

Dec. 7, 1954

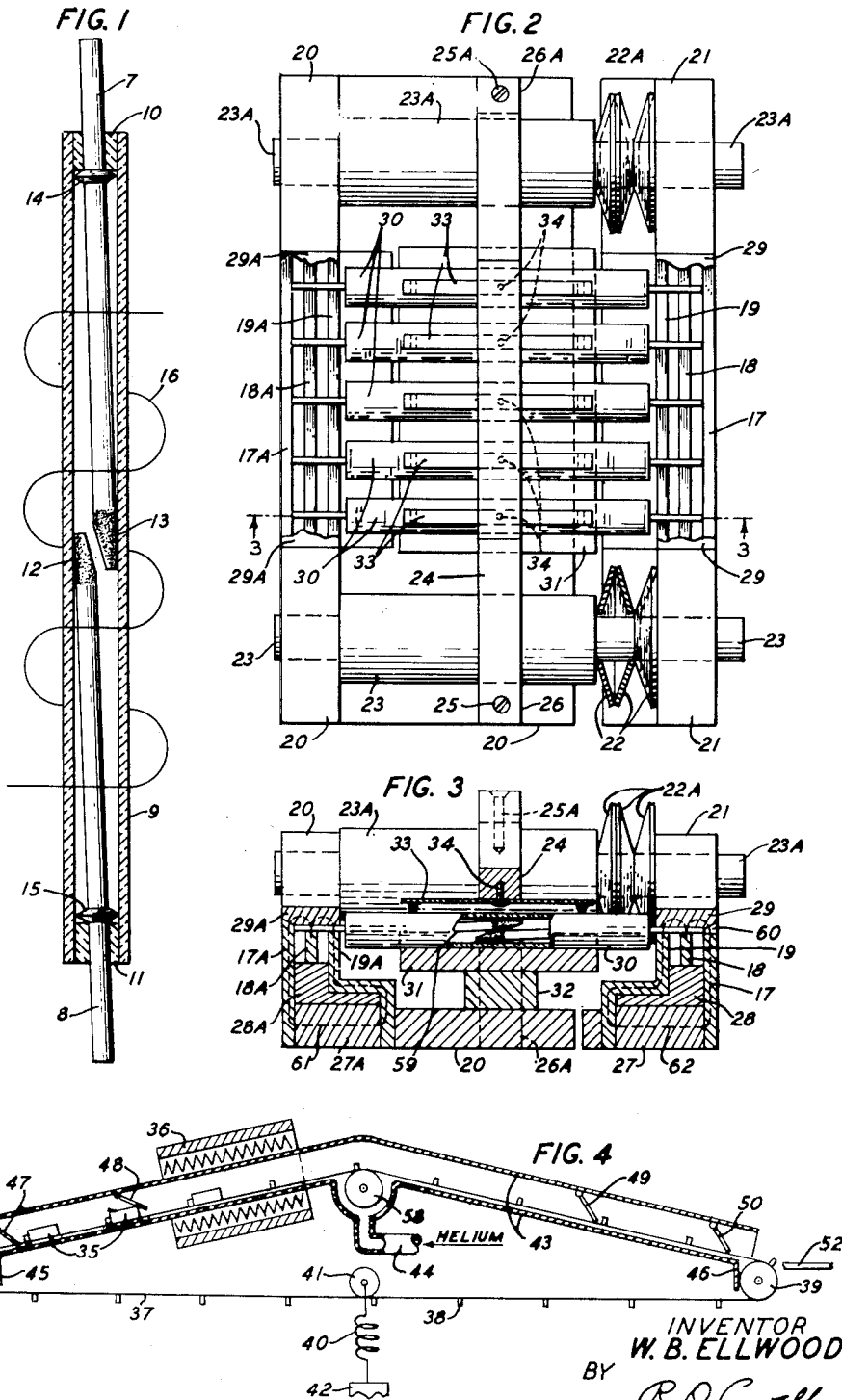
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2,696,543

