

Aug. 9, 1966

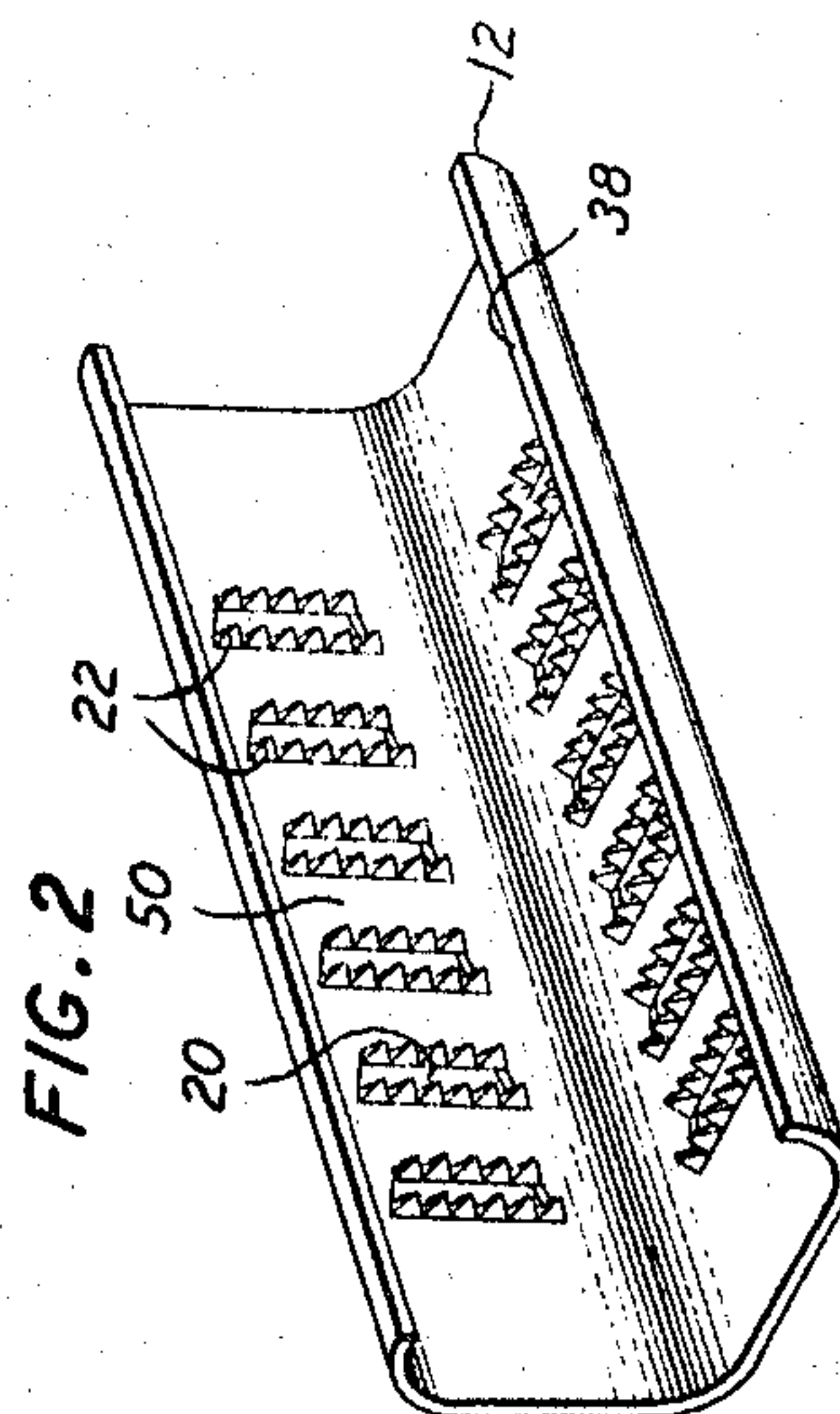
