April 21, 1942. C. S. PENFOLD ET AL 2,280,352

METHOD OF SWAGING

Original Filed Feb. 1, 1940 5 Sheets-Sheet 1

Fig. 1.

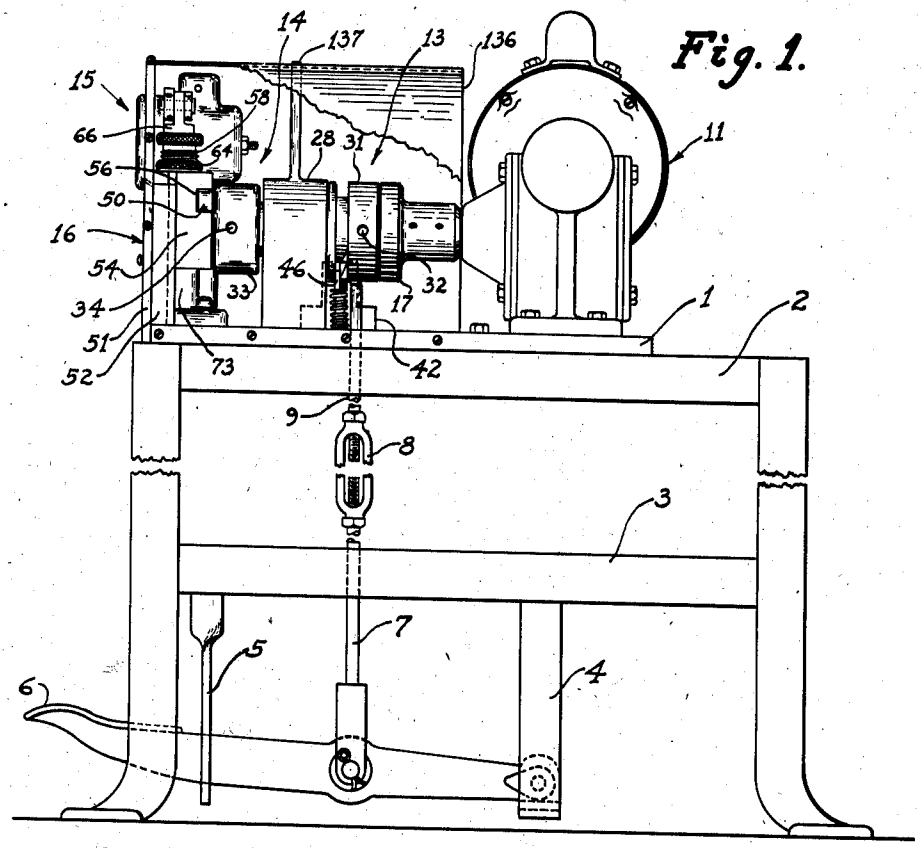
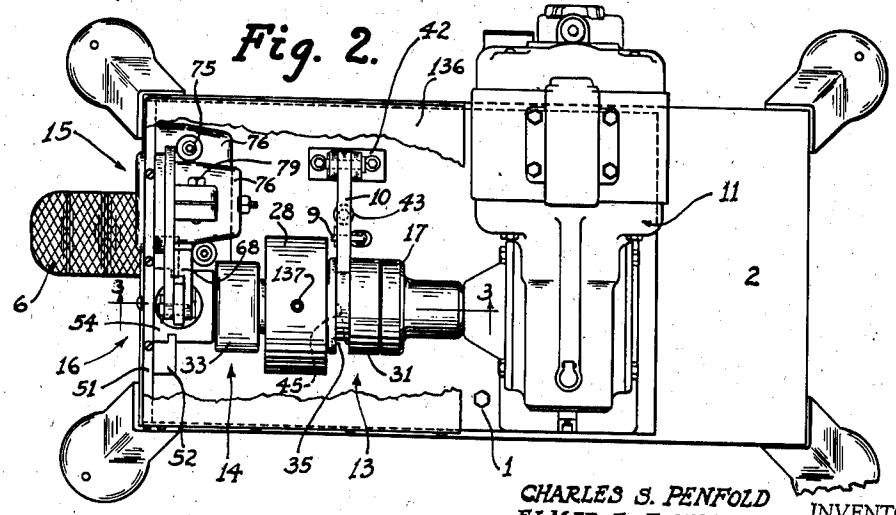


Fig. 2.



CHARLES S. PENFOLD
ELMER E. JOHNSON
GEORGE H. BRAILSFORD
INVENTORS.

BY

Charles S. Penfold

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METHOD OF SWAGING

Original Filed Feb. 1, 1940 5 Sheets-Sheet 2

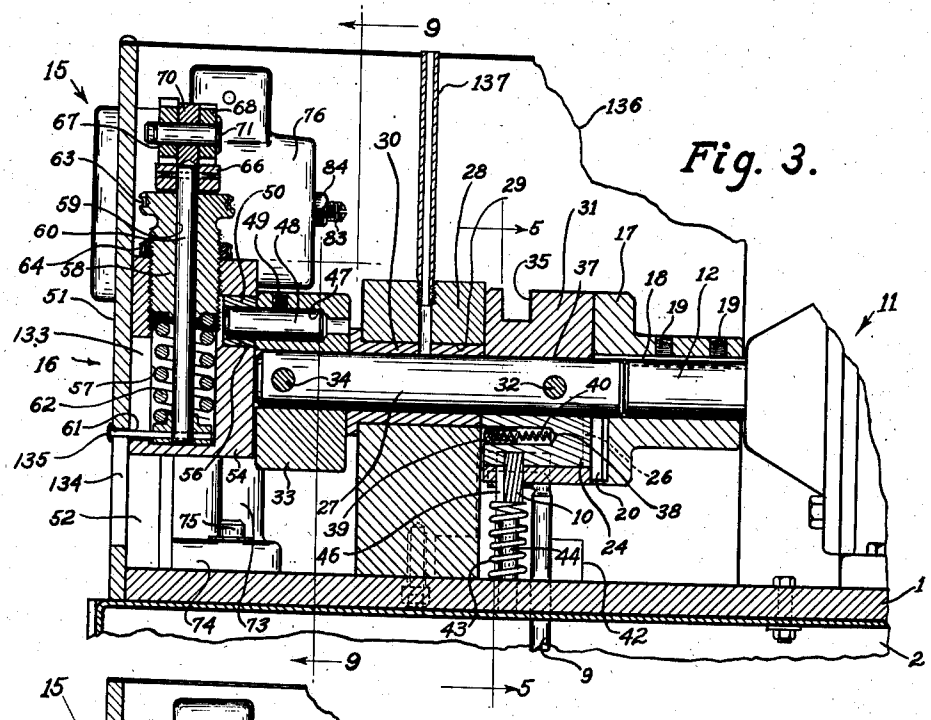


Fig. 3.