ELECTRIC SWITCH

Original Filed Dec. 18, 1948

2 Sheets-Sheet 1



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FIG. 5

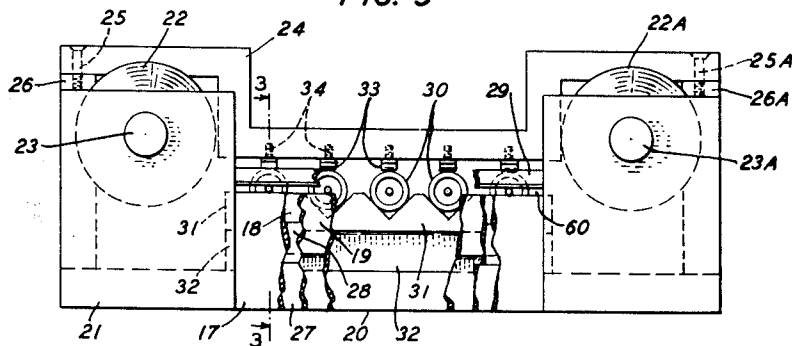
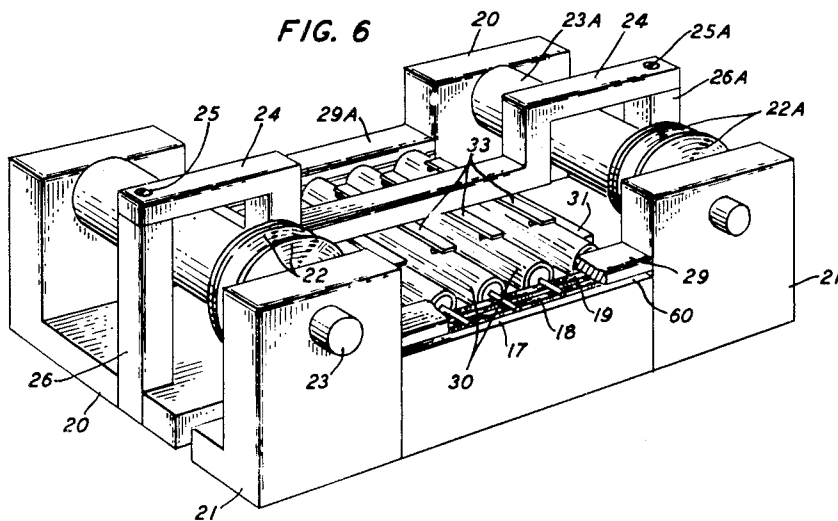


FIG. 6



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2,696,543

## ELECTRIC SWITCH

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Original application December 18, 1948, Serial No. 66,084, now Patent No. 2,648,167, dated August 11, 1953. Divided and this application November 8, 1952, Serial No. 319,483

## 5 Claims. (Cl. 200—144)

This invention relates to switches, and more particularly to dry reed switches which can be readily and precisely manufactured.

An object of the invention is to provide an inexpensive switch of the dry reed type that has a definite and preascertainable gap between its electrodes.

Another object of this invention is to produce a switch with a gap between the electrodes thereof that is readily reproducible in other such switches on a mass-production basis.

A feature of the invention resides in using an envelope and a pair of resilient electrodes one end of each being supported at opposite ends of the envelope while their other ends overlap within the envelope and include contact surfaces which are, at the same time, always oblique to the line between ends of the envelope and parallel to each other, and which other ends are biased to abut opposite inner surfaces of the envelope so that the gap between the contact areas of the electrodes is dependent simply upon the longitudinal displacement of the electrodes along the line joining the ends of the envelope while the mating ends thereof are abutting the opposite inner surfaces of the envelope.

There has been difficulty in the past in manufacturing dry reed switches with a high degree of uniformity. This difficulty is overcome and the objects of the invention attained if the switch which is manufactured comprises an envelope wherein two electrodes are placed substantially end-to-end in a longitudinal manner with respect to each other, with the contact ends of said electrodes being beveled to form surface contact areas that are parallel to one another. It is particularly important for obvious electrical reasons that they be essentially parallel when mating. Small variations from parallelism is not harmful. With such a switch configuration the gap between the two beveled contact surfaces may be accurately and uniformly determined by inserting the switch electrodes into opposite ends of the envelope and pushing them towards one another until the beveled edges of the electrodes engage and the sides of the electrodes opposite the beveled edges abut the sides of the envelope, by influencing the electrodes to produce a repelling force between them, and by then separating the electrodes longitudinally by a controlled amount. These acts are accomplished, for example, by means of a machine which comprises a temperature-responsive jig which holds the switches while the electrodes are spaced and the switch envelope is sealed in a furnace. A belt guide may be used to carry a series of these switch-holding jigs into a temperature-controlled furnace where the spacing and sealing steps occur. A suitable machine is disclosed herein, and is also disclosed and claimed in my Patent 2,648,167, dated August 11, 1953, which was issued from the parent application of which this application is a division.