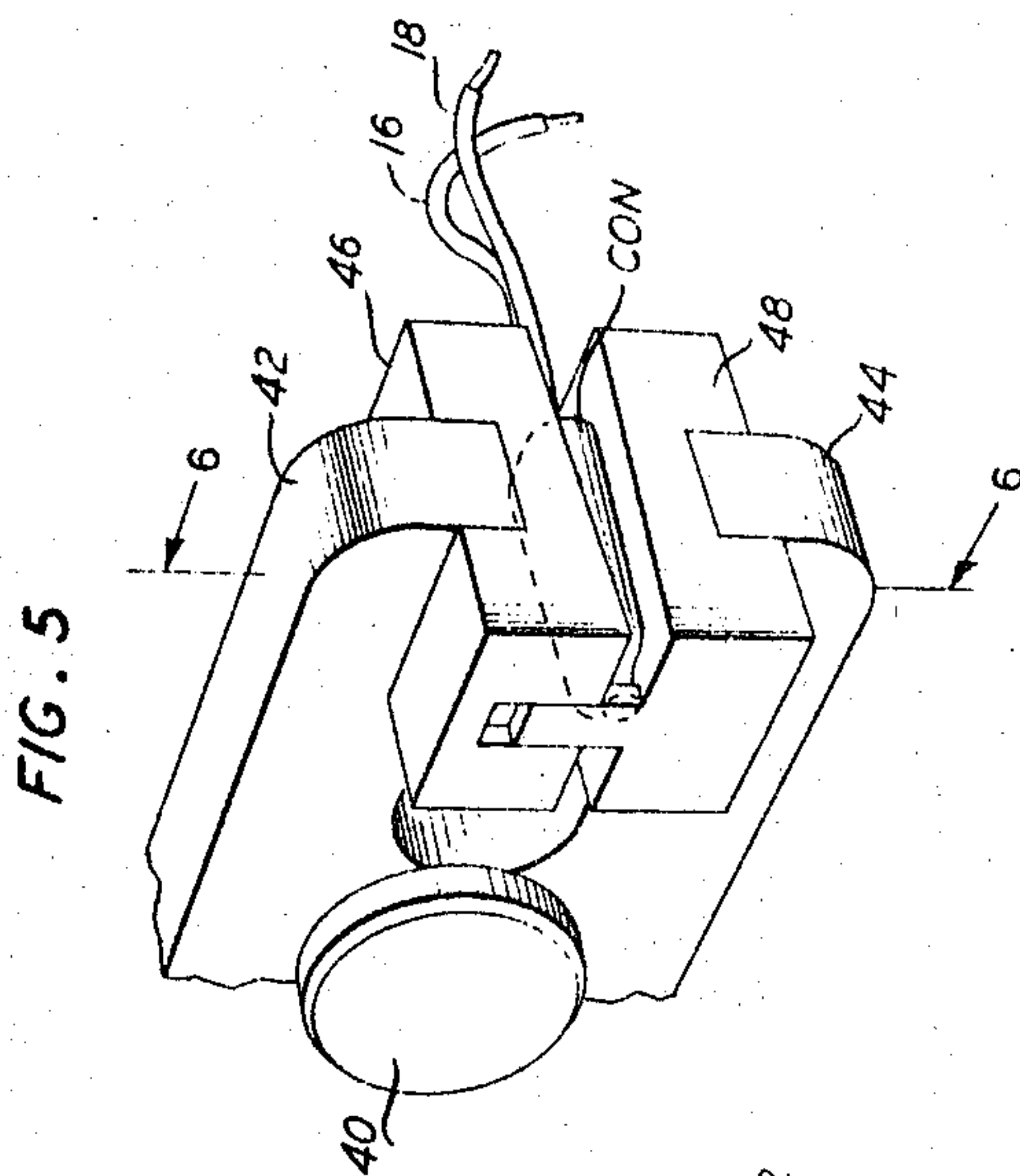
