

Nov. 16, 1954

J. W. FULTON ET AL
CONTACT PIN CRIMPING MACHINE

2,694,433

Filed Aug. 22, 1950

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Fig. 1.

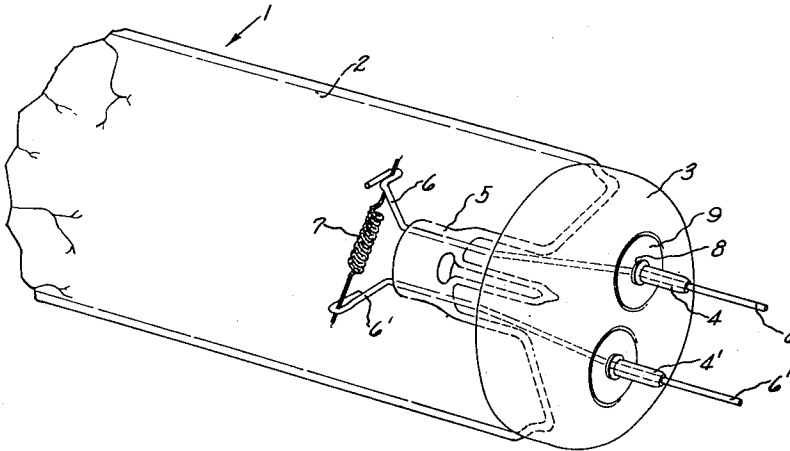
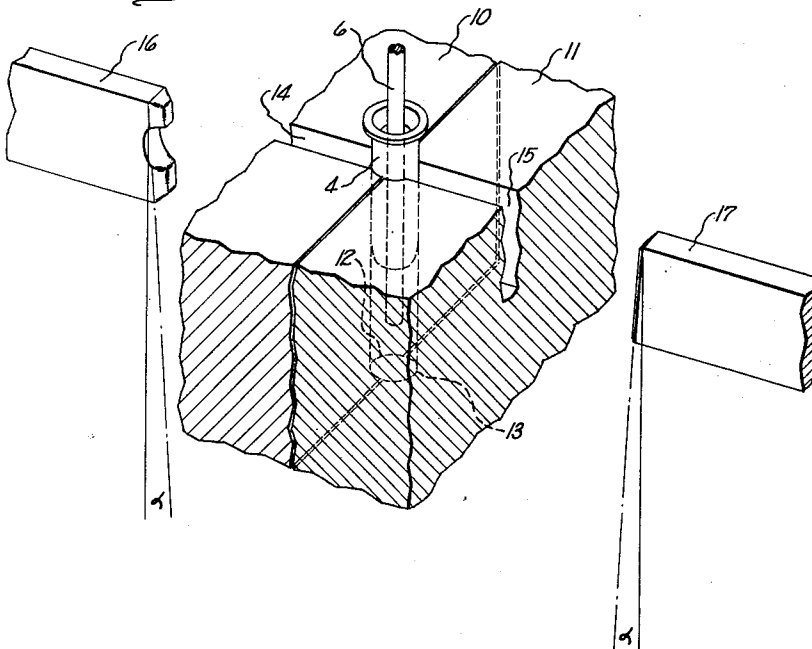


Fig. 2.



Inventors:
John W. Fulton,
Robert A. Kuebler,
by *Vernett C. Kauffman*
Their Attorney.

