

Nov. 26, 1968

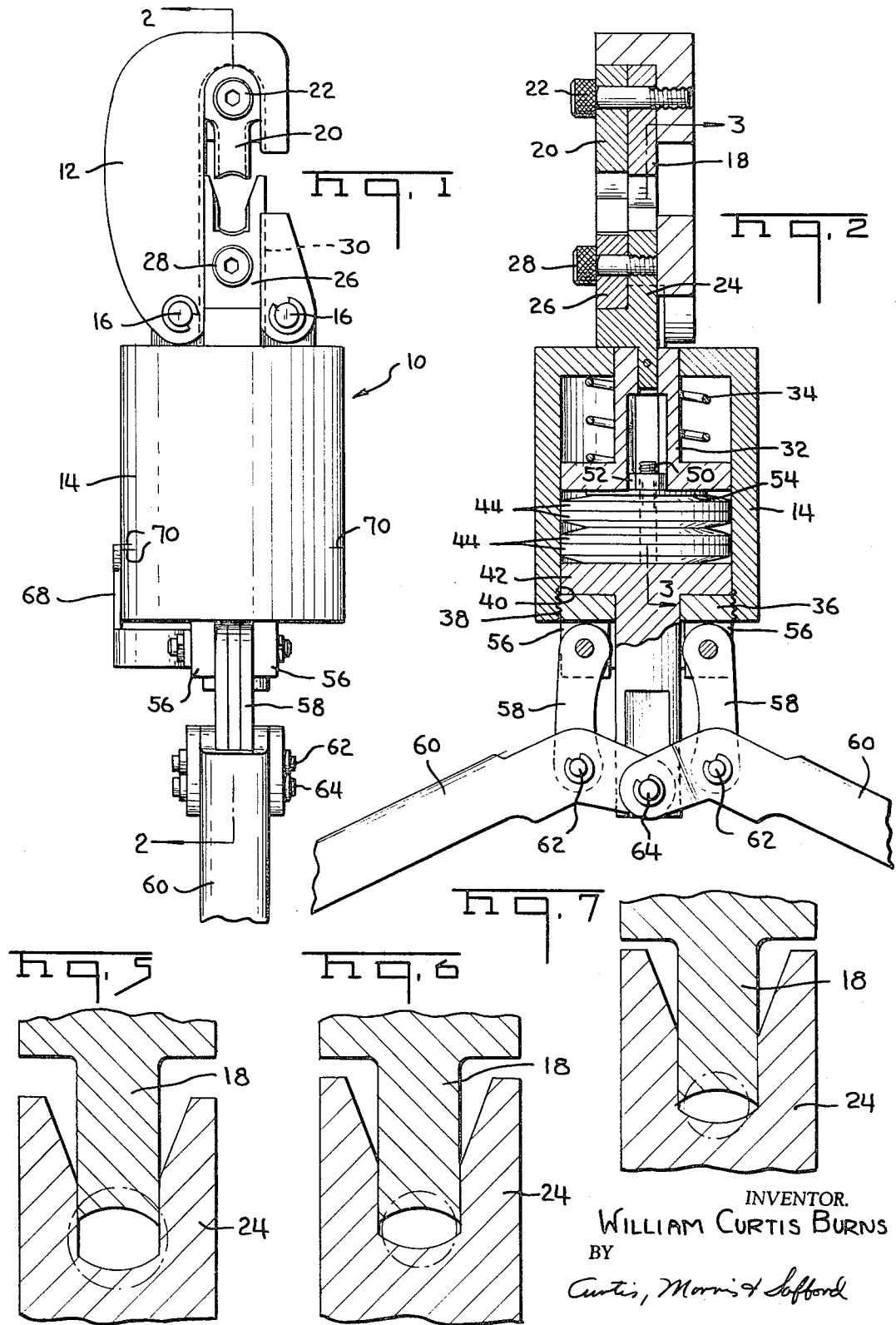
W. C. BURNS

3,412,596

COMPRESSING TOOL

Filed Dec. 30, 1965

3 Sheets-Sheet 1



