

Dec. 15, 1959

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2,917,099

TERMINAL ATTACHING MACHINE

Filed Feb. 7, 1958

3 Sheets-Sheet 1

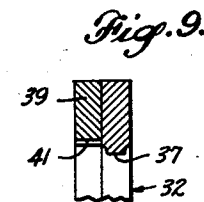
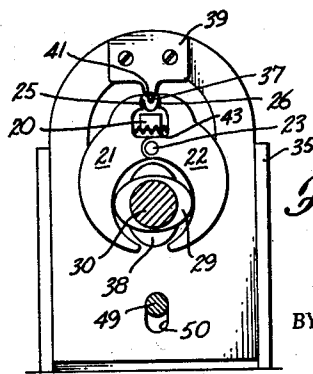
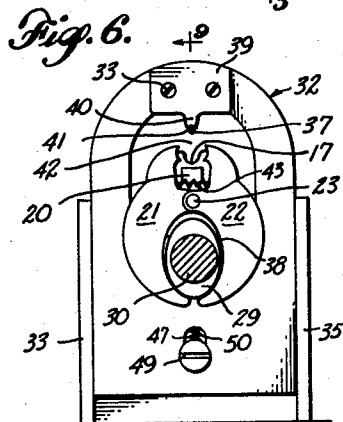
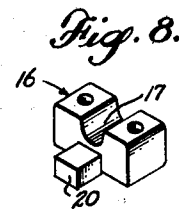
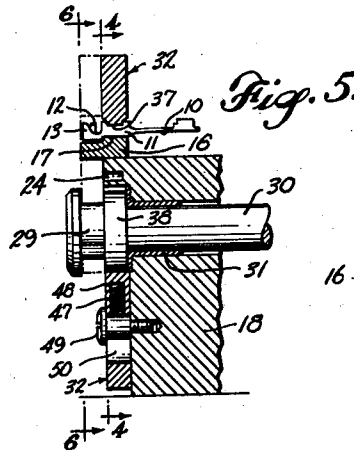
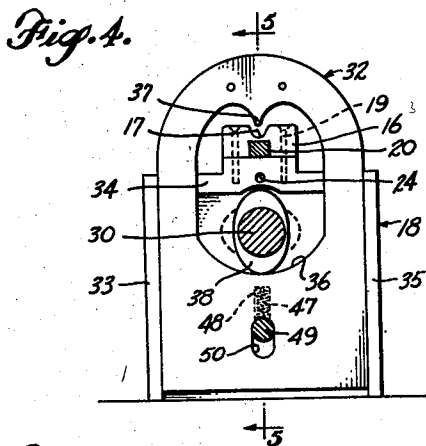
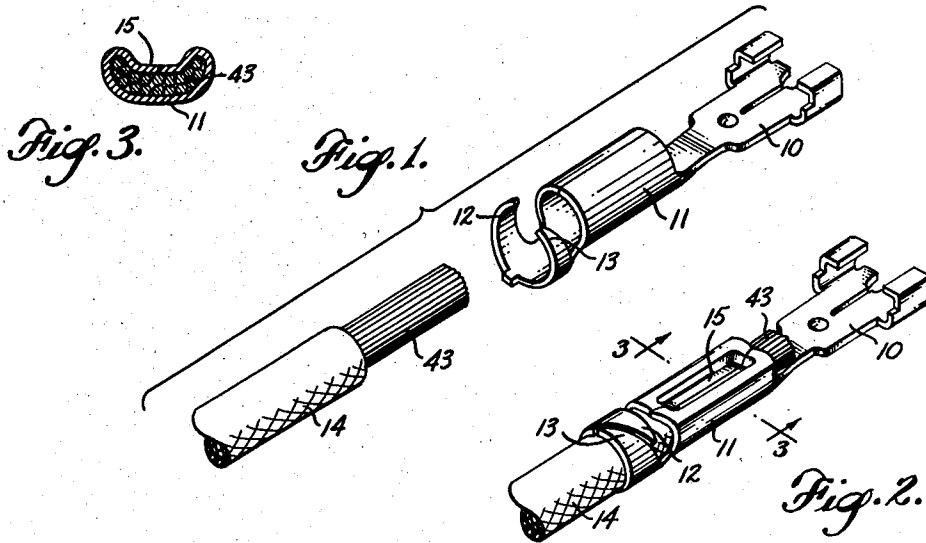


Fig. 7.

