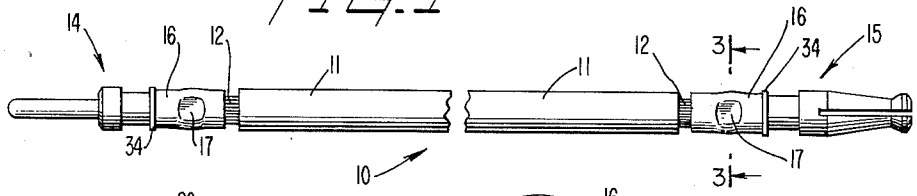
Dec. 7, 1965 J. F. BAZATA ETAL 3,221,532

CRIMPING APPARATUS

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Fig. 1



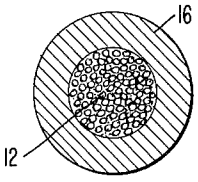


Fig. 2

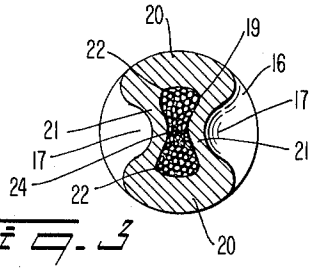


Fig. 3

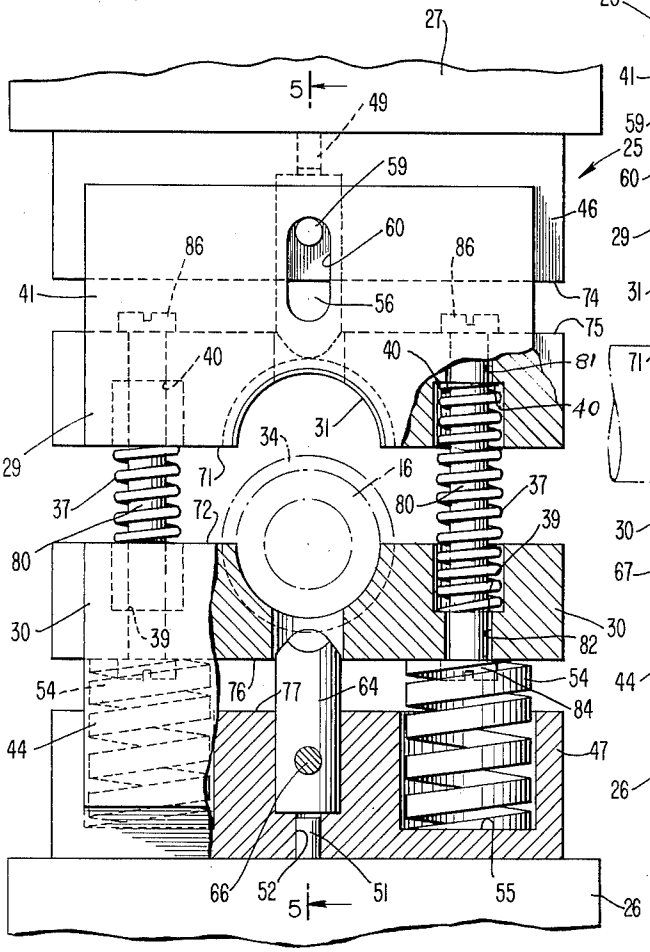