The invention, the attainment of its objects, and the nature thereof, may be more fully understood from the following detailed description, when read in conjunction with the accompanying drawings in which:

Fig. 1 shows a front view in section of an assembled switch in an inoperated or open condition with the electrodes separated from each other;

Fig. 2 shows a partially broken away top view of the jig which holds the switches during the electrode-spacing and envelope-sealing steps;

Fig. 3 shows a section view of the jig taken through

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3—3 of Fig. 2, showing the electrodes of the switch fully inserted into the envelope;

Fig. 4 shows a view of a belt guide carrying a plurality of jigs identical in structure to the jig of Fig. 2 into a furnace where the spacing of the switch electrodes and the sealing of the switch envelopes are accomplished;

Fig. 5 shows a partially broken away side view of the jig of Fig. 2; and

Fig. 6 shows a perspective view of the jig of Fig. 2.

In Fig. 1 of the drawings, the two electrodes 7 and 8 of a complete but unoperated switch are enclosed in the tubular envelope 9 which may be glass or other suitable material. In an exemplary embodiment electrodes 7 and 8 are made of a nickel-iron alloy consisting of about fifty-one per cent nickel and forty-nine per cent iron which has very nearly the same coefficient of expansion as that of the annular glass seals 10 and 11. It is to be noted, however, that any electrical conducting material possessing magnetic properties may be used as electrodes. The contact tips or mating ends 12 and 13 of electrodes 7 and 8, respectively, are plated with a metal which assures hard, long wearing, low resistance contact surfaces. Rhodium is suitable although other metals can be employed. Each of the two electrodes 7 and 8 is provided with an upset flange 14 and 15, respectively. These upset flanges center the electrodes in the glass tub during the sealing process. They also define the cantilever length and serve as location stops for the annular glass seals 10 and 11. The contact surfaces of the electrodes are beveled in such a manner that the two surfaces lie in planes approximately parallel to each other, thus providing for good contact when the relay is actuated. While these beveled edges are shown parallel at all times such as merely the preferred arrangement involving symmetrically arranged electrodes. Parallelism when mating is the only essential electrical requisite. Small variations of parallelism due to using non-symmetrical electrodes and due to usual manufacturing tolerances, etc. can be tolerated without going beyond the scope and spirit of the invention, as will be apparent to those skilled in the art. The annular glass seals 10 and 11, which are inserted in envelope 9 before the spacing and sealing steps occur, have a very low melting point so as to reduce the furnace temperature required for sealing the envelope. The seals should preferably have the same coefficient of expansion as the glass envelope 9 and as the metallic electrodes 7 and 8, otherwise the seals are apt to crack under the unequal stresses imposed upon them when the switch is subjected to temperature variations. The melting point of the glass seals should be below the softening point of the glass envelope so that the cylindrical form of the envelope will not be materially changed during the sealing process. As is represented by the wire 16, the assembled switch is adapted for use in conjunction with a coil or other source of magnetic flux to form an electromagnetic relay.

In Figs. 2 and 3 of the drawings, the assembled switches 30 are positioned in the V grooves of V-block 31 of the jig. Pole-pieces 17, 18, 19, 17A, 18A and 19A, which are constructed of magnetic material, cooperate with permanent magnets 27 and 27A (Fig. 3) to constitute two magnetic chucks which grip the electrodes of each switch. These chucks are firmly affixed to end piece 21 and frame 20, respectively, so that the electrodes are held in a fixed position with respect to frame 20 and end piece 21, respectively. As will be seen in Fig. 3, one of the electrodes for each switch abuts pole-piece 17A, which aids in properly positioning the electrodes prior to the spacing and sealing of the electrodes within a furnace.

