

June 11, 1968

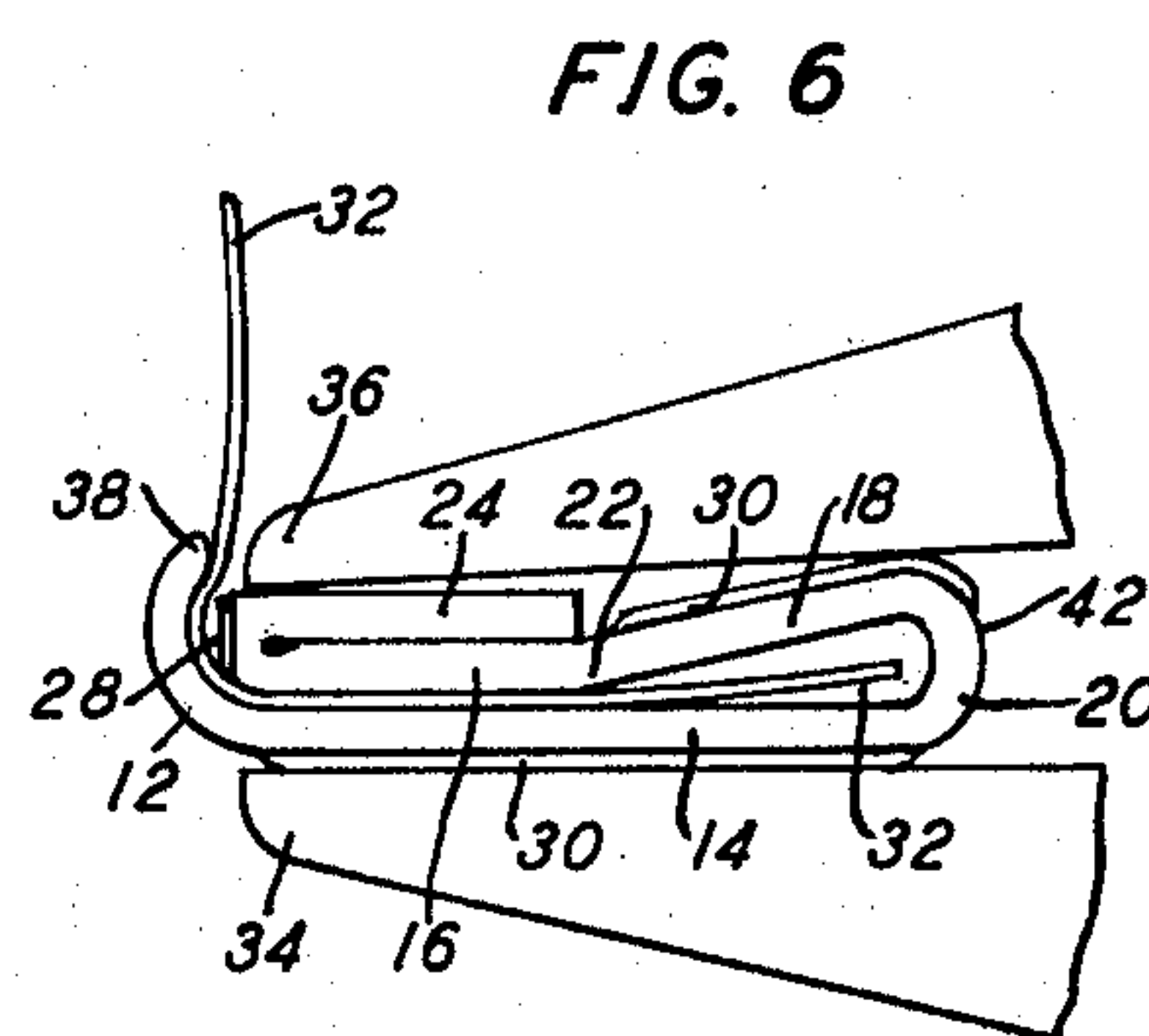
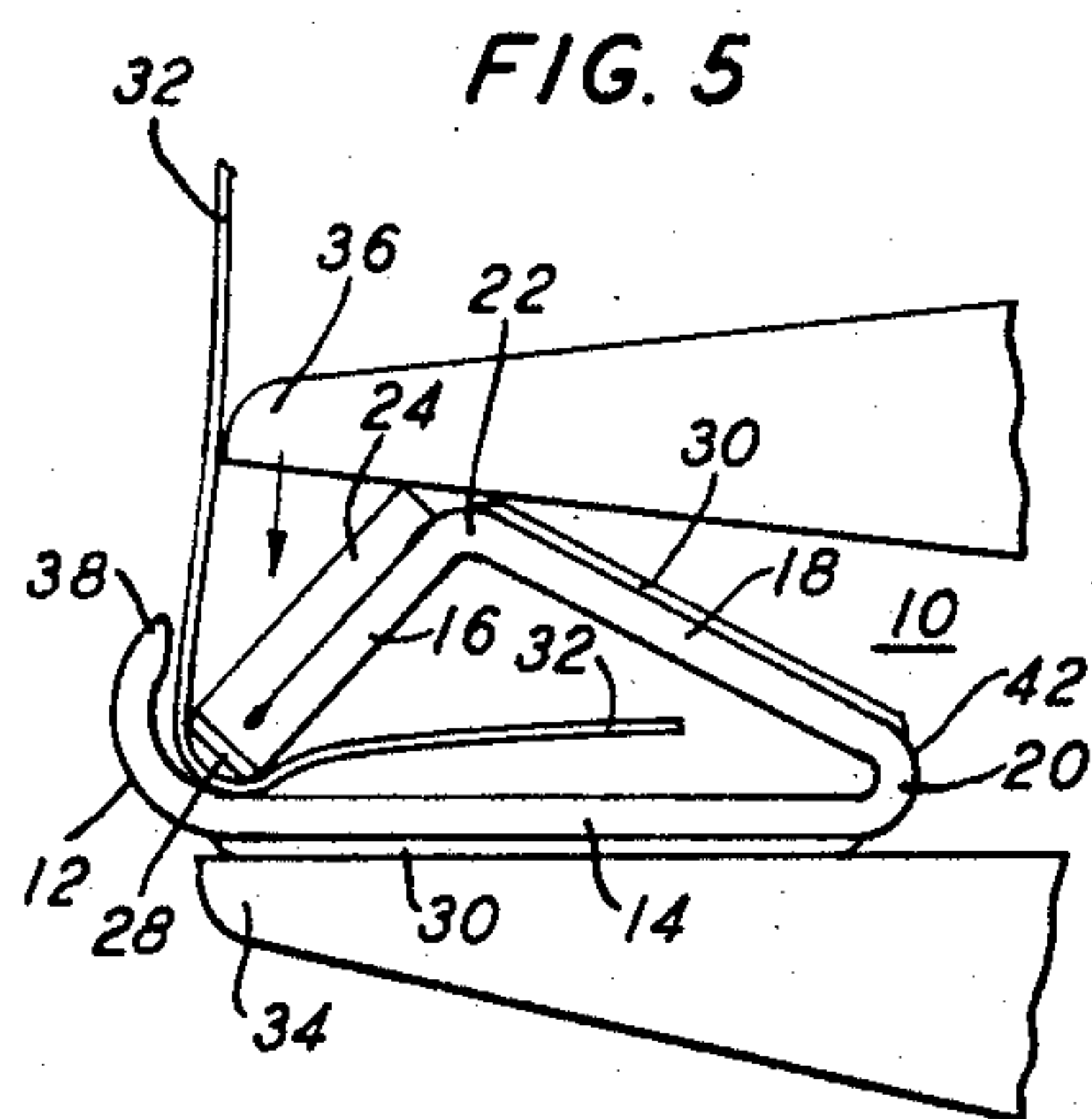
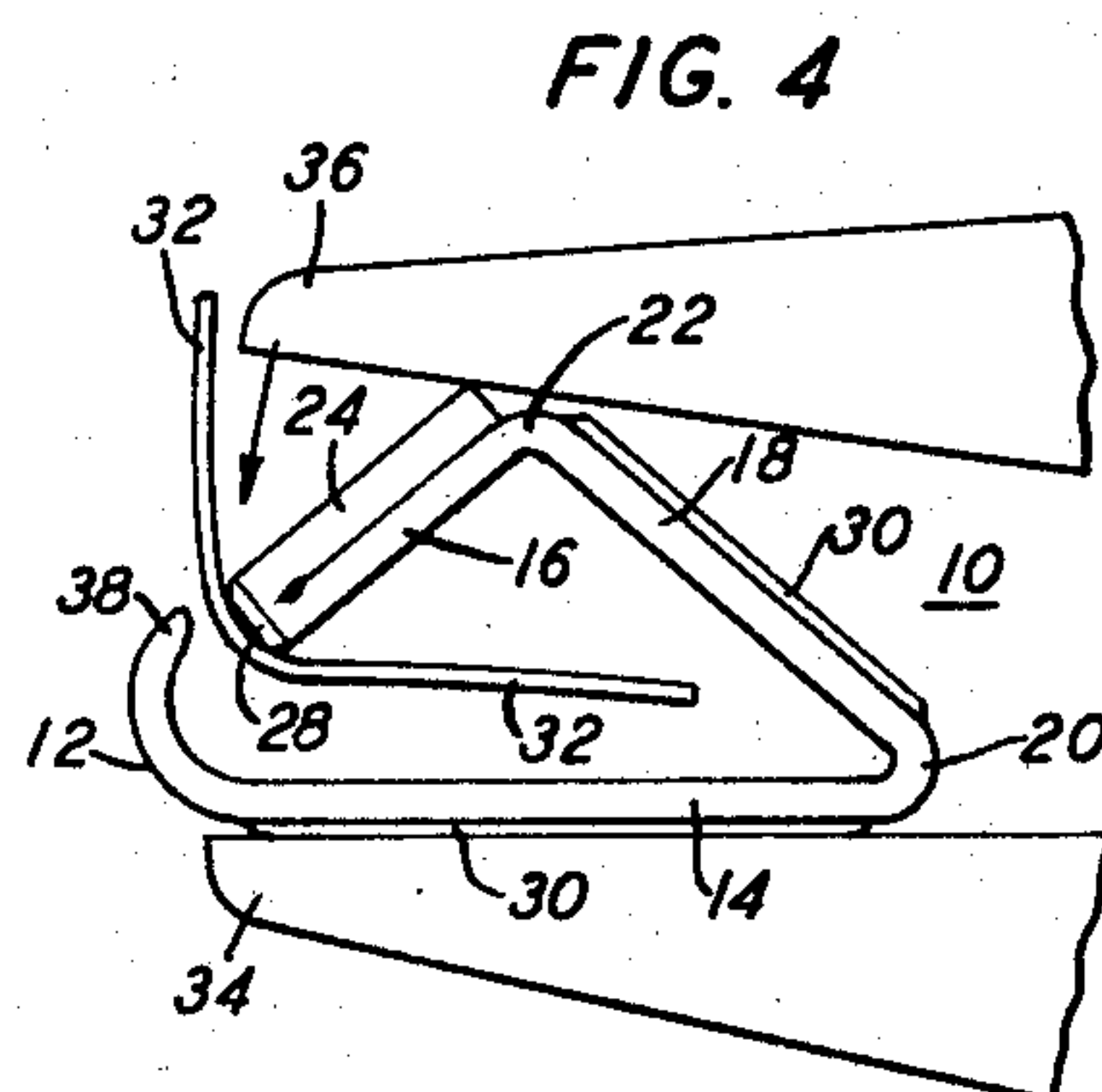
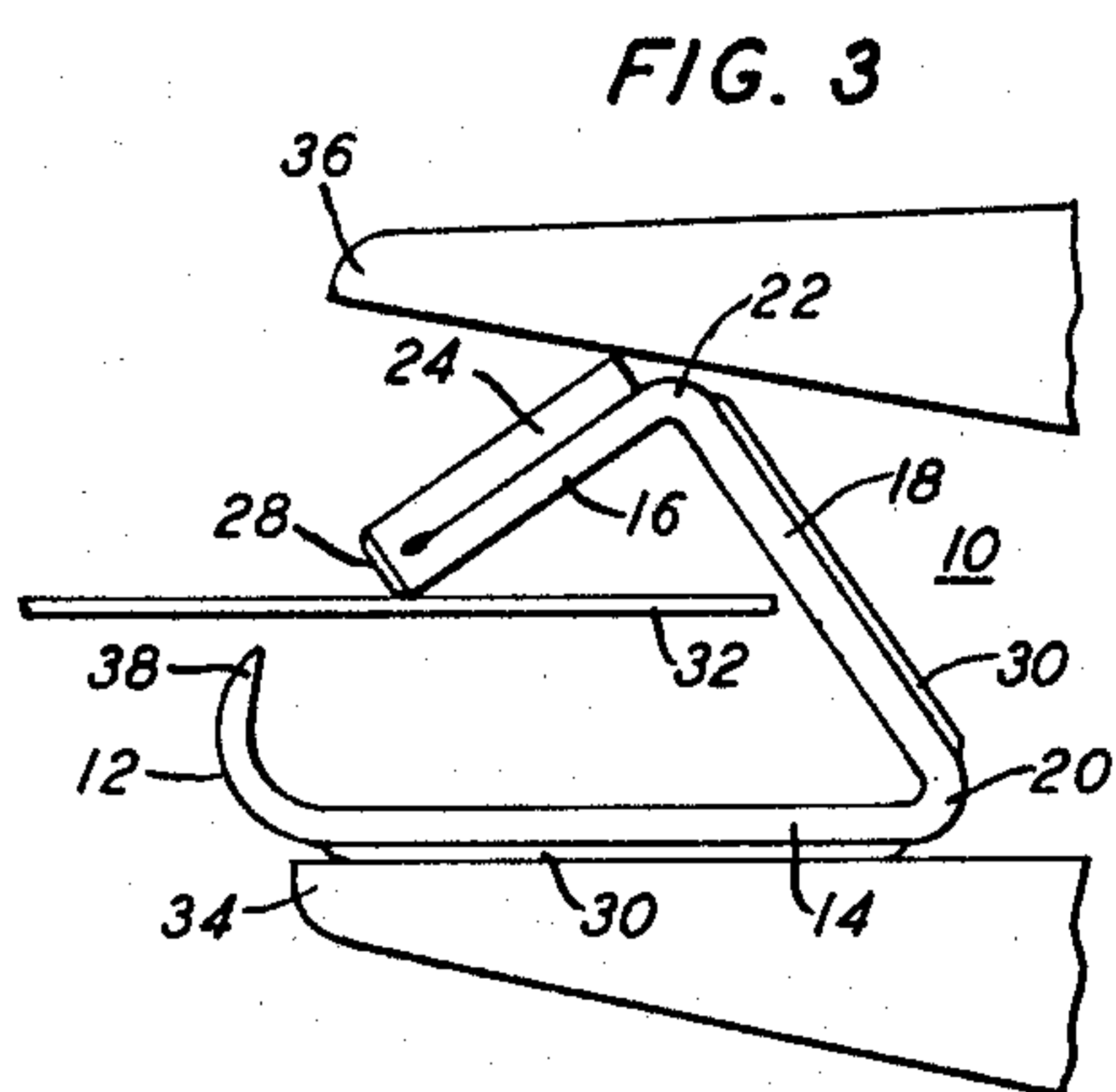
