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J. B. KNUTSON

2,641,664

SWITCH

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2 Sheets-Sheet 2

FIG. 3

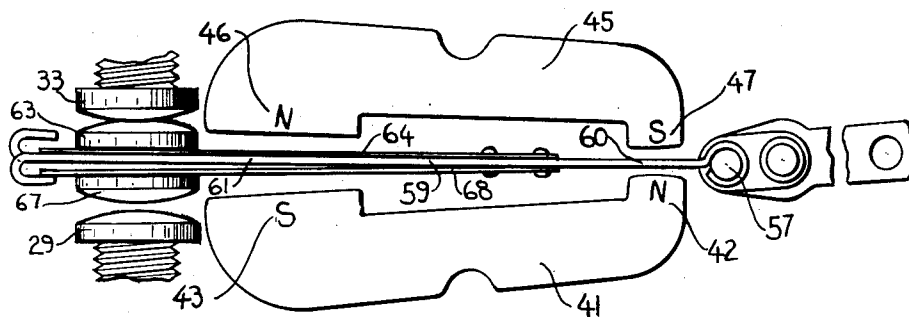


FIG. 4

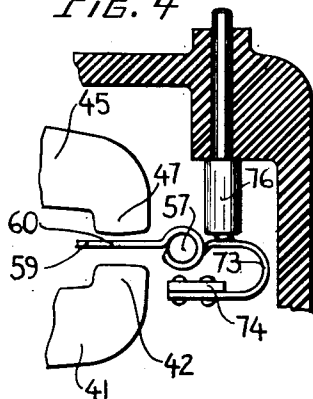


FIG. 5

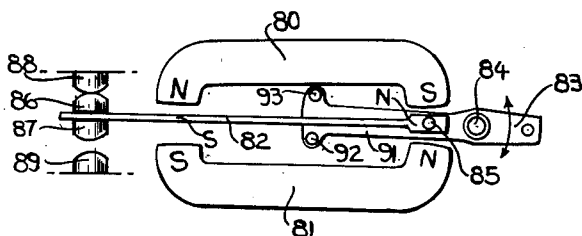


FIG. 6

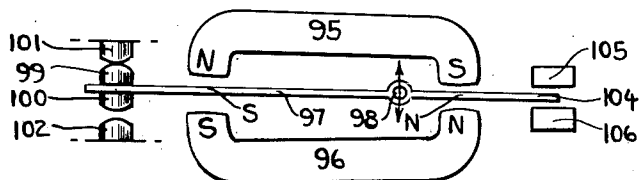
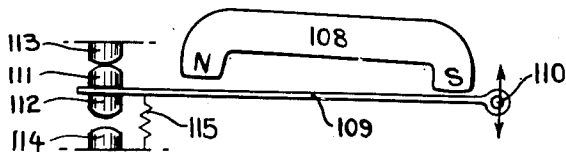


FIG. 7



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UNITED STATES PATENT OFFICE

2,641,664

SWITCH

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6 Claims. (Cl. 200—67)

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This invention relates to switches, and particularly to switches in which the switching operation is accomplished with a snap action.

An object of the invention is to provide a mechanically actuated snap switch requiring no springs or other flexible members for storing or giving up energy prior to the snap action, but in which the required energy is stored by moving an armature in a magnetic field.

Another object is to provide a switch in which snap action is produced by a floating armature movable between the poles of two permanent magnets of reversed polarity, one end of the armature being actuated to determine the polarity of the opposite end which, in turn, actuates the switching means.

It is also an object to provide a switch having an armature opposite ends of which are movable in separate magnetic fields so that gradual positioning of one of the ends of the armature results in sudden movement of the other end for actuating electric contacts or other switching means with a snap action.

Other objects will be evident from the following written description together with the claims and the drawing, in which:

Figure 1 is a plan view of a switch embodying my invention, with the cover removed,

Figure 2 is a sectional elevation of the switch of Figure 1 with the cover in place,

Figure 3 is a fragmentary plan view of the switch of Figure 1 showing the mechanism in a position in which snap action is about to occur, and

Figure 4 is a fragmentary view of a modified form of actuating mechanism,

Figure 5 is a diagrammatic view of a switch having an armature pivoted directly between a pair of opposing poles of two magnets,

Figure 6 is a diagrammatic view of a switch having an armature pivoted intermediate the poles of two opposed magnets, and

Figure 7 is a diagrammatic view of a switch embodying certain features of the invention but employing only one magnet.

