June 5, 1956 J. H. HORMAN ET AL 2,749,403

ELECTROMAGNETIC RELAY

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FIG. 1

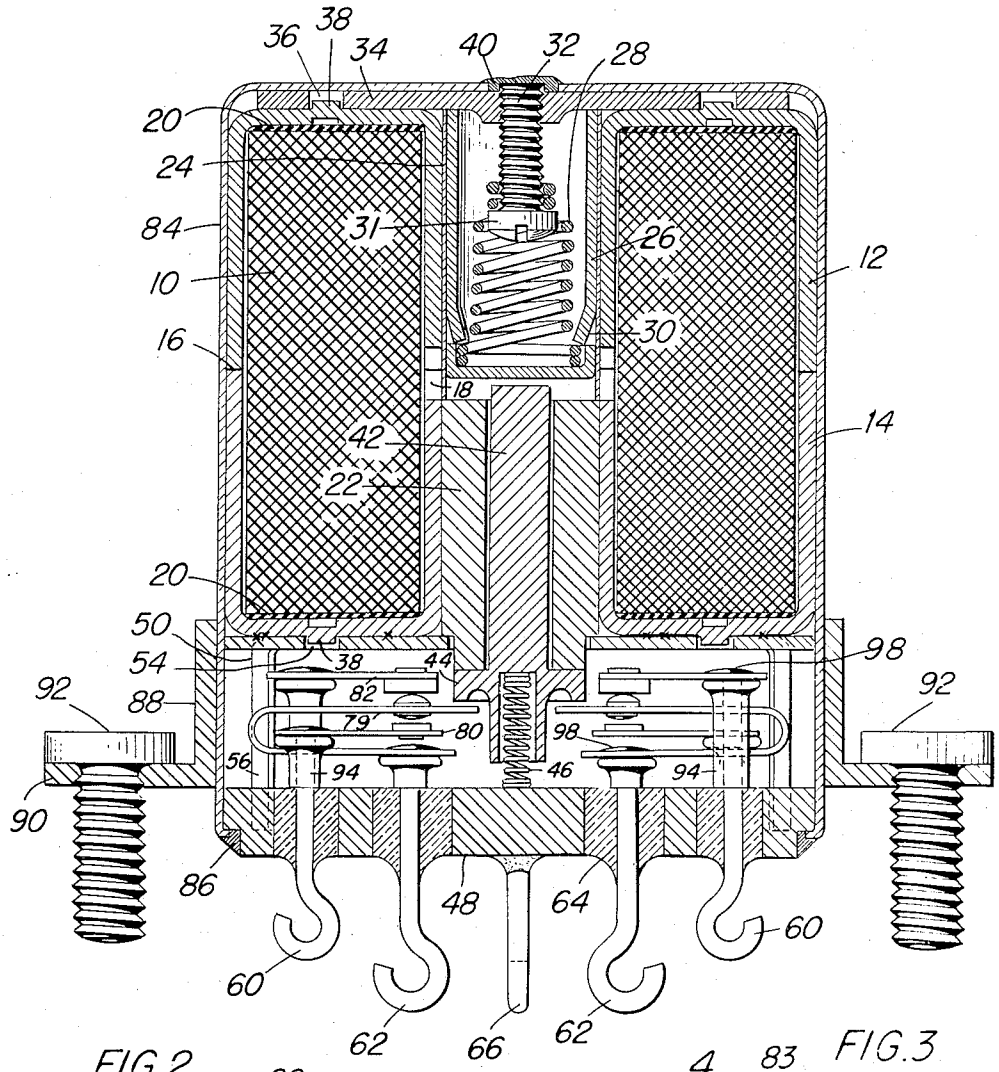


FIG. 2

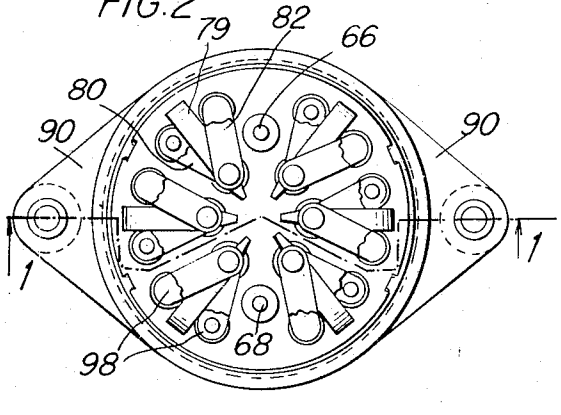


FIG. 3

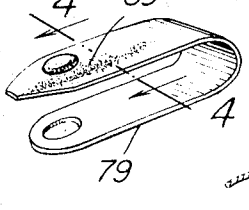


FIG. 4



Inventors
John H Horman
Edward C. Hoell
By Williamson, Ruth & Moore
