Aug. 5, 1947. T. MILLER 2,425,113

PRODUCTION OF ELECTRIC ARC ETCHING ELECTRODES

Original Filed June 24, 1942

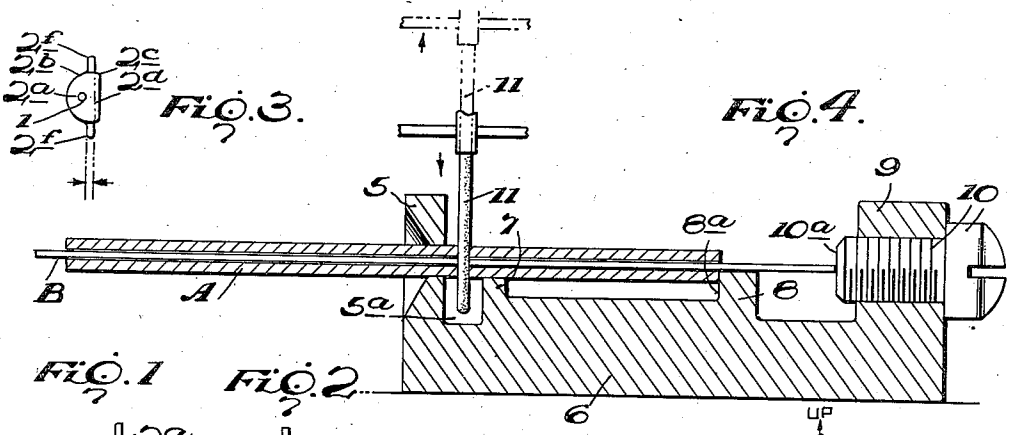


FIG. 3.

FIG. 4.

FIG. 1.

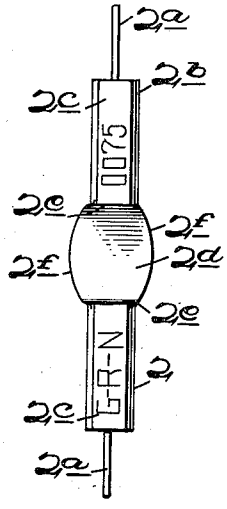


FIG. 2.

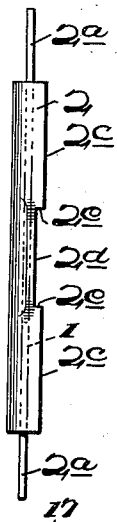


FIG. 5.

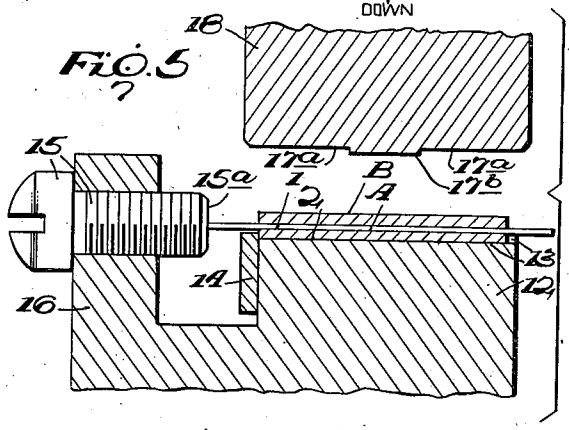


FIG. 6.

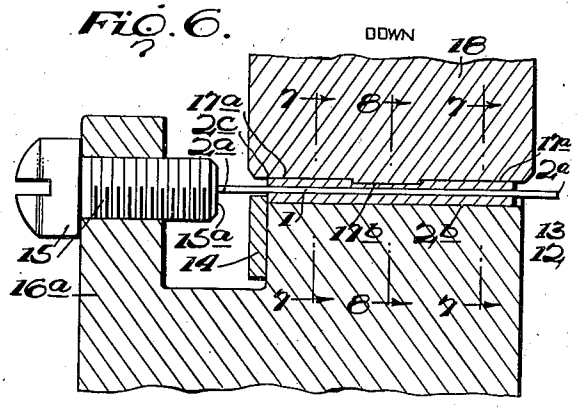


FIG. 7.