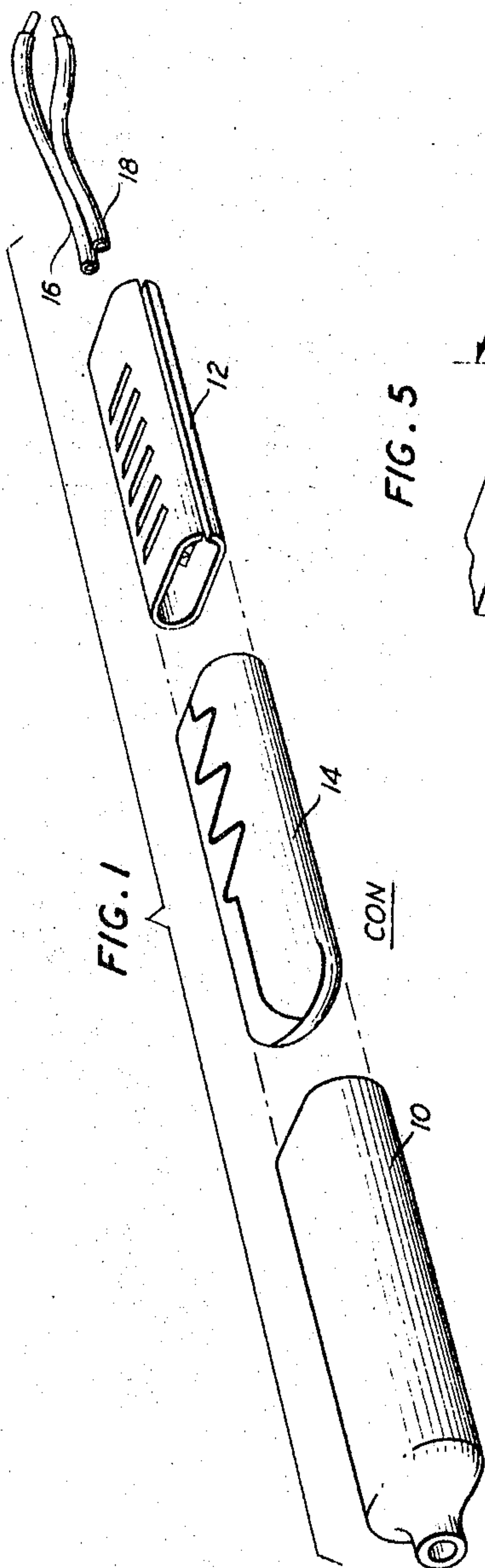
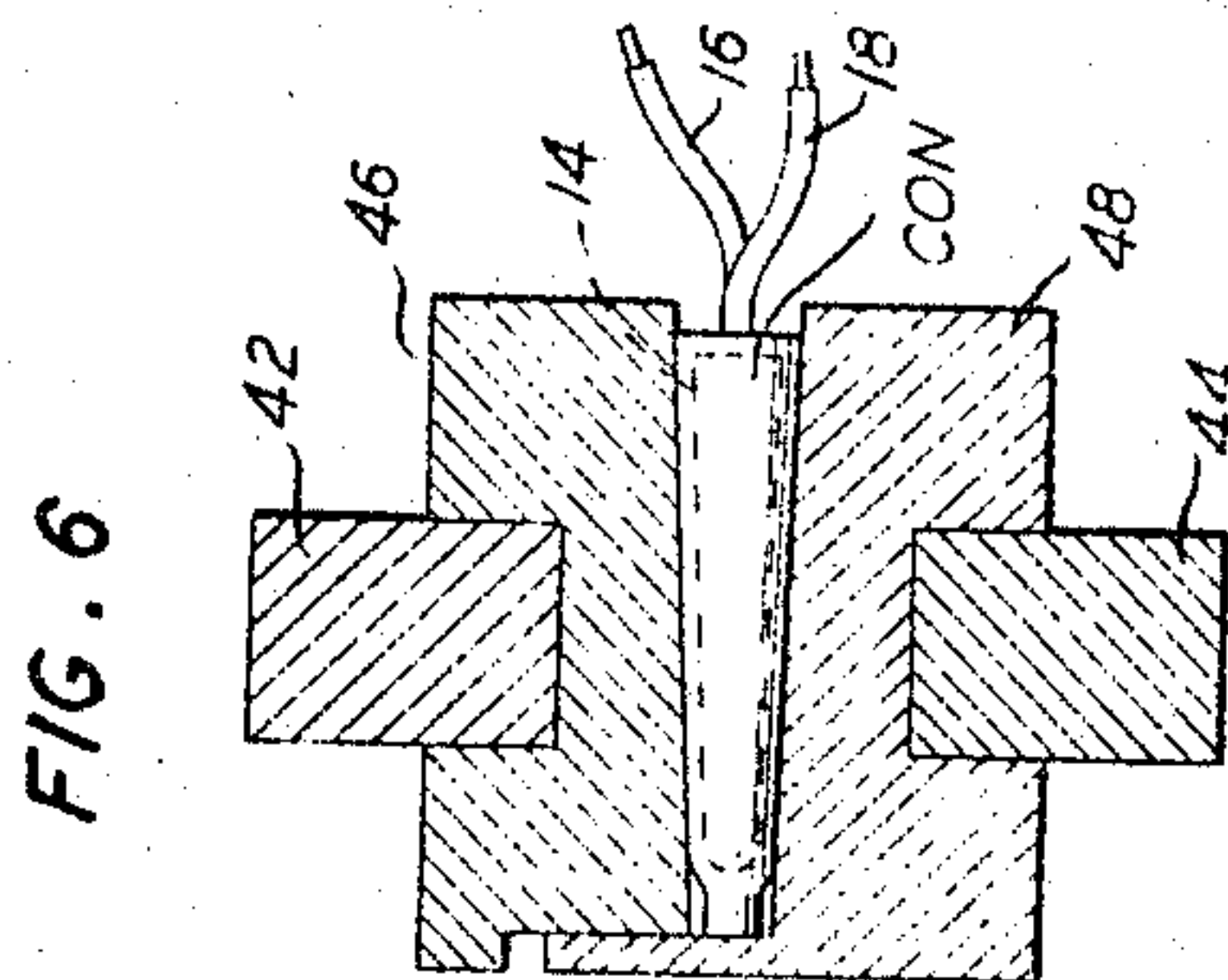