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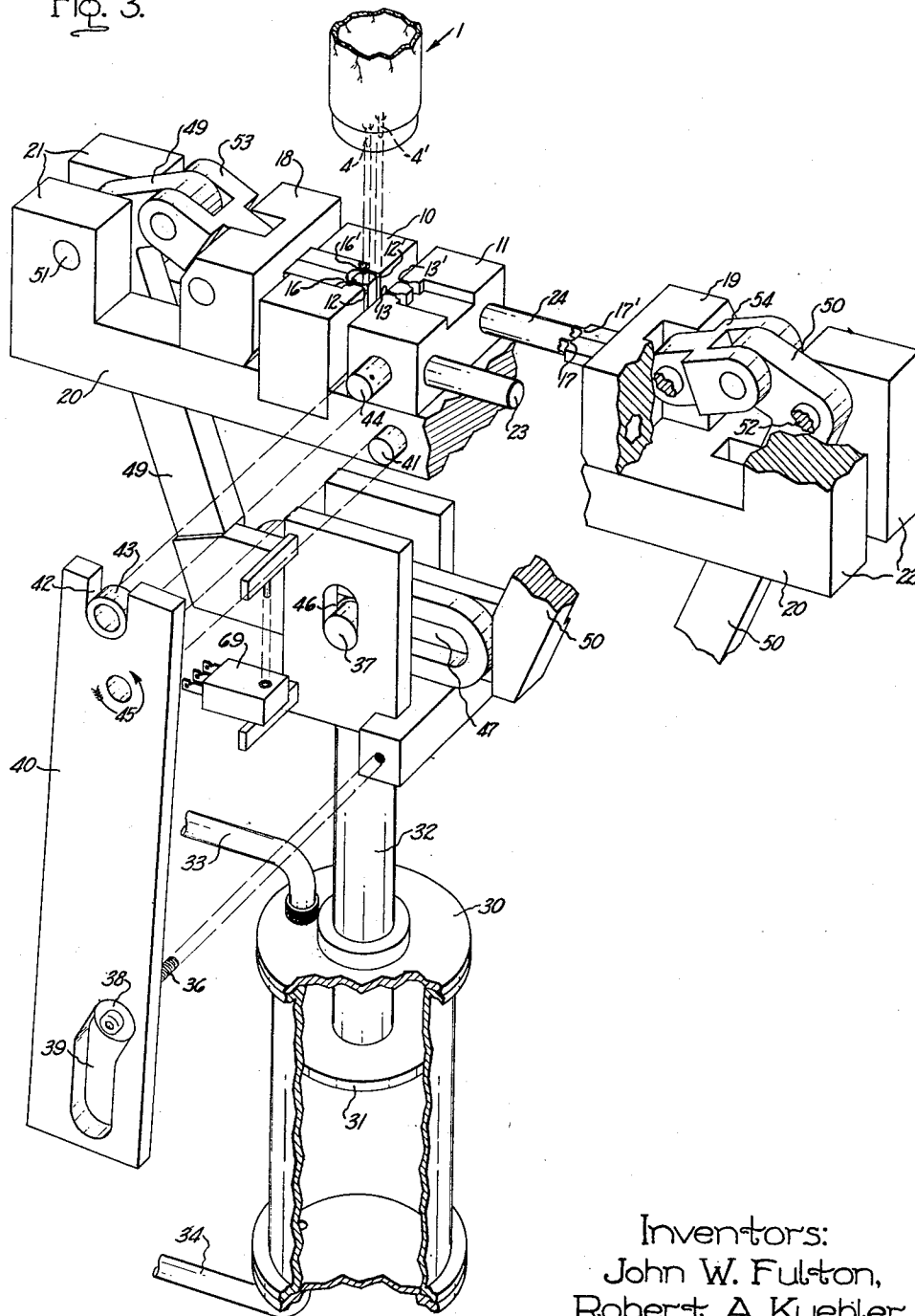
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Fig. 3.



Inventors:
John W. Fulton,
Robert A. Kuebler,
by *Vernett C. Kauffman*
Their Attorney.