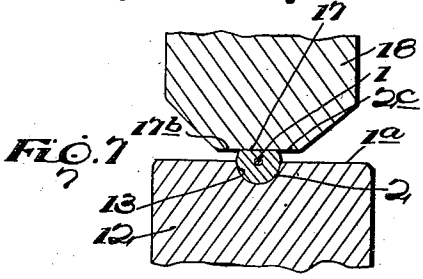
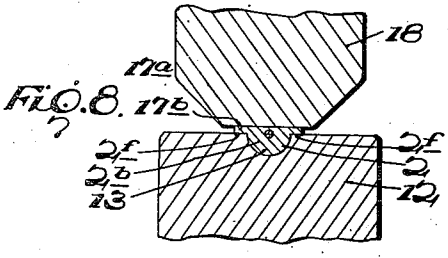


FIG. 8.



Inventor

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By Peck & Peck Attorneys

Patented Aug. 5, 1947

2,425,113

UNITED STATES PATENT OFFICE

2,425,113

PRODUCTION OF ELECTRIC ARC ETCHING ELECTRODES

Theodore Miller, Racine, Wis., assignor to George Gorton Machine Co., Racine, Wis., a corporation of Wisconsin

Original application June 24, 1942, Serial No. 448,320, now Patent No. 2,354,871, dated August 1, 1944. Divided and this application June 2, 1944, Serial No. 538,510

5 Claims. (Cl. 29—25.15)

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This invention concerns the art or method of producing electric arc etching electrodes, particularly such small consumable electrodes that are replaceably employed in the high speed vibratory electrode holders of electric arc etching machines; and the objects and nature of the invention will be apparent to those skilled in the art, in the light of the following descriptions of preferred example steps followed in the electrode production, and the illustrated example embodiments of apparatus, among others, that can be employed in carrying out the new method.

The instant application constitutes a division of my parent application, filed June 24, 1942, Serial No. 448,320, now Patent No. 2,354,871, granted August 1, 1944, disclosing the new electric arc etching electrode, and the production method and apparatus of this divisional application.

The object of the instant invention is the provision of an economical time saving method for the economical accurate production of consumable electric arc etching electrodes for replaceable use in the vibratory electrode holders of arc etching machines, and the like.

With the foregoing objects in view, and any others developed by the following description, my invention consists in certain novel and advantageous method steps, more fully explained hereinafter and specified by the appended claims.

Referring to the accompanying drawings, forming a part hereof:

Figs. 1, 2, and 3 show the preferred electric arc etching electrode product of my method, greatly enlarged, in front elevation, edge elevation, and end elevation, respectively.

Fig. 4 shows more or less diagrammatically preferred mechanism, in enlarged longitudinal vertical section, that can be employed in carrying out certain steps of my method, such as assembling stock lengths of capillary tubing with stock lengths of tenuous consumable electric arc etching wire, and simultaneously severing such tube and wire of relatively gauged lengths.

Fig. 5 shows more or less diagrammatically, preferred mechanism, in enlarged longitudinal vertical section, with its pressing plunger elevated, designed to receive the severed tube length with its contained projecting wire, from the mechanism of Fig. 4, for carrying out the method steps necessary to complete the desired electrode product.

Fig. 6, more or less diagrammatically, shows the mechanism of Fig. 5, in enlarged longitudinal vertical section with its parts in position after the completion of the compressing and shaping operation, to produce the preferred completed electrode shown in said mechanism in longitudinal vertical section.

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Fig. 7 is an enlarged cross section, taken on either line 7—7, Fig. 6.

Fig. 8 is an enlarged cross section, taken on the line 8—8, Fig. 6.

Reference is made to my said parent application Serial No. 448,320, for a full disclosure of the particular electrode product of the instant method, and of certain electric arc etching requirements to which said electrode is subjected.

The product of my instant method preferably consists of a longitudinal shank 2, of copper, or other good electrical conductor metal sufficiently soft when cold to flow laterally under the required compressing pressure.

The consumable electric arc etching electrode wire 1, is preferably composed of any suitable high melting point metal or alloys of good electrical conductivity, such as tungsten, or tungsten group metal or alloys, or the equivalent thereof for electric arc etching purposes.