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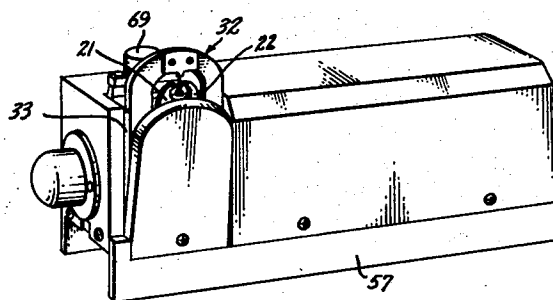
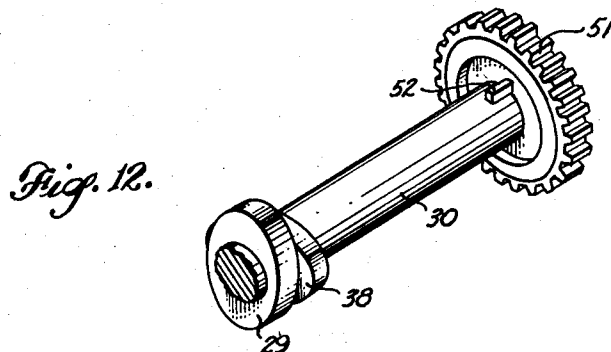
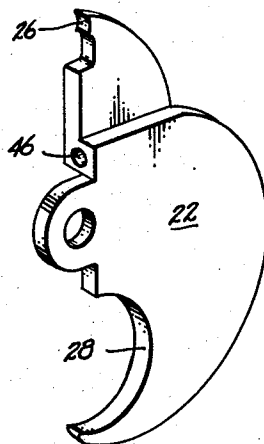
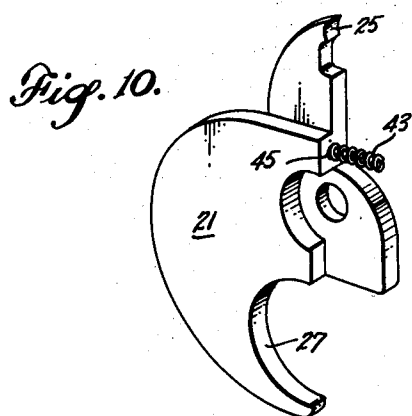
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3 Sheets-Sheet 3