Nov. 16, 1954

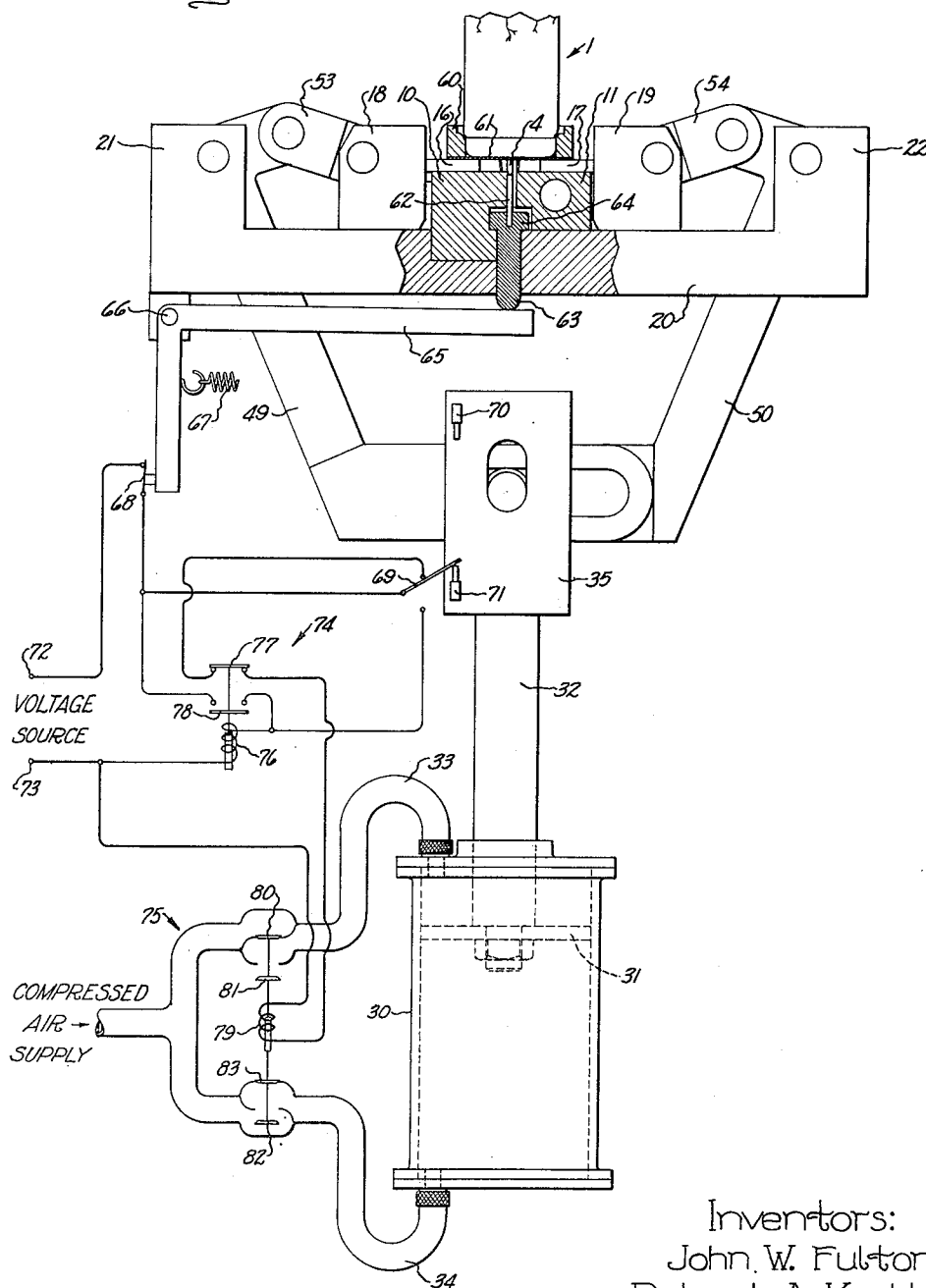
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FIG. 4.



Inventors:
John W. Fulton,
Robert A. Kuebler,
by *Vernett C. Kauffman*
Their Attorney.

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2,694,433

CONTACT PIN CRIMPING MACHINE

John W. Fulton, Chardon, and Robert A. Kuebler,
Cleveland Heights, Ohio, assignors to General Electric
Company, a corporation of New York

Application August 22, 1950, Serial No. 180,819

3 Claims. (Cl. 153—1)

This invention relates generally to the manufacture of outside terminal connectors for electric discharge devices such as fluorescent lamps and radio tubes, and more particularly to an automatic machine for making a solderless contact pin assembly wherein a tubular pin is crimped over a lead wire threaded through its bore.

In the manufacture of electrical devices requiring an outside connector for a lead wire penetrating into the device through a seal, it has generally been the practice to utilize brass pins and to make a soldered joint between the lead wire and the pin. Although such soldered contact pin connector assemblies are generally satisfactory, they are relatively expensive due to the large amount of manual labor involved.

