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[54] BISTABLE ELECTRIC SWITCH

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[52] **U.S. Cl.** .....**335/205,** 200/84 C

[51] **Int. Cl.** **H01h 35/18**

[58] **Field of Search** .....335/205, 206, 207; 200/84 C

[56] **References Cited**

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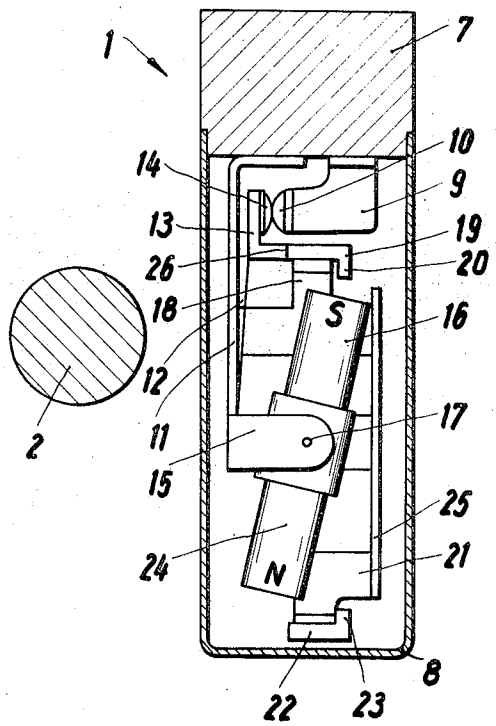
[57] **ABSTRACT**

The invention relates to a bistable electric switch assembly of the type having an actuating permanent magnet pivotally mounted relative to a central axis and held in each of its stable positions by two soft iron pole pieces offset from the central plane. The actuating magnet is responsive to an operating permanent magnet arranged to pass one of the poles of the actuating magnet and disposed at a right angle relative thereto. Fixed and movable contacts are provided with the movable contact being mounted on an armature which forms a variable width air gap with one of the pole pieces. A spring biases the armature and the movable contact towards an open position. A substantial part of the magnetic flux extends across the air gap which sequentially causes closing and opening forces to be exerted on the armature of the movable contact depending on the position of the permanent actuating magnet.