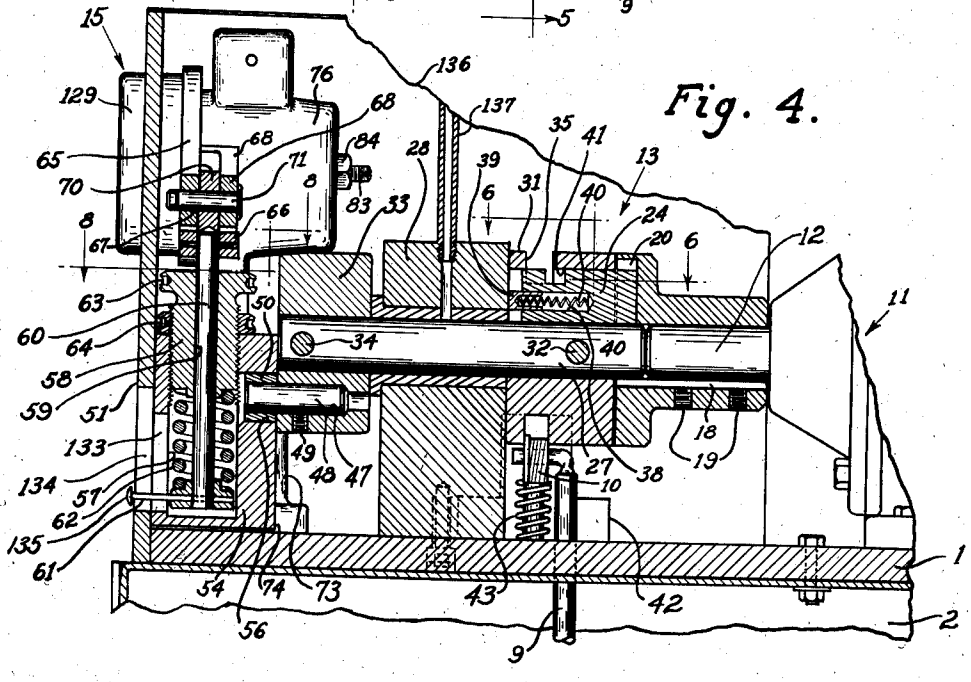


Fig. 4.

CHARLES S. PENFOLD
ELMER E. JOHNSON
GEORGE H. BRAILSFORD
INVENTORS.
BY
Charles S. Penfold

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METHOD OF SWAGING

Original Filed Feb. 1, 1940 5 Sheets-Sheet 3

Fig. 5.

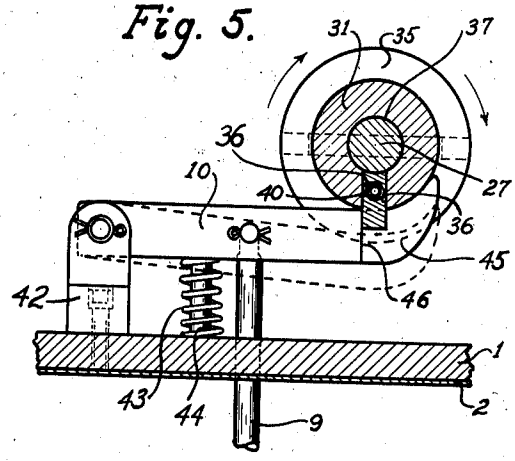


Fig. 6.

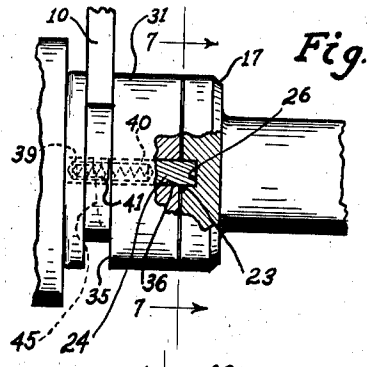


Fig. 7.

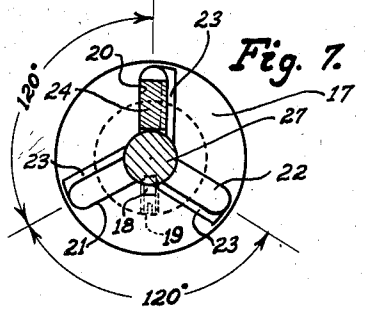


Fig. 8.

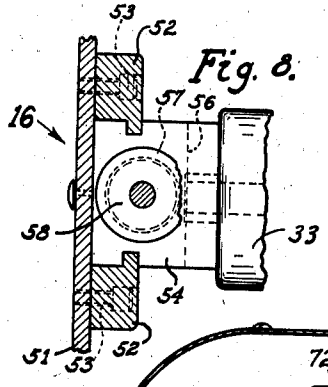
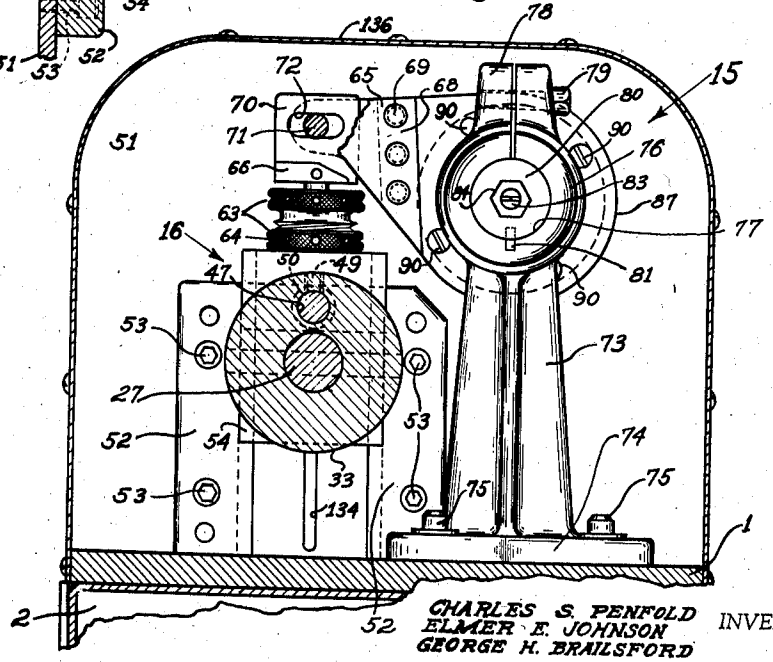


Fig. 9.



CHARLES S. PENFOLD
ELMER E. JOHNSON
GEORGE H. BRAILSFORD
INVENTORS.

BY

Charles S. Penfold

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METHOD OF SWAGING

Original Filed Feb. 1, 1940 5 Sheets-Sheet 4

Fig. 10.

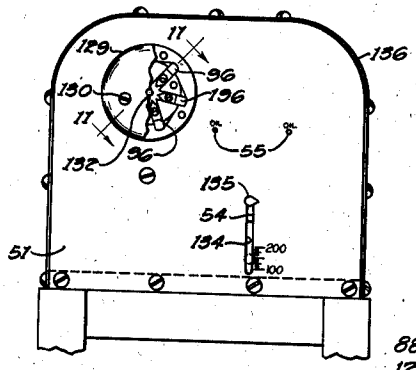


Fig. 11.

