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METHOD OF MAKING AN ELECTRICAL CONTACT MEMBER
CONTAINING COMMINGLED COPPER AND STEEL

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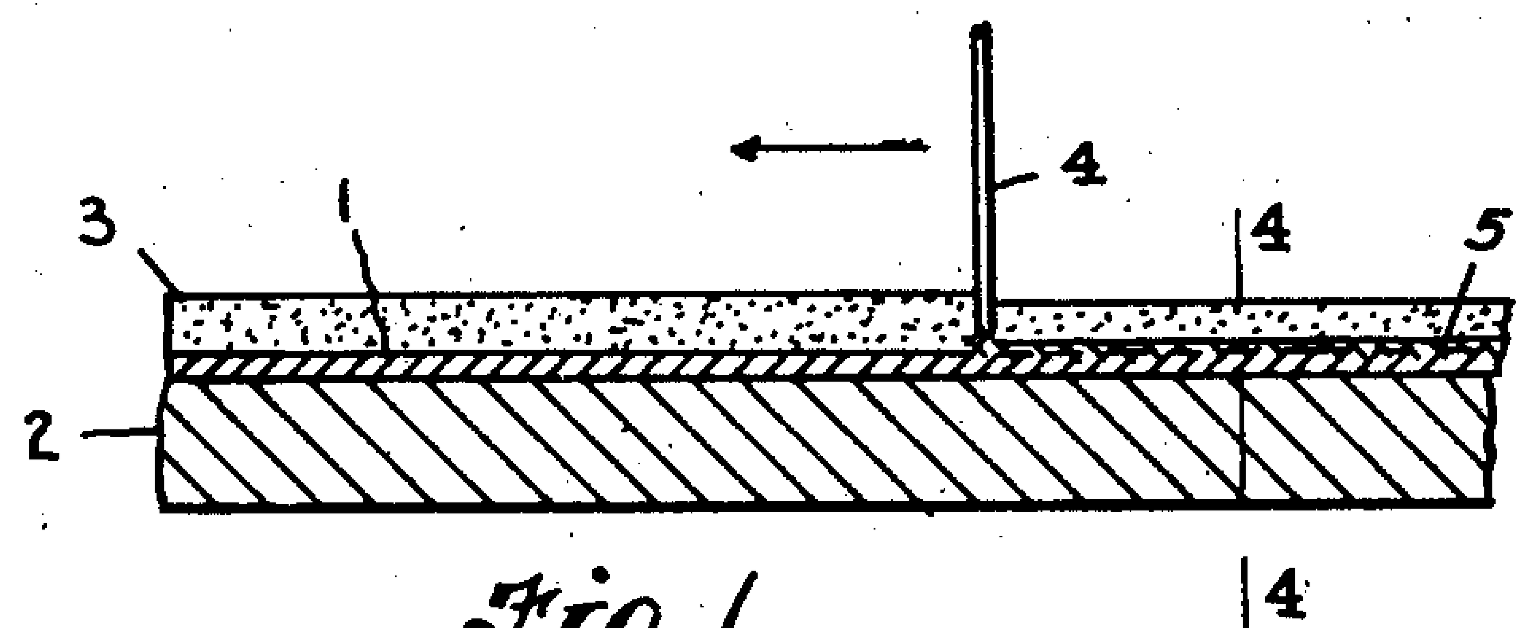

