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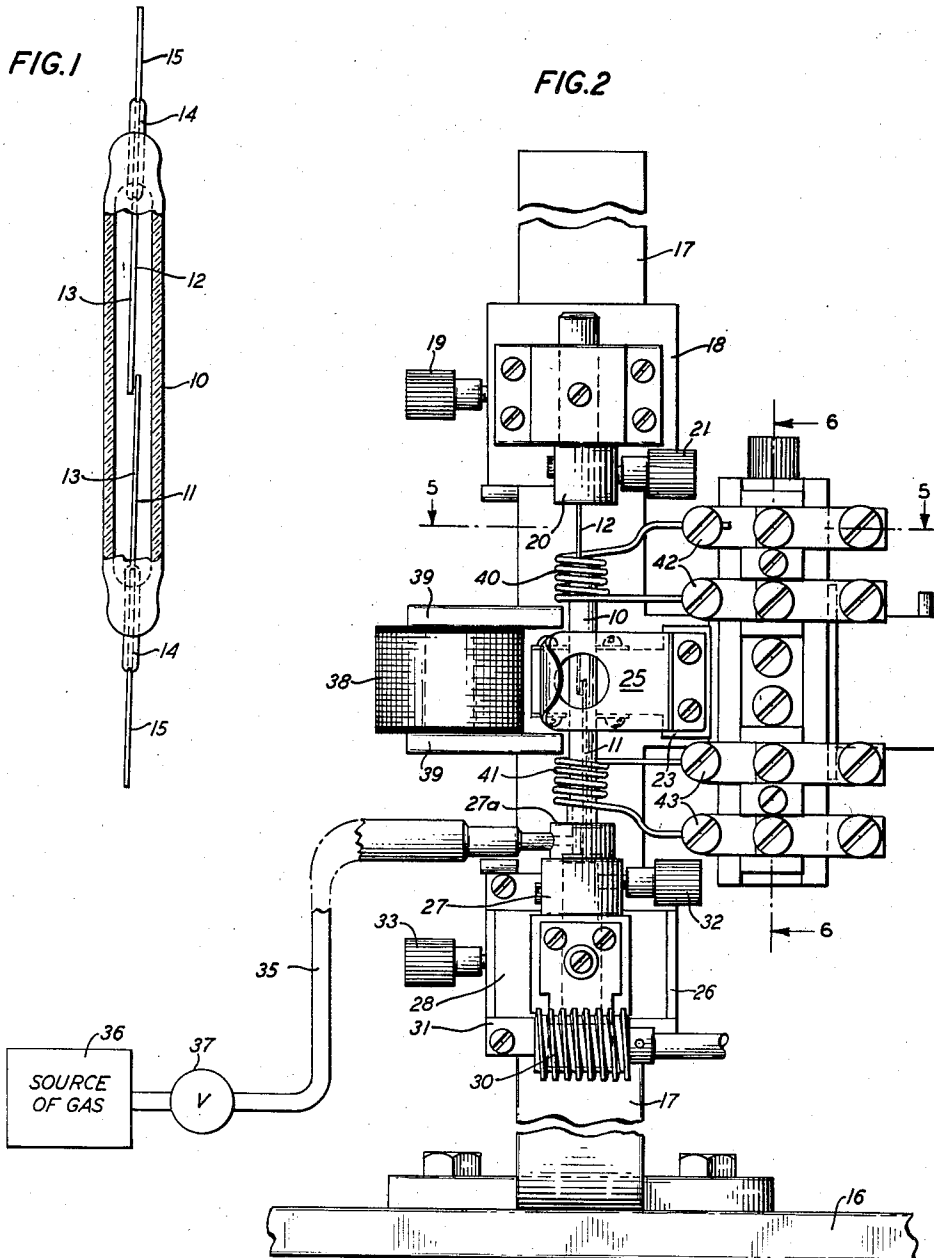
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SWITCH MANUFACTURE