Fig. 4

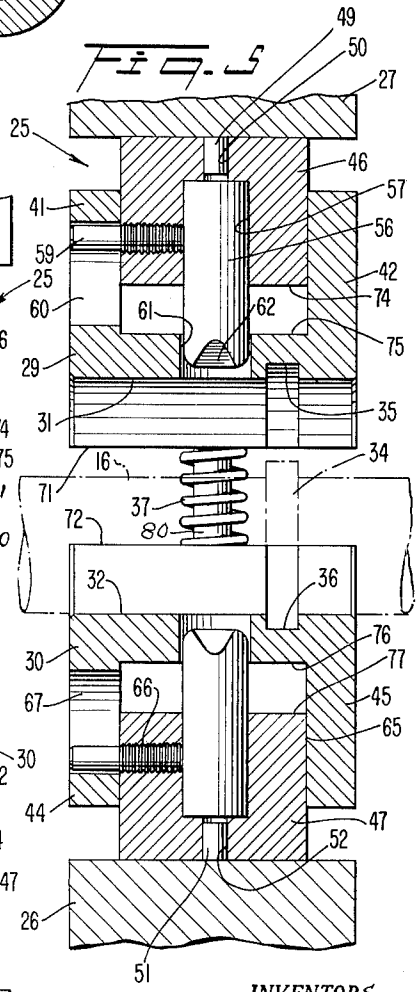


Fig. 5

INVENTORS
JOSEPH F. BAZATA
ROBERT GOEBELER

BY Bauer and Seymour

ATTORNEYS

Dec. 7, 1965 J. F. BAZATA ETAL 3,221,532

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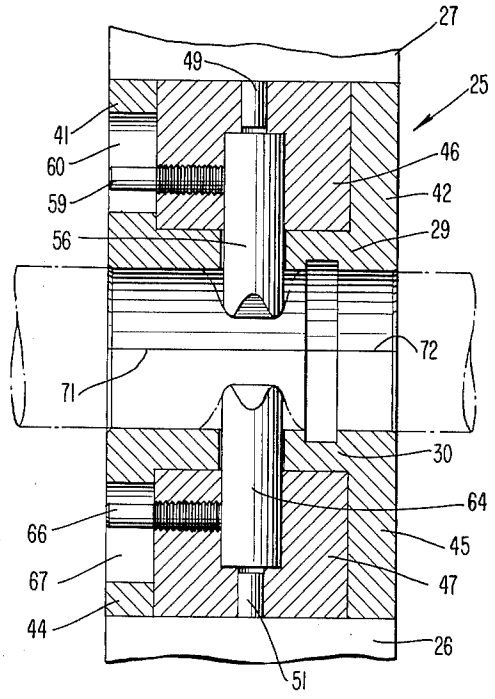