In the illustrative embodiment of the invention an elongated armature of low magnetic retentivity is located between two permanent magnets the poles of which are reversed so that each end of the armature is under the influence of both a north and a south magnetic pole. By limiting the approach of the contact carrying end of the armature to both the north and south poles it is possible to determine the polarity and therefore the position of that end of the arma-

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ture by actuating the opposite end of the armature into somewhat closer proximity to its associated magnetic poles. If the actuated end of the armature is brought closer to the north than to the south pole then a south pole will be induced in that portion of the armature and a north pole will be induced in the opposite end of the armature, which induced pole will be repelled by the associated north pole and attracted by the associated south pole. If the actuated end of the armature is then moved toward the south pole, the polarity of both ends of the armature will be reversed and the armature will snap to its other operative position.

While the particular switch to be described is of the type adapted to be actuated by very small mechanical displacement of the switch actuator, the principle of operation obviously is applicable to other switches and mechanisms.

Referring now to Figures 1, 2 and 3 of the drawing, a base 10 of suitable insulating material such as Bakelite has three electrically conducting inserts 11, 12 and 13 molded therein. The inserts are tapped to receive binding screws 15, 16 and 17 to facilitate connecting the switch to suitable external lead wires. A conducting plate 20 lies along the top surface of the base 10 and is secured thereto by staking to the insert 12. The plate 20 is provided with an opening surrounding the insert 11 but is insulated therefrom by an upwardly extending portion 21 of the base 10. A plate 23 is staked to an extension 25 of the insert 11 and is spaced from the plate 20 by an insulating washer 26. The plate 23 also serves to secure the left end of the plate 20 to the base 10. The plate 20 is bent at right angles to the base to form an ear 28 to carry a stationary contact 29 which has a portion 30 screw-threaded in the ear 28. Likewise the plate 23 is bent at right angles to the base to provide an ear 32 which carries a stationary contact 33. The contact 33 is also provided a portion 34 which is screw-threaded in the ear 32 to permit adjustment.

The base 10 is formed to provide two raised portions 37 and 38 which support a plate 40 in spaced relation to the base. The plate 40 carries a permanent magnet 41 having a north pole 42 and a south pole 43, and also carries a permanent magnet 45 having a north pole 46 and a south pole 47. A strip 49 extends over both of the magnets and is fastened to the base 10 by a pair of screws 50 and 51 to secure both the magnet and the plate 40 to the base 10. It will be seen that the actual polarity of the two poles

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of each of the magnets is of no importance. The only requirement is that opposing poles of the two magnets be of opposite polarity.

A pivot post 53 is secured to the plate 49 with its axis perpendicular to the plate 40 and lying in a plane equally spaced from the opposing poles of the magnets 41 and 45 and equally spaced from the stationary contacts 29 and 33. An actuating member 54 and an actuating lever 55 are pivoted on the post 53. The actuating member 54 carries a pivot pin 57 on which an armature 59 is pivotally mounted. The armature 59 is of magnetic material of low magnetic retentivity, for example, soft iron. The armature 59 has a portion 60 lying between the north pole 42 of magnet 41 and the south pole 47 of magnet 45. The armature 59 also has a portion 61 lying between the south pole 43 of magnet 41 and the north pole 46 of magnet 45.

A movable contact 63 that cooperates with stationary contact 33 is carried on the armature 59 by a thin resilient pressback blade 64 which is riveted to the armature 59 at 65. An extension 66 of the armature 59 is bent to engage the remote side of the blade 64 to limit the possible extent of separation of the blade 64 from the armature 59. The blade 64 is preformed to normally engage the stop portion 66 when the contacts 33 and 63 are out of engagement. Likewise, a movable contact 67 is carried on a pressback blade 68 and is adapted to cooperate with the stationary contact 29. The blade 68 is also riveted to the armature 59 at 65 and is preformed to engage a stop portion 69 on the armature 59 when the contact 67 is out of engagement with the contact 29.

