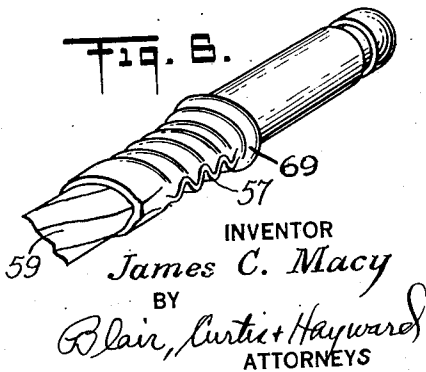


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TOOL FOR CRIMPING FERRULES

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2,639,754

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Fig. 7.

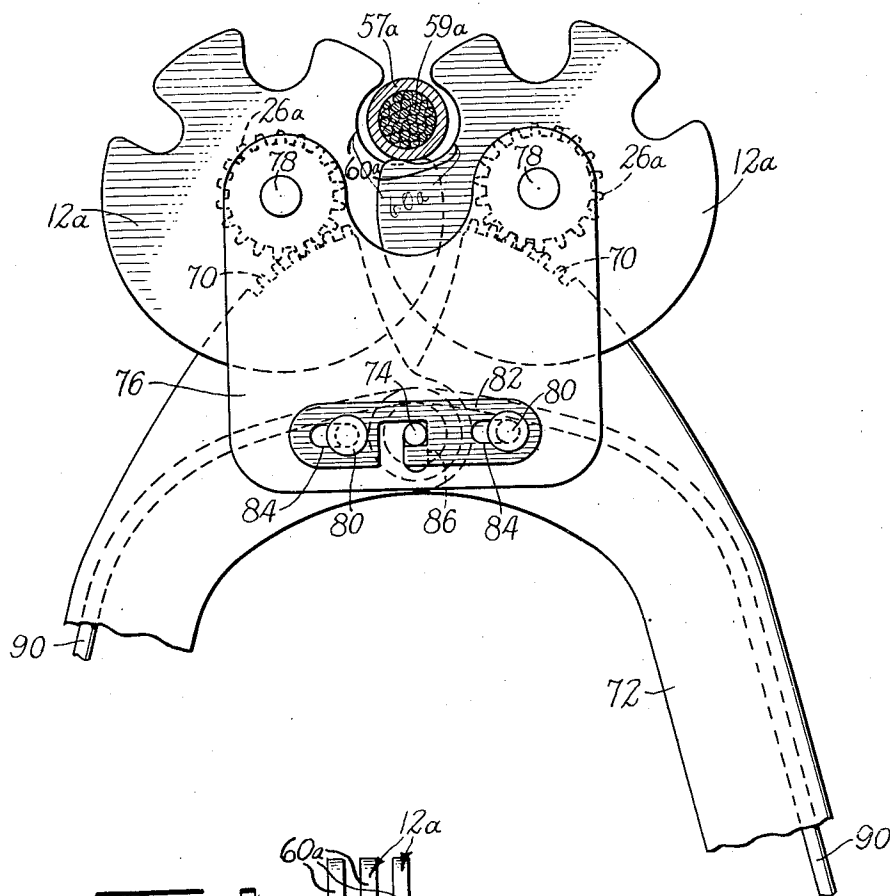
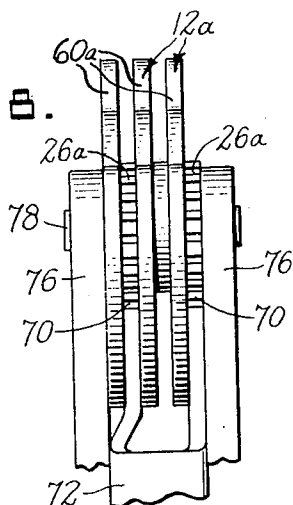


Fig. 8.



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TOOL FOR CRIMPING FERRULES

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This invention relates to the crimping into interlocking and good electrically conductive relation to each other of terminal ferrules and electrical conductors and a general object of the invention is an improved means for practicing the method.