Fig. 6

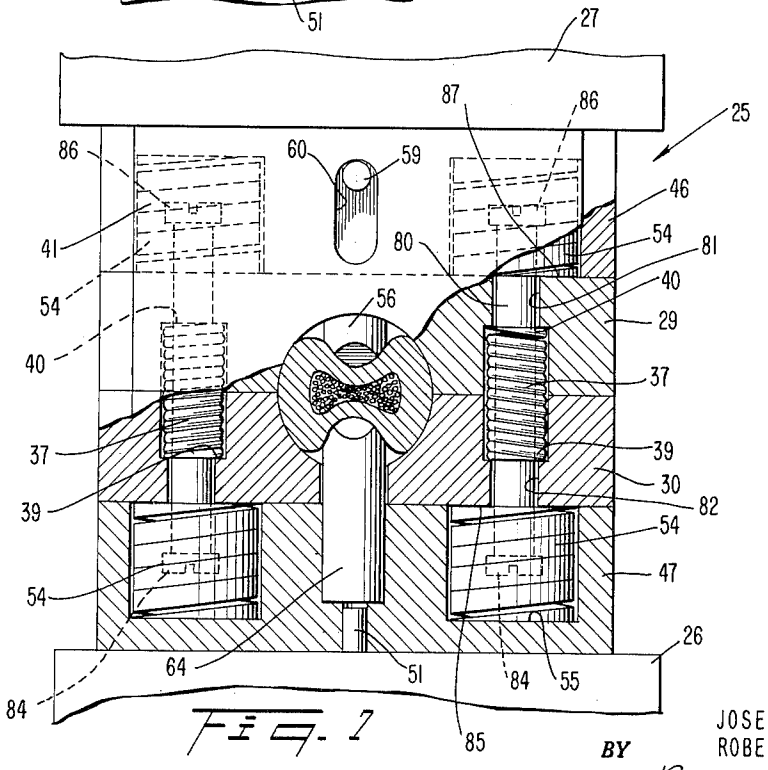


Fig. 1

INVENTORS
JOSEPH F. BAZATA
ROBERT GOEBELER

BY Bauer and Seymour
ATTORNEYS

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CRIMPING APPARATUS

Joseph F. Bazata, Sidney, and Robert Goebeler, Unadilla, N.Y., assignors to The Bendix Corporation, Sidney, N.Y., a corporation of Delaware

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8 Claims. (Cl. 72—312)

This invention relates to an apparatus for crimping ferrules, as for effecting secure mechanical and electrical connection between a ferrule and a conductor telescoped therein.

The invention has among its objects the provision of improved ferrule crimping apparatus which is particularly characterized by its economy, simplicity, and ease of maintenance.

Still another object of the invention lies in the provision of ferrule crimping apparatus which is easily operated and which produces crimped joints which are substantially uniform from joint to joint during production.

The above and further objects and novel features of the invention will more fully appear from the following description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a view in elevation of an illustrative cable provided with socket and pin contacts at its respective ends, the conductor being joined to the contacts by use of the method and apparatus of the present invention;

FIG. 2 is a view in transverse section through the ferrule of one of the contacts shown in FIG. 1 before it has been deformed by use of the apparatus and method of the invention, a multi-strand conductor being shown telescoped within the ferrule;

FIG. 3 is a view in transverse section through the crimped joint which connects one of the contacts to the conductor, the section being taken along the line 3—3 of FIG. 1;

FIG. 4 is a fragmentary view partially in end elevation and partially in vertical transverse section through an illustrative embodiment of crimping apparatus in accordance with the invention;

FIG. 5 is a view in vertical section through the apparatus of FIG. 4, the sectioning plane passing through the axis of the ferrule-embracing cavity of the apparatus, the section being taken along the line 5—5 of FIG. 4;

FIG. 6 is a fragmentary sectional view similar to FIG. 5, but with the ferrule-embracing elements and crimping tools fully advanced to their final position; and

FIG. 7 is a view in end elevation of the apparatus in the condition shown in FIG. 6, the view being taken in the direction from left to right in FIG. 6.

Crimped connections between circuit elements such as socket pins, contacts, and the like and electric cables or conductors are rapidly displacing soldered joints. Not only can the crimped connection be made without the use of heat, thereby avoiding possible damage to the circuit elements and the wire, but it has been found that when properly made a crimped connection is more reliable from an electrical standpoint than is a soldered joint. Difficulty has been experienced, however, in making satisfactory crimped joints between relatively large diametered, heavy walled ferrules and conductors telescoped therein. Such difficulty has arisen because with prior methods and apparatus the configuration of the ferrule wall could not be accurately controlled, particularly at those locations which were not directly engaged

by the crimping tools. The present invention overcomes such difficulties by controlling the configuration of the deformed ferrule throughout its extent, thereby restraining the portions of the ferrule not directly engaged by the crimping tools from unwanted expansion which would destroy the efficiency of the joint.

Turning now to the drawings, in FIG. 1 there is shown an illustrative lead wire or cable assembly, generally designated by the reference character 10. Such assembly includes an insulated multi-strand wire 11, the conductor of which is designated 12. Affixed to a bared portion of conductor 12 at one end of cable 11 is a contact pin generally designated 14, there being a socket contact 15 similarly affixed to the other end of the conductor. Each of contacts 14 and 15 has a rearwardly open ferrule 16 integral therewith. In the assembly shown in FIG. 1 the bared end of conductor 12 has been telescoped within each of the ferrules 16 and has been joined thereto by a crimped joint formed by two oppositely disposed indentations 17 in the wall of the ferrule.