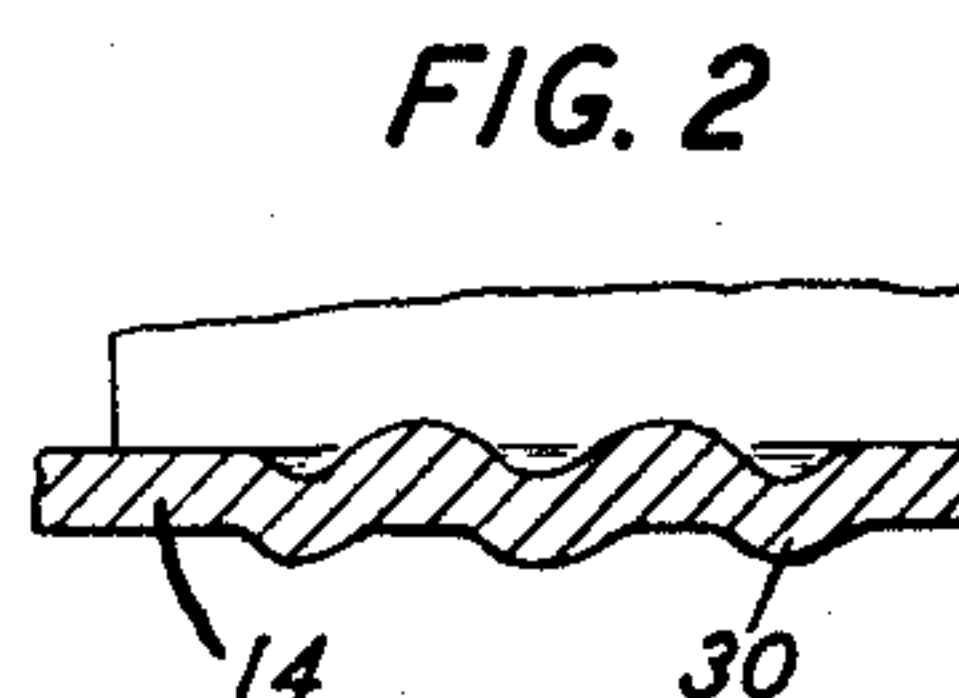
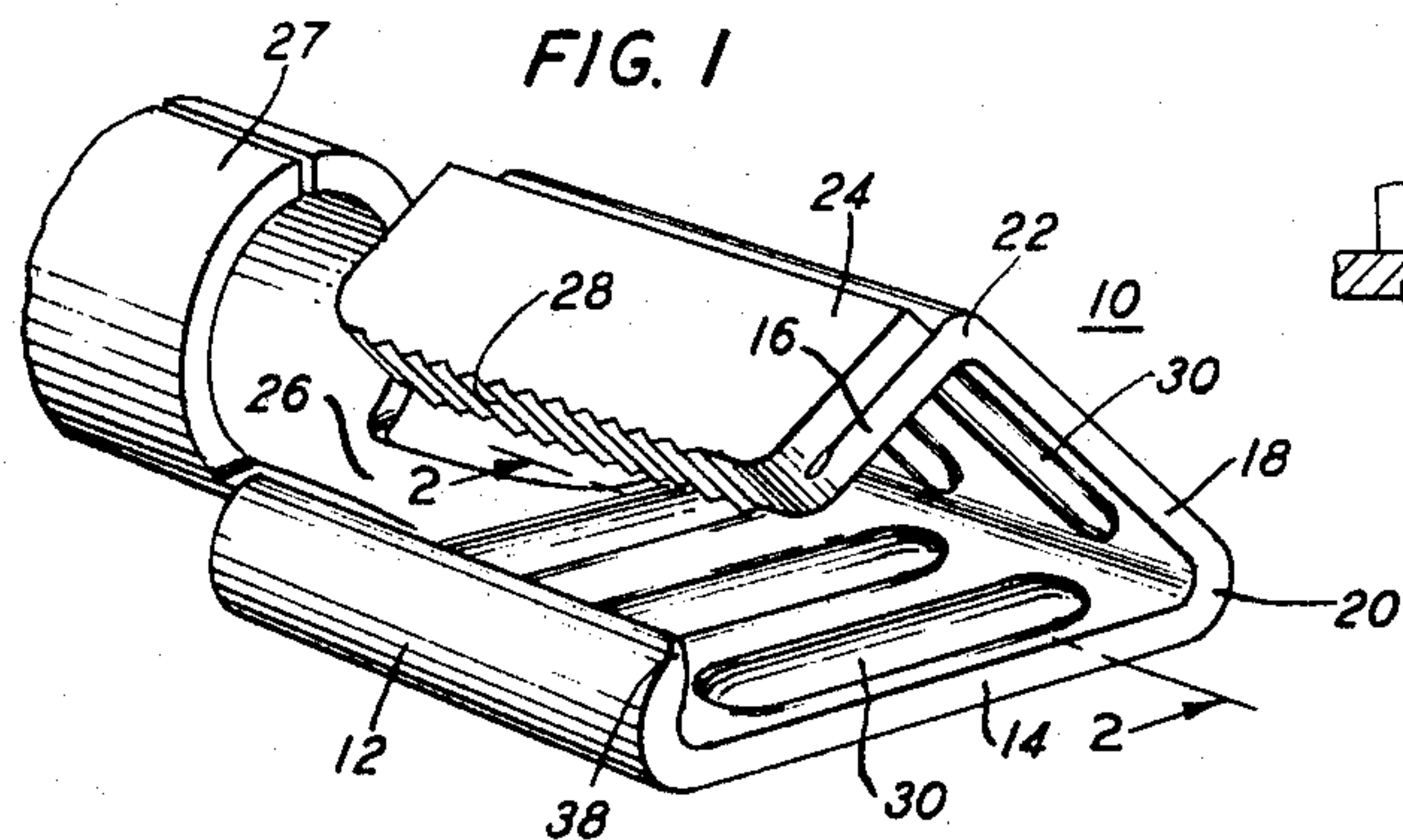
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3,388,369

