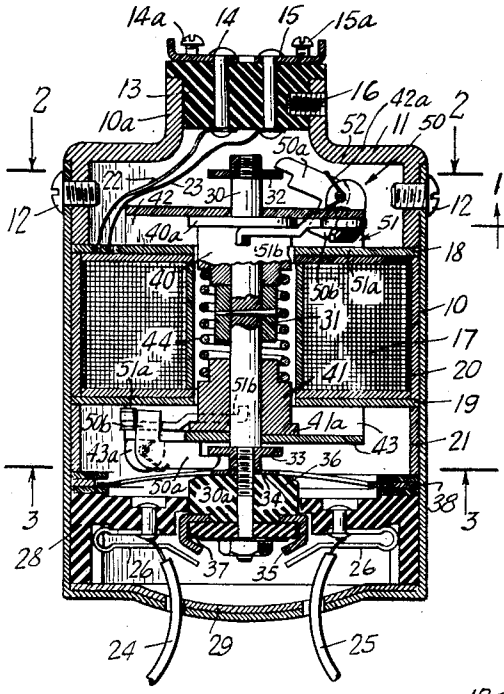


FIG. 2

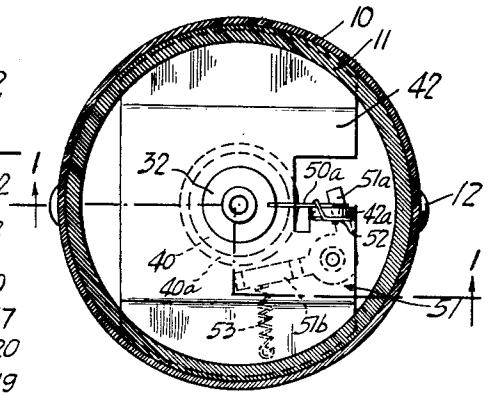


FIG. 3

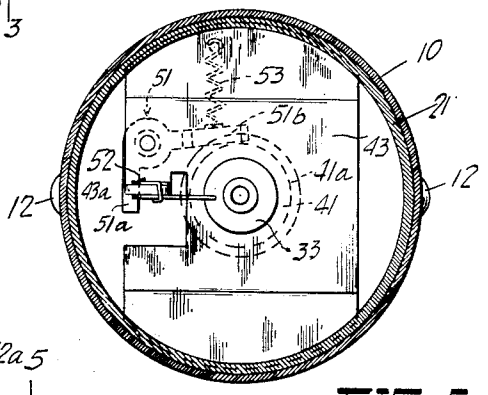


FIG. 4

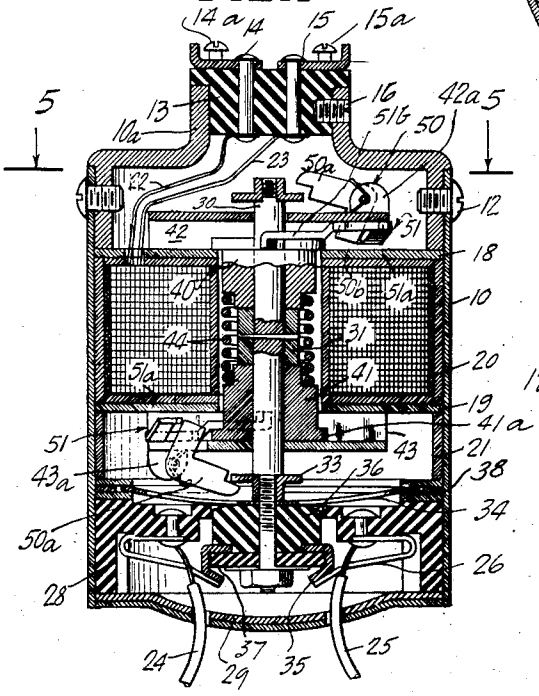
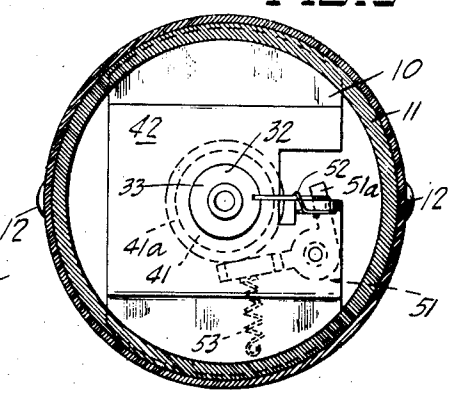


