July 22, 1941. L. FERGUSON 2,250,156

ELECTRICAL CONNECTION

Filed June 2, 1939

FIG. 1

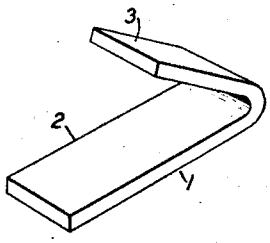


FIG. 2

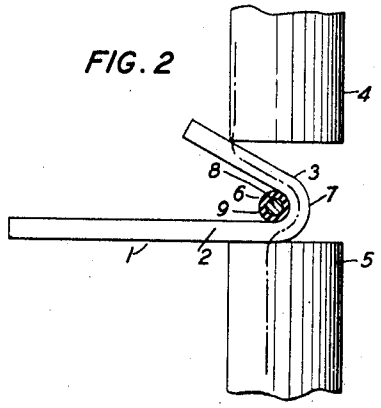


FIG. 3

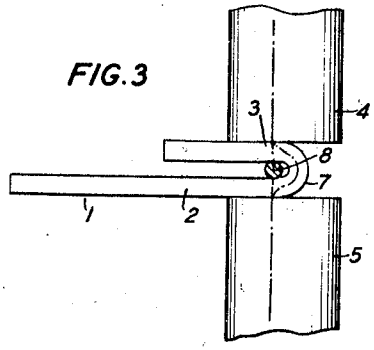


FIG. 1A

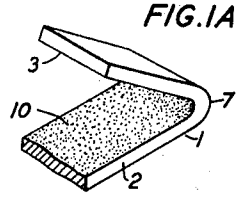


FIG. 6

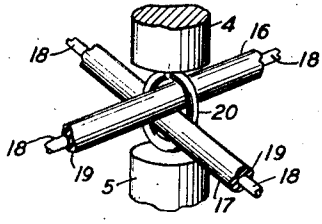


FIG. 4

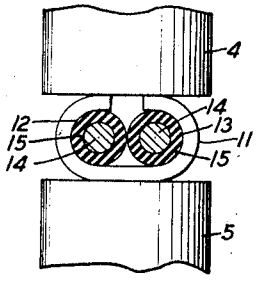


FIG. 5

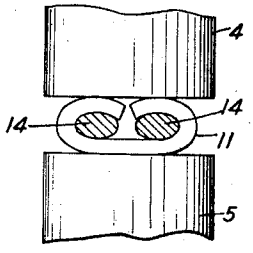
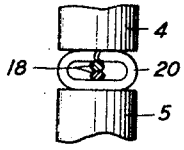


FIG. 7



INVENTOR
L. FERGUSON

BY
J. MacDonald
ATTORNEY

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2,250,156

ELECTRICAL CONNECTION

Lawrence Ferguson, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application June 2, 1939, Serial No. 276,977

5 Claims. (Cl. 219—10)

This invention relates to a method of securing metal parts together and, more particularly, to the securing of such parts together when one at least of the parts is covered with insulating material.

The object of the invention is to obtain electrical connection of two conducting elements, one at least of which is covered with insulating material without requiring stripping of the insulating material from the insulated element or elements prior to the making of the electrical connection.

The invention may be used in electrically connecting a terminal to an insulated conductor wire or may be used in electrically connecting a plurality of insulated conductor wires.

In the drawing, Fig. 1 is a view in perspective of an uninsulated element of conducting material suitably formed for connecting to an insulated conductor wire in accordance with the invention;

Fig. 1A is a view of a portion of Fig. 1 but modified to include a coating of relatively low melting metal on one of the surfaces;

Fig. 2 is a side elevational view of the part shown in either Figs. 1 or 1A associated with an insulated conductor wire and placed between spaced electrodes of an electrical welding device;

Fig. 3 shows the parts illustrated in Fig. 2 but in an advanced step relative to Fig. 2;

Fig. 4 shows two insulated conductors ready to be electrically connected in accordance with the invention and means for forming the electrical connection;

Fig. 5 shows the parts illustrated in Fig. 4 but in an advanced step relative to Fig. 4;

Fig. 6 is a view in perspective of two insulated conductor wires placed between two relatively movable electrodes, the wires crossing each other and being encompassed by a metal ring and the parts arranged ready to form an electrical connection between the two conductor wires; and

Fig. 7 shows the parts illustrated in Fig. 6 in an advanced step in the formation of the connection.