ELECTRICAL CONNECTOR FOR SHEET CONDUCTORS

Filed March 18, 1966

3 Sheets-Sheet 1



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3,388,369

ELECTRICAL CONNECTOR FOR SHEET CONDUCTORS

Filed March 18, 1966

3 Sheets-Sheet 2

FIG. 7

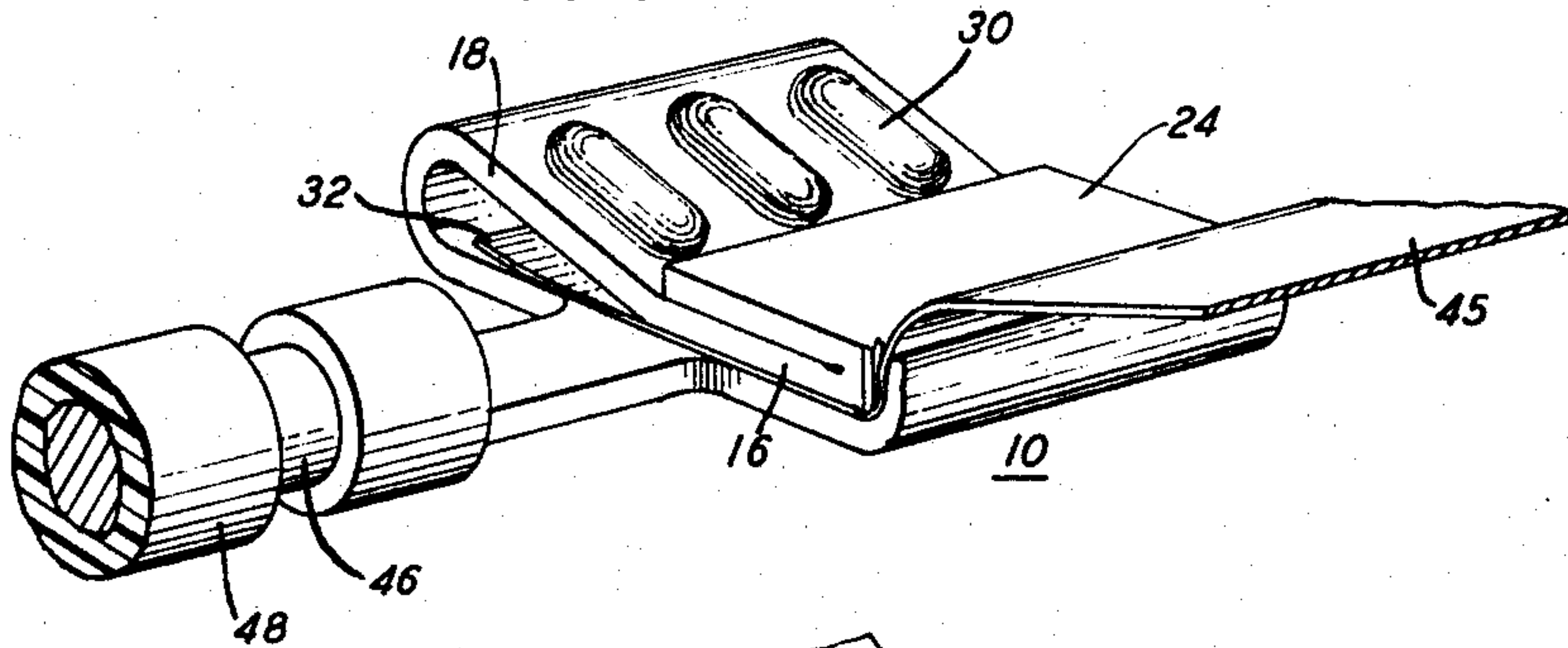


FIG. 8

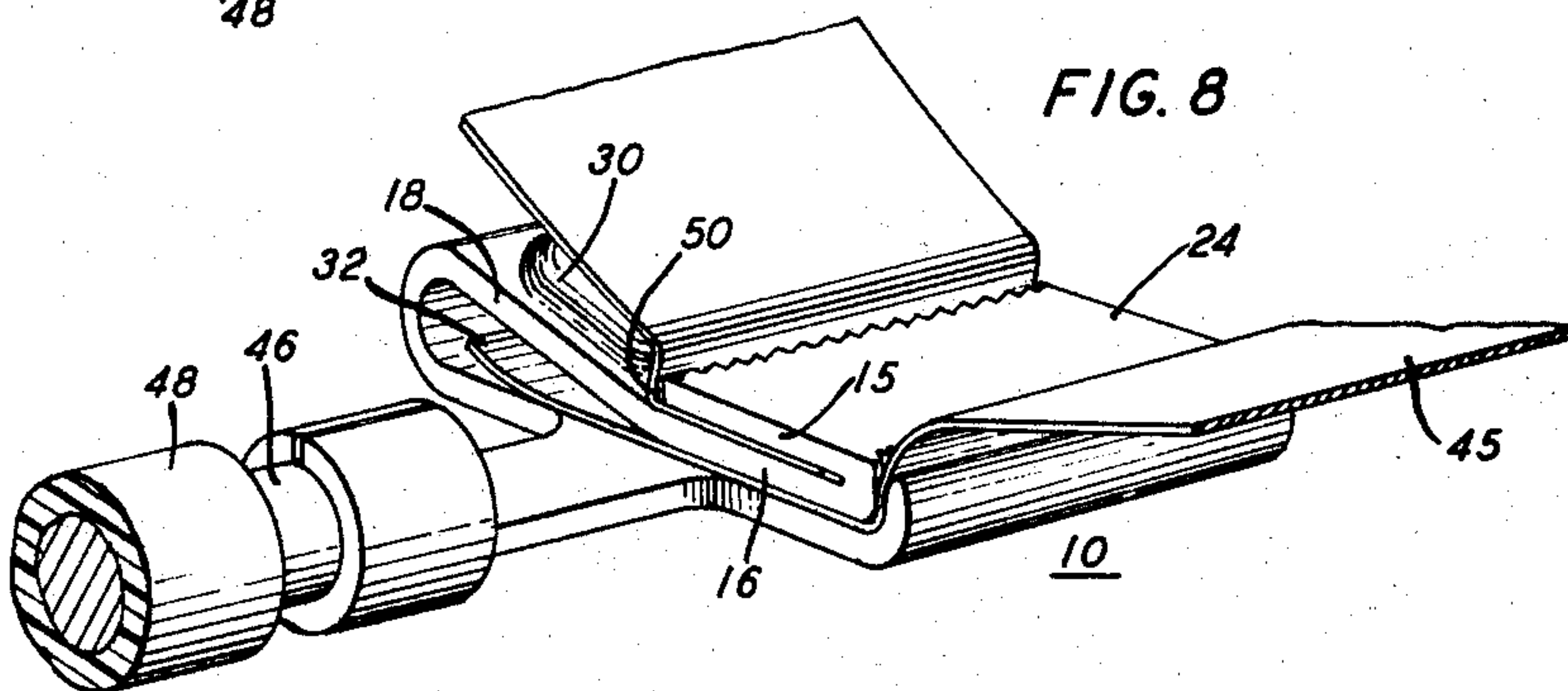


FIG. 9

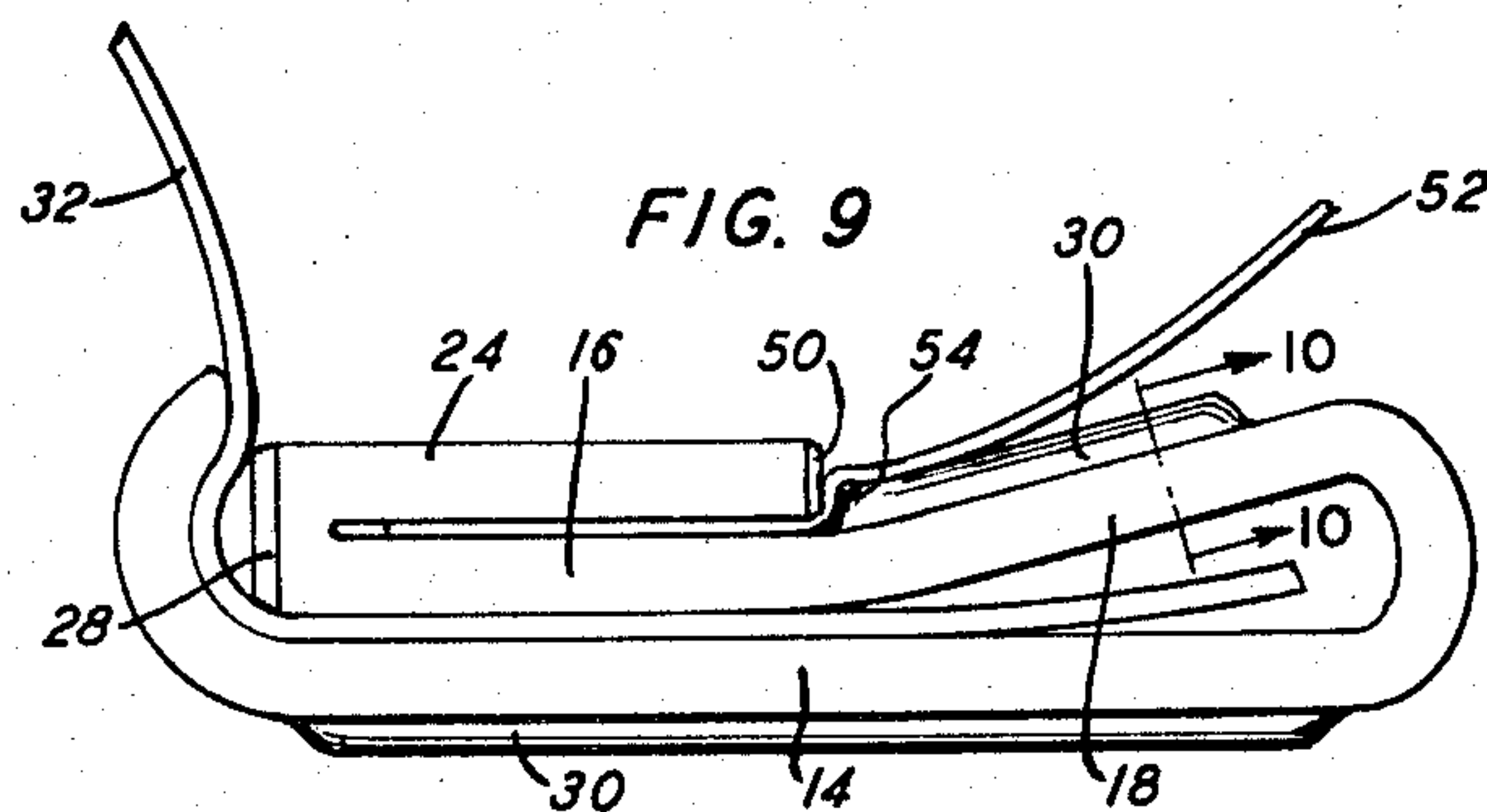
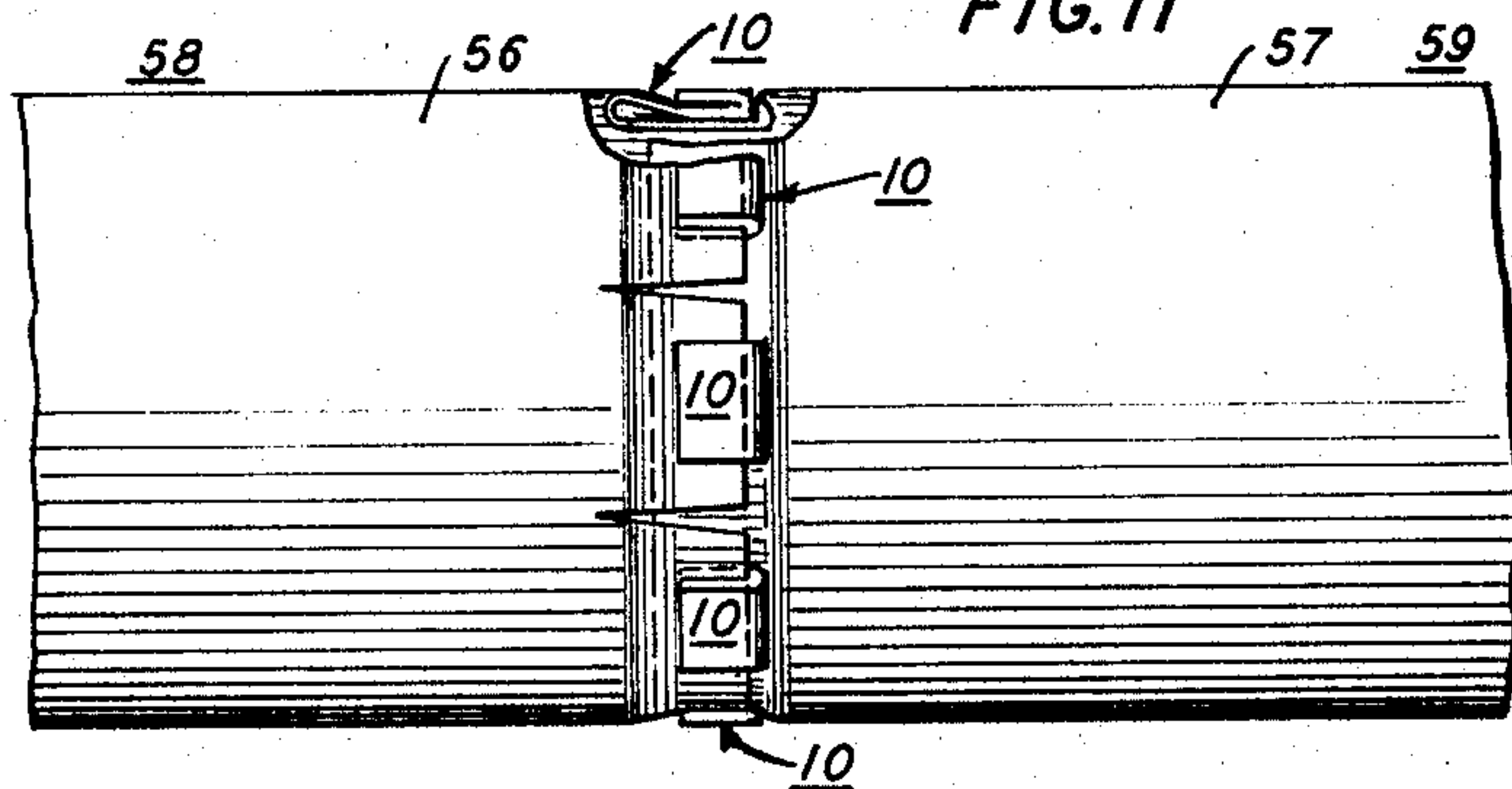


