

April 3, 1956

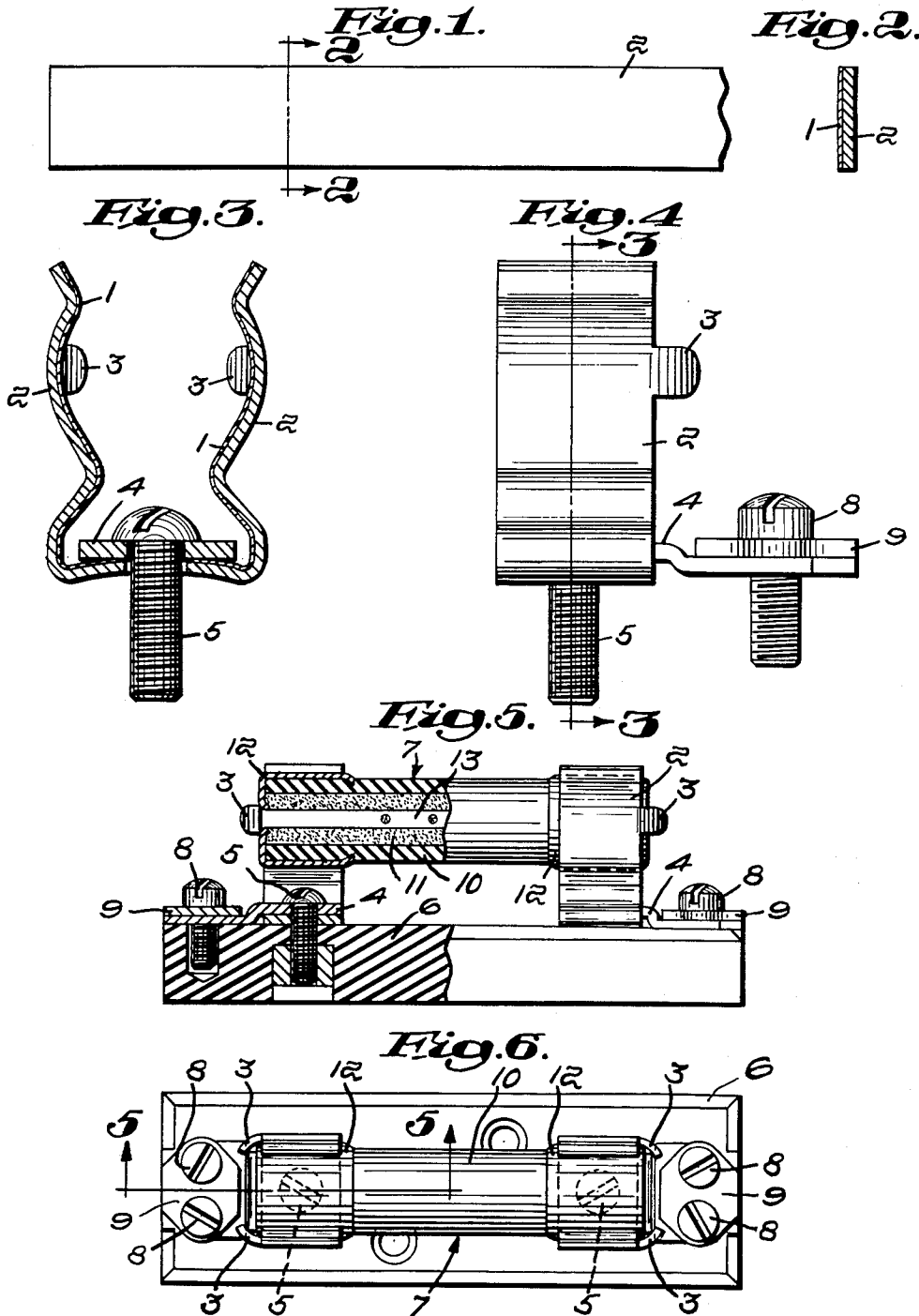
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2,740,735

METHOD OF FORMING CONTACT STRUCTURES OF COMPOSITE METALS

Filed May 18, 1953

2 Sheets-Sheet 1



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METHOD OF FORMING CONTACT STRUCTURES OF COMPOSITE METALS

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2 Sheets-Sheet 2

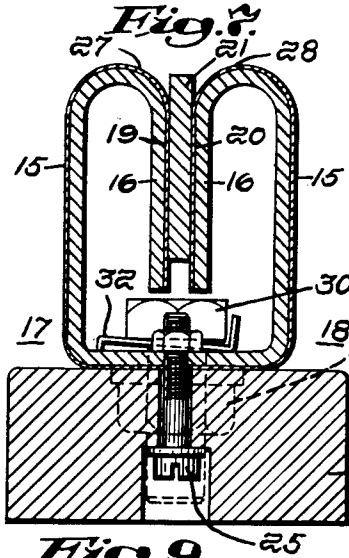


Fig. 7.