In an exemplary embodiment of the invention, bimetal washers 22 and 22A are placed on support rods 23 and 23A, respectively, one end of each of the rods 23 and 23A being permanently attached to frame 20, the other end of each of the rods being frictionally engaged by end piece 21. When the jig is heated in a furnace the bimetal washers expand and the depth of the cone formed by washers 22 and 22A increases, thereby forcing end piece 21 away from frame 20. End piece 21 is held in this displaced position when the jig is cooled

and the washers return to their normal dimensions by virtue of the frictional engagement between the rods 23 and 23A and the end piece 21. Thus, the electrode spacing created by the washer expansion is maintained. Spring clamp holder 24, which maintains the switch envelopes in position, is held in place by screws 25 and 25A which are inserted in common supports 26 and 26A. Frame 20, end piece 21, and support rods 23 and 23A are all made of non-magnetic material.

Magnets 27 and 27A are composed of a magnetic material which will retain its permanent magnet properties to a high degree at temperatures in excess of 500° C.; for example, a material of this type which is suitable is disclosed in Kelsall et al. United States Patent 2,190,667, dated February 20, 1940, as containing 29 per cent nickel, 50 per cent iron and 13 per cent aluminum, although other alloys of suitable properties are also known in the prior art.

Metallic pieces 28 and 28A are fabricated from non-magnetic material since their function is to support pole-pieces 17, 18 and 19 and 17A, 18A and 19A, respectively, without shorting the magnetic circuits. Top clamp plates 29 and 29A, which are constructed of magnetic material, are laid on the top of the projecting extremities of the switch electrodes so as to reduce the reluctance of the magnetic path for the magnetic chucks, as is best shown in Figs. 5 and 6. V-block 31 is firmly supported by and fastened to block 32, the combination of which is secured to frame 20. Fastened to spring clamp holder 24 by rivets 34 is a series of spring clamps 33, one for each switch being manufactured. These spring clamps help to hold the glass envelopes in a fixed position during the spacing and sealing steps.

In Fig. 4, jigs 35, which hold the switches to be spaced and sealed, are carried through heater furnace 36 on conveyor belt 37. Regularly spaced on the conveyor belt 37 are stops 38 designed to hold and position jigs 35 as they pass through tube 43 and furnace 36. The conveyor belt is guided and driven by pulleys 39, 57 and 58. An idle pulley 41 and spring 40 with a weight 42 attached to said spring 40 is provided to maintain a desired tension in the conveyor belt. The conveyor belt 37 passes through the cylindrical metal tube 43 which has an extension 44 leading to a supply of helium or any other type gas with which it is desired to fill the glass envelopes of the switches. Also attached to metal tube 43 are flexible flaps 45, 46, 47, 48, 49 and 50, preferably made of a silicone rubber although other suitable heat resistant materials impermeable to gases may be used. These flexible flaps help to prevent air contamination of the helium or other gas injected into the metal tube 43. The purpose of injecting this gas into the metal tube 43 is to allow the unsealed envelopes of the switches to become filled with the injected gas by diffusion before the ends of the glass envelope are sealed in heater furnace 36. At both ends of the conveyor belt are platforms, platform 51 being designated as the entrance platform and platform 52 as the exit platform. The loaded jigs are manually placed on the conveyor belt and automatically leave the conveyor belt and rest upon exit platform 52.

The method of manufacture will now be described in detail. Each switch is assembled by placing two electrodes having a structure identical to that of electrodes 7 or 8 (Fig. 1) in a glass envelope such as envelope 9. The beveled surfaces of these electrodes are forced against one another in a manner shown in the broken section 59 of Fig. 3. Annular glass seals such as 10 and 11 are inserted over the projecting extremities of the electrodes until they rest on the upset flanges 14 and 15, respectively. The assembled switches are then placed in the jig in a manner which is best shown in Fig. 6. In particular, the assembled switches rest in the V grooves of block 31. The electrodes at the same end of each switch rest against pole-piece 17A as is shown in Fig. 3. The magnetic top plates 29 and 29A rest on top of the projecting extremities of the electrodes. To make sure the electrodes are positioned so that their contact surfaces are touching each other and the side of each electrode opposite the beveled surface is in contact with the inner wall of the glass envelope as is shown in the broken section 59, each electrode end exposed by aperture 60 can be tapped lightly. The electrodes are held in a fixed position with respect to frame 20, end piece 21 and the magnetic chucks by the forces exerted