FIG. 10



FIG. 11



June 11, 1968

J. J. ZALMANS

3,388,369

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Filed March 18, 1966

3 Sheets-Sheet 3

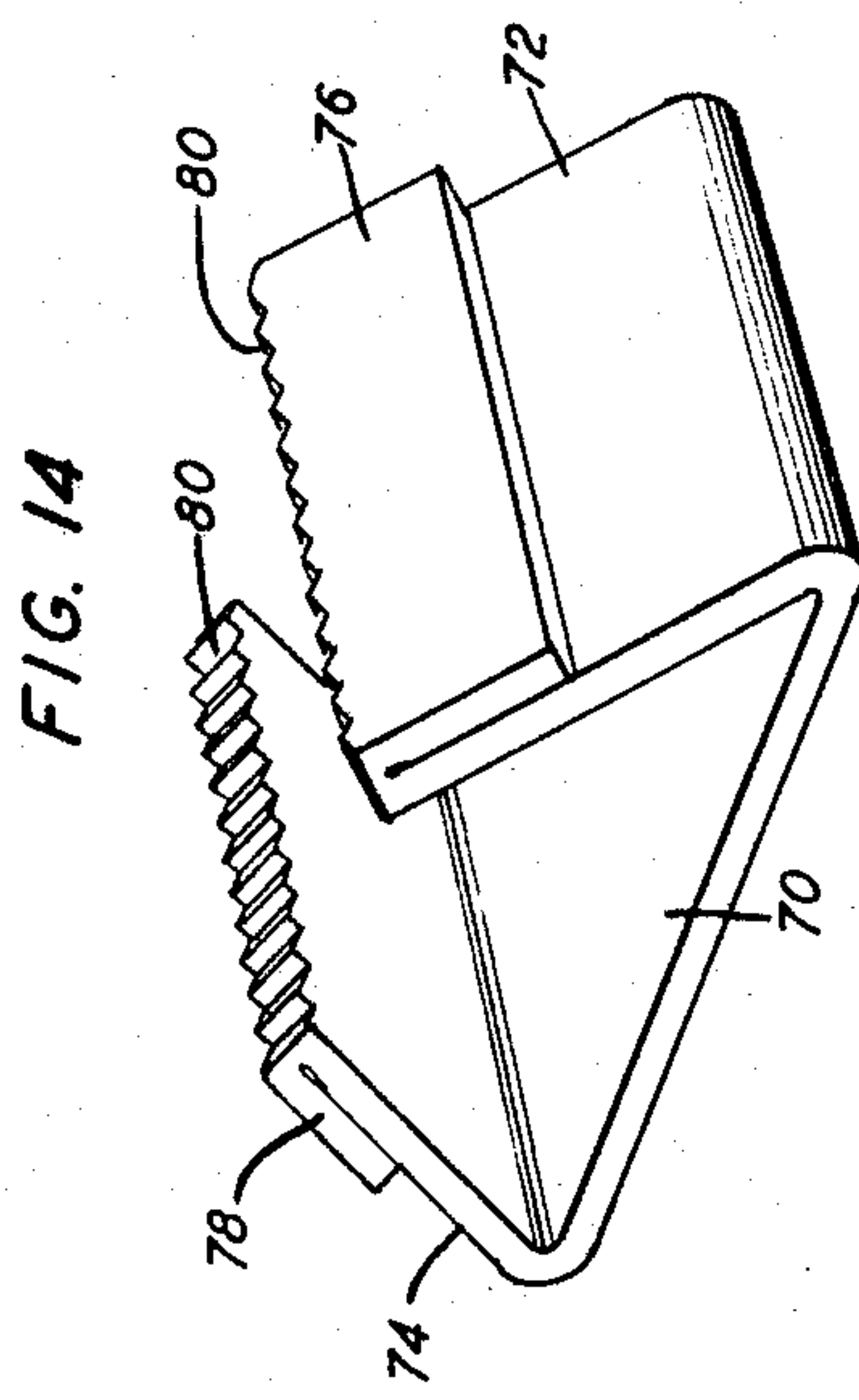


FIG. 15

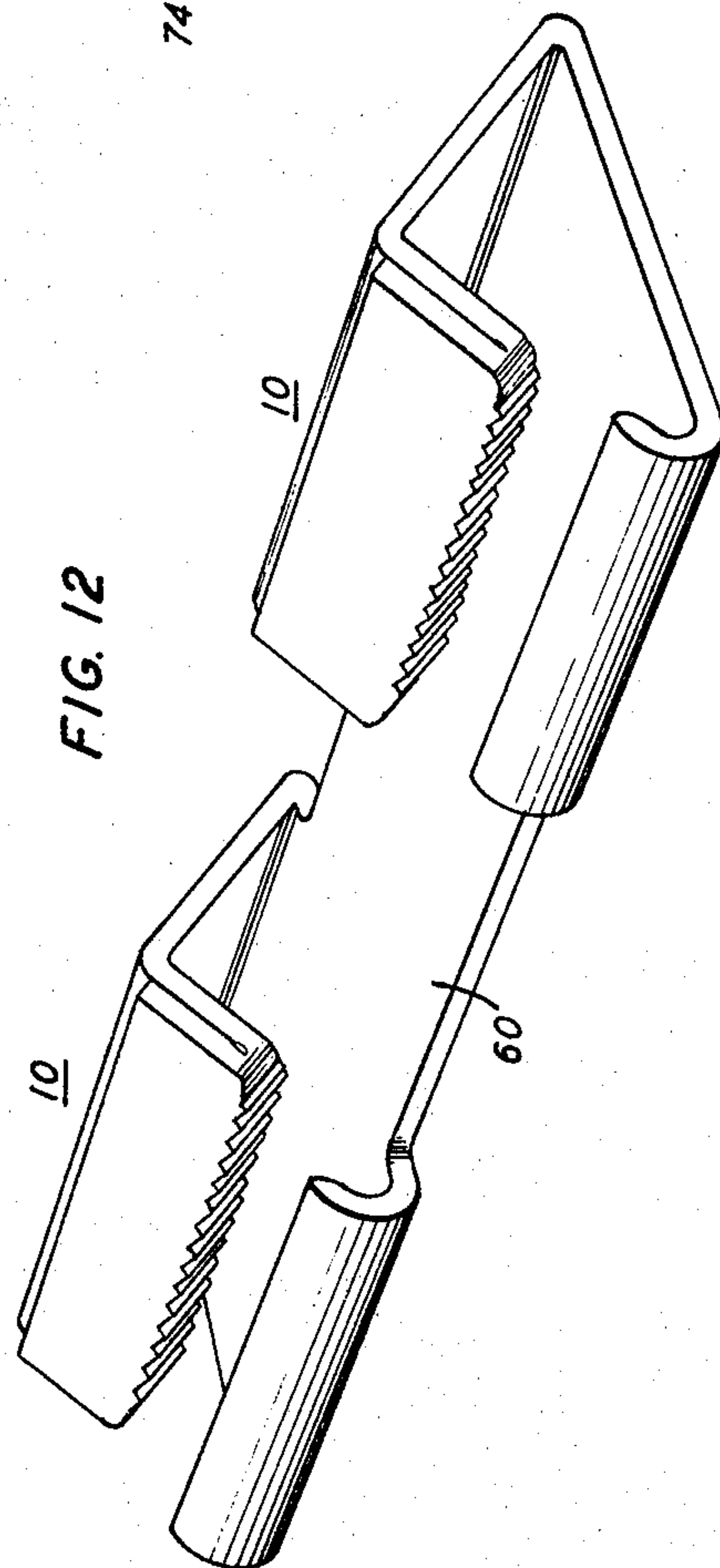
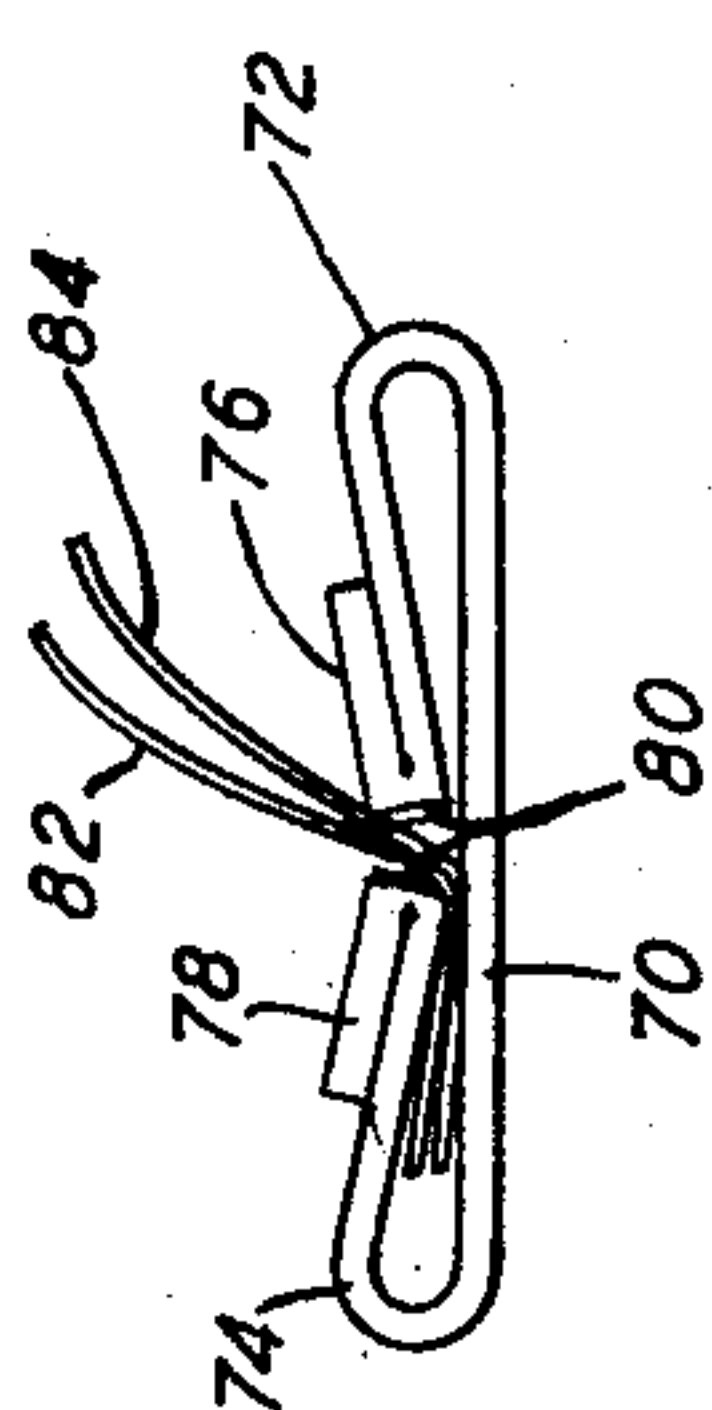
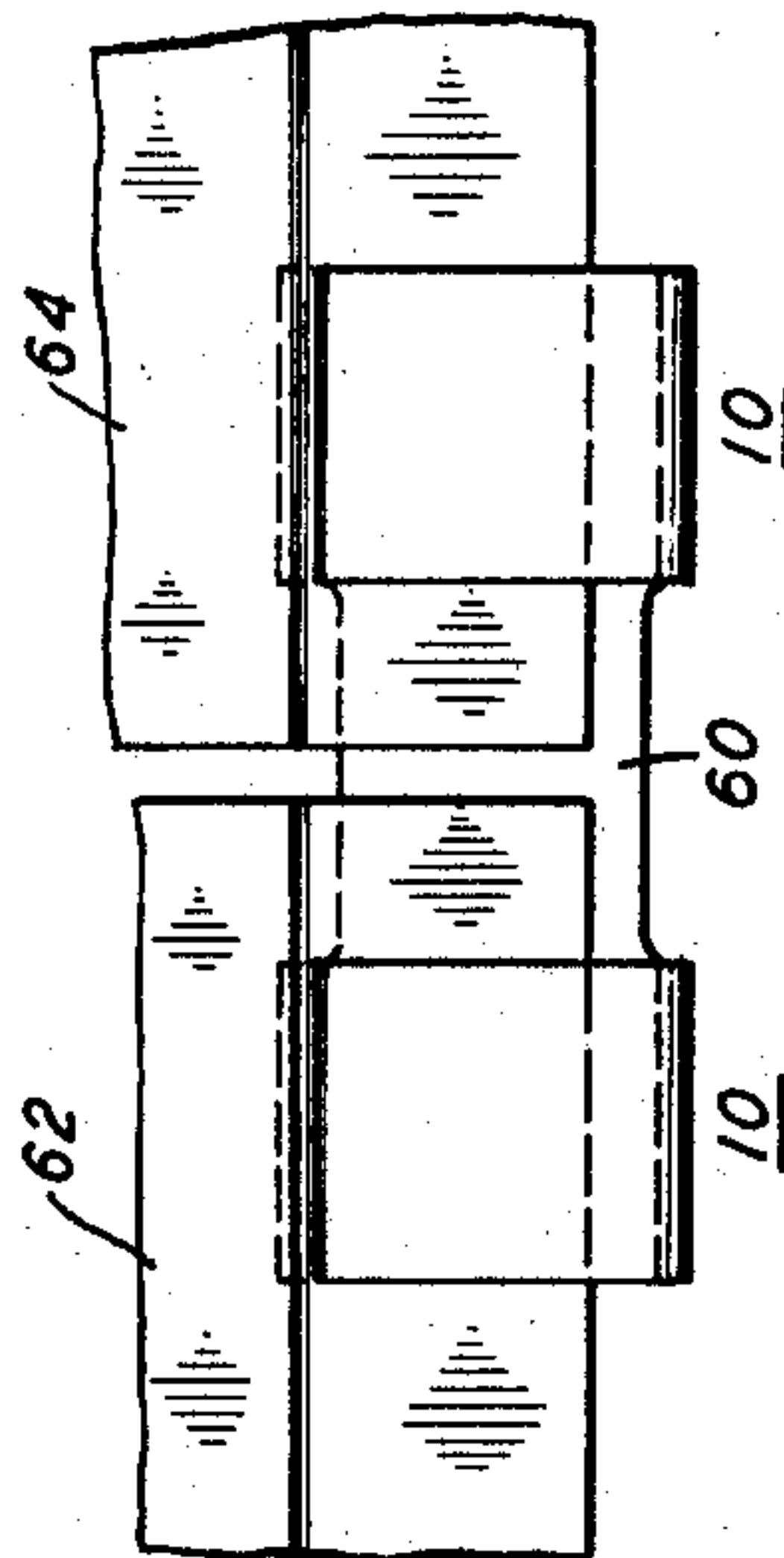


