Jan. 5, 1943. J. M. FLUKE 2,307,579

METHOD OF ATTACHING STRIP CONTACT MATERIAL TO SWITCH MEMBERS

Filed July 9, 1940

Fig. 1.

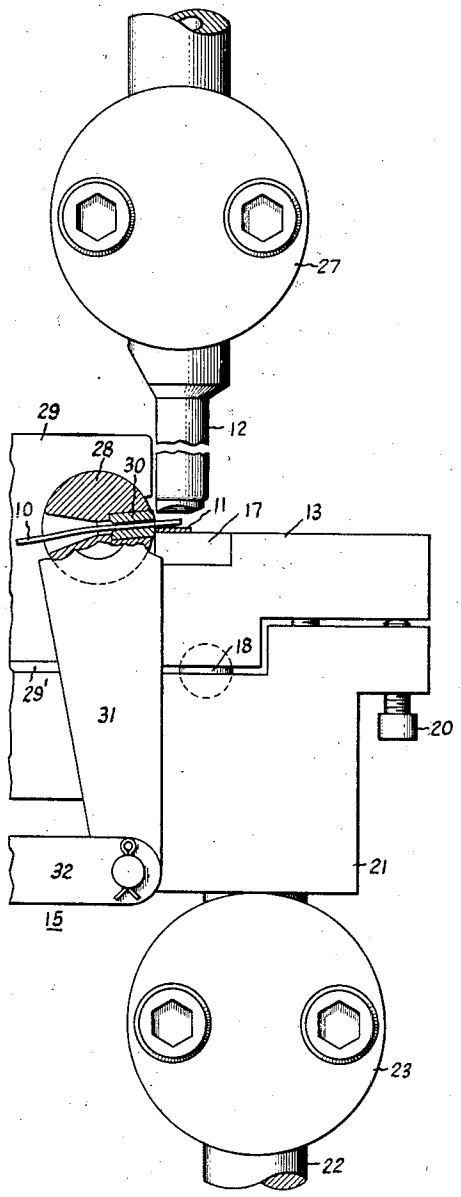


Fig. 2.

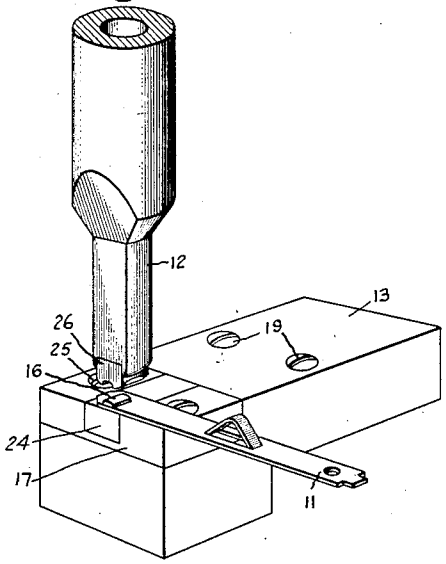


Fig. 3.

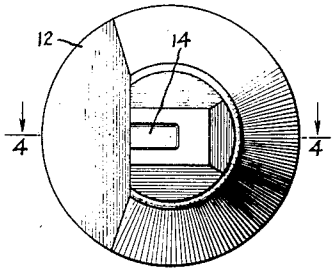


Fig. 4.

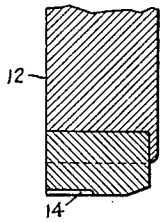


Fig. 5.

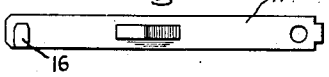
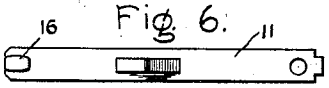


Fig. 6.



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by Harry E. Dunham
His Attorney

Patented Jan. 5, 1943

2,307,579

UNITED STATES PATENT OFFICE

2,307,579

METHOD OF ATTACHING STRIP CONTACT MATERIAL TO SWITCH MEMBERS

John M. Fluke, Bridgeport, Conn., assignor to General Electric Company, a corporation of New York

Application July 9, 1940, Serial No. 344,533

2 Claims. (Cl. 219—10)

My invention relates to a method of attaching strip contact material to switch members. Although not limited thereto, my invention is particularly suited for applying silver contacts to switch members.

Silver or alloys of silver have proved to be the best materials for contacts or contact facings of electric switch devices. For this use, silver and its alloys have been applied to a supporting structure by plating, riveting and welding.

Plating is undesirable because the deposited metal is porous, thin and difficult to place without wastefully covering the entire article. Furthermore, when it is deposited in thicknesses greater than a few ten-thousandths of an inch it is subject to scaling and is of a porous nature.