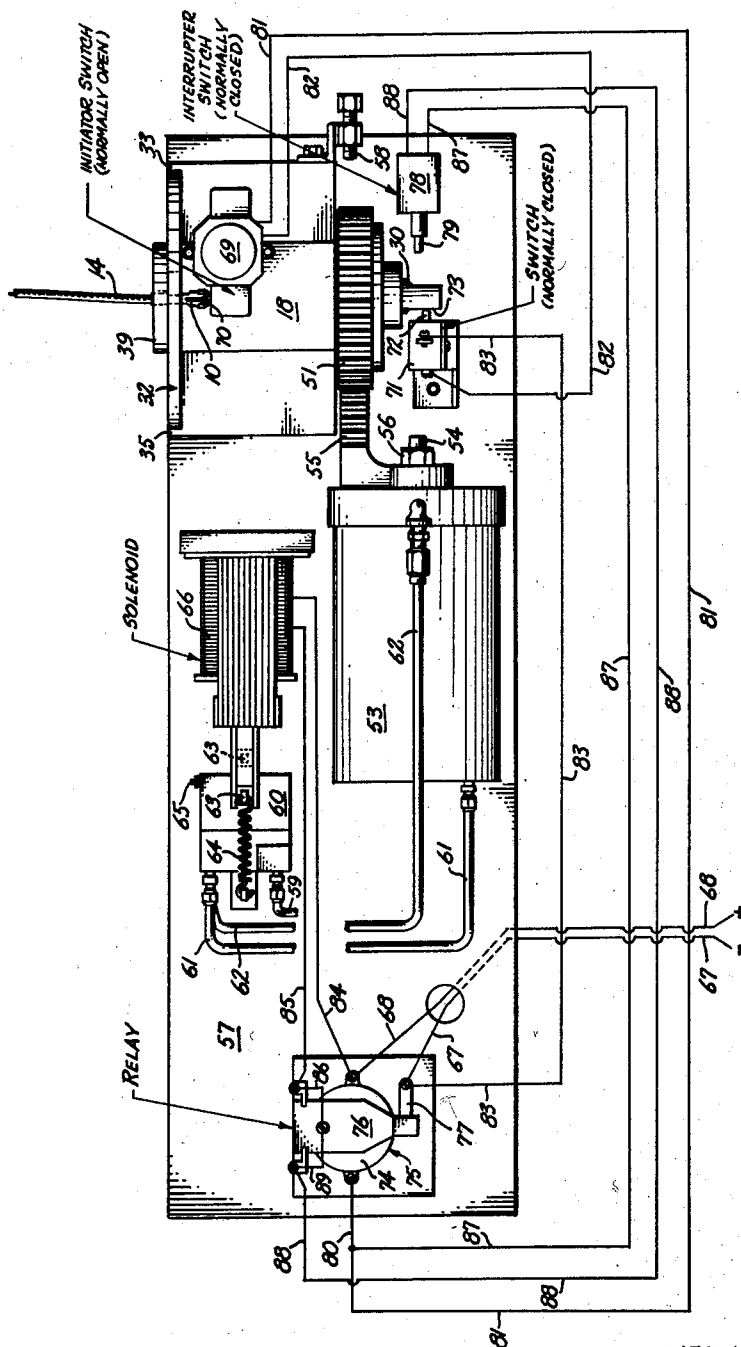


Fig. 13.

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2,917,099

TERMINAL ATTACHING MACHINE

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1 Claim. (Cl. 153—1)

This invention relates to a machine for firmly securing the sleeve of a pre-formed electrical terminal or connector to the bared end of an electrical conductor in a manner which assures good electrical contact between the two.

A specific embodiment of this invention is a machine which includes a plurality of cooperating swaging jaws which define a terminal swaging region, the jaws being power operated to perform their swaging and terminal attaching function in response to the insertion of a terminal into such swaging region.

Important object of the invention are to provide a machine which will firmly and conductively secure terminals and connectors to cable ends as fast as such terminals or conductors are fed into the machine by an operator; which provides safety for the operator; and which is so constructed that a separate operator actuated hand or foot control is eliminated.

The invention together with other objects will be more clearly understood when the following description is read in connection with the accompanying drawings, in which

Figs. 1 and 2 are perspective views of electrical terminal or connector which the machine of this invention is capable of securing to a conduit, shown before and after the attaching operation;

Fig. 3 is a cross sectional view through the terminal of Fig. 2, and is taken along the line 3—3 of Fig. 2;

Fig. 4 is a detailed front view, with parts removed, of the terminal swaging assembly of a machine embodying my invention;

Fig. 5 is a detailed fragmentary sectional view of that portion of the swaging assembly illustrated in Fig. 4, and is taken along the line 5—5 of Fig. 4;

Figs. 6 and 7 are front views of the swaging assembly with parts in section and parts removed, and illustrate the action of the terminal swaging jaws;

Fig. 8 is an enlarged perspective view showing details in the construction of one part of the swaging assembly;

Fig. 9 is an enlarged fragmentary sectional view showing details of construction of two of the coaxing terminal swaging members of the assembly;

Figs. 10 and 11 are perspective views illustrating two other coaxing swaging members of the assembly;

Fig. 12 is a perspective view of a swaging jaw operating shaft and its attached jaw actuating cams, and constitutes a part of the power assembly of the machine;

Fig. 13 is a combination top plan view and wiring diagram of a machine embodying my invention, the housing being removed for clarity;

Fig. 14 is a perspective view of the machine of Fig. 13, enclosed in its housing and ready for operation.