Fig. 1

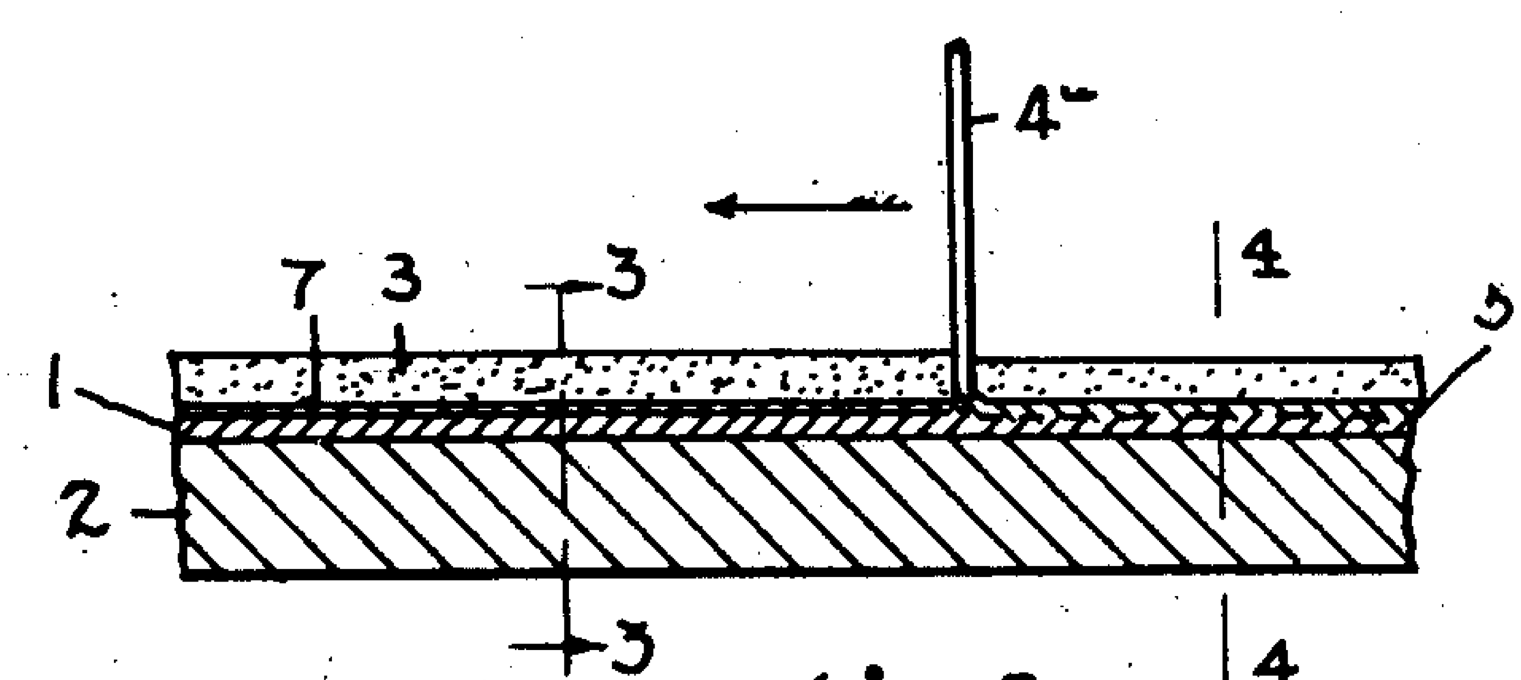

Fig. 2

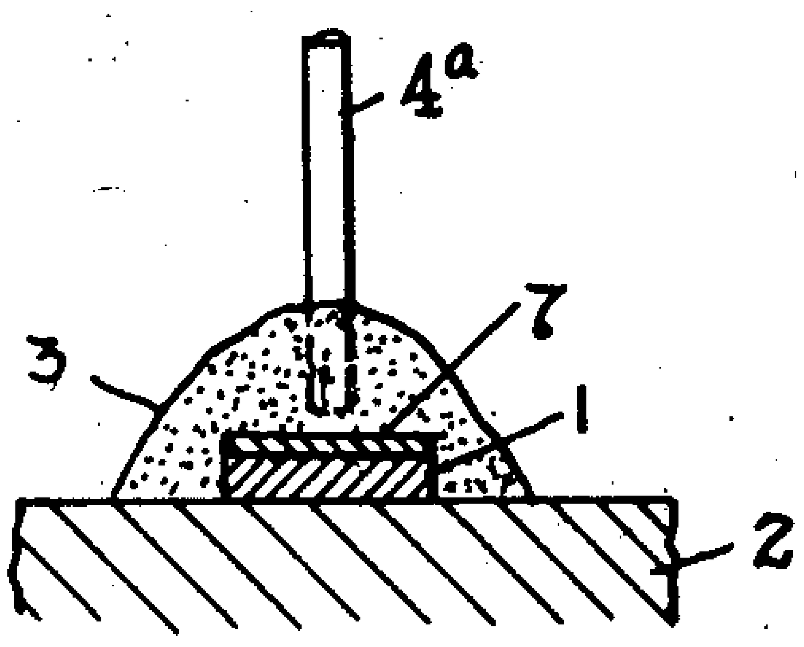

Fig. 3

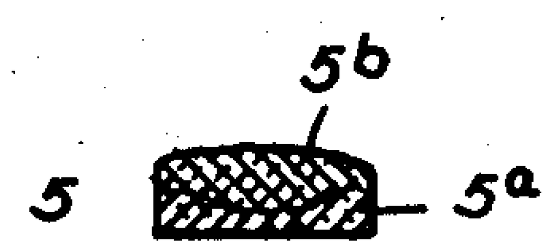

Fig. 4

