March 31, 1953 A. J. DAWE 2,633,487

SELF-INTERLOCKING ELECTROMAGNETIC REVERSING SWITCH

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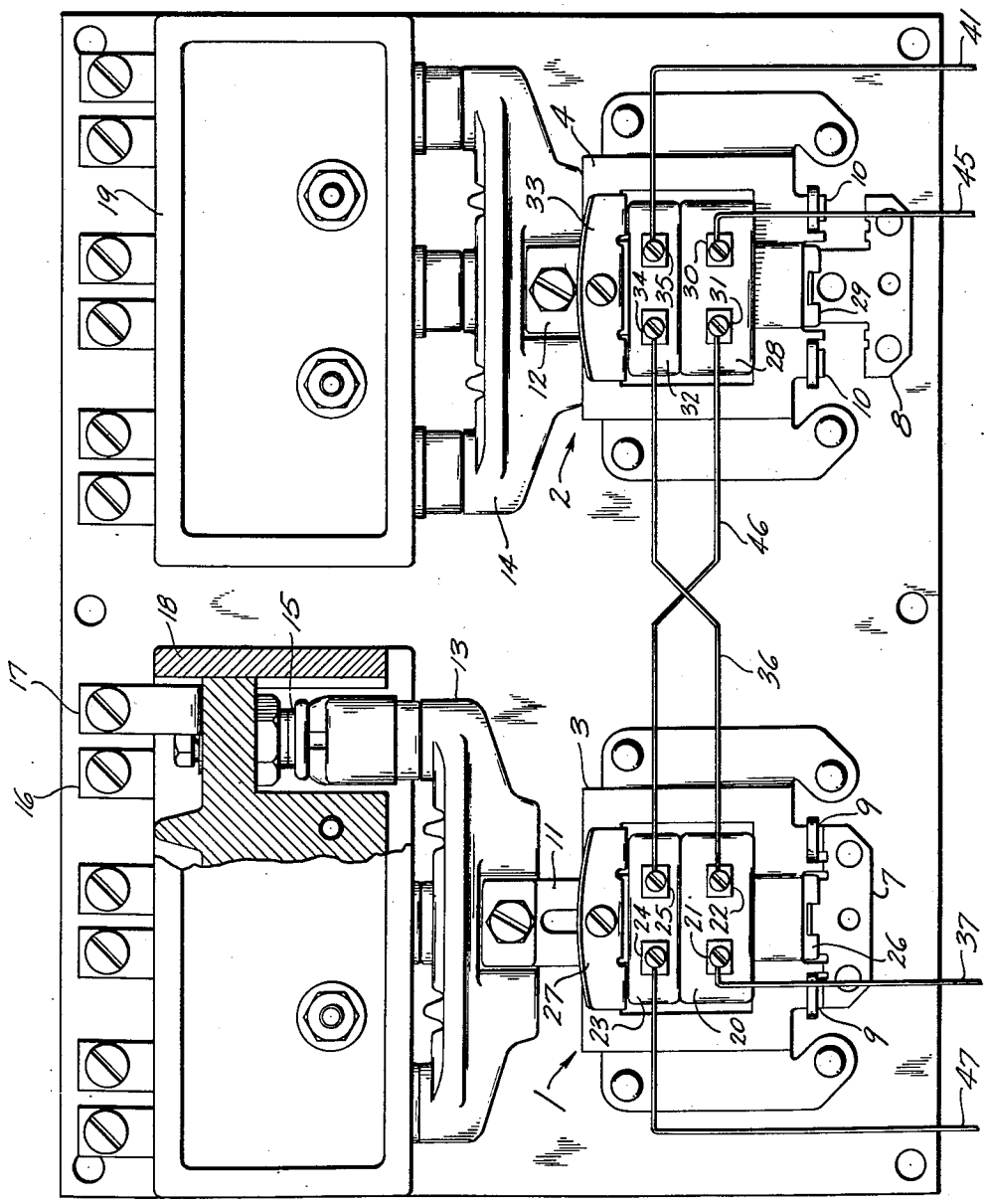