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3 Sheets-Sheet 1



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FIG. 3

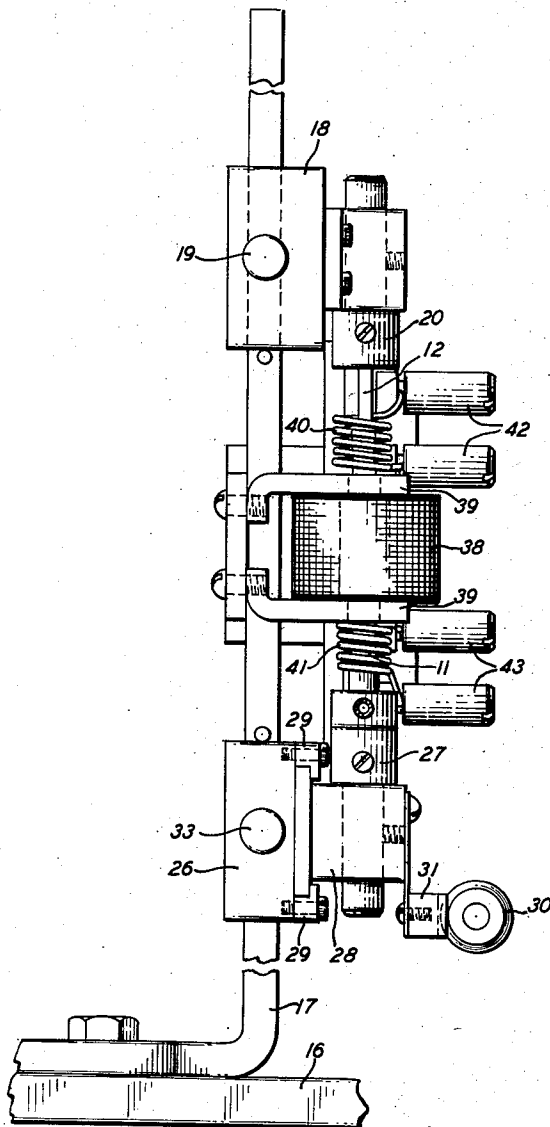
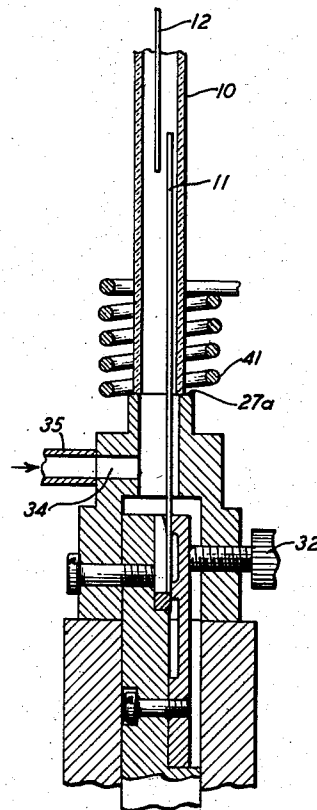


FIG. 4



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SWITCH MANUFACTURE

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1 Claim. (Cl. 49—81)

This invention relates to the manufacture of electrical switching devices and more particularly to methods of fabricating switches of the sealed reed type, e.g., such as that disclosed in Patent No. 2,289,830, issued July 14, 1942, to W. B. Ellwood.

Sealed or dry reed switches comprise, in general, a pair of essentially parallel flexible reeds overlapping on one end and whose opposite ends are fixedly retained by the corresponding opposite ends of an enclosing vessel. The overlapping ends of the reeds or elements are formed as cooperating contact surfaces, and the enclosing vessel ordinarily is hermetically sealed under vacuum or a protective gas is injected therein to prevent oxidation and/or other deterioration of the contact surfaces.

The air gap between the cooperating contact surfaces must be determined accurately if a switch is to function properly upon the application of a preselected magnetic field. And, of course, this requirement is further emphasized by the need of obtaining the same operating characteristics within close tolerances for a group of such switches.

Heretofore, switches of this type have been fabricated in a number of ways, but none of these has proven entirely satisfactory. Prior techniques have entailed, inter alia, fabricating such sealed reed switches in evacuated Bell jars to obtain a vacuum seal or jars filled with a gas to obtain a gas atmosphere, using one solid reed and one tubular reed with the evacuation or filling being attained through the agency of the tubular reed which is thereafter sealed, or using two tubular reeds and evacuating the vessel or flushing the gas through the vessel via the reeds and flattening them to seal the switch. These and other methods employed in the past have involved a complexity of manipulations, a multiplicity of operations and/or discontinuities in manufacturing steps, and hence, have not been readily adaptable to mass production techniques.

One general object of this invention is to improve methods of manufacturing switches of the sealed reed type.

More specifically, objects of this invention are to reduce the complexity and multiplicity of operations required in the manufacture of dry reed switches, to expedite the fabrication of sealed reed switches having prescribed and uniform characteristics, and to realize continuity in the series of steps in the manufacture of such devices. The attainment of these objects permits rapid and economical manufacture of sealed reed switches in large quantities.