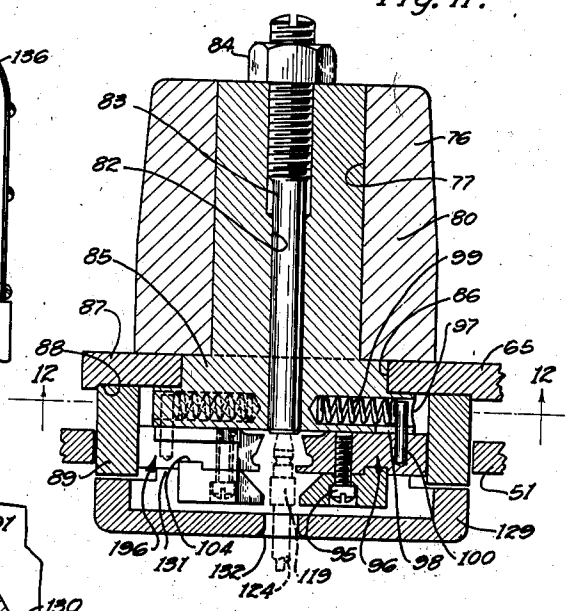


Fig. 12.

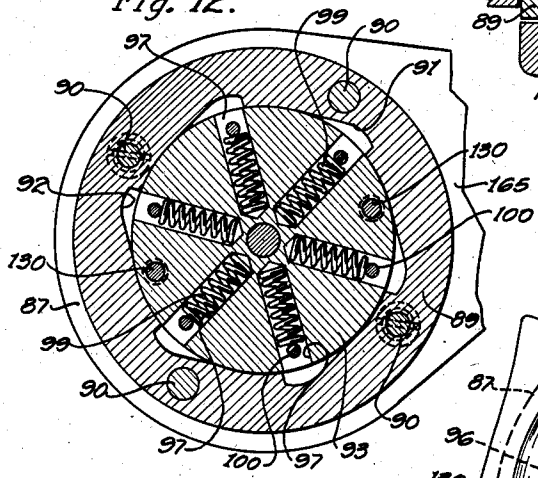


Fig. 13.

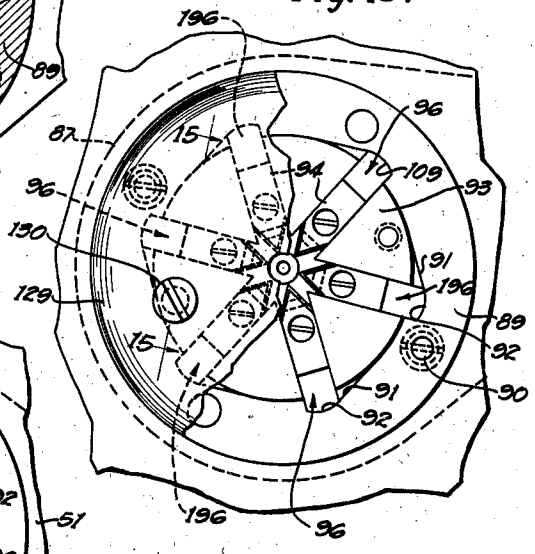
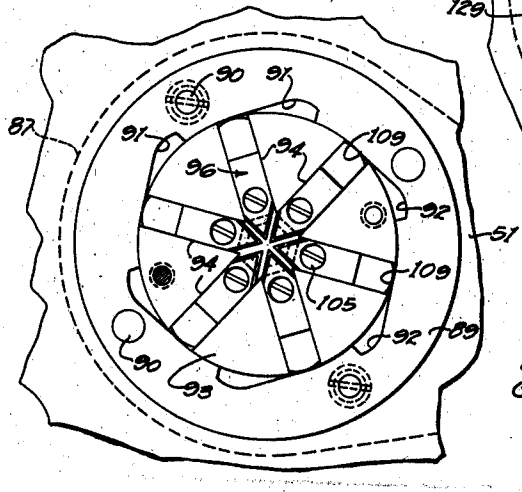


Fig. 14.



CHARLES S. PENFOLD
ELMER E. JOHNSON INVENTORS.
GEORGE H. BRAILSFORD
BY
Charles S. Penfold

April 21, 1942. C. S. PENFOLD ET AL 2,280,352

METHOD OF SWAGING

Original Filed Feb. 1, 1940 5 Sheets-Sheet 5

Fig. 15.

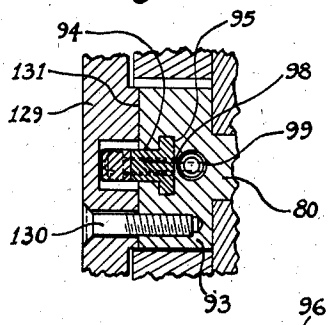


Fig. 16.

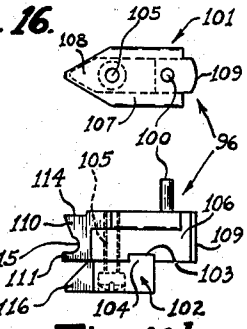


Fig. 16a.

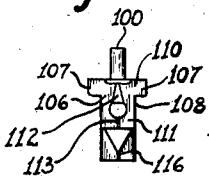


Fig. 16b.

Fig. 17

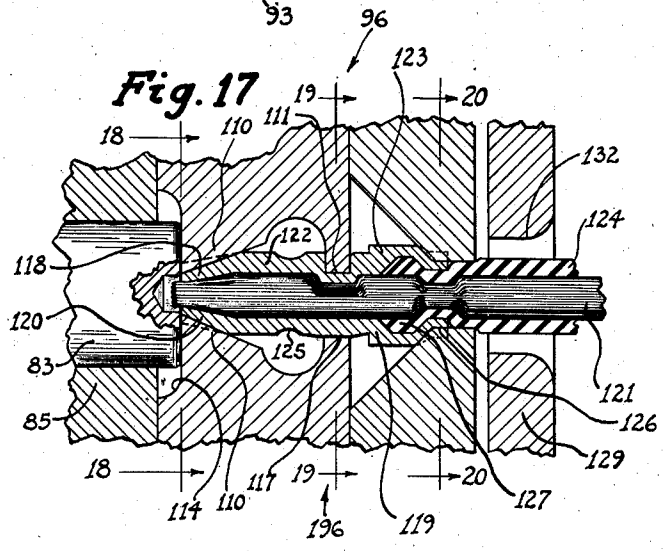


Fig. 18.

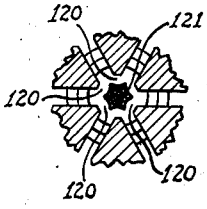


Fig. 19.

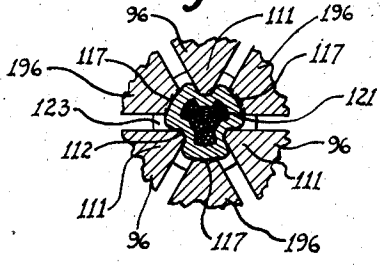


Fig. 20.