FIG. 5



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FIG. 6

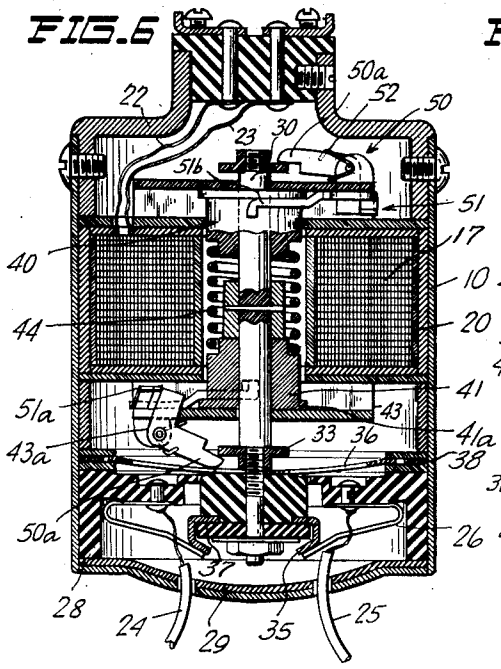


FIG. 7

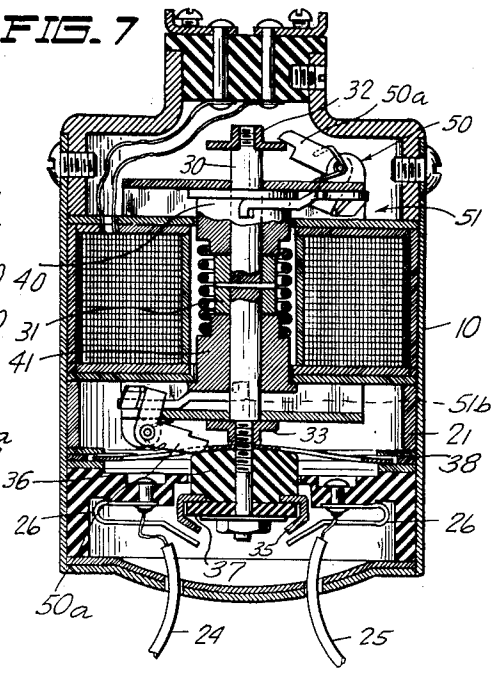


FIG. 8

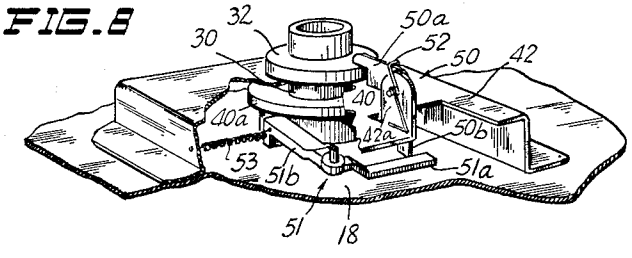


FIG. 9

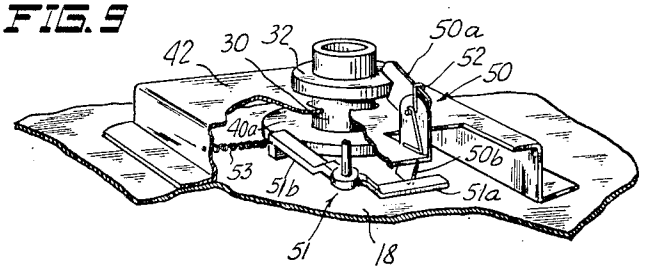
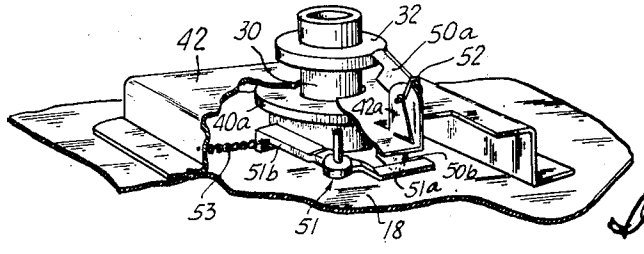


FIG. 10



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ELECTROMAGNET WITH SPLIT CORE ARMATURE

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Application April 8, 1947, Serial No. 740,144

6 Claims. (Cl. 175—337)

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This invention relates to electrical relays and to solenoid mechanisms component thereto. It constitutes an improvement on the subject matter disclosed and claimed in our similarly entitled copending application Serial No. 726,362 filed February 4, 1947.