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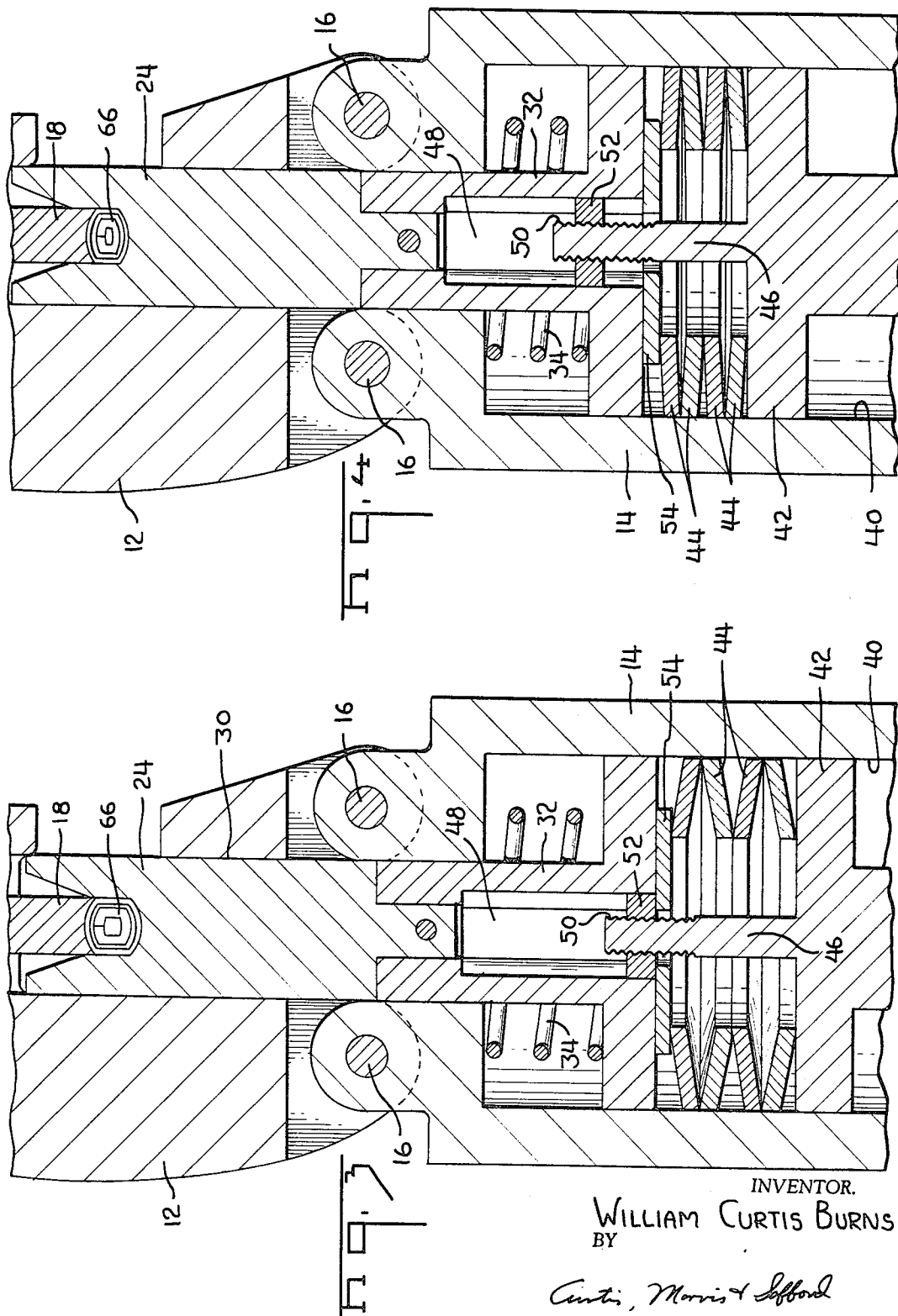
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