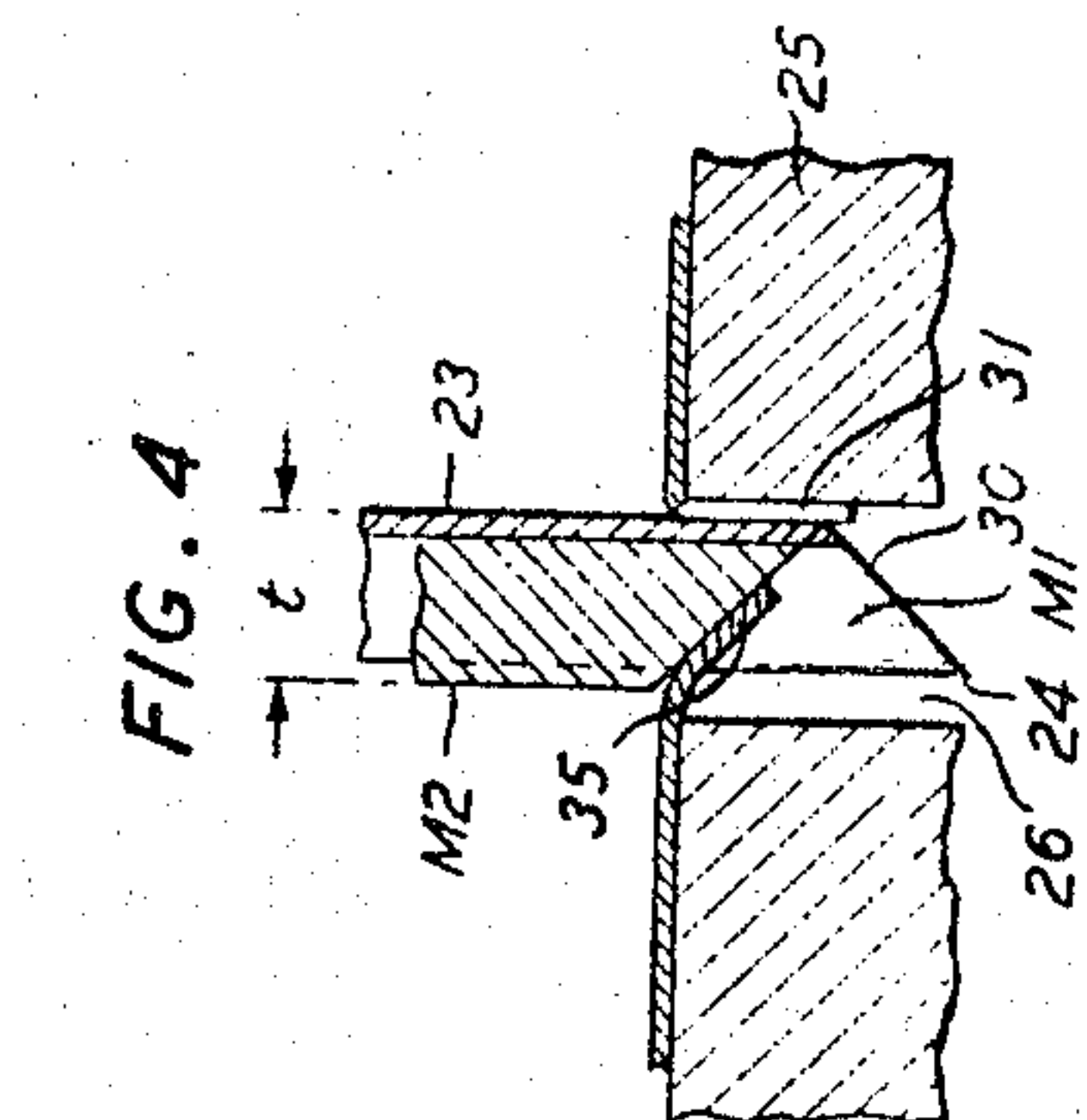
D. T. SMITH