To insure good electrically conductive connections between terminals and conductors, without the use of solder, it is important that such a coining or die-pressing of the metal, both of the terminal ferrule and of the conductor, be brought about, when crimping the ferrule into interlocking relation to the conductor, that a permanent set of the two parts in their new relation to each other is obtained. It is also important, where the conductor is made up of a plurality of wires or strands, that the crimping action not only set the ferrule permanently in its new relation to the strands of the conductor, but that it effect a distortion of the conductor by which it is interlocked with the ferrule substantially permanent relation to each other. This requires, as above suggested, a die-pressing of the metal, both of the ferrule and of the conductor strands, not only sufficient to bring them into intimate contact with each other and to produce an interlocking relation of the ferrule and the conductor but also with flow of metal sufficient to set them in this relation, whereby the mechanical and electrical connection relation thus brought about will be permanent.

As heretofore practiced, the crimping of terminal ferrules into electrically conductive and interlocking relation to each other has usually involved the use of directly opposed crimping dies. Because of the fact that the crimping pressures upon opposite sides of the ferrule are in such case directly opposed to each other, interlocking and clean metal-to-metal contact are brought about by extrusion cold flow of the metal under pressure exerted by the dies. This extrusion causes a lengthening of the ferrule during crimping, and requires special precautions to avoid weakening of the wire.

Among the objects of the present invention is an improved method of effecting the interconnection and interlocking of the conductor and ferrule which insures a permanent low resistance connection that has very high holding power under longitudinal strain, and that can be effectively formed with application of substantially lower pressures on the wires during the crimping operation. To this end the invention contemplates bringing to bear both upon the ferrule and through it upon the conductor therewithin of

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staggered crimping dies at alternately spaced locations along opposite sides of the ferrule and pressing them together, whereby compression occurs along spaced shear planes of a magnitude sufficient to effect a solid compacting or coining of the metal, both of the ferrule and of the conductor, combined with a "wiping" action which brings about a better metal-to-metal contact. After this pressing, both the ferrule and the conductor are permanently distorted into zig-zag interlocking relations to each other.

An important feature of the invention is the construction and arrangement of the crimping means and the limitation of the relative movements of the parts thereof so that, while sufficient shear stress can be exerted upon the ferrule and the conductor therewithin to produce such permanent zig-zag interlock between the ferrule and the conductor, there will be sufficient clearance of the die surfaces laterally from a shear plane so that no actual shearing of the metal occurs. This not only insures a good electrically conductive interlock of the ferrule and conductor of a character that will resist endwise pull but the overlapping of the dies at the edges insures a tight sheath-like fitting of the ferrule about the conductor.

Other objects and important features of the invention to which reference has not specifically been made hereinabove will appear when the following description and claims are considered in connection with the accompanying drawings.

In this specification and the accompanying drawings I have shown and described a preferred embodiment of my invention and various modifications thereof; but it is to be understood that these are not intended to be exhaustive nor limiting of the invention but, on the contrary, are given for purposes 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 and adapt it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

Figure 1 is a side elevation of a crimping die assembly embodying the structural features of the present invention and designed to practice the novel process of the present invention;

Figure 2 is a view in end elevation taken from the right-hand end of Figure 1;

Figure 3 is a perspective view of one of the assembly of crimping plates or dies which go to

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make up the composite crimping die of the invention as illustrated in Figure 1;

Figure 4 is a fragmentary view in elevation of one of the separator or filler plates and one of the plates shown in operative relation;

Figure 5 is a longitudinal section through the crimping dies of Figure 1, with a terminal plug therein and with the dies in their operative crimping relation to each other,

Figure 6 is a perspective view of a conductor and terminal plug crimped into interlocking relation to each other in accordance with the present invention;

Figure 7 is a view in elevation of a hand-crimping tool with the handles broken away and with a terminal ferrule shown in section ready for initial engagement between the crimping jaws, and

Figure 8 is a fragmentary view in elevation taken from the right-hand side of Figure 7.