A suitable flexible connection 71 is soldered both to the armature 59 and to the insert 13 to provide an electrical connection between the insert 13 and the movable contacts 63 and 67.

Operation

It will be noted that engagement of the movable contact 63 and stationary contact 33 limits the possible approach of armature portion 61 to the north pole 46 of the permanent magnet 45. Likewise, engagement of movable contact 67 with the stationary contact 29 serves to limit the possible approach of the armature portion 61 to the south pole 43 of the permanent magnet 41. The north pole 42 of the magnet 41 and the south pole 47 of the magnet 45 are located somewhat closer together than the opposite poles of these magnets, and the armature portion 60 may be moved into close proximity to these poles by actuation of the lever 55 which moves the armature pivot 57.

In the armature position shown in Figure 1 the south pole 47 of the magnet 45 induces a north pole in armature portion 60 since the north pole 42 of the magnet 41 is more remote from the armature and therefore has less influence thereon. Also, the portion 61 of the armature is closer to the north pole 46 of the magnet 45 than it is to the south pole 43 of the magnet 41 and a south pole will be induced in this portion of the armature.

If the armature pivot 57 is moved from the position shown in Figure 1 to that shown in Figure 3, in which the armature portion 60 is closer to the north pole 42 of the magnet 41 than to the south pole 47 of the magnet 45, there will be a tendency to induce a south pole in the armature portion 60. However, the armature portion 61 remains closer to the north pole 46 of the

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magnet 45 than to the south pole 43 of the magnet 41 and there will remain a tendency to induce a south pole in the armature portion 61. If the armature portion 60 is now moved slightly closer to the north pole 42 of the magnet 41 a stronger south pole will be induced in the portion 60 and this south pole will tend to induce a north pole in the armature portion 61. The pressback blade 64 is tending to move the portion 61 of the armature 59 away from the pole 46 and toward the pole 43, and this effect will aid the induced magnetic effect in initiating movement of the armature toward the magnet 41. Once movement is started in this direction the magnetic effect will be cumulative since the armature portion 61 will be moving out of the effect of the north pole 46 and toward the south pole 43. Likewise the armature portion 60 will be moved slightly closer to the north pole 42. Hence, movement of the armature 59 will continue until the contact 67 is in engagement with contact 29 and the pressback blade 68 which carries contact 67 is lying flat against the armature 59. The contacts and armature will then be in a position similar to that shown in Figure 1 but with the armature 59 lying closer to the magnet 41 and with the opposite set of contacts in engagement. Reverse operation of the armature and movable contact is accomplished in the same way as has been described.

It is not necessary that the armature portion 60 be brought into actual engagement with the pole pieces 42 or 47 since it is possible to induce a sufficiently strong polarity in the armature by merely bringing the armature into close proximity with the poles. Since the armature portion 61 is limited in its approach to the poles 43 and 46, it is the position of the armature portion 60 that controls the polarity of the entire armature. Also, it is not essential to the operation of this switch that the movable contacts be supported on pressback blades but the use of pressback blades determines certain practical operating characteristics of the switch as is well known in the art.

In the illustrated switch no means is provided to limit movement of the actuating member 54. If the device that is to actuate the switch is not provided with stops for limiting movement it may be desirable to incorporate suitable internal stops to limit movement of the member 54. Otherwise continued upward movement of the pivot 57 as seen in Figure 1 might cause engagement of the armature portion 60 with the pole 47 which could then act as a fulcrum to cause movement of the armature 59 to separate the contacts 63 and 33.

Figure 4 shows a modified form of the actuating mechanism. Here the pivot 57 for the armature 59 is carried by a spring strip 73 the other end of which is fixed to a support 74 carried by the switch base. An actuating pin 76, which may be guided for longitudinal movement in the switch base or in a suitable cover, engages the spring strip 73 to shift the pivot 57. The strip 73 is formed normally to hold the armature portion 60 in a position adjacent the pole 47 on the magnet 45. If the actuating pin 76 is depressed from the position shown in Figure 4 the armature 59 will be actuated to shift the movable contacts, and release of the pin 76 will permit the spring strip 73 to return contacts to their original position. Otherwise the switch will operate exactly the same way as that described above.