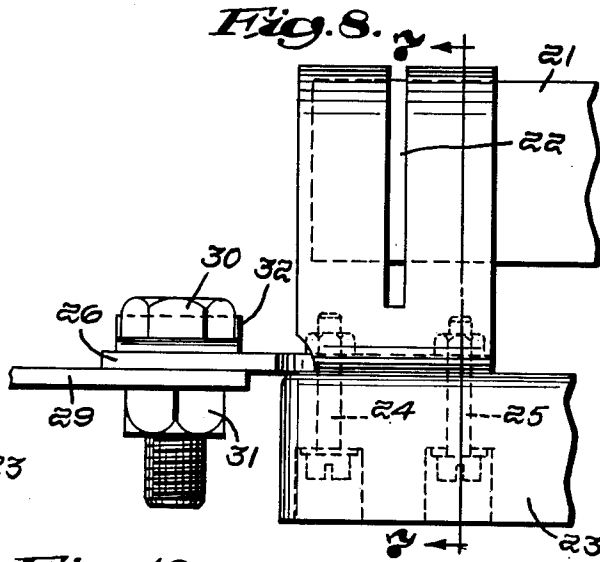


Fig. 8.

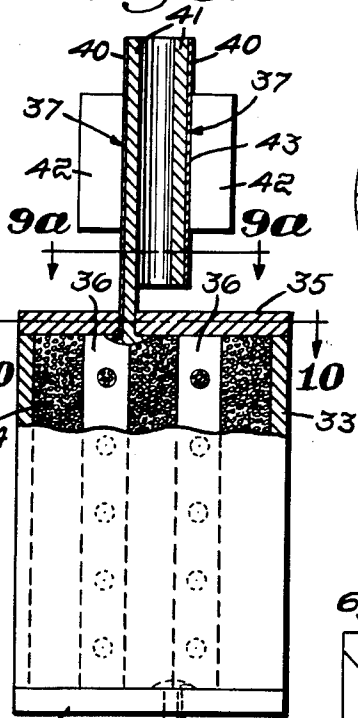


Fig. 9.

Fig. 10.

Fig. 11.

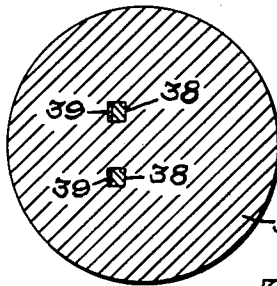


Fig. 12.

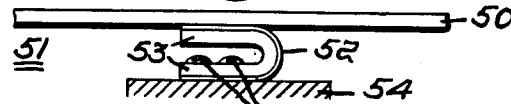


Fig. 13.

Fig. 14.

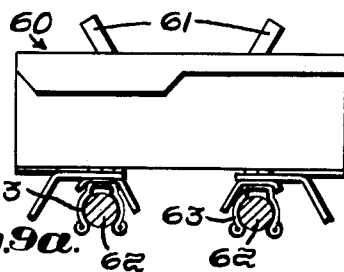


Fig. 15.

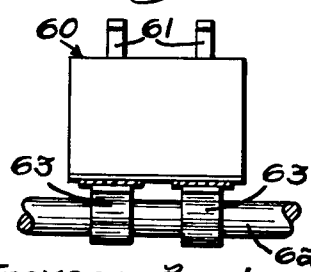


Fig. 16.

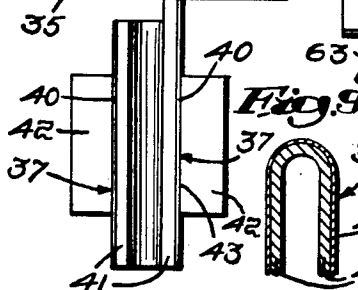


Fig. 17.

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2,740,735

METHOD OF FORMING CONTACT STRUCTURES OF COMPOSITE METALS

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Application May 18, 1953, Serial No. 355,493

4 Claims. (Cl. 148—11.5)

This invention relates to electrical contact structures in general, and more particularly to electrical contact clips as, for instance, fuse clips.