Riveting has been used and is still used to some extent. This method is not entirely satisfactory because more silver is required mechanically than electrically. Furthermore, in service, this type of contact has been found to loosen at the point of riveting causing increased thermal and electrical resistance.

Previously proposed methods of directly welding a silver contact to its support surface have proved to be either too costly or uncertain to warrant their extensive use. Bimetallic contacts have, however, been extensively used because of the ease with which they may be resistance welded to the switch members of which they form a part. One bimetallic contact button which has been developed and extensively used, consists of a thin silver facing on a steel backing. This button is punched from a sheet of material prepared by rolling a bar of silver with a bar of steel after the two have been suitably joined. Usually, the steel backing portion of the button is provided with projections which facilitate the welding operation by which it is attached to a switch member. These projections, however, restrict the size of the joint between the button and the switch member. This and the presence of the backing material may result in undesired heating. The cost of manufacturing such buttons is at least two or more times the cost of the silver facing. A steel backing obviously is of no functional value once the contact has been welded in place, and as a matter of fact is an undesirable addition to the electrical and thermal circuit of which it forms a part. It is also apparent that several shapes and sizes of contact buttons must be carried in stock for the wide variety of devices in which they are used. This increases manufacturing costs and complicates manufacturing operations since different feeding mechanisms must be employed when changing from one size of button to another. Furthermore, these buttons are easily spilled and lost by welding operators and in storage rust or otherwise deteriorate so that the welding operation by which they are attached to switch members is rendered uncertain.

It is an object of my invention to provide a method of fabricating switch assemblies which avoids the above difficulties of previously proposed plated, riveted or welded assemblies.

It is another object of my invention to provide a method of directly bonding contacts to switch members with certainty and at speeds that greatly reduce the cost of the resulting assemblies.

It is a further object of my invention to provide a method of attaching contacts to switch members which makes it possible to use automatic machines which are readily adapted for attaching contacts of various sizes and shapes.

Further objects of my invention will become apparent from a consideration of the following description thereof and its application by an automatic machine, the essential portions of which have been illustrated in Figs. 1, 2, 3 and 4 of the accompanying drawing. Two representative pairs of switch contacts embodying my invention have also been illustrated in Figs. 5 and 6 of this drawing.

In accordance with my invention, a round wire of silver or other contact material is attached to a switch member by positioning a predetermined length thereof across a surface of the switch member and then simultaneously shaping and attaching it to said switch member by the simultaneous application of pressure and electric current thereto. The silver wire is then severed at the edge of the switch member to complete the manufacturing operation. The resulting switch assembly forms the subject matter of my divisional application Serial No. 380,739, filed February 26, 1941. As shown in Figs. 2, 5 and 6 of the drawing it comprises a strip of contact material having a molded surface portion and a flattened base portion both of which are bounded by a thin rounded edge portion of the contact except at one end where the contact is cut even with the edge of the switch member to which it is directly attached by an integral union of its base portion with the surface of the switch member.

During the bonding and forming operation, the silver wire becomes plastic and at its bonding surface with the switch member is at least part-

ly fluid. There is, consequently, a marked tendency for the silver to blow out from beneath an electrode which engages it and applies pressure and current thereto. I have found that by confining the plastic and molten silver in a cavity of slightly less volume than that of the predetermined length of wire used in forming the contact, it is possible to impart a desired surface configuration to the contact while at the same time preventing any of the silver being blown away while it is being bonded to the switch member.

The principles involved in practicing my invention will be better understood from a consideration of its application through the agency of an automatic welding machine whose essential parts have been illustrated in the accompanying drawing. This welding machine forms the subject matter of my United States Letters Patent 2,263,294, granted November 18, 1941, on an application filed concurrently herewith, and assigned to the same assignee as my present invention.

In the automatic welding machine partially illustrated in the drawing, means are provided for feeding a predetermined length of contact material 10 across a switch member 11 which is located between its electrodes 12 and 13. The switch member and contact material are properly positioned relative to one another to secure the desired location of the contact. By directing the contact material across a side or an end of switch members, switch elements such as shown in Figs. 5 and 6 may be produced.

The predetermined length of contact material and the switch member upon which it has been placed are then engaged by the electrodes of the welding machine and pressure and electric current supplied thereto to form and attach the contact material to the switch member. Due to the passage of the electric current, the contact material becomes plastic or softened and one side thereof is shaped to the configuration of a cavity 14 in the upper electrode 12 while the other side thereof is flattened and attached to the switch member 11. Thereafter, the flow of electric current is interrupted and while the switch contact thus produced is still clamped between the electrodes, the portion of the contact material bonded to the switch member is cut even with the edge of the switch member by a cutting mechanism 15. The electrodes are then separated to release the switch member which has attached thereto a contact 16 such as shown in Figs. 2, 5 and 6 of the drawing.