In the copending United States patent application of Robert A. Kuebler, Serial No. 180,818, filed August 22, 1950, entitled Crimped Contact Pin Assembly, and assigned to the same assignee as the present invention, there is disclosed a solderless contact pin and lead wire assembly wherein the pin is crimped by longitudinal tapered indentations on opposite sides. This assembly has the decided advantages that the general outline of the pin is not distorted as a result of the crimping operation, the strength of the pin is equal to or superior to that of a soldered pin, and a cheaper material such as aluminum, which is not readily soldered, may be used for the pin.

The general object of this invention is to provide new and improved apparatus for making a crimped contact pin to lead wire assembly.

The specific object of the invention is to provide a power actuated machine for automatically making the crimped contact pin assemblies described in the above-mentioned copending application.

In accordance with the invention, there are provided a pair of movable compression dies having semicylindrical grooves cut into their adjacent faces for defining a cylindrical cavity in which the pin is confined when the dies are moved into apposition. Narrow slots are cut into the compression dies in a direction parallel to their paths of movement and abutting against the semicylindrical grooves. A pair of indenting punches move through the slots for crimping the pin to the lead wire by means of corresponding indentations on opposite sides of the pins. The confining dies prevent any distortion of the pin during the crimping operation and, in the case of pins formed from sheet metal and having a longitudinal seam, prevent any splitting of the pins along the seam. In the preferred form of our invention, the indenting punches have sloping faces for providing a deeper indentation at the outer end of the pin than at the inner end and one of the punches is split near its center. A slope is provided in order to cause a flow of metal in the lead wire from the outer to the inner end of the pin, which flow lengthens the lead wire in the direction of the seal thereby preventing breakage of the seal. The compression dies and the indenting punches are preferably power actuated and automatically controlled in a manner to be more fully described hereinafter.

For further objects and advantages and for a better understanding of the invention, attention is now directed to the following description and accompanying drawings. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawings, wherein like reference numerals refer to corresponding parts in the different figures:

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Fig. 1 is a pictorial representation of one end of a fluorescent lamp of a well-known commercial type.

Fig. 2 is a pictorial sectionalized view illustrating the essential features of the compression dies and indenting punches in accordance with the preferred embodiment of our invention.

Fig. 3 is a pictorial view of an automatic contact pin crimping machine constituting the preferred embodiment of our invention. Portions of the machine have been cut away, and other portions have been exploded in order to provide a more readily understood illustration.

Fig. 4 is a simplified representation, partly schematic in form, illustrating the electrical and mechanical control apparatus utilized in conjunction with the machine of Fig. 3, for effecting automatic operation thereof.

Referring to Fig. 1, there is shown an end of a commercial fluorescent lamp 1 of conventional design, comprising a glass envelope 2 having its extremities slightly reduced in diameter for the securing thereto of a cup-shaped base 3 to which the contact pins 4 and 4' are anchored. Envelope 2 has a re-entrant stem portion which is flattened at its inner end into a press 5 through which pass the filament mounting and lead-in wires 6 and 6'. A filament 7, which may be the usual tungsten wire coil coated with activated electron-emitting materials, is mounted transversely across the ends of the wires 6, 6' within the envelope 2.

The end cap or base 3 is usually formed of some thin metal such as brass or aluminum; and, accordingly, it is necessary to provide some means for insulating the pins 4 from the base. This is achieved by mounting the pins through oversize holes in the base and providing insulating washers on both sides of the hole for locating the pin. Pin 4 is provided with an annular flange or ridge 8 which seats against the outer insulating washer 9 and has a corresponding flange seating against another similar washer on the inner side of the base 3. Thus, the pin is firmly anchored and, at the same time, insulated from the metal of the base 3. The external portions of the lead wire 6, 6' are pulled through the bore of the pins and are normally cut off flush with their ends.

In the usual manufacturing operations, it is necessary to pull up the lead wires through the pins in order to obviate any possibility of mutual contact of the lead wires 6 and 6' under the base. In practice, the lead wires are pulled up sharply so that they are taut and no slackness is left in the wires between the seals in the press 5 and the contact pins 4. As a result, it is necessary to insure that no stretching of the lead wires away from the seals occurs during the crimping since, otherwise, either the seal through the press or the lead-in wire will be broken.