Merely as examples, without limitation, I have successfully produced by my method, reversible electrodes, where the tungsten electrode wire was of the order of .0075'' diameter, and the shank for said wire was composed of a straight length of cylindrical capillary copper tubing having an original internal diameter of the order of .012'', and an exterior diameter of the order of .076''; and where the tungsten wire was of the order of .010'' diameter, its copper tube shank was of the order of .020'' internal diameter; and where the tungsten wire was of the order of .015'' diameter, the copper tube surrounding the same was of the order of .025'' internal diameter. Without intending to so limit my method, the copper tube shanks of these just mentioned completed example electrodes, in length were of the order of eleven-sixteenths of an inch, and the opposite-end consumable projecting electrode wire ends 2*a*, of each electrode were preferably alike in length, with such length being of the order of from six sixty-fourths to twelve sixty-fourths of an inch depending on the diameters of the electrode wires employed, the larger the wire diameter the longer the wire length 2*a*.

The example electrode produced by my method consists of the tubular straight shank 2, through which the electrode wire 1, extends longitudinally and approximately centrally with its opposite ends 2*a*, projecting longitudinally from the shank ends.

This shank is so formed that one side thereof is straight, smooth, and partially cylindrical throughout the length of the shank, as indicated at 2*b*. This partially cylindrical side 2*b*, is preferably concentric with the straight wire located therein, and preferably extends through slightly less than one hundred and eighty degrees around the shank. The opposite longitudinal side of said shank is preferably flat throughout its length and

of a width, slightly greater than half the diameter of the tube, and provides a pair of longitudinal flats 2c, for the reception of visual indicia such as marks to identify the maker and the diameter of the particular electrode wire. Also, a longitudinally extending relatively deep cross groove 2d, is interposed between the flats 2c, with its opposite ends terminating at more or less abrupt cross edges forming parallel stop walls 2e. The depressed longitudinal flat or floor of this groove 2d, is flat and parallel with the flats 2c, but is depressed with respect to said flats, and the longitudinal planes of the flats and said groove floor are parallel with the longitudinal axis of the electrode wire within the shank, but said floor and the flats are laterally remote from said wire.

The operation of shaping the shank by radially applied pressure forces the metal thereof to reduce the internal diameter of the copper tube and tightly grip and clinch the electrode wire throughout the length thereof. Such shaping action in forming the relatively deep groove 2d, forces the metal of the shank to flow outwardly at the opposite ends of said groove and form the opposite side exterior longitudinally extending projecting bulges or lips 2f, that not only stiffen the shank but also form stops.

I have devised a novel method for the economical and advantageous production of the electric arc etching electrode, and in the following description of said method dimensions are given as mere examples for purposes of description, not for purposes of literal limitation.

For example, where the reversible or double end electrode, substantially as disclosed hereby, is to be produced with tungsten (or equivalent metal or alloy) cylindrical wire of .010'' diameter, the shank can be composed of copper (or equivalent metal or alloy) preferably cylindrical tubing of .076'' outside diameter and .020'' inside diameter.

The production method preferably starts with a usually straight stock section of said tubing of a length to produce a predetermined number of the electrode shanks. The length of electrode wire for each electrode equals the length of the shank plus the total lengths of the two consumable wire ends projecting from the shank, for example, each ⅛'' or more in length. A stock section of said wire is selected that in length will equal the total lengths of the number of shanks to be produced from said tubing section plus the total lengths of the consumable wire ends for said number of shanks.

The straight stock length of copper tubing A, into which the stock length of electrode wire B, has been slidably threaded, is then inserted forwardly through the fixedly located guide eye 5, of a suitable gauging and cutting off device. This device comprises a suitable base 6, from which said eye 5, upstands. A fixed tube guiding and supporting member 7, also upstands from said base a short distance to the rear of the vertical rear side of the eye 5, and the vertical space 5a, between said eye and said member 7, defines and locates the vertical plane of the tube and wire cut-off operation. A distance to the rear of said cut-off plane 5a, equal to the length of the shank to be cut from said tube and wire, the base provides a fixed upstanding elevated tubing stop 8, the transverse top end of which provides a supporting guide for the electrode wire. The rear end of said base provides a fixed upstanding wall 9, having a transverse internally threaded hole.

This hole receives a longitudinally-adjustable electrode wire stop screw 10, having its longitudinal axis in alinement with the tubing entrance eye 5, and with the longitudinal length of wire on the guiding uprights 7, and 8. The vertical end face of said screw forms a wire end abutting stop 10a.

