Oct. 24, 1944. L. T. RADER 2,361,238

ELECTRIC SWITCH

Filed June 26, 1943

Fig. 1.

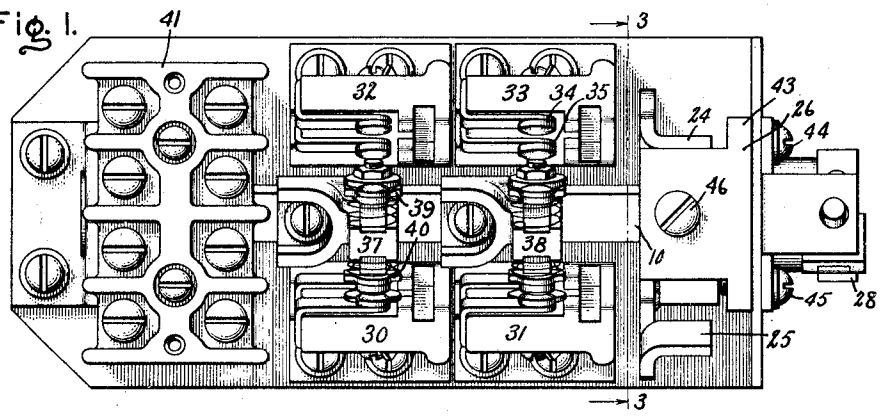



Fig. 2.

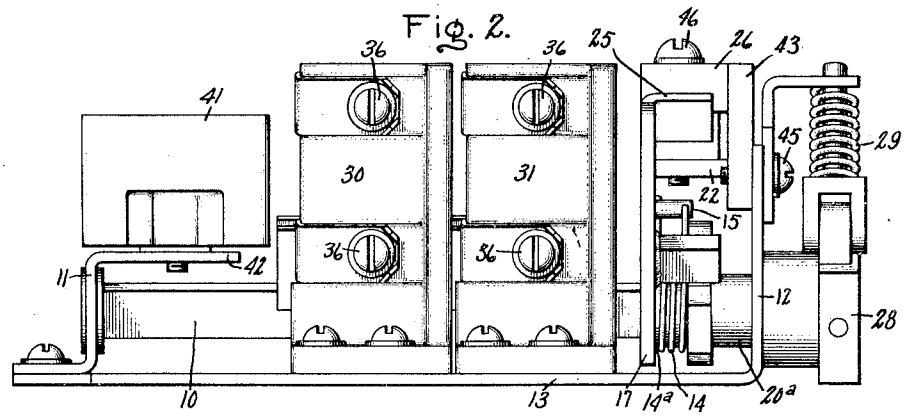
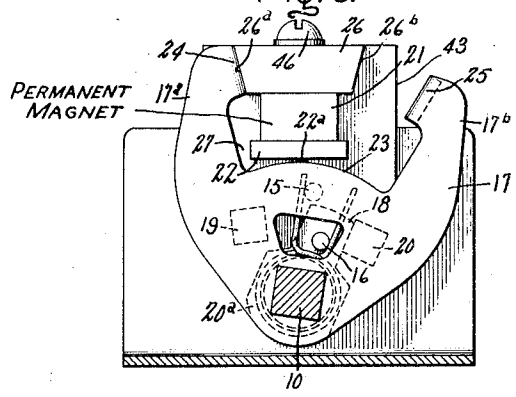



Fig. 3.




Inventor:
Louis T. Rader,
by Harry C. Dunham
His Attorney.

Patented Oct. 24, 1944

2,361,238

# UNITED STATES PATENT OFFICE

2,361,238

## ELECTRIC SWITCH

Louis T. Rader, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application June 26, 1943, Serial No. 492,431

4 Claims. (Cl. 74—97)

My invention relates to electric switches, more particularly to mechanically operated limit switches, and has for its object a simple and reliable magnet snap action mechanism for snapping the movable element of the switch between its two positions.

My invention is especially useful in limit switches of the type described and claimed in Patent 2,175,932, issued on October 10, 1935, to Kenneth J. Unwin. The device of this patent is provided with a permanent magnet for effecting a snap action of the movable switch element, this magnet having two pairs of pole faces engaged alternately by mechanically operated armatures. One of the pole faces of each pair is spaced slightly from the armature when in its attracted position to provide an air gap. While this arrangement is perfectly operable, it has been found that in installations requiring operation of the switch many million times, the restriking of each armature on the single pole face gradually pounds down the pole face which reduces the length of the air gap between the armature and the other pole face of the same pair, and consequently increases the magnetic holding force applied to the armature. This increased holding force causes increased wear on various parts of the mechanism with the result that the mechanism wears out quickly.

In accordance with one form of my invention, I provide as before a single pole for engagement with each of the two armatures, but in place of an air gap between two other poles of the magnet and the armatures respectively, I extend or position the magnet so that the air gap is formed with relation to the hub of the switch operating member bearing the armatures. Thus the air gap is independent of the position of the armature and the pole faces of the magnet may be hammered down by the impact of the armatures for an indefinite time without affecting the length of the air gap.

