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(54) Electrica terminal for flat power cable.

(57) A transition adapter for terminating single or dual conductor flat power cable (214) includes at least a stamped and formed member (208) having one or opposed plate sections (202) against or between which an end or edge portion of the cable is receivable to be terminated. Opposed plate sections (202) have opposed transverse arrays of shearing wave shapes (222) alternating with arcuate shapes defining relief recesses (224), with each wave shape opposing a relief recess and the lateral edges of the opposing arrays of shearing wave shapes cooperating as shearing edges. When the plate sections are urged together against the cable therebetween, the shearing edges shear the cable insulation and conductor into strips while the crests the wave shapes deflect the sheared cable portions into the opposing relief shapes thus exposing sheared conductor edges for electrical connections therewith and forming mechanical and electrical connections with the cable. Copper insert members (228) may be secured along the plate sections and have apertures into which the sheared conductor strips are deflected, and the insert members (228) may be staked forcing metal against the sheared conductor edges for gas-tight connections. A pair of such adapters may be used to terminate dual conductor cable.

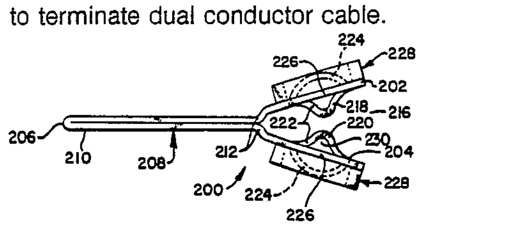

FIG. II

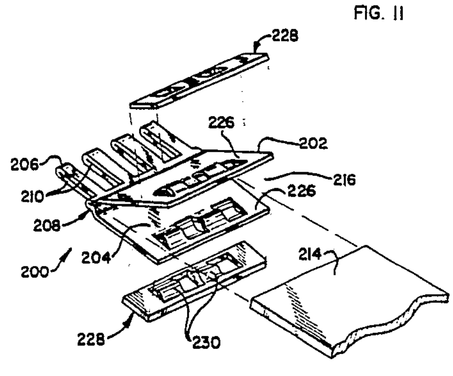

FIG. I2

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ELECTRICAL TERMINAL FOR FLAT POWER CABLE

The invention relates to electrical terminals and more particularly to the termination of terminals to flat power cable.

One type of flat power cable terminal comprises a transition adapter which is secured onto a flat power cable by being crimped thereto, and the adapter includes one or more contact sections to be engaged with corresponding contacts of an electrical connector to transmit power current from the cable to the connector. The cable is of the type entering commercial use for transmitting electrical power of for example 75 amperes nominal, and includes a flat conductor one inch wide and about 0.020 inches thick with an extruded insulated coating of about 0.004-8 inches thick over each surface with the cable having a total thickness averaging about 0.034 inches. The metal of the flat conductor is for example of Copper Alloy 110 and the insulation is for example TEFZEL thermoplastic resin known as polyethylene-co-tetrafluoro-ethylene copolymer (trademark of the E. I. DuPont de Nemours and Company, Wilmington, Delaware).

The terminal above includes a pair of plate sections hinged together at the forward or terminal end of the adapter, and a still-insulated end or edge portion of the cable is to be crimped therebetween. At a selected location forwardly of the cable-crimping region at least one of the plate sections is bent at an angle away from the other so that the plate sections are facing each other at an angle and are thus spaced apart to receive the cable end or edge therebetween. A plurality of lances extend from one plate section toward corresponding apertures in the other so that upon pressing the plate sections together the lances penetrate through the cable. The lances are then received through the apertures and the ends thereof are bent over and against the outer surface of the other plate section, being bent over by tool means or by being curled around by integral arcuate guides at each aperture. By penetrating the cable a plurality of electrical connections are formed between the adapter and sheared conductor edges of the cable. By being stamped from sheet metal of an appropriate alloy, the lances are preferably defined by shear edges and penetrate through the insulation and also the conductor of the cable in cooperation with the lance-receiving apertures which preferably include at least one shear edge against which the cable is pressed during penetration by the lances. Additional electrical connections are made by a plurality of barbs which penetrate the cable insulation to engage and bite into the cable conductor.

Also entering commercial acceptance is a dual conductor flat cable, wherein a pair of parallel spaced coplanar flat conductor strips having insulation extruded therearound define power and return paths for electrical power transmission. One method has been devised as disclosed in U. S. Patent No. 4,241,498 which involves a member associated with one of the two conductors having upper and lower sections joined at a tab. The upper and lower sections are brought along the upper and lower surfaces of the conductor from the side of the cable so that the tab is disposed laterally of the cable. The upper and lower sections have semicylindrical metallic jaws having alternating grooves and lands with the grooves of one jaw adapted to receive thereinto the lands of the opposing jaw then the upper and lower sections are pressed against the conductor. The lands shear strips of the conductor and extrude the sheared strips into the opposing grooves, in a punch and die process. After termination the sheared conductor edges are disposed adjacent sides of the grooves of the semicylindrical jaws to form electrical connections therewith. The tab extends laterally from the cable and is exposed for electrical engagement therewith by another electrical article. The other conductor may be similarly terminated at a nearby location.

It is desirable to provide an adapter having means for shearing through a flat power cable conductor at a plurality of locations to provide a plurality of electrical connections between the adapter and the cable conductor wherein the connections are and remain gas-tight by reason of stored energy.

It is also desirable to provide each gas-tight connection with substantial surface area of engagement between the adapter and the cable's conductor.

It is further desirable to provide elongated gas-tight connections to provide greater interconnecting metal surface area.

It is additionally desirable to provide terminals for terminating dual conductor flat power cable.

It is yet further desirable to provide mechanical and electrical connective joints between an adapter and a flat cable which remain strong and viable and do not weaken over long-term in-service use.

It is still further desirable to provide an adapter of a metal alloy compatible with transmission of electrical power current and which retains its stamped and formed shape and its shear edges to penetrate the cable, and also to provide an adapter of a metal alloy capable of assuming a shape upon termination to the cable which maximizes surface area engagement with the sheared edges of the cable conductor while retaining stored energy to maintain the gas-tight nature of the connections during long-term in-service use.

The present invention is an adapter crimpable to a flat power cable by penetrating the insulation covering the cable's conductor and also shearing through the conductor at a plurality of locations. The adapter is stamped and formed of sheet metal and in one embodiment includes at least one plate section to be disposed along a major surface of the cable upon termination and including at least one terminating region transversely thereacross, which is formed of one or preferably several spaced shearing wave shapes. When the plate section is urged against the insulated flat cable which is supported by an appropriate die, the wave crests begin to extrude or deflect the engaged cable portions into relief recesses of the die surface; simultaneously the shearing edges at ends of the wave crests penetrate and tear the insulation covering and begin shearing the portions of the cable adjoining the crest-deflected cable portions which in turn allows substantial further deflection by the wave crest and also elongation of the crest-deflected conductor portions. The sheared conductor edges of the crest-deflected cable portions are thus pushed out of the plane of the cable and are exposed along substantial lengths such as 0.25 inches to be electrically joined such as by being soldered to the adapter, or by a soft copper adapter portion being staked and thereby deformed tightly against the exposed conductor edges. The plate section maintains a mechanical attachment to the cable by reason of the end portions shearing edges of the wave shapes tightly engaging the sheared edges of the cable conductor at the ends of the crest-deflected conductor portions; additional retention means may be used such as conventional lances penetrating the cable and bent over along the far side, or tabs bent over about the side edges of the cable.

In a second embodiment, the adapter includes a body member having a pair of opposed plate sections each having at least one terminating region transversely thereacross, with the terminating regions of the opposed plate sections being associated in opposing pairs. Each terminating region of the pair is formed of alternating shearing wave shapes and relief recesses, and the plurality of wave shapes of one plate section extend toward the other plate section and are spaced from each other by the relief recesses, with the wave shapes of one plate section corresponding with the relief recesses of the other. Each shearing wave shape includes a transverse radiussed crest extending between parallel axially aligned shearing edges which are perpendicular with respect to the crest. Essentially the wave shapes of one plate section would intermesh with those of the other if urged toward each other, but preferably essentially with zero clearance.

