

May 15, 1962

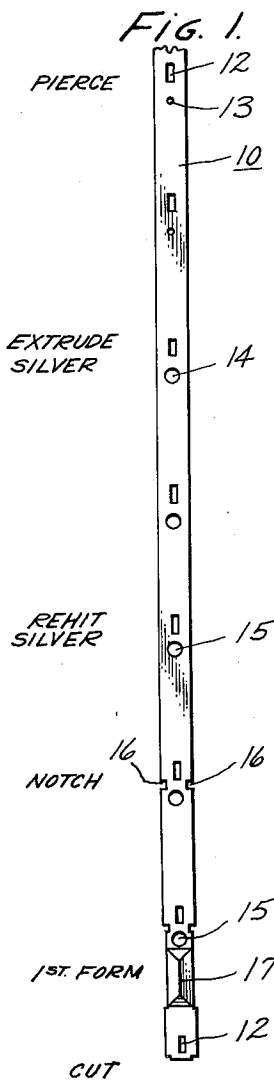
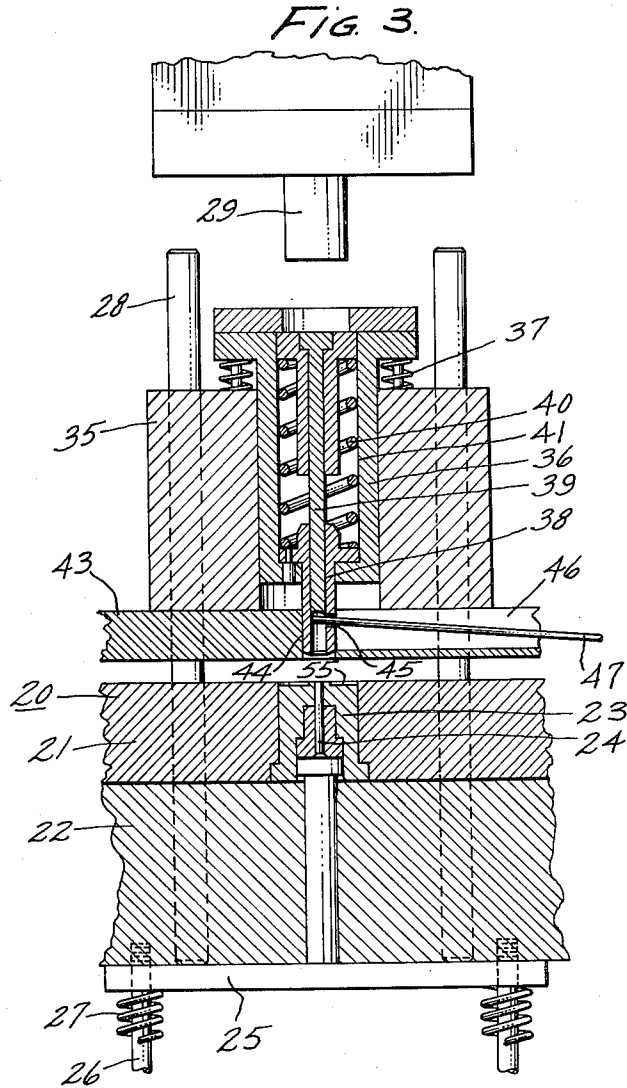
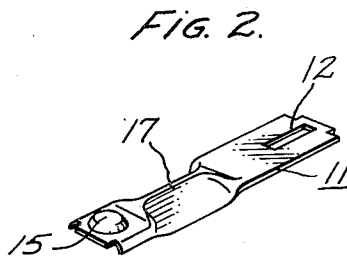
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3,034,641

APPARATUS FOR EXTRUDING SILVER CONTACTS

Filed May 31, 1957.

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 4.