One type of pre-formed terminal which the machine attaches to electrical conductors is illustrated in Figs. 1, 2 and 3 of the drawing. The terminal is in the form of a connector or coupling, and includes a plate 10, an integral wire embracing sleeve 11, and a pair of opposed

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integral conductor gripping fingers 12 and 13. Fig. 1 illustrates the terminal before it is attached to the bared end of the conductor 14, and Figs. 2 and 3 after attachment.

It will be noted from Fig. 2 that the machine not only wraps the fingers 12 and 13 tightly around the adjacent insulated portion of the conductor, but that it swages the sleeve 11 by compression and creates an indenture 15 in the sleeve. Such deformation not only firmly and securely attaches the terminal to the conductor, but assures electrical contact between the inner wall of the indented sleeve and the bared end of the conductor, as clearly shown in Fig. 3.

Generally, the illustrated embodiment of the invention includes: (1) sleeve and finger swaging means in the form of a plurality of cooperating movable swaging jaws and one fixed jaw which together define a swaging region within which the terminal is operated upon; (2) power means for operating the movable jaws and for returning them to their normal at rest positions; and (3) control means located within the swaging region and responsive to physical contact by the plate end of a terminal inserted into the swaging region to actuate the power means.

These three major assemblies which make up the machine illustrated will be described separately.

Terminal swaging and attaching assembly

It should be understood that the number, size and shape of both the fixed and movable swaging dies or jaws will vary with the type of terminal or connector to be attached to the conductor. If the terminal includes no conductor gripping fingers 12 and 13 then no finger compressing dies or jaws are required.

For attaching the type of sleeve illustrated and referring to drawing Figs. 4 to 11, the machine includes the following swaging, compressing and forming jaws:

(I) A fixed jaw or anvil 16 (Fig. 8) which includes a semi-cylindrical sleeve receiving groove 17 and which is supported on a stationary metal block 18 by screws 19; jaw 16 includes an integral or securely attached outwardly projecting supplemental finger supporting and forming jaw 20, the upper or die surface of which is offset downward to a level slightly below the bottom of groove 17 to conform to the corresponding offset in the finger portion of the terminal.

(II) Two cooperating finger compressing jaws 21 and 22 (Figs. 10 and 11) which are pivotally mounted on a pivot pin 23, which is threaded into a hole 24 (Fig. 5) in block 18; above the pivot point these jaws are provided with cooperating slightly concave die surfaces 25 and 26 respectively; below their pivot point these jaws are provided with facing concave camming surfaces 27 and 28 which cooperate with a generally elliptical shaped cam 29 on shaft 30 journaled in bushings 31 in block 18.

(III) A sleeve swaging and indenting jaw 32 in the form of a vertically movable plate the vertical side edges of which are parallel and guide the vertical movement of the jaw by sliding contact with guides 33, 34 and 35, formed integral with block 18; the upper portion of plate jaw 32 is hollowed out to provide a concave camming surface 36 (Fig. 4) and a central downwardly projecting indent type die surface 37 which cooperates with the groove 17 to swage and indent the sleeve 11 of the terminal to be attached. Camming surface 36 cooperates with a second generally elliptically shaped cam 38 (Fig. 12) fixed on shaft 30.

(IV) A finger compressing jaw 39 which is rigidly secured to the upper end of vertically movable jaw 32 by screws 33. Jaw 39 is provided with a central depending die portion 40 (Fig. 6) which has a slightly concave

finger contacting surface 41 (Figs. 6 and 9), the center of which is aligned fore and aft with the center of indent 37 and with the centerline of groove 17. Surface 41 lies and moves in a vertical plane common to the plane in which the die surfaces 25 and 26 lie, and these three surfaces, together with the upper die surface of jaw 20 cooperate to bend the terminal fingers 12 and 13 inward and to wrap and compress them tightly about the conductor.

The normal at rest positions of all the above described forming jaws or dies is illustrated in Fig. 6. In these positions it will be noted that the die surfaces 17, 20, 25, 26, 37 and 41 generally define what is termed herein a terminal swaging region, designated as a whole by the numeral 42.

