Jan. 1, 1946. C. E. POLLARD, JR 2,392,099

MANUFACTURE OF GLASS SEALED CONTACT UNITS

Filed July 29, 1943

FIG. 1

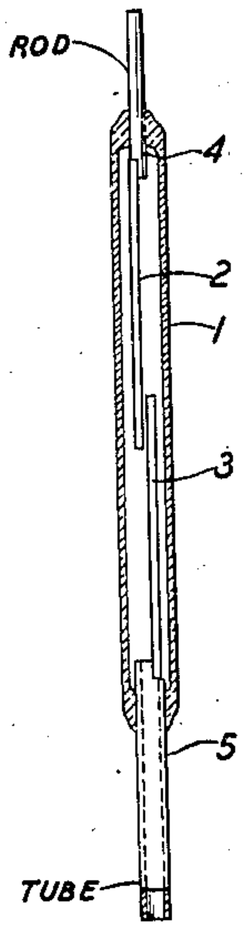


FIG. 2

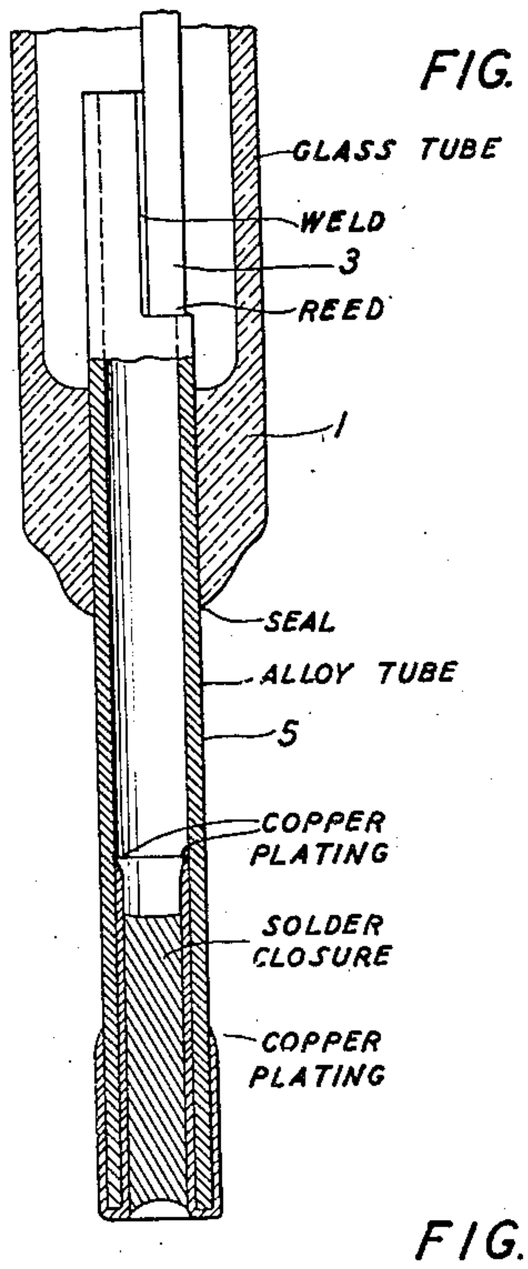
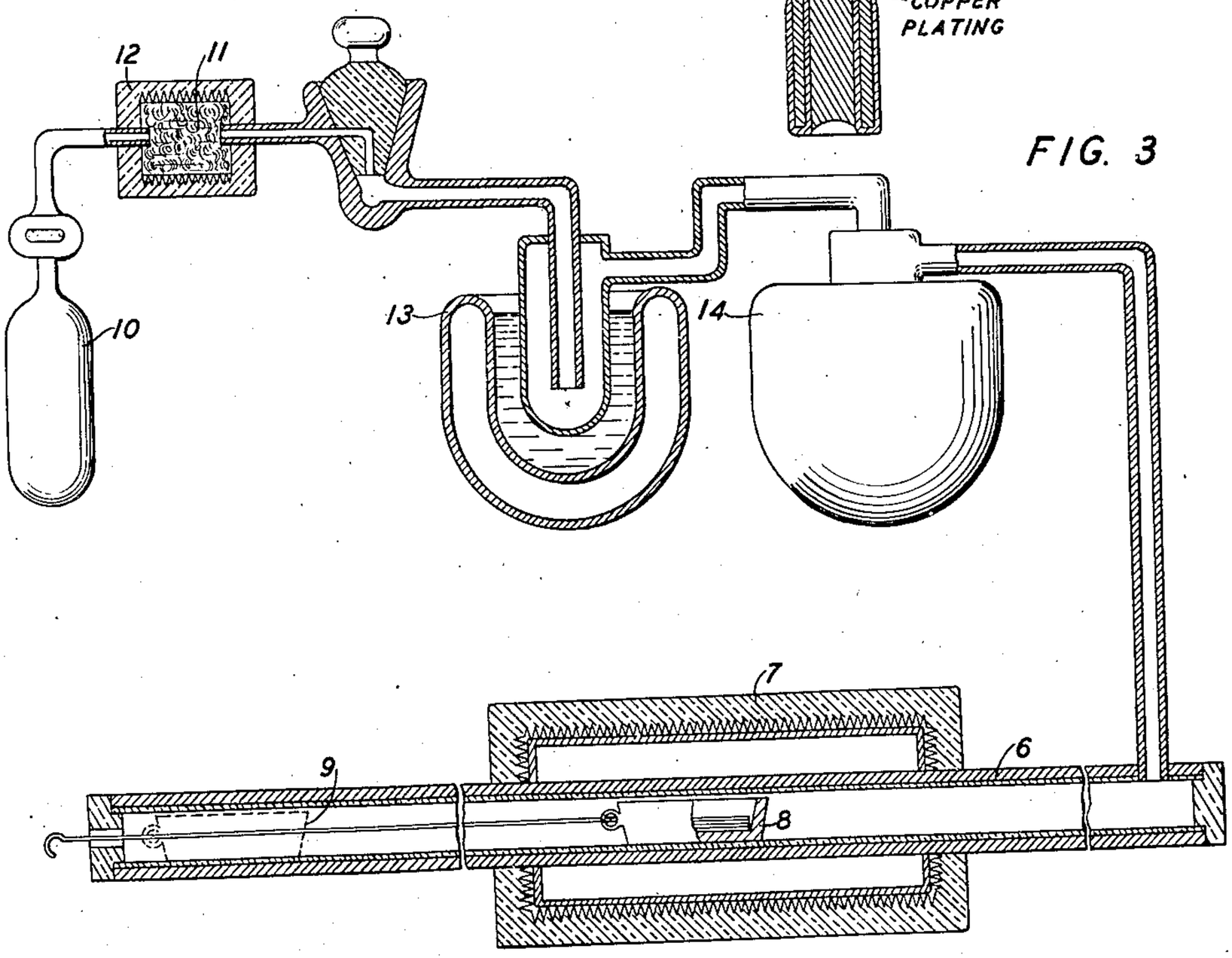


FIG. 3



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MANUFACTURE OF GLASS SEALED CONTACT UNITS

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2 Claims. (Cl. 49—89)

This invention relates to processes of annealing and chemically cleaning and applies particularly to processes employed in the manufacture of electrical apparatus.

The object of the invention is primarily to effect a cleaning of electrical apparatus sealed in glass envelopes after assembly and to remove impurities and accumulations of matter resulting from previous manufacturing steps. The process of the present invention is particularly applicable to the manufacture of a piece of apparatus known as the Ellwood unit which is disclosed in Patent No. 2,289,830, granted to W. B. Ellwood on July 14, 1942, though it will apply as well to the manufacture of other similar apparatus and to electronic devices.