In the illustrative embodiment of the invention, which shows a crimping die assembly for use in a standard press, e. g. of the toggle, pneumatic or hydraulic type. The die shown is particularly designed for crimping a plug terminal onto the end of a stranded conductor. Upper and lower die carrier blocks or jaws 2 and 4 are arranged for rectilinear movement to and away from each other, such rectilinear movement being insured by a die holder guide pin 6 fitting into vertical openings 3 and 10 respectively in the jaws of blocks 2 and 4. The guide pin 6 may be fixed in the opening 3, and may slide in the opening 10 or vice versa, the relative movements of the die carrier blocks being comparatively small.

In the illustrative embodiment of the invention, each die holder has within it a series of crimping plates or dies 12, e. g. as best shown in Figures 3 and 4. As shown, spacer plates 26 alternate with the die plates 12 and in addition special crimping dies 14, such as best shown in Figure 2, are provided for crimping the end of the ferrule in accordance with the Patent No. 2,359,083. As shown in Figure 1, the upper clamping block 2 is provided with a die-receiving socket 16 for holding the crimping dies and the lower block 4 is provided with a similar socket 18 for holding the cooperating dies. It will be noted that each of the dies 12 and 14 is provided with two openings to receive die-holding pins 20, each provided with a machine screw head 22 and with a threaded end 24, received in a corresponding tapped opening in the die block, for securing the holding pin in holding relation to the die block or jaw.

As shown in Figure 1, the upper die holder is provided with three crimping dies or plates 12 of the form shown in Figure 4 and with one crimping plate 14 of the form shown in Figure 2. The lower die block or holder 4 is provided with four crimping plates or dies of the form shown in Figure 2 and with one special crimping plate or die 14 of the form shown in Figure 3. Filler plates or separators 26 are arranged between the dies 12 in each of the blocks 2 and 4 in such manner that the dies 12 in the upper block 2 are in staggered relation to the dies 12 of the lower block 4, and vice versa, the filler or separator plates 26 being each of slightly greater thickness than the thickness of the opposite die plate 12. The spacer plates may be the same thickness, or less than, the die plates or may even be omitted entirely, but in any case it is desirable to allow sufficient clearance between adjacent edges of the

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adjacent, overlapping die plates so that a continuous sinuous integral sinuous border strip is left at each edge as shown in Figure 6, without actual shearing of the metal. The spacer plates 26 as shown serve additional functions as further discussed below.

To avoid any tendency to cut the metal of the ferrule or of the conductor when shear stresses are being brought to bear upon it by the dies 12, the edges of the metal-engaging parts of the dies 12 may be slightly rounded or dulled somewhat.

To permit connection and proper positioning of the die blocks or jaws 2 and 4 in a press or a pressure tool, e. g. a plier-like tool, each is provided with a slotted pin which is received in a corresponding opening in the press or tool.

To insure quick and accurate location of a terminal between the crimping dies, a spring stop is preferably located in a recess 42 in the lower block or die holder 4. The illustrated spring stop comprises a block 44 mounted in said recess and provided with a longitudinal guideway for a stop slide 46 having at one end an upwardly extending terminal engaging stop 48 and at its other end a downwardly extending spring-engaging portion 50. The spring 52 is received in a spring guide below the guideway for the slide 46 and at its other end engages a pin 54 fixed in the block 44. A cover 56, held in position by machine screws 58, confines the slide 46 in the guideway in the block and at the same time serves as a stop to limit the movement of the stop 48, under the action of the spring 52, toward the dies.

From the foregoing description the operation of the device will readily be understood.