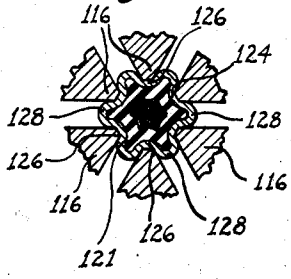
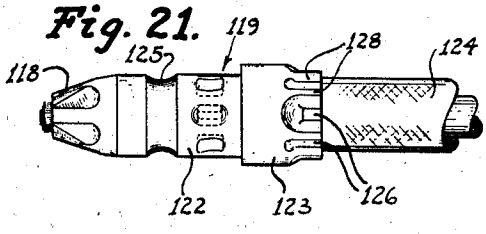


Fig. 21.



CHARLES S. PENFOLD
ELMER E. JOHNSON
GEORGE H. BRAILSFORD
INVENTORS.

BY

Charles S. Penfold

Patented Apr. 21, 1942 2,280,352

UNITED STATES PATENT OFFICE

2,280,352

METHOD OF SWAGING

Charles S. Penfold, Elmer E. Johnson, and George H. Brailsford, Bronson, Mich., assignors to H. A. Douglas Mfg. Co., Bronson, Mich., a corporation of Michigan

Original application February 1, 1940, Serial No. 316,720. Divided and this application October 11, 1941, Serial No. 414,662

8 Claims. (Cl. 29—155.55)

This invention relates generally to a method of swaging and more specifically to a method adapted to swage or crimp a terminal onto a conductor wire.

The method is particularly designed to swage on a terminal of the so-called snap type, which is adapted to fit into a receptacle having a detent cooperable with a groove or other desirable abutment provided on the terminal, for detachably holding the terminal in relation to the receptacle.

This application is a division of our application, Serial No. 316,720, filed February 1, 1940.

One particular object of the invention is to provide improved method which will simultaneously swage a terminal onto a conductor wire and onto the insulation in such a manner that a good electrical and mechanical connection or bond is established between the terminal and conductor without the use of solder or other means.

Many other objects and advantages of the invention will appear after considering the description hereinafter set forth in conjunction with the drawings annexed hereto.

In the drawings, Figure 1 is a side view of the swaging apparatus, with portions broken away for illustrative purposes;

Figure 2 is a top plan view, with portions broken away;

Figure 3 is an enlarged vertical sectional view taken substantially on line 3—3 of Figure 2, showing certain mechanisms in inoperative position to receive a terminal as shown in Figure 11;

Figure 4 is a section substantially corresponding to Figure 3, showing the mechanisms in Figure 3 in operative position, in which position the swaging jaws are moved centripetally or inwardly to swage or crimp a terminal onto a conductor as depicted in Figure 17;

Figure 5 is a partial vertical section taken substantially on line 5—5 of Figure 3, showing a part of the clutch means employed for establishing operative connection between the driving and the driven means of the apparatus;

Figure 6 is a partial section taken substantially on line 6—6 of Figure 4, showing other details of the clutch means;

Figure 7 is a vertical section taken substantially on line 7—7 of Figure 6, also showing further details of the clutch;

Figure 8 is a section taken substantially on line 8—8 of Figure 4, showing elements of the machine reciprocated by the driven means;

Figure 9 is a vertical section taken substantially on line 9—9 of Figure 3, showing a rear view of the swaging means and related structure;

Figure 10 is a front view in elevation of a part of the apparatus;

Figure 11 is an enlarged section taken substantially on line 11—11 of Figure 10, showing certain details respecting the structure of the jaws and related parts;

Figure 12 is a section taken substantially on line 12—12 of Figure 11, showing certain details of the cam structure, and the means for maintaining the jaws in normally retracted positions;

Figure 13 is a partial front view of the swaging means, with a portion of the structure broken away, so as to further show the jaws in said retracted position;

Figure 14 is a view substantially corresponding to Figure 13, showing the jaws projected radially inwardly to the fullest extent; in other words to positions same would take provided a terminal is not inserted for swaging;

Figure 15 is a partial section taken substantially on line 15—15 of Figure 13, showing details of a jaw and related structure;

Figures 16, 16*a*, and 16*b* clearly show top, front, and side views, respectively, actual size, of a certain swaging jaw;

Figure 17 is an enlarged sectional view taken through a part of the swaging means clearly showing the active or operative position of the swaging jaws as applied to a terminal for affixing the latter to a conductor;

Figure 18 is a vertical section taken substantially on line 18—18 of Figure 17, showing the swaging jaws in the act of swaging a reduced portion of a terminal, such as the nose onto a wire;

Figure 19 is a section taken substantially on line 19—19 of Figure 17, showing the act of swaging another portion of the terminal onto a wire, including improved means for preventing undue distortion of the terminal;

Figure 20 is a section taken substantially on line 20—20 of Figure 17, showing the act of swaging or crimping an enlarged portion, such as the skirt, of a terminal onto the insulation of a conductor; and

Figure 21 is a side view of the terminal shown in Figure 17, after same has been secured to the conductor.

The apparatus or machine, among other things, preferably includes a swaging mechanism for attaching a terminal onto a conductor; electric driving means, means driven thereby including a clutch or coupling; a lost-motion resilient

connection between the swaging mechanism and the driven means; and means for predetermining the extent or sufficiency of the swaging.

Referring first to Figures 1 through 4, the parts just referred to, are preferably substantially carried by or mounted upon a heavy metal foundation or mounting plate 1 as a unit, which may be desirably detachably secured to a suitable support, such as the top of a portable table 2. The table herein shown, is preferably provided with a horizontal shelf 3, from which depends a bracket 4 and a guide member 5. A foot operated treadle 6 is pivotally connected at one end to the lower extremity of bracket 4, and its other end projects through a slot in guide 5 for guidance. As most clearly shown in Figure 1, a rod 7 extends through the shelf, and has one end pivotally secured adjacent the center of the treadle 6, and its other end is connected to a turnbuckle 8. A rod 9 projects through the mounting plate 1 and the table top, and its extremities are connected to the turnbuckle, and latch or cam lever 10, respectively. By this arrangement, certain parts are made adjustable, and pressure on the treadle will cause the latch 10 to move downwardly to release the clutch to operate certain mechanisms, which will now be described.

Referring specifically to Figures 2 and 3, the numeral 11 generally designates driving means in the form of an electric motor, the speed of which is reduced and predetermined, preferably at about 148 R. P. M. The motor is continuously adapted to rotate a drive shaft 12, which, through the intermediation of clutching means generally designated 13, is adapted to drive the driven means generally designated 14. The swaging means employed for securing a terminal onto a wire is generally designated 15, and 16 generally designates means providing a lost-motion resilient connection between the driven means and the swaging means. Thus, downward movement of the treadle will throw in the clutch 13 to cause the drive shaft to rotate the driven means, and the latter to reciprocate the lost-motion means 16, which in turn operates the swaging means 15. In operation, it is only necessary to thread a terminal on to the bare end of a conductor wire, insert the terminal into the swaging means 15, and then press down on the treadle 6, whereupon the jaws within the swaging means will be moved centripetally to a position substantially corresponding to that shown in Figure 17.