In that prior invention the relay and component solenoid mechanisms possess a single solenoid coil necessitating only a two-wire control circuit, as distinguished from earlier devices of similar type utilizing a pair of solenoid coils and a three-wire control circuit. Associated with the solenoid coil, as an armature, is a plunger assembly embodying a plunger or throw rod which effects the end result desired of the device. The action of the components of the plunger assembly under successive momentary energizations of the solenoid coil, together with the correlative action of mechanical latching means operative on the plunger assembly, makes it possible to achieve a throwing of the plunger rod and a holding of it in its thrown position, as in the closing and the maintaining closed of a load circuit controlled by the relay, followed by a return thereof and a holding of it in its return position, and likewise for repeated operative cycles. Thus, such an electrical relay can be effectively operated remotely by means of a single momentarily acting push-button in the control circuit.

The present invention retains the generic combination of single solenoid coil, plunger assembly, and mechanical latching system, but eliminates certain disadvantages inherent in the prior arrangement.

Whereas in the prior arrangement resilient catches or latching elements are employed to effect mechanical latching of certain of the plunger elements component to the plunger assembly, and these require close tolerances in the manufacture of various of the parts, as well as frequent adjustment during use, in accordance with the present invention a system of rigid latches and levers, subject to neither of these disadvantages, is utilized to achieve the same end result.

Thus, it is an object of the present invention to eliminate both the need for close tolerances in the manufacture of a device of the type concerned and the need for frequent adjustments during its use.

It is an object to reduce the cost of manufacture and upkeep.

It is a further object to provide for more positive operation and greater reliability.

These and additional objects and features of the invention will be fully considered in the following detailed description of the preferred specific embodiment illustrated, by way of example only, in the accompanying drawings.

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In the drawings:

Fig. 1 is a vertical sectional view taken partially on the line 1—1, Fig. 2, but for the most part centrally through the device in its unenergized "off," or circuit opening, position;

Fig. 2 is a horizontal section taken on the line 2—2, Fig. 1;

Fig. 3 is a horizontal section taken on the line 3—3, Fig. 1;

Fig. 4 is a view corresponding to that of Fig. 1, but illustrating the device in its energized "on," or circuit closing, position;

Fig. 5 is a section taken on the line 5—5, Fig. 4;

Fig. 6 is a view corresponding to those of Figs. 1 and 4, but illustrating the device in its unenergized "on" position;

Fig. 7 is a corresponding view, but illustrating the device in its energized "off" position;

Fig. 8 is a fragmentary perspective view of a portion of the latch mechanism drawn to an enlarged scale, the position of the mechanism corresponding to that of the upper part of Fig. 6;

Fig. 9 is a similar view, the position corresponding to those of the upper parts of Figs. 4 and 7; and

Fig. 10 is another similar view, the position corresponding to that of the upper part of Fig. 1.

Referring to the drawings: In the form illustrated, which is now considered to be the preferred form, the device comprises an external casing 10 of cupped formation provided with an inset cover 11 removably secured in place by the screws 12. Both casing and cover are preferably formed of a non-magnetic material such as aluminum. The cover is formed with an open neck portion 10a, into which is set a removable terminal block 13 of insulation, such block carrying electrical binding post arrangements 14 and 15. A set screw 16 serves to secure terminal block 13 in place.

Within the casing 10 is disposed the solenoid-operated mechanism of the invention, which, in this instance, serves to make and break an electrical circuit, and therefore is operable as an electrical relay. Such mechanism includes a single solenoid coil 17 enclosed by a shell of magnetic material, advantageously steel, the shell comprising opposite pole pieces 18 and 19 of disc formation, and a coil encircling ring 20. A spacer ring 21, which is desirably of electrical insulating fiber, serves to retain the solenoid coil and its enclosing shell snugly against the internal

shoulder formed by the cover member 11. Electrical lead wires 22 and 23 extend from the respective binding post arrangements 14 and 15 to the coil 17, and serve to conduct electricity thereto from a suitable control circuit (not shown), usually of low voltage—say 24 volts, which may be connected to the device by means of the binding screws 14a and 15a. Wiring leads 24 and 25 for connection with the electrical load circuit to be controlled by the device, a circuit which may be of considerably higher voltage than the control circuit, say the usual 110 volts of an ordinary domestic wiring system, pass through suitably provided openings in the casing 10 to electrical union with respective contacts 26, 26 which are secured in mutually spaced relationship to an insulating mount 28. The interior of the casing below the mount 28 is preferably lined with insulation 29.