The three upper die plates 12 in staggered and overlapping relation with the four lower die plates 12, define a circular or elliptical die opening into which the terminal is inserted for crimping. When the jaws or blocks 2 and 4 move toward each other, the outer edges of the upper die plates 12 will move in the spaces between the outer edges of the lower die plates 12 and vice versa, until the bottom 60 of each die opening contacts the ferrule 57 having a conductor 59 therein. Upon further relative movement between the upper and lower die plates 12 they engage the top and bottom of the ferrule, flattening it until it fills the lenticular aperture defined between the upper and lower die faces, slightly indenting the spaced and staggered areas at the top and bottom of the ferrule. The further crimping action exerted by the rounded bottom of the recess 60 will at first be compression from all sides—directly on the top and bottom and by inward camming of the side portions by the dies as they move past each other. The final crimping action, when the overlapping die faces are at a substantial angle to each other, will be in the nature of a shear action, producing a wiping of the ferrule walls at opposite edges of each die face, and a simultaneous compression thereof, against the conductor 59, and forcing both the material of the ferrule and the material of the conductor into offset relation to the parts of the ferrule and of the conductor engaged by the dies on each side of the given die, as shown in Figures 5 and 6. This will result in producing a zig-zag interlocking of the material of the ferrule and of the material of the conductor, as shown, and will expose fresh metal to give a forged contact. The shear stresses exerted by the dies will cause a coining

or flow of the material sufficient to give it a permanent set, as in fact there will obviously be considerable cold flow of the metal in the crimping operation.

Where the parts 62 of the die plates actually move into overlapping relation to each other, that is in the areas where the ferrule is extended beyond the intersection of the curved die surfaces 60 of the upper and lower dies, the clearance from the shear planes, allows the edges of the ferrule to be drawn down between the overlapping die plates to effect the zig-zag crimping of the material at the same time extruding metal laterally against the conductor and thus forming the ferrule into a tight embrace of the conductor and its locking in this condition to insure a permanent substantially air- and water-tight interengagement of the parts and a good electrically conductive contact.

In the form of the invention shown in Figures 3 to 6, the separator or filler plates 64 are shown as being provided with concave abutments 66, each brought into predetermined spaced relation to the bottom of the recess 60 in each of the adjacent associated dies whereby this abutment serves, in addition to the usual stop means provided to limit the extrusion of the material of the ferrule into the space between adjacent die plates 12 and to provide an anvil against which the final pressure from the opposite die plate is exerted, thus assuring thorough compacting of the crimped area and a lateral extrusion of the ferrule material toward the corrugated edges, which further assures against "spring-back" of the ferrule. It is also important that, due to the offset relation of the opposed indentations, the compression of the conductor is diagonal and with corrugation of the wire, so that if spring-back of the ferrule occurs only a fraction of the spring-back is available in the direction of compression to relieve contact pressure on the wire, whereas any spring-back in the wire itself acts to maintain a high contact pressure.

The special closing dies 14 differ from the die plates 12 in that they are not located on the blocks or jaws 2 and 4 in shear relation to each other but rather in opposed relation to each other and their action, as shown by the shape of the recess therein in Figure 2, is to crimp the sides of the ferrule at the open end thereof to insure a tight sheath-like fit of the ferrule about the conductor without zig-zag interlocking thereof at this point.

It will be understood that a suitable stop means may be provided if desired to limit the relative movement of the dies in the crimping operation. It is an advantage of the invention, however, that an exact limit is not necessary as it is with the crimping dies heretofore in use. In the form of the invention shown in Figure 1 an adjustable stop 68 might be located between the blocks 2 and 4. In the form of an invention shown in Figures 3, 4 and 5 the abutments 66 serve to limit the crimping movement.

As will be evident, the embodiment shown in Figures 1-5 is designed for crimping a terminal or ferrule which can be inserted endwise between the dies. However, the invention is applicable likewise to ferrules and terminals having enlargements such that they can only be inserted laterally into the dies. One example of this is shown in Figures 7 and 8 wherein the die plates 12a are spiral in form and overlapped so that as they are rotated with a ferrule 57a inserted into the recesses, the ferrule is compressed onto the

wire 59a by a toggle action with result substantially similar to that described above.