The transition adapter is terminated to a cable disposed between the plate sections, by the preferably hingedly joined plate sections being pressed tightly together with the cable therebetween. Each shearing wave shape will be forced against an adjacent surface portion of the cable and its crest will deflect that adjacent surface portion of the cable out of the plane of the cable and will stretch the conductor portion thus deflected. Simultaneously, the shearing edges of that wave shape cooperate with the shearing edges of the adjacent wave shapes of the opposed plate section: the shearing edges are aligned under zero clearance and pair up so that when the wave shapes are forced against the opposite surface of the cable, the paired shearing edges penetrate and tear the insulating layers and shear the conductor perpendicularly to the wave crest. Preferably an arcuate relief shape is formed at each relief recess extending away from the other plate section, and each wave shape is received into a corresponding opposed relief recess with the crest-deflected cable portion disposed between the wave's crest and the inner surface of the opposed arcuate relief shape. Portions of each shearing edge of the wave shapes of one plate section of the adapter engage newly formed edges of the cable conductor sheared by the adjacent wave shapes of the other plate section. The cable conductor is sheared at a plurality of locations for axial shear lengths of for example 0.25 inches and substantially without great bulk deformation of the metal thereof during the shearing process. Also since the shearing is axial with respect to the cable when the adapter is terminated on an end of the cable, the cable is not materially weakened. Essentially the intermeshing adapter wave shapes form a plurality of interlocking wave joints with the cable conductor thus defining a strong termination transversely across the cable, with the opposing plate sections acting as a zero clearance tool and die which will resist opening thereafter.

According to an aspect of the present invention, a pair of insert members are preferably affixed to and predisposed against the outwardly facing surfaces of the respective plate sections of the stamped and formed adapter body member of the second embodiment, along and across the terminating or wave regions thereof. Each insert member is shaped to conform to the wave region of the associated plate section by having conforming wave shapes and by having apertures within which the arcuate relief shapes are disposed. Each insert member is formed of high copper content alloy and is malleable so that after shearing the cable, each wave shape of the insert member may for example be deformed by a staking operation. Each wave shape of the insert member would be staked from the outwardly facing surface of the insert member to expand the wave shape tightly and fully against the sheared edges of the cable conductor now beside that wave shape on both sides, and also against the adjacent shearing edges of the adjacent wave shapes of the adapter body member. The insert members are adapted to establish the primary electrical connections to the cable conductor, while the transition adapter body member provides the strong mechanical means of attachment to the cable.

In an additional embodiment suitable for dual conductor flat power cable, but also usable with single conductor cable a pair of transition adapter terminals are terminated adjacent each other to a cable end. The terminals may be initially joined together by a severable link for facilitating handling and assembly to the cable. The pair of terminals may be used with single conductor flat power cable but are especially suitable for terminating dual conductor flat power cable, in which case the pair of terminals are separated from each other by severing the link therebetween after termination after which the terminals are inserted into the housing. Each terminal has a pair of opposed plate sections transversely across each of which are an array of shearing wave shapes alternating with relief recesses, so that when the pair of plated sections are pressed against the cable end portion therebetween the arrays of shearing wave shapes cooperate to shear the conductor of the flat cable into a plurality of strips which remain integral with the cable, and extrude the newly sheared conductor strips into the opposing relief recesses. The pair of plate sections of each terminal extends forwardly from a rearward cable-receiving terminal end where they coextend forwardly at a slight angle from a pair of bight sections spaced laterally apart defining a cable-receiving slot therebetween of known transverse width. Tab-shaped portions are formed on the end section of the cable and are inserted through the cable-receiving slots and are disposed between the upper and lower plate sections of each terminal. The tab-shaped portions are prepared by cutting an axial slot precisely along the cable centerline, thereby exposing sheared conductor edges axially along both sides of the slot whether the cable is single or dual conductor, with a slot width corresponding to the widths of the respective cable-receiving slots of the terminals to be received at least closely thereinto. The upper and lower plate sections of each pair are pressed respectively together by being rotated about the bight sections which act as integral hinges, so that the shearing wave shapes shear and extrude strips of the conductor (or conductors) of the cable forming a termination of the terminals to the cable. The terminals are then placed into respective cavities of an integral housing, or into respective housings. A separate elongate bifurcated strain relief member may then be placed over the cable and latched to the rearward housing end which clamps the cable and also provides a rearward stop for the terminals in the housing cavities.

It is an objective of the present invention to provide an adapter for terminating to flat power cable which is easily applied without cable preparation, which results in an assured electrical and mechanical connection to the cable.

It is another objective to provide gas-tight joints between the adapter and the cable conductor which retain substantial stored energy thereat for long-term in-service use and do not relax due to heat and vibration over time.

It is also an objective of the present invention to provide an adapter which selectively deforms the cable in cooperation with the shearing of a plurality of locations for substantial lengths without materially weakening the cable conductor, to expose the sheared conductor edges for the forming of a plurality of electrical connections having substantial surface area.

It is yet another objective to provide an adapter which includes a metal portion stiff enough to be capable of including edges for shearing through a relatively thick (0.020 inches) metal conductor at a plurality of locations for substantial lengths, while including a metal portion capable of being formed to conform tightly against substantially the entire surface area of the sheared conductor edges with stored energy after cable penetration.

It is still another objective to provide an adapter which after cable termination distributes current carried by the conductor evenly to selected contact sections in an assured manner.

It is an additional objective to provide terminals for terminating dual conductor flat power cable as well as single conductor cable.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

FIGURE 1 illustrates an electrical connector for flat power cable utilizing the transition adapter of the present invention;

FIGURE 2 is an isometric view of the transition adapter of Figure 1 ready to receive a cable end thereinto for termination;

FIGURE 3 is an isometric view of the adapter with the inserts exploded from the body member;

FIGURE 4 is a plan view of the body member prior to its plate sections being bent back along each other;

FIGURES 5 and 5A are elevation views showing the insert members being affixed to the body member, and an enlarged isometric part-sectional view thereof illustrating staking;

FIGURES 6A to 6C are longitudinal section views of the adapter ready to receive a cable end thereinto, after receiving the cable end, and after being terminated thereonto respectively;

FIGURES 7A to 7C are cross-sectional views taken across the region of the wave termination showing respective shearing and two staking operations;

FIGURES 8A and 8B are views of the two types of staking blade tips for use in the staking operations of Figures 7B and 7C;

FIGURES 9 and 10 are microphotographs taken along a cross-section of a cable to which a transition adapter has been terminated as in Figures 7A-C, and an enlargement of a single staked wave joint thereof, respectively;

FIGURES 11 and 12 are elevation and isometric views of an alternate embodiment of transition adapter with inserts;

FIGURES 13A to 13C illustrate a transition adapter having one plate section to be joined to a cable using an opposing die, and thereafter having a copper insert member secured to the terminated cable region and then staked;

FIGURES 14A and 14B are enlarged views of a relief aperture of an alternate insert member embodiment having tapered side walls and being secured to a wave joint;

FIGURE 15 illustrates using solder with a single plate adapter without an insert member; and

FIGURES 16A and 16B illustrate a transition adapter having a pair of plate sections as in Figure 4 but without insert members, being mechanically joined to a cable.

FIGURE 17 shows a pair of terminals of the invention being applied to tab portions of a dual conductor cable, and a housing and strain relief member therefor, and a mating pair of terminals and housing therefor;

FIGURES 18 and 19 are longitudinal section views of the housed terminals of Figure 17 before and after mating; and

FIGURES 20 and 21 illustrate separate housed terminals for dual conductor cable.

Figure 1 illustrates the connector assembly 10 in which the transition adapter 40 of the present invention is used to terminate an end 12 of flat power cable 14 for a power distribution system for within electronic devices such as computers, copying machines and the like, and also for card cage systems. Cable 14 is of the type comprising a flat conductor 16 such as 0.020 inches thick copper or aluminum with an insulative coating 18 extruded therearound, such as four to eight mils thickness of TEFZEL thermoplastic resin (trademark of E. I. DuPont de Nemours and Company) along each surface. After application of transition adapter 40 onto cable end 12, the terminated end is secured within a dielectric housing assembly 22 comprising first and second cover members 24,26 for example. Cover members 24,26 can be hinged to facilitate being rotated together and latched to enclose the terminated cable end. Passageways 28 extend inward from mating face 30 to contain the contact sections of the adapter for mating to corresponding contacts (not shown). The housing assembly can be configured in accordance with the type of contact section or sections 42 desired to be formed on the adapter 40, and also the particular use to which the connector is to be put. A variety of contact sections for the transition adapter may be used.