As in my afore-referred-to copending application Serial No. 726,362, the solenoid-operated mechanism includes, besides the single actuating coil, a plunger assembly which acts as an armature in the sense that certain of its components are movable by the magnetic flux of the coil; such mechanism includes, also, mechanical latching means operable on certain components of the plunger assembly, and a snap spring operable on other components of the plunger assembly.

The plunger assembly comprises a plunger throw-rod 30 of brass or other non-magnetic material to which is fixed intermediate its length, a solenoid-responsive plunger element 31. The rod 30 is capped at one end by a striker element 32, here shown in the shape of a disc, and is formed at the other end as an elongated shank 30a on which are positioned an opposite or second striker element 33, a snap spring in the form of a double equilibrium spring disc 34, and an electrical contact 35 sandwiched between blocks of insulation 36 and 37. A conventional nut and washer serve to secure the several parts tightly in place on the throw rod shank, as shown. The spring disc 34 is anchored about its circumference in a frame structure 38 disposed between the mount 28 and the spacer ring 21.

As so constituted the throw-rod extends through a suitably provided aperture in the mount 28, so that electrical contact 35 is positioned to bridge the gap between the spaced contacts 26, 26 of the load circuit when the rod is thrown by a given energization of the coil 17 acting on the intermediate plunger element 31, see Fig. 4.

The plunger assembly comprises, further, a pair of solenoid-responsive auxiliary plunger elements 40 and 41 freely mounted on the throw-rod 30 at opposite ends of the fixed intermediate plunger element 31.

Secured to the opposite pole pieces 18 and 19 are respective bracket plates 42 and 43. These serve to mount the latching mechanism about to be described. A coil spring 44 of brass spring wire or other suitable non-magnetic material is interposed between the two auxiliary plunger elements, and normally urges both outwardly against the respective plates as limit stops, see Figs. 1 and 6. The spring disc 34, it should be noted, determines the position of intermediate plunger element 31 relative to the auxiliary plunger elements, depending upon which position of equilibrium it is in, and energization of the solenoid coil 17 determines the particular position of equilibrium of the spring disc.

The latching mechanism is arranged to be actuated by the oppositely positioned striker elements 32 and 33, and to act upon the auxiliary plunger elements by means of respective latch arms which engage flanges 40a and 41a of the respective auxiliary plunger elements. Such latching mechanism comprises two independent and oppositely disposed identical latch assemblies mounted on the bracket plates 42 and 43, respectively.

Each latch assembly comprises a bell crank 50 pivoted on a horizontal axis (considered from the standpoint of the drawing) for oscillation within a vertical plane in accordance with the control exerted by its corresponding striker element 32 or 33, as the case may be. As illustrated, the bell crank is pivoted to a bracket arm 42a or 43a, extending perpendicularly outwardly of the corresponding bracket plate 42 or 43, its pivotal axis lying in a plane which is perpendicular to the plane in which plunger rod 30 moves. A trip arm portion 50a of the bell crank extends into the path of travel of the corresponding striker element of rod 30, while a tripper arm portion 50b extends through a suitably provided aperture of the bracket plate into the vicinity of the trip arm portion 51a of a second bell crank 51, such second bell crank being pivoted to the bracket plate on a vertical axis, that is to say so the pivotal axis is parallel to rod 30, for oscillation in a horizontal plane under the control of first bell crank 50 and having a latch arm portion 51b which engages the corresponding auxiliary plunger element 40 or 41. The bracket arms 42a and 43a are preferably struck from the bracket plates themselves, leaving the requisite apertures (desirably enlarged by suitable punch operation) for accommodating the tripper arm portions 50b of respective bell cranks 50, see Figs. 2, 3, and 5, and Figs. 8, 9, and 10.