The distance from the front stop face 8a, of fixed part 8, to the front stop face 10a, of screw 10, is equal to twice the length of each uncovered consumable wire end 2a, of the electrode for which the apparatus is set to produce. This length from 8a to 10a, can be increased or diminished by adjustment of screw 10, to produce consumable wire ends of the desired length.

The stock tubing A, containing the stock length of wire B, is pushed through the eye 5, and across the fixed part 7, until the square cut front end of the tube abuts the tube-stop face 8a, which determines the tube length to be cut off. The wire B, is then pushed forward through the stationary tube A, until the squarely cut-off front end of the wire squarely abuts the wire stop face 10a, of the screw, which determines the length of wire projecting forwardly from the tube end abutting stop 8a.

The copper tubing and its contained tungsten wire, are then simultaneously severed in a plane perpendicular to the longitudinal axis of the tubing B, to produce square cut wire and tube ends. This severing plane is located midway between fixed upright parts 5, and 7, and the straight distance from said severing plane to tube stop face 8a, determines the length of the shank produced, and the straight distance from said severing plane to wire stop face 10a determines the length of the cut-off wire. As the tungsten wire is not satisfactorily severed by snipping or shearing, I sever the same by a frictional or abrasive cutter. For instance, I show a suitably driven rotary abrasive saw, cutting wheel, or thin rotary grinding disk 11, located in said severing plane and carried by any suitable support or hanger, and normally spaced laterally from the tube A, in the device 5, 7, 8, 10, with provision for relative lateral movements between said device and said cutter to cause the cutter to sever the tube and its wire and then return laterally therefrom. The cutter can be stationarily positioned longitudinally with the said gauging and cut-off device 5, 7, 8, movable bodily laterally to and from the cutter or vice versa.

The severed tube section with its double length free wire end extending from one end, is then removed, and the stock tube and its contained wire is then moved forward in the gauging and cut-off device until the square cut end of the tube engages stop face 8a, and the wire is slipped forward in the tube until its square cut end engages stop face 10a. Thereupon the parts are operated to cause the abrasive cutter to sever said length. This length is removed and the gauging and cutting operations are repeated from time to time.

Each severed tube section with the double length free end wire projecting from one end thereof, is then transferred to a gauging and shank swaging or shaping device. This device comprises a fixed female die 12, having a straight somewhat less than semi-cylindrical female die groove 13, of uniform radius throughout its length and fully open at the top and at one end and extending longitudinally the full length of the horizontal usually otherwise flat top face of said die. This groove 13, is slightly less than 180°, i. e., the

width of its longitudinal top opening is slightly less than the diameter of the complete cylinder.

This groove 13, is at least equal to the length of the electrode shanks to be finished by said shaping device but is preferably slightly longer. At the inner end of said groove, I locate a fixed tube end stop 14, that obstructs said inner end of the groove against passage of the tube but permits free passage of the wire.

A longitudinally-adjustable stop screw 15, is carried by a fixed upstanding member 16, usually rigid with the die 12, and the front end face of said screw provides an electrode wire stop 15*a*, spaced a distance behind the front stop face of the stop 14, equal to the required or predetermined length of the projecting free wire ends of the electrodes being produced. The longitudinal axis of the screw 15, is alined with the longitudinal axis or center line of the die groove 13.

The severed required lengths of tubing, each frictionally holding its slidable contained required length of severed electrode wire, as removed from the gauging and cutting off device, are then applied successively to the shaping die groove 13, of the swaging or shaping device. Each such severed length of tubing, with its double-length electrode wire projecting forwardly from its front end, is thus inserted into the entrance or outer end of the die groove and pushed forwardly longitudinally in said groove. The forwardly projecting wire end will first strike stop-face 15*a*, and thus halt the wire while the tubing will then slide forward in the groove relatively to the halted wire until said tubing is halted by its engagement with tubing stop 14. The relative longitudinal positions of the tubing and wire as required in the completed electrode, are thus quickly established, as the just described manipulation automatically locates the tubing on the central portion of the wire with wire ends substantially alike in length projecting oppositely therefrom. The tubing and its contained wire are now ready for the electrode completing step.