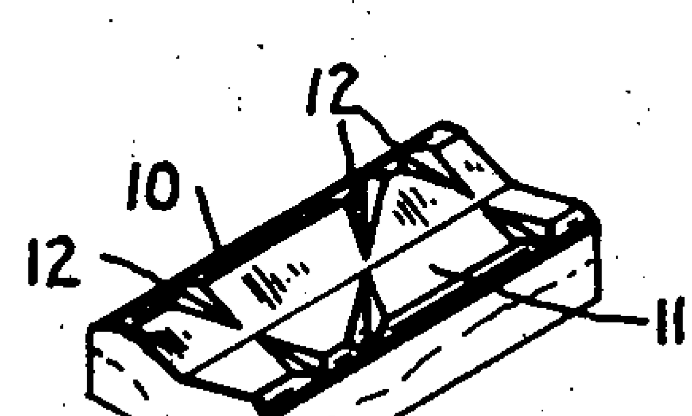

Fig. 5

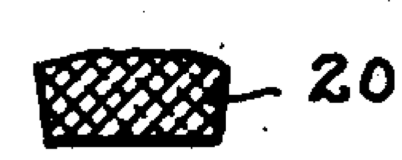

Fig. 7

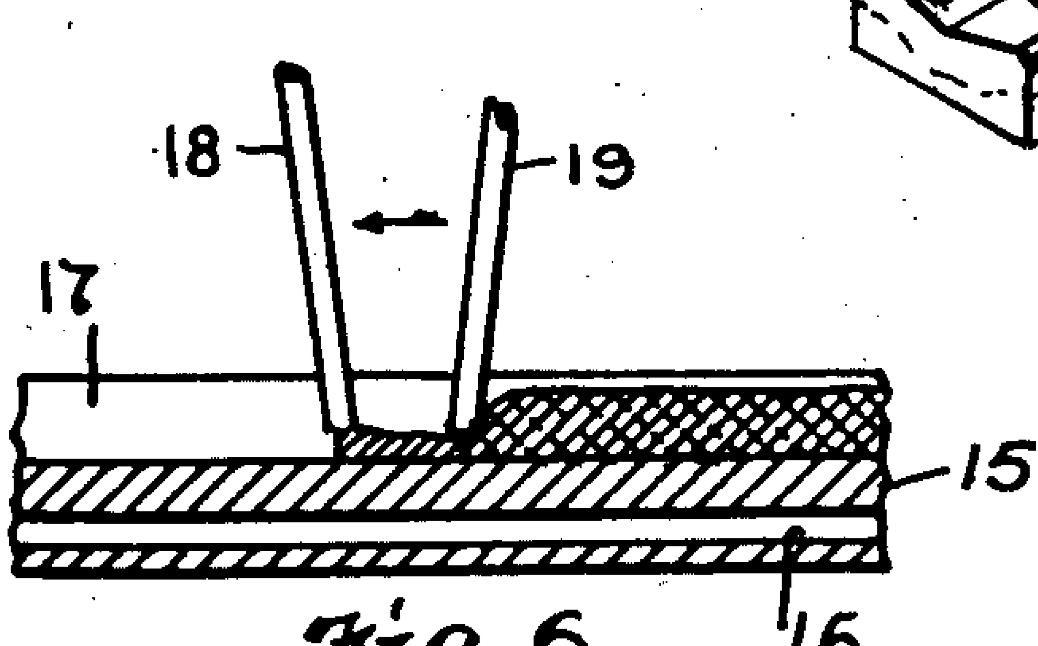

Fig. 6.

