Feb. 16, 1943. C. E. SWARTZ 2,311,138

CONDUCTOR

Filed March 15, 1939

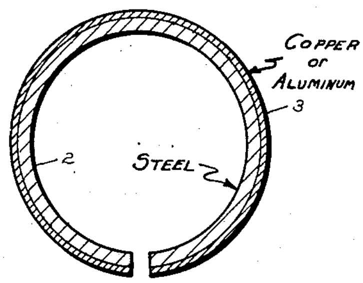

Fig. 1

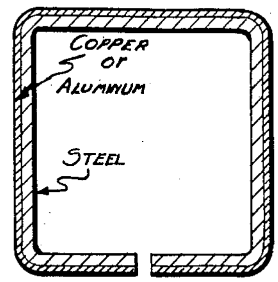

Fig. 2

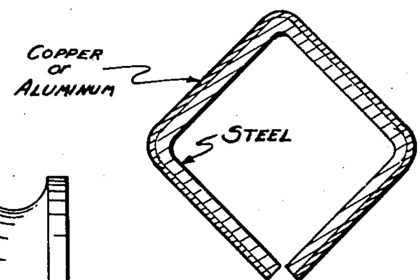

Fig. 3

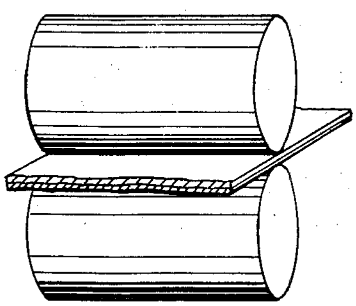

Fig. 5

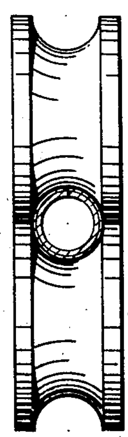

Fig. 6

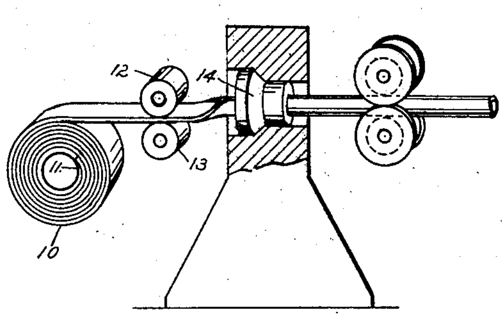

Fig. 4

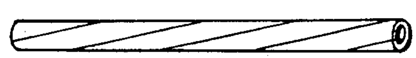

Fig. 7

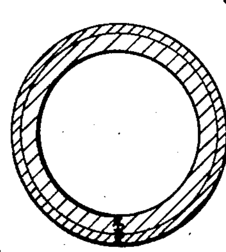

Fig. 8.

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2,311,138

CONDUCTOR

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Application March 15, 1939, Serial No. 262,070

12 Claims. (Cl. 174—132)

The present invention relating, as indicated, to conductors is more particularly directed to a hollow tube or conductor for the transmission of alternating electrical currents in which the conductor is characterized by a comparatively lower cost of production, greater convenience and economy in shipment from factory to installation point, greater strength, lower corona discharge and high capacity for carrying alternating current. Briefly stated, my invention consists of a composite strip of two metals integrally bonded together into a strip formed into a suitable cross-sectional shape and one in which the inner metal is of relatively strong material such as a ferrous metal or alloy and the outer metal is of relatively high conductivity metal such as copper or aluminum.

To the accomplishment of the foregoing and related ends, said invention then consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawing and the following description setting forth in detail a certain structure embodying the invention, such disclosed means constituting, however, but one of various structural forms in which the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a transverse section through one form of my improved conductor;

Figs. 2 and 3 are similar views through modified forms of my conductor;

Fig. 4 is a diagrammatic view in elevation illustrating one form of apparatus which may be employed either in the factory or in the field for forming flat composite strip into the desired cross-sectional shape;

Fig. 5 is a view in perspective of the feeding rolls of the apparatus shown in Fig. 4;

Fig. 6 is an end elevation of the feeding rolls employed in the apparatus of Fig. 4 to draw the formed tube therethrough;

Fig. 7 is a view in perspective of another form of my conductor; and

Fig. 8 is a view similar to Fig. 1, but showing the edges of the formed conductor welded to each other.