3,265,807

CONNECTOR FOR INSULATED CONDUCTORS

Filed July 24, 1964

3 Sheets-Sheet 1



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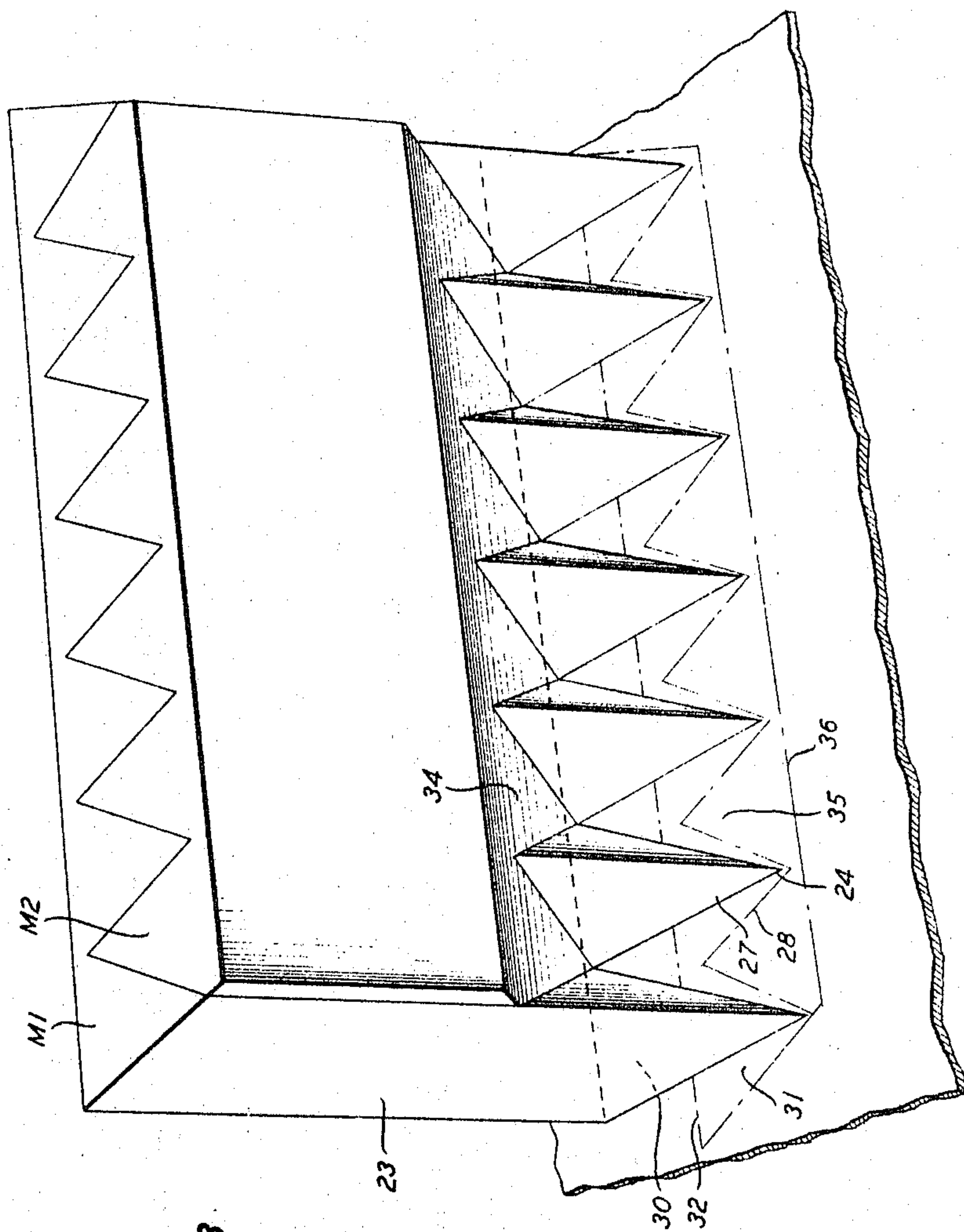


FIG. 3

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FIG. 7

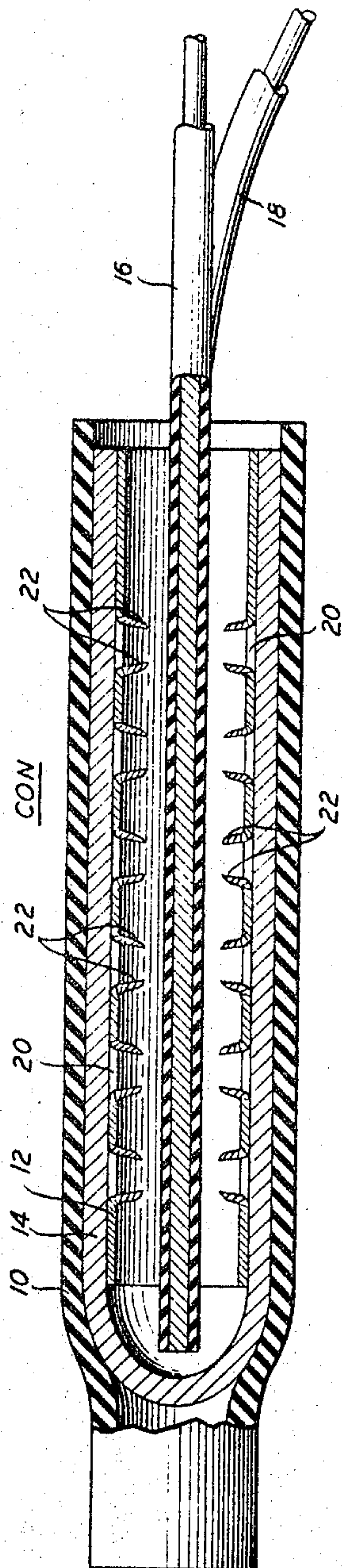
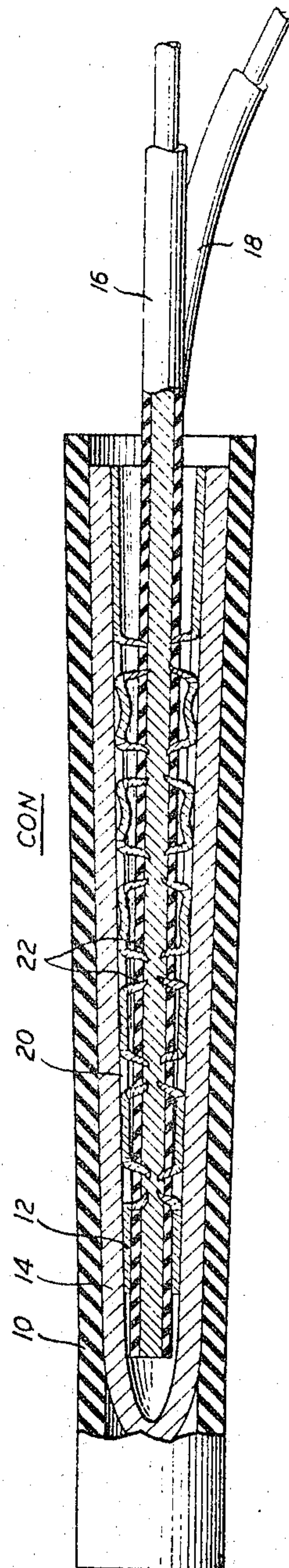