Since heat losses increase in proportion to contact resistance and since contact resistance is proportional to contact pressure, it is necessary in most power applications to effect engagement of electrical contacts under relatively high pressures. Relatively high contact pressures may either be produced by positive means, such as mechanisms predicated on wedge or screw action, or by elastic or resilient means, such as springs. As a general rule materials such as steel having desirable spring properties, are relatively poor conductors of electricity. For this reason contact structures calling for low resistance and high spring-produced contact pressures are generally of a relatively complex nature, i. e. they involve a first element, or a first group of elements, having a high electric conductivity and a separate second element or a second group of elements, exerting a spring action upon said first element, or first group of elements.

It is therefore a general object of this invention to provide a method for manufacturing contact structures which are simpler and less expensive to manufacture than the composite contact structures which were known heretofore.

Another object of this invention is to provide a method for manufacturing contact structures having spring-biased contact surfaces of copper but dispensing with the separate spring means which were required and used heretofore for exerting resilient contact pressures.

A further object of the invention is to provide a method for manufacturing contact structures having a high conductivity and desirable spring properties and consisting of composite materials capable of being formed or fashioned in the same way as unitary materials.

Still another object of the invention is to provide a method for manufacturing a contact structure wherein the function of separate and distinct contact members and spring members is performed by a bimetallic element consisting of two coextensive metal layers of uniform thickness inseparably bonded together by the application of heat and pressure to form a material which may be considered a unitary material.

Still another object of the invention is to provide a bimetallic contact structure including a layer of soft, i. e. annealed copper and a layer of hard, i. e. heat-treated spring steel, the electrical properties of the structure being significantly governed by those of the first mentioned layer and the mechanical properties of the structure being significantly governed by those of the last mentioned layer.

Still another object of the invention is to provide a method for manufacturing contact structures and more particularly contact clips which method is more efficient than any comparable method which has been used heretofore for this purpose.

Other objects and advantages of the invention will become apparent as this specification proceeds and the fea-

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tures of novelty will be pointed out with particularity in the appended claims forming a part of this specification.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

Fig. 1 is a top plan view of a strip of bimetallic material which may be deemed a unitary material and is suited for carrying the invention into effect;

Fig. 2 is a section along 2—2 of Fig. 1;

Fig. 3 is a section along 3—3 of Fig. 4 showing a fuse clip embodying the present invention;

Fig. 4 is a side elevation of the structure shown in Fig. 3;

Fig. 5 is partially a side elevation and partially a section along 5—5 of Fig. 6 showing a fuse holder or cut-out embodying the present invention;

Fig. 6 is a top plan view of the structure shown in Fig. 5;

Fig. 7 is a section along 7—7 of Fig. 8 showing a contact structure embodying the present invention;

Fig. 8 is a side elevation of the structure illustrated in Fig. 7;

Fig. 9 is in part a front view and in part a longitudinal section of a fuse embodying the present invention;

Fig. 9a is a section along 9a—9a of Fig. 9;

Fig. 10 is a section along 10—10 of Fig. 9;

Fig. 11 is a side elevation of the upper connector of the fuse shown in Fig. 9, the bimetallic portion of the connector being bent into a plane;

Fig. 12 is a side elevation of a slide contact embodying the present invention;

Fig. 13 is a top-plan view of a circuit breaker structure embodying the present invention; and

Fig. 14 is a side elevation of the structure shown in Fig. 13.

Many metals, including copper and steel, can be bonded together inseparably to form what is in essence a unitary bimetallic material. The invention is predicated upon the use of such bimetallic materials having two coextensive layers of which one consists substantially of copper and the other consists substantially of carbon spring steel, both layers being bonded together by the application of heat and pressure to form a unitary sheet material. Any desired shape or shapes may be produced from such sheet materials by using a blanking die process or stamping or punching operations. Thereupon the short lengths of sheet material so obtained are formed by conventional forming methods such as pressing, bending, etc., to impart to them the desired spatial configuration. Upon their final forming the contact structures are subjected to a heat-treatment or annealing process whereby the steel layer thereof is hardened and obtains the requisite spring properties and whereby the copper layer thereof is softened. This post-forming dual-purpose heat-treatment completes generally the process according to this invention of manufacturing contact structures. However, for many applications it is advisable to silver-plate the contact structures following the heat-treatment thereof in order to preclude oxidation of the copper layer.