Fig. 1

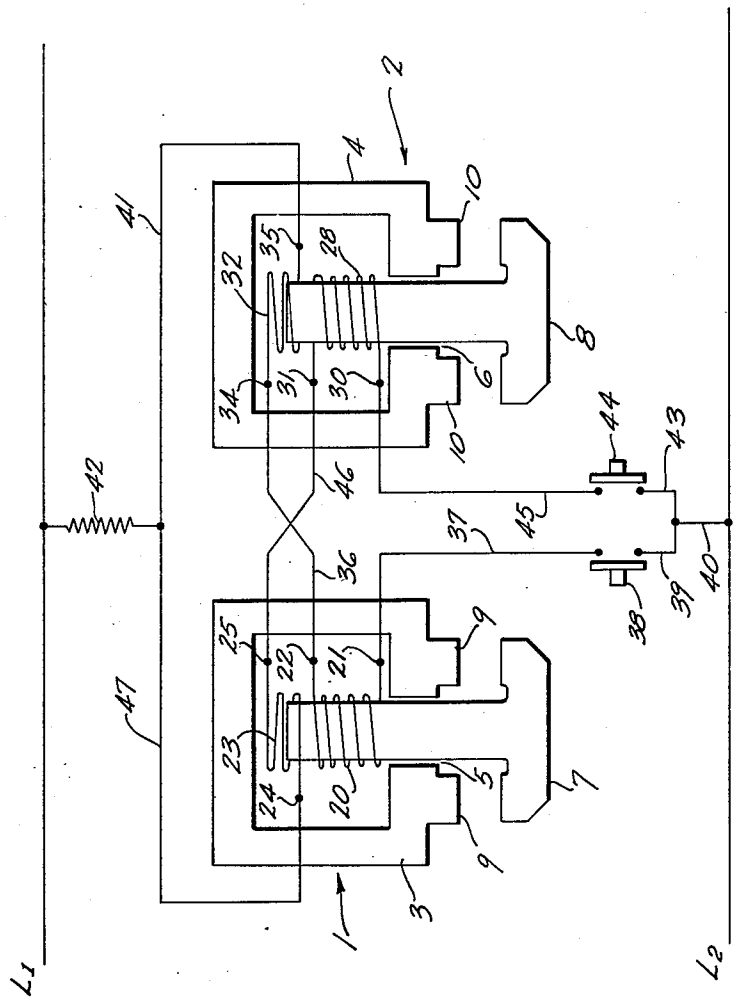
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Fig. 2



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SELF-INTERLOCKING ELECTROMAGNETIC REVERSING SWITCH

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1 Claim. (Cl. 175—335)

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This invention relates to electro-magnets intended to be operated alternatively in pairs such as are frequently employed for actuation of electro-magnetic reversing switches and the like and it resides more specifically in an improved apparatus of this character in which a pair of magnets is provided, each magnet having a closing coil and an opposing coil, the closing coil of each magnet being connected to be energized simultaneously with the opposing coil of the other magnet with the result that the armature of only one magnet at a time may be moved to or maintained in attracted position.

Electro-magnets intended to be operated alternatively in pairs are commonly employed for the operation of so-called reversing switches. Reversing switches are interposed in the power connections of electric loads such as motors in such manner that closure of both switches simultaneously will cause a short circuit. For the purpose of avoiding such short circuits it has been common to provide interlock control contacts for magnetically operated reversing switches so arranged that when one switch is closed, the energizing circuit for the magnet of the opposite switch is opened and vice versa. This method of interlocking is objectionable for the reason that it is possible by closing both the forward and reverse position push buttons simultaneously to cause a momentary closure of both switches.