FIG. 8



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CONNECTOR FOR INSULATED CONDUCTORS

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4 Claims. (Cl. 174-87)

This invention relates to electrical connectors, particularly for joining insulated conductors without removing the insulation therefrom.

Such connectors are disclosed in United States Patent 3,064,072, of H. J. Graff et al., dated November 13, 1962, and assigned to the assignee of this application. According to that patent, an insulating jacket surrounds an outer liner or sleeve of relatively soft metal and an inner liner or sleeve of relatively hard resilient metal. The inner sleeve has been pierced to form a plurality of spaced perforations that define inwardly extending protuberances. If insulated wire is placed into the inner sleeve, a pressure applied to the insulating jacket asserts a pressing action to the outer sleeve, which in turn presses the inner sleeve and forces the protuberances through the insulation on the conductor and establishes contact with its metallic core.

Ideally, the perforations as disclosed in the above-mentioned Graff et al. patent should be square; that is, they should be produced by pyramidal punches that are guided by square guide holes to pass through the metal and enter square openings in a die that supports the metal. However, since dies and guides having a number of square holes are prohibitively costly, it has become necessary in practice to use pyramid-tipped round punches with dies and guides having round holes. With such equipment, the perforations take on a circular shape; and the triangular protuberances, rather than being planar, are cylindrical about an axis perpendicular to the sleeve surface. This curvature adds a degree of stiffness to the protuberances. Stiffness limits the distance they can be elastically deflected without reaching the yield point. Thus, after plastic deformation, such as by pressing the connector to connect conductors, the cylindrical curvature limits the distance through which the protuberances will spring back. As the connector ages during its expected forty to sixty year life span, the comparatively stiff protuberances of limited spring-back may not accommodate themselves elastically to changes in the shape of the conductors and sleeves and therefore may not maintain the desired stability of electrical contact.

Moreover, the perforations leave spaces between each other in the longitudinal direction of the sleeve. It is possible that a wire placed into the inner sleeve may align itself with one of the spaces, and the possibility exists that pressing of the soft sleeve will create contact between only a few of the protuberances and the wire. Such limited contact would not be immediately noticeable. However, during aging, when the comparatively unresilient protuberances decrease contact with the conductors, this limited contact may become evident.

Thus, it is an object of the present invention to improve connectors for insulated conductors.

Another object of the present invention is to extend the distance through which insulation-piercing and wire-engaging protuberances on such connectors for insulated conductors spring back, so as to retain intimate contact with the wires when the environment changes during aging.

Another object is to simplify the equipment required for producing such a connector.

Still another object of the invention is to multiply the probability, in connectors of the type described, of a large number of protuberances piercing the insulation

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and establishing electrical contact with the metallic core of the conductor.

To these ends and in accordance with a feature of the present invention, the connector comprises a soft metallic outer sleeve surrounded by an insulating jacket and a hard spring-like metallic sleeve telescopically placed within the outer sleeve wherein the inner sleeve possesses a plurality of straight, elongated perforations, each having a component extending transverse to the axis of the inner sleeve and each defining a plurality of inwardly extending insulation-piercing and wire-engaging protuberances.

According to another feature of the invention, the protuberances or tangs are formed by piercing or cutting the metal along a plurality of zigzag paths each transverse to the axis of the sleeve and pushing in the sawtooth protuberances formed thereby so as to produce the elongated perforations. Such sawtooth protuberances are flat and have bases extending along a straight line defining the perforation edge. Preferably the webs between perforations are made sufficiently long relative to the metal thickness to deflect elastically like a beam in response to forces on the tangs. These features extend the distance through which the tangs can spring back after deformation.

Since the perforations are elongated, a continuous row of contiguous tangs project from the inner liner. Moreover, such protuberances on one edge of a perforation are displaced relative to the protuberances on the other edge so that the roots at one edge are opposite the tips on the other edge. Thus, the probability of a protuberance electrically contacting a conductor is multiplied.