The drive shaft 12 has a driving clutch flange 17 fixed thereto by a spline 18, secured in place by screws 19. The clutch flange is provided with an annular head having a plurality of radial slots 20, 21, and 22, clearly shown in Figure 7, which are spaced substantially 120 degrees apart circumferentially in non-intersecting relation with respect to its periphery. The entrance side of each slot is preferably chamfered as indicated at 23 so as to pilot or otherwise assist in guiding a reciprocating key member 24, carried by the clutch, into one of the slots. To assist further in this respect, the entering or operating end of the key is chamfered as indicated at 26 in Figure 6.

A clutch or driven shaft 27 is adapted to be rotated clockwise by the clutch means generally designated 14. A relatively heavy metal bearing member 28, is firmly suitably secured in an upright position to the mounting plate 1, and provided with a transverse aperture 29 which receives a bushing 30, within which rotates the driven shaft 27. One extremity of the shaft 27 has a cylindrical driven clutch element 31 preferably firmly detachably secured thereto by a pin 32, and the other extremity is provided with a relatively heavy metal annular member 33, which is also preferably firmly detachably secured thereto by a pin 34. As shown, a portion of the bushing is disposed between the bearing member 28, and member 33; in other words the arrangement is such that the bushing provides an abutment for member 33, and the member 28 an abutment for element 31. The element 31 and annular member 33 are so connected to the shaft 27 with respect to bearing 28, that there is substantially no axial thrust in the aligned connections during the rotation of the shaft.

Considering further, the construction of the clutch means, the driven clutch element 31 is provided with an annular peripheral groove 35, and a radially extending keyway 36. This keyway 36 also extends longitudinally entirely through the member and intersects the clutch shaft aperture 37 and the annular groove 35, but does not intersect the periphery of the member. Reference to Figures 3 and 4, will indicate that the key 24 is adapted to be slid or reciprocated within the keyway 36 to couple and uncouple the clutch, the key cooperating with one of the radial slots 20 through 22 provided in the head of the clutch flange 17.

A hole 38 extends longitudinally inwardly from the other or front end of the key 24, and within this hole is a cap 39 backed by a helical spring 40. By this arrangement, the cap 39 is urged forwardly to normally continuously engage the bearing member 28, and urge the key rearwardly. The key, which is provided with a notch 41, is adapted to be normally held as shown in Figure 3, by means of the latch most clearly shown in Figure 5. The free end of the latch 10 is continuously held in an elevated position within the annular groove 35 of element 31. When the element 31 is in the inoperative position shown in Figure 3, the latch 10 rests within the notch 41 of the key 24. Thus, assuming the clutch flange 17 is rotating, it will be evident that when the treadle 6 is depressed, the latch 10 will be withdrawn or released from the notch 41, whereupon the key will be projected by the spring 40 into one of the radial slots 20 through 22, in which event, the shaft 12 will drive and rotate the clutch shaft 27 in a clockwise direction, assuming the machine is viewed from the front. Obviously, the driving and the clutch means could be arranged to rotate the shaft in the opposite direction. As shown in Figure 3, the clutch is shown in inoperative position, whereas in Figure 4 the clutch is in operative position with the key 24 in engagement with one of the radial slots.

The latch 10, above referred to, operated by the treadle 6, is shown as having one end pivotally connected to an upstanding bifurcated bracket member 42, which member is preferably anchored to the mounting plate 1 by screws. The lever and treadle are normally held in the elevated or inoperative full line positions, shown in Figures 1 and 5, by means of a compressed helical spring 43, held in place by a stop pin 44. The stop 44 acts to hold the free end of the latch within the groove 35 of element 31 regardless of whether or not the machine is operating, and also prevents both the latch and treadle from being depressed to an extent farther than is necessary.

The thickness of the latch 10 is substantially uniform throughout its entire length except near its free end, which is upturned and more or less pointed. One side of the upturned free end of the latch is preferably provided with a curved or slightly convex bevelled portion 45 and a shoulder 46. The shoulder 46 most clearly shown in Figure 3 is adapted to provide an abutment, which, when engaged by the key member 24 acts to maintain the driven element 33, including the lost-motion connection and swaging means above referred to in predetermined inoperative positions. In other words, when the treadle 6 is depressed and quickly released, the latch 10 will release the key into the nearest revolving radial slot to drive the clutch shaft 27 one complete revolution, whereupon, the key 24 substantially engages the shoulder 46 on the latch to hold the shaft against further rotation. Just prior to the completion of this revolutionary movement, the upturned pointed end of the latch being pressed upwardly by the spring 43, gradually enters the notch 41 to gradually withdraw the key 24 from one of the radial slots, and when it is actually withdrawn, throwing out the clutch, the shoulder stop 46, which in the meantime has moved into place, is engaged by the key. The arrangement is such that a portion of the notch 41 is at all times presented or open so that the pointed end of the latch may always enter the notch as the shaft 27 nears the end of its revolution. As clearly shown in Figure 6, the side of the notch adapted to engage the bevel 45 is slightly curved or chamfered in order to permit the pointed end of the latch to better enter the notch. Obviously, the driven or clutch shaft 27 can be made to rotate continuously without interruption by holding the treadle down with the foot. It will also be evident, that the revolving radial slot nearest the key 24, when the latch is tripped, will receive the operating end of the key, and that since the slots are spaced 120 degrees apart, the key will engage one of the slots at every third or less than every third of a revolution of the clutch plate 17. The chamfered portion 23 adjacent each of the radial slots 20 through 22, and the chamfered portion 26 on the key member 24 cooperate in a manner whereby to permit easy entrance of the key into either of the slots.

Referring back to the driven means generally designated 13, the heavy annular member 33 secured to the clutch shaft 27, is provided with an aperture 47 disposed at one side of the axis of the member. A pin 48 is adjustably held in this aperture by a set screw 49. This pin, clearly shown in Figures 3, 4, and 9, is eccentrically connected to member 33 with its forward end projecting outwardly from the member whereby to receive a roller 50. Thus, the means generally designated 14 is adapted to be driven, and in turn drives the lost-motion connection generally designated 16, which will now be described.

A relatively heavy metal upstanding plate 51 is preferably firmly secured to the front end of the mounting plate 1 by screws. The front plate 51 is also supported and maintained in place to some extent by being secured to the swaging means generally designated 15. As clearly shown in Figures 2, 3, 8, and 9, a pair of parallel upstanding guiding channels 52 are secured by screws 53 to the rear side of the front plate 51 opposite the driven means 14. A substantially rectangular metal block 54 is arranged for reciprocating movement between the channels. Two of the opposite sides of the block are preferably provided with vertical grooves which receive tongues provided on the channels 52. Obviously, this tongue and groove arrangement might be reversed. By this arrangement the front side of the block may slidably engage the rear side of the front plate 51, and portions, the channels 52 so as to provide a substantial track or guideway for the block. If found desirable, the front plate, as shown in Figure 10, may be provided with holes 55 adjacent the upper extremities of the tongue and groove connections so that the latter may be oiled from the outside. The side of the block 54 opposite the driven means 13 is provided with a transverse horizontal slot 56 which receives the roller 50 provided on the drive pin 48 eccentrically connected to the annular member 33. Thus, rotation of the clutch shaft 27 and element 33 will cause the roller 50 to roll back and forth or slide within the slot 56 to reciprocate the block with respect to the channels 52. If found desirable, the block could be connected to the swaging means without riding in guiding channels. Moreover, the driven means could be directly connected to the swaging means, with or without, a resilient lost-motion connection. Also, a lost-motion connection, other than one of the resilient type could be used to advantage.