In connecting an electrical terminal to an insulated conductor wire, the common practice is to strip the insulating coating from a portion of the conductor wire before the electrical connection is made. In forming an electrical connection between two insulated conductor wires, the common practice is to strip the insulating coating from portions of the conductor wires before making the electrical connection.

My invention provides a method and means for electrically connecting the parts above mentioned without requiring stripping of the insulating material from the insulated parts prior to forming the electrical connection between the parts.

For the purpose of illustrating and explaining the invention, and not in the sense of limiting it to the particular form shown and described, it will be assumed that an electrical terminal is to be electrically connected to a conductor wire having an outer protective coating of insulating material, the insulating material being of such a nature that it can be melted or consumed under the action of heat applied through electrodes of an electrowelding machine and the terminal.

The terminal 1, as shown in Fig. 1, is a strip of metal bent into V-shape form and having a relatively long leg portion 2 and a shorter leg portion 3. The terminal 1, as shown in Fig. 2, is placed between spaced and relatively movable electrodes 4 and 5 of an electrowelding machine. The electrodes 4 and 5 are the only parts shown of the welding machine since the showing of other parts of the machine is not necessary to an understanding of the invention. A conductor wire 6 to be electrically connected to the terminal 1 is placed within the V-shaped portion of the terminal and so that the conductor wire 6 is held between the leg portions 2 and 3 of the terminal and the bent portion 7 of the terminal passes partly around the conductor wire 6. The conductor wire 6 comprises an electrical conducting metal core 8 and a jacket 9 of insulating material. It will be seen that when the terminal 1 is placed in the position shown in Fig. 2, the terminal 1 forms an electrical conducting path from the electrode 4 to the electrode 5, the path being by way of the bent portion 7 and being indicated by the dot and dash line shown in the figure. It is to be noted that, because of the current path provided by the bent portion 7 of the terminal, there will be no electrical arc developed between the electrodes 4 and 5.

The electrodes 4 and 5 are relatively heavy and have a greater current-carrying capacity than the bent portion 7 of the terminal 1. Due to this difference in current-carrying capacity of the parts and the passage of current through the parts, the temperature of the terminal 1 is considerably raised when the electrodes 4 and 5 are energized. The size and form of the electrodes 4 and 5 and the current-carrying capacity of the welding machine employed and the currents applied will, of course, depend to some extent on the size of the terminal 1 and the kind of electrical connection it is desired to form between the terminal 1 and the conducting core 8 of the conductor wire 6 and also on the kind of material found in the jacket 9 of insulating material. The temperature of the leg portions 2 and 3 and of the bent portion 7 of the terminal 1 at

the points of engagement with the jacket 9 of insulating material, or at least one of these portions, must be raised to a sufficient extent to melt or consume the material of the insulating jacket 9. The electrodes 4 and 5 are relatively movable and are moved toward each other while the current is being applied. As the material of the jacket 9 is melted or consumed, the leg portions 2 and 3 of the terminal 1 are moved into engagement with the metal core 8 of the conductor 6 and to the position shown in Fig. 3. When the parts have reached this position, the leg portions 2 and 3 are in physical contact with the metal core 8 of the conductor 6 and, while there is still a current path through the bent portion 7 of the terminal, there is also a current path transversely through the metal core 8 of the conductor wire 6, as indicated by the dot and dash lines in the figure. The terminal 1, as shown in this figure, has been changed from its original V-shaped form to a U-shaped form and the bent portion 7 has been bent somewhat beyond the elastic limit of the terminal material so that it will remain in this form when released from the pressure of the electrodes 4 and 5. In some cases only good electrical contact between the leg portions 2 and 3 of the terminal 1 and the metal core 8 of the conductor 6 will be required. If a more positive and stronger connection is required, however, the terminal 1 may be readily electrowelded to the metal core 8 by simply applying sufficient current through the electrodes 4 and 5 and through the points of engagement of the leg portions 2 and 3 of the terminal 1 and the metal core 8 to electrically weld the leg portions 2 and 3 to the core 8 of the conductor 6.