For a more complete understanding of my invention, reference should be had to the accompanying drawing in which Fig. 1 is a plan view of a limit switch embodying my invention; Fig. 2 is a side elevation view of the device shown in Fig. 1; and Fig. 3 is a view partly in section taken along the line 3—3 of Fig. 1 looking in the direction of the arrows.

Referring to the drawing, in one form of my invention I provide a switch operating shaft 10 which is square for convenience in attaching the various switch parts to it, except at its ends which are cylindrical and rotatably supported on the upright supports 11 and 12 secured to a metallic base member 13. The operating shaft 10 is provided with a helical snap spring 14 surrounding a cylindrical hub 14*a* attached to the shaft and having its ends on opposite sides of two pins 15 and 16 extending lengthwise of the shaft. These pins are secured, respectively, to an armature member 17, rigidly mounted at its lower end on the shaft, and a laterally extending projection 18 which is movable through a predetermined angle between projections 19 and 20 carried by the armature member 17. The projection 18 is mounted in a hollow cylindrical member 20*a* which forms a bearing for the right-hand end of the shaft 10 and is in turn journalled in the support 12. In order to give an initial restraining force to effect the snap action, a permanent magnet 21 is mounted in position with its center line passing through the axis of the shaft 10 and perpendicular thereto to restrain the armature member for movement in each direction. The magnet also holds the armature member in each position to which the armature is snapped.

In accordance with my invention, I provide a single pole piece 22 at the lower end of the magnet, which pole-piece extends transversely with respect to the center line of the magnet 21 and is in a predetermined spaced relation with an arcuate section 23 on the armature member. Thus magnetic flux passes from the pole piece 22 through the air gap 22*a* to the armature member, and thence through one or the other of the two arms 17*a* and 17*b* of the armature member and one or the other of the pole pieces 24 or 25 to an upper pole piece 26 on the magnet 21. It will be noted that each of the two arms together with the arcuate section constitutes an armature.

The permanent magnet 21 preferably is made of a material having a high coercive force and a high resistance to change in magnetic properties due to shock. One such material is an alloy of 12 per cent aluminum, 25 per cent nickel, and 5 per cent copper, the balance being mainly iron, such as described and claimed in Patent 1,947,274, issued on February 13, 1934, to William E. Ruder, and Patent 2,027,997, issued on January 14, 1936, to Tokushichi Mishima.

The upper magnet pole piece 26 is provided with two pole faces 26*a* and 26*b* at its opposite ends which are bevelled downward and preferably lie in planes passing through the axis of the shaft 10. The armature pole pieces 24 and 25 have pole faces which likewise lie in planes

passing through the axis of the shaft 10 and fit on the pole faces 26a or 26b, depending upon the position of the armature member.

It will thus be observed that the hammering or battering down action of the pole pieces 24 and 25 on the magnet pole faces has no effect in reducing the air gap 22a between the pole piece 22 and the arcuate section 23. Consequently, this latter air gap remains uniform throughout the life of the device.

The air gap between the side edges of the pole piece 22 and the armatures, such as the air gap 27 between the side of the pole piece 22 and the left-hand arm of the armature member, is many times greater than the air gap 22a between the end of the pole piece 22 and the portion 23. This air gap 27, furthermore, can be increased if desired and made much greater than shown on the drawing. In any case, it is long enough so that a great amount of pounding down of the faces 26a and 26b can be effected without any effect on the length and function of the air gap between the parts 22 and 23. Of course, it will be understood that when the armature member is thrown to its counterclockwise position with the pole piece 25 in engagement with the armature face 26b, an air gap similar to the air gap 27 is provided between the right-hand arm of the armature member and the pole piece 22. Preferably, the movable pole pieces 24 and 25 are hardened to reduce the wear and hammering effect on them.

In the operation of this switch the operating shaft 10 is operated by mechanical engagement of a part carried by the member 20a with an operating member secured to the moving part of the machine being controlled, such as paper planer, milling machine, lathe, etc., as described in the aforesaid Unwin patent. Thus, as the part of the machine operating the switch moves back and forth, it turns the member 20a through a small angle sufficient to throw the switch from one position to another and thereby effect a control operation, such as the reversal of the driving motor for the machine. Thus to move the shaft 10 counterclockwise, as viewed in Fig. 3, the operating member 20a, which is journalled on the outer cylindrical end of the shaft 10 and in turn mounted for rotation in the support 12, is turned in a counterclockwise direction, as seen in Fig. 3, whereby the pin 16 engages and moves the left-hand end of the spring 14 toward the left, the other end of the spring bearing on the pin 15. This end bearing on the pin 15 applies a counterclockwise force to the armature member 17 which tends to overcome the force of the magnet. In any case, as the member 28 is turned, the projection 18 engages the projection 19 and forcibly disengages the armature member from the magnet whereupon the spring 14 snaps the armature member counterclockwise to its opposite position.