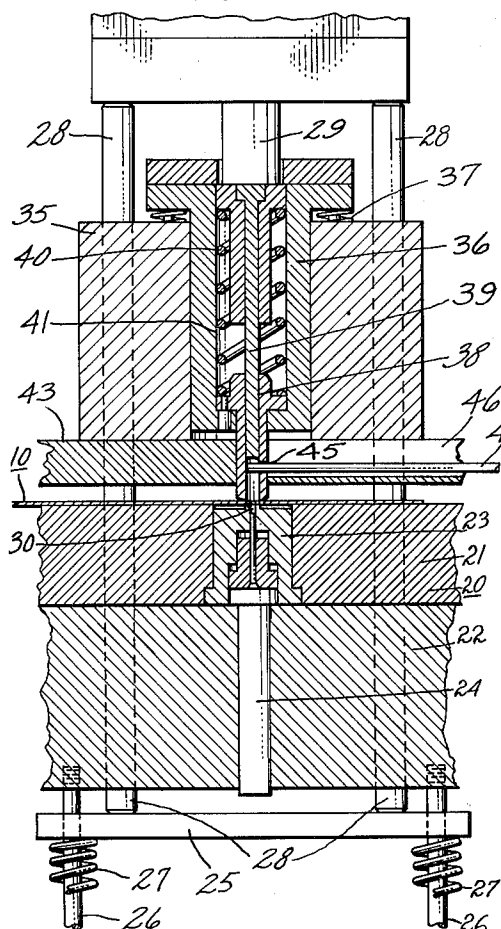


FIG. 5.

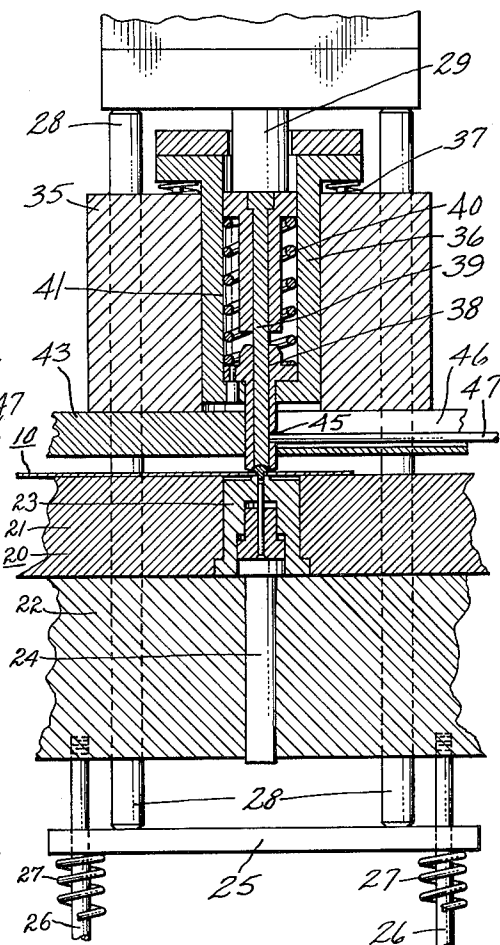


FIG. 6.

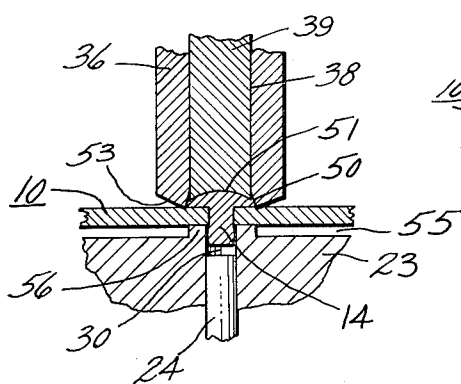


FIG. 7.

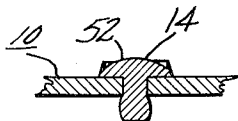


FIG. 8.



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APPARATUS FOR EXTRUDING
SILVER CONTACTS

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Electric Company, a corporation of New York
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10 Claims. (Cl. 207-1)

The present invention relates to a method and machine for automatically attaching silver contacts to metal strip material before it is formed into the contacts for electric switches and circuit breakers.

It has been the practice for many years to make the current-carrying elements of electric switches of copper, brass or Phosphor bronze material. However, under certain high-current conditions an objectionable amount of heating occurs at the contacts which causes the contacting surfaces to oxidize. The presence of oxides on the contacting surfaces caused increased heating of the contacts so that in many cases the contacts became overheated and tended to weld together. The solution has been to form the actual contacting surfaces of a material such as silver, which is not susceptible to overheating on oxide formation.

There are two generally used methods of applying silver contacts to thin strip material. The first method is by welding a small slug of silver to the strip material, and the second method is by taking silver in the shape of a rivet and riveting it in an opening in the strip material. Both methods have proved satisfactory, but they are relatively expensive because they entail a first operation of stamping out the contacts and a second operation of applying the silver to each individual contact.

The principal object of this invention is to provide a high speed machine which will automatically assemble silver contacts to thin strip material for use as electrical switch parts.