Jaw and die operation

When the bared end 43 (Fig. 1) of a conductor 14 is inserted into the sleeve 11 of a terminal with the adjacent insulated portion of the conductor embraced by the separated terminal fingers 12 and 13, the entire assembly is inserted by the operator into swaging region 42, with the sleeve positioned in groove 17, as clearly illustrated in Fig. 5.

As shaft is rotated 90° in either direction from the position shown in Fig. 6, to the position shown in Fig. 7, die surfaces 25 and 26 first contact fingers 12 and 13 respectively and bend them inward and upward into compressing contact with the conductor 14. With a slight delay, occasioned by the relative size and shape of cams 29 and 38, die surface 41 is forced downward against the tip ends of fingers 12 and 13 and completes the wrapping of the fingers tightly and firmly about the conductor insulation.

Simultaneously indent die 37 contacts the upper portion of sleeve 11 and with the help of die groove 17 deforms the sleeve metal (Fig. 3) and spreads the strands of the cable to establish firm gripping and electrical contact between the sleeve and the bared end of the cable. The completed conductor and terminal assembly is illustrated in Fig. 2.

On completion of the terminal swaging and attaching operation shaft 30 and its attached cams 29 and 38 are returned to the normal at rest positions illustrated in Fig. 6. This permits the movable jaws to also return to their respective at rest positions, also shown in Fig. 6, and permits withdrawal of the conductor and terminal assembly from the swaging region.

Jaws 21 and 22 are returned to their normal positions by a compression coil spring 43 (Fig. 10), the opposite ends of which bear against the blind ends of registering bored holes 45 and 46 in jaws 21 and 22, respectively.

Vertically movable plate jaw 32 and its integral indent die 37 are returned to their normal at rest positions by means of a compression coil spring 47 (Figs. 4 and 5) seated in a bore hole 48 in plate 32. The opposite ends of the spring bear against the blind end of hole 48 and against a stud 49 which projects through an elongated perforation 50 into block 18.

Power means for operating the swaging jaws or dies

The jaw operating power means is preferably powered by a suitable source of compressed air, such as a compressor fed air tank (not shown).

The power means includes the previously mentioned shaft 30 and its attached cams 29 and 38. On its opposite end shaft 30 carries a gear 51 (Figs. 12 and 13) which is secured to rotate with the shaft by a key 52.

Referring now to Fig. 13, the power means includes a conventional double acting working cylinder 53, with a plunger reciprocated rod 54. A rack bar 55 is connected to the outer end of plunger rod 54 by means of a nut 56, and is positioned to mesh with and rotate gear 51 as the plunger rod reciprocates. All the above mentioned parts are suitably secured on a machine base 57.

An adjustable rack bar stop 58 is also mounted on this base in a position to contact the outer end of the rack bar and thus selectively limit the outward movement of plunger rod 54.

Pressurized air is fed to the cylinder through a supply pipe 59, a conventional two-way valve 60, and pipes 61 and 62, connected to opposite ends of the cylinder. Valve 60 is provided with a control lever 63 which is urged to one end of its permitted travel by a tension coil spring 64, as shown. With lever 63 in the solid line position shown, the right hand end of cylinder 53 is pressurized and the plunger rod remains in its retracted position. The left hand end of cylinder 53 is at the same time connected to atmosphere through a valve vent 65.

Valve control lever 63 is moved to the opposite end of its permitted travel, as illustrated by the broken lines in Fig. 13, by means of a conventional solenoid 66. With the lever 63 in the broken line position pressure air is fed through pipe 61 to the left hand end of cylinder 53, and the right hand end thereof is connected through pipe 62 and vent 65 with the atmosphere.

The permitted outward travel of plunger rod 54 is such as to rotate gear 51 and its shaft 30 approximately 90°. From the above it will be seen that when shaft 30 is rotated 90° from its normal at rest position, as shown in Figs. 6 and 13, both the finger swaging and the sleeve swaging jaws will have completed their attaching operation on the workpiece terminal. When the rack bar 55 and the gear 51 return to their normal at rest positions (as in Fig. 13), then the various swaging jaws will likewise have returned to their respective at rest positions (Fig. 6).