Attorneys

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ELECTROMAGNETIC RELAY

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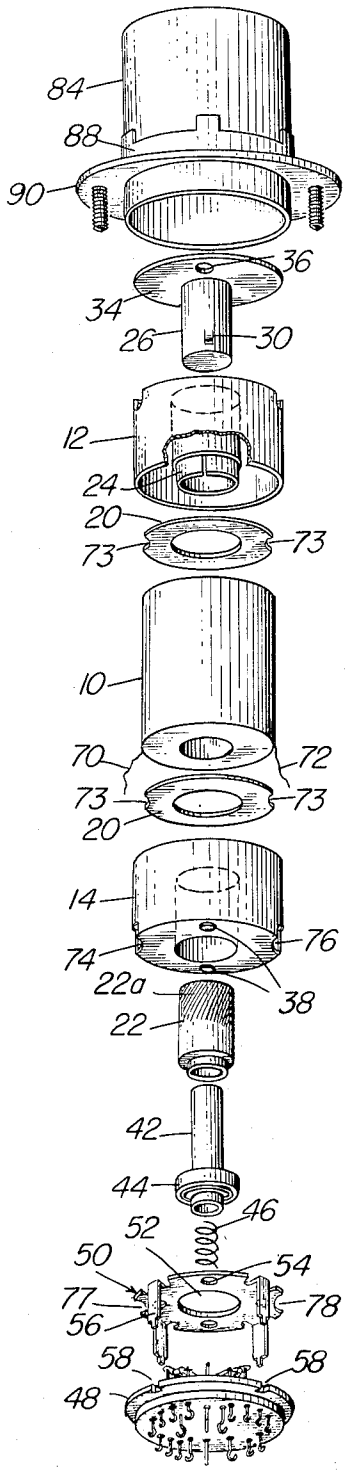


FIG. 7

FIG. 8

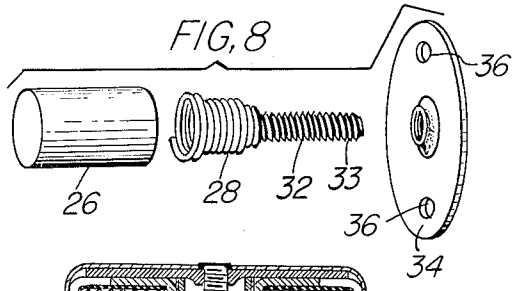


FIG. 5

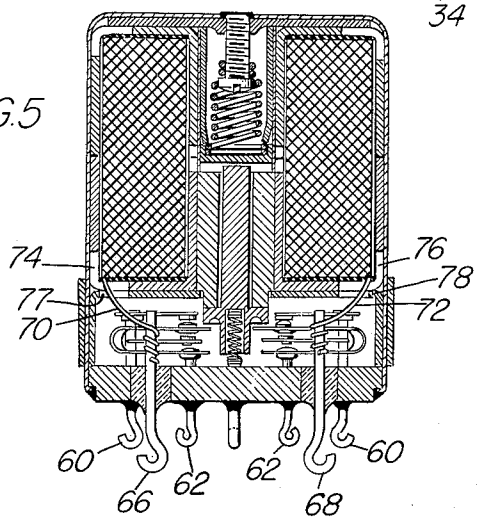
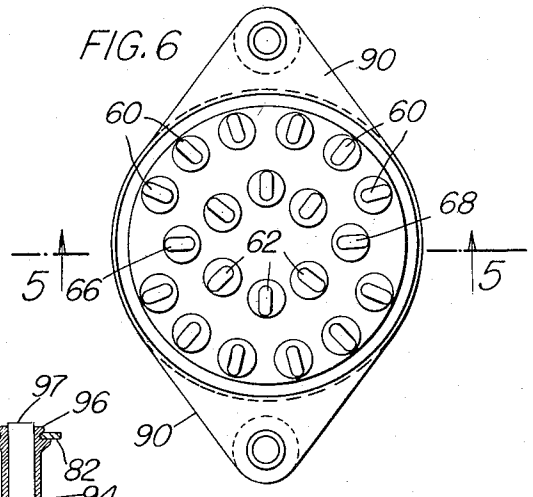