In some cases all that may be required is to solder the terminal 1 to the metal core 8 of the conductor wire 6. In this event, the terminal 1 is previously coated with relatively low melting point metal. As shown in Fig. 1A, a coating 10 of relatively low melting point metal has been provided on the leg portions 2 and 3 of the terminal 1 and on the inner surface of the bent portion 7. The terminal 1 coated with relatively low melting point metal 10 may be placed between the electrodes 4 and 5 in the position shown in Fig. 2 and with the conductor wire 6 disposed in the V-shaped portion of the terminal. When the electrodes 4 and 5 are energized and moved toward each other, the temperature of the terminal 1 is raised to a sufficient extent to melt or consume the insulating jacket 9 and bring the metal coating 10 to a molten condition. When contact is made between the leg portions 2 and 3 of the terminal and the metal core 8 of the conductor wire, the metal coating 10 will form a solder connection between the leg portions 2 and 3 of the terminal and the metal core 8 of the conductor wire 6.

To electrically connect two insulated conductors I employ the same principle as outlined above in connecting the terminal 1 to the insulated conductor wire 6, to this extent, that I employ a member of conducting material to carry the electrical current from the electrode 4 to the electrode 5 while the connection is being made. The member of conducting material in this case, as shown in Figs. 4 and 5, is an incomplete ring 11 of conducting material. The ring 11, however, may be completely closed. The ring 11 is placed about two parallelly arranged conductor wires 12 and 13, each of which comprises a core 14 of metal and a jacket 15 of insulating material. The ring 11 is placed between the electrodes 4 and 5 of the electrowelding machine. When the electrodes 4 and 5 are energized, the current will flow from one electrode to the other by way of the ring 11. This will result in raising the temperature of the ring 11. By the application of sufficient current to the electrodes 4 and 5, the temperature of the ring 11 is raised to a sufficient extent to melt or consume the insulating material 15. As the insulating material 15 is melted or consumed, the electrodes 4 and 5 are moved to the position shown in Fig. 5. In this figure the ring 11 has been somewhat flattened and brought into physical contact with the metal cores 14 of the two conductor wires. The ring 11 thus forms an electrical connection between the metal cores 14 of the conductor wires. If the electrowelding of the ring 11 to the cores 14 is required, this can be accomplished by the application of sufficient current by way of the electrodes 4 and 5 and the ring 11 and by suitably pressing the ring 11 against the cores 14. A solder connection may be formed between the cores 14 and the ring 11 by previously coating the ring 11 with solder and maintaining the ring 11 at a required temperature to melt the solder while the ring 11 is being pressed into engagement with the cores 14 of the conductor wires.

The same principle is also followed where it is desired to form an electrical connection between two insulated conductor wires crossing each other at an angle. To form such a connection as shown in Figs. 6 and 7, the insulated conductor wires 16 and 17, each of which comprises a core 18 of conducting material and a sleeve 19 of insulating material, are placed one above the other at the required angle. An incomplete or complete ring 20 of metal and of a diameter sufficient to encompass the two wires is disposed around the wires at the point of crossing. The ring 20 is placed between the spaced electrodes 4 and 5 of the welding machine so that it forms an electrical connection between the electrodes 4 and 5. When a suitable current is applied through the electrodes 4 and 5, the ring 20 is heated to a sufficient extent to melt or consume the insulating sleeves 19 of the conductor wires 16 and 17 at the point of crossing of the conductor wires. As the insulating material on the conductor wires is melted or consumed, the electrodes 4 and 5 are moved toward each other to the position shown in Fig. 7 so that the cores 18 of the conductor wires are brought into physical contact with each other and with the ring 20 and so that the cores 18 and the ring 20 are deformed to a sufficient extent to retain the wires in this position. By properly regulating the current applied through the electrodes 4 and 5 and by way of the ring 20 to the cores 18 of the conductor wires, the wires may be welded together at their point of crossing and the ring 20 may be welded to the conductor wires at this point.

In making connections between metal parts as above described, the size and form of the metal part used in carrying the current from one electrode of the welding machine to the other and around the desired points of connection while the connection is being made and the amount of current and the duration of its application will depend somewhat on the type of connection required, the character of the insulating material to be melted or consumed, and the material of which the metal part and parts to be connected are made. I have found that by the method and arrangement described a terminal of brass com-

position may be connected to a copper conductor wire having a coating of insulating enamel, rubber, cotton, or silk without previously stripping the coating of insulating material from the copper conductor wire. I have also found by actual experiment that, by using my invention, an electrical connection may be formed between two copper wires coated with a double serving of insulating thread and lacquered without previously stripping the insulating material from the copper wires.