In Figures 2 and 3, transition adapter 40 of the present invention includes at least a body member 44 to which the one or more contact sections 42 are joined or are an integral part, at mating end 46. Body member 44 also includes a cable-receiving end 48 which may be at the opposite end from mating end 46. Body member 44 also includes a pair of plate sections 50,52 preferably integrally joined at hinge 54 so that the plate sections after termination will be disposed in parallel along opposed major side surfaces of cable end 12 and clamped onto cable 14. Preferably and as shown, hinge 54 is located at cable-receiving end 48 although the hinge can also be located proximate mating end 46 as seen in Figures 11 and 12.

Plate sections 50,52 have respective opposed terminating regions 56,58 extending transversely thereacross, each comprising a row of spaced shearing wave shapes 60 (see Figure 6A) alternating with relief recesses formed by arcuate relief shapes 62. Each of the wave shapes of each of the plate sections is located opposed from an arcuate relief shape of the other of the plate sections. The wave shapes of each plate section extend outwardly of the cable-proximate surface 64 thereof and toward the other plate section to radiussed crests 66 (Figure 6A); the arcuate relief shapes extend outwardly of the cable-remote surface 68 thereof and away from the other plate section. Essentially wave shapes 60 of each of plate sections 50,52 present a cooperating pattern with wave shapes 60 of the other which are offset, and the wave shapes would intermesh if the plate sections were to be urged against each other about hinge 54.

Preferably transition adapter 40 includes insert members 100,102 to establish assured electrical connections to cable conductor 16. Insert members 100, 102 are affixed to cable-remote surfaces 68 of respective plate sections 50,52 of body member 44 across termination regions 56,58 thereof. Each insert member 100,102 has a pattern of wave shapes 104 alternating with relief apertures 106 likewise presenting a cooperating pattern with those of the other insert member after being secured appropriately to body member 44. Wave shapes 104 include crests 108 and are shaped to conform to the adjacent surfaces of corresponding wave shapes 60 of the plate section to which the insert member is affixed. Preferably each of insert members 100,102 includes a shaped boss 110 at one end 112 and a shaped boss-receiving aperture 114 at the other end 116 so that upon termination the shaped boss of one insert member is received into the boss-receiving aperture of the other.

In Figures 2 and 6A cable end 12 is insertable into cable-receiving end 48 of transition adapter 40 which preferably comprises a slot 70 (Figure 4) extending between a pair of hinge sections 72 of body member 44 joining plate sections 50,52. It is preferable that plate sections 50,52 be previously bent almost together about hinge sections 72 prior to cable insertion, with crests 66 of wave shapes 60 close enough together so that the spacing therebetween has a dimension smaller than the thickness of cable 14, so that cable end 12 deflects plate sections 50,52 slightly outwardly against spring bias generated at hinge sections 72 so that transition adapter 44 self-retains onto cable end 12 to facilitate handling prior to the crimping step to follow. Hinge sections 72 should be formed to have a radius about equal to one half of the cable thickness. Outwardly extending flanges 74 along both sides of elongated slot 70 provide strength after termination to provide resistance to plate sections 50,52 being deflected apart resulting from torque which may be applied to the transition adapter due to stresses on the relatively wide, relatively stiff cable.

Figure 4 shows the metal blank of body member 44 prior to application of insert members 100,102 thereto, and prior to being bent at hinge sections 72. Blade type contact sections 42a are shown at mating end 46; plate sections 50,52 are shown on either side of slot 70 and flanges 74; and terminating regions 56,58 are seen to have a width across body member 44 about equal to that of a cable, with recesses 76 on either side of hinge sections 72 providing clearance for the bosses 110 of each of insert members 100,102 (Figure 3) to extend beside body member 44 upon termination to be received in boss-receiving apertures 114 of the opposed insert member. Terminating regions 56,58 are slit at equally spaced, precisely opposed locations during the formation of the wave shapes 60 and arcuate relief shapes 62 in a manner not creating gaps laterally between the formerly joined shearing edges at slits 61. Plate sections 50,52 also include integral portions 78 forwardly and rearwardly of the ends of slits 61. Flanges 74 can be comprised of the metal formed from creating slot 70 and are bent 90° about small radii.

Body member 44 can be formed for example from strip stock of 0.025 inches thick copper alloy such as sold by Olin Corporation under Alloy No. 7025 half hard copper alloy, or such as Alloy No. 151 tempered hard alloy, Temper No. H05 with annealing for good stress relaxation properties. Insert members 100,102 can be formed for example of dead soft Copper CDA 110 generally about 0.066 inches thick with a height at the wave crest 108 of about 0.132 inches, and can have a length in the axial direction of about 0.326 inches. Both the insert members and the body member can be silver plated, if desired, to assure the integrity of the electrical connection for long-term in-service use.

Referring to Figures 5 and 5A, each insert member 100,102 can be affixed to a respective plate section 50,52 by a slight staking operation wherein the insert members are tapped by blades 148 centered on the outwardly facing surface of each raised wave shape, which slightly deforms the insert wave shape laterally against the edges of the adjacent arcuate relief shapes of the particular adapter plate section to which the insert member is being secured.

In Figure 6A the assembled transition adapter 40 is ready to receive cable end 12 into cable-receiving end 48, and wave shapes 60 are almost together at upper and lower crests 66a,66b. The cable end is inserted into slot 70 and deflects plate sections 50,52 apart in Figure 6B and is moved forwardly until leading edge 12 is appropriately located a small distance in front of the terminating regions 56,58 but rearwardly of contact sections 42a. Spring bias at hinge sections 72 creates a gripping of the cable by the crests 66a,66b against insulated upper and lower surfaces 32,34 of cable 14. In Figure 6C the transition adapter 40 has been pressed together by tooling 150 (Figure 7A) such as an arbor press. Shearing edges created by slits 61 along the sides of wave shapes 60 of each plate section have acted in cooperation with those of the offset wave shapes of the opposing plate section and have first punctured and torn the tough, ductile insulative coating 18 of cable 14 and have sheared the cable conductor 16 lengthwise for distances of about 0.25 inches. Crests 66a,66b have deflected outwardly and elongated the thus sheared portions of cable conductor 16 forming alternatingly upward and downward arcuate conductor loops within the opposed arcuate relief shapes of the opposing plate section. At each wave shape 60 has been formed a wave joint 80. In the present embodiment there are shown six wave joints 80 transversely entirely across cable 14, and the transition adapter of the present invention can easily be modified to create four such wave joints leaving integral adapter straps along lateral ends of the termination regions.

It is believed that the wave shapes assist the shearing of the cable by initiating the outward deflection of the cable in opposite directions first at a single point along the cable axis (by the wave crest) and then gradually axially forwardly and rearwardly therefrom and also by initiating the shearing first at that single point simultaneously with the deflection from both surfaces of the cable by paired shearing does having zero clearance. The deflected conductor strips remain integrally joined to the cable and the cable is not materially weakened. The termination is considered to be controlled and precise and is performed by shearing edges of the adapter itself and without any prior preparation of the cable required. Another benefit of the present invention is that since the transition adapter grips the cable after cable insertion, handling to place the cable end into the application tooling is simplified since the stiff cable itself is used for manipulation.

With reference to Figures 7A to 7C, following the application of compressive force by planar surfaces of a first pair of dies 152 of tooling 150 to shear the cable, preferably dies 152 remain locked together continually pressing most of the outer surfaces of the upper and lower portions of the transition adapter 40 against the upper and lower cable surfaces 32,34. Dies 152 may preferably have limited apertures 154. at each location of wave joint 80 and insert wave shape 104 and at both insert ends 112,116 to expose bosses 110 and the wave joints and insert wave shapes for subsequent staking operations. A second step is then performed by a second pair of dies 156 in Figure 7B. Pointed chisel blades 158 have axially oriented tips (Figure 8A) and simultaneously strike the transition adapter 40 from both above and below at each wave joint 80 first along the outer surfaces 82 of arcuate relief shapes 62. Referring to Figures 7B and 10, blades 158 penetrate into each wave joint 80 a selected depth and split the arcuate relief shapes 62 and also bend the split portions 84 down along the inside of the resultant V-shape of a staked wave joint 86 at the axial center of the wave. Split portions 84 act as paired spring members having free ends 88 which are permanently deformed by blades 158 into cable 14. With the wave crest 66 of the opposing wave 60 acting as a die, free ends 88 act on softer conductor 16 to urge portions 90 thereof laterally outwardly even though conductor portions 90 may usually remain integrally joined to each other. Spring members 84 thereafter trap conductor portions 90 against side surfaces 120 of insert member relief apertures 106 and retain them against surface 120 under spring bias, acting as stiffly compliant structures. At the same time an additional set of blades 160 (Figure 8B) stake bosses 110 into boss-receiving apertures 114 of insert members 100,102, thereby deforming the bosses into enlarged shapes within the undercut apertures and firmly joining the inserts together at assured electrical and mechanical joints 122.

