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2,377,137

ELECTROMAGNETICALLY OPERATED SWITCH

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Fig.1.

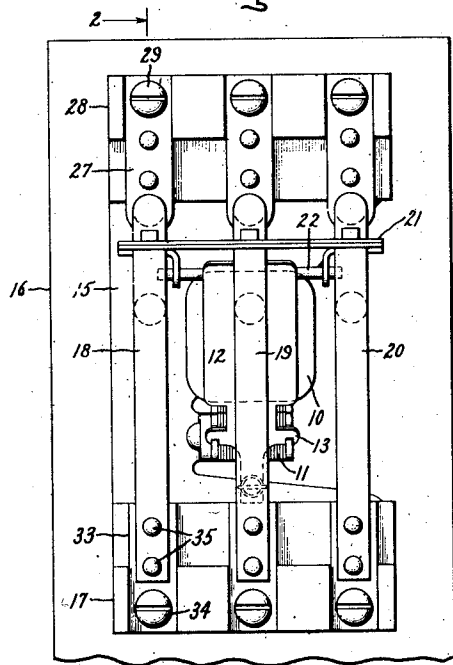


Fig.2.

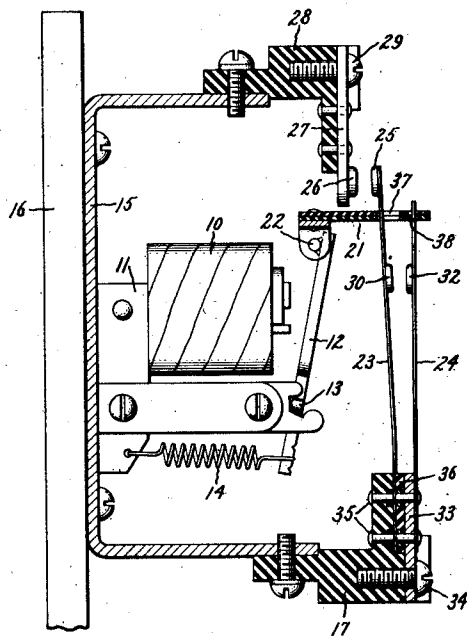


Fig.3.

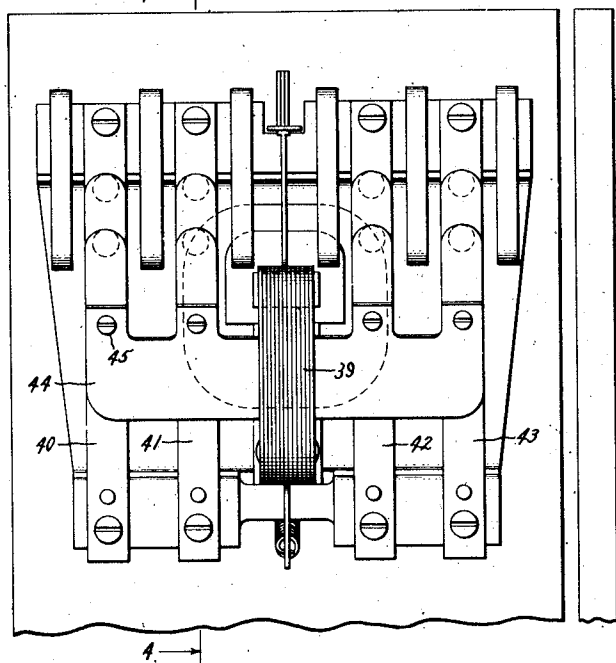
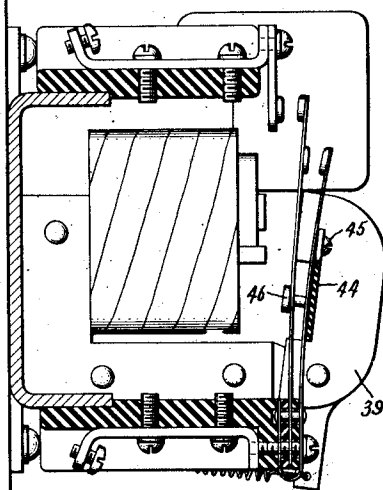


Fig.4.