The die plates 12a are held apart by gear portions 26a which both act as spacers and engage the gear racks 70 formed on the ends of the handles 72. These handles are pivoted on a shaft or pivot bearing 74 and are held to the die plates 12a by tie plates 76 on opposite sides. These plates are held together by axles 78 of the die plates which fit in holes in the plates 76 and are headed as shown, thus forming a die-holder assembly and by pins 80.

Pins 80 on the plates 76 are slidably received in slots 84 of a locking plate 82 and hold the locking plates with limited movement on plates 76. The bottom of this slide plate 82 has a right angle slot 86, into which the end of the pivot shaft 74 extends. Thus when the plate 82 is pushed to the left, the shaft 74 is held at the top of its slot 86, and when pushed to the right the shaft may be dropped to the bottom of slot 86 thus disengaging gears 26a from racks 70 and allowing free rotation of the die plates 12a to bring to the bight the die recesses 60a of the proper size for the ferrule to be crimped.

A spring 90 is looped over the pivot 74 and extends into the handles to urge them apart.

It is an advantage of the invention that the dimensions and materials of the ferrules to be crimped are not critical. Excellent results are obtained with soft, pure, high-conductivity copper provided that filler plates such as those shown at 26 are used enough wider than the die plates, or the edges of the die plates are sufficiently rounded and separation of the die plates during crimping permitted so that, in either case, shearing of the ferrule is avoided. With brass or harder copper or other relatively springy metal the advantage of the invention is even greater and, as these metals are not so easily sheared, the filler plates are less important and the edges of the dies need not be so dull as with pure, dead soft copper.

Advantageously, the diameter of the recess in the die is just enough larger than the diameter of the ferrule to provide a comfortable clearance during insertion and removal, but greater clearance may be allowed as in the case illustrated, wherein the diameter is sufficient to allow ready insertion and removal of the enlarged collar 69 (Figures 5 and 6). In general the diameter of the die recesses should be kept, where possible, between 1 and 1½ times the diameter of the ferrule and the radius of curvature of the ferrule and of the dies, where they intersect in the fully crimped position, should be in the same ratio.

Although I have described the portion 66 merely as an abutment and it is not necessary that it exert substantial pressure on the ferrule, it is within the scope of my invention that it should act also as an opposing die-plate so that the ordinary opposed die crimping action is combined with the corrugating, offsetting and wiping actions produced by the principal die plates as described above. Such combined action, however, requires greater crimping force and ordinarily is unnecessary. For an ordinary 18-22 gauge ferrule of brass I position the surfaces 66 about 0.005" above and below the upper and lower die surfaces 60 respectively.

I claim:

1. A tool for crimping an electrical connector ferrule onto a metallic electrical conductor which comprises a plurality of opposed dies, each in the form of a plate having a concave bottom recess

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at its area of contact with said ferrule, each pair of opposed dies being in staggered relationship and being movable in parallel paths to and from mutually overlapping and interleaving relationship at the sides of the recesses and means defining a spacer plate between each pair of adjacent dies, the spacer plates being thicker than the die plates to space said parallel paths apart a predetermined distance to avoid actual contact of opposed dies when in the mutually overlapping position whereby the ferrule is subjected to shearing stresses without actual cutting of the ferrule.

2. A tool for crimping an electrical connector ferrule onto a metallic electrical conductor which comprises a plurality of opposed dies, each in the form of a plate having a concave bottom recess at its area of contact with said ferrule, each pair of opposed dies being in staggered relationship and being movable in parallel paths to and from mutually overlapping and interleaving relationship at the sides of the recesses and means defining a spacer plate between each pair of adjacent dies, the spacer plates being thicker than the die plates to space said parallel paths apart a predetermined distance to avoid actual contact of opposed dies when in the mutually overlapping position, each of said spacer plates having a ferrule contacting portion extending into and forming part of the cavity between opposed dies whereby each of said spacer plates as well as each of said die plates bears on the ferrule when the dies are closed.

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rule contacting portion extending into and forming part of the cavity between opposed dies whereby each of said spacer plates as well as each of said die plates bears on the ferrule when the dies are closed.

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