A further object of this invention is to provide a die for a standard punch press whereby thin strip material may be fed through the die and silver wire will be cut into short slugs and a portion extruded through openings in the strip material to form silver rivet contacts.

A still further object of this invention is to provide a progressive die for extruding silver contacts on thin strip material so that the silver will not adhere to the clamping member of the die.

A further object of this invention is to provide a die for automatically attaching extruded silver contacts to thin strip material wherein means are provided in the die to prevent the strip material from warping in the area adjacent the silver contact due to the heavy downward blow forming the silver.

The present invention relates to a die that forms part of a progressive die in a standard punch press. This die is designed to extrude a silver contact in each of a series of openings made in a coil of thin strip material. The silver is in the form of a wire that is likewise coiled and fed into the die to provide an automatic machine and method for forming silver contacts on electrical contacting parts. The die includes a worktable on which the strip material is supported. A shallow hole in the table locates the station at which the silver contact is to be applied. As the strip material moves through the progressive die, a series of small circular openings are pierced in the material and each opening is brought in succession to overlie the hole in the worktable. A vertically movable clamping member is arranged above the worktable and normally held in its uppermost position by a series of light springs. The clamping member has a vertical bore directly over the hole in the worktable but of a larger diameter. Located within the bore is a vertically movable plunger that is likewise spring biased to its uppermost po-

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sition. The springs holding the plunger are heavier than those holding the clamping member so that the clamping member will descend first and engage the strip material before the plunger is caused to move toward the strip material.

An aperture is formed in the side of the clamping member and one end of the silver wire extends through the aperture. A vertically reciprocating punch, that moves at a high rate of speed, is caused to engage the plunger on its downward stroke and force the clamping member down onto the strip material. Then the plunger is likewise forced downwardly to cut off a slug of the silver wire and extrude a portion of the silver through the opening in the strip material thereby molding a head and a shank of a silver rivet.

The inner surface of the mouth of the bore in the clamping member is flared outwardly so that it will be possible to raise the plunger and clamping member without lifting the head of the silver contact. Also, the worktable has been recessed in the area slightly removed from the hole in the table whereby the area of the table that directly resists the downward force of the clamping member and plunger is substantially equal to the area included by such members. Means are also provided to release the shank portion of the silver contact from the shallow hole in the worktable so that the strip material may be shifted to its next station for a subsequent forming operation.

My invention will be better understood from the following description taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

FIGURE 1 is a plan view of the strip material illustrating the various steps of operations that are performed on the material as it progresses through the die.

FIGURE 2 is an isometric view of a typical switch sub-assembly having a silver contact applied by the method of this invention.

FIGURE 3 is a cross-sectional view of a die embodying this invention taken at the starting position with the punch in its raised position.

FIGURE 4 is a cross-sectional view similar to that of FIGURE 3 with the die in an intermediate position showing the clamping member engaging the strip material while the plunger is still in a raised position.

FIGURE 5 is a cross-sectional view similar to that of FIGURE 4 after the plunger has descended to mold the head of a silver rivet while extruding the shank of the rivet through the opening in the strip material.

FIGURE 6 is an enlarged cross-sectional view showing in greater detail the relationship of the clamping member, the plunger and the worktable in the formation of the extruded silver rivet.

FIGURE 7 is a cross-sectional view through the strip material showing the condition of the extruded silver rivet after the forming operation of FIGURE 6.

FIGURE 8 is a cross-sectional view similar to that of FIGURE 7 showing the nature of the silver rivet after it is rehit to round off the head and flatten the shank of the rivet.

Referring in detail to the drawings, and in particular to FIGURE 1, there is shown a thin strip material 10 of the nature of copper, brass or Phosphor bronze, and the different operations that are performed on the material to produce the finished part 11 of FIGURE 2. Looking at the top of FIGURE 1, the first operation is a piercing operation that establishes both a rectangular opening 12 and a small circular opening 13 adjacent thereto. In the next operation, a silver rivet 14 is extruded through the opening 13 by the die of FIGURES 3-5. At this point the rivet 14 is in the shape illustrated in FIGURE 7. The next step is to rehit the silver and

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flatten the shank of the rivet into the shape shown in FIGURE 8. Next, a notch 16 is formed in each side of the strip 10 in the area between the rectangular opening 12 and the silver rivet 15. Finally, a longitudinally extending crease 17 is formed in the strip 10, and the finished blade 11 is cut from the strip by severing across the notches 16. It will be understood that the rectangular opening 12 is at the fixed end of the blade 11 so that a terminal means (not shown) may be staked to the blade for supporting the blade in a switch housing.