Associated with each bell crank 50 is a follower spring 52, constraining the trip arm portion 50a thereof to follow its striker element 32 or 33 whenever the travel of such striker element is receding, and associated with each bell crank 51 is a follower biasing spring 53, Fig. 2, constraining the trip arm portion 51a thereof to follow the receding tripper arm portion 50b of the particular bell crank 50 concerned whenever the trip arm portion 50a thereof is actuated by its striker element on a positive stroke of the throw-rod 30. The spring 52, it should be noted, is stronger than the spring 53 for effecting the results desired.

The unenergized "off" position of the device is illustrated in Fig. 1. There throw-rod 30 is maintained in its upwardly (from the standpoint of the drawing) thrown position by means of the spring disc 34, which is in its upward position of equilibrium, electrical contact 35 being in break position relative to its associated stationary load circuit contacts 26, 26. The two auxiliary plunger elements 40 and 41 are maintained in outward limit positions against the respective bracket plates 42 and 43 by means of coil spring 44, the intermediate fixed plunger element 31 being maintained substantially against the upper auxiliary plunger element 40 and an air gap existing between such intermediate plunger element and the lower auxiliary plunger element 41. So far as the latching mechanism is concerned, trip arm portion 50a of bell crank 50 of the upper latch assembly is completely tripped by striker element 32, thereby allowing latch arm 51b of bell crank 50 of the same assembly to be maintained in unlatching position relative to flange 40a of the

upper auxiliary plunger element 40 by reason of the influence of its spring 53, see especially Figs. 2 and 10. On the other hand, trip arm portion 50a of the lower latch assembly is maintained in untripped position against its retracted striker element 33 by means of its spring 52, thereby maintaining latch arm 51b of the same assembly in latching position overlying flange 41a of the lower auxiliary plunger element 41 against the influence of its spring 53, see Fig. 3. (Fig. 8 also illustrates this condition, though inverted since it deals with the upper latch assembly.)

The energized "on" position occurs when the push button or other control instrumentality of the control circuit (not shown) is actuated, thereby energizing the solenoid coil 17. This occurs only momentarily, but is sufficient to throw the throw-arm 30 to effective position, the positions of the several parts being as illustrated in Fig. 4. The cessation of actuation of the control instrumentality, as for instance the release of the push button, de-energizes the solenoid coil, and the several parts assume the positions of Fig. 6. Re-actuation produces the energized "off" position of Fig. 7, while cessation of such re-actuation returns the device to the unenergized "off" position of Fig. 1.

In the energized "on" position of Fig. 4, throw-arm 30 has been thrown downwardly by action of energized solenoid coil 17, so that electrical contact 35 makes with the stationary load circuit contacts 26, 26. Spring disc 34, flipped as it is to its opposite position of equilibrium, is now in position to maintain throw-arm 30 downwardly, as thrown. Because of their mutual adjacency, auxiliary plunger element 40 and intermediate plunger element 31 have been moved downwardly as a unit; auxiliary plunger element 41 has been restrained by latch arm 51b from movement upwardly under the influence of the magnetic flux of the solenoid coil. By the time the throw-rod assumed its downward position, however, the trip arm portion 50a of the lower latch assembly was tripped by striker element 33, so that the latch arm portion 51b thereof has been moved to its non-latching position. Trip arm portion 50a of the upper latch assembly tried to completely follow the receding striker element 32 by reason of the urge of spring 52, but was stopped midway because the latch arm portion 51b of the associated bell crank 51 struck flange 40a of the downwardly displaced auxiliary plunger element 40, as shown, and could not complete its full strike, see also Figs. 5 and 9.

Upon de-energization of the solenoid coil the device assumes the unenergized "on" position of Fig. 6, wherein auxiliary plunger element 40 has been displaced upwardly to its normal limit position against bracket plate 42 and the aforementioned latch arm portion 51b has snapped into latching position under flange 40a thereof.

In both the energized "on" position of Fig. 4 and the unenergized "on" position of Fig. 6 the lower latch assembly is unlatched; the latter position is just the reverse of the unenergized "off" position of Fig. 1.

The energized "off" position of Fig. 7 is just the reverse of the energized "on" position of Fig. 4, the latch arm portion 51b of the lower latch assembly, in this instance, having struck the flange 41a of the auxiliary plunger element 41, thereby preventing the trip arm portion 51a of the bell crank 50 from following the upwardly receding striker element 33, as illustrated.