The structure of the crimped joint at the location of the indentation 17 is shown more clearly in FIG. 3. As there shown, the opposite indentations 17 in the sidewalls of the ferrule have caused the multi-strand conductor 12 to become deformed from an initially generally circular shape (FIG. 2) to a dumbbell shape designated 19 in FIG. 3. Portions 21 of the sidewall of the ferrule at and approaching the most constricted portion of the squeezed cable 19 have been thinned or drawn somewhat, the deformed ferrule engaging cable portion 19 forcibly throughout its extent, including the zone of the cable confronting the substantially undeformed portions 20 of the ferrule and the thin center section thereof, designated 24. The individual strands making up the cable have been thrust together so that they have substantially the appearance of a single solid piece of metal. The resulting joint is most satisfactory, both by reason of the security of mechanical retention of the cable in the deformed ferrule, and because of the excellence of the electrical connection therebetween. The tight engagement between the deformed ferrule and the cable, as well as the engagement between the individual strands in the cable, virtually prevents the intrusion of air between the engaging surfaces forming the joint.

The illustrative crimping apparatus of the invention is generally designated by the reference character 25. Such apparatus is shown as being mounted upon the bottom platen 26 of a press. The upper platen or plunger 27 of the press, which is shown fragmentarily, upon approaching platen 26 causes the crimping appartus first to embrace a ferrule to be crimped and, in the latter part of the relative travel of the platens, causes oppositely disposed indenting tools to form the above-described indentations 17 in the wall of the ferrule. Apparatus 25 has opposed, generally similar upper and lower cage members 29 and 30, respectively. Half-bores 31 and 32 are formed by the confronting faces of elements 29 and 30, respectively, such half-bores when placed together as shown in FIGS. 6 and 7 forming a circular cylindrical bore which accurately and snugly embraces the outer sidewall of the undeformed ferrule. The illustrative contacts 14 and 15 each includes a collar or flange 34 located close to the blind end of the bore in the ferrule. Bores 31 and 32 are accordingly provided with part-circular recesses 35 and 36, respectively, which, when elements 29 and 30 are together, accurately receive flange 34 on the ferrule. As a consequence, the ferrule may be accurately located and held in a predetermined axial position in the crimping apparatus.

Disposed between elements 29 and 30 are two coil compression springs 37, located at equal distances from the ferrule-receiving cavity. Springs 37 are retained in

elements 29 and 30 by having their ends telescoped within deep spring seats in the respective elements, one such spring seat in element 30 being shown at 39 and another of which is shown at 40 in element 29 (FIG. 7). The springs 37 are of such construction and the spring-receiving seats are of such depth that elements 29 and 30 may be thrust together with their confronting faces 71 and 72, respectively, in contact, as shown in FIGS. 6 and 7.

As shown in FIGS. 5 and 6, the upper cage element 29 is provided with two axially spaced upstanding end flanges 41 and 42. The bottom cage element 30 is provided with two similar flanges 44 and 45 which, however, extend downwardly. An upper indenting tool mounting block 46 is accurately received between flanges 41 and 42 and is vertically reciprocable in the guideway formed by such flanges. A generally similar lower indenting tool mounting block 47 is mounted for vertical reciprocation between flanges 44 and 45. Blocks 46 and 47 have small central vertically disposed bores 50 and 52 therein, respectively. Such bores may receive a pilot pin 49 which projects from the lower surface of upper platen 27, and an upstanding pin 51, which projects from the upper surface of lower platen 26. With such construction a proper alignment of the upper and lower parts of the indenting apparatus is assured. It is to be understood, however, that other means may be employed, if desired, accurately to align the parts of the apparatus on the respective platens.