Consideration will now be given to the design features of the die of FIGURES 3-5. Looking at FIGURE 3, there is shown a horizontal worktable 20 having an upper portion 21 and a lower portion 22. A removable insert 23 is mounted in the table portion 21 for supporting one end of a vertically movable pushrod 24. The lower end of the pushrod 24 extends out through the bottom of the table portion 22. This is done so that a crossbar 25 may be spring biased up against the pushrod 24 to hold the rod normally in an upper position with an end flush with the working surface of the table. The bar 25 is supported on a pair of opposite guide rods 26 and normally held against the bottom of the table portion 22 by means of coil springs 27.

The purpose of the pushrod 24 is twofold. First, in its lowered position of FIGURES 4-6 it establishes a shallow hole 30 in the worktable for receiving the shank portion of an extruded silver rivet; and, secondly, in its upper position it forces the rivet out of the hole so that the strip material may be shifted to another position for a subsequent forming operation. The pushrod 24 is raised by means of the coil springs 27 and it is lowered by gravity after the bar 25 is forced out of engagement with the lower end of the pushrod. Drive pins 28 extend vertically through the worktable 20 and rest on the top of the crossbar 25. The upper ends of the pins 28 extend above the main portion of the die for engagement by the head of a punch 29 that provides the driving force and extrudes the silver into the shape of a rivet. As the punch 29 descends the head of the punch will strike the pins 28 thereby lowering the crossbar 25 and allowing the pushrod 24 to drop to its lower position.

The metal strip 10 is fed intermittently across the working face of the table 20. Each time it is brought to a standstill a circular opening 13 is centered over the shallow hole 30 formed by the pushrod 24 in its lowered position. A stationary block 35 is spaced above the table 20 for supporting a vertically movable clamping member 36 centered over the hole 30 in the table. Light springs 37 bear against the clamping member and normally hold it in its upper position shown in FIGURE 3. A vertical bore 38 is made in the clamping member 36 for receiving a plunger 39. A heavy coil spring 40 is assembled within an enlarged bore section 41 of the clamping member for exerting an upward force on the plunger 39 and normally holding it in an upper position.

Arranged below the stationary block 35 is a removable plate 43 with a vertical opening 44 that guides the lower end of the clamping member 36 in its vertical movement toward and away from the metal strip 10. An aperture 45 is cut through the side of the clamping member 36 and communicates with the vertical bore 38. The plate member 43 is slotted as at 46 so that a silver wire 47 may be fed from the side through the slot 46 and aperture 45 into the bore 38. This is the condition of the die when it is in its at-rest position before the cycle of operation is started.

Attention is now directed to FIGURE 4 which shows an intermediate position of the die. The punch 29 has been brought down to engage the plunger 39. In so doing, the head of the punch 29 will drive the pins 28 against the crossbar 25 to remove the support for the pushrod 24 which will then drop to its lower position and form the shallow hole 30. Since the springs 37 holding up the clamping member 36 are weaker than the coil

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spring 40 supporting the plunger 39, the punch 29 will first cause the clamping member to engage the top surface of the metal strip 10. Only then will the plunger begin to move downwardly in the bore 38. In so doing, the plunger will chop off a slug of the silver wire 47 and drop it over the opening 13 in the metal strip 10.

The downward pressure of the clamping member 36 is large enough to form a tight sealed chamber around the opening 13 so that as the plunger continues its downward movement, a rivet head will be molded in the bore of the clamping member and a portion of the silver slug will be extruded through the opening 13 and into the shallow hole 30 as best seen in FIGURE 6. At this point the die is in the position of FIGURE 5. The force exerted on the silver is so great that as it enters the hole 30 it tends to expand slightly to fasten the rivet 14 in the strip temporarily until it can be rehit to smooth out the head and flatten the shank into the shape 15 of FIGURE 8.