Referring now to Figs. 1 and 2 of the drawing, these figures illustrate a preferred bimetallic material for carrying my invention into effect. This material comprises a first layer 1 which may consist substantially of copper and of a second layer 2 which may consist substantially of steel. A variety of steels may be used but I prefer carbon steels which can readily be heat-treated after forming to impart to them the requisite spring characteristics. For certain applications copper-clad 1040 SAE steel number material is very satisfactory and for other applications I prefer copper-clad 1065 SAE steel number sheet material. For manufacturing clips for a small fuse holder or cut-out of the kind shown in Figs. 5 and 6 copper-clad steel strips having a width of $\frac{7}{8}$ " and a thickness ratio of

20% may be used to advantage. The strips are first stamped into short lengths, whereupon the stampings are formed or shaped as best shown in Figs. 3 and 4, and finally the finished clips are heat-treated to decrease the elasticity and hardness of the copper layer and to increase the elasticity and hardness of the steel layer. As mentioned before, it is desirable to silver-plate the clips after the heat-treatment thereof to protect the copper layer 1 against oxidation.

In the finished clip contact illustrated in Figs. 3 and 4 the copper layer 1 is situated on the inside and the steel layer 2 on the outside. Copper having a larger coefficient of thermal expansion than steel—the coefficient of linear expansion per deg. Fahr. being about 9.6×10^{-6} for copper and 6.6×10^{-6} for steel—bimetallic contact clips of the type shown in Figs. 3 and 4 will have a certain tendency of lateral expansion and concomitant reduction of contact pressure upon any rise in temperature. This undesirable tendency of lateral expansion and reduction of contact pressure can be minimized by by reducing the elasticity of the copper layer 1 and increasing that of the steel layer 2 by appropriate heat-treatment and/or reducing as much as possible the ratio of the thickness of the copper layer 1 to the thickness of the steel layer 2.

The contact clip shown in Figs. 3 and 4 is provided with a pair of inwardly bent projections or tabs 3 forming axially outer abutments precluding accidental removal of a fuse from a fuse holder or cut-out comprising clips of the type illustrated in Figs. 3 and 4.

As shown in Figs. 3 and 4 the terminal bar 4 forming an integral part of the fuse clip 1, 2 engages the inner layer of the clip 1, 2 under pressure. The contact pressure between layer 1 and terminal bar 4 is produced by a clamping screw 5 which may be screwed into any suitable base as, for instance, base 6 shown in Fig. 5.

It will be apparent from Figs. 3 to 5, inclusive, that the electric current carried by cartridge fuse 7 flows directly from the inner highly conductive copper layers 1 of the fuse clips to the terminal bars 4, i. e. the steel layers 2 of the fuse clips have no part in, and do not interfere with, current conduction. The only purpose of the outer steel layers 2 is to provide a mechanically strong and highly resilient back-up for the inner copper layers 1 which lack mechanical strength and resiliency but have a sufficiently high conductivity to carry the required magnitude of current. The mechanical effectiveness of the back-up layers 2 of steel will be readily apparent when considering how much larger the modulus of elasticity of heat-treated steel is in comparison to the modulus of elasticity of annealed copper.

As clearly shown in Figs. 4 to 6, inclusive, the terminal bars 4 associated with each fuse clip 1, 2 are each provided with a pair of terminal screws 8 and with a clamping element 9 for attaching terminals of cables or other leads to the terminal bars 4.

The fuse generally indicated in Figs. 5 and 6 by the reference numeral 7 comprises a casing 10 of a suitable insulating material as, for instance, a synthetic-resin-glass-cloth-laminate, a pulverulent arc-quenching filler 11 arranged within casing 10, a pair of crimped terminal caps 12 each arranged on one end of casing 10 and a fuse link 13 arranged in casing 10, submersed within filler 11 and interconnecting caps 12. The terminal caps 12 are inserted into the fuse clips 1, 2 and carry the current from link 13 to the clips 1, 2.

The contact arrangement shown in Figs. 7 and 8 may be used either for fuse holders or cut-outs for fuses having blade contacts, or as a contact for knife switches. This contact is intended to carry continuously higher currents than the clips shown in Figs. 3 to 6, inclusive. The configuration of the copper and steel layers in the structure of Figs. 7 and 8 is such that contact pressure tends to increase as the temperature increases and as the structure expands due to increase in temperature.