Any suitable reciprocatory power or manually actuated plunger punch or die 18, is arranged in cooperative relationship with and complementary to the female die 12. The die 18, provides longitudinal narrow alined flats 17*a*, to cooperate with the female groove 13, in die 12 and form the flats 2*c*, of the completed electrodes, and the longitudinal relative wide flat raised portion 17*b*, to cooperate with the female die face and die groove in swaging, compressing, and shaping the electrodes to produce the formations 2*d*, 2*e*, 2*f*.

The somewhat less than semi-cylindrical die groove 13, is of greater radius, than the radius of the cylindrical stock tubing A, through which the stock wire B, is slidable, to enable the male die to compress and swage the tubing in the gorove to the increased radius of said groove and to thereby tightly grip and clinch the tubing and wire together while not causing the formation of a flash laterally along the sides of the flats 2*c* of the electrode shank under the male die flats 17*a*, while the male die raised portion 17*b*, in cooperation with the complementary female die portion, assists the male die portions 17*a* in compressing the tubing to clinch the wire and enlarge its radius, while swaging and causing flow of the tubing metal to form the flat 2*d* and the stop walls 2*c* and the opposite side enlargements 2*f*.

The male die portions are also, preferably, so formed to stamp or impress in the shank of each electrode suitable indicia such, for instance, as hereinbefore described.

Each length of tubing properly positioned on its electrode wire, while in the die groove 13, of the die 12, can be thus quickly compressed to clinch its contained wire and swaged or shaped to final electrode form and at the same operation can have desired indicia pressed therein.

The electrodes thus successively completed, can be quickly removed from the female die block, and as quickly fresh assembled blanks, from the gauging and cutting off device, can be successively applied to and positioned in the female die for compression and shaping.

The female die groove 13, of relatively enlarged radius with respect to the radius of the copper tube length, is preferably slightly less than 180°, in cross section, to permit easy release of the finished electrode shank therefrom, and to permit the formation of laterally projecting opposite-side longitudinal stop lips 2*f*, intermediate the length of the electrode shank, all by the cooperation of the peculiar male die 18, with the described female die 13.

The stock lengths of somewhat resilient tenuous electrode wire are unwounded from a coil or reel, and usually are not absolutely straight but tend to assume an arcuate form, and hence when a wire length is threaded through the copper tubing of relatively large internal diameter, said wire will at various opposite points press laterally against the interior walls of the tubing, and thus exert such pressure as to frictionally hold the wire temporarily in its position in the tube, while rendering the wire frictionally slidable in the tube. If the wire is too straight to exert the required light pressure against the interior wall of the tube, a simple curling operation will impart the necessary arcuate form to the wire. This light frictional contact between wire and tube prevents the wire from falling from the tube by action of gravity or other forces imposed upon the tube and wire during fabrication prior to clinching.

It is possible under my instant method and apparatus to produce, the electrode with but one free consumable wire end of any suitable length projecting from either end of the shank, while the opposite ends of the squarely cut-off shank and wire will be located in a common transverse plane.

To attain this result, the wire stop screw 10, of the gauging and cut-off device, is adjusted toward the stop wall 8, to set the distance between stop faces 8*a*, 10*a*, to predetermine the desired length of the consumable electrode wire end from one end of the shank of the electrode to be produced.

The cutting of the blank composed of shank tube length and its contained wire, will then proceed as hereinbefore described. This blank with the wire projecting from one end thereof, is then transferred to the shaping or swaging press, which has previously had its wire stop screw 15, set to the required projecting wire end distance between stop faces 15*a*, and 14. The blank is then placed in die groove 13, with the tubing end against stop 14, and the projecting wire end against stop face 15*a*. The shaping and swaging operation, as hereinbefore described, can then be carried out to complete the electrode.

While that method step which squarely severs the capillary tube and its contained tenuous tungsten electric arcing wire to produce the desirable electrode wire with substantially blunt end faces, constitutes an important specific species of my method invention, yet I do not wish to so limit all features of my method invention.

My method invention from its specific aspect preferably produces the peculiar electrode with its electric arc etching tungsten wire having the blunt end face, as the finished article, as it goes to the trade for arc etching purposes, but this fact does not control the formation of such end face, during its use for electric arc etching, when the wire is gradually consumed by evaporation or otherwise under the high temperature of the etching arcs.