Then as is shown in Figure 7C, as blades 158,160 are withdrawn but dies 152 remain closed, a third step is performed by a third pair of dies 162 of tooling 150. Pointed chisel blades 164 have axially oriented tips (Figure 8A) and simultaneously strike the transition adapter 40 from above and below along the outer surfaces 124 of each insert member 100,102 at each wave shape 104 and between the now-staked wave joints 86. Blades 164 thus are pressed into the wave shapes 104 of insert members 100,102 and split and deform the softer copper material laterally and loading the contact interface between the freshly sheared edges of the cable conductor portions 90 along each staked wave joint 86 and the relief aperture side surfaces 120 of the insert members. Free ends 88 of spring members 84 also prevent the deflected conductor strips from bulging outwardly at the center during staking of the insert member wave shapes 104. Blades 158,160,164 may optionally be separate members urged into blade-receiving apertures 154 by a separate comb member (not shown).

Figure 9 is an enlarged cross-sectional view transversely through an actual termination 92 and represents the type of termination resulting from the transition adapter described with respect to Figures 7A to 7C. Four of the six staked wave joints 86 are seen. In Figure 10 which is an enlargement of one of the staked wave joints 86 of Figure 9, sheared conductor edges 94 are clearly shown tightly against adjacent side surfaces 120 of adjacent insert wave shapes forming the primary electrical connections 96 between the transition adapter and the conductor of the cable. Near the axial center of each staked wave joint 86, the conductor 16 consists of two portions 90 which have been urged laterally outwardly with sheared conductor edges 94 being impacted against surfaces 120; the curvature at 96 indicates the existence of substantial column strength creating stored energy cooperating with the adjacent staked insert portions to form an assured electrical connection. Dark layered areas 98 within staked wave joints 86 comprise portions of insulative cable covering 18 which have become lodged within available spaces and do not affect the assured mechanical and electrical connections. Measurement of resistance levels of terminations formed in this manner indicate acceptably small levels of voltage drop, indicating good electrical connections after aging at elevated temperatures. Conventional thermal shock tests indicate excellent mechanical stability in the terminations.

Figures 11 and 12 show an alternate embodiment of transition adapter 200 in which plate sections 202,204 are integrally joined at bight sections 206 at the forwardmost end of body member 208. Contact sections 210 comprise pin shapes and are formed of double thicknesses of the metal blank from which body member 208 is stamped, and extend rearwardly from bight sections 206 which constitute the leading ends of contact sections 210. Upper and lower plate sections 202,204 are bent upwardly at bends 212 located just rearwardly of contact sections 210 so that they diverge extending rearwardly. Cable end 214 is inserted from cable-receiving end 216 to be disposed between opposed termination regions 218,220 of upper and lower plate sections 202,204 respectively. When plate sections 202,204 are crimped onto cable end 214, wave shapes 222 will then shear cable end 214 at a region which is spaced rearwardly from the forwardmost portion of cable end 214, at a plurality of locations thereacross, and deform the thus-sheared axial strips against the inner surfaces of opposed arcuate relief shapes 224, as in the embodiment of Figures 2 to 7C. Four such wave shapes 222 are shown, with integral plate section straps 226 extending laterally beside the terminating regions to assist maintaining insert members 228 thereon which have been affixed to the outer surfaces of plate sections 202,204 of body member 208, although without bosses and boss-receiving apertures at ends thereof. The wave joints can then be staked and the insert member wave shapes 230 can then also be staked as in Figures 7A to 7C. Cable strain relief can be provided by the connector assembly into which the terminated cable end is to be secured.

In Figures 13A and 13B a transition adapter 300 has only one plate section 302, with one terminating region 304 thereacross although a plurality of spaced terminating regions may be desired. A die surface 306 of a die means 308 supports cable 310 while plate section 302 is applied under sufficient pressure by another die means 312 against cable 310. Crests 314 of waves 316 deflect adjacent cable portions into relief recesses 318 of die surface 306 as edges of waves 316 shear the cable conductor. Additional cable-securing means such as tabs 320 of adapter 300 may be used, which are bent around side edges of cable 310 by recesses 322 of die surface 306. Also conventional cable-piercing lances (not shown) may be used for securing. By shearing the cable conductor at a plurality of locations across the terminating region 304 and then deflecting the sheared conductor strips 328 out of the plane of the cable, edges of the conductor strips 328 are now exposed to be electrically connected. An insert member 330 having relief apertures 332 can then be placed across the wave region so that sheared and deflected conductor strips 328 are received in respective relief apertures 332, and the cable-proximate surface of insert member 330 is planar. Insert member 330 can then be secured to the termination by tabs 324 of adapter 300 being bent upward and over ends of the insert member so that tab flange portions 326 can be secured around upstanding insert flange portions 334, as seen in Figure 13C. Insert member 330 can now be staked beside its relief apertures 332 as shown in Figure 7C, leaving impressions 336; also, the conductor strips 328 can be staked similarly to the wave joint staking shown in Figure 7B, leaving impressions 338, forming an assured electrical connection.

Insert member 350 in Figures 14A and 14B has relief apertures 352 having tapered side surfaces 354. When pressed over a wave region 360, similar to that shown in Figure 13B, an electrical connection is formed with the cable conductor. Adapter 364 has a terminating region having a plurality of wave shapes thereacross; cable 362 has a wide, flat conductor and thin insulative covering 368 thereover; sheared and deflected conductor strip 366 has exposed conductor edges 370, and the adapter wave shape shown has shearing edges 372. As insert member 350 is pressed onto the terminating region, conductor edges 370 and wave shape edges 372 scrape and scive or deform side walls 354 near the far end of relief aperture 352 in Figure 14B establishing an electrical connection therewith at 380. It is also possible to form vertical serrations on side surfaces of the relief apertures of the insert member, which can then scrape and scive the exposed sheared conductor edges, increasing the surface area of the electrical connection between the conductor and the insert member.

In Figure 15, adapter member 400 is pressed against cable 410 as shown in Figure 13A, creating a terminating region across the cable by reason of wave shapes 414 (in phantom) shearing and deflecting conductor strips 424 (in phantom) out of the plane of the cable. Adapter member 400 can have tabs 420 to be secured to cable 410. Edges of conductor strips 424 are exposed to be electrically connected to adapter member 400 by using solder 430. Termination 432 thus formed can then be placed in an insulative housing.

Figures 16A and 16B illustrate a transition adapter 500 having a pair of plate sections 502,504 and formed from a blank similar to the blank of Figure 4. Transition adapter 500 without any insert members, can be terminated to a cable end 506 with intermeshing waves 508 deflecting and shearing cable portions as in Figures 6A to 6C, until the deflected cable portions are pushed against the inner surfaces of arcuate relief shapes 512. When applied to the cable the adapter has thereby been mechanically joined to the cable, with some electrical connection existing between portions of the shearing edges of the waves and portions of the sheared cable conductor. Exposed portions of sheared cable conductor edges 510 can be electrically connected such as with solder as in Figure 15. The termination 514 can then be placed in a connector housing (not shown).

Although a transition adapter utilizing the wave crimp of the present invention preferably includes insert members of softer metal to optimize the termination for long-term in-service use, it is foreseeable that a transition adapter can be used without separate insert members and obtain significant benefits from the shearing action performed by the zero clearance opposing shearing edges of the wave shapes disclosed herein, and obtain wave joints which are mechanically strong and which provide substantial surface area of exposed cable conductor of the cable for establishing electrical connection therewith. Lateral edges of the wave shapes may be serrated if desired thus forming corresponding serrations in the sheared conductor edges and increasing the surface area thereof exposed for electrical connection such as by soldering. Also, insert members having a different configuration may be used. The plate sections can have two terminating regions instead of one, if desired, and can be separate members. Further, it is easily seen that an embodiment of the transition adapter can be terminated to a side edge of a flat cable rather than an end portion.