Interposed between block 46 and cage 29 is a pair of heavy coil compression springs 54, such springs being disposed at either side of the ferrule-embracing cavity substantially coaxial of springs 37. The upper ends of such first pair of springs 54 are received within deep spring seats in block 46. A similarly located similar pair of lower springs 54 is interposed between lower cage element 30 and lower block 47. As shown in FIG. 4, the lower end of each of the latter pair of springs is received in a deep spring seat 55 in block 47. As will appear hereinafter, the compressive strength of each of springs 54 substantially exceeds that of the springs 37. Thus upon downward travel of the upper platen 27, the two cage elements 29 are first moved together against the opposition of springs 37, and before substantial compression of springs 54, following which the springs 54 are compressed to allow the indenting tool mounting blocks 46 and 47 to approach each other.

An upper indenting tool, designated 56, has a circular cylindrical body portion which is accurately received within a central vertical bore 57 in block 46. Tool 56 may be retained in block 46 by a driven fit, if desired, or it may be held by a transverse pin 59 which has threaded connection with a bore extending laterally in block 46 to bore 57. In the construction shown, pin 59 is reciprocably mounted in a vertical slot 60 through flange 41 so as to guide block 46 vertically and to retain it from undue lateral motion. A vertical central bore 61 through block 29 accurately and slidably receives the lower end or nose portion of tool 56. Engagement between such tool and bore 61 thus additionally guides block 46 relative to cage 29. The lower end of tool 56 is located appreciably above the central portion of surface 31 of the upper cavity part when the parts are in the position shown in FIG. 5, such lower end of the tool remaining spaced radially outwardly of the cavity until springs 37 have been compressed to place cages 29 and 30 in contact with each other. The lower end of tool 56 is bevelled on both sides thereof, as indicated at 62, so as to form an indentation 17 having the shape shown in FIGS. 1, 3, and 7.

The lower indenting tool 64 is similarly mounted in a vertical bore 65 in block 47. A horizontally extending pin 66 is threaded into a bore in block 47 so that its inner end is in engagement with tool 64. Pin 66 cooperates with slot 67 in flange 44 to guide block 47 in the same manner as the upper block 46. The upper end of tool 64 extends accurately and slidably into a central bore 69 in the upper portion of cage 30, so as to guide block 47 relative to cage 30. The upper end of tool 64, which is bevelled at 70 in the same manner as the lower end of the upper tool, lies radially outwardly of or below the ferrule-embracing cavity until the springs 54 have begun to be appreciably compressed.

The cage members 29 and 30 are preferably further connected and guided by headed vertical pins 80 which extend axially within the springs 37, as shown. The upper end of each pin 80 is slidably received in a bore 81 in cage member 29, the upper head 86 on the pin lying above upper surface 75 of member 29. The lower end of each pin is slidably received in a bore 82 in cage member 30, the lower head 84 on the pin lying below lower surface 76 of member 30. When the cage members 29 and 30 are retracted from each other, heads 86 and 84 of pins 80 engage or substantially engage surfaces 75 and 76, respectively, to prevent accidental disassembly of the cage members. The pins 80 permit the cage members 29 and 30 freely to approach each other and to assume the fully advanced position of FIG. 7.

In forming a crimped joint by use of the apparatus of the present invention, the bared end of a cable 12 is telescoped within an undeformed ferrule 16 as shown in FIG. 2. Such assembly of ferrule and cable is now mounted in the cavity presented between the cages 29 and 30 positioned as shown in FIGS. 4 and 5. The flange 34 is disposed in recess 36, so as to locate the ferrule axially. The press is now operated to cause platens 26 and 27 relative to approach each other. Springs 37 first become compressed, before appreciable compression of springs 54, so that the confronting broad faces 71 and 72 of cages 29 and 30, respectively, engage each other. The ferrule is now completely and snugly embraced within the cavity formed by cavity parts 31 and 32. Continued approach of platens 26 and 27 toward each other now causes progressive compression of springs 54 and thus progressive entry of the working ends of tools 56 and 64 into such cavity, thereby to deform the ferrule and the wire telescoped therewithin in the manner shown in FIGS. 3 and 7.