With the object in mind of precluding such abuse of the apparatus some reversing switches are provided with mechanical interlocking means in addition to the electrical interlocking contacts above referred to. Such mechanical interlocking means are usually made up of a system of pivots, levers and linkage so arranged as to interpose a positive mechanical hindrance to the closure of one switch whenever the other switch is in closed position and to positively hinder both switches if a condition arises under which the magnets are energized simultaneously. The reliability of mechanical interlocking arrangements is dependent upon their remaining in good mechanical condition, but wear ultimately introduces the possibility of failure. Also, it is difficult to arrange mechanical interlocking systems so that the magnets forming the pair may be separated by any substantial distance.

In accordance with the present invention a pair of interlocked electro-magnets incapable of simultaneous operation and which may be as widely separated as may be desired is provided without dependence upon mechanical linkage and

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without resort to interlocking contacts. This is accomplished by providing each magnet of the pair with an operating coil capable of exerting attractive force adequate to move the armature and by providing each magnet of the pair with an opposing coil which when energized is effective to prevent the operating coil from moving the armature but which in and of itself when energized alone is incapable of exerting sufficient attractive force to move the armature. The two magnets provided with windings as thus described are provided with circuit connections such that the operating coil of one magnet and the opposing coil of the other become energized simultaneously. By reason of this arrangement if both operating coils are simultaneously energized, neither magnet will close and if one magnet is in closed position at the time such simultaneous energization is established, the closed magnet will drop to open position.

The invention is herein described by reference to the accompanying drawings forming a part hereof in which there is set forth by way of illustration and not of limitation one form in which the apparatus of this invention may be embodied.

In the drawings:

Fig. 1 is a front plan view with parts broken away and in section of a reversing switch employing a pair of magnets constructed in accordance with this invention, and

Fig. 2 is a circuit diagram showing the circuit of the magnets shown in Fig. 1.

The form of the apparatus of this invention which is set forth in the drawings is shown applied to a so-called reversing switch of well known construction. As there shown the apparatus of this invention is made up of a pair of magnets designated generally 1 and 2. The magnets 1 and 2 are of identical construction and include roughly rectangular magnetic field frames 3 and 4 having gaps 5 and 6 in their lower sides as appears more clearly in Fig. 2. Arranged for sliding movement through the gaps 5 and 6 are magnetic armatures 7 and 8 the T-shaped heads of which when in closed position engage pole faces 9 and 10 which are formed as a part of their respective field frames 3 and 4 in flanking position adjacent the respective gaps 5 and 6.

Attached to the upper ends of the tongues of the armatures 7 and 8 are actuator bars 11 and 12 which pass through slots not shown in the tops of the respective field frames 3 and 4. The actuator bars 11 and 12 are attached, respectively, to insulating movable contact carriers 13

and 14 carrying a plurality of movable contacts one of which is shown at 15. The movable contacts 15 are arranged to bridge electrically in well known manner pairs of terminals as, for example, terminals 16 and 17. The terminals 16 and 17 are mounted upon the stationary contact mounting and housing 18 and similar terminals and stationary contacts are mounted upon housing 19. Since the parts of the switch proper form no part of this invention the detail of the same is shown only sufficiently to permit understanding of the parts of the apparatus with which the invention is concerned.

Surrounding the path of travel of the tongue of the armature 7 and within the rectangular opening in the field frame 3 is a closing coil 20 having terminals 21 and 22. Located immediately above the closing coil 20 and positioned substantially opposite the air gap which exists when armature 7 is in open position is an opposing coil 23 having terminals 24 and 25. The coils 20 and 23 are held in place by a guiding sleeve 26 through which the tongue of the armature 7 may slide and by a spring clip 27.

The magnet 2 is provided with a closing coil 28 corresponding to the closing coil 20 of magnet 1 similarly located and held in place by guiding sleeve 29. Coil 28 is provided with terminals 30 and 31. Above the closing coil 28 is disposed an opposing coil 32 corresponding to the opposing coil 23 of magnet 1. The opposing coil 32 is guided also by the sleeve 29 and is held in place by a clamping spring 33. The opposing coil 32 is provided with terminals 34 and 35.