FIG. 6



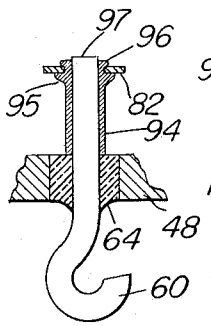


FIG. 9

Inventors
John H. Horman
Edward C. Hoell

By Williams, Pitt & Moore
Attorneys

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ELECTROMAGNETIC RELAY

John H. Horman, Tuckahoe, and Edward C. Hoell, New York, N. Y., assignors to Allied Control Co., Inc., New York, N. Y., a corporation of New York

Application February 28, 1952, Serial No. 273,962

6 Claims. (Cl. 200—104)

This invention relates to electromagnetically operated switch mechanisms, often called relays.

The general objects of the invention are to provide an electromagnetically operated switch mechanism capable of controlling a plurality of circuits, which is compact and has but little free internal space, which may be readily adjusted in the course of its construction, which is not adversely affected by vibration or shock, which may be easily and economically manufactured and assembled, and which may be readily evacuated and filled with an inert gas and sealed.

The invention resides in the construction and cooperative relation of the various parts, and particularly in various aspects of the electromagnetic structure, in the construction and arrangement of the contact members and the actuating means therefor.

The invention will best be understood from the following description of a preferred embodiment thereof, taken in connection with the drawings, in which:

Fig. 1 is a central sectional elevation generally on the line 1—1 of Fig. 2;

Fig. 2 is a plan view of the inside of the terminal header supporting the contact arms;

Fig. 3 is a perspective view of one of the movable contacts showing the curvature of its end portion for a purpose hereinafter explained;

Fig. 4 is a section on the line 4—4 of Fig. 3;

Fig. 5 is a sectional elevation, similar to but on a smaller scale than Fig. 1 and at a different angle on the line 5—5 of Fig. 6, showing the ends of the magnetizing coil secured to terminals;

Fig. 6 is a plan view looking at the opposite side of the terminal header from that shown in Fig. 2;

Fig. 7 is an exploded view of the various parts of the relay;

Fig. 8 is an exploded view showing how the armature and its associated parts may be assembled; and

Fig. 9 is a detail, partly in section, of the means for mounting the contacts.

The magnetic structure of the relay, best shown in Figs. 1 and 7, will first be described. The magnetizing coil 10 is enclosed within a shell of magnetic material consisting of two preferably identical annular cup-shaped pole-pieces 12 and 14, the outer edges of which are flattened to closely engage one another as shown at 16, and the inner edges of which are spaced apart thereby providing in the shell a gap 18 located within the magnetizing coil. As best shown in Fig. 7, the pole pieces 12 and 14 have concentric inner and outer cylindrical walls between which is the annular space occupied by the coil 10. Before assembling the pole-pieces 12 and 14 on the coil 10, insulating washers or disks 20 of suitable material, such as cellulose acetate, are inserted in the bottoms of the pole-pieces 12 and 14. The coil and the washers are preferably cemented in the pole-pieces with an insulating cement. A pole-piece bushing 22 of magnetic material is then forced into the pole-piece 14, the length of said pole-piece bushing 22 being such that its inner end lies

adjacent the gap 18 and its diameter being such as to have a press fit in pole-piece 14. A shell 24, of non-magnetic material such as brass, is inserted into the opening in the other pole-piece 12, serving as a bearing in the passage adapted to receive a movable armature 26. This shell 24 may be of thin shim brass and split as shown in Fig. 7, its length being such as to bridge gap 18.