Following this energized "off" position, de-energization of the solenoid coil 17 permits coil spring 44 to return the device to the unenergized "off" position of Fig. 1, whereupon the device is in condition for repetition of the aforementioned operative cycle.

Whereas this invention is here illustrated and described with respect to a preferred specific construction thereof it should be understood that various changes may be made therein and various other constructions may be produced on the basis of the teachings hereof by those skilled in the art, without departing from the generic scope of the invention as defined by the following claims.

We claim:

1. In combination, a solenoid coil; a plunger arrangement mounted in said coil and operable thereby, said plunger arrangement comprising an elongated plunger rod, an intermediate plunger element of magnetic material fixed to said rod, and respective auxiliary plunger elements of magnetic material freely mounted on said rod at opposite ends of said intermediate plunger element for longitudinal movement along said rod; respective stops fixed with respect to said solenoid coil limiting the extent of outward movement of said auxiliary plunger elements relative to said intermediate plunger element; resilient means extending between said auxiliary plunger elements normally urging said elements against their respective stops; double equilibrium means fixed with respect to said solenoid coil and with respect to said plunger rod for maintaining said plunger rod in the alternate positions to which it is thrown by successive energizations of said solenoid coil, said alternate positions placing the intermediate plunger element closely adjacent one or the other of the auxiliary plunger elements and coincidentally producing a gap between it and the opposite auxiliary plunger element; oppositely disposed striker means associated with said plunger rod; and oppositely disposed latch assemblies pivoted respectively to said stops and engageable respectively with said auxiliary plungers for alternating locking against movement when the solenoid coil is energized the one of said auxiliary plunger elements which is not adjacent said intermediate plunger element, each of said latch assemblies embodying a system of levers having a trip arm extending into the path of movement of one of said striker means, and a latch arm responsive to the movement of said trip arm and operative to engage one of said auxiliary plunger elements so as to restrain movement thereof.

2. The combination recited in claim 1 wherein each latch assembly comprises a bell crank having a pivotal axis lying within a plane which is substantially perpendicular to the plane within which the plunger rod moves, a second bell crank having a pivotal axis substantially parallel with said plunger rod, one arm of the first bell crank providing the trip arm which extends into the path of movement of a striker means, one arm of the second bell crank providing the latch arm which engages an auxiliary plunger element, and the other arms of the said bell cranks being disposed relative to each other to effect correlated movement of the two bell cranks in the operation of the combination, a follower spring operative on the first bell crank, and a follower spring operative on the second bell crank.

3. The combination recited in claim 1 wherein the respective stops are bracket plates mounted at opposite ends of the solenoid coil, the plunger rod operatively extending through said bracket

plates, and wherein the respective latch assemblies are mounted on said bracket plates.

4. The combination recited in claim 1, wherein the means for maintaining the plunger rod in the alternate positions to which it is thrown by successive energizations of the solenoid coil is a double equilibrium spring disc.

5. In an electrical relay having a solenoid coil and composite plunger means, said means including a plurality of plungers of magnetic material co-axially in line and movable one against the next, said means being operative as an armature, latch means operative on the plunger means, comprising a pair of coacting bell cranks mounted for mutually correlated movement, one of said bell cranks having a resiliently positioned trip arm which is arranged to be tripped by a given movement of the plunger means, and the other of said bell cranks having a resiliently biased latch arm normally maintained in latching engagement with a component of said plunger means; tripping of the trip arm of one of said bell cranks effecting unlatching of the latch arm of the other of said bell cranks.

6. In a solenoid having a composite plunger, including a plurality of plunger elements of magnetic material coaxially in line and movable one against the next, as an armature, a latch operative to restrain movement of one element of the composite plunger, said latch comprising a bell crank pivoted to engage and latch an element of the composite plunger, a weak spring connected to said bell crank for turning it out of engagement with the plunger element, a second bell crank pivoted to turn said first-named bell crank into latching position, and a strong spring connected to said second bell crank for moving it to turn said first-named bell crank into latching position against the action of the said weak spring, said second bell crank having a trip arm portion thereof extending into the path of a second plunger element for movement thereby against the action of said strong spring to release said first-named bell crank.

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