INVENTORS
ROBERT A. WILSON and
BENJAMIN H. MATTHEWS
BY
Oberlin, Limbach & Day.
ATTORNEYS

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METHOD OF MAKING AN ELECTRICAL CONTACT MEMBER CONTAINING COMMINGLED COPPER AND STEEL

Robert A. Wilson, University Heights, and Benjamin H. Matthews, Chagrin Falls, Ohio, assignors to The Lincoln Electric Company, Cleveland, Ohio, a corporation of Ohio

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1 Claim. (Cl. 29—155.55)

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The present improvements, relating as indicated to electrical contact members, have more particular regard to such members which are designed not merely to serve as separable electrical conductors, but also as gripping or holding means through which an electric current requires to be conducted.

One illustration of such use would be the electrical contact members which form the jaws in so-called electrode holders, i. e. devices employed to hold weldrod, and more especially metallic weldrod, in arc welding by hand. Under service conditions such contact members or jaws are subject to rapid wear and deterioration, and while copper or bronze will serve satisfactorily from the standpoint of conductivity as a composition for such jaws, these metals do not have the hardness necessary to provide desirable wear resistance.

Point contacts or tips, such as are used in spot welders, as well as sliding contacts, such as are used in other types of welders, in electric-railway trolleys, etc., present a similar problem.

One principal object of the present invention, accordingly, is to provide a method of producing a metallic composition which, while electrically and thermally conductive to a satisfactory degree compared with copper, will be much harder and wear resistant than copper, bronze or other material at present commercially available for use in the fields just described, or related fields. Indeed, the novel composition involved has also been found to give surprising results as a bearing material, e. g. in piston heads subject to hard service.

Briefly stated, such improved material comprises an intermixture of copper with iron, with the incidental production to a limited extent of a copper iron alloy, and the invention further includes certain novel procedures whereby such product is obtained.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the steps and means hereinafter fully described and particularly pointed out in the claims.

The annexed drawing and the following description set forth in detail several methods and products exemplifying our invention, such disclosed procedure and product constituting, however, but some of the various applications of the principle of our invention.

In said annexed drawing:

Fig. 1 is a central longitudinal section more or less diagrammatic in character illustrating the materials used and one method which may be employed to make such improved electrical contact member;

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Fig. 2 similarly diagrammatically illustrates a modification in such method;

Fig. 3 is a transverse section through the parts and materials illustrated in Fig. 2, the plane of such section being indicated by the line 3—3 on said Fig. 2;

Fig. 4 is a transverse section through the product resulting either from the operation as illustrated in Fig. 1 or Fig. 2;

Fig. 5 illustrates a completed electrical contact member in the form of an electrode holder jaw;

Fig. 6 is a view similar to that of Fig. 1 diagrammatically illustrating still another method which may be employed in the making of our improved electrical contact member; and

Fig. 7 is a transverse section similiar to that of Fig. 4 through the product resulting from the operation illustrated in Fig. 6.

Referring to the arrangement of parts and material illustrated in Fig. 1, a steel strip 1 is laid on a conductive support or bed 2 such as is familiarly employed in arc welding operations. Said strip will desirably be of approximately the same width as, and of a thickness somewhat less than, that of the contact member when finished. A layer 3 of heavy granular flux is then placed over strip 1 to a depth which will completely cover the same and substantially conceal the arc produced when the metallic weldrod 4 is moved longitudinally along the strip, it being understood that such weldrod and the strip, or the support 2 on which the latter rests, are included in the usual welding circuit as need not be described.

In the particular operation illustrated in Fig. 1, strip 1 will consist of a mild steel and the electrode 4 will be a copper electrode. The current employed and the rate of movement of the electrode along the strip (the direction of such movement being indicated by the arrow) will be such that molten copper produced by melting down the end of the electrode in the arc will be interfused with the upper portion of the strip which is simultaneously rendered molten, the two metals intimately commingled, and a certain limited amount of copper-iron alloy produced.

The support or bed 2 will ordinarily be of steel or other relatively good conductor of heat so that the molten metal consisting of commingled copper and steel that results from the operation of the arc as it travels along the steel strip will cool quite rapidly to at least atmospheric temperature. In any event, such cooling should be at a rate which will substantially prevent any segregation of the steel and copper into separate masses, but leave the steel still in the form of finely divided discrete particles as the copper sets.