The armature 26 of magnetic material is cup-shaped, hollow and light in weight, and is arranged to slide within the brass shell 24 in cooperative relation to the pole-piece bushing 22 and the gap 18. The armature being of light weight the relay is not likely to be operated by inertia forces even of considerable magnitude. Within the cup-shaped armature 26 and biasing it to its normal position away from the pole-piece bushing (as shown in Fig. 1) is a spring means. As shown, this comprises a tension spring 28 which is attached at one end to the armature 26 by several crimped portions 30 in the latter, and at its other end engages the head 31 of a threaded member or screw 32 threaded into a brass end-plate 34 from which the threaded end 33 of the screw 32 initially projects. The end-plate 30 is provided with openings 36 adapted to cooperate with lugs 38 punched from the bottoms of the pole-pieces 12 and 14. Thus, there is provided an armature assembly in which the spring 28 and screw 32 serve to bias the armature 26 toward its normal position as shown in Fig. 1, but permits movement of the armature 26 within the brass shell 24 toward and into engagement with the pole-piece bushing 22 when the magnetizing coil 10 is energized. The tension exerted by the spring 28 may be adjusted by rotating the screw 32; and, after the desired adjustment has been effected, the portion 33 of the screw 32 which projects beyond the end plate 34 and the casing 84 (hereinafter mentioned) is cut off, and the opening in the casing 84 through which the screw 32 passes is sealed with solder as shown at 40.

Slidingly mounted within the pole-piece bushing 22 is an actuator 42 of the form shown in the drawings, composed of rigid insulating material such as synthetic resin. Its upper end normally projects beyond bushing 22 toward the armature 26 in a position to be engaged thereby when the armature 26 is magnetically moved into engagement with the pole-piece bushing 22. It will be noted, as shown in Fig. 1, that there is normally a gap between armature 26, in its retracted position, and actuator 42 so that these two parts are not in contact when coil 10 is deenergized for a reason to be explained later. The movement of the actuator 42 within the pole-piece bushing 22 toward the armature 26 is limited by a flange 44 which engages the end of the pole-piece bushing 22 as shown. The amount of possible movement of the actuator is governed by the distance it projects beyond bushing 22. Flange 44 also serves to actuate the contact members of the relay as hereinafter described, and the flange 44 is formed with a groove on the side toward the contact members as shown to facilitate performance of that function. At its outer end, the actuator 42 is provided with a cavity which contains a light compression spring 46 which engages the center of disk 48 of the terminal header assembly (hereinafter described) and serves to hold the actuator 42 against bushing 22 out of engagement with the contact members so as to leave a gap between them and the actuator for a reason to be explained later.

Secured to the pole-piece 14, preferably by spot welding, is a bracket 50 the form of which is best shown near the bottom of Fig. 7. This bracket 50 is provided at its center with an opening 52 which receives the end of the pole-piece bushing 22, and with openings 54 which cooperate with the lugs 38 on the pole-piece 14, thereby facilitating proper positioning of the bracket 50. The

arms 56 of the bracket engage at their outer ends with notches 58 in the disk 48 of the header, holding by friction until final assembly. Thus the disk 48 is secured in properly spaced relation to the magnet shell 14, thereby providing a space for a plurality of movable and fixed contact members carried by the disk 48 and arranged as described below.

The construction of the terminal header assembly is best shown in Figs. 1, 2 and 6. The disk 48 (which, as hereinbefore described, is supported on the arms 56 of the bracket 50) is provided with a plurality of holes arranged in two circles around the center of said disk, the number of holes in the outer circle being double the number of holes in the inner circle. Contact terminals 60 are secured in the holes in the outer circle, and contact terminals 62 are secured in the holes in the inner circle, by the use of a suitable rigid insulating material such as glass as best shown in Fig. 1 at 64. That is, the contact terminals 60 and 62 are mounted in the disk 48 and are insulated from it and from one another. Mounted in the same way in holes in the disk 48, are the two terminals 66 and 68 to which are secured the leads 70 and 72 of the magnetizing coil 10, as shown in Fig. 5 from which it will be apparent that the wires 70 and 72 pass through notches 73 (Fig. 7) in the edges of the disks 20, through openings 74 and 76 in the pole-piece 14, and through notches 77 and 78 in the bracket 50.