Connector 610 of Figure 17 includes a housing member 612 and cable strain relief member 614, adapted to house a pair of terminals 616 terminated onto flat power cable 618. Connector 620 is matable with connector 610 and is adapted to house a pair of corresponding pair of terminals 622 which are shown to include post sections 624 extending rearwardly from housing 626 for insertion into corresponding plated through-holes of a printed circuit board (not shown). Terminals 622 also are shown having spring arm contact sections 628 at forward ends thereof matable with splines 630 at forward ends of terminals 616, when connectors 610 and 620 are mated. Housing 612 includes a plurality of forward passageways 632 in communication with mating face 634 within each of which is disposed a spline 630 after terminals 616 are inserted into housing member 612 from rearward end 636. Housing 626 of connector 620 includes a large cavity 638 within which are disposed spring arms 628, and large cavity 638 is adapted to receive thereinto forward section 640 of housing 612 of connector 610 upon mating, with spring arms 628 received within passageways 632 to electrically engage respective splines 630. Housing 612 is shown having a pair of latch arms 642 along sides thereof which ride over and latchingly engage a pair of corresponding latching projections 644 of housing 626 to secure the connectors together. Latch arms 642 are shown having rearward gripping portions 646 to facilitate delatching from projections 644 upon connector unmating. Strain relief member 614 is insertable across flat cable 618 from lateral edge 648 and then movable forwardly therealong to latch securely to housing member 612 along rearward end 636. Strain relief member 614 includes upper and lower struts 650,652 extending laterally from integral section 654 spaced slightly apart for cable 618 eventually to be disposed therebetween. At lateral end 656 including integral section 654, first latch arm 658 extends forwardly to inwardly directed latching projection 660. At lateral end 662 a pair of second latch arms 664 extend forwardly from ends of upper and lower struts 650,652 to inwardly directed latching projections 666 which will cooperate as a single latch arm during latching to connector housing 612. Housing member 612 includes near rearward end 636 and along outer surfaces 668 a pair of latching recesses 670 for receiving thereinto latching projections 660,666,666 when strain relief member 614 is secured to housing member 612.

Upon assembly to housing member 612 cable strain relief member 614 defines a cable exit between facing surfaces 674,676 of upper and lower struts 650,652. Strain relief member 614 is dimensioned and shaped to clamp against cable 618 along the upper and lower cable surfaces and also against the lateral cable edges, upon being latched to housing member 612.

Terminals 616 include stamped and formed adapter members 678 disposed immediately against cable surfaces 684,686, and also insert members 680 secured along cable-remote surfaces of adapter members 678 and being of high copper content which establish gas-tight electrical engagement with sheared edges of the cable conductors after termination. Cable 618 has two spaced flat conductors, and an axial slot 682 has been cut along the cable centerline, removing narrow inner edge portions of the conductors and the medial strip of insulative material therebetween, creating tab-shaped cable portions insertable into cable-receiving slots of the pair of terminals 616 defined between inner ones of the pairs of bight sections of the terminal adapter members 678, with the axial slot 682 having a width selected for the tab-shaped portions to fit at least closely between the pairs of bight sections of each adapter member 678. Preferably the fit of the tab-shaped portions is so close upon insertion through the cable-receiving slots that upon pressing the plate sections of the adapter members together for cable termination, the outer bight sections of each pair expand incrementally inwardly against and dig into the lateral edge cable insulation and the inner bight sections are slightly deformed and expand incrementally inwardly against the adjacent metal conductor edge and biting thereinto to establish a stop mechanism against movement of the terminals axially along the cable after termination.

Figures 18 and 19 show a terminal 616 terminated to cable 618 and disposed within a respective cavity 688 of housing member 612, and a terminal 622 disposed within housing 626. Cable strain relief member 614 is shown latched in place defining a cable exit with cable 618 clamped between facing surfaces 674,676 of upper and lower struts 650,652 and a bight section 690 of adapter section 678 of terminal 616 disposed in a recess 692. Forwardly facing surfaces 694 of upper and lower struts 650,652 provide stop mechanisms holding terminal 616 in cavity 688 in a manner not permitting substantial axial movement therewithin. Connectors 610 and 620 are shown being mated, with a downwardly angled spline 630a and an upwardly deflectable spring contact arm 628a electrically engageable together.

In Figures 20 and 21 are shown an alternate arrangement wherein terminals 750,752 are terminated to ends of respective cable portions 754,756 containing individual conductors of a dual conductor cable 758. Individual housing members 760 are shown for terminals 750,752, with individual cable strain relief members 762 shown to be placed and latched to rearward ends of housing members 760. The arrangement shown accommodates the desire to space the connectors 764,766 apart for the power and return paths established by the individual conductors of the cable.

Claims

1. A transition adapter for flat power cable (14,214,310,362,410,506,618,758) of the type having flat conductor means (16) with a thin insulative covering (18,368) thereover, for terminating to the conductor means and electrically interconnecting the conductor means to another electrical article (620) having contact means (628) matable with contact means (42,210,302,630) of the adapter for the transmission of power current, characterised in that:

said transition adapter comprises at least a body member (44,208,300,364,400,500,678,750,752) formed from metal having spring characteristics and suitable for transmitting power current, said body member including contact means (42,210,302,630) at a mating end thereof and at least a first plate section (52,202,302,504) having a cable-proximate surface and including at least one terminating region (56,58,218,220,360), each said terminating region including a plurality of shearing edges (61,372) with said first plate section (52,202,302,504) being integral surrounding each said shearing edge (61,372);

each said terminating region (56,58) including at least one wave shape (60,222,316,414,508) extending outwardly from said cable-proximate surface of said first plate section (52,202,302,504), each said wave shape (60,222,316,414,508) including a crest portion (66,314) extending between two parallel ones of said shearing edges (61,372), whereby each said terminating region (56,58,218,220,360) comprises a plurality of shearing edges (6!,372) for shearing the insulative covering (18,368) and conductor means (16) of a cable (14,214,310,362,410,506,618,758) at a plurality of locations when said first plate section (52,202,302,504) is pressed relatively against a portion of the cable supported by a die means (50,204,306,502) having a relief recess (62,224,318,512) opposed from each said wave shape (60,222,316,414,508), and the crest portion (66,314) of each wave shape (60,222,316,414,508) deflects a respective strip (90,328,366) of the cable (14,214,310,362,410,506,618,758) sheared by the shearing edges (61,372) into a respective relief recess (62,224,318,512) of the die means (50,204,306,502), whereafter upon removal from the die means substantial lengths (90,328,366) of the sheared cable conductor (16) are held out of the plane of the cable and sheared edges (94,370) thereof exposed for electrical connection to the transition adapter, and the transition adapter is terminated to the cable.

2. A transition adapter as set forth in claim 1 further characterised in that said body member (44,208,300,364,400,500,678,750,752) includes a pair of opposed first and second plate sections (50,52,202,204,502,504) adapted to receive a portion of a cable (14,214,310,362,410,506,618,758) therebetween from a cable-receiving end (48), at least one of said first and second plate sections being integral with said body member;

said plate sections (50,52,202,204,502,504) having cable-proximate surfaces facing each other and cable-remote surfaces facing outwardly away from each other, said first plate section (52,202,302,504) including at least one first terminating region (56,58,218,220) and said second plate section (50,204,502) including at least one second terminating region (56,58,218,220), said first and second

