May 13, 1958 H. H. EAVES ET AL 2,834,846

RELAY SWITCH

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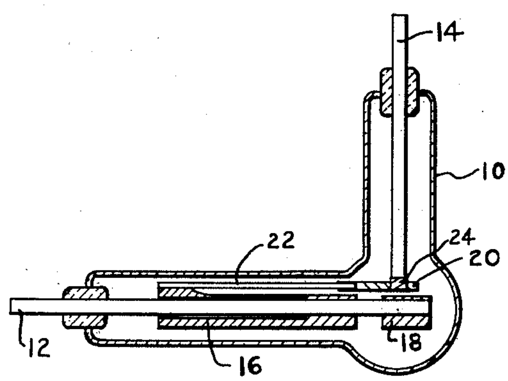

FIG. 1

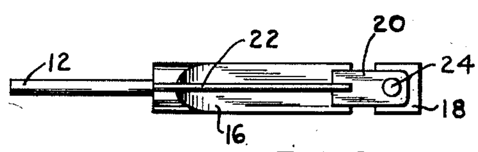

FIG. 2

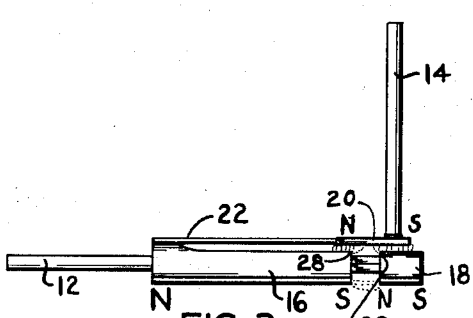

FIG. 3

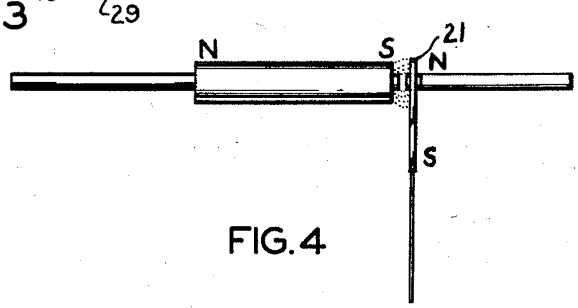

FIG. 4

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RELAY SWITCH

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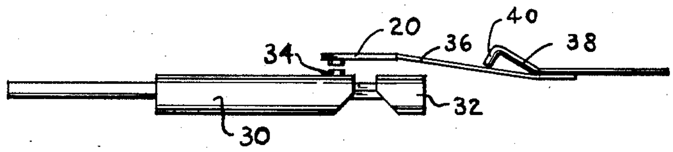

FIG. 5

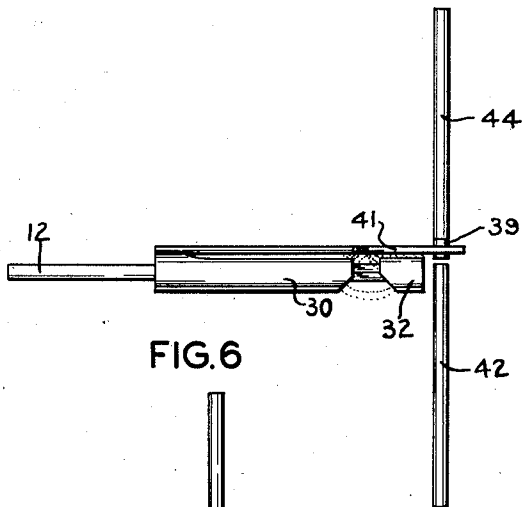

FIG. 6

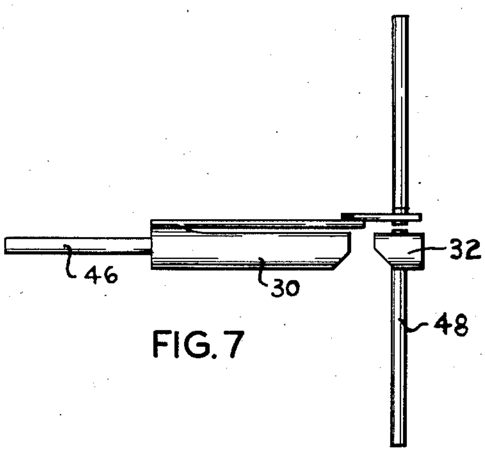

FIG. 7

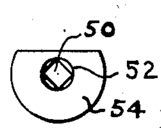

FIG. 8

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RELAY SWITCH

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4 Claims. (Cl. 200—87)