The extent to which there is formed a true alloy of the metals in question is a matter of indifference, but in any event finely sub-divided particles derived from the steel strip are disseminated through the copper deposited from the weldrod to form the upper layer of the finished article, the back of which consists of the residual portion of the original strip, the relative ratio of steel to copper increasing naturally from the upper face of the deposit layer to the residual steel backing. Furthermore, since the electrode will be passed along the center of the strip, i. e. midway of its sides, such strip will be fused more deeply and the superposed layer of mingled steel and copper be of correspondingly greater depth along such line than at the sides of the strip. Finally, the amount of copper thus interfused with the steel strip per unit of length of the latter will determine both the ratio of the two metals in the fused layer and the depth of the latter, or in other words, the thickness of the finished strip product 5.

Fig. 2 will be used to describe two modified procedures in both of which a steel strip 1 is supported on a bed 2 and covered by a deep layer 3 of heavy granular flux as before. However, the electrode 4a instead of being of copper is a 100 point carbon steel electrode, and a layer 7 of metallic copper is placed directly on top of the steel strip 1, such layer 7 consisting either of a copper strip or of copper in sub-divided form, e. g. copper chips.

The sectional view, Fig. 3, shows in general the disposition of parts where the interfusion of metals is carried on as illustrated in Fig. 2; while Fig. 4 illustrates generally the resulting product whether obtained by the method of Fig. 1 or either of the methods of Fig. 2.

Instead of forming the metallic product consisting of commingled copper and steel by interfusing the copper with a preformed strip of steel, as illustrated in Figs. 1 and 2, with a portion of such strip left intact to form the base of the finished product, a product wholly consisting of the two metals in question thus commingled may be formed by the arrangement of parts and material illustrated in Fig. 6.

The principal piece of apparatus employed in this last modified procedure is an elongated longitudinally channeled mold 15 which may be made of copper or, if desired, of suitable refractory material, and which in either event will be desirably provided with one or more passages 16 whereby a cooling fluid may be circulated therethrough. The channel 17 is formed in the upper face of the trough-like mold 15 and may be of any desired depth, width and cross-sectional form, although the side walls will preferably diverge slightly, as indicated by the cross-sectional form of the resulting product, as illustrated in Fig. 7. Into such trough molten steel and copper are then introduced by means of two metallic weldrods 18 and 19, one composed of the one metal and the other of the other, which are mounted so as to be conjointly movable longitudinally of the channel 17, and a deep flux layer, as illustrated in Fig. 1, may be employed if desired, although not here shown.

Preferably the two rods will be connected in series in the arcing circuit so that the main path of current travel will be between their lower ends, with little or no current passing through the mold or trough 15 even where the latter is made of conductive material, e. g. copper, as mentioned

above. The rate of travel of the weldrods will be properly correlated with the rate at which they are fused down so that the channel 17 will be substantially filled with the resulting product consisting of commingled steel and copper. The proportions of the two metals in such product may likewise be varied by using weldrods of different diameters or other known methods for controlling their respective rates of fusion.

By the method last described a bar 20 (see Fig. 7) of cross-sectional form corresponding with that of the channel 17 and of any desired length may be made which will be of substantially uniform composition throughout instead of the relative amounts of copper and steel varying from the base to the upper surface of the strip as in the case of the product illustrated in Fig. 4.

The following table gives the relative hardnesses in Rockwell or Brinell of the products obtained by the methods described above, and also for purposes of comparison the hardnesses of copper, a typical commercially available copper alloy and mild steel, viz.:

	Measured Rockwell	Converted Brinell
Soft drawn copper	37 F	Below scale
Hard drawn copper	43–45 B	83–86
A typical commercially available copper alloy	47–62 B	88–107
Mild steel	64–66 B	114–117
Material A	75–80 B	137–150
Material B	82–88 B	156–176
Material C	110–115 B	311–375

In the foregoing table, Material A was made by using copper wire as the electrode and interfusing with a mild steel backing, as in the first described method; Material B was made using a mild steel backing, copper chips and a mild steel wire as electrode; and Material C was made using a steel backing with a copper strip laid thereon, and a 100 carbon steel electrode.

Reference is made to a typical commercially available copper alloy in the foregoing table because it is quite frequently employed for electrical contact members in the field of use for which the present improved product has been found not only more serviceable but at the same time considerably less expensive to make.