I have, for instance, formed an electrical connection between two No. 22 gauge enameled wires covered with two servings of cotton and lacquered with cellulose acetate in the manner described. In making this connection, the insulated wires were enclosed in a nickel band bent from a strip of such material approximately .025 inch thick and .110 inch wide. About twenty pounds pressure was applied to the electrode to squeeze the parts together as the insulation was burned away. The welding current was allowed to flow for one-half second. Sufficient heat was generated in this time to bring the nickel band to a temperature of approximately 1200° C. This resulted in burning away the insulation at the points of contact and the formation of an electrical weld between the metal parts. After the welds were made, attempts were made to break the welds, but the welds were found to be stronger than the wires. I have found, by microscopic examination, that these joints are actually welded and, by electrical tests, that the electrical contact is permanent. Nickel was chosen for the material of the band because of its ability to withstand a comparatively high temperature without melting or breaking apart under the pressure applied. Other reasons for the choice of nickel were the ease and speed with which it wets and alloys with copper, its comparatively high electrical resistance enabling smaller welding currents to be used and its freedom from tarnish films which might interfere with the flow of current and welding action.

Although I have mentioned nickel as being a suitable material for use in the band, it is obvious that various other materials may be used for the same purpose without departing from the spirit of the invention, the scope of which is indicated in the following claims.

What is claimed is:

1. A method of forming an electrical connection between metal parts, one at least of which is covered with insulating material, comprising placing said parts between a pair of spaced and relatively movable electrodes of an electrical current-carrying machine and so that said insulating material on one of said parts is in contact with another of said parts, providing in one of said parts a metal electrical current-carrying path from one of said electrodes to the other and in by-pass of the point of contact of said parts, applying sufficient current through said electrodes and said current-carrying path to raise the temperature of one of said parts to a sufficient extent to remove said insulating material from the point of contact of said parts and moving said electrodes toward each other as the insulating material is removed and until said parts are electrically connected.

2. A method of forming an electrical connection between two conductor wires, individually covered with insulating material, comprising placing said conductor wires between spaced and relatively movable electrodes of an electrical current-carrying machine, placing a band of metal around said conductor wires and between the insulating covering of said wires and said electrodes, moving said electrodes to press said band toward the conducting elements of said wires, applying sufficient current through said electrodes and by way of said band to raise the temperature of said band to a sufficient extent to melt said insulating material, pressing said band into engagement with the conducting elements of said wires while said insulating material is being melted and applying sufficient electrical current through said band and said wires to electrically join said band to the conducting elements in said wires.

3. A method of forming an electrical connection between conductor wires crossing at an angle and individually covered with insulating material, comprising placing a metal band around said wires at the point of crossing and placing said wires and said band between and so that said metal band is in contact with spaced and relatively movable electrodes of an electrical current-carrying machine, applying sufficient current through said electrodes and by way of said band to raise the temperature of said band to a sufficient extent to consume the insulating coverings of said wires and moving said electrodes toward each other while said insulating coverings are being consumed and until the conducting elements of said wires and said band are electrically connected at the point of crossing of said wires.

4. A method of connecting an uninsulated electrical conducting element to an electrical conducting element covered with insulating material, comprising bending said uninsulated element at least partially around said insulated element, placing said uninsulated element between and in contact with spaced electrodes of an electrical welding machine and so that said uninsulated element forms a conducting path between said electrodes and in by-pass of said insulating material, heating said uninsulated element by passing an electrical current therethrough sufficient to remove the insulation from at least a portion of said insulated element and applying sufficient pressure to said elements to bring them into electrical contact with each other.

5. A method of connecting an electrical terminal to a conductor wire covered with insulating material, comprising forming said terminal to at least partially encompass the insulating material on said wire, placing said wire within said terminal so that the insulating material on said wire is engaged on two sides by said terminal, placing said terminal in electrical engagement with oppositely disposed spaced electrodes of an electrical welding apparatus, electrically energizing said electrodes to pass a heating current through said terminal sufficient to remove the insulating material from said wire at the points of engagement with said terminal and relatively moving said electrodes to press said terminal into engagement with said conductor wire and electrically connect said terminal to said conductor.

LAWRENCE FERGUSON.