The magnets 1 and 2 are intended to be mounted in vertical position so that gravity acting upon the armature and switch parts secured thereto causes these parts to be continuously urged to open position with a substantial force. To overcome the opening force coils 20 and 28 are wound to create a magnetic attractive force somewhat in excess of that necessary to cause the armature to move to closed position. The opposing coils 23 and 32 are wound in magnetic opposition to their respective closing coils 20 and 28 and are provided with that number of ampere turns which is sufficient to offset something more than the excess attractive force which closing coils 20 and 28 are capable of exerting.

The relationship of the characteristics of the opening and closing coils above described is availed of as indicated more clearly in Fig. 2 by connecting closing coil 20 through its terminal 22 and the lead 36 with terminal 34 of the opposing coil 32 of magnet 2. Terminal 21 of coil 20 is joined by a lead 37 to a normally open push button 38 which is connected in turn through leads 39 and 40 with line L–2 of the source of actuating current. Terminal 35 of coil 32 is joined by lead 41 and ballast resistor 42 with line L–1 of the source of actuating current. By reason of the connections above described when the push button 38 is closed coils 20 and 32 become connected in series with one another through the ballast resistor 42 to a source of actuating current.

In similar fashion coil 28 is joined with line L–2 of the actuating current source by leads 40 and 43, a normally open push button 44, lead 45 and the coil terminal 30. The opposite terminal 31 of the coil 28 is joined by a lead 46 with terminal 25 of coil 23 which is connected in turn through its terminal 24, lead 47 and ballast resistor 42 with line L–1 of the actuating current source. Upon closure of push button 44 coils 28 and 23 become connected in series with one another through the ballast resistor 42 with the source of actuating current.

The energization of coils 20 and 32 by closure of push button 38 causes a sufficient attractive force to be applied to the armature 7 to cause the same to move to closed position. Some attractive force is applied by the coil 32 to the armature 8 of magnet 2, but this attractive force by reason of the characteristics of winding 32 is insufficient to move the armature 8. An exactly similar action occurs with respect to coils 28 and 23 upon closure of push button 44. This action results in movement of the armature 8 without any movement of armature 7 taking place. There is thus obtained the normal, simple action of a pair of magnets capable of being alternatively operated.

The interlocking properties of the apparatus of this invention are brought into play when the push buttons 38 and 44 are for any reason operated simultaneously rather than alternatively. For example, if while push button 38 is held in closed position and magnet 1 is in closed position one attempts to simultaneously close the push button 44, magnet 2 will refuse to close by reason of the opposing effect produced by current flowing in coil 32. By reason of the symmetrical arrangement of the circuit it is obvious also that if push button 44 is held in closed position causing magnet 2 to be closed, closure of push button 38 will be without effect to cause closure of magnet 1. It is thus apparent that with the apparatus of this invention, simultaneous operation of the two magnets is precluded without dependence upon any mechanical interlocking device or any magnet operated contacts. The two magnets forming the pair may be spaced any convenient distance apart calling only for simple wire connections between them.

Not only are the magnets of this invention positively interlocked against simultaneous functioning but by reason of the relationship of the coils simultaneous closure of push buttons 38 and 44 calls for a condition under which both magnets are in open position. If, for example, magnet 1 is previously closed by closure of push button 38 closure of push button 44 wil not only fail to cause movement of armature 8 but armature 7 will be caused to drop to open position. The converse is true if push button 44 is first closed followed by closure of push button 38. Where a pair of magnets is employed for the operation of reversing switch mechanism as shown in Fig. 1 the user of the apparatus is thus discouraged from ever attempting to close both push buttons 38 and 44 simultaneously.