The switch shown in Figure 5 operates in the

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same way as the switch shown in Figure 1, the principal difference being that the armature supporting pivot is located directly between the poles of the two permanent magnets rather than beyond these magnets as in Figure 1. Here a pair of permanent magnets 80 and 81 have dissimilar poles on opposite sides of corresponding portions of an armature 82. An actuating arm 83 is pivoted at 84 and has the armature pivoted thereto at 85 directly between the south pole of magnet 80 and north pole of magnet 81. The opposite end of the armature 82 carries movable contacts 86 and 87 which are adapted to engage stationary contacts 88 and 89. The actuating arm 83 has an extension 91 which carries a pair of stops or abutments 92 and 93 adapted to engage the armature 82 intermediate its ends. The stops 92 and 93 engage the armature 82 only if the actuating arm 83 is moved beyond the position at which the contacts would normally be operated. If the arm 83 is moved to separate the contacts 86 and 88 a stop 93 will engage the upper side of the armature 82 to positively separate the contacts in case they should become stuck for any reason. Likewise the stop 92 is adapted to engage the armature in case the contacts 87 and 89 should be stuck.

Figure 6 shows a further modification of the invention in which the armature is pivoted at a point intermediate the two pairs of magnetic poles. Here a pair of permanent magnets 95 and 96 have dissimilar poles disposed on opposite sides of corresponding portions of an armature 97. Suitable means, not shown, actuates the armature pivot 98 to position the armature relative to the south pole of magnet 95 and the north pole of magnet 96. The opposite end of the armature 97 carries movable contacts 99 and 100 which are adapted to cooperate with stationary contacts 101 and 102. Operation of this switch is similar to the switch of Figure 1, but since the pivot for the armature is located between the magnetic poles the portion of the armature between the south pole of magnet 95 and the north pole of magnet 96 will be withdrawn slightly from the pole toward which it has been moved by movement of the pivot 98 on movement of the movable contact. This effect may be desirable in certain cases reducing the operating differential of the switch. The armature 97 is provided with an extension 104 lying between a pair of fixed stops 105 and 106. The armature does not normally engage either of these stops but if the pivot 98 is moved to a position which normally should cause contact actuation, then further movement of the armature will result in one of the other of the stops 105 or 106 acting as a fulcrum for positively separating the contacts.

Figure 7 shows a modification employing only one permanent magnet. A magnet 108 has its two poles disposed adjacent an armature 109 that is pivoted at 110. The remote end of the armature carries movable contacts 111 and 112 that are adapted to cooperate with stationary contacts 113 and 114. Engagement of the contacts 111 and 113 limits the approach of the armature to the north pole of the magnet 108. The pivot 110 is adapted to be actuated to bring the armature toward the south pole of the magnet 108 and also to separate it therefrom. Biasing means here shown as a spring 115 tends to withdraw the armature 109 from the north pole of the magnet 108. When the pivot 110 is moved to bring the armature close to the south magnetic pole the flux density between the armature and the north

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magnetic pole is increased to a value sufficient to raise the attraction between the north magnetic pole and the armature to a value greater than the force in the opposite direction provided by the spring 115. When the pivot 110 is moved to move the armature 109 away from the south magnetic pole the flux density at the north magnetic pole is reduced to a value below the force of the spring 115 and the armature will move to separate the contacts 111 and 113 and to cause engagement of the contacts 112 and 114.

In each of the modifications described above permanent magnets have been employed that have their north and south poles disposed longitudinally of the armature. Such construction has the advantage of providing a return magnetic path for the flux that passes through the armature. However, the magnets could be otherwise arranged. As an example, one permanent magnet might have its opposite poles disposed on opposite sides of one portion of the armature and another permanent magnet could have its poles disposed on opposite sides of another portion of the armature. Also it would not be essential in every case that magnetic poles be provided for each side of both ends of the armature, and it would be possible to provide an operating device in which any one of the four poles were omitted.

Numerous arrangements of the poles not illustrated might be provided. For example a device could be made similar to that shown in Figure 7 but with the two magnetic poles on opposite sides of opposite ends of the armature.