The contact shown in Figs. 7 and 8 includes two co-extensive layers 15, 16 of uniform thickness inseparably bonded together to form a unitary bimetallic structure. The metal sheet 15, 16 is bent upwardly and downwardly on opposite sides 17 and 18 thereof substantially in the shape of an inverted U to form a pair of spaced parallel contact surfaces 19, 20. Blade contact 21 fills the gap formed between contact surfaces 19, 20 and is in physical engagement with both said surfaces. The outer layer 15 of metal sheet 15, 16 which is turned inwardly consists substantially of copper and the inner layer 16 which is turned outwardly consists substantially of hardened spring steel. The coefficient of thermal expansion of layer 16 exceeds the coefficient of thermal expansion of layer 15; this type of contact tends to cause an increase of the pressure exerted upon blade contact 21 with increasing temperature.

The contact member 15, 16 is provided with a transverse slot 22 to increase the flexibility thereof and is mounted on ceramic socket 23 by means of a pair of screws 24, 25. A portion 26 of the contact member 15, 16 located between the two re-entrant portions thereof generally indicated by the reference numerals 27 and 28 serves as terminal tab for attaching a cable or other conductor to the contact member. Fig. 8 shows a conductor means 29 in contact with the surface of terminal tab 26 which is situated opposite to the re-entrant portions 27, 28 of the contact member 15, 16. The connection between the tab 26 and the conductor means 29 is effected by a screw 30 and a nut 31. Relative rotation of parts 30, 31 is normally precluded by an appropriately bent metal strap 32. Since the conductor means 29 is in physical engagement with the copper layer 15, the contact resistance is low at the point of transition of the current between the parts 26 and 29, and the steel layer 16 does not in any way interfere with the current carrying ability of the device. There is no practical limit with regard to the thickness of copper layer 15 in the structure shown in Figs. 7 and 8, except for the fact that for reasons of economy the thickness of the copper layer 15 should never substantially exceed what is needed to achieve the required current-carrying ability.

Referring now to Figs. 9, 9a, 10 and 11, the fuse structure shown therein comprises a casing 33 of insulating material which is filled with a pulverulent or granular arc-quenching material 34 such as, for instance, pure quartz sand. Each end of casing 33 is closed by a terminal element 35 formed by a flat metal plate. Terminal elements 35 are conductively interconnected by one or more fuse links 36 which are preferably multiperforated to increase the rate of rise of the arc voltage on interruption of fault currents of short-circuit current proportions. A pair of contacts generally indicated by the reference numeral 37 is provided for connecting the fuse structure into the circuit which is to be protected by it. Each contact 37 projects from one of said terminal elements 35 in a direction longitudinally of casing 33. Each of said pair of contacts 37 comprises a length of bent sheet metal substantially U-shaped in cross-section as clearly shown in Fig. 9a. Each of contacts 37 is fastened to one of terminal plates 35. To this end each terminal element 35 is provided with a pair of holes 38 and each contact 37 is provided with a pair of prong-like projections 39 inserted into holes 38. Upon insertion of projections 39 into holes 38 the former are upset in the fashion of rivets, thus providing a solid rivet-like tie between terminal elements 35 and contacts 37. The left portion of Fig. 11 shows a projection 39 of a contact 37 before upsetting thereof and the right portion of Fig. 11 shows a projection 39 of a contact 37 after rivet-like upsetting thereof.

The sheet metal of which contacts 37 are made consists of two co-extensive layers 40, 41 of uniform thickness inseparably bonded together to form an essentially unitary bimetallic material. The outer layer 40 consist substanti-

ally of a metal having a relatively high electric conductivity and relatively little resiliency; the inner layer 40 consists substantially of a metal having a relatively high resiliency and a relatively small electric conductivity. Layer 40 consists preferably of annealed copper and layer 41 consists preferably of heat-treated spring steel.

Since contacts 37 are inherently flexible, the contacts intended to cooperate with them may be rigid. Fig. 9 shows two solid metal blocks 42 of which each is provided with a groove 43 for receiving one of contacts 37. The copper layers 40 of contacts 37 are biased by the spring action of steel layers 41 against the surfaces of grooves 43.