What I claim is:

1. The method of producing electric arc etching electrodes each comprising a tubular shank longitudinally containing an electrode wire projecting therefrom and held thereby, which comprises assembling shank forming tubing of a stock length for cutting into a plurality of tubular shank-forming sections alike in length with a stock length of electrode wire slidable longitudinally through said stock tubing and at least of sufficient length to provide the electrode wire for each of said plurality of shank sections; guiding and longitudinally advancing said stock tubing to abut its front end against a tubing stop halting the tubing advance; advancing said stock wire through said halted tubing to abut its front end against a wire stop gauging the forward projection of the uncovered end wire beyond the stock tubing; simultaneously severing both the stock tubing and its contained stock wire at the required shank tube length from said tube stop and at the required electrode wire length from said wire stop; and thus successively advancing said stock tubing and stock electrode wire against said stops and cutting off the shank and electrode wire sections; and then compressing and shaping each shank tubing section on its contained wire section.

2. The method of producing electric arc etching electrode blanks which includes steps as follows: longitudinally advancing a stock length of shank forming tubing with its contained longitudinally and relatively slidable stock length of electrode wire to bring the front end of the stock tubing into tubing halting contact with a tubing stop and by relative longitudinal movements between the stock tubing and the stock wire, bringing the front end of said stock wire into wire halting engagement with a stock wire stop arranged a predetermined distance in advance of said stock tubing stop; and simultaneously severing both the stock tubing and its contained stock wire the required shank-length distance from said stock tubing stop, and the required electrode-wire-length distance from said stock wire stop; said stock lengths of tubing and contained wire being advanced and simultaneously severed step by step to successively produce a number of electrode blanks of tubing sections and their contained projecting electrode wire sections for shaping and compressing to final arc etching electrode condition.

3. In the production of electric arc etching electrodes, each consisting of a longitudinal tubular shank and an elongated electrode wire extending therethrough, clinched thereby and projecting longitudinally from the opposite ends thereof; those steps which include producing a succession of similar electrode blanks from a stock length of shank-forming tubing containing a stock length of electrode wire, said stock tubing and its contained stock wire being relatively and longitudinally slidable, feeding said stock tubing and wire forward through a severing station step by step, at each step stopping the tubing and wire advance when the tubing section in front of said station equals the required shank length and when the wire in front of said station equals the shank length plus the combined lengths of the projecting wire ends required by the electrode, and then simultaneously severing both the stock tubing and the stock wire at said station; then by relative longitudinal sliding movements between the severed tubing and wire length locating the tubing on the wire substantially midway between the opposite projecting wire ends; and then subjecting the tubing to substantially radial die shaping pressure compressing the tube section to tightly grip the wire.

4. In the production of an electric arc etching electrode for replaceable use in the vibratory electrode holder of an arc etching machine, where said electrode consists of a straight relatively soft metal capillary tube length, and a relatively long length of tenuous tungsten electrode wire extending longitudinally through and rigidly grasped by said tube and providing an uncovered consumable arcing electrode wire end projecting longitudinally therefrom; those steps which include slidably threading an elongated length of stock tenuous tungsten wire in an elongated length of stock tubing; successively advancing said stock tubing and projecting the stock wire length forwardly therefrom; and successively, transversely and simultaneously severing electrode tube and wire lengths from said stock tube and wire lengths, by a grinding and abrasive action.

5. The method of producing electric arc etching electrodes each comprising a tubular shank longitudinally containing an electrode wire projecting therefrom and held thereby, which comprises curling a length of electrode wire to produce a tendency in such wire to assume an arcuate form and press frictionally against the wall of the tubular shank when inserted therein, assembling shank forming tubing of a stock length for cutting into a plurality of tubular shank-forming sections alike in length, with a stock length of electrode wire slidable longitudinally through said stock tubing and at least of sufficient length to provide the electrode wire for each of said plurality of shank sections; guiding and longitudinally advancing said stock tubing to abut its front end against a tubing stop halting the tubing advance; advancing said stock wire through said halted tubing to abut its front end against a wire stop gauging the forward projection of the uncovered end wire beyond the stock tubing; simultaneously severing both the stock tubing and its contained stock wire at the required shank tube length from said tube stop and at the required electrode wire length from said wire stop and thus successively advancing said stock tubing and stock electrode wire against said stops and cutting off the shank and electrode wire sections; and then compressing and shaping each shank tubing section on its contained wire section.

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The following references are of record in the file of this patent:

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