The Ellwood unit compared to other types of magnetic switches or relays, has certain unique characteristics. It is an assembly of specially stable elements bound to each other entirely by fusion. The parts themselves and the mechanical bonds between them are practically unaffected by humidity and are stable with respect to ordinary temperature variations. This results in a high degree of stability of adjustment, compared, for instance, to spring pile-ups molded or clamped in plastic or other insulating materials. No adjustment after assembly or while in service is possible and therefore it is necessary to employ methods of manufacture which will result in a high degree of uniformity in the product. Each manufacturing step must be characterized by nicety of control.

These units are made with a metal tube as a terminal at one end which is used after assembly for removing air and substituting therefor some non-corrosive gas and the tube which is copper plated on its inner surface is finally sealed with solder. The tube is composed of an alloy of nickel and iron which has a temperature coefficient of expansion almost exactly equal to the temperature coefficient of expansion of the lead glass used as the body of the unit. The bond between the glass and the magnetic alloy is made simply by the application of heat, the surface tension of the molten glass being the only force involved in bringing the elements into contact. As this force is relatively small, it is possible in assembling to hold the parts of the switch in a desired position with respect to each other and then to fix this position permanently simply by applying heat to the glass. The metal oxide formed during the sealing insures wetting of the metal by the molten glass and a tight seal is characterized by a homogeneous dark gray color due to this oxide.

Heretofore removal of extraneous matter from electronic apparatus has been practiced by heating the apparatus while maintaining a partial vacuum within. Heretofore also certain cleaning operations have been performed by heat treating in an atmosphere of hydrogen but in the present case certain special problems have had to be met. It is necessary to completely clean the parts of the switch unit without discoloring the unit, without changing the relative position of the parts and without destroying the metal oxide in the seal between the glass and the magnetic alloy. Heat treatment in an atmosphere of hydrogen at too high a temperature will tend to reduce the composition of the glass and to produce discoloration through reduction of the lead silicates and the formation of metallic lead. At too high a temperature the oxide of the seal will be attacked. At too low a temperature the hydrogen in its commercial form will have little if any cleaning effect. A feature of the invention, then, is a process which involves the purification of the hydrogen to a point where it will affect the desired cleaning at a temperature which will not affect the assembly or the adjustment of the parts thereof.

Another feature of the invention is a process which results in the simultaneous annealing of the glass to remove stains from the seals and the cleaning of the inside surfaces of the device. The metal tubulation is copper plated to render the solder seal tight and this annealing and cleaning operation must clean the copper inside surface of the metal tube so that the solder will thoroughly wet such surface in order to produce the requisite seal.

In accordance with these features two processes are combined and carried out in a single operation. It is necessary to anneal the glass which forms the body of the contact unit after the reeds have been sealed in and the adjustment of the parts has been made without altering and such adjustments. It is also necessary to condition such apparatus so that after the final seal is made and while in service the operation will be stable and dependable and will not be affected by any foreign substance on the parts left there by previous manufacturing steps. Applicant has found that by heat treating his apparatus in an atmosphere of purified hydrogen at a temperature of approximately 420° C. he can in one step anneal the glass and clean the parts of the apparatus. This temperature is only critical to the extent that it applies to the particular nature of the materials used and may be changed in ac-

cordance with other materials. It is dictated by the fact that higher temperatures are to be avoided in order to speed the cleaning process.

The temperature mentioned is therefore in the nature of a range since certain deviations in either direction may be allowed without departing from the spirit of the invention.

Other features will appear hereinafter.

The drawing consists of a single sheet having three figures as follows:

Fig. 1 is a sectional view of a sealed reed contact unit;

Fig. 2 is a fragmentary sectional view greatly enlarged of the end of such a unit in which the metal tube is sealed showing the copper plating and the solder seal which is made after the annealing and cleaning operation; and

Fig. 3 is a diagram showing how the annealing and cleaning operation is carried out.

The contact unit as shown in Fig. 1 comprises a glass body portion 1 having therein two overlapping reeds 2 and 3 of magnetic material. The reed 2 is welded to a wire 4 of magnetic material which is sealed in one end of the glass tube and the reed 3 is welded to a tube 5 of similar material which is sealed in the other end of the glass tube 1.