In one illustrative embodiment of this invention, the magnetic elements or reeds are mounted within a vitreous open-ended tube, in the generally desired parallel and over-lapping relation to one another. The tube ends are sealed to the elements or reeds at successive times and a gas filling is provided in the vessel thus formed.

In accordance with one feature of this invention, with the vessel and magnetic elements held in proper spatial relationship to one another, a flow of the gas to be sealed

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therein is established through the tubular vessel past the magnetic elements or reeds. The exhaust and intake tube ends with respect to the flow of gas through the tube are sealed in that order to their respective elements by heating the tube ends causing them to collapse upon the elements. During the heating of the tube ends the gas flow through the tube is continued and, as a result, a pressure slightly above atmospheric pressure is attained within the enclosing vessel.

In accordance with another feature of this invention, the heating of the ends of the vitreous tube to seal them to the reeds is controlled in accordance with a certain time cycle whereby the pressure upon the inner sealing portions of the vessel, caused by the thermal expansion of the gas, is maintained at a reasonable value. This value is such as not to impede or prevent the formation of seals of sufficient strength to insure hermetically strong joints.

In accordance with a further feature of the invention, one of the reeds is mounted for controlled movement relative to the other to enable the air gap between contact surfaces to be adjusted.

Yet another feature pertains to a mechanism to adjust this air gap spacing automatically such that closure of the contacts will be obtained by the application of a prescribed magnetic field. This adjustment is made in cooperation with the gas filling and sealing operations; hence, the performance characteristics of a completed switch meet preassigned requirements within close limits without undue loss of motion in the over-all manufacturing process.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a side view of a sealed magnetic reed switch of the type fabricated in accordance with this invention;

Fig. 2 is a front elevational view of one form of apparatus illustrative of this invention;

Fig. 3 is a side view of this apparatus;

Fig. 4 is a detail view in section depicting the mounting of the tube and one of the reeds in the apparatus shown in Figs. 1 and 2;

Fig. 5 is a sectional view taken along the lines 5—5 of Fig. 2; and

Fig. 6 is a diagram representing the circuit for controlling the adjustment of the spacing of the reeds and for heating the ends of the vitreous tube to produce the seals between the tube and the reeds.

Referring now to the drawing, the switching device depicted in Fig. 1 comprises an elongated vitreous vessel 10 having sealed at opposite ends thereof each of a pair of magnetic reeds 11 and 12. Each of these reeds comprises a flattened flexible portion 13, a circular intermediate portion 14 and a flattened terminal portion 15 as shown in Fig. 1. The inner ends of the two reeds are in overlapping spaced relation to one another and their cooperating surfaces are coated or have thereon a layer of a low-resistance, long-life contact metal. In one particular and illustrative construction, the envelope 10 is constructed of glass, the reeds 11 and 12 are composed of approximately equal parts of nickel and iron, the juxtaposed contact surfaces are gold infused, and the vessel 10 is filled with a protective gas composed of 97 percent nitrogen and 3 percent hydrogen (forming gas).

The apparatus for fabricating switches of the construction shown in Fig. 1 comprises, as shown in Figs. 2 to 5, a base 16 having an upstanding support bracket 17 mounted thereon. This bracket 17 acts as a vertical guide way for adjustable carriage 18 which is slidably supported upon it and may be locked to the bracket 17 by a thumb screw 19. The carriage 18 fixedly retains a chuck 20

for receiving one of the reeds, for example 12, which may be firmly locked in place by a thumb screw 21.

A second carriage 26 is slidably mounted upon guide bracket 17 and may be locked in position through the agency of a thumb screw 33. A second chuck 27 is fixedly retained by a third carriage 28 which, in turn, is slidably supported by horizontal rails 29 (Fig. 3) affixed to the second carriage 26. Chuck 27 is for receiving the other of the reeds, for example 11. In the instant apparatus the reed is securely locked in the chuck 27 through manipulation of a thumb screw 32, as illustrated most clearly in Fig. 4, after its contacting surface is disposed parallel to the contacting surface of reed 12. The horizontal carriage 28 may be moved laterally (to the left or right on Fig. 2) through rotation of a worm gear 30 cooperating with a gear segment 31 attached to carriage 28.

Quite often the chuck 27 is constructed so that reed 11 is fixed insofar as its vertical movement is concerned, but left free to turn about its longitudinal axis. This allows reed 11 to cam its contact surface into a position parallel to the contact surface of reed 12 when the two reeds come together, thus making a manual adjustment for the same purpose unnecessary. Of course, the result in either case is the same.