This inveniton relates to a switch and more particularly to an enclosed relay switch operable with low actuating forces.

The vacuum relays known in the prior art have commonly been provided with an envelope having three arms. One arm supports a cylindrical magnetizable core, the second arm which is at right angles to the first arm supports the moving armature, the third arm supports a lead against which the armature rests to make a normally closed switching contact when the core is not magnetized. Some of the disadvantages of this known configuration are that the switch is difficult to activate, three metal-to-glass seals are required, and connections are provided which are superfluous for many applications. In the instant invention, the armature is mounted on the lead supporting the core or on the core itself so that a normally closed switch may be made with only two arms, and the magnetic core is preferably divided into two (or more) parts in order to concentrate the magnetic flux. It is possible to similarly construct a double pole switch by introducing a third lead into the envelope.

An object of the invention is to provide an improved construction and arrangement of the elements of a switch.

Another object is to provide an improved magnetizable core for controlling an armature.

A further object is to provide an improved mounting and arrangement for an armature in a relay switch.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following description.

Fig. 1 is a view in cross section of a switch embodying the invention;

Fig. 2 is a plan view of a core and armature as seen from above;

Fig. 3 is a diagrammatic view of the elements of the switch shown in Fig. 1;

Fig. 4 is a diagrammatic view of the elements of a switch known in the prior art;

Fig. 5 is a diagrammatic view of a modified form of the switch shown in Fig. 3.

Fig. 6 is a diagrammatic view of another modified form of the switch shown in Fig. 3;

Fig. 7 is a further modified form of the switch shown in Fig. 6; and

Fig. 8 is an end view of a magnetizable core with an improved mounting therefore.

The switch shown in Figs. 1 and 2 comprises an outer glass envelope **10** and supporting leads **12** and **14**. A magnetizable core, preferably consisting of two elements **16** and **18**, is supported by lead **12** which must be non-magnetic in the span between the two elements. Armature **20** is attached as by welding to core element **16** by means of tensioning member **22** which serves as a spring. A contact button **24** on armature **20** is positioned to make contact with lead **14**. In the operation

of the above described device, a solenoid, not shown, is positioned over the arm of envelope **10** which encloses the magnetizable core. The elements of the core function as magnets when the solenoid is energized thus attracting armature **20** and breaking contact between lead **14** and contact **24**. When the solenoid is de-energized, the attraction of the core elements for the armature ceases and spring **22** urges the switch into the normally closed position which contact button **24** presses against the inner end of lead **14**.

The flux pattern generated when the core is initially magnetized is shown by the dashed lines in Fig. 3. The concentration of flux lines is greatest between projecting points **28** and **29** of elements **16** and **18** respectively due to the small air gap between the points and the low reluctance of armature **20** which completes the magnetic circuit. This strong concentration of flux lines is effective to exert a strong downward pull on armature **20** thus breaking the contact with lead **14**. The induced polarities, for a given direction of current flow in the energizing solenoid, are indicated on the drawing. The concentrated flux of the above described switch may be contrasted with the switch known in the prior art and illustrated in Fig. 4. Armature **21** in the previously known switch is attracted by a diffuse flux field and by a single magnetic pole rather than by two magnetic poles and hence will not move toward the core until a very strong magnetic field is set up around the core.