In manufacture, after the parts are assembled and sealed together as shown in Fig. 1, the parts inside the tube and the surfaces of the tube 5 are cleaned in an atmosphere of purified hydrogen and the assembly is simultaneously annealed at an elevated temperature. Since the relative adjustment of the parts cannot be allowed to alter during heat treatment and since commercially available hydrogen is ineffective at a lower temperature, it has been found that effective annealing and effective cleaning can be secured at a temperature which will not soften the parts sufficiently to cause deformation thereof in an atmosphere of specially purified hydrogen.

The assembled switches are heat treated at 420° C. with purified hydrogen in a quartz tube furnace. In Fig. 3, a quartz tube 6 is shown as extending through an electrically heated furnace 7. This temperature is below that usually used to anneal the glass but is effective in removing strains from the seals and the purified hydrogen at this temperature will clean the copper surface on the inside of the tube 5 so that solder used later to seal this tube will properly wet the surface and adhere thereto, will also remove possible traces of oxide and volatile matter from the electrical contact surfaces and will remove oxide coatings which might tend to flake off inside the switch.

This annealing temperature is one which not only will avoid changes in adjustment of the switch due to softening of the glass but will also avoid blackening of the glass by the hydrogen. At and above the annealing temperature (431° C. as recommended by the manufacturer of the glass) hydrogen tends to reduce the lead silicates in the glass to metallic lead.

The switches in batches are placed in a heavy copper boat 8 and inserted in the oven. After fifteen minutes in the position where they are subjected to a temperature of 420° C. the boat is moved, as indicated by the boat in outline 9, to the comparatively cool part of the furnace. The function of the heavy boat is to limit the rate of temperature change in the glass, particularly on cooling. A safe maximum rate of cooling is considered to be about 100° C. per minute.

The period of treatment may be adjusted to the particular furnace used. It has been found that if inspection with polarized light shows a substantial reduction in strain as the result of the annealing, the switches will be satisfactory. Darkening of the glass is an effective indicator of over annealing, although switches showing slight darkening do not appear to be objectionable otherwise. Precise and reliable control of temperature is particularly desirable.

The hydrogen from container 10 used in the furnace is purified by passing it through palladium coated asbestos 11 heated by means 12 at 300±50° C., then through two liquid air-traps 13 and 14 in series. The palladium acts as a catalyst to combine free oxygen with hydrogen, the resultant water vapor being removed along with other moisture in the traps. This purification of the hydrogen greatly increases the effect of the heat treatment in reducing oxides in the switch. Actually the cleaning effect obtained at this relatively low temperature of 420° C. with commercial hydrogen has been found to be negligible.

After the above-described annealing and cleaning operation the contact units are placed upright in an iron basket, evacuated, filled with purified hydrogen and sealed with solder. The tube 5 is copper plated on the outside for a short distance from the bottom and on the inside for a greater distance as shown in Fig. 2. The cleaning operation prepares this inside surface for the soldering operation in which the said iron basket is lowered to the point where the tubes 5 enter a pool of molten solder up to a specified depth. With the inside copper-plated surface clean the outside pressure of the hydrogen atmosphere is raised and the solder slowly rises in the tube 5, cooling as it rises above the outside level thereof and reaching the solid state before it reaches the seal to the glass tube 1. The bucket and the switches are then raised above the level of the solder and the assembly is allowed to cool.

What is claimed is:

1. In the manufacture of electrical apparatus consisting of glass sealed magnetic and electrical elements, the step of heat treating such apparatus in an atmosphere of purified hydrogen at a temperature of 420° C.

2. In the manufacture of electrical apparatus consisting of glass sealed magnetic and electrical conducting elements, the step of heat treating such apparatus at a temperature of approximately 420° C. for a period of approximately 15 minutes and then cooling such apparatus at a rate of approximately 100° C. per minute, in an atmosphere of purified hydrogen.

CHARLES E. POLLARD, JR.