terminating regions (56,58,218,220) being located to be opposed from each other prior to termination to said cable (14,214,310,362,410,506,618,758), and cooperable during termination, each said terminating region (56,58,218,220) including a plurality of shearing edges (61,372) and each said plate section (50,52,202,204,502,504) being integral surrounding a respective said terminating region (56,58,218,220) thereof;
said first and second terminating regions (56,58,218,220) respectively comprising at least one first and second wave shape (60,222,316,414,508) extending outwardly from said cable-proximate surface of a respective said plate section (50,52,202,204,502,504), and at least one first and second relief recess (62,224,512) therebeside, each said at least one first and second relief recess (62,224,512) being associated with and disposed opposed from a said second and first wave shap (60,222,316,414,508) respectively;
each said first and second wave shape (60,222,316,414,508) including a crest portion (66,314) extending between two parallel ones of said shearing edges (61), and said at least one first wave shape (60,222,316,414,508) being precisely adjacent said at least one second wave shape (60,222,316,414,508) just prior to termination so that one of said shearing edges (61) thereof is opposed from and aligned with a respective shearing edge (61) of the other to cooperate therewith during termination to the cable (14,214,310,362,410,506,618,758) to shear said cable from opposite sides at the same location, and each said shearing edge (61) being opposed from at least an edge (61) formed in the opposing said plate section (50,52,202,204,502,504) and cooperable therewith to shear through said cable during termination;
whereby said first and second terminating regions (56,58,218,220) comprise a plurality of opposed shearing edges (61) cooperable upon said first and second plate sections (50,52,202,204,502,504) being forced together against said cable portion inserted therebetween to shear the insulative covering (18) and the conductor (16) of the cable at a plurality of locations, and a plurality of wave shapes (60,222,316,414,508) having respective crest portions (66) for deflecting integral strips (90) of said cable sheared by said shearing edges (61) into a plurality of relief recesses (62,224,512), whereafter at least portions of said shearing edges (61) engage portions of said sheared edges (94) of said strips (90) of the cable conductor (16) and other sheared edge (94) portions remain exposed for establishing electrical connection therewith, and the transition adapter is terminated to the cable.

3. A transition adapter as set forth in claim 2 further characterised in that both said first and second plate sections (50,52,202,204,502,504) are integral portions of said body member (44,208,300,364,400,502,678,750,752).

4. A transition adapter as set forth in claim 3 further characterised in that said first and second plate sections (50,52,202,204,502,504) are integrally joined to each other at a hinge (54,690) and adopted to be pressed together by being rotated about said hinge (54,690) during termination to said cable (14,214,310,362,410,506,618,758) disposed therebetween, and said shearing edges (61) of said first and second terminating regions (56,58,218,220) being oriented substantially perpendicular to said hinge (54,690) to shear said cable perpendicularly to said hinge during termination.

5. A transition adapter as set forth in claim 4 further characterised in that said hinge (54,690) is disposed at the cable-receiving end (48) of said body member (44,208,300,364,400,500,678,750,752) and comprises a pair of hinge sections (72,690) spaced transversely apart defining a cable-receiving slot (70) therebetween having a height about equal to a cable thickness through which an end of the flat cable is insertable to be disposed between said plate sections (50,52,502,504), whereafter said plate sections are rotatable together about said hinge (54,690) to mechanically and electrically join to the cable defining the termination, whereby after termination the hinge sections (72,690) resist torque applied on the adapter and the mechanical and electrical connections of the termination are protected.

6. A transition adapter as set forth in any of claims 2 to 5 further characterised in that first and second insert members (100,102,228,680) are affixed to said cable-remote surfaces of said first and second plate sections (50,52,202,204,504) respectively at said first and second terminating regions (56,58,218,220) thereof, each said insert member (100,102,228,680) having a surface adjoining and shaped to conform to said cable-remote surface of the respective said terminating region (56,58,218,220) and including insert wave shapes (104,230) and insert relief apertures (106) associated and aligned with the respective said wave shapes (60,222,316,414,508) and relief recesses (62,224,512) of the said terminating region (56,58,218,220) of the adjoining said plate section (50,52,202,204,502,504), each said insert wave shape (104,230) extending between parallel side surfaces (120) aligned with edges (61) of said terminating region (56,58,218,220) of said adjoining plate section (50,52,202,204,502,504), each of said side surfaces (120) comprising an electrical con-

nection surface to adjoin a sheared edge (94) of a said portion (90) of the cable conductor (16) after termination.

7. A transition adapter as set forth in claim 6 further characterised in that said insert members (102,104) include integral means (110,114) adapted to be utilized to lock said insert members (102,104) to each other upon termination to the cable with said plate sections (50,52) and said cable portion clamped therebetween, thereby locking the termination together forming an assured mechanical joint with the cable.

8. A transition adapter as set forth in any of claims 5 and 6 wherein the cable (618,758) comprises a pair of conductor members, further characterised in that the cable includes an axial slot (682) cut therein from an end along the cable centerline defining a pair of spaced tab-shaped portions (754,756), and each said tab-shaped portion is insertable through a said cable-receiving slot of a respective said body member (678) defined between a pair of said hinge sections (690) to be disposed between said opposed plate sections thereof, whereby each conductor of said pair of conductors is terminatable to a respective said body member upon pressing together said opposed plate sections with said tab-shaped cable portion therebetween.

9. A method of terminating flat electrical cable (14,214,310,362,410,506,618,758) of the type having at least one flat conductor member (16) and thin insulative covering (18) thereover, comprising the steps of:

forming first and second plate sections (50,52,202,204,502,504) respectively, each one first and second terminating region (56,58,218,220) including a plurality of shearing edges (61) surrounded by integral portions of said first and second plate sections (50,52,202,204,502,504) having at least said first and second terminating region (56,58,218,220) further including at least one first and second wave shape (60,222,316,414,508) respectively, each wave shape including a crest portion (66) extending between a pair of said shearing edges (61), and each said first and second terminating region (56,58,218,220) including at least one first and second relief recess (62,224,512) each extending between a respective pair of edges, at least one of said first and second plate sections (50,52,202,204,502,504) including contact means (42,210,302,630) thereon adapted to be engaged by corresponding contact means (622) of an electrical article (620);

opposing and aligning said first and second plate sections (50,52,202,204,502,504) such that said first wave shapes (60,222,316,414,508) extend toward said second relief recesses (62,224,512) and said second wave shapes (60,222,316,414,508) extend toward said first relief recesses (62,224,512), said relief recesses (62,224,512) being shaped to receive thereinto during termination said wave shapes (60,222,316,414,508) opposed therefrom, and said shearing edges (61) of each one of said first and second terminating regions (56,58,218,220) opposing and being aligned with at least an edge (61) of the other thereof;

placing a selected edge portion of said cable (14,214,310,362,410,506,618,758) between said aligned first and second plate sections (50,52,202,204,502,504);

urging said first and second plate sections (50,52,202,204,502,504) together against said cable portion therebetween under sufficient force until said wave shapes (60,222,316,414,508) engage portions of said cable and said shearing edges (61) simultaneously shear said cable at a plurality of locations along said first and second terminating regions (56,58,218,220) puncturing said thin insulative covering (18) and forming sheared edges (94) of said cable conductor (16), said wave shapes (60,222,316,414,508) deflecting thus-sheared portions (90) of said cable into associated opposed relief recesses (62,224,512),

whereby the shearing edges (61) of the wave shapes (60,222,316,414,508) thereafter engage portions of said sheared conductor edges (94) forming mechanical joints and electrical connections of said first and second plate sections (50,52,202,204,502,504) with said cable conductor (16).

10. A method as set forth in claim 9 wherein prior to said urging step, insert members (100,102,228,680) are affixed to cable-remote surfaces of the plate sections (50,52,202,204), the insert members (100,102,228,680) including relief apertures (106) to receive the sheared conductor strips (90) along with adjacent arcuate relief shapes (62) and opposed shearing wave shapes (60,222) of the plate sections (50,52,202,204) after said urging step; staking the wave joints (80) of the termination disposed within insert member relief apertures (106) including axially splitting the arcuate relief shapes (62) of the plate sections (50,52,202,204) defining the relief recesses (62) and deflecting inwardly free ends (88) of the split arcuate relief shapes (84) against and into outwardly facing surfaces (32,34) of the sheared and deflected conductor strips (90) thereby providing stiffly compliant structures (84) to hold the conductor strip portions (90) engaged thereby in place against adjacent opposed crest portions (66) of said shearing wave shapes (60,222) and storing energy in the wave joint (80); and

staking each insert member (100,102,228,680) at each location between the relief apertures (106) thereof, from a cable-remote surface thereof, to deform portions thereof laterally toward and against adjacent ones of the sheared and deflected conductor edges (94) within the relief apertures (106), creating gas-tight electrical connections between the sheared conductor edges (94) and the side surfaces (120) of the insert member relief apertures (106).