The straight line switch shown in Fig. 5 comprises a magnetizable core having elements **30** and **32** and provided with a contact button **34**. Armature **20** is secured to a resilient wire **36** which in turn is secured to lead **38** in such a manner that the armature is normally urged upwardly. A stop **40** limits the upward travel of the armature and provides a stable position from which the armature may not be moved by any force appreciably less than the pull caused by the concentrated magnetic flux generated when the two elements of the core are magnetized. This form of switch is compact because the structure is in a straight line but at the same time the encircling solenoid may readily be spaced far enough from the unenclosed ends of the leads so that applied voltages of over 20,000 volts will not arc over from the leads to the solenoid case. The structure is particularly suited to applications where the switch is subjected to the effects of acceleration or vibration as in guided missiles, for example, since the components of the switch have substantially a single common axis and may be oriented in a direction least subject to stresses.

The switch shown in Fig. 6 is a modified form of the switch shown in Fig. 3. That part of armature **41** bearing contact button **39** extends past the end of the core thereby making possible a circuit through lead **12** and armature **41** to lead **42** or to lead **44**. It has been found particularly advantageous to mechanically secure the armature in the arm of the switch bearing the magnetizable core for the reason that the spring tension positioning the armature relative to the core may be precisely and uniformly set during assembly of the metal part of the switch. In switches known in the past, the spring tension was adjusted during the glass sealing operation, but the adjustment is difficult to make and the switches varied widely with respect to the force required to move the armature.

The core members **30** and **32** are preferably cut away at the gap on the side opposite the armature. This is done to lengthen the gap and thus decrease flux leakage from one core member to the other since this leakage flux is not effective to exert a pull on the armature. The relative distribution of the flux is indicated by the dashed lines in Fig. 6.

The switch shown in Fig. 7 has one element **30** of the magnetizable core mounted on lead **46** and the other element **32** mounted on lead **48**. The operation of this switch is the same as for the switch shown in Fig. 6.

Fig. 8 shows an end view of the preferred form of the core assembly in which lead **50** is square and the bore **52** of core element **54** is cylindrical. It has been found that a cylindrical lead of a refractory metal, such as tungsten, press fitted into a cylindrical opening in a soft iron core will not be tight after the heating and cooling cycles which are a necessary part of the switch assembly since the expansion and contraction of the dissimilar, closely fitting metals results in a permanent loosening. It has been found that a non-circular lead pressed into a circular opening, however, will remain tight after the heating and cooling cycles. Leads having a square cross-section are particularly suitable.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a vacuum switch of the type having magnetically operable first and second contact points within an evacuated envelope and a magnetic flux producing means positionable adjacent the envelope operable to produce a magnetic flux field to operate the contact points, the combination of: an integral electrically conductive non-magnetic shaft having a first section supported by the walls of the envelope, a second section within said envelope in spaced relation from the envelope walls, and a third section extending exteriorly of the envelope to form a terminal lead for the first contact point of the switch; first and second cylindrical magnetic core members axially aligned on the shaft; said first member being longer than said second member and positioned within the flux field of magnetic flux producing means; said second core member being spaced from said first core member to form a gap between the core members; a magnetic electrically conductive armature aligned substantially parallel with said core members and positioned to overlie the first and second core members and the gap, electrically conductive spring means mounted on said first core and supporting said armature; said spring means formed to resiliently bias said armature in a first position in spaced relation with said cores whereat said armature is positioned to be magnetically shifted into a second position in abutting engagement with the cores upon magnetic flux producing means being energized; said first contact point positioned on said armature; and means to position the second contact point in electrical contact with the first contact point when the armature is in one of said first and second positions but not in the other; the second contact point having a terminal lead extending exteriorly of the envelope.

2. A vacuum switch according to claim 1 and wherein the adjacent ends of said first and second magnetic cores are beveled so as to provide a smaller gap on the side of the cores adjacent the armature than on the side of the cores furthest from the armature.

3. A vacuum switch according to claim 1 and wherein said second contact point is positioned to form a stop means to prevent movement of said armature beyond a predetermined distance from said cores.

4. A vacuum switch according to claim 1 and wherein the envelope and first core member are formed to position the magnetic flux producing means so that the first core member is subjected to substantially more of the flux field from the magnetic flux producing means than the second core member and armature.

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