FIG. 13



1

3,388,369

ELECTRICAL CONNECTOR FOR SHEET CONDUCTORS

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10 Claims. (Cl. 339-95)

ABSTRACT OF THE DISCLOSURE

A soft metal strip bent into a triangular shape has a gap in one arm. One portion of the arm at the gap is folded back toward its angle. A first metal sheet when placed into the gap is held by squeezing the beforementioned angle toward its opposing side till the arms adjacent the angle perform toggle action. A second metal sheet is held by the folded-back portion.

This invention relates to electrical connectors particularly for gripping a conductive metal sheath, such as the aluminum lightning protecting sheath of a so-called Stalpth cable, or the copper outer conductor of a cable.

Some currently available connectors achieve this conductive connection by grasping an edge of the metal sheet between two integrally joined leaves of a soft-metal, folded clasp. Such connectors rely on the force afforded by the fold in the soft metal to obtain the necessary grasping force. Because the moment arm from the fold to the outer edge of each leaf may be comparatively large, the fold's holding force is often inadequate to keep gripping the sheath when the connector is subjected to pulling forces expectable in its normal 15- to 40-year life-span.

Other connectors grasp sheaths between opposing arrays of tangs projecting in opposite directions from folded-over soft-metal leaves. These, however, tend to tear the sheath when the connector is pulled in normal use.

In these fold-over connectors, the large effort necessary to store the needed holding torque in the fold demands the use of special tools. These may not be available at all times to cable repairmen in the field.

Thus, it is an object of this invention to improve connectors for grasping conductive sheets, particularly by avoiding these shortcomings.

Another object of the invention is to grip a metal sheet in a cable, and furnish a secure electrical connection, over long periods of time despite the expectable pulls exerted on the connector during the cable's lifespan.

Yet another object of the invention is to establish a connection with a sheet in a cable without high-force-exerting special tools.

Still another object of the invention is to establish such a connection without tearing the sheet.

Another object is to connect two sheets with a single connector.

The invention accomplishes these ends by aligning two compression arms so they can be force-fitted toggle-fashion between holding means at respective ends of a tensionable member, and by gripping the sheet to be connected in the force fit. The alignment, hinging and other necessary conditions are met by forming all arms, members, holding means, hinges, and joints from a single soft-metal strip.

In one embodiment of the invention, the strip before its connection exhibits the shape of an incomplete triangle having a complete base, one complete arm and one broken arm. The base constitutes the tensionable member. The arms form the compression members. The

2

angles form arm- and base-aligning hinges. The upstanding metal at each base angle forms the respective holding means. When the sheet enters the break in the arm, a pair of pliers can squeeze the top angle toward the base and thus make the end of the broken arm squeeze the sheet between itself and the nape of the nearest base angle. The two connected arm portions are longer than the base. Preferably the other base angle is sufficiently rounded so when the plier pressure forces the peak against the base, the peak angle reverses and pressure jams the pressure members between holding means of the tensionable base.

According to another embodiment of the invention, the broken arm includes an ear folded back from its free end and terminating near the peak angle. Making the ear long enough to form an interference fit when the peak angle reverses enables a user to grasp a second sheet at the interference fit by slipping the sheet beforehand between the ear and arm.

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 when read in light of the following drawings wherein:

FIG. 1 is a perspective view illustrating a connector embodying features of the invention;

FIG. 2 is a section 2-2 of FIG. 1;

FIGS. 3, 4, 5 and 6 are end views illustrating four positions of the connector of FIG. 1 as it is being pressed onto a metal sheet;

FIG. 7 is a perspective view illustrating the connector of FIG. 1 joining a metal sheet;

FIG. 8 is an end view illustrating the connector of FIG. 1 joining two metal sheets;

FIG. 9 is a perspective view of another connector embodying features of the invention;

FIG. 10 is a section 10-10 of FIG. 9;

FIG. 11 is a plan view of connectors of FIGS. 9 and 10 joining two metal cable sheaths;

FIG. 12 is a perspective view of still another embodiment of the invention;

FIG. 13 is a plan view of the connector of FIG. 12 joining two metal sheets;

FIG. 14 is a perspective view of yet another embodiment of the invention; and

FIG. 15 is an elevation showing the connector of FIG. 14 joining two metal sheets.

In FIG. 1 a tin-coated copper or copper-alloy strip 10 is folded into a somewhat triangular shape open near one corner 12, and forming a base 14, two arms 16 and 18, and two other corners 20 and 22. The arm 16 near the corner 12 is folded back upon itself to form an ear 24. Extending integrally from the rear edge of the base 14 is a protrusion 26 that terminates in a longitudinally split cylinder section 27 for clamping the conductor of an insulated wire. The end of the arm 16 formed by the fold exhibits a sawtooth portion 28 for scraping through oxide coatings on aluminum or other metal sheets. Longitudinal ribs 30 such as shown in FIG. 2 strengthen the arm 16 and base 14.

FIGS. 3, 4, 5 and 6 illustrate the manner in which a craftsman applies the strip 10 of the clip in FIG. 1 to a metal sheet 32 that may represent the edge of an unseamed outer conductor in a coaxial cable or a sheet embracing the outer conductor. As shown in FIG. 3, the craftsman holds the strip 10 of the clip between the jaws 34 and 36 of a pair of pliers or other squeezing tool. The sheet 32 is placed between the portion 28 and the corner 12. When the craftsman applies pressure to the jaws 34 and 36, as shown in FIG. 4, the arms 16 and 18 articulate about the corner 20 between the arm 18 and

the base 14. The angle between the arms 16 and 18 is such as to force the portion 28 to carry a portion of the sheet 32 into the interior nape of an upstanding boss 38 at the corner 12. Essentially, the only change in the strip 10 occurring between FIGS. 3 and 5 is at the corner 20. When force is continued from the position of FIG. 5 by the jaws 34 and 36, the arms 16 and 18 behave as compression members with the corner 22 forming a hinge between them. Moreover, as pressure increases, the interior angle of the corner 22 increases and continued articulation occurs from the upper end of what now constitutes an upstanding member 42 of the corner 22.