In the transmission of alternating currents, it has long been known that in conductors used for this purpose, the outer surface of the conductor carries the larger portion of the energy and the inner portion is effective mainly in its ability to reinforce, strengthen and support the outer current carrying layer. Many designs of conductors have been devised to take advantage of these conditions, among which the more common and commercially used are steel cored solid wire cable having a copper or aluminum outer layer and steel cored stranded copper or aluminum cable. Another type of conductor consists of a hollow copper tube in which relatively flat segments are engaged along their edges with others to form a hollow cylindrical section and the strips maintained in this relation by tongue and groove projections on the edges of the individual strips or segments. This type of conductor has the advantages of low corona discharge because of the large radius of the outer surface and the smooth condition of the surface as compared with the radius and surface condition of the usual commercial type of conductor.

The present invention is intended to provide a conductor having in a high degree the advantages obtained in the last described conductor without the considerably higher cost of that type of conductor.

The present invention consists of a composite strip formed of two layers of metal, one a metal such as steel of high tensile strength to carry the physical load and the other of copper or similar metal of high electric conductivity to carry the electrical load combined into a single element in which the two metals are substantially uniformly and integrally bonded together all over their adjacent surfaces and one in which the metal of high conductivity has its thickness limited to that which really serves to carry the alternating current transmitted therethrough.

Referring to Figs. 1, 2 and 3, I have shown three forms out of many which my improved conductor may assume. In Fig. 1 I have shown an open cylindrical conductor which consists of an inner shell **2** of steel and an outer shell **3** of copper. The conductor shown in this figure is an open cylinder having its adjacent edges slightly spaced from each other. In Fig. 2 I have shown a similar conductor also formed of an inner steel layer and an outer copper layer **3** formed in the shape of a substantial square and also having its edges slightly spaced from each other. In Fig. 3 the form of the conductor is shown as being roughly diamond shaped with the open edges at one of the corners of the diamond and it will be understood that the conductor may take various other forms as may be desired.

The thickness of the inner supporting layer of steel and of the outer carrying layer of copper will obviously depend upon the physical strains which will be imposed upon the conductor in one case and the magnitude of the electric current which is to be transmitted in the other. In a conductor of approximately two inch diameter, the thickness of the inner steel layer will range from 40 to 120/1000 of inch and the thickness of the copper layer from about 25 to 50% of the thickness of the steel layer. These proportions will be maintained regardless of the shape of the conductor. The composite strip may be formed in the first instance by the method described in the co-pending application of George Edwards, Serial No. 246,127, now Patent 2,203,679 dated June 11, 1940, in which there is described a process of applying a molten layer of a metal of lower melting point than steel to a strip of metal such as steel which serves as a backing and reinforcing element for the copper or metal of lower melting point.

One of the advantages of the present conductor is that it may be formed from the flat composite strip into the desired cross sectional shape economically and rapidly either in the factory or in the field in the following manner:

The composite strip when first formed is coiled into a coil 10 having a length of several hundred or even several thousand feet. This coil may then be mounted on a suitable shaft 11 and the strip slowly unwound and drawn between rollers 12 and 13 and thereby passed through a die 14 which may be of any desired interior shape to form the flat strip into the desired hollow cross sectional shape, either of the type illustrated in Figs. 1, 2 and 3 or some other form. This apparatus which is commonly employed in the shop to form open or channel like tubing of various cross sections is inexpensive, rapid in operation and entirely standard in construction. It lends itself readily to being mounted upon a truck or other movable platform which can be taken into the field where the composite strip can be formed into the desired cross sectional shape as it is needed to be strung in transmission lines usually carried on spaced supports of the types now in general use.

In a conductor the corona discharge depends upon the diameter of the conductor and becomes lower with increased diameter and is also lower if the surface of the conductor is extremely smooth. Conductivity of the copper also varies with the density of the copper structure and in the present conductor the composite strip can be rolled to increase the density of the structure and hence its current carrying capacity and also to produce an extremely smooth outer surface on the composite tube. By reason of the tubular form of the conductor, allowance is automatically made for circumferential expansion and contraction while the strength of the steel core will prevent collapse. Flexibility of the entire element is also secured from the strength and characteristics of the steel inner core.

A further advantage of the present conductor is that it can be manufactured in a relatively flexible condition, in which condition the composite strip can be coiled readily and transported to its place of use. After being formed in the manner shown in Figs. 4, 5 and 6 into a hollow cylindrical square or other shaped tube, it naturally becomes very much more rigid while still possessing a sufficient flexibility to permit it to be hung between the usual supports and to carry the usual loads and to resist the torsional forces resulting from wind and rain which have been known to give some trouble with present types of conductors. For some purposes it may be desirable to unite the adjacent edges of the formed tubular member which constitutes the present conductor either continuously or intermittently and this may be done in any of the various forms of conductors herein shown. In Fig. 8, for example, I have shown the edges of the conductor of Fig. 1 welded to each other to form a closed tubular conductor.