In order to provide the finished contact members, using the composite strip made as first described above, such strip will be cut into pieces of desired length and the resulting sections or blocks then individually swaged or coined so as to impart to the upper surfaces thereof the particular shape or contour required for the intended use. Thus in Fig. 5 there is illustrated the finished article in the form of an electrode holder jaw 10 in which such upper surface, in addition to being formed with a central longitudinally extending depression or groove 11 is also formed with a series of transverse grooves or notches 12 disposed at various angles so that an electrode may be gripped between two such contact members or bodies, either in alignment with said groove 11 or disposed at an angle as defined by said transverse grooves or notches 12.

The bar 20 resulting from the method of production described in connection with Fig. 6 may be fabricated into similar contact members as illustrated and described in connection with Fig. 5, or the product resulting from the procedure in question may be employed in the making of point contacts for spot welding machines, or sliding or rolling contacts such as are employed in making travelling electrical connection as in the case of trolleys or the like.

Where for any purpose a contact member having a wider face than the steel strip illustrated is required, so that a single passage of the electrode therealong would not serve to interfuse the whole of such face with copper derived either from the electrode or from a layer of metallic copper resting on the upper face of the strip, the electrode may be passed back and forth across the upper face of the strip a plurality of times either longitudinally or transversely until the whole of the original steel strip or sheet has been converted into the composite product described, consisting of a portion of the original steel which remains as a backing or support for a larger body of intermingled steel and copper resulting from the action of the electric arc under the deep flux layer.

While in the case of the composite product illustrated in Fig. 4, the ratio of copper to steel in the facing may vary, being greater in the upper surface of such facing than in the lower portion thereof adjacent the residual steel strip which forms the base of the contact member, such ratio in any event will be considerably larger than in any commercial product heretofore known. This of course will be equally true of the ratio of copper to steel in the product of uniform composition illustrated in Fig. 7. Indeed (see Hoyt's "Metallography," Part II, The Metals and common alloys, New York, 1921, p. 250 and pp. 331 et seq.), copper in amounts exceeding 2 percent cannot be added to steel with any success, citing Wigham and Breuil as authorities.

In counterdistinction to the foregoing, the content of copper in the facing layer of such first-mentioned product, that of Fig. 4, or the product as a whole where of uniform composition, that of Fig. 7, should be substantially greater than 2 percent and preferably above 20 percent. In fact we have found that a product consisting of copper and steel commingled in the manner herein described in which the content of copper ranges from 20 percent to 80 percent will produce a superior electrical contact member of the type in question. For most uses, a 50-50 mixture of the two metals has proven quite satisfactory.

While not committed to any particular theory, it would appear that relatively quick cooling of the molten mixture of copper and steel is essential to the production of our improved product; otherwise the two metals, except to the extremely limited extent to which they form an alloy, will tend to segregate. On the other hand, by quick cooling of the molten mass the steel remains in the form of finely divided discrete particles imbedded in the copper, or at least as where the amount of copper approaches the lower of the limits mentioned above it still forms a continuous lattice more or less surrounding the steel particles. The greater the amount of copper the better will be the electrical and heat conductivity of the resulting product, whereas the greater the amount of steel the better will be its wearing characteristics.

Where our improved metallic composition is used as a bearing material, its electrical conductivity will not be an important factor, but its adequate heat conductivity coupled with superior wearing qualities admirably adapts it for this field of use.

Other modes of applying the principle of our invention may be employed instead of the one explained, change being made as regards the composition and method herein disclosed, provided the ingredients or steps stated by any of the following claims or the equivalent of such stated ingredients or steps be employed.

We therefore particularly point out and distinctly claim as our invention:

In a method of making electrically conductive wear resistant contact members for electrical equipment, the steps which comprise depositing a layer of copper on a steel backing from an electrode of copper, the intensity of the arc between such electrode and backing being sufficient to fuse the steel surface and commingle a sufficient amount of steel with such copper to form a layer in which the copper is present in the proportion of approximately 20% to 80%, cooling such layer relatively rapidly to retain such steel dispersed therethrough, the relative ratio of steel to copper increasing gradually from the upper surface of such layer to the residual steel backing, the layer of copper having its greatest thickness along its mid-line, and mechanically swaging the composite contact member so formed to reduce the thickness of the copper layer at the mid-line and cause the copper to flow laterally outwardly from said mid-line.

ROBERT A. WILSON.
BENJAMIN H. MATTHEWS.

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