The arrangement shown in Fig. 12 comprises a conductor 50 in the shape of a rail or taut wire and a co-operating sliding contact generally indicated by the reference numeral 51. Sliding contact 51 is made up of a bimetal having an outer layer 52 of copper and an inner layer 53 of carbon spring steel. Layer 53 biases layer 52 against conductor 50 due to the spring characteristics inherent in layer 53. The U-shaped bimetallic structure 52, 53 is supported by a metal block 54 to which it is secured by a pair of screws 55. This arrangement has a relatively high current-carrying capacity and avoids the use of flexible conductors in the nature of braids which are generally liable to rapid wear. Another desirable feature of the structure is its simplicity resulting from the absence of separate contact-pressure-producing spring means.

Referring now to Figs. 13 and 14, the arrangement shown therein comprises a circuit breaker generally indicated by the reference numeral 60. Circuit breaker 60 may be of any known design or type, e. g., a thermal molded case type circuit breaker. Circuit breaker 60 is provided with a pair of handles or tumblers 61 for the operation thereof. A pair of stud-type bus bars 62 is arranged at the rear of circuit breaker 60 and the latter is provided with a pair of plug-in disconnect type contacts 63 which enable a direct mechanical and electrical connection between the circuit breaker 60 and the bus bars 62. The contacts 63 are of the clip type and are bimetallic and are generally made-up in the same way as the clip type contacts illustrated in Figs. 3 and 4.

The process of manufacturing contact clips of the type illustrated in Figs. 3, 4, 13 and 14 comprises the steps of moving a strip of bimetal as shown in Figs. 1 and 2, i. e., a strip consisting of two coextensive layers of copper and carbon steel of uniform thickness, in a direction longitudinally thereof and of successively stamping from said strip portions of predetermined length and shape. Thereafter these portions or stampings are formed to clips by bending inwardly the copper layer thereof. Finally the formed clips are being heat-treated to soften the copper layer and to impart the desired spring characteristics to the steel layer.

The simultaneous heat-treatment of the copper layer and of the steel layer of the pre-formed clips has substantially opposite effects upon each constituent metal. It is well known that drawn or rolled copper can be softened by annealing, i. e., by heating it to temperatures in the order of 450 to 600 deg. cent. whereby its structure is rendered crystalline. On the other hand, the heat treatment applied to the layer of steel of the contact clips

produces an elastic limit thereof suitable to given load requirements, precludes an excess of permanent set, results in fatigue resistant properties ensuring a long life of the contact clips and increases the hardness of the steel layer.

It will be understood that I intend to refer to multilayer sheet metal structures having at least two and possibly more than two metal layers when using in this specification the term bimetallic structure and like terms, and that by using such terms I do not wish to make any illusions in regard to the coefficients of expansion of the metals involved.

It will also be understood that I have illustrated and described herein preferred embodiments only of the invention and that various alterations may be made in the details thereof without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. The process of manufacturing electric contact clips comprising the steps of moving a metal strip consisting of a layer of copper and a layer of carbon steel bonded together to form a unitary metal in a direction longitudinally of said strip, of stamping from said strip successively portions of predetermined length and shape, of forming said portions to clips by inwardly bending said copper layer thereof and thereafter heat-treating said clips to impart the desired spring characteristics to said steel layer.

2. A method for manufacturing electric contact clips from a material comprising a layer of copper and a layer of soft steel inseparably bonded together to form a unitary metal comprising the steps of forming said metal to clip-shape before heat-treatment thereof and thereafter heat-treating the clip thereby imparting spring characteristics to said layer of steel and simultaneously annealing said layer of copper.

3. A method for manufacturing electric contact clips from a material comprising a layer of copper and a layer of carbon steel inseparably bonded together to form a unitary metal comprising the steps of banding a flat piece of said metal into clip-shape before heat-treatment thereof and thereafter heat-treating the clip thereby imparting spring characteristics to said layer of steel and simultaneously annealing said layer of copper.

4. In the process of manufacturing an electric contact from a length of composite metal comprising layers of copper and carbon steel integrated to form a unitary metal sheet the steps of performing at least one bending operation on said length of metal while said layer of steel is in the relatively soft and non-resilient state of carbon steel and said layer of copper is in a relatively hard state, and thereafter subjecting said pre-bent length of metal to a heat-treatment at sufficiently high temperatures to render said layer of steel relatively hard and resilient and to render said layer of copper relatively soft.

References Cited in the file of this patent

UNITED STATES PATENTS

1,925,856	Vaughan	Sept. 5, 1933
1,971,392	Carlisle	Aug. 28, 1934
2,013,868	Soderberg	Sept. 10, 1935