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ELECTROMAGNETICALLY OPERATED
SWITCH

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2 Claims. (Cl. 200—104)

My invention relates to electromagnetically operated switches, more particularly to contactors of the double break type, and has for its object a simple and reliable switch having greater contact pressure for a predetermined force applied by the armature of the magnet.

In the conventional form of double break contactor the operating force of the armature is applied to the middle of a bridging contact member and, therefore, the force applied to each of the two contacts is approximately one-half of the force applied to the bridging member by the armature.

It is an object of my invention to provide a double break contactor in which the force applied to each pair of contacts is approximately as great as the total operating force of the armature. In carrying out my invention in one form, I provide two spring contact arms of different lengths, the longer of which carries a contact on its end which is movable to engage a stationary contact, and also a second movable contact intermediate its length which is engaged by a contact carried by the shorter contact arm. The longer contact arm is biased to apply a predetermined force to the stationary contact when released, and this force is further increased by the force applied by the operating armature to the shorter contact arm and transmitted to the longer contact arm. When the operating coil is deenergized, the armature is moved to its unattracted position by means of a spring which also forces the longer contact arm to its open circuit position against its bias.

For a more complete understanding of my invention, reference should be had to the accompanying drawing in which Fig. 1 is a front elevation view of a contactor embodying my invention; Fig. 2 is a side elevation view mainly in section along the line 2—2 of Fig. 1 looking in the direction of the arrows; Fig. 3 is a front elevation view of a modified form of my invention; while Fig. 4 is a side elevation view of the device shown in Fig. 3 mainly in section along the line 4—4 of Fig. 3 looking in the direction of the arrows.

Referring to the drawing, I have shown by invention in one form as comprising an operating coil 10 mounted on a magnetic core 11 and provided with an armature 12 pivoted at 13 on the end of one leg of the magnet core and held in its unattracted position by means of a helical tension spring 14. This magnet is mounted in a metal casing 15 which may be secured to the usual insulating panel support 16.

On the lower end of the casing 15 is mounted a support 17 made of electrically insulating ma-

terial which, in turn, forms a support for a plurality of pairs of spring contact arms 18, 19 and 20. These pairs of contact arms are operated simultaneously by the armature 12 by means of a horizontal bar 21 made of electrically insulating material extended across them and pivotally secured at its middle on its left-hand side by means of a pivot connection 22 to the upper end of the armature 12.

It will be understood that the connections between the common operating member 21 and each pair of the contact arms are identical, and these connections will be described with reference to the arms 23 and 24, shown in Fig. 2, which contact arms form the pair 19 of Fig. 1.

As shown, the two spring strip contact arms 23 and 24 are mounted in substantially parallel relation with each other on the insulating support 17 and with the planes of the arms substantially parallel with the pivot axis 13 of the armature so that the arms are free to flex upon movement of the armature. Furthermore, the longer arm 23 is mounted next to the armature and is provided on its end with a movable contact 25 which cooperates with a stationary contact 26. This stationary contact 26 is mounted on a bar of electrically conducting material 27 secured to a support 28 made of electrically insulating material which, in turn, is secured to the upper side of the casing 15. A screw 29 is provided in the bar 27 by means of which electrical connections can be detachably made with the bar and stationary contact 26, the bar and screw thus forming a terminal connector for the switch.

Also, the longer arm 23 carries a second movable contact 30 which is on the opposite side of the arm as compared with the contact 25 and, as shown, is in a position lengthwise of the contact arm about one-half the distance from the contact 25 as from the lower end of the contact arm at the point where it is secured to the support 17. On the shorter contact arm 24 is a movable contact 32 which is arranged upon flexure of the shorter contact arm toward the other to engage the movable contact 30.

The lower ends of the two contact arms are secured to the support 17 in electrically insulating relation with each other, the shorter arm 24 being electrically connected to a bar 33 forming a second terminal connector of the switch and provided with a connection screw 34. As shown, the lower ends of the two arms are secured by rivets 35 to the support 17 which, at the same time, clamps the arm 24 against the bar 33. A layer of insulating material 36 is provided be-

tween the bar 33 and the arm 25 and, furthermore, cylindrical insulators, as shown, are provided around the rivets 35 where they pass through holes in the arm 23.