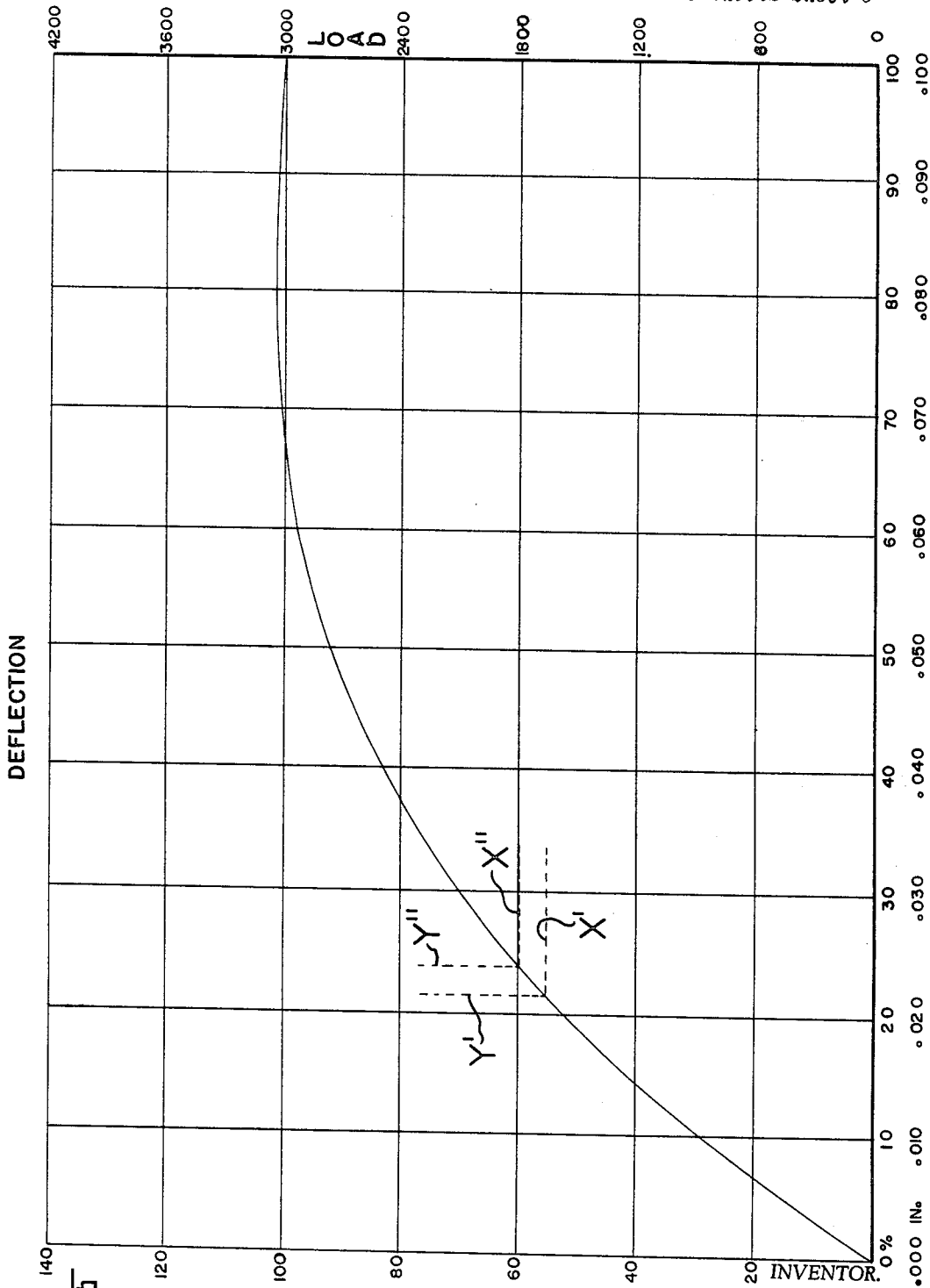
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LOAD - IN % OF LOAD - IN FLAT POS - T - OZ