In Fig. 7 I have shown a conductor consisting of a spirally wound bimetallic strip of the character already described formed into a substantially cylindrical element. This spiral strip may have the adjacent edges either continuously or intermittently joined and the width of the strip should be relatively high in proportion to the diameter of the strip to provide strength and resistance to deformation sufficient to maintain the strip in the form shown.

The present invention provides a conductor for alternating currents which is very much less expensive in its construction and much more economical in the use of the more expensive metals contained therein than that of the conductor now employed in transmission lines.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the structure herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A tubular conductor having a high capacity for carrying alternating currents comprising a strip of steel and a strip of metal of substantial thickness and of relatively high conductivity superimposed directly thereon against one side thereof and substantially integrally and uniformly bonded directly thereto all over their contacting surfaces, said high conductivity metal lying on the outer surface of the tubular conductor and having a dense compacted structure and smooth outer surface, resulting in a higher current carrying capacity.

2. A conductor having a high capacity for carrying alternating currents comprising a bimetallic tubular member of substantially square cross-section having its edges closely adjacent but spaced from each other and having an inner layer of steel and an outer layer of compacted copper, resulting in higher current carrying capacity.

3. A conductor having a high capacity for carrying alternating currents comprising a bimetallic tubular member of substantially cylindrical cross-section having its edges united to each other and having an inner layer of steel and an outer layer of compacted copper, resulting in higher current carrying capacity.

4. A conductor having a high capacity for carrying alternating currents comprising a bimetallic tubular member consisting of a bimetallic strip formed into a spiral tube-like coil, one of the metals of said bimetallic strip being a compacted metal of high conductivity and forming the outer surface of the conductor, said compacted metal resulting in a higher current carrying capacity.

5. A conductor having a high capacity for carrying alternating currents comprising a composite strip formed into a curved section, said strip consisting of a layer of metal of substantial thickness and of relatively high conductivity on its outer surface and a layer of metal of high tensile strength on its inner surface, the two layers being substantially uniformly and directly bonded together all over their contacting sur-

faces, and the outer layer of said conductor having a dense, compacted structure and a smooth outer surface, resulting in a higher current carrying capacity.

6. A conductor having a high capacity for carrying alternating currents comprising a composite strip of steel and a strip of compacted aluminum superimposed thereon against one side thereof and substantially integrally and uniformly bonded thereto all over their contacting surfaces.

7. A conductor having a high capacity for carrying alternating currents comprising a bimetallic tubular member consisting of a bimetallic strip formed into a spiral tube-like coil with the adjacent edges of the strip joined to each other, one of the metals of said bimetallic strip being a compacted metal of high conductivity and forming the outer surface of the conductor.

8. The method of making a bimetallic tubular conductor having a high capacity for carrying alternating current which comprises providing a strip consisting of a layer of steel, applying a layer of substantial thickness of a metal of high conductivity to said steel strip and integrally and uniformly bonding said applied metal to said steel strip all over their contacting surfaces, compacting said high conductivity metal to provide a dense structure and a smooth outer surface, and forming said strip into a tubular member of which said high conductivity metal forms the outer surface of the tubular conductor.

9. The method of making a bimetallic tubular conductor having a high capacity for carrying alternating current which comprises providing a strip consisting of a layer of steel, applying a layer of copper of substantial thickness to said steel strip and bonding said copper layer to said steel strip integrally and uniformly all over their contacting surfaces, compacting the copper layer to provide a dense structure and a smooth outer surface, and forming said strip into a tubular member of which said copper forms the outer surface of the tubular conductor.

10. The method of making a bimetallic tubular conductor having a high capacity for carrying alternating current which comprises providing a bimetallic strip consisting of a layer of steel and a layer of compacted aluminum of substantial thickness, said layers being integrally and uniformly bonded together all over their contacting surfaces, and forming said strip into a tubular member of which said aluminum forms the outer surface.

11. The method of making a bimetallic tubular conductor having a high capacity for carrying alternating current which comprises pouring molten metal having a high conductivity onto a moving backing strip of steel, thereby integrally and uniformly bonding said metal and strip together all over their contacting surfaces, rolling or compacting said high conductivity metal to densify the structure thereof as well as to produce a smooth outer surface thereof, and forming said strip into a tubular member of which said high conductivity metal forms the outer periphery of the tubular conductor.

12. The method of making a bimetallic tubular conductor having a high capacity for carrying alternating current which comprises pouring molten copper onto a moving backing strip of steel, thereby integrally and uniformly bonding the copper and steel together all over their contacting surfaces, rolling or compacting the copper to densify the structure thereof as well as to produce a smooth surface thereon, and forming said strip into a tubular member of which the copper forms the outer periphery of the tubular conductor.

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