Control means

The means for controlling the power means (Fig. 13) is primarily electrical and includes an electrical power source, indicated by negative and positive power conduits 67 and 68, an initiating circuit, a solenoid circuit, a holding circuit, and an interrupter for the holding circuit.

The initiating circuit includes a normally open control or initiating switch 69 mounted on block 18 adjacent the swaging region 42 (Fig. 6). This switch is provided with a trigger 70 which closes the switch when pushed inward. Trigger 70 is located in swaging region 42 in a position to be contacted and pushed inward by a terminal inserted into the swaging region, as shown in Fig. 13.

The initiating circuit also includes a normally closed switch 71, also provided with a "push-in" type trigger 72 which is positioned to be contacted by the gear carrying end of shaft 30, which has a flattened side surface 73. With shaft 30 in its normal at rest position as shown in Fig. 13 the outer end of trigger 72 just touches the flattened shaft surface 73. When shaft 30 begins to rotate the shaft surface cams trigger 72 inward and opens the switch.

The initiating circuit also includes a coil 74 of a relay 75 which is provided with normally separated switch contact elements 76 and 77.

The last two above mentioned contacts are not interposed in the initiating circuit, but are interposed in the holding circuit, which also includes a normally closed interrupter switch 78. This switch is also provided with a "push-in" type trigger 79 which is located in axial alignment with plunger rod 54, which during its outward travel passes beneath switch 71 and shaft 30, and is adapted to contact and actuate trigger 79 to open switch 78 as the rod reaches the outer end of its permitted path of travel.

Operation

To secure a terminal 10 (Fig. 1) to a conduit 14 the end of the conduit is bared of insulation in the usual manner. The bared end 43 is then inserted into the sleeve 11 with the adjacent insulated portion of the conduit resting between the fingers 12 and 13. The free end of this terminal assembly is then inserted lengthwise

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into the previously defined swaging region 42 (Fig. 6) and the free end of the terminal itself is forced against switch trigger 70 to close switch 69 as in Fig. 13. Trigger 70 is so positioned that when this trigger actuation occurs the terminal sleeve 11 is resting in jaw groove 17 in position to be deformed and indented by jaw indent 37. Similarly fingers 12 and 13 rest on jaw 20 in position to be contacted and compressed into firm cable contact by the jaw surfaces 25, 26 and 41.

The closing of normally opened switch 69 completes the initiating circuit. Current flows from positive power conduit 68 through relay coil 74, through conduit 80, conduit 81, through switch 69, through conduit 82, through normally closed switch 71, through conduit 83, and then to negative power conduit 67, completing the circuit.

The flow of current through relay coil 74 moves relay switch contact 76 downward into contact with relay switch contact 77 completing a solenoid circuit. Current then flows from positive power conduit 68 through conduit 84, through solenoid coil 66, through conduit 85, through jumper 86, through contact 76 and contact 77 to negative power conduit 67.

The passage of current through solenoid coil 66 causes the solenoid to move valve lever 63 from the full line position in Fig. 13 to the broken line position. Air under pressure flows from pressure line 59 through the valve 60, through line 61 to the left hand end of cylinder 53. Plunger 54 is thereby forced to the right in Fig. 13, and rack bar 55 turns gear 51 which in turn rotates shaft 30 to actuate the various swaging jaws as previously described. When the outer or free end of rack bar 55 contacts adjustable stop 58 the gear 51 has rotated shaft 30 approximately 90° from its Fig. 13 position. During its initial movement the flat surface 73 of shaft 30 forces switch trigger 72 inward and breaks the initial initiating circuit.

When relay switch contact 76 is first moved downward into contact with switch contact 77 due to the closing of the above described initiating circuit, an additional circuit is closed. This additional circuit will be termed the holding circuit. In the holding circuit the current flows from positive power conduit 68 through relay coil 74, through conduits 80, 87, through normally closed switch 78, conduit 88, jumper 89, switch contacts 76 and 77 and to negative power conduit 67. Thus when the initiating circuit is opened by the contact of shaft surface 73 against switch trigger 72, even though switch trigger 70 remains in closed position, current continues to flow through solenoid coil 66 as previously described.