As illustrated clearly in Fig. 4, the lower chuck 27 (Figs. 2 and 3) is provided with a port or aperture 34 whereby a flow of the gas which will form the internal atmosphere for the magnetic elements in the completed switch may be introduced into the vessel. This port 34 is coupled by an appropriate pipe 35 through a suitable valve 37 to a gas source 36 (Fig. 2).

Also supported by the bracket 17 is a mounting block 22 (Fig. 5) which carries an arm 23 having therein a V-shaped slot or groove 24 for accommodating and locating a length of vitreous tubing 10. The tubing is held firmly in the slot or groove 24 by a flat spring 25.

An electromagnet comprising a coil 38 and pole-pieces 39 is fixedly mounted upon the upstanding bracket 17. Also included in the apparatus and supported at the terminal posts 42 and 43 mounted on the upstanding bracket 17 are a pair of heating coils 40 and 41. These heating coils surround upper and lower ends (per Fig. 2) of the vessel 10 wherein are positioned reeds 12 and 11, respectively.

In the fabrication of the switch, a length of vitreous tube 10 is seated upon the upper surface 27A of the lower chuck 27 and the reeds 11 and 12 are locked in their respective chucks 27 and 20, the reeds being positioned so that the contact-carrying ends are in preselected overlapping spaced relation to one another. The spacing between the contact surfaces of reeds 11 and 12, that is to say the air gap, should be somewhat greater than that specified for the completed switch. A flow of gas is introduced into and through the tube from the source 36, the flow being lengthwise of the tube and over the two reeds 11 and 12 whereby contaminants and atmospheric air within the tube are expelled to prevent deleterious oxidation of the reeds during the sealing steps. With the flow of gas extant, the coil 38 is energized to subject the reeds to a magnetic field of a preselected strength in a manner to be described in detail hereinafter. Through manipulation of the worm gear 30, the reed 11 is moved toward the reed 12 until, under the influence of the magnetic field, the two reeds contact. As soon as this occurs, the energizing current for the coil 38 is cut off and the lower horizontally displaceable chuck 27 is firmly locked into position by manipulation of the thumb screw 33.

With the flow of gas continuing, the heating coils 40 and 41 are energized sequentially and in that order whereby the respective ends (upper and lower in Fig. 2) of the vitreous tube 10 are rendered plastic sequentially and in that order. As these ends of the vessel 10 become plastic, they collapse upon their respective reeds and each

is sealed to their respective reeds. More specifically, the coil 40 is energized to render the upper or outlet end of the tube 10 plastic whereupon it collapses and engages the reed 12. At this time in the cycle and while the coil 41 is also energized, the rate of flow of gas into the tube is decreased. The sequential energization of the heating coil 40 is energized to render the upper or outlet end of the tube 10 so that the pressure of the gas upon the plastic upper portion of the tube 10 is not great enough to prevent formation of a satisfactory hermetic seal between the upper portion of the vessel 10 and the reed 12. As energy is supplied to the heating coil 41, the lower end of the tube 10 becomes plastic and collapses about the reed 11. When the lower portion of the tubular container 10 engages the reed 11 the energizing current for the heating coil 41 is cut off. Such timing, as will be obvious to those skilled in the art, may be done manually or by the proper construction and orientation of timing element 50 (Fig. 6) as disclosed hereinafter. The magnitude of the pressure obtained within the sealed tube 10 depends upon the stagger time relation between the energization and de-energization of heating coils 40 and 41. If the seal created by the first coil 40 is not allowed to cool for a sufficient period of time prior to the sealing of the other end of the tube 10, a "blowout" will occur, i.e., the pressure within the vessel due to the thermal expansion of the gas will become so great that it will "blowout" or rupture the hermetic seals. Hence, it is quite important that the heating cycle be a staggered one.

It may be remarked that initially the flow of gas from the port 34 is through the tube 10. Following the formation of the seal at the upper end of the tube 10 the flow of gas is into the tube at the lower inlet and out at the same end of the tube 10 by way of a leakage path between the lower end of the tube 10 and the positioning surface 27A on the lower chuck 27. Thus, throughout the entire sealing process a continuous flushing of the interior of the vessel 10 by gas is maintained.

It is apparent, of course, that the reeds might all extend from one end of the enclosing vessel. Such an arrangement would not materially affect the method described supra. It would mean simply that, upon becoming plastic, the upper end of tube 10 would not collapse about a reed, but would close the end of the tube in a glass-to-glass seal rather than a glass-to-metal seal.