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3,412,596

COMPRESSING TOOL

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ABSTRACT OF THE DISCLOSURE

A tool is provided having a pair of dies for compressing an article disposed between the dies. The drive train includes resilient force imposing means having a non-uniform spring rate. During the final stages of compression of an article the spring rate of the force imposing means is approximately zero thereby permitting a constant force output from the tool despite variance in size of the article due to manufacturing tolerances or the like. The tool is adjustable to permit a wide range of articles to be compressed without requiring substitution of the compressing dies.

Electrical terminals of a given type normally are available in a variety of sizes to accommodate various size electrical conductors. Most crimping tools employ a separate set of dies for each size terminal. For a given set of dies and terminal size it can be determined to what extent the terminal barrel must be compressed around the conductor to achieve optimum electrical and mechanical characteristics. This optimum condition is then translated in terms of die closure or "crimp height," that is the amount of distance between the upper and lower dies when bottoming occurs. The use of crimp height has several distinct disadvantages. Firstly, a given size terminal usually is employed with more than one closely related wire size with the result that a set crimp height which is proper for one wire size will produce a crimp which is either too loose or too tight for another wire size.

Secondly, a given size terminal will vary slightly in size due to manufacturing tolerances with the result that a set crimp height will produce crimps of varying quality. Manufacturing tolerances produce drastic size variations in the case of preinsulated terminals, that is where the barrel portion of the terminal comprises a layer of terminal material, a layer of metallic ferrule material and a layer of plastic insulating material.

Thirdly, the job of setting crimp height is a tedious one and this height must be reset for each set of dies.

It is therefore an object of the present invention to provide a tool which avoids the drawbacks of the type referred to above.

A further object is to provide a crimping tool whereby a single set of dies may be utilized for crimping a variety of sizes of terminal members.

A still further object of the present invention is to provide a tool which will produce uniform quality crimps on a given size terminal despite variations in size due to manufacturing tolerances.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described an illustrative embodiment of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purpose of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

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In the drawings, in which like reference numerals refer to like parts:

FIGURE 1 is a side elevational view of a tool embodying the teachings of the present invention;

FIGURE 2 is a view partly in section taken along the line 2-2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken along the line 3-3 of FIGURE 2 but showing the tool in a partially closed condition;

FIGURE 4 is a cross-sectional view similar to FIGURE 3 but showing the tool in its fully closed position;

FIGURES 5 through 7 are cross-sectional views of a pair of crimping dies used with the tool of FIGURE 1 showing the closed position of the dies when used on three different size terminals; and

FIGURE 8 is a graph showing the load-deflection characteristics of the tool of FIGURE 1.

Turning now to the drawings and in particular to FIGURES 1 and 2 there is shown a tool 10 for use in connecting metallic terminals to electrical conductors. The tool 10 comprises a generally C-shaped head section secured to a cylindrical body portion 14 by pins or the like as indicated at 16. A pair of male crimping dies 18 and 20 are rigidly secured at 22 to the head 12. For purposes of illustration the die 18 will secure the center conductor of a wire to a suitable terminal while the die 20 will secure the insulation of the wire conductor to the terminal. A pair of female dies 24 and 26, secured together at 28, cooperate with the dies 18 and 20 respectively to produce the crimping operation. The dies 24 and 26 are mounted for reciprocating movement within the head 12 and are guided therein by a pair of channels 30.

An upper ram 32 is slidably disposed within body section 14 and is rigidly secured at its upper end to the dies 24 and 26. A spring 34 is disposed between body section 14 and ram 32 and biases the ram downwardly as seen in FIGURE 2 to normally bias the dies 24 and 26 out of contact with the dies 18 and 20.

A bottom plate 36 is disposed in the lower portion of cylindrical body 14 and is externally threaded at 38 to mate with internal threads 40 formed in the body 14. Plate 36 has a central aperture through which extends a lower ram 42. Disposed within body 14 and between the upper ram 32 and lower ram 42 is a force imposing means shown in the figures as a series of Belleville washers 44. These washers have substantially a truncated cone configuration and are normally formed of a spring steel. It is to be understood that although Belleville washers have been shown and constitute a preferred form of force imposing means the washers may be substituted for other spring members without departing from the spirit of the present invention.

An elongated spindle-like member 46 extends from the upper surface of the lower ram 42, the said spindle extending through the openings in the washers and into a recess 48 formed in the upper ram 32. Spindle 46 is threaded at its free end as indicated at 50 and engages a nut 52 disposed in the recess 48. The recess 48 and nut 52 are so dimensioned that the nut is free to reciprocate up and down within the ram 32. However, the nut 52 is restrained against rotational movement relative to the ram 32. One or more spacer washers 54 may be utilized as required.

The bottom plate 36 has a pair of depending legs 56 extending therefrom to which are secured a pair of intermediate links 58. A pair of handles 60 are pinned at 62 to the links 58 and are pinned at 64 to the lower ram 42. In normal use the handles 60 will be grasped by an operator and pivoted between their opened and closed position to effect operation of the tool.