The increasing alignment of the compression members represented by arms 16 and 18 due to downward movement of the corner 22 stretches or places the base 14 into tension.

When the arms 16 and 18 reach their ultimate position illustrated in FIG. 6, the angle between them has been reversed. The arms 16 and 18 and the corner 22 in effect form a toggle. The arms 16 and 18 are in a state of compression while the base 14 is in a state of tension. The ribs 30 illustrated in FIG. 2 prevent the base 14 and arm 18 from bowing in response to the outward torques applied to the upstanding boss 38 and upstanding member 42 at the end of the base 14. The portion 28, because of the applied pressure digs into the metal of the sheet 32 to establish a firm reliable contact. This pressure cannot be released simply by attempting to reverse the bending that has occurred shown in FIGS. 3 and 6. This is so because any attempt to raise up the hinge of the toggle at the corner 22 with the arms 16 and 18 results in increased pressure upon the sheet 32. On the other hand, the jaws 34 and 36 have moved the hinge corner 22 into its ultimate position in the other direction thereby achieving a secure bond. The overlapping portion of the arm 16 in effect thickens that arm so that pressure from the jaws 34 and 36 will not crush the arcuate upstanding portion 42 during the application movement. This upstanding portion 42 helps the toggle movement for stabilizing the connection.

FIG. 7 illustrates the clip according to the invention gripping the end of an outer conductor 45 on a coaxial cable enjoining the latter to the conductor 46 of a wire 48. The outer conductor 45 may also represent the shielding sheath of a cable.

The connector of FIG. 1 is also capable of electrically connecting and holding two conductive sheets. This would be desirable, for example, when joining one cable length directly to another. In performing this double function, the connector according to the invention is used as shown in FIG. 8. Here, because of the toggle action of the arms 16 and 18, an interference fit occurs between the extreme edge 50 of the ear 24 and the top face of the arm 16 if the ear 24 is made sufficiently long as it is in FIG. 1. The edge 50 at the end of ear 24 squeezes a second sheet 52 between itself and the arm 16.

To aid the squeezing action on the sheet 52, the ribs 30 on arm 18 extend far enough toward edge 50 in FIG. 9 and in the sectional drawing of FIG. 10. The ribs 30 furnish upstanding bearing surfaces 54 against which the edge 50 forces portions of the sheet 52. In FIG. 9 sawteeth on the edge 50 penetrate and scrape the oxide layers protecting metals such as aluminum and copper.

Connectors according to the invention achieve a considerable mechanical advantage because of the toggle action achieved by the arms 16 and 18 that hinge at corner 20. This mechanical advantage is obvious from the fact that considerable approaching motion between the jaws 34 and 36 of the squeezing pliers in FIGS. 3 to 6 are necessary for producing but slight outward motion of the portion 28 into the nape of corner 12. The force there is considerably greater than that applied by the pliers. A similarly effect occurs with the edge 50 and the upper surface of arm 18.

FIG. 11 illustrates how several connectors such as those shown in FIG. 9 retain the shielding quality of two

metallic sheaths 56 and 57 that they join on separate cables 58 and 59 when applied at uniform frequent peripheral intervals to join one sheath of one cable to the sheath of another. As is evident from FIGS. 9 and 11, the sheaths or portion of sheaths joined by each clip substantially overlap. Thus, the radiation only escapes from the cables or coaxials through the gaps that may have to be cut between segments of each sheath, and through gaps needed to permit entry of the squeezing device.

It is conceivable, according to the invention, that the squeezing be accomplished by a simple plier device. Only low squeezing forces are necessary to achieve high gripping forces on the metal sheets. These high gripping forces are in effect self-sustaining because of the locking action produced by the toggle configuration both at edges 50 and 28. Moreover, contact between the connector surfaces and sheet or sheets exists over comparatively broad areas.

The invention is effective not only on bare metal sheaths or sheets but also on metal-plastic laminates frequently used as vapor barrier sheaths in cables.

FIGS. 12 and 13 show another embodiment of the clip of FIG. 1. Here two triangular strips 10 extend from the end of a connecting bar 60. As shown in FIG. 13, the triangles 10 connect to sheets 62 and 64 when pressed as shown in FIGS. 3 to 6.

FIGS. 14 and 15 illustrate still another embodiment of the invention in its open condition and grasping condition, respectively. Here the triangles comprise a base 70 and two arms 72 and 74. The triangle, however, is broken at the peak. The ends of the arms 72 and 74 fold back to form overlaps 76 and 78. The edges 80 are formed into sawteeth, as shown.

As before, the lengths of arms 72 and 74 combined exceed the length of base 70. As shown in FIG. 15, the connector of FIG. 14 is used by sliding two sheets 82 and 84 through the opening and simultaneously pressing the arms toward the base 70. The downward motion of the arms produces a mechanical advantage that squeezes the sheets 82 and 84 between the ends 80.

While the embodiments of the invention have been described in detail, it will be obvious to those skilled in the art that the invention may be embodied otherwise within its spirit and scope.

What is claimed is:

1. A connector for connection to a conductive sheet comprising tensionable means (14), bearing means (12, 20) at the ends of said tensionable means, first compression means (16) and second compression means (18) together having a total length greater than said tensionable means, structural means (22) between said compression means for joining said compression means at an angle and for guiding said compression means into substantial alignment with said tensionable means when said compression means are moved toward said tensionable means so as to form a force fit of said pair of compression means from one of said bearing means to the other; said tensionable means, said first and second compression means and said structural means all being formed from a single folded soft-metal sheet, said sheet having grasping surfaces (50, 54; or 12, 23) located outside of said tensionable means for clasping a conductive foil between said surfaces when said compression means are forced toward said tensionable means, said soft-metal sheet forming from one of said bearing means an upstanding member (20) holding an end of one of said compression means (18) at said upstanding member away from the tensionable means so that the angle between said two compression means may be reversed when said compression means are pressed toward said tensionable means, the one of said compression means (16) more remote from said upstanding member including a fold-over portion (24) extending toward said structural means.
2. A connector as in claim 1 wherein said grasping surfaces (50, 54) coincide with ends of each of said compression means (16, 18) near said structural means.

5

3. A connector as in claim 1 wherein said grasping surfaces (12, 28) occur between one of said bearing means and one of said compression means.

4. A clip for connection to a conductive foil, comprising tensionable means, bearing means projecting from said tensionable means, first and second compression means each having respective ends, hinge means at one end of each of said compression means, upstanding means extending from said tensionable means in the same direction as said bearing means, articulation means including a portion of said upstanding means and connecting the other one of said ends of said first compression means to said upstanding means, the combined length of said compression means and said hinge means being greater than the length of said tensionable means between said articulation means and said bearing means; said compression means, said tensionable means, said bearing means, said upstanding means and said articulation means all being formed from a single soft-metal sheet for clasp-
ing a conductive foil between the other one of said ends of said second compression means and said bearing surface when the said compression members and said hinge means are forced toward said tensionable means to perform a toggle movement, said second compression means including a foldover portion extending toward said hinge means.

5. A connector as in claim 4 wherein said tensionable means include ribs extending in the longitudinal direction from said bearing means to said upstanding means.

6. A connector as in claim 4 wherein said end of said second compression means remote from said hinge means is free and has an oxide-penetrating surface.

6

7. A connector as in claim 4 wherein said free end of said second compression means has sawteeth.

8. A connector as in claim 4 wherein said foldover portion is sufficiently long to produce an interference fit with said first compression means at said hinge means when said hinge means are forced toward said tensionable means.

9. A connector as in claim 8 wherein said foldover portion terminates in a sawtooth surface.

10. A connector as in claim 8 wherein said one compression means is ribbed to form an interference fit with the end of said foldover portion.

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