It is believed that the reverse operation to the position shown in Fig. 3 will be obvious from the preceding description.

As described and claimed in the aforesaid Unwin patent, I also provide a helical over-center snap spring 29 whose function is to turn the operating member 20a still farther in its operating direction after the armature member has snapped to its other position. This additional movement of the operating member turns it out of the path of the part of the machine which operated it, thus providing for free movement of the machine.

Any suitable switching means can be secured to the shaft 10. As shown, I have provided four supports 30, 31, 32 and 33 mounted in two pairs on opposite sides of the shaft. These supports are made of a suitable electrically insulating material, such as a molded phenolic resin product. Each is provided with two stationary contacts 34 and 35 mounted on electrically conducting U-shaped pieces whose outer ends are provided with quickly detachable screws 36 for the connection of electrical conductors thereto. Mounted on the shaft are two electrically insulating supports 37 and 38, each being provided with a pair of bridging contacts 39 and 40 mounted on opposite sides in position to engage the corresponding pair of stationary contacts. A terminal connection member 41, also made of an electrically insulating material, is mounted on a projection 42 on the support 11. These various parts are secured to the supports 11 and 13 by suitable screws, as shown in the drawing.

As shown, the magnet 21 is supported on the upper pole piece 26 which in turn is secured to the upper end of a rectangular plate support 43. The support 43 is in turn secured at its lower end by screws 44 and 45 to the upper end of the support 12. A non-magnetic screw 46 secures the magnet 21 and lower pole piece 22 to the upper pole piece 26. Although the screw 46 may be made of magnetic material and still make the device operable, it is essential for best performance that this screw be of non-magnetic material. Otherwise it will tend to short-circuit the useful working flux.

It will be understood that under certain conditions requiring the magnet to hold the armature in only one position, only one armature pole piece 24 or 25 may be provided and only one magnet pole face 26a or 26b.

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. A switch comprising an operating shaft, a permanent bar magnet mounted in a fixed position with relation to said shaft and provided on one end with oppositely disposed pole faces, an armature member secured to said shaft having a pair of arms on opposite sides of said magnet provided with pole pieces for engagement alternately with said magnet pole faces, a rotatably mounted operating member, a loose connection between said operating member and said armature for disengaging said armature from said pole faces, a spring for snapping said armature to its other position after such disengagement, said armature being provided with an arcuate portion between said arms in closely spaced air gap relation with the other end of said magnet, thereby to maintain a predetermined air gap irrespective of the final attracted position of said armature.

2. A switch comprising an operating shaft, a permanent bar magnet mounted in a fixed position with relation to said shaft and provided on one end with oppositely disposed pole faces, an armature member secured to said shaft having a pair of arms on opposite sides of said magnet provided with pole pieces for engagement alternately with said magnet pole faces, an operating member rotatably mounted on one end of said shaft, a laterally extending projection on said operating member, a pair of pins extending

lengthwise of said shaft mounted respectively on said armature and said projection, a helical snap spring surrounding said operating member and having its ends extending laterally away from said shaft on opposite sides of said pins, said armature being provided with an arcuate portion between said arms in closely spaced air gap relation with the other end of said magnet, and projections on said armature spaced apart on opposite sides of said first projection and engageable by said first projection upon turning movement of said operating member thereby forcibly to move said armature against the pull of one or the other of said oppositely disposed pole faces whereupon said armature is snapped by said spring into engagement with the other of said magnet pole faces.

3. The combination in a snap action device, of a permanent magnet mounted in a fixed position and provided with a first pole face at one end and a second pole face at its other end extending transversely with respect to said first pole face, an armature pivotally mounted for movement about an axis substantially parallel with said first pole face and provided with an arcuate portion having a surface in a predetermined spaced relation with said first pole face during pivotal movement of said armature about said axis, an arm on said armature provided with a pole piece movable upon movement of said armature about said axis to an attracted position in engagement with said second pole face and to an unattracted position in spaced relation with said second pole face, said arcuate portion being coextensive with the angular movement of said armature between said positions so that the surface of said arcuate portion is a predetermined distance from said first pole face throughout the range of movement of said armature, and means for operating said armature with a snap action into engagement with said second pole face.

4. A switch comprising a permanent bar magnet mounted in a fixed position and provided with oppositely disposed pole faces at one end, an armature member mounted for limited rotation and having a pair of spaced apart arms on opposite sides of said magnet provided with pole pieces for engagement alternately with said magnet pole faces when said armature is rotated between two positions, an operating member for said armature member, a snap spring between said operating member and said armature member for rotating said armature member with a snap action between said two positions, said armature member being provided with an arcuate portion between said arms coextensive with the angular movement of said armature between said positions, and a third pole face on the other end of said bar magnet having its face in a predetermined spaced relation with said arcuate portion throughout the entire movement of said armature between said positions.

LOUIS T. RADER.