7 Claims, 3 Drawing Figures



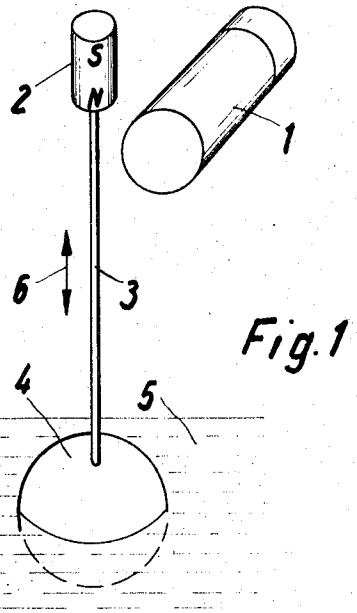


Fig. 1

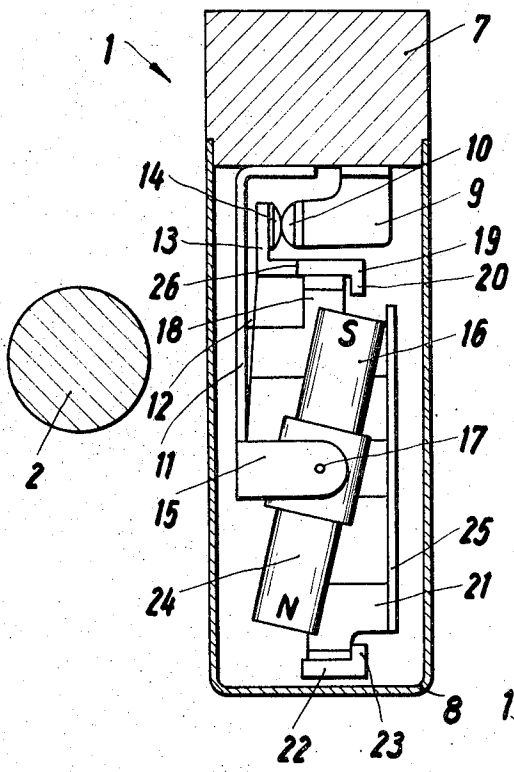


Fig. 2

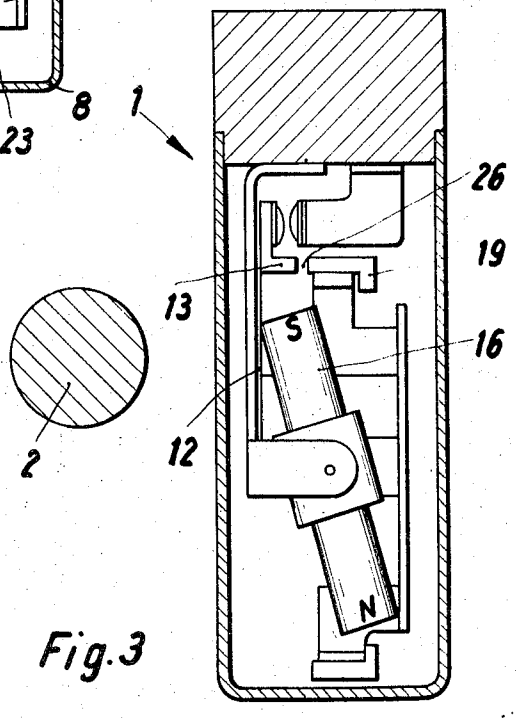


Fig. 3

BISTABLE ELECTRIC SWITCH

This invention relates to a bistable electric switch having a contact actuating permanent magnet which is mounted to swing about a central axis and is held in each of the stable positions by two soft-iron pole pieces offset from the central plane, the actuating magnet being responsive to an operating permanent magnet arranged to pass one of the poles of the actuating magnet and disposed substantially at right-angles to the actuating magnet, and in which the movable contact is mounted on a soft-iron armature.

Bistable electric switches of this kind offer the advantage that the switching mechanism can be fully encased and can be actuated from the outside with the aid of the operating permanent magnet, i.e. without any mechanical connection.

In the case of a known switch of this kind, two soft-iron pole pieces are associated with one of the poles of the contact actuating permanent magnet, the soft-iron pole pieces being fitted on a pivotable soft-iron armature. The soft-iron armature is adapted to pivot about a plane of symmetry and carries the movable contact. However, difficulties arise with this arrangement. To obtain a sufficiently firm contact pressure, the soft-iron pole piece must be caused to swing into close contact with the pole of the actuating permanent magnet and the danger arises that the operating permanent magnet is no longer enabled to apply sufficient force to move the actuating permanent magnet into the other stable position. If on the other hand the distance between the soft-iron pole piece and the pole of the actuating permanent magnet is such that the latter can be moved into its other position by the operating permanent magnet in all circumstances, the forces occurring in the contact system are limited.

The object of the invention is to provide a bistable electric switch of the initially described kind in which on the one hand the actuating permanent magnet can be readily displaced, while on the other hand fairly large forces can be produced in the contact system.

According to the invention, this object is achieved by forming the soft-iron pole pieces on fixed pole shoes each associated with a pole of the contact actuating permanent magnet and offset on the same side from the central plane, by biassing the movable contact by an opening spring, and by arranging that the soft-iron armature forms with one of the pole shoes an air-gap of variable size across which passes a substantial portion of the magnetic flux received by the soft-iron pole piece in that position of the actuating permanent magnet which corresponds with the closed position of the switch.

In this arrangement, the fixed soft-iron pole pieces enable well-defined conditions to be established that permit the actuating permanent magnet to be displaced from the outside by the use of small forces. The closing force in the contact system on the other hand depends upon the air-gap between the soft-iron armature and one of the pole shoes. Since this air-gap may become zero, very large closing forces are obtained simply with the magnetic forces present in the system. The force applied by the opening spring can be selected to cover a wide range. If it is to be used merely for holding the system open, it may be very weak and if it is intended to reinforce the opening action or to act as a closing spring for a co-operating contact, it can be made

stronger within the range governed by the magnetic closing force.

Expediently, the pole shoes have salient poles and extensions projecting slightly beyond the central plane. In this way, a greater portion of the magnetic flux is conducted across the pole shoes.

A particular advantage accrues if the air-gap between one of the pole shoes and the soft-iron armature is disposed on that side of the central plane opposite the pole of the actuating magnet. This arrangement ensures that part of the magnetic flux flows across the soft-iron armature and part across the pole shoe, irrespective of all the other details of the construction. Thus, not only is there no magnetic force of attraction between the two parts, but a repulsive force which strengthens the opening force is even set up.

In a particularly simple form of construction, the opening spring is a leaf spring which carries the movable contact, so that the contact carrier and contact spring are constituted by a single component.

In this connection it is advantageous if the contact actuating permanent magnet strikes the leaf spring upon displacement into the position associated with the open position of the switch. Additional opening force is thus obtained in the contact system. In the extreme case therefore, impact of the actuating magnet, the opening force of the spring and the repulsive force between the armature and the pole shoe can come into action so that even contacts that have become adhered together can be separated.

An advantageous form of construction is one in which the soft-iron armature is constituted by an angled element, the free end of one of the limbs of which helps to define the air-gap, and the other limb of which is fitted to the leaf spring and carries the movable contact. Then, only one attachment means is required for securing the contact and angled elements to the leaf spring. Furthermore, the contact is reinforced by the angled element.

To ensure particularly accurate operation, the pivoting movement of the switching permanent magnet may be limited by a stop. This results in very precisely defied stable positions and therefore also in precisely defined forces in the switch.