When the extreme outer end of plunger 54 contacts and depresses switch trigger 79 the swaging jaws 21, 22, 37 and 40 have already completed their swaging action on the terminal 10 and the terminal has been firmly and securely attached to the end of the conduit 14.

When switch trigger 79 is forced inward by plunger 54 and switch 78 is opened, the previously described holding circuit is broken. Consequently current ceases to flow through solenoid coil 66, because relay switch contacts 76 and 77 are no longer in electrical contact. When energy ceases to flow through solenoid coil 66 the spring 64 moves valve lever 63 back to the solid line position shown in Fig. 13 and air under pressure flows through line 62 to the right hand end of cylinder 53 and the plunger rod 54 is thereby retracted into the position shown in Fig. 13. During this retraction shaft 30 is also returned to its original at rest position. Simultaneously, spring 47 (Fig. 4) returns jaw 32 to its original at rest position and spring 43 (Fig. 10) returns jaws 21 and 22 to their respective original at rest positions (Fig. 6).

As shaft 30 returns to its Fig. 13 position, switch trigger 72 is allowed to move outward from the switch

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and again permit the switch to close. Similarly, switch 78 is also allowed to close and the entire machine is thus conditioned for the start of the next cycle of operation. This swaging cycle is completed in an extremely short time and the machine is capable of attaching terminals to cable ends as fast as the terminals can be fed by the operator into the swaging region, as above described.

From the foregoing it will be apparent that the described invention provides an improved mechanism for attaching terminals or the like to the ends of electrical conduits in a manner which forms a positive electrical contact between the terminal proper and the bared end of the conduit, and also in a manner which prevents the terminal from later becoming disconnected from the conduit. It is apparent that jaw designs may be varied to handle various sizes and shapes of terminals and connectors, whether they are provided with the additional insulation gripping fingers or not.

It should be understood that it is not desired to limit the present invention to the exact details of the construction of the mechanism herein illustrated and described because various modifications which are within the scope of the appended claim may occur to persons skilled in this art. It is also intended that the specific descriptive terms used herein be given the broadest possible interpretation consistent with the disclosure.

Having described the invention with sufficient clarity to enable those familiar with this art to construct and use it, I claim:

A machine for swaging and thereby attaching the generally tubular sleeve of an electrical terminal to a sleeve insert comprising: a fixed anvil having a die surface; a swaging member having a cooperating die surface, said swaging member being mounted for guided reciprocable movement in the plane of the anvil die surface said swaging member having an aperture there-through, an edge of which constitutes a camming surface; resilient means urging the swaging member to move in a direction to separate the two said die surfaces; a pair of elongated cooperating swaging jaws each mounted on a fixed pivot intermediate its ends, the adjacent working ends of said jaws having confronting die surfaces movable toward each other and toward the anvil and swaging member die surfaces in a common plane when the adjacent opposite ends of said jaws are forced apart, the respective facing edges of said adjacent opposite ends constituting camming surfaces for forcing said ends apart; resilient means urging said jaws to pivot in directions to separate their respective die surfaces; a shaft journaled in fixed bearings and extending transversely through the aperture in said swaging member and between the said adjacent opposite ends of said swaging jaws; and cam means carried by the shaft for contacting the respective camming surfaces of the two swaging jaws and of the swaging member to simultaneously move the respective die surfaces of the jaws and the swaging member toward and into swaging positions with respect to the cooperating die surface of the anvil when said shaft is rotated.

References Cited in the file of this patent

UNITED STATES PATENTS

2,694,433	Fulton	Nov. 16, 1954
2,800,157	Malka	July 23, 1957

OTHER REFERENCES

An article titled "Terminal Assembly Methods that Reduce Costs" published in Electrical Manufacturing Magazine, August 1948, pp. 96-100 and 174 (Reprinted in TMP Technical Data Bulletin 494). (Copy in 153-1 B, Div. 57.)