The block 54 is provided with an upstanding chamber 57, which is open adjacent its upper extremity and internally threaded. An externally threaded substantially cylindrical bushing 58 is threadedly connected to the upper extremity of the chamber to close the same. This bushing is provided with a hole 59 which slidably receives a rod 60. The lower extremity of the rod 60 extends into the chamber 57 and has a circular washer or abutment affixed thereto by any suitable means, such as a pin 61. Interposed between the inner or bottom end of the bushing 58 and the abutment is an expansible and contractable helical spring 62 which normally functions to force the abutment including the rod 60 downwardly, into engagement with the bottom of the chamber 57, when the machine is in the inoperative position shown in Figure 3. The upper end of the bushing 58 may be enlarged and provided with a plurality of openings 63 into which a suitable tool may be inserted, whereby the bushing may be adjusted with respect to the block 54 to compress and maintain a predetermined tension or stress upon the spring 62. A nut 64 may be employed for locking the bushing in place after the tension has been predetermined.

The upper end of the rod 60 extends above the bushing 58 and is adapted to be desirably connected to an operating crank or arm 65 of the swaging means generally designated 15, through the intermediation of a coupling element 66. The coupling element 66 may be secured to the upper extremity of the rod 60 by any suitable means, but as herein shown, the base of the coupling is provided with an aperture, which receives the end of the rod, and the latter is secured in place by means of a pin clearly shown in Figures 3 and 4. The free end of the arm is preferably tapered and provided with an aperture 67. An angle piece 68 is firmly secured to the inner or rear side of the free end of the arm by any suitable means, such as rivets 69, shown in Figure 9. A portion of the piece 68 is arranged in spaced apart relation with respect to the arm 65

so as to provide a bifurcation adapted to receive the upstanding portion 70 of the element 66. The arm 65 and that portion of the angle piece parallel thereto, and the upstanding portion 70 of the connecting element are each provided with an aperture through which extends a pin 71 for pivotally connecting these parts together. As clearly shown in Figure 9 the aperture in the upstanding portion 70 of the element 66, is in the form of a slot 72 within which the pin 71 may ride, so as to allow proper movement of the moving parts without binding. Thus, reciprocating movement of the block 54 will cause movement of the rod 60 and the arm 65, the latter operating the swaging means which will now be described.

The swaging means includes a pedestal 73 having a base portion 74 suitably secured to the mounting plate 1 by screws 75. The upper extremity of the pedestal 73 is enlarged forming a housing 76, provided with a horizontally arranged transverse opening 77. The upper extremity of the housing 76 is preferably split to provide portions 78 which may be drawn together by a screw 79 to clamp and firmly secure a cylinder 80 within the opening 77. Also assisting to hold the cylinder in place is a key 81 which fits into portions of the cylinder and housing, as clearly shown in Figure 9. The cylinder is provided with a longitudinal aperture 82 which receives a bolt 83, which acts as a stop to limit the inward movement of a terminal into the swaging means, as shown in Figure 11. The inner end of the bolt may be provided with a small flared hole to act as a pilot for the nose of the terminal for centering purposes. The bolt 83 is threadedly connected to the cylinder and may be secured in a fixed position by means of a locknut 84.

The cylinder 80 is preferably provided with an annular portion 85 which fits into a round aperture 86 provided in the enlarged circular end 87 of the operating arm 65. The front face of the end 87 of the arm is provided with an annular rebate 88, within which is firmly secured a ring or annulus, or more specifically a tubular cylindrical cam member 89. This annulus or cam member may be secured in place by any suitable means, but as herein shown, a plurality of pins and screws 90 are used, as clearly shown in Figures 9 and 12. The inner face or periphery of the cam member 89 is provided with a plurality of tangential cam surfaces 91, preferably six in number, terminating in recesses 92. The outer extremity of the fixed cylinder 80 is also preferably provided with an integral cylindrical head 93 of a diameter greater than the diameter of the portion 85, and slidably receives a plurality of jaws, the movement of which is caused by the cam surfaces 91 acting thereupon whenever the operating arm 65 is rotated about the said head of the cylinder.

Referring now to the improved jaw means and the manner in which same are operatively associated with respect to the head 93 and cam member 89, the head is provided with a plurality of radially extending grooves 94, which are preferably spaced 60 degrees apart circumferentially and intersect the center and periphery of the head. Each groove is preferably undercut to provide a slot 95, clearly shown in Figure 15, so that each groove and each slot 95 together provide a substantially T-shaped guideway for each of the jaw members generally designated 96 and 196. As clearly shown in Figures 11, 12, and 15, the head 93 is also provided with a plurality of holes 97 which extend radially inwardly from its periphery. The wall between each hole and slot 95 is provided with a recess 98, clearly shown in Figures 11 and 15. A helical spring 99 is arranged in each of the holes 97. A pin 100 projects transversally from one side of each of the jaws 96 and 196, through the recess 98, and into the hole 97. Each spring is placed under compression or tension and engages a pin 100 to urge the jaws 96 and 196 outwardly to the inoperative position, shown in Figure 11, in which position a terminal to be swaged can be inserted into the opening between them.

The jaw members 96 and 196 include improved principles of design and construction over existing jaw constructions, and will now be described.

As viewed in Figure 16, each of the jaws 96 is preferably comprised of two complementary parts 101 and 102. The upper and lower surfaces of these parts are substantially flat and parallel. The upper surface of part 101 is provided with the pin 100, above referred to, and its lower surface has a notch 103, which snugly receives a tenon 104, provided adjacent the upper surface of part 102. The parts are preferably held in assembly by a screw 105. Obviously, the notch and tenon arrangement might be reversed, and if found desirable, the parts may be integrally connected together. Part 101 is provided with a portion 106, and integral lateral portions 107 which project outwardly substantially at right angles therefrom. These portions 106 and 107 slidably cooperate with the radial grooves 94 and slots 95, respectively, provided in the head 93 of the fixed cylinder 80, as clearly shown in Figure 15. The side walls adjacent the inner extremity of part 101 converge or taper at substantially 60 degrees as indicated at 108, and its outer extremity is rounded to present a cam surface 109 adapted to cooperate with one of the tangential cam surfaces 91, provided on the annulus or cam member 89. The outer free end of the taper is provided with a pair of spaced apart projections or teeth 110 and 111, the latter of which extends longitudinally a slight distance in advance of tooth 110. The tooth 110 is preferably bevelled inwardly to present a substantially triangular swaging face 112. The tooth 111 presents a substantially rectangular or square swaging face 113. Clearance is provided for the inner end of the stop bolt 83, and the teeth as indicated at 114 and 115, respectively.