While the device has been shown as a single-pole double-throw switch, obviously it could be used as a single-pole single-throw switch with one of the stationary contacts merely acting as a stop for the armature movement in that direction. Also, the device could be used for other than electric switching. As an example, the switching operation performed might be that of opening and closing a pilot valve. Similarly, the device might find utility in a mechanism where it is desired that slow movement of the actuating member result in snap movements of some other member, or in other words, a mechanism of general utility other than as a switching device.

It is to be understood that the described modifications of the invention are illustrative only and that the scope of the invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In a snap acting device, means forming a plurality of magnetic poles, an armature having a first portion movable selectively toward and away from each of a spaced pair of said poles of opposite polarity, said armature having a second portion movable selectively toward and away from each of a second spaced pair of said poles of opposite polarity, a pivotal support for said armature adjacent the first portion thereof, actuating means for moving said support to move the first portion of said armature with respect to said first pair of poles, and stop means limiting the range of movement of the second portion of said armature so that the ratio of movement of the second portion of said armature to the length of the air gap between the second pair of poles is less than the ratio of possible movement of the first portion of said armature to the length of the air gap between the first pair of poles.

2. In a snap switch, means forming a plurality of magnetic poles, an armature having a first portion movable selectively toward and away

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from each of a spaced pair of said poles of opposite polarity, said armature having a second portion movable selectively toward and away from each of a second spaced pair of poles of opposite polarity, a pivotal support for said armature adjacent the first portion thereof, actuating means for moving said support to move the first portion of said armature with respect to said first pair of poles, and means including a pair of contacts for limiting the ratio of possible movement of the second portion of said armature to the length of the air gap between the second pair of poles to a value less than the ratio of movement of the first portion of the armature to the length of the air gap between the first pair of poles, said limiting means restricting movement of the second portion of said armature to a range substantially midway between the second pair of poles.

3. In a snap acting device, means forming a plurality of magnetic poles, an armature having a first portion movable selectively toward and away from each of a spaced pair of said poles of opposite polarity, said armature having a second portion movable selectively toward and away from each of a second spaced pair of said poles of opposite polarity, a pivotal support for said armature adjacent the first portion thereof, actuating means for moving said support to move the first portion of said armature with respect to said first pair of poles, and stop means limiting the range of movement of the second portion of said armature so that the possible change of reluctance of the magnetic path through said armature due to movement of the second portion is less than the change of reluctance that may be attained by movement of the first portion.

4. In a snap switch, means forming a plurality of magnetic poles, an armature having a first portion movable toward and away from a first of said poles and a second portion movable toward and away from a second of said poles, said first and second poles being of opposite polarity, a pivotal support for said armature adjacent the first portion thereof, actuating means for moving said support to move the first portion of said armature with respect to the first of said poles, and means including a pair of contacts for limiting the range of movement of the second portion of said armature so that the possible change of reluctance of the magnetic path through said armature due to movement of the second portion is less than the change that may be attained by movement of the first portion.

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5. In a snap acting device, means forming a plurality of magnetic poles, an armature having a first portion movable toward and away from one of said poles and a second portion movable toward and away from a second pole of opposite polarity, a pivotal support for said armature adjacent the first portion thereof, actuating means for moving said support to move the first portion of said armature with respect to the first of said poles, and stop means limiting the range of movement of the second portion of said armature so that the possible change of reluctance of the magnetic path through said armature due to movement of the second portion is less than the change of reluctance that may be attained by movement of the first portion.

6. In a snap acting device, means forming a plurality of magnetic poles, an armature having a first portion movable toward and away from one of said poles and a second portion movable toward and away from a second pole of opposite polarity, a pivotal support for said armature adjacent the first portion thereof, actuating means for moving said support to move the first portion of said armature with respect to the first of said poles, stop means limiting the range of movement of the second portion of said armature so that the possible change of reluctance of the magnetic path through said armature due to movement of the second portion is less than the change of reluctance that may be attained by movement of the first portion, and biasing means acting on the second portion of said armature to move the second portion away from the second pole when the first portion is moved away from the first pole.

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