If precautions are not taken, the head of the silver rivet 14 will adhere to the inner surface of the bore 38 of the clamping member. If this happens the rivet will be picked up by the clamping member as the punch 29 is raised, and it will be impossible to feed the metal strip 10 through the die. This condition is especially prevalent when the sides of the bore 38 are parallel. In that event the lead of the silver rivet would exert excessive hoop stresses in the bore of the clamping member and be practically cold-welded therein. The solution has been to flare the inner surface of the mouth of the bore as at 50 thereby molding the side walls of the head into a tapered or beveled edge. Also, the lower end of the plunger 39 is made concave as at 51 which impresses a dished out surface 52 on the top of the head. Of course, the lower end of the plunger could be made flat, or otherwise, depending upon the final shape desired for the silver rivet. Now as the clamping member 36 is raised it discharges the head of the silver rivet to permit freedom of movement of the metal strip 10.

During the extrusion operation of the silver slug a small fraction of the silver will tend to flash out from under the clamping member 36 unless a very tight seal is maintained between the clamping member and the metal strip 10. This condition can be controlled by reducing the area of contact between the clamping member and the metal strip, thereby increasing the pressure and holding the silver within the confines of the flared mouth 50 of the bore. This increase in pressure is obtained by cutting back or chamfering the lower edge of the clamping member as at 53. This leaves a fine line circle of engagement between the clamping member 36 and the metal strip 10 which actually digs slightly into the strip material and establishes a tight seal for the silver.

If the metal strip 10 were placed on a flat surface and struck hard with a hammer, the strip would tend to spring up or warp at the sides where the hammer made its impression. Of course, it is undesirable to have spring blades which are warped and of non-uniform shape. This condition can be avoided by providing substantially the same area of contact below the metal strip as is made above the strip by the plunger and clamping member. Looking at FIGURE 6, the worktable 20 has been recessed as at 55 or relieved in the area slightly spaced from the hole 30 to establish a small ring or flange of material 56 around the edge of the hole 30. Thus, there is an equal and directly opposite reaction provided by the flange 56 to the downward force of the plunger 39. In the event the worktable were perfectly flat, components of the downward force exerted by the plunger would extend to the side of the plunger and into the worktable. These components of sideward force would be resisted by the worktable, but there would be no equal and opposite reaction exerted downward on the metal strip. Hence, the metal strip would naturally fold upwardly and become warped.

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Having described above my invention of a new and improved die for automatically attaching silver contacts to electrical switch parts, it will be readily apparent that I have improved upon the former methods of welding or riveting silver to the contacts by adopting a method of automation at a cost of operation only slightly greater than the raw material. The silver contact is so firmly united to the strip material that there is no possibility of oxidation or corrosion at the interface. The standard punch press with which this invention will be combined operates at approximately 120 strokes per minute rendering 120 subassemblies of switch parts with silver contacts. It should be understood that those methods which are practiced by hand are not always successful when carried over into mass production processes using high speeds and large forces and pressures for forming the material.

Modifications of this invention will occur to those skilled in this art, and it is to be understood, therefore, that this invention is not limited to the particular embodiments disclosed, but that it is intended to cover all modifications which are within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A die for a high speed punch press to automatically attach a silver contact in a series of openings formed in a metal strip of electrically conductive material, the die comprising a worktable with a shallow hole, the metal strip being fed across the table intermittently with the openings in the strip being brought to overlie the hole in the table so that the silver contact may be assembled therein, an upright clamping member arranged above the table and normally spring biased to a position above the table which will enable the strip material to move across the table, the clamping member having a vertical bore centered over the hole in the table, and a plunger vertically movable within the bore of the clamping member, spring means within the clamping member holding the plunger in a raised position, and an aperture in the side of the clamping member that communicates with the vertical bore and is below and in the path of movement of the plunger when the plunger is in its raised position, a silver wire being fed through the aperture, and a punch located above the clamping member and capable of vertical reciprocating motion whereby in its downward stroke it will engage the said plunger and lower the clamping member onto the strip material and then force the plunger downwardly to cut off a slug of the silver wire and extrude a portion of the slug through the opening in the strip material thereby forming a head and a shank of a silver rivet, the worktable being slightly recessed in the area slightly removed from the hole in the table to form a flange around the hole in the table that does not extend beyond the dimensions of the area of contact of the downward forces exerted by the plunger and clamping member so as to provide an equal and opposite reaction to these downward forces.

2. A die as recited in claim 1 wherein the inner surface of the mouth of the vertical bore of the clamping member is flared outwardly so that the opposite sides of the head of the silver rivet will not be parallel and tend to adhere to the clamping member.

3. A die as recited in claim 2 wherein the bottom surface of the clamping member is chamfered to form a thin circular clamping surface with the flared inner mouth of the bore, the outer diameter of this clamping surface being substantially equal to the outer diameter of the flange on the worktable.