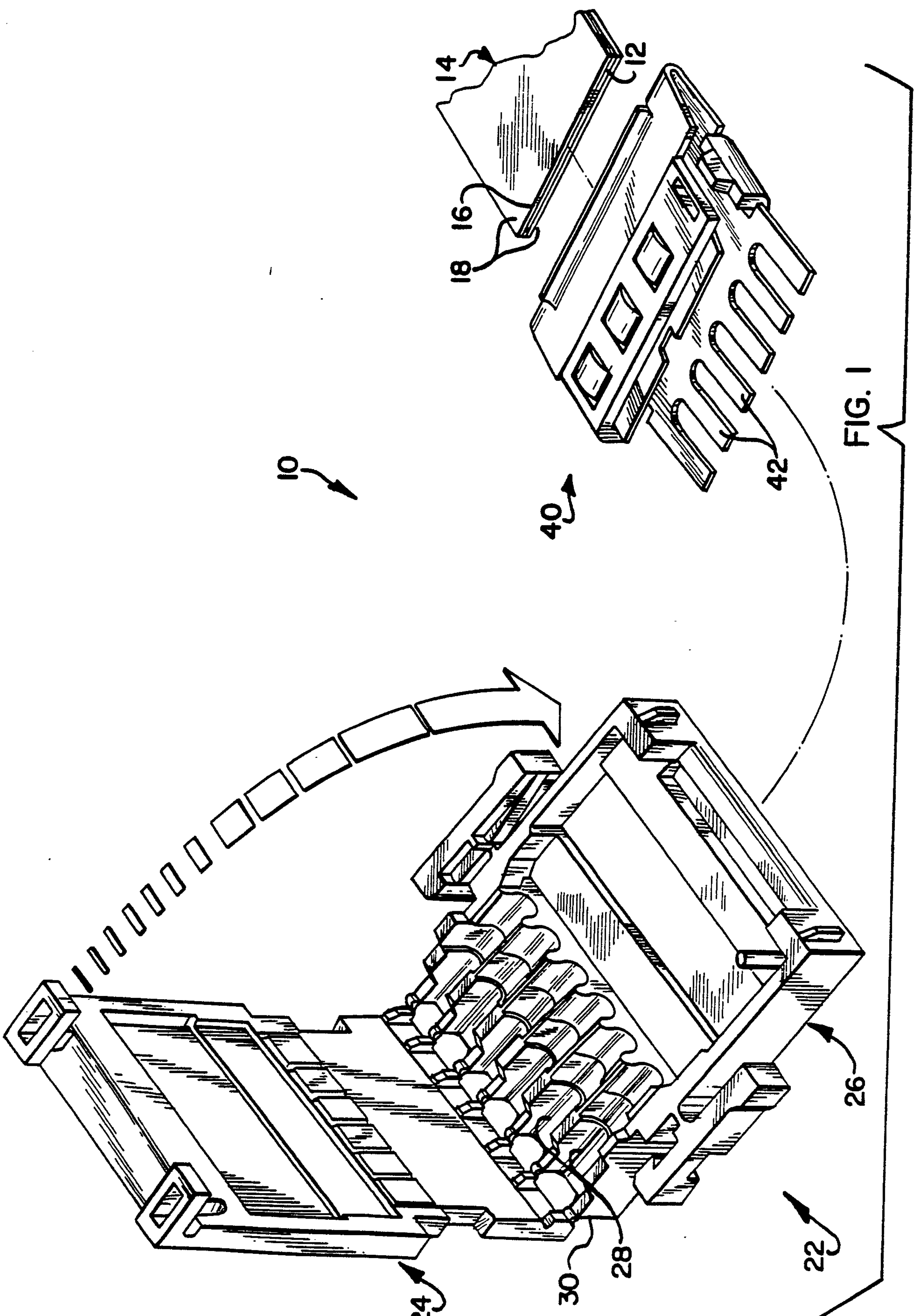
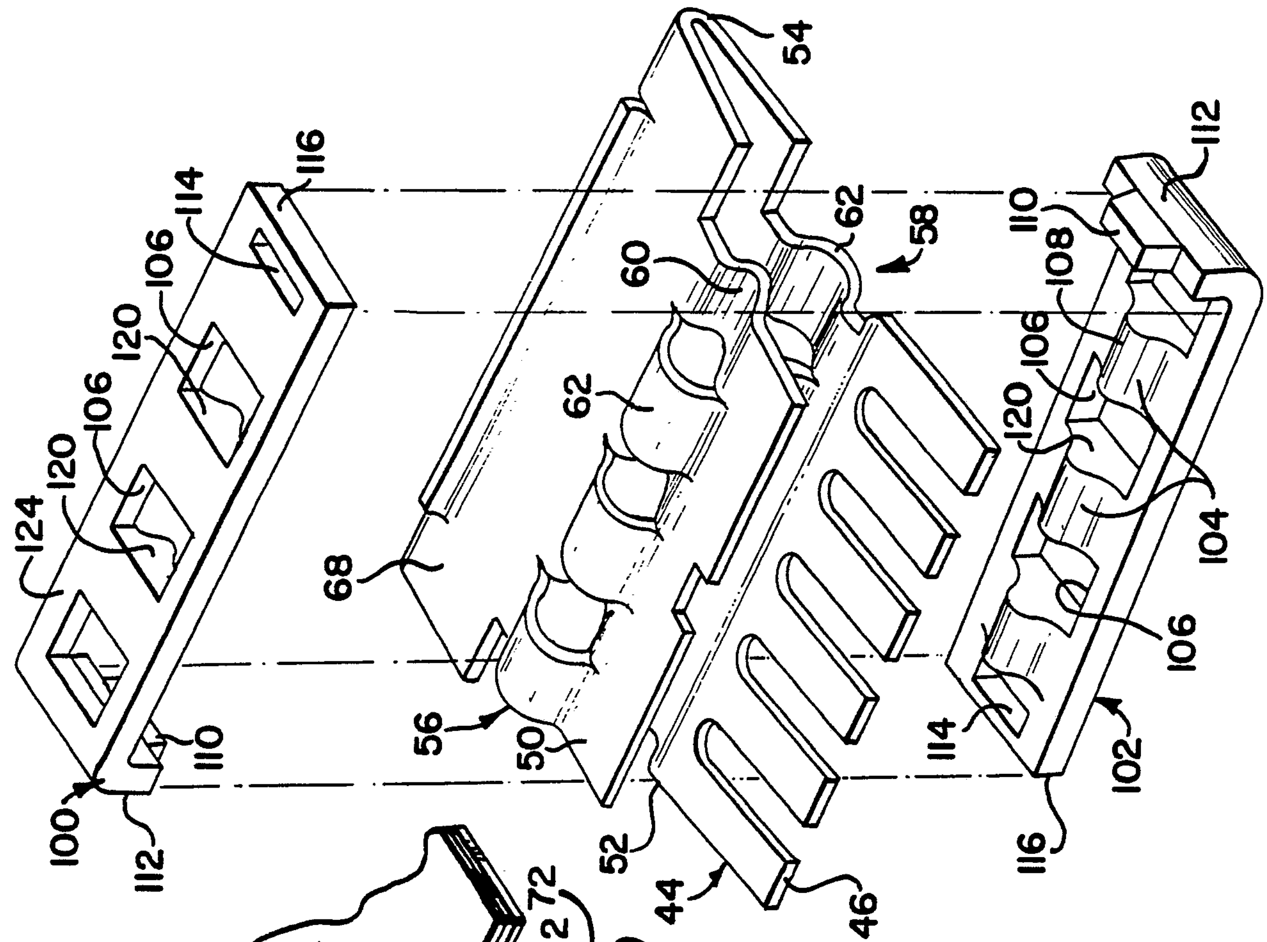