When attaching contacts of silver or silver alloys, for which my invention is particularly suited, the design of the electrodes 12 and 13 plays an extremely important part. In order to secure uniform bonding of the strip of silver contact material with the switch member over the entire surface of contact between them, the electrode surfaces should be very nearly parallel so that equal pressure and thus uniform density of electric current flow will occur over the entire contact. To aid in this respect, the lower electrode 13 is supported at one end on a bronze ball 18 about which it may be swiveled through the relative adjustment of screws 19 and 20 located at its other end. Screws 19 pass through electrode 13 into a supporting member 21 attaching it thereto, and screw 23 passes through the flanged portion of member 21 to engage the outer end of electrode 13 as shown in the drawing.

Member 21 is provided with a rod 22 which passes through a clamp in the lower arm 23 of the welding machine. Electric current is supplied from one terminal of its source through arm 23 of the welding machine and through rod 22, member 21 and ball 18 to electrode 13. The face of this electrode is in part formed of the flat ground surface of a block of tungsten 24 which is located and brazed in a groove in a block 17 having side and end surfaces which are flush with the corresponding surfaces of the electrode. Block 17 is attached by screws 25 to electrode 13.

The forming of the surface contour of the contact 16 is accomplished by the upper electrode 12. This upper electrode has an insert 26 of tungsten which is located and brazed in its end portion. This insert is provided with the above referred to cavity 14 which has a length substantially equal to the predetermined length of contact material fed across the switch member 11 to form contact 16. This cavity has a concave molding surface of flatter curvature than the wire of contact material. Furthermore, its volume is slightly less than the volume of the predetermined length of contact material which is formed into the contact. This dimensioning of the cavity makes certain that the predetermined length of contact material within it, when rendered soft and plastic by the flow of electric current, will be shaped to the contour of the cavity and that a small amount of the contact material will be forced out around the edges of the cavity and between the end of the electrode and the switch member to which the contact is being attached. This insures the maintenance of sufficient pressure on the strip of contact material to prevent arcing at the electrodes and makes certain that the upper electrode will never come into contact with the material to which the silver is being bonded. For example, when bonding pure silver wire (99.9% or more silver) having a diameter of 0.055 inch, the cavity 14 may have a depth of 0.016 inch and a width at the tip of the electrode of 0.115 inch. The length of the groove may be 0.200 inch. The contact 16 formed when using a wire and cavity of these dimensions will be 0.200 inch long, 0.115 inch wide, and have a maximum thickness of 0.020 inch. The switch member 12 may be formed of a strip of Phosphor bronze 0.025 inch in thickness and 0.250 inch in width.

Electrode 12 passes through a clamp in the end of the upper arm 27 of the welding machine and electric current is supplied from its source through arm 27 to electrode 12. Preferably both electrodes 12 and 13 are artificially cooled by circulating a cooling fluid through passageways formed in them. The passageway in electrode 12 is shown in Figs. 1 and 2. The expedient of artificially cooling welding electrodes is well known and consequently the passageways and cooling system have not been fully illustrated in the drawing.

Tungsten electrodes, or electrodes tipped with tungsten as illustrated, are employed to increase the heating effect of the electric current flowing therethrough. Tungsten has a specific resistance several times that of silver and the resistance of electrodes made therefrom, in addition to the contact resistance resulting from the initially limited engagement of the opposite side surfaces of the contact wire with the molding surface of electrode 12 and the flat surface of switch member 11, cause this contact material to become softened and plastic when electric current is passed through them so that under the

pressure applied through the electrodes substantially all of the exterior of the wire of contact material is formed into oppositely disposed coextensive flattened surfaces one of which constitutes the exterior surface of the switch contact 16 and the other of which is attached or bonded by an integral union with the flat surface of the switch member 11.

The strip of contact material itself closes the opening in the side wall of electrode 12 through which it extends into cavity 14 and cooperates with the walls of this cavity in preventing any expulsion of softened or molten contact material resulting during the bonding operation.

After the predetermined length of contact material has been attached to the switch member, the stock material is severed from the strip contact by the operation of a cutting cylinder 28 through which this contact material extends. This cutting cylinder is mounted for rotation in a block 29 which is attached to and electrically insulated from member 21 of the welding machine at 29'. The strip of contact material passes through a hardened bushing 30 in cylinder 28 which upon rotation moves the end of this bushing across the edge portion of the switch member 11 supported on the tungsten insert 24 of electrode 13 to shear the contact from the body portion of the strip of contact material 10. It is to be noted that one side of electrode 12 is cut away to permit proper positioning of the cutting mechanism relative to the lower electrode 13.