Referring to Fig. 2, there is shown in simplified pictorial outline a preferred apparatus for crimping the contact pin 4 and lead wire 6 and achieving the assembly described in the above-mentioned copending application. The apparatus comprises a pair of relatively movable compression dies 10 and 11 having corresponding semicylindrical grooves 12 and 13 cut into their adjacent or contacting faces. When the dies 10 and 11 are brought together, these grooves form a cylindrical cavity wherein the pin 4 is confined and which prevents any distortion of the pin during the subsequent indenting or crimping operation. Slots 14 and 15 are cut into dies 10 and 11, respectively, in a plane normal to their contacting faces, and located to abut on the semicylindrical grooves 12 and 13, respectively. Slots 14 and 15 form channels through the compression dies for allowing the inward movement of a pair of punches 16 and 17 against the pin 4, thereby to crimp it and achieve the required indentation on opposite sides thereof.

The indenting faces of the dies 16 and 17 are shaped like blunted wedges with slightly rounded corners, of which the forward faces slope upwardly away from the vertical longitudinal axis of the pin. The angle of slope or inclination of the forward faces of the punches has been denoted by α in the drawing; and, in practice, we have found that this angle may be approximately 6° for the common fluorescent lamp pin which is approximately $\frac{1}{4}$ " long and $\frac{3}{32}$ " in diameter. The purpose of

the sloping faces on the indenting punches is to initially grip the lead wire 6 in the pin 4 at the bottom or outer end of the pin. Thereafter, the lead wire metal flows upward through the bore of the pin as the crimping operation progresses; and the lead wire is thus stretched back towards the seal. This insures that the portion of the lead wire between the pin and the seal is lengthened rather than shortened and thus obviates any tendency towards either breaking of the wire or the seal of the glass envelope of the lamp.

In addition to the features which have been described whereby the front face of the punch of the indenting punch slopes away from the axis of the pin, one of the punches, namely 16' in the drawing, is slotted near its center so that, in fact, the face of the punch has two wedge-shaped portions spaced slightly apart. This configuration causes a pocketing of the material of the pin between the two indentations during the crimping operation. The metal of the lead wire thereupon lumps under the pocket and insures positive locking of the lead wire in the pin. This prevents any longitudinal sliding of the lead wire in the pin even though it should subsequently split along the seam. The character and advantages of the resulting pin configuration are more fully explained in the above-mentioned copending application.

Referring to Fig. 3, there is shown a machine into which the basic combination of the compression dies and indenting punches shown in Fig. 2 is incorporated for power actuation thereof and automatic crimping of contact pins. The moving parts of the machine are supported on a bed plate or base 20, which is formed into split bearing blocks 21 and 22 at either end. The left compression die 10 is securely anchored to the bed plate 20 with its front face coinciding with a transverse plane through the center of the bed plate. The right compression die 11 is mounted with its front face facing the die 10 and is adapted to slide on two dowel pins 23 and 24 which are clamped in compression die 10. The indenting punches 16 and 17 and, likewise, the corresponding pair 16' and 17' are mounted on steel blocks 18 and 19, respectively. These steel blocks are likewise adapted to slide on the bed plate 20 and are maintained in alignment by the dowel pins 23 and 24. It will be understood that the dowel pins project the required distances on both sides of compression die 10 to guide blocks 11 and 19 on the right-hand side and block 18 on the left-hand side for the full length of their path of movement.

The rearward sides along with the top faces of compression dies 10 and 11 are machined out into suitably shaped channels or slots for allowing the movement of the rectangular body portions of the punches 16—16' and 17—17', respectively. The front faces of the blocks or compression dies 10 and 11 contain a pair of semi-cylindrical grooves 12—12' and 13—13' which, upon movement of the blocks 10 and 11 into apposition, constitute the cylindrical cavities for confining the pins 4—4' of the fluorescent lamp 1. A broken lower section of lamp 1 is shown in the drawing in a position immediately above that which it occupies during the crimping operation of the machine. It will be understood that for the actual crimping operation, the lamp is lowered vertically so that the pins 4—4' fit into the grooves 12—13 and 12'—13', respectively.