As will be evident from Figs. 1 and 2, groups of cooperating contact members are mounted on the terminals 60 and 62. Each of these groups of cooperating contact members includes a U-shaped movable contact member 79 which is secured at one end to a terminal 62 in the inner circle of terminals, and extends therefrom radially outwardly of the disk 48 and then back toward the center of said disk. Each of said groups of contact members also includes two fixed contact members 80 and 82 which are supported on adjacent terminals 60 in the outer circle of terminals, and these contact members 80 and 82 are arranged to converge from the terminals on which they are supported toward one another and on opposite sides of (that is, below and above, as shown in Fig. 1) the U-shaped movable contact member 79 in that group. In the particular contact assembly illustrated, movable contact member 79 in each group is normally in electrical contact with upper fixed contact member 82 in that group; and flexing of contact member 79 breaks its electrical connection with the upper contact 82 and completes its electrical engagement with lower contact 80.

Thus, there is a group of normally closed contacts (79, 82) and a group of normally open contacts (79, 80). It will be observed that no member which might tend to move under vibration or shock is in engagement with the movable contacts in the deenergized condition of the relay so that the normally closed contacts will remain closed even under severe shock. This absence of engagement results from the provision of the gaps between armature 26 and actuator 42 and between flange 44 of the actuator and the movable contacts 79.

As is obvious from Fig. 2, the ends of the movable contact members 79 extend into the path of the flange 44 of the actuator 42. When the actuator 42 is moved by the magnetic actuation of the armature 26 against the force exerted by the spring 46, the edge of the flange 44 engages each of the movable contact members 79 and flexes those contact members to effect the breaking and completion of the electrical connections as above mentioned. Of course, when the actuating coil 10 of the relay is deenergized, the armature 26 and the actuator 42 return to their normal positions, and the movable contact members 79 return to their normal positions, as shown in Fig. 1. As shown in Figs. 3 and 4, each of the U-shaped contact members 79, near its free end, is provided with a longitudinally extending bulge 83, so that it is shaped somewhat like a pen nib, which serves to stiffen that portion of the contact member 79 and causes most of the flexing of it to take place at the bend, which is desirable. The annular groove in the face of flange 44 of actuator 42 causes the flange to engage the contacts 79 inwardly a short distance from their ends so that if there is a burr on the end it does not affect the operation.

It will be noted that the arrangement of contacts is very compact. In the embodiment illustrated the relay contains six double-throw single pole switching units all operated simultaneously. Obviously the terminal header may be designed to provide a different number of switching units.

The arrangement shown allows for the placing of a large number of contacts in a very small space while allowing adequate spacing for a high breakdown voltage, not only as between adjacent contacts of a set but also as between the contacts and ground and between adjacent groups of contacts.

As best shown in Fig. 1, the various parts of the relay are enclosed within a cup-shaped casing 84, preferably of magnetic material, which is provided at its top with an opening to accommodate the end 33 of the screw 32 which initially projects from the end plate 34. The casing 84 is slipped over the pole-pieces 12 and 14, and over the edge of the disk 48 of the terminal header. The edge of the casing 84 is crimped over the edge of the disk 48 into a notch provided therein as shown. The notch is then filled with solder which hermetically seals one end of the unit. After the protruding end 33 of the screw 32 has been cut off, solder is applied at 40 (as hereinbefore mentioned) to close the opening at that point in the casing 84. Thus, the various internal parts of the relay are hermetically sealed within the casing 84 and the disk 48. Prior to this sealing operation, if desired, the relay may be baked and subjected to exhaustion of the air and volatile materials within it, and the spaces within the relay may be filled with an inert gas such as nitrogen thereby minimizing corrosion of the internal parts of the relay. A mounting ring 88, which may be secured by spot welding or otherwise in any position on the outside of the casing 84, is provided with perforated flanges 90 adapted to receive cap screws 92 for mounting the relay.