The longer arm 23 is bent or shaped so that it has a spring bias to move its upper end toward the left hand and bring the contact 25 into engagement with the contact 26 with a predetermined force. As shown in Fig. 2, the arm 23 is bent by the operating member 21 against its bias toward the right hand so that the contacts 25 and 26 are in their full open spaced relation. This is effected by means of a loose connection between the member 21 and the arm 23, the arm 23 extending at its upper end through an aperture 37 in the operating member 21 which is elongated in the direction of movement of the arm and arranged so that when the armature is held by the spring 14 in its fully unattracted position, as seen in Fig. 2, the left-hand wall of this opening engages the arm 23 and forces it toward the right to the position shown.

A similar connection is provided between the shorter arm 24 and the operating member 21, the upper end of the arm extending through an aperture 38 in the member 21. In this case, however, the aperture 38 is large enough only to provide a loose connection with the arm 24. When in its open circuit position, as shown in Fig. 2, the arm 24 has no bias and applies no force either in an opening or closing direction to the operating member 21. As shown, the upper end of the arm 24 is reduced in width to provide shoulders on which the right-hand end of the member 21 is supported.

Thus it will be observed that when the arms are in their open positions, as shown in Fig. 2, the spring 14 must exert a force great enough to overcome the bias toward the left hand or closed position of the arm 23 and hold this arm in its open position. It will be observed that this arrangement forms a double break switch between the two terminal connector straps 27 and 33, the portion of the longer arm 23 between its two movable contacts 25 and 30 corresponding to the conventional bridging contact, and the two pairs of contacts 25, 26 and 30, 32 being connected in series with each other between the terminal connector strips.

When the coil 10 is energized, the armature 12 is moved toward the left to its attracted position thereby moving the contact arms to their closed positions. During the first part of the movement of the armature, the electromagnetic force exerted on the armature is equal to the difference between the opposing force applied by the spring 14 and the assisting force applied by the arm 23 to the operating member 21. As the armature moves, the force applied by the spring increases somewhat as the spring is stretched and the oppositely directed bias of the arm 23 may decrease slightly before engagement of its contact 25 with the stationary contact 26. When this occurs, the bias of the arm 23 is suddenly removed from the armature and the movement of the armature is now opposed by the full force applied by the spring 14 and the opposing spring force of the arm 24. It will be understood that the arm 24 is moved continuously with the operating member 21 and, consequently, the force applied by the arm 24 opposing the movement of the armature increases somewhat, as does also the force applied by the spring 14.

By the time the contact 25 has engaged the contact 26, the armature has moved toward its at-

tracted position far enough so that the magnetic force operating it has increased greatly as compared with the force applied to the armature when the armature was in its fully unattracted position. Consequently, the force applied to the armature is amply sufficient to continue its movement after the sudden removal of the biasing force of the arm 23.

As the armature continues its movement, the contact 32 engages the contact 30. This will be the point where the armature is near its fully attracted position so that the armature has ample force applied to it to continue its movement to its attracted position thereby applying a predetermined force to the contacts 32 and 30, which force probably will bend the arm 23 somewhat. It will be observed, however, that this force applied to the contact 30 is transmitted in part to the contact 25 thereby increasing the force applied to that contact. Thus by suitably arranging the relative strengths of the arms 23 and 24 and the leverage ratio between the contacts 30 and the upper and lower ends of the arm 23, equal forces may be applied to the two pairs of contacts, this force being substantially equal to the force applied by the magnet through its armature and the operating member 21. Thus, if the arm 23 applies a bias to its contact 25 of 1 ounce, and the armature in its attracted position applies a force of 3 ounces to the contact 32, which in turn results in 2 ounces additional force applied to the contact 25, then the device applies a force to each pair of contacts or contact surfaces equal to the force applied by the armature of the magnet.

It will be understood that any desired number of pairs of contact arms may be used. The device shown with three pairs is specially designed for use in a three-phase circuit, such as the circuit of a three-phase motor.