The coils 23 and 32 are preferably placed as shown opposite the air gap formed when the armatures 7 and 8 are in open position. By reason of this arrangement under normal operation the impedance of the opposing coils 23 and 32 is low with the result that the closing coils 20 and 28 receive adequate current to cause them to perform the closing function. The closing of either magnet, however, substantially increases the impedance of the opposing coil associated therewith with the result that a subsequent attempt to simultaneously close the opposite magnet is inhibited not only by the effect of the opposing coil of that magnet but by a substantially reduced current supply to its closing coil. If for any reason both magnets should be simultaneously energized for any appreciable period, the impedances of the circuits of both will be ab-

normally low by reason of the open condition of the same, and for this purpose the ballast resistor 42 is provided to limit the current which may be drawn.

The selection of the proper number of turns in any given pair of magnets for the closing and opposing coils may be made on the basis of well known properties of magnetic circuits and will depend upon the dimensions and configuration of the magnet parts and the amount of closing effort required. In one instance in a pair of magnets employed for the actuation of a pair of reversing switches of 50 ampere capacity of well known construction the closing coils were provided with 550 turns while the opposing coils were provided with 275 turns. In this case the magnets were arranged to be operated by alternating current at 115 v. and 60 cycles. A ballast resistor having a resistance of 20 ohms was sufficient to limit maximum current to a moderate value.

In selecting the number of turns to be employed in the opposing coil for any given magnet the same should be of sufficient strength to offset something more than the excess closing force which may be exerted by the closing coil. Since it is important that the opposing coil not exert in and of itself sufficient closing force to move the armature, it is obvious that the closing coil should not be of sufficient strength as to exert a large excess closing force either in the open position or in the closed position of the magnet. For example, in a magnet requiring 4 pounds of closing force when in open position to overcome friction and gravity or other biasing force tending to hold the magnet in open position a closing coil capable of exerting about 5 pounds of closing force would preferably be employed. Under these conditions an opposing coil capable of exerting an opposing effect equivalent to 2 pounds would, if simultaneously energized with the closing coil, reduce the net closing force to 3 pounds which would be inadequate to move the armature. If for any reason the opposing coil were energized alone the closing effort produced thereby would be approximately 2 pounds and this also would be inadequate to cause closure of the magnet. With these relationships in mind the proportioning of windings in any given magnet in accordance with this invention may be arrived at by well known methods. Since each magnet is provided with an independent closing circuit which also acts to preclude closure of the opposite magnet without exerting sufficient attractive force to close the opposite magnet the need for simultaneous weak excitation of the opposite magnet's closing circuit is avoided. In this way the circuit is simplified and an apparatus is provided which fails safe in case of derangement of the closing circuits.

I claim:

In a pair of interlocked alternatively operative electro-magnets the combination comprising a

first field piece, a first movable armature normally biased in open position spaced from said first field piece with an air gap therebetween, a first operating winding for said first movable armature positioned to apply an attractive force thereto when energized sufficient to move said armature through said air gap to closed position with respect to said first field piece, a first opposing winding for said first movable armature encircling said air gap to create when energized an opposing flux sufficient to render the attractive force of said first operating winding ineffective to move said armature, said opposing flux being insufficient in and of itself to create an attractive force sufficient to move said first armature, a second field piece, a second movable armature normally biased in open position spaced from said second field piece with an air gap therebetween, a second operating winding for said second movable armature positioned to apply an attractive force thereto when energized sufficient to move said second armature through said second air gap to closed position with respect to said second field piece, a second opposing winding for said second movable armature disposed about said second air gap to create when energized an opposing flux sufficient to render the attractive force of said second operating winding ineffective to move said second armature, said opposing flux of said second opposing winding being insufficient in and of itself to create an attractive force sufficient to move said second armature, a normally open actuating current supply circuit including means for closing the same joining said first operating winding and said second opposing winding in series adapted to excite said windings when closed and to exclude therefrom when open any substantially effective excitation current, and a normally open actuating current supply circuit including means for closing the same joining said second operating winding and said first opposing winding in series, said circuit being effective to excite said windings when closed and to exclude any substantally effective excitation current therefrom when open.

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