The top and side walls of the front extremity of part 102 are also preferably bevelled at 60 degrees to present a substantially rectangular swaging face 116. Although it is not absolutely essential, it is to be noted that the swaging faces just referred to, are not what you would exactly call pointed, but are preferably formed slightly blunt, as most clearly shown in Figures 18 through 20.

The jaws above described are those designated 96, of which there are three, preferably spaced 120 degrees apart. The jaws generally designated 196 substantially correspond to jaws 96, except for certain details, and are likewise spaced 120 degrees apart, and are arranged between the jaws 96. In other words, all of the jaws are spaced 60 degrees apart, as clearly shown in Figures 12 through 14, and 18 through 20. The only material difference between the jaws is the fact that the jaws 196, are each provided with a pro-

jection 117 presenting a rather blunt face, which is adapted to engage or preferably slightly bite into the exterior or peripheral surface of a terminal, as clearly shown in Figures 17 and 19 at approximately the same time that the swaging teeth are nearing their innermost swaging position.

Referring specifically to Figures 17 through 21, it will be apparent that when the treadle is tripped to operate the swaging means, the teeth 110 provided on the sets of jaws 96 and 196 will be forced radially into the nose or tapered fore end 118 of the terminal 119 to forge, swage, or otherwise cause, preferably six, portions 120 of the metal to flow at a predetermined angle into intimate contact with the conductor wire 121 whereby to provide an efficient electrical and mechanical connection or bond between the terminal and the wire, the latter of which may be of the single or stranded type. It is to be particularly noted that when the tapered nose 118 is properly swaged, as shown in Figures 17 and 18, the swage extends substantially the full length of the taper. This offers the distinct advantage of providing a substantially solid or integral connection between the wire and terminal adjacent the extreme free end of the nose, as clearly shown in Figure 18, whereas farther back the portions 120 act to squeeze or compress the wire a lesser extent. In other words, the swaging is more or less pronounced at one point, and gradual or tapered therefrom. The teeth 110 are preferably constructed to slightly reduce the normal outside diameter of the nose, so that the terminal can be more easily inserted into a receptacle.

As clearly shown, the terminal 119 is also formed to include a cylindrical or land portion 122, through which the bare end of the wire extends, and a larger cylindrical or skirt portion 123, which receives a portion of the insulation 124. The terminal may be provided with a detent groove or abutment 125, which is adapted to cooperate with a detent provided in some desirable form of a receptacle. Obviously, the terminal may be otherwise constructed, for the one just described is but a preferred form.

The teeth 111 provided on the jaws 96 are so arranged with respect to the teeth 110, that same will swage the cylindrical or land portion 122 of the terminal, preferably at three places intermediate the abutment 125, and the skirt portion 123, as clearly shown in Figures 19 and 21. All of the jaws are adapted to move centripetally simultaneously, and the blunt faces on projections 117 of the jaws 196 act to engage, and preferably slightly bite into the periphery or outer wall of the terminal, preferably at three places, intermediate the teeth 111, whereby to prevent the material at said intermediate places from becoming distorted outwardly, while the teeth 111 are swaging the terminal. These projections 117 preferably engage the terminal at or near the close of the swaging operation, assist in reshaping or holding the terminal to prevent the outward flow of the material of which the terminal is comprised. Obviously, if found desirable the faces provided on the projections 117 may be made slightly concave to better confine the material. Although it is not essential, it has been found advantageous to make the swages caused by teeth 111 more effective and positive than those adjacent the nose. In any event, it is preferable to cause more metal to flow into making the connection caused by teeth 111.

The six teeth 116 provided on the jaws 96 and 196, as clearly shown in Figures 17 and 20, function to swage, crimp, or otherwise forge portions 126 of the skirt radially inwardly to compress and reduce the cross-sectional size of the insulation 124 and the wire 121. Such reduction locks an uncompressed portion 127 of the insulation within the confines of the skirt, and portions of the insulation are forced outwardly into the six channels 128 formed intermediate the swaged portions 126. The crimping of the skirt primarily acts to prevent twisting and buckling of the conductor adjacent the skirt, and at the same time alleviates any strain that might be placed on the other swaged connections.

As most clearly shown in Figures 10 and 11, the annulus or cam member 89 projects through and rotates freely within a hole provided in the front plate 51. A pilot plate 129 is preferably detachably secured to the head 93 of the cylinder by screws 130. A boss 131 on this plate engages the head and maintains the remainder of the plate in spaced apart relation to the jaws and the face of the part 89 to alleviate friction. This plate 129 is provided with a flared central hole 132 through which each terminal is adapted to be inserted to guide the terminal in between the jaws, and engage the stop 83 so as to properly position the portions of the terminal to be swaged with respect to the various swaging teeth.

As mentioned previously, one object of the invention is to provide improved means for swaging a terminal onto a wire. The resilient lost-motion connection means generally designated 16 is adapted to assist in this respect. As clearly shown, when a terminal is being swaged, the block 54 will move downwardly at a faster rate than the free end of the operating arm 65 of the swaging means, and this is due to the fact that the spring 62 within the block is slightly compressed. In other words, a resilient variable pressure is exerted upon the swaging jaws whereby the latter may latterly adjust themselves with respect to a terminal. Otherwise expressed, the operating arm is operated by resilient means. This lost-motion connection functions to gradually ease the jaws into a terminal, and primarily prevents the jaws from moving inwardly beyond the point necessary to provide proper swages.

Heretofore, the tension placed on the spring 62 has been ascertained by making tests until approximately a forty pound pull is required to remove a swaged terminal from a conductor wire. In other words, if the terminal cannot be disconnected from a conductor after a forty pound pull, it is assumed that the terminal has been properly swaged. Thus, it is evident that no accurate or reliable means have been provided for maintaining the proper tension on the compensating spring 62 after a test has once been made. In order to provide the machine with accurate means for maintaining this predetermined tension, the pin 61 securing the abutment to the lower end of the rod 60 is preferably extended through a slot 133 provided in the block 54 and a slot 134 provided in the front plate 51; and the pin has a pointer 135, as clearly shown in Figures 3, 4, and 10. This pointer is adapted to cooperate with a suitable dial, preferably provided on the plate 51, to indicate the tension in pounds, as illustrated in Figure 10. The upper full line position of the pointer merely indicates that the swaging means is inoperative to receive a terminal, whereas, in the lower dotted line position the

pointer indicates the fact that approximately 150 pounds tension is required to force the jaws **96** and **196** into a terminal to obtain a proper connection, as shown in Figures 4 and 17. Obviously, a lesser number of swaging jaws may be used, in which less tension will be required.