Referring to Fig. 9, each contact is mechanically and electrically connected to its contact terminal by means of solder and a mounting sleeve which has a sliding fit on the terminal. The sleeve is shown in section at 94. It has a hub portion 95 with a flat upper face and an initially cylindrical extension 96. A perforated contact such as 82 is slipped over this extension which is then riveted over as shown. The length of the sleeve, which is different for each of the three contacts of a set, determines the contact spacing. When the contacts have been aligned, solder is applied over the top 97 of terminal 60 and the surrounding parts of the sleeve and contact, fixing the position and forming a low resistance electrical union. The solder is shown at 98 in Figs. 1 and 2.

Some of the advantages of the above described construction will be appreciated from the following description of the steps in assembling the relay.

Bracket 50 is first assembled on pole-piece 14 and spot welded thereto. Lugs 38 which fit in holes 54 will relatively position these parts during welding but by the use of an appropriate jig the lugs and holes may be dispensed with. Pole-piece bushing 22, part of the outer surface of which is preferably spirally knurled as shown at 22*a* in Fig. 7, is then pressed into the center of pole-piece 14 from the open side of the pole-piece 14. Its final position may be determined by suitable locating means in a jig which holds the pole-piece and bracket during this operation. Insulating washers 20 are then placed in the pole-pieces 12 and 14 and these are assembled on coil 10 with the aid of insulating cement which, upon drying, maintains this portion of the relay in assembled condition.

In making this assembly the coil leads **70** and **72** are brought out through the openings **74** and **76** in pole-piece **14**. Actuator **42**, with its spring **46**, is slipped into bushing **22** and the terminal header assembly is mounted on the bracket arms **56** which are inserted in the notches **58** of the header plate. The bracket arms may be positioned so as to grip the header and hold it in place by friction. At this time the coil leads **70** and **72** are soldered to terminals **66** and **68**. This is the only internal wiring in the relay.

Referring to Fig. 8, the armature sub-assembly is made up separately by placing spring **28** over the head of screw **32**, inserting the largest coils of the spring in armature **26** against its head, after which the ears **30** are punched inwardly to secure the spring. End plate **34** is run onto the screw until the plate is in contact with the open end of the armature. End portion **33** of the screw will then extend beyond the plate.

The brass shell **24** is then inserted in the open end of pole-piece **12** and armature **26** is inserted therein with the openings **36** in plate **34** engaging the lugs **38** on pole-piece **12**. All of the parts shown in Fig. 7, with the exception of casing **84**, are now assembled and these assembled parts as a unit are placed in the casing, the edge of which is crimped over the terminal header. In the crimping operation considerable pressure is applied axially of the electromagnet which, in the absence of some means to prevent it, could disturb the relationship, dimension-wise, of parts such as the actuator and the contacts which must bear fixed relations to close tolerances. The means which prevents such disturbance is the enclosing shells **12** and **14** the outer walls of which abut forming a rigid enclosure which prevents the crimping force from compressing the coil **10** which, being a mass of wire and insulation, is easily compressed. Hence, apart from forming part of the magnetic circuit, the shells serve this very useful purpose, assuring that the planned internal dimensions are not changed when sealing the mechanism in the casing **84** by crimping its edge. This crimped connection is sealed with solder **86**.

It will be understood that all of the contacts have been preliminarily assembled in the disk **48** of the terminal header and adjusted. Since they are directly mounted on the terminals **60** and **62**, internal wiring to the contacts is completely eliminated.

The tension of spring **28** is then adjusted from outside by rotating screw **32** and since all parts of the relay are now in their final fixed relationship, electrical tests of the contact operation may be made during this adjustment.

The assembled relay may then be baked to drive off volatile materials and subjected to a pressure below atmospheric to draw them out together with most of the air. The volatile materials and air can escape through the opening in casing **84** surrounding the screw **32**, there being sufficient leakage past the screw for this purpose. The relay may then be allowed to refill in an atmosphere of inert gas, after which the screw is cut off and the surrounding opening sealed with solder. This also fixes screw **32** in adjusted position.

It will be understood that the above described specific embodiment is merely illustrative of the invention, which is not limited to the foregoing details but is to be construed broadly in accordance with the appended claims.