FIG. 1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102

FIG. 3

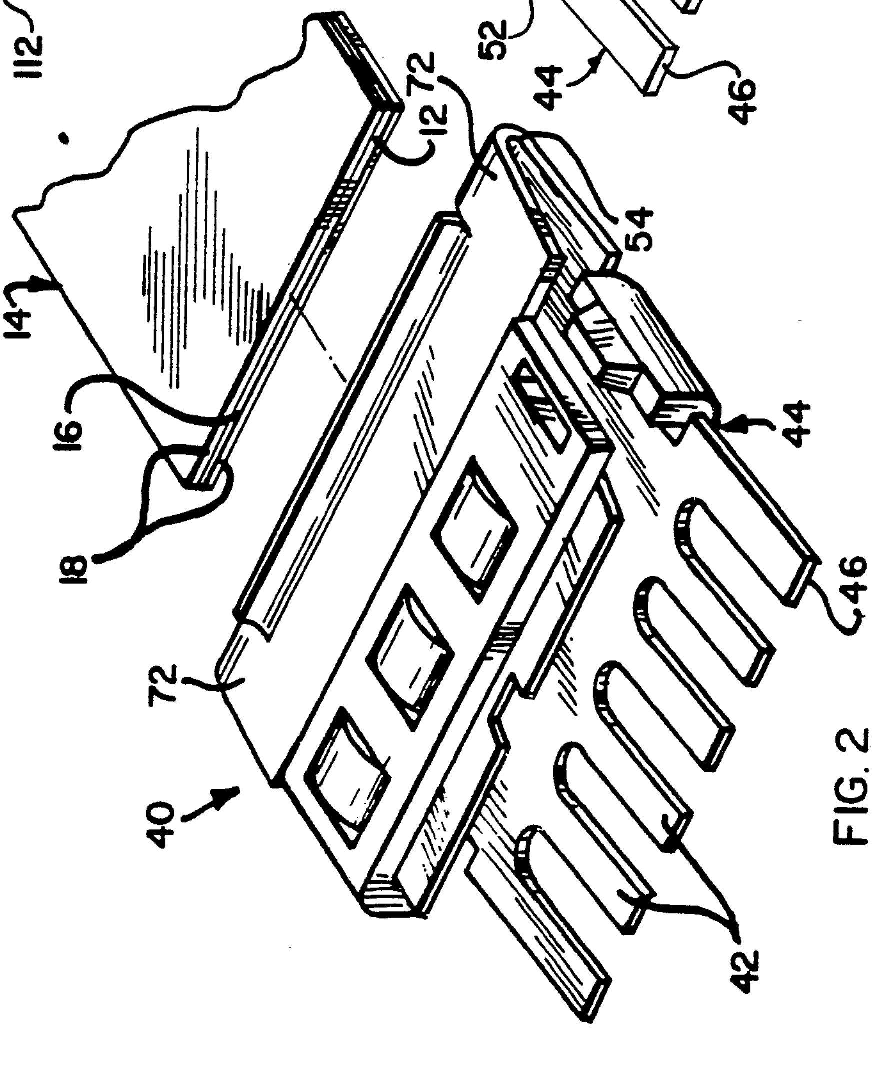
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FIG. 2

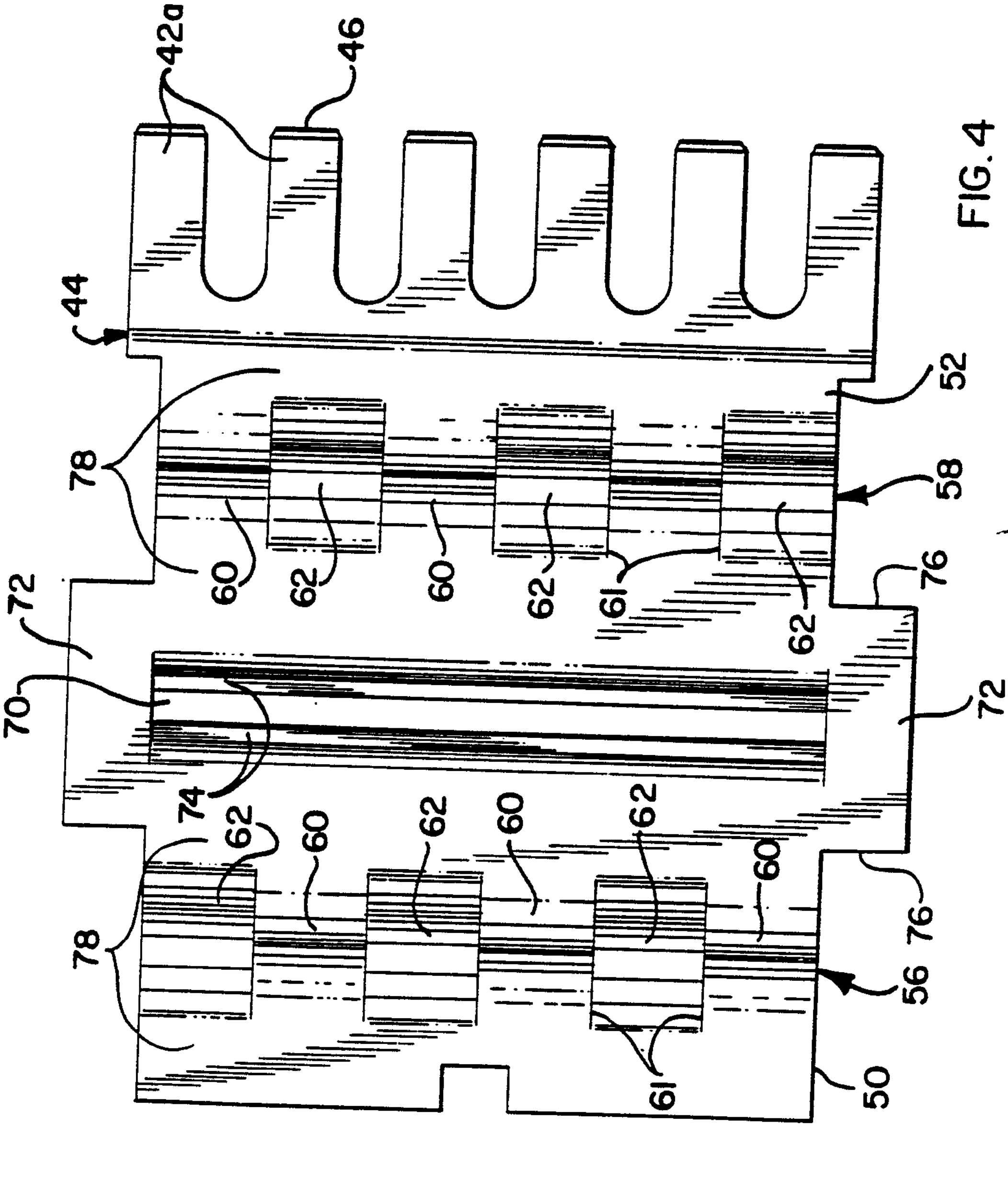

FIG. 4

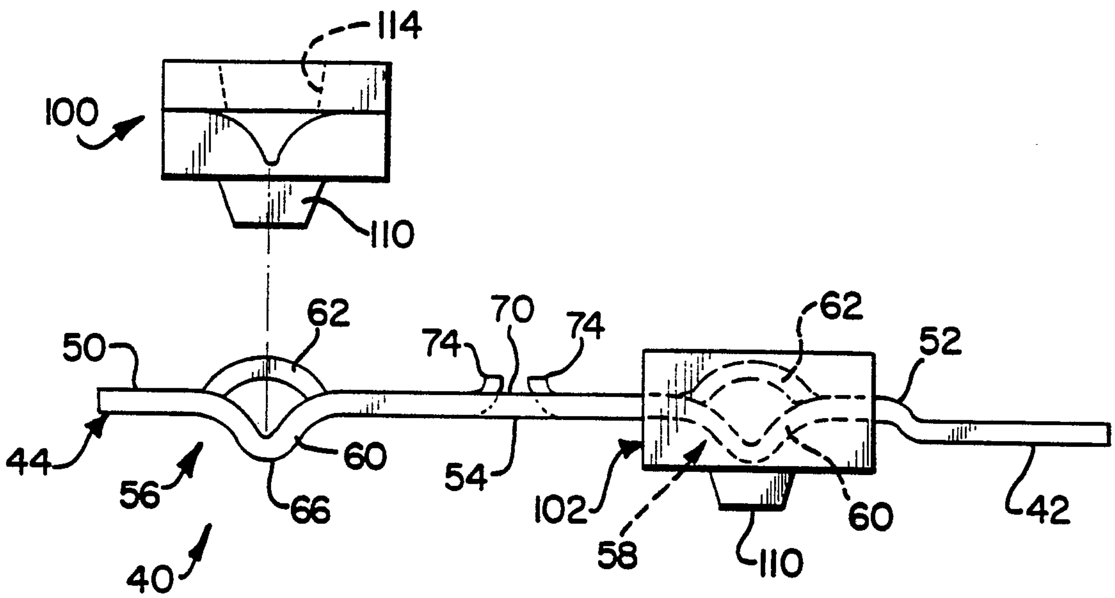
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FIG. 5