This arrangement of the arms 23 and 24, it will be observed, results in a gradual application in steps of the required operating load to the magnet as the magnet moves toward its attracted position. Thus, when the magnet is in its fully unattracted position, as seen in Fig. 2, the force opposing movement of the armature to its attracted position, i. e., the load on the armature, is the force applied by the spring 14 minus the opposing force of the spring bridging contact arm 23. In other words, at this time the magnetic force available is at a minimum and the load on the armature is also at a minimum and is less than the force applied by the armature biasing spring 14. Then, when the contact 25 engages the contact 26, the force of the spring arm 23 is suddenly removed and the load on the armature is thereby suddenly increased to the total force of the spring 14 plus the force required to bend the spring arm 24. However, at this time the armature has moved a considerable distance toward its attracted position, and consequently its magnetic force is ample to move the armature with this increased load. As the armature moves still further, the contact 32 engages the contact 30 when an additional load is added consisting of the force required to bend the arm 23. In other words, the movement of the armature toward its attracted position is begun with a relatively light load and the load is increased in two steps, the first when the contact 25 engages the contact 26, and the second when the contact 32 engages the contact 30. Finally, when the armature reaches its fully attracted position, the load on it is equal to the force applied by the spring 14 plus the forces required to bend the spring arms 23 and 24.

This arrangement for the increase of the load on the armature as the magnetic force available to move the armature increases makes possible the use of a smaller coil for a given biasing spring 14 and given contact pressures. A relatively strong biasing spring 14 is desirable to assure separation of the contacts but, as previously observed, the full load of this spring 14 is applied to the armature only when the contact 25 engages the contact 26. In the modified form shown in Figs. 3 and 4, a somewhat different mechanical connection is provided between the armature 39 and the pairs of arms 40, 41 and 42, 43. This connection consists of a bar 44 made of electrically insulating material extending across the pairs of arms and suitably connected by screws 45 to the outer shorter arms of the pairs. The bar 44 is also suitably connected to the armature so as to be moved by the armature. This arm extends in front of the armature which is at substantially the middle of the arm so that when the armature is attracted, the two arms of each pair are moved to their closed positions in the manner described in connection with Fig. 2. Moreover, the bar 44 is provided with a plurality of stop pins 46 having enlarged heads which pass loosely through suitable holes (not shown) provided for them in the longer contact arm whereby when the armature is in its unattracted position shown, the heads of the screws pull the longer arms to their open circuit positions against their biases to their closed circuit positions.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electromagnetically operated double break switch comprising a coil, an armature for said coil, a spring for biasing said armature to its unattracted position, a stationary contact, a bridging arm having a first movable contact movable into engagement with said stationary contact and a second movable contact on its opposite side, a contact arm having a third movable contact engageable with said second movable contact, means biasing said contact arm to an open circuit position in disengaged relation with said second movable contact, means biasing said bridging arm to bring said first movable contact into engagement with said stationary contact, a loose connection between said bridging arm and said armature whereby said bridging arm is held by

said spring in an open circuit position when said armature is in its unattracted position, and a connection between said armature and said contact arm providing for the positioning of said contact arm in its said open circuit position in accordance with its bias when said armature is in its unattracted position, said armature when moved to its attracted position being first opposed by the forces of said spring and the bias of said contact arm minus the biasing force of said bridging arm until said first movable contact engages said stationary contact at which time said armature moves independently of said bridging arm against the combined forces of said spring and the bias of said contact arm until said third movable contact engages said second movable contact.

2. An electromagnetically operated double break switch comprising a coil, an armature for said coil, a spring for biasing said armature to its unattracted position, a stationary contact, a spring bridging arm having a first movable contact on one end movable into engagement with said stationary contact and a second movable contact on its opposite side spaced along said bridging arm from said first movable contact, a spring contact arm having a third movable contact engageable with said second movable contact, said contact arm being biased by its own resiliency to an open circuit position in disengaged relation with said second movable contact and said bridging arm being biased by its own resiliency to bring said first movable contact into engagement with said stationary contact, a loose connection between said bridging arm and said armature whereby said bridging arm is held by said spring in an open circuit position when said armature is in its unattracted position, and a connection between said armature and said contact arm providing for the positioning of said contact arm in its said open circuit position in accordance with its bias when said armature is in its unattracted position, said armature when moving to its attracted position being first opposed by the forces of said spring and said contact arm minus the biasing force of said bridging arm until said first movable contact engages said stationary contact at which time said armature moves independently of said bridging arm against the combined forces of said spring and said contact arm until said third movable contact engages said second movable contact after which said armature is opposed in moving to its attracted position by the force of said spring plus the force required to bend said two arms.

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