4. A die as recited in claim 3 wherein the said worktable contains a vertically movable pushrod that forms the bottom portion of the hole in the table, the pushrod in its uppermost position being flush with the top of the table so as to raise the shank portion of the silver rivet out of the table and enable the strip material to be shifted to another position for a subsequent forming operation,

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spring means for normally holding the pushrod in its upper position, and means to lower the pushrod against the action of its springs as the said punch descends toward the plunger so that the hole in the worktable will be present before the silver slug is extruded through the opening in the metal strip.

5. A die for use in a punch press to automatically extrude a silver contact through a series of spaced openings in a metal strip, the die comprising a worktable having a shallow hole that is slightly larger in diameter than the size of the openings in the strip material, each opening in the strip being positioned in succession over the hole in the table for receiving the silver contact, a strip clamping member supported for vertical movement above the table and normally spring biased to its uppermost position so that the strip material may be fed across the worktable, the clamping member having a vertical bore that is centered over the hole in the table and of a larger diameter than the said hole, a spring biased plunger assembled in the vertical bore and movable between two extreme positions, the springs acting against the plunger being stronger than the springs holding the clamping member in the upper position, and a punch held above the plunger and capable of vertical reciprocating motion whereby the punch will engage the plunger and lower the clamping member until it engages the strip material, whereupon the plunger will begin to move relative to the clamping member and toward the strip material, and an aperture in the side of the clamping member through which a silver wire is fed into the path of movement of the plunger so that the plunger will cut off a slug of silver as the plunger descends toward the strip material to extrude a portion of the silver through the opening in the strip material that results in a silver rivet with a head and a shank portion.

6. A die as recited in claim 5 wherein the inner surface of the mouth of the vertical bore of the clamping member is flared outwardly so that the head of the silver contact will not adhere to the inner walls of the bore.

7. A die as recited in claim 6 wherein the worktable is recessed in the area slightly spaced from the hole in the table, there being a ring formation around the edge of the hole of similar over-all dimensions to the area of contact included by the plunger and clamping member where the downward force is exerted on the strip material, so that the reaction force exerted by the table is equal and directly opposite to the downward force exerted by the plunger and clamping member.

8. A high speed die for automatically attaching extruded silver contacts in a series of openings in a metal strip, the die comprising a worktable that supports the strip as the strip is intermittently fed through the die, a shallow hole in the table over which each opening in succession is centered for the application of the silver contact, a spring biased clamping member that is normally raised above the table and may be driven down into a strip clamping position centered around the said opening, the clamping member having a vertical bore that carries a plunger that is normally spring biased toward the upper end of the clamping member and is automatically movable toward the lower end after the clamping member engages the strip, an aperture through one side of the clamping member and communicating with the said bore below the lower end of the plunger when the plunger is in its upper position, a silver wire extending through the aperture and being fed into the bore whenever the plunger moves upwardly to uncover the aperture, whereby the clamping member may be driven into clamping relation with the strip material and the plunger forced to cut off a slug of the wire and extrude a portion of the slug through the opening in the strip, the remaining portion of the slug forming a head within the said bore, the inner surface of the mouth of the bore of the clamping member being flared outwardly so that the head of the contact will not become attached to the bore of the clamping member.

9. A die as recited in claim 8 wherein the reciprocable clamping member is normally held in a raised position above the worktable by relatively weak springs, the bore of the clamping member containing a relatively strong spring that holds the plunger normally in a raised position, and a punch that may be brought down to engage the said plunger and compress the first-mentioned weak springs until the clamping member engages the strip material, further movement of the punch causing the plunger to compress the strong spring and shear the wire to extrude a silver slug through the opening in the strip material.

10. A die as recited in claim 9 wherein said worktable includes a vertically movable pushrod, the lower position of the pushrod establishing said shallow hole in the worktable over which each opening in the strip material is centered, the pushrod when raised serving to lift the strip material and eject from the worktable the lower portion of the silver slug that has been extruded through the opening of the strip material, whereby the strip material may be shifted to another position for subsequent forming operations, said pushrod being normally spring biased to its uppermost position with its upper end flush with the supporting surface of the worktable, and connecting means directly engageable by the punch as the punch approaches said plunger, said means serving to lower the pushrod against the action of its spring biasing,

before the slug of silver is extruded through the metal strip.

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