The remainder of the machine is concerned with effecting the power actuation of the compression dies and indenting punches and with automatic control thereof. The necessary sequence of operations for crimping the pins of the lamp comprises, firstly, moving the compression die 11 against the stationary compression die 10 in order to form the semi-cylindrical cavities which grip the pins 4—4' and prevent any distortion thereof; secondly, moving the punch blocks 18 and 19 forward against the compression dies in order to allow the punches 12—12' and 13—13' to indent the pins on opposite sides thereof; thirdly, withdrawing the indenting punches; and fourthly, withdrawing the movable compression die 11 in order to release the pins and permit withdrawal of the lamp. It will be understood that many modifications may be made in the mechanism for performing these four operations in the proper sequence. That which will now be described utilizes a single pneumatic air cylinder with suitable linkages for effecting all four operations and constitutes a preferred embodiment of our invention.

The pneumatic air cylinder which provides the force necessary for actuating the mechanism is shown at 30,

and it will be understood that the front side portion thereof has been broken away in the drawing. A piston 31 mounted on a rod 32 is adapted to move vertically up and down in the cylinder 30, the movement being controlled by the admission of compressed air either above the piston through the inlet pipe 33 or below the piston through a similar inlet pipe 34. The rod 32 of the air cylinder carries a yoke or crosshead 35 which supports a pair of pins 36 and 37 mounted transversely thereon.

The elements associated with pin 36, which are shown in a so-called exploded view to the front of the machine, cause the actuation or movement of the compression die 11 against the stationary compression die 10. It will be understood that these elements are duplicated on the rearward side of the machine in order to apply a balanced force to the movable die 11. The transverse pin 36 carries a roller 38 at its end which rides in a slot or cam track 39 cut into a lever 40. This lever is pivoted on a pin 41 fixed to the bed plate 20 and engages at its upper end in a cam track 42 a roller 43, which is mounted on a pin 44. Pin 44, in turn, is fixed to the movable compression die 11 for forcing it either towards or away from the stationary compression die 10.

The air cylinder starts its active stroke from its uppermost position, and the roller 38 riding in the cam track 39 immediately causes a movement of the lower portion of lever 40 to the right. This causes lever 40 to pivot about pin 41 in the sense shown by the arrow 45 and, in turn, causes movable compression die 11 to advance to the left and press firmly against the forward face of stationary compression die 10. The movement of compression die 11 continues while roller 38 is in the upper inclined portion of the cam track 39. As soon as roller 38 has entered the straight vertical portion of the cam track, the movement of compression die 11 ceases, and it is simply held in fixed contact with compression die 10. The straight vertical portion of the slot 39 may thus be considered as a lost motion arrangement for taking care of the excess movement of air piston 31 which is necessary for effecting the operation of the indenting punches 16 and 17.

The second transverse pin 37 carried by the yoke 35 rides in a pair of lost motion slots 46, 46' in the yoke and engages slot 47 in toggle link 49 and a similar slot in toggle link 50. These toggle links are hinged on the bed plate 20 of the machine through pins 51 and 52 mounted in the bearing blocks 21 and 22, respectively. The upper ends of the toggle links 49 and 50 carry connecting links 53 and 54 which provide the necessary coupling for causing the movement of blocks 18 and 19 carrying the indenting punches 16 and 17, respectively.

At the point in the air cylinder travel where the roller 38 enters the straight portion of the cam track 39 and the movement of the compression die 11 ceases, the pin 37 engages the upper faces of the lost motion slots 46, 46' and begins to carry the toggle links 49 and 50 downward. The slots 47 and 48 in the toggle links permit this movement, and the toggle links thus pivot about the pins 51 and 52 with respect to the bed plate 20. The pivoting of the toggle links 49 and 50 causes corresponding movements of the connecting links 53 and 54 which cause blocks 18 and 19 to slide towards the compression die blocks on the dowel pins 23 and 24. The punches 16—16' and 17—17' operating in the slots in the die blocks thereupon indent the pins of the lamp to make a permanent joint with the lead wires in the manner previously described and more fully explained and illustrated in the copending application No. 180,818 of Robert A. Kuebler.