In FIGURE 2 the tool is shown in its fully opened position, i.e. the bottom ram 42 is at its lowermost point, the washers 44 are in their relaxed condition, and the return spring 34 is in its extended position to bias upper ram 32 to its lowermost position, thereby holding the crimping dies out of contact. In order to effect a crimp a terminal and wire conductor 66 are placed between the upper and lower crimping dies and the handles 60 are pivoted toward each other. Since the space between the upper and lower dies is greater than the outside diameter of the terminal barrel to be crimped there will be an initial period of quick takeup movement, that is the upper and lower rams will raise as a unit until the distance between the upper and lower dies equals the diameter of the terminal barrel. At this point, shown in FIGURE 3, the return spring 34 has been partially compressed while the washers 44 remain in their initial position. Further closure of handles 60 will result in resistance exerted by the terminal 66 and this resistance will be countered by the force exerted by the washers 44. As the washers 44 compress and exert their force the lower ram 42 will move relative to the upper ram 32. Movement of lower ram 42 is directly proportional to the amount of closure of handle 60 while movement of upper ram 32 is dependent on both the movement of lower ram 42 and on the amount of compression of the washers 44. As seen in FIGURE 4, which represents the final position of the tool, the washers 44 can be seen in their compressed condition with the spindle 50 and nut 52 having been displaced upwardly in the recess 48 in the upper ram 32.

The amount of force exerted on the terminal barrel to effect the crimping operation will be determined by the particular washers 44 which are employed. Since the washers will exert a predetermined force it can be seen that a fixed crimping force will be exerted to the terminals regardless of variations in size of the terminals due to manufacturing tolerances.

In order to fully understand the operation of the tool reference is made to FIGURE 8 wherein there is shown a graph illustrating the spring characteristics or spring rate of the typical Belleville washer. Conical spring washers may be produced to provide varying load deflection characteristics. The particular graph shown in FIGURE 8 is that of a conical spring washer having a "dish" equal to approximately 1.5 times the thickness of the washer. The particular washer chosen will exert a force of 3000 pounds when deflected into its flat position. As can be seen in FIGURE 8 the washer will exert a force of approximately 3000 pounds from its position of 67% deflection to its flat position or 100% deflection. This is an extremely desirable characteristic of the washers in that variations in size of the terminals to be crimped which results in slight variations in the amount of displacement of the washers will not appreciably change the force exerted by the washers.

The particular tool illustrated has been designed for use with three size terminals. The largest size, shown in phantom in FIGURE 5, requires a force of 3000 pounds for an effective crimp. The intermediate size terminal, shown in phantom in FIGURE 6, requires a crimping force of approximately 1350 pounds. The smallest size terminal, shown in phantom in FIGURE 7, requires a crimping force of approximately 1200 pounds. It is important to note in these figures that the crimping dies never bottom regardless of the size terminal being used, this being a drastic departure from conventional crimping tools. Since the dies do not bottom, the manufacturing tolerances of the dies which must be rigidly held in conventional tools are not critical with the present tool, thus resulting in a considerable savings in the cost of die manufacture. For purposes of illustration a total deflection of 0.100 inch has been chosen as representing 100% deflection. Therefore the tool may be designed to effect 0.070 inch deflection of the washers to produce the required 3000 pounds force. When it is desired to crimp the intermediate size terminal of FIGURE 6 an adjustment must

be made to the washers 44 in order to change the force exerted from 3000 pounds to 1350 pounds. As seen in the graph of FIGURE 8 axes X' and Y' are shown in dotted lines and intersect the graph at a point representing 1650 pounds. This leaves a remainder of 1350 pounds which is the desired force. The axes X' and Y' intersect the graph at a deflection of 0.021 inch which represents the amount of deflection which must be taken out of the washers in order to achieve the final force of 1350 pounds. Referring again to FIGURE 2 it can be seen that the tool is adjusted by grasping the body 14 to hold it stationary while taking the handles 60 and rotating them relative to the body 14, the adjustment being made prior to operation of the tool. This rotation will cause the bottom plate 36 to rotate relative to body 14 and to be displaced axially therealong due to the threads 38 and 40. It can also be seen that the bottom ram 42 will rotate together with handles 60 and rotation of the ram 42 causes rotation of spindle 46 relative to nut 52 to thereby cause compressing movement of the washers 44. Assuming the threads 38 and 40 to have a lead of 0.006 inch it would require three and one-half revolutions of the handles 60 in order to axially displace the ram 42 0.021 inch. With this initial compression of the washers 44 the tool will then be used exactly as before, the only change being the ultimate force produced will be limited to 1350 pounds.