Cylinder 28 is rotated in its supporting block 29 by an arm 31 which mechanically connects it to a link 32 which passes to an operating mechanism synchronized with the electrode movement and forming part of the welding machine. A hitch feed also forming part of the machine not shown in the drawing is used for supplying periodically predetermined lengths of the strip of contact material 10 through the cutting cylinder 28. This and the cutting mechanism is supported wholly or in part on member 21 of the welding machine.

In an automatic machine, such as partly illustrated in the drawing, means are provided for predetermining the sequence of operations as follows: Feeding the length of contact material, applying a predetermined pressure and a predetermined value of current thereto until the contact is formed and bonded to the switch member, interrupting the flow of current after a predetermined time while maintaining the pressure, cutting the contact from the stock of contact material and then releasing the pressure to free the assembly. It is, of course, apparent that when performing a hand operation, this sequencing will be under the control of the operator.

Silver and alloys of silver are most conveniently bonded to switch members of cupreous material, such as copper, brass, bronze, Phosphor bronze and the like. When bonding such contacts to steel, Monel and similar materials, it is desirable to provide a cupreous surface by suitably coating these members where the contact material is to be attached. Tin, silver, cadmium or nickel coatings may also be used in order to facilitate the bonding operation of silver and alloys of silver to a switch member.

The bond between silvery materials and cupreous materials may equally well be defined as a weld or a silver brazed union. The silver wets the copper surface in a manner similar to that of solder and although the attachment between the silver and copper may be defined, due to the melting points of these materials, as a weld there is sufficient evidence to also call it a soldered or brazed union. If my procedure is considered as a brazing or soldering procedure, it is important to note that the same is effected without the use of fluxing materials which are always a nuisance and a source of trouble in manufacturing operations.

Strip contacts manufactured in accordance with my procedure not only cost considerably less than equivalent contacts manufactured by other procedures but are capable of being manufactured at high rates of speed through the agency of automatic machines. A great variety of shapes and sizes of contacts may be made by merely changing the size of wire and the size of cavity in the electrode used in fabricating these contacts. Furthermore, since the contact is directly bonded to the switch member, no undesirable material is introduced which will lead to increasing the electrical or thermal resistance of the contact. As against the various forms of bimetallic contacts, a contact made in accordance with my invention is much cheaper not only because of the reduction in the cost of materials but also because of the great reduction in the cost of labor used in manufacturing them. Furthermore, the overall dimensions of a pair of my switch contacts is much less than that of an equivalent pair of bimetallic contacts. This space factor is a decided advantage in that it permits a much desired decrease in the sizes of switches using my contacts.

As previously stated, it is apparent that my invention is not limited to the formation and attaching of silver contacts to switch members since alloys of silver or contact material of other metals or alloys may be used. Furthermore, the switch member need not be of a cupreous material or have a surface portion of cupreous material although I have found this to be most desirable when forming and attaching silver contacts.

The apparatus above described in describing my invention is not essential thereto since other arrangements of electrodes and other feeding and cutting means may be used in practicing it. When following the method of my invention many instrumentalities other than those described may be used and I consequently intend to cover by the appended claims all such methods as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of attaching strip contact material to switch members which comprises positioning a length of round wire of said contact material on a switch member whose contacting surface initially makes a limited engagement therewith, softening and deforming said length of wire by simultaneously applying pressure and electric current thereto through the agency of an electrode which initially is brought into engagement with one side of said length of wire along a surface of flatter curvature than said wire, said surface being formed in said electrode as part of the contour of a cavity also formed in said electrode to have substantially the same length but slightly less volume than said length of wire, maintaining the flow of electric current through said electrode and said length of wire to said switch member until said length of wire

becomes softened and conforms to the contour of said cavity and the supporting surface of said switch member while forming a union with said switch member, and maintaining the pressure of said electrode on the contact thus produced until its union with said switch member has solidified through cooling.

2. The method of simultaneously shaping and attaching a predetermined length of round wire to a switch member which comprises forming in a material of greater specific electrical resistance than said wire a cavity which has slightly less volume than said predetermined length of wire and which has a concave molding surface of flatter curvature than said wire and of substantially the same length as said predetermined length of wire, applying pressure to said predetermined length of wire by pressing one side thereof into contact with a flat surface of said switch member by engaging the other side thereof with said concave molding surface of said cavity, applying electric current through said molding surface of said cavity, said wire, and said switch member until said length of wire softens and under the pressure applied thereto conforms to said cavity and said switch member while making an integral union with said switch member, thereafter interrupting the flow of electric current and maintaining said applied pressure until said integral union is completed by cooling and solidification, and then removing said applied pressure to release the assembly thus produced.

JOHN M. FLUKE.