An embodiment of the invention will now be described in greater detail by way of example with reference to the accompanying drawings in which:

FIG. 1 is a schematic illustration of the switch of the invention used in conjunction with a float,

FIG. 2 is a horizontal longitudinal section through the switch with the contacts closed; and

FIG. 3 is an illustration of the switch of FIG. 2 with the contacts open.

The switch consists of a working assembly indicated generally at **1** and an operating permanent magnet **2**. The latter is connected by way of a rod **3** to a float **4** and is moved up and down in the directions indicated by the arrow **6**, by the change in the level of a liquid **5**.

The working assembly is contained in a glass envelope **8** closed by a ceramic plug **7**. Fitted on the plug **7** are a carrier **9** for a fixed contact **10**, and a bracket **11** on which is mounted by way of a bronze spring **12** biassed in the opening direction, an angled soft-iron armature **13** carrying a movable contact **14**. The bracket **11** also carries a bowed element **15** in which a

switching or contact actuating permanent magnet **16** is mounted to pivot about its central axis **17**. A pole shoe **19**, made of soft-iron and having a salient pole **20**, is secured to a further bowed element **18**. A third bowed element **21** carries a soft-iron pole shoe **22** having a salient pole **23**. The two poles **20** and **23** are offset on the same side in relation to the central plane **24**. Each of the pole shoes extends from the pole to a point slightly beyond the central plane **24**. A web **25** on the bracket **11** acts as a stop for the switching permanent magnet **16** in its two switching positions. On that side of the central plane opposite to the pole **20**, the pole shoe **19** and the armature **13** form an air-gap **26** extending parallel with this central plane. In FIG. **2** this air-gap is zero, and in FIG. **3** it is at its widest.

In FIG. **2**, i.e. in the closed position of the contacts **10** and **14**, the permanent switching magnet **16** occupies the position as illustrated. The greatest portion of the magnetic flux lines emanating from the end face of the south pole S is concentrated at the pole **20** and is passed across the air-gap **26** to the armature **13**. The magnetic flux lines emerge from the armature and pass through the air to the end face of the north pole N. There is consequently created, between the pole shoe **19** and the armature **13**, a strong force of attraction which keeps the contacts **10** and **14** closed despite the opening force applied by the spring **12**. In order not to affect the other components of the magnetic system, the contacts **10** and **14** may be made of silver, the carrier **9** and the bracket **11** of brass, and the spring **12** of bronze.

If the operating permanent magnet **2** is now moved upwards, the south pole S of the switching permanent magnet **16** is attracted and snaps over into the position seen in FIG. **3**. It is held there in a stable manner even upon continued movement of the magnet **2**, since the salient pole **23**, in conjunction with the magnetic forces, holds the magnet **16** in the position shown in FIG. **3**. During the opening movement, the magnetic conditions in the air-gap **26** first change since one portion of the magnetic flux, emanating from the end face of the south pole S of the switching permanent magnet **16**, passes across the pole shoe **19**, while the other portion passes across the armature **13**. Consequently, not only does the force of attraction between the two soft-iron parts cease, but a repulsive force is even created. The biased spring **12** provides further thrust in the direction for opening. Finally, the south pole of the magnet **16** encounters the spring **12**, so that separation of the contacts takes place even if they are adhering to each other.

What we claim is:

1. A bistable electric switch assembly comprising frame means, a permanent actuating magnet mounted on said frame means for pivotal movement about a fixed axis, two soft iron pole shoes attached to said frame in respective proximity to the ends of said actuating magnet and in magnetically cooperable relation thereto, a permanent operating magnet disposed at substantially a right angle to said actuating magnet near one of the poles of said actuating magnet and movable relative thereto, the poles of said operating magnet being alternately movable into close proximity to said one of said poles to alternately effect movement of said actuating magnet, a movable switch contact mounted on a soft iron armature, said soft iron armature being movable relative to said one of said pole shoes with which it forms a variable width air gap which varies between a zero opening and a predetermined opening, said armature being movable in response to being operatively contacted by said actuating magnet during movement thereof, and spring means biasing said armature away from said one of said pole shoes.

2. A switch assembly according to claim **1** wherein said poles shoes have salient poles offset on one side of said axis.

3. A switch assembly according to claim **2** wherein said armature is on the opposite side of said frame relative to said axis and said salient pole pieces.

4. A switch assembly according to claim **1** wherein said spring means is a leaf spring.

5. A switch assembly according to claim **1** wherein said actuating magnet engages said spring means to move said movable contact to an open position.

6. A switch assembly according to claim **1** wherein one of said shoe pieces is L-shaped with one leg thereof forming a salient pole and the other leg thereof borders said air gap.

7. A switch assembly according to claim **6** wherein said other leg of said shoe piece is connected to said resilient means.

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