These and other features of the invention are pointed out in the claims. Other objects and advantages of the invention will become obvious from the following detailed description of a connector embodying features of the invention when read in light of the accompanying drawing, wherein:

FIG. 1 is an exploded perspective view of the connector of this invention disclosing the component parts thereof, together with a pair of insulated wires intended to be inserted therein;

FIG. 2 is an enlarged perspective view of the inner sleeve before it is finally formed, disclosing the configuration of the protuberances on the interior thereof formed by the perforations therein;

FIG. 3 is a perspective view of a cutter forming the perforations in the inner sleeve;

FIG. 4 is a sectional view of the cutter in FIG. 3 after it has pierced the inner sleeve;

FIG. 5 is a fragmentary perspective view of a tool suitable for pressing the connector into intimate contact with the conductors contained therein;

FIG. 6 is a fragmentary cross-sectional view taken on line 6-6 of FIG. 5 and illustrating the configuration of the jaws and their relation to the connector positioned therein after deformation;

FIG. 7 is an enlarged longitudinal view, partly in section, illustrating the relative position of the conductor and the components of the connector before deformation; and

FIG. 8 is a view similar to FIG. 7 illustrating the appearance of the connector and the conductors contained therein after it has been deformed and illustrating how the insulation is ruptured and the protuberances bite into the metal conductor.

In the drawings, the connector CON of this invention comprises three components; namely, and outer plastic jacket 10, a first inner metallic sleeve or inner liner 12, and a second outer metallic sleeve or outer liner 14.

The plastic jacket 10 comprises a heat shrinkable material, such as polyethylene, which is heat shrunk onto the outer sleeve 14 when the components are assembled during manufacture. A pair of conductors or leads 16 and

18 are placed into the interior of the sleeve 12 when the conductor is to be used.

As shown in FIG. 1, the inner liner or inner sleeve 12 is comparatively thin with respect to the outer liner 14 and is constructed of hard spring-like material such as tin-coated spring-tempered Phosphor bronze. The inner surface of the sleeve 12 is provided with a plurality of in-turned elongated perforations 20 extending transverse to the axial direction of the sleeve. The latter form at each long edge of each perforation a number of substantially flat and aligned sawtooth protuberances or tangs 22 that project transverse to the plane of the perforation. The protuberances 22 form a series of contiguous knife-like edges, of sawtooth shape.

Each perforation 20 and its protuberances 22 are formed in the sleeve 12, when it is still in a flat condition, by the sawtooth cutting tool 23 shown in FIGS. 3 and 4. For reasons of simplicity, this tool 23 is made of two members M1 and M2 whose zigzag surfaces mate. The tool pierces the metal of the sleeve 12 with respective points 24 as it moves downwardly against the metal. Horizontally supporting the metal is a suitable die 25 having a slot 26 wider than the thickness (shown as t in FIG. 4) and is aligned with the tool. As the tool 23 moves downwardly, it imposes angular edges 27 to cut the metal of sleeve 12 along a zigzag or sawtooth line 28 (shown in phantom). During this downward movement, an angular surface 30 joining angular edges 27 forces the sawtooth tangs 31, cut by the edges 27 and which are more remote in FIG. 3, downwardly so as to fold them down at the lines 32 (shown in dot-dash lines in FIG. 3). This is shown most clearly in FIG. 4. As the tool 23 progresses even further downward, angular surfaces 34 joining the piercing surfaces of the tool 23 bend the closer (in FIG. 3) sawtooth tangs 35 along the (dot-dash) lines 36. After the tool 23 is withdrawn, the procedure is repeated for a number of perforations all parallel to the original perforation. Of course, several perforations can be made simultaneously with a multiple tool. Also it is contemplated that the sawtooth cut be made otherwise, in a step separate from the folding of the tangs.

The resulting tangs are of a substantially flat sawtooth shape in alignment with each other and having substantially straight bases which impart very little curvature about their vertical axes.

Before or after, preferably after, the tangs have been produced in the sleeve 12, its edges 38 are cut transverse to the perforations and curved as shown in FIG. 2 and then bent to the shape shown in FIG. 1. The connector CON is assembled by placing the inner liner 12 into the soft outer liner 14 and heat shrinking the insulating plastic jacket 10 about the outer liner.

In use, the ends of two insulated conductors 16 and 18 to be electrically joined are inserted as far as they fit into the inner liner of the assembled connector CON. A tool then compresses the connector.

FIG. 5 illustrates a suitable tool 40 which is the well known type of pressing tool with jaws 42 and 44 on which are mounted pressing dies 46 and 48 that press the assembled connector therein onto the conductors 16 and 18. The tool 40 presses the connector after leads 16 and 18 have been placed therein so as to contact the tangs 22 with the metal cores in the conductors 16 and 18.

As shown in FIG. 6, the dies 46 and 48 have a tapered configuration to impart to the conductor CON, placed therebetween, a varying closure; that is, closed tighter at the closed end than at the open end into which the conductors 16 and 18 have been placed.

FIG. 7 illustrates the relative position of the components of the connector CON and the conductors 16 and 18 placed therein before deformation. The jacket 10 and sleeves 12 and 14 now have a substantially uniform diameter, and the tangs or protuberances 22 are in spaced relation with respect to the conductors 16 and 18 of which only 16 is discussed for convenience.