It will be noted that fabrication of the switch is effected as a continuous process and, thus, the method of the invention is amenable to economical mass production techniques. By virtue of the continual flushing of the tube with gas during the adjusting and sealing steps, most contaminants present are removed, the atmospheric air is replaced by a non-oxygen atmosphere, and any salutary effect the gas atmosphere may have on the reeds as they are heated is realized. Further, due to the fact that the seal at one end of the container 10 is formed before that at the other, through the control of the heating cycle and the gas pressure, strong hermetic seals are provided between the reeds and the vessel. It is also to be noted that as the gas flow continues during the sealing of the second end of the vessel to its associated magnetic element, the pressure and velocity of the gas at the lower end of the tube is such that it prevents ingress of atmospheric air into the tube as by an aspirator action adjacent the abutting surface 27A of the chuck 27 and the vessel 10.

A circuit for energizing the coils 40 and 41 and effecting adjustment of the space relation of the reeds is illustrated schematically in Fig. 6. As there shown, the electromagnet 38 is energized from a source 45, the energizing current being controllable by a switch 61 and a variable resistor 46. The worm gear 30 may be driven by a motor through a reduction drive 48, the energizing windings of the motor being illustrated at 47. The motor's winding 47 may be energized from source 49 to turn the shaft of the motor in either direction over an obvious cir-

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cuit under the control of switch 56. The heating coils 40 and 41 also are arranged for energization from the source 49 over a rotatable timing element 50 driven by a motor 51. Switch 57 completes the circuit for motor 51. Associated with the reeds 11 and 12 is a relay 52 5 having make contacts 53 and an armature 54 and energizable from a source 55 over an obvious series circuit including the two reeds and switch 62.

In operation, with the coil 38 energized from the source 45, the motor 47 is rendered operative by closure of 10 the switch 56, whereby the reed 11 is moved toward the reed 12. When, due to the magnetic field set up by the coil 38 and the pole-pieces 39, the reeds 11 and 12 are flexed to contact each other, the energizing circuit for the relay 52 is completed whereby the armature 54 bridges the make contacts 53, effectively short-circuiting the windings 47. Thus, lateral movement of the reed 11 is stopped substantially instantly upon contact between the 15 two reeds. With the proper positioning of reeds 11 and 12 and gas flowing through the vessel 10 via port 34, closure of switch 57 energizes the motor 51 to begin rotation of the timer 50 whereby the heating coil 40 is energized and at a specified time thereafter energizing current is supplied to the heating coil 41. As shown, the 20 timer comprises an arcuate conductive element 58 of substantially 270 degrees, with which brushes 59 and 60 cooperate, each of said brushes being associated with a respective one of the coils 40 and 41. It should be evident that energizing current is supplied to the heating coil 40 at a prescribed time before current is supplied 30 to the heating coil 41 and, conversely, the supply circuit for the coil 40 is interrupted at a definite time prior to a similar interruption for the coil 41.

It is apparent that a ganged switch including switch 61 for energizing coil 38, switch 56 for energizing motor 35 windings 47, and switch 62 for conditioning the circuit path of relay 52 could be utilized. This ganged switch might also include a switch for opening the valve 37 (Fig. 2) in order to flow gas through the vessel and past the magnetic elements. Further, motor 51 and its associated 40 timing element 50 could be made operable in response to

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the operation of the relay 52 instead of being controlled only by switch 57, as shown by example. And lastly, timing element 50 in addition to energizing and de-energizing heating coils 40 and 41, could enable a solenoid (not shown) whereby the valve 37 (Fig. 2) would be partially closed to reduce the rate of gas flow into the vessel after the upper end of the vessel has been sealed. With these obvious modified arrangements, the sequence of operations could be made largely automatic.

It is to be understood that the above-described arrangements are illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

15 What is claimed is:

A method of fabricating a dry reed switch of the type having a pair of electrodes sealed in a tubular envelope comprising the steps of fixedly mounting said envelope, supporting by one end each of the pair of electrodes within the envelope such that each electrode projects inwardly from a different end of the envelope and the free ends of the two electrodes overlap, supplying a forming gas to one end of the envelope for flow past the free ends of the electrodes, while maintaining such flow 25 heating first the other end of the envelope for causing its collapse around the supported end of the corresponding electrode and so sealing such end of the envelope, thereafter reducing the rate of flow of the forming gas into said one end of the envelope, and while maintaining said 30 flow at a reduced rate heating the said one end of the envelope for causing its collapse and sealing such end.

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