Accordingly, to maintain the proper tension it is merely necessary to check the clock or register, preferably at regular intervals, and if the pointer fails to register at the 150 mark, showing the proper tension, the bushing **58** may be adjusted to obtain this tension. Although, from a practical standpoint it is advantageous to check the tension during the swaging operation, it is, nevertheless, feasible to provide an arrangement whereby the desired tension may be ascertained while the machine is in an inoperative or other position. Obviously, to increase the tension it is only necessary to screw the bushing farther into the block **54**. This increased tension may be necessary when, for example, the diameter of a terminal, the thickness of its wall, or the character of the metal is such that additional tension is required to obtain a proper swaging job. Moreover, if for some reason or other the terminal is of a character that less than 150 pounds tension is required, the bushing **58** may be adjusted to reduce the tension.

To operate the machine, assuming the motor is in operation, it is only necessary to apply force to the treadle **6** to throw in the clutch mechanism generally designated **13** to rotate the shaft **27** and annular member **33**, whereupon the block **54** is reciprocated in its guideway by means of the pin **48**. The block **54** moves the crank arm **65** to pivot the circular cam member **89** and cause the jaw elements to move centripetally to swage the terminal disposed between the jaws as illustrated in Figure 11. One trip of the treadle is sufficient to operate the clutch mechanism and cause the swaging jaws to effect the swaging of one terminal, after which the parts including the shaft **27** are automatically returned to positions whereby they may again be operated by the clutch. As set forth above, certain of the swaging jaws act to prevent distortion of the terminal while it is being swaged onto a conductor wire. The compensating spring **62**, including other parts, provides a lost-motion connection between the crank arm **65** and the block **54** so that a predetermined pressure may be automatically placed upon the terminal while it is being swaged. This compensation has proven desirable because in some instances the resistance encountered by the jaws in swaging the terminal and the conductor wire is slightly greater in a given instance than in another, in which event the jaws will simultaneously move together a less distance to compensate for the greater resistance. Thus, the mechanism automatically compensates for slight variation in the bores of terminals or in the diameter of the conductor wires, and as above described, improved means including a scale are provided whereby the amount of pressure may be definitely ascertained in order that the operator may be in a position to know whether or not the terminals are being properly swaged to provide a good electrical and mechanical connection.

Although it is not essential, the unit above referred to is preferably covered by a cover or guard **136** whereby to protect an operator from the moving parts. Also, if desired, an oil tube **137** extending to the exterior of the cover may be provided for the bearing **28**.

Having thus described our invention, it is obvious that various modifications may be made in the same without departing from the spirit of the invention; and therefore, we do not wish to be understood as limiting ourselves to the exact form, construction, arrangement, and combination of parts, herein shown and described.

We claim:

1. The method of affixing a metallic sleeve to a metallic conductor means, comprising: disposing the conductor means in position in the sleeve, swaging in the sleeve simultaneously at a plurality of places spaced about the periphery of the sleeve by driving a plurality of pointed jaws into the sleeve at those places, forging localized sections of the sleeve ahead of said jaws producing a force on the underlying metal of said sections causing a flow of the inner metal of the sleeve to forge the sleeve and the conductor means at the plane of said sections into a solid cross-section, and at the same time drive a plurality of projections inwardly to substantially engage portions of the sleeve intermediate said sections whereby to substantially hold or reshape the periphery of said sleeve while said sections are being forged by said jaws.

2. The method of affixing a metallic sleeve to a metallic conductor means comprising: disposing the conductor means in position in the sleeve, and swaging in the sleeve simultaneously at a plurality of places spaced about the periphery of the sleeve, by driving a plurality of pointed jaws into the sleeve at those places, forging localized sections of the sleeve ahead of said jaws producing a force on the underlying metal of said sections causing a flow of the inner metal of the sleeve to forge the sleeve and the conductor means at the plane of said sections into a solid cross-section, and at the same time drive a plurality of projections inwardly to substantially engage portions of the sleeve intermediate said sections whereby to maintain said intermediate portions substantially static as respect to any substantial outward flow of the metal while said sections are being forged.

3. The method of affixing a metal sleeve to metallic conductor means, comprising: disposing the conductor means in position in the sleeve, and swaging in the sleeve simultaneously at at least three places spaced about the periphery of the sleeve by driving at least three jaws into the sleeve at those places, forging localized sections of the sleeve ahead of said jaws producing a force on the underlying metal of said sections causing a flow of the inner metal of the sleeve to forge the sleeve and the conductor means at the plane of said sections into a solid cross-section, and jaw means acting in conjunction with said jaws operating on said sleeve assisting to prevent outward flow of the metal intermediate said forged sections.

4. The method of affixing a metallic sleeve having a nose, land and skirt portion to conductor means, comprising: disposing the conductor means in position in the sleeve, swaging in the sleeve simultaneously on the nose, land and skirt at a plurality of places spaced about the periphery of the sleeve to cause the swaged portions of the sleeve to engage the conductor means in a manner whereby to secure the sleeve to the conductor means, and holding the sleeve to prevent undue distortion thereof while it is being swaged.

5. The method of affixing a metallic sleeve to metallic conductor means, comprising: disposing

the conductor means in position in the sleeve, swaging in the sleeve simultaneously at a plurality of places spaced about the periphery of the sleeve to engage said conductor means by driving a plurality of jaws into the sleeve in those places, and driving a plurality of projections inwardly to substantially engage portions of the sleeve intermediate at least some of said places whereby to substantially hold or reshape the sleeve while said sleeve is being swaged by said jaws.

6. The method of affixing a metallic sleeve to a metallic conductor means comprising: disposing the conductor means in position in the sleeve, and swaging in the sleeve simultaneously at a plurality of places spaced about the periphery of the sleeve, by driving a plurality of jaws into the sleeve at those places, forging localized sections of the sleeve ahead of said jaws producing a force on the underlying metal of said sections causing a flow of the inner metal of the sleeve to forge the sleeve and the conductor means at the plane of said sections into a solid cross-section, and driving a plurality of projections inwardly to substantially engage portions of the sleeve intermediate said sections whereby to maintain said intermediate portions substantially static as respect to any substantial outward flow of the metal while said sections are being forged.

7. The method of affixing a metallic sleeve having a land portion and a skirt portion to metallic conductor means having insulation thereon, comprising: disposing the conductor means in position in the sleeve with at least a portion of the insulation disposed in said skirt portion, swaging in the sleeve simultaneously on the land and on the skirt portions at a plurality of places spaced about the periphery of the sleeve by driving a plurality of jaws into the sleeve at those places to cause the swaged portions of the sleeve to engage the conductor means and the insulation in a manner whereby to secure the sleeve to the conductor means and the insulation, and driving a plurality of projections inwardly to substantially engage portions of the sleeve intermediate at least some of the places swaged whereby to substantially hold the sleeve while said sleeve is being swaged by said jaws.

8. The method of affixing a metallic sleeve to metallic conductor means, comprising: disposing the conductor means in the sleeve, moving means in a direction to swage in the sleeve at a plurality of places spaced about its periphery to engage the conductor means, and substantially at the same time moving other means in the same direction to engage the sleeve intermediate the places swaged whereby to substantially hold the sleeve while it is being swaged.

CHARLES S. PENFOLD.
ELMER E. JOHNSON.
GEORGE H. BRAILSFORD.