When it is subsequently desired to crimp the smallest size terminal requiring 1200 pounds another adjustment must be made. Turning again to FIGURE 8 there is shown the axes X'' and Y'' which intersect the graph at 1800 pounds leaving a remainder of 1200 pounds representing the final desired force. The axes X'' and Y'' also can be seen to intersect the graph at a deflection of 0.024 inch which again will represent the amount of deflection which must be taken out of the washers 44 in order to achieve the desired final force. Turning again to FIGURE 2 it can be seen that if the tool is adjusted to 0.021 inch initial compression all that will be required is a half revolution of handles 60 which will add 0.003 deflection to the washers which will result in the total initial deflection of 0.024 inch. Again the tool will be utilized as before with the total force developed at full handle closure being 1200 pounds.

Since the adjustments to the tool are all internal of the body 14 there is provided a means to indicate to the operator the position of adjustment of the tool. This means is shown as an indicating arm 68 which may be secured to the bottom plate 36 thereby causing the arm 68 to rotate together with the handles 60. The body 14 is provided with three indicia marks 70 which may be cross hairs and may be color coded or the like to indicate to the operator the three positions of adjustment of the tool. When the indicator 68 is aligned with one of the indicia 70 the operator will know which size terminal the tool has been adjusted to operate on.

It is to be noted that the washers 44 have been shown in series arrangement, such arrangement having the effect of maintaining the force available in the washers constant while permitting adjustment of the amount of deflection of the washers. In other words if each washer is designed to produce a force of 3000 pounds at a deflection of 0.025 inch, a series of four washers will produce a force of 3000 pounds at a deflection of four times 0.025 inch or 0.100 inch.

It can be seen that the objects of the invention have been achieved in that a tool has been provided which will operate on various size terminals and will produce a constant high quality crimp regardless of slight variations in size of the terminals within a given group. Also a single set of dies may be employed for use with the various size terminals.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered

by way of illustration only. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective against the prior art.

What is claimed is:

1. A compressing device comprising a tool body, a first die fixed to said body, a second die movable relative to said body and cooperable with said first die to compress an article disposed therebetween, a first ram secured to said second die and movable relative to said body, a second ram movable relative to said body and to said first ram, means to effect movement of said second ram towards and away from said first ram, and force imposing means disposed between said first and second rams for transmitting force from said second ram to said second die, said force imposing means comprising resilient means having a non-uniform spring rate, said spring rate approaching zero during compression of said article between said first and second dies.

2. A compressing device as set forth in claim 1 wherein said resilient means comprises at least one spring washer.

3. A compressing device as set forth in claim 1 further comprising spring means disposed between said first ram and said body for effecting return movement of said second die away from said first die.

4. A compressing device as set forth in claim 1 further comprising means to adjust the position of said second ram relative to said first ram.

5. A compressing device as set forth in claim 4 further comprising means to indicate the adjusted position of said second ram.

6. A compressing device as set forth in claim 1 further comprising externally threaded means secured to said second ram, nut means disposed within said second ram, said nut means being capable of axial displacement relative to said second ram and restrained against rotation relative thereto, said threaded means threadably engaging said nut means, means to effect relative rotational movement between said second ram and said first ram whereby said threaded means adjusts the relative position of said first and second rams and whereby said resilient means is

preloaded to thereby effect a change in the compressing force produced by movement of said second die into cooperation with said first die.

7. A compressing device for swaging metallic terminal members of different sizes to corresponding electrical conductors comprising a body member with a head on one end thereof, operating handles on the other end of said body member, a first swaging die secured to said head, a relatively movable swaging die disposed in said one end of said body member and aligned with said first die, force imposing means in said body including adjustable resilient means having a spring rate and transmitting force from said handles to said movable die, and means for changing the adjustment of said resilient means to limit the amount of force transmitted, said adjustment changing means being operative to initially compress said resilient means prior to operation of said handles to thereby decrease the available force transmitting capability of said resilient means by an amount dependent upon said spring rate, whereby different size terminal members may be swaged onto corresponding conductors with the same tool and the same swaging dies.

8. A compressing device as set forth in claim 7 wherein said adjustment means comprises an end plate on said tool body adapted to move into said tool body by increments to compress said force imposing means to thereby vary the output forces produced between said swaging dies.

9. A compressing device as set forth in claim 2 wherein said spring washer has a dish equal to approximately 1.5 times the thickness of said washer.

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