What is claimed is:

1. In an electromagnetic switch of the type having a hollow magnetizing coil with a fixed core occupying part of the space within said coil, armature means adapted to coact with said core when said coil is energized, said means comprising a hollow cup-shaped armature positioned in the remaining space within said coil with its closed end toward said core, a tension spring positioned within said armature and having one end attached to said armature adjacent its closed end, said armature having a thin side wall which is deformed inwardly to engage the end portion of said spring which is attached to said armature, and fixed anchoring means for the other end of said spring extending across the open end of said armature whereby said armature is held away from said core in its deenergized condition.

2. In an electromagnetically operated switch structure of the type having a hollow magnetizing coil with an armature movable therein, a magnetic shell enclosing the ends and outer surface of said coil and only a part of the inner surface thereof, said shell comprising two unitary pole pieces each having concentric inner and outer cylindrical walls joined by an end wall and defining an annular space which encloses part of said coil, the edges of said outer walls engaging one another when assembled on the coil, and the edges of said inner walls being spaced apart thereby providing a gap in the shell within said coil, the engagement of said outer walls resisting forces axially of the coil which would act to compress it.

3. A shell structure according to claim 2 wherein said shells are identical and each has an inner wall which is shorter than its outer wall, whereby when the edges of the outer walls are engaged the edges of the inner walls are spaced apart to provide said gap.

4. A shell structure according to claim 2 wherein one of said pole pieces is provided with a magnetic pole piece bushing having a pressed fit with its inner wall and terminating inside the coil adjacent said gap.

5. An electromagnetic switch mechanism comprising, a magnetizing coil, a shell of magnetic material enclosing said coil and consisting of two pole pieces each having concentric inner and outer cylindrical walls defining an annular space, the outer edges of said pole pieces engaging one another and the inner edges thereof being spaced apart to provide a gap in the shell within said coil, a pole piece bushing of magnetic material located within the inner cylindrical wall of one of said pole pieces adjacent said gap, a cup-shaped armature of magnetic material movably arranged within the inner wall of the other pole piece in cooperative relation to said bushing and said gap, a spring located within and operatively associated with said armature to bias it to its normal position away from said bushing, an actuator of non-magnetic material slidably mounted within said bushing and adapted to be engaged by said armature on movement thereof, means for limiting the movement of said actuator toward said armature, a spring biasing said actuator in the direction in which its movement is limited by said means, a terminal header, means securing said header in spaced relation to the end of the pole piece in which said bushing is located, and a movable contact member carried by said header and located in the space between the header and the pole piece to which it is attached and in cooperative relation to said actuator whereby movement of said armature causes movement of said actuator and said contact member.

6. In an electromagnetic switch of the type having a hollow magnetizing coil with a fixed magnetic core occupying part of the space within the core; a movable armature sub-assembly adapted to be supported across the open end of the coil and comprising, a non-magnetic plate having a tapped hole adapted to overlie the end of the coil, a screw having a head adapted to lie within the space in the coil and threaded into said plate, a hollow cup-shaped armature adapted to be positioned in the space in said coil with its closed end toward said core, a tension spring positioned within the armature with one end attached thereto adjacent its closed end, the other end of the spring being anchored to the head of said screw, said spring normally holding the open end of said armature against one face of said plate, said screw being accessible from the other face of said plate to adjust the tension of said spring.

(References on following page)

References Cited in the file of this patent

UNITED STATES PATENTS

389,196	Chase	Sept. 11, 1888
687,060	Perry	Nov. 19, 1901
1,071,886	Cubitt	Sept. 2, 1913
1,156,201	Barnum	Oct. 12, 1915
1,175,323	Wikander	Mar. 14, 1916
1,201,491	Neahr	Oct. 17, 1916
1,241,139	Neahr	Sept. 25, 1917
1,895,767	O'Keeffe	Jan. 31, 1933
1,932,164	Petit	Oct. 24, 1933
1,981,967	Parker et al.	Nov. 27, 1934
2,279,395	Gardiner	Apr. 14, 1942
2,300,868	Bottinger	Nov. 3, 1942
2,308,660	Kouyoumjian	Jan. 19, 1943
2,350,938	Sparrow	June 6, 1944
2,379,772	Wellman	July 3, 1945
2,435,484	Wellman	Feb. 3, 1948
2,444,198	Hasselhorn	June 29, 1948
2,538,020	Lomholt	Jan. 16, 1951
2,582,131	Jorgensen et al.	Jan. 8, 1952