Although only one embodiment of the invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be especially understood that various changes, such as in the relative dimensions of the parts, materials used, and the like, as well as the suggested manner of use of the apparatus of the invention, may be made therein without departing from the spirit and scope of the invention as will now be apparent to those skilled in the art.

What is claimed is:

1. Apparatus for crimping a ferrule about a wire to effect mechanical retention of the wire in the ferrule, comprising two opposed blocks connected together for reciprocable movement relatively toward and away from each other, the blocks each having an open sided cavity in the face thereof which confronts the other, the cavities together presenting an opening in the blocks when the blocks are close together, the opening being of such size and shape as closely to receive and confine an undeformed ferrule, a first yieldable means constantly urging the blocks away from each other, a passage in at least one of the blocks generally aligned with the path of relative reciprocation of the blocks and opening into the cavity in the block, a punch-like tool having a shank aligned with and receivable through the passage in said one block, means supporting the tool, and a second yieldable means, having a yielding point appreciably higher than that of the first yieldable means, acting between the said one block and the tool-supporting means constantly to urge the tool supporting means and the said one block apart, whereby when the other of the blocks and the tool-supporting means are thrust toward each other the first yieldable means is first overcome and the blocks are

forced together to embrace and hold a ferrule positioned in the opening, following which the second yieldable means is overcome and the tool is advanced through the passage into the opening to indent the wall of the thus held ferrule.

2. Apparatus as claimed in claim 1, wherein the yieldable means comprise springs, and the springs of the second yieldable means are stiffer than those of the first yieldable means.

3. Apparatus as claimed in claim 1 wherein said opening in the blocks receives and confines the ferrule throughout the zone of indentation.

4. Apparatus for crimping a ferrule about a wire to effect mechanical retention of the wire in the ferrule, comprising two opposed blocks connected together for reciprocable movement toward and away from each other, the blocks each having an open sided cavity in the face thereof which confronts the other, the cavities together presenting an opening in the blocks when the blocks are close together, the opening being of such size and shape as closely to receive and confine an undeformed ferrule, a first yieldable means constantly urging the blocks away from each other, a passage in each of the blocks generally aligned with the path of relative reciprocation of the blocks and opening into the cavities in the blocks, opposed punch-like tools having shanks aligned with and receivable through the passages in the respective blocks, a separate means beyond each of the blocks supporting the respective tools, and a second yieldable means, having a yielding point appreciably higher than that of the first yieldable means, acting between each of the tool-supporting means and the respective block through which its tool is adapted to extend constantly to urge such tool-supporting means away from its respective block, whereby when the tool-supporting means are thrust together the first yieldable means is first overcome and the blocks are forced together to embrace and hold a ferrule positioned in the opening, following which the second yieldable means is overcome and the tools are advanced through the passages ito the opening to indent the wall of the thus held ferrule.

5. Apparatus as claimed in claim 4, comprising means acting between each of the blocks and its respective tool-supporting means to retain them together and mutually to guide them during their relative reciprocation.

6. Apparatus as claimed in claim 5, wherein the blocks have parallel flanges extending away from the cavities, and the tool-supporting means are in the form of further blocks slidably received between and guided by the said flanges.

7. Apparatus as claimed in claim 6, wherein when the first named blocks are spaced from each other the outer ends of the further blocks protrude outwardly beyond the ends of the flanges, and when the indenting tools have completed their inward working stroke the outer ends of the further blocks lie substantially flush with the outer ends of the flanges.

8. Apparatus as claimed in claim 6, comprising an elongated slot in one of the flanges of each first named block, the slots lying parallel to the direction of reciprocation of the first named blocks, and a pin-like member secured to each of the further blocks and protruding into the slot in the flange of the respective first named block.

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CHARLES W. LANHAM, *Primary Examiner.*