As soon as the air cylinder has reached the bottom of its stroke, the supply of compressed air is removed from inlet pipe 33 and is connected to inlet pipe 34 in order to return the piston 31 to its uppermost position and to operate the indenting punches and compression dies in reverse order to that which has just been described. The supply of air to the air cylinder may be controlled by the operator. However, we have found it highly advantageous to mechanize the whole operation so that immediately lamp 1 is inserted in the slots 12—12', 13—13', the whole operation takes place without further action or supervision on the part of the operator. This automatic operation is brought about by means of an electromechanical system which controls the compressed air supply and which is more readily understood by reference to Fig. 4.

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Referring to Fig. 4, the crimping machine is shown in a somewhat simplified sectional view with certain parts removed in order to facilitate showing the control system for achieving automatic operation. The machine, as shown, has a lamp 1 mounted in the crimping position; and the electrical system is energized for actuating the air cylinder. In order to facilitate locating the pins 4—4' of the lamp 1 in the semicylindrical grooves in the compression dies 10 and 11, a guide member or collar 60 is located immediately above these grooves and has a suitably shaped bottom plate 61 for guiding the pins.

When the lamp is properly positioned, the lamp pins 4—4' bear against a pair of receiving pins 62—62' which are mounted on a plunger 63 located immediately below the cylindrical cavities formed when the compression dies 10 and 11 are forced together. The receiving pins may be shaped to force the lead wires a short distance back into the pins in order to cover up any sharp ends. Plunger 63 is normally pushed up to the top of the cavity 64 by means of a bell crank 65 which is hinged at 66 and biased by means of a spring 67. The bell crank 65 actuates a suitable switch 68 whenever the lamp is positioned within the collar or guide 60.

The machine is controlled by means of the switch 68 mentioned above and a second switch 69 which is actuated between one of two positions by means of projecting arms 70 and 71 on the yoke 35. These switches are preferably of the type commonly known as micro-switches having the general appearance shown at 69 in Fig. 3. Switch 68 is normally open and closes when actuated; switch 69 closes on the side to which it is actuated and remains so until further actuation. The electrical circuit is energized from a suitable voltage source connected across the terminals 72—73 and comprises, in addition to switches 68 and 69, a relay 74 and an electromechanical air valve 75. Relay 74 comprises an operating coil 76, a pair of normally closed contacts 77 and a pair of normally open contacts 78. Air valve 75 comprises an operating coil 79, a normally closed air inlet valve 80 and a normally open air exhaust valve 81 associated with supply tube 33, and a normally open air inlet valve 82 and a normally closed air exhaust valve 83 associated with inlet tube 34. The circuit connections may more readily be understood by referring to the manner of operation of the apparatus, which form of presentation will henceforth be followed.

The machine, along with the associated control apparatus, is shown in the position occupied immediately upon the insertion of a lamp within the guide 60 but before the relay 74 and the air valve 75 have had time to operate. When switch 68 is closed by the depression of plunger 63, a circuit is completed through switch 68, the upper contact of switch 69, the normally closed contact 77 of relay 74, and the operating coil 79 of air valve 75. The air valve is thus energized and its armature moves upwards, thereby opening valve 80 and closing valve 82, the associated exhaust valves 81 and 83 being respectively closed and open. Compressed air is thus admitted to the top side of piston 31 within the cylinder 30, and forces the piston 31 downward. The movements of the compression dies 18 and 19 and of the indenting punches 16 and 17 thereupon occur in the manner which has been described earlier.

At the bottom of the stroke of piston 31, the stop pin 70 and the yoke actuates switch 69 and opens the upper contact while closing the circuit through the lower contact. As a result, relay 74 is energized while the air valve 75 is simultaneously de-energized. The energization of relay 74 breaks the circuit to operating coil 79 of the air valve through the upper contact 77 and prevents this circuit from being completed as long as the relay remains energized. The lower contact 78 of the relay at the same time completes an auxiliary holding circuit which may be traced from terminal 72 through switch 68, contact 78, operating coil 76, and back to terminal 73. This auxiliary holding circuit will maintain switch 74 energized as long as switch 68 remains closed. The air valve 75 having been de-energized, the compressed air supply is now connected to the lower side of piston 31 in air cylinder 30, and yoke 35 is carried upward, back to the rest position. The indenting punches 16 and 17 and the compression dies 18 and 19 are thus retracted, and lamp 1 may be removed from the socket 60. However, as long as lamp 1 remains in the socket with the plunger 63 depressed, switch

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68 remains closed and the holding relay 74 remains energized. Thus, no further operation of the machine can occur even though the operator should forget to remove the lamp from the socket immediately after the crimping operation. When the lamp 1 is removed, switch 68 is opened, relay 74 is de-energized, and the apparatus is now in its rest position ready to operate on another lamp whenever it may be inserted in the socket 60.