FIG. 8 illustrates the effect of subjecting the connector CON to deformation by the tool 40 shown in FIG. 5. Compression between the jaws 42 and 44 results in rupturing the insulation on the conductor 16 and subsequent biting into the metallic conductor as shown with varying degrees of closure due to the tapered structure of the embracing dies.

The dies 46 and 48 permanently press the sleeve 14 by plastic flow, which sleeve in its pressed condition restricts "spring-back" of the elastically deformed sleeve 12 of spring material.

Inspection of FIG. 8 will reveal that the tangs 22 at the closed end of the connector CON having the tighter closure bite quite far into the conductor 16. It is possible that such a bite may accidentally pass through the conductor and sever it. The tapered configuration of the dies 46 and 48 and the varying closure produced thereby assures that such severing, if it occurs, is restricted to the very tip of conductor 16 within the closed end of the connector CON.

The elongated perforations 20 assure straight bases for the tangs 22 and minimize curvature of the sawtooth tangs about their upright axis. Any curvature is limited substantially to axes parallel to the metal of sleeve 12 due to curling during formation of the tangs. However, since such curvature does not stiffen the tangs in opposition to force from the direction in which they point, this curling has few, if any, undesirable consequences.

These tangs are made with comparatively simple dies whose slots can be considerably longer than the width w in FIG. 3 of the piercing tools 23 with which they register. In fact, the die may consist merely of two mechanically spaced members whose spacing may be adjusted to determine the angle assumed by the planes of the tangs relative to the surface of an unused connector. This contrasts with the complex dies necessary to produce the square perforations illustrated in the Graff et al. patent.

The tangs are placed across the inner sleeve 12 in extended rows of contiguous edges. Thus, the likelihood of a tang in each row biting into a conductor inserted into the sleeve 12 is considerably increased. By virtue of this sawtooth pattern produced by the punch 23 which displaces the tangs on one edge of each perforation from the tangs at the other edge, this probability is increased even further.

The distances or webs 50 between perforations are made comparatively large relative to the metal thickness. Because the tangs and webs are integrally formed from hard metal, the force on the tangs when the sleeve 12 is pressed will also deflect the web by arching it inwardly. This arching is shown most clearly in FIG. 8. A longer web can be elastically deflected over a longer distance than a short web. This, together with the flat bases of the tangs, increases the ability of the tangs to recover elastically through long excursion. Large webs are impractical with the tangs disclosed in the above-mentioned Graff et al. patent because the distances between the perforations must be small enough to establish the probability of many tangs contacting a conductor.

Still another advantage of the connector according to the invention resides in the uniformity of tang sizes readily obtainable. Such uniformity prevents undesirably long tangs from inadvertently severing conductors when the connector is pressed, and at the same time assures that all the tangs are long enough to penetrate the insulation and contact the conductors. Such uniformity was difficult to obtain on a commercially acceptable basis in connectors of the type illustrated in the Graff et al. patent. Because of the intricacy and high cost of square dies and guides for square punches, it was inconvenient to produce the square perforations illustrated in the Graff et al. patent. Thus, in practice, square perforations have been approximated by using round dies which receive pyramidally-tipped round punches. These round punches and round dies, in addition to the tendency of curving the

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tangs, have the tendency to tear the tangs at the bases and produce tangs of comparatively nonuniform sizes and shape. Experience has shown that the sawtooth configuration to the invention permits production of far more uniform tangs with little difficulty.

While an embodiment of this invention has been disclosed in detail, it will be obvious to those skilled in the art that the invention may be practiced otherwise within its scope. For example, it is contemplated that the liners 12 and 14 be made flat and open to receive and hold sheet conductors.

What is claimed is:

1. A deformable electrical connector for establishing contact with an insulated conductor, comprising an inner liner of relatively hard spring-like conductive material, an outer cover of relatively soft material, and a plurality of flat protuberances extending inwardly from said liner, said protuberances being aligned in separate rows each having major components transverse to the axis of said liner, said protuberances in each row having respective elongated bases aligned with each other and with the row, said liner having perforations forming therebetween webs of liner material supporting said protuberances, each of said perforations defining an edge extending along all the aligned bases of the aligned protuberances of one of said rows for urging the web at adjacent ones of said pro-

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tuberances in a row to arch in substantially the same direction in response to force applied by a conductor upon any protuberance in a row when said outer liner is deformed about a conductor.

2. A connector as in claim 1 wherein said rows are substantially parallel and each web includes two opposite ones of said edges extending along the aligned bases of all the aligned protuberances in adjacent rows, and wherein said protuberances are part of said liner material.

3. A connector as in claim 2 wherein said perforations each define two additional edges extending between said other opposite edges, said liner material terminating at said additional edges.

4. A connector as in claim 2 wherein said protuberances in each row are substantially contiguous sawteeth bent inward from said liner material.

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