by the magnetic lines of force 61 and 62 shown in Fig. 3. Positioned as shown in Fig. 1 the glass seals 10 and 11 will melt when subjected to the heat of the furnace and upon cooling will form a seal. The jigs are moved from the entrance platform 51 so as to approach the furnace 36 through tube 43, the glass envelopes are filled with helium by diffusion, and by the time the seals are made, the glass envelopes contain helium of sufficient purity for useful operation of said switches. As the switches are subjected to heat the bimetal washers 22 and 22A expand and push end piece 21 and its associated magnetic chuck away from frame 20. Since the magnetic chuck is fastened securely to end piece 21, the electrodes of each switch are pulled apart a certain fixed and uniform longitudinal distance which is dependent upon the coefficient of expansion of the bimetal washers and their temperature. There is a friction surface between support rods 23 and 23A and end piece 21 so that upon cooling, the end piece 21 does not return to its original position, but remains in the position it was in during the heating period. Thus, the gap between the electrodes is a reproducible one since the temperature is controllable. It should be noted here that the polarity of magnets 27 and 27A should be arranged so that the contact ends of the electrodes are of the same magnetic polarity and thus will repel each other as one is drawn away from the other during the manufacturing process. This keeps the electrodes in continuous contact with the inner surfaces of the glass tubes during the entire manufacturing process, which insures a uniform, reproducible gap between said electrodes.

It is to be understood that the above description is an exemplary embodiment of the invention and that other materials, elements, and arrangements may be utilized without departing from the spirit and scope of the invention.

What is claimed is:

1. In a switch, a tubular envelope having a longitudinal axis, and a pair of electrodes affixed at one end to and extending longitudinally within said envelope, each electrode having a surface contact area on its other end capable of mating with the contact area of the other electrode, said mating ends of said electrodes normally engaging the opposite inner sides of said envelope and displaced with respect to each other along said axis so as to overlap one another to provide a predetermined gap between said contact surfaces, said mating surfaces of said electrodes being at all times oblique to said longitudinal axis and being parallel to one another.

2. In a switch, an envelope, a pair of displaceable electrodes one end of each being supported at opposite ends of said envelope and overlapping each other at their outer ends within said envelope, said other ends having cooperating parallel contact areas always oblique to the axis joining the ends of said envelope, said other ends biased to abut opposite inside surfaces of said envelope and disposed with respect to each other along said axis of said envelope to define a predetermined gap between the contact areas thereof.

3. In a switch, an envelope, a pair of displaceable electrodes one end of each being supported at opposite longitudinal ends of said envelope and overlapping each other at their other ends within said envelope, said other ends having cooperating parallel beveled contact areas always oblique to the longitudinal axis of said envelope, said other ends biased to abut opposite inside surfaces of said envelope and disposed with respect to each other along the longitudinal axis of said envelope to define a predetermined gap between the contact areas thereof.

4. In a switch, an elongated envelope, a pair of magnetically responsive electrodes one end of each being supported at respective ends of said envelope and overlapping each other at their other ends within said envelope, said other ends having cooperating parallel beveled contact areas always oblique to the longitudinal axis of said envelope, said other ends biased to abut opposite inside surfaces of said envelope and disposed with respect to each other along the longitudinal axis of said envelope to define a predetermined gap between the contact areas thereof.

5. In a switch, a hermetically sealed elongated tubular envelope, a pair of magnetically responsive rod-like electrodes one end of each being fixed to respective ends of said envelope and overlapping each other at their other ends within said envelope, said other ends having beveled

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contact tips comprising facing parallel contact areas always oblique to the longitudinal axis of said envelope, said tips biased so that the sides of said tips opposite said contact areas abut opposite inside surfaces of said envelope and disposed with respect to each other along the longitudinal axis of said envelope to define a predetermined gap between the contact areas thereof.

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