It will be understood that a certain number of elements have been omitted from the description of the machine of Figs. 3 and 4 in order to simplify the explanation and facilitate an understanding of its manner of operation. Thus, it will readily be realized that, in practice, suitable bearings are provided for the different pins and rollers and also that means are provided to permit fine adjustments of the different operating levers in order to obtain exactly the right pressure and movement on the indenting punches and on the confining dies. These adjustments are necessitated by the fact that different indenting pressures may be required, depending upon the metal whereof the pins 4 are made. For instance, considerably less pressure is required to indent aluminum pins than is required to indent similar pins made of brass.

While a certain specific embodiment has been shown and described, it will of course be understood that various modifications may be made without departing from the spirit of the invention. Thus, various modifications may be provided in the mechanism for energizing the dies and punches; and, likewise, even with the machine which has been described, modifications of the control apparatus are also possible for providing the same or different operating characteristics. The appended claims are therefore intended to cover any such modifications coming within the true scope of the invention.

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

1. A crimping machine for tubular contact pins having a wire internally threaded therethrough, comprising a bed plate, a pair of compression dies, one fixed and the other slidably mounted on said plate, grooves in the adjacent faces of said dies defining a cavity for gripping said pin when said dies are forced together, slots in said dies parallel to their direction of movement and terminating in said grooves, punches adapted to advance through said slots for indenting said pin on opposite sides, a crosshead reciprocable perpendicularly to said bed plate, a linkage comprising a lever pivoted on said bed plate and engaging said slidable die and a portion of said crosshead for actuation thereby, and toggle linkages between said punches and said crosshead, said linkages including lost motion means allowing actuation of said dies for gripping said pin previous to actuation of said punches.

2. A crimping machine for tubular contact pins having a wire internally threaded therethrough, comprising a bed plate, a pair of compression dies, one fixed and the other slidably mounted on said plate, grooves in the adjacent faces of said dies defining a cavity for gripping said pin when said dies are forced together, slots in said dies parallel to their direction of movement and terminating in said grooves, punches adapted to advance through said slots for indenting said pin on opposite sides, a crosshead reciprocable perpendicularly to said bed plate, a linkage comprising a lever pivoted on said bed plate and having one portion engaging said slidable die and another portion engaged by said crosshead and including lost motion means to achieve positive actuation of said slidable die followed by holding thereof in its actuated position during first and second parts, respectively, of the motion of said crosshead, and toggle linkages between said punches and said crosshead including lost motion means to achieve holding of said punches in their unactuated positions followed by positive actuation thereof during first and second parts, respectively, of the motion of said crosshead.

3. A crimping machine for tubular contact pins having a wire internally threaded therethrough, comprising a bed plate, a pair of compression dies, one fixed and the other slidably mounted on said plate, grooves in the adjacent faces of said dies defining a cavity for gripping said pin when said dies are forced together, slots in said dies parallel to their direction of movement and terminating in said grooves, punches adapted to advance

through said slots for indenting said pin on opposite sides, a crosshead reciprocable perpendicularly to said bed plate, pneumatic means actuating said crosshead, a linkage comprising a lever pivoted on said bed plate and having one portion engaging said slidable die and another portion engaged by said crosshead and including lost motion means to achieve positive actuation of said slidable die followed by holding thereof in its actuated position during first and second parts, respectively, of the motion of said crosshead, and toggle linkages between said punches and said crosshead including lost motion means to achieve holding of said punches in their unactuated positions followed by positive actuation thereof during first and second parts, respectively, of the motion of said crosshead, a plunger located below said dies and actuated upon insertion of a contact pin into the space between said dies, a switch actuated by said plunger, and an electrically controlled fluid valve for

said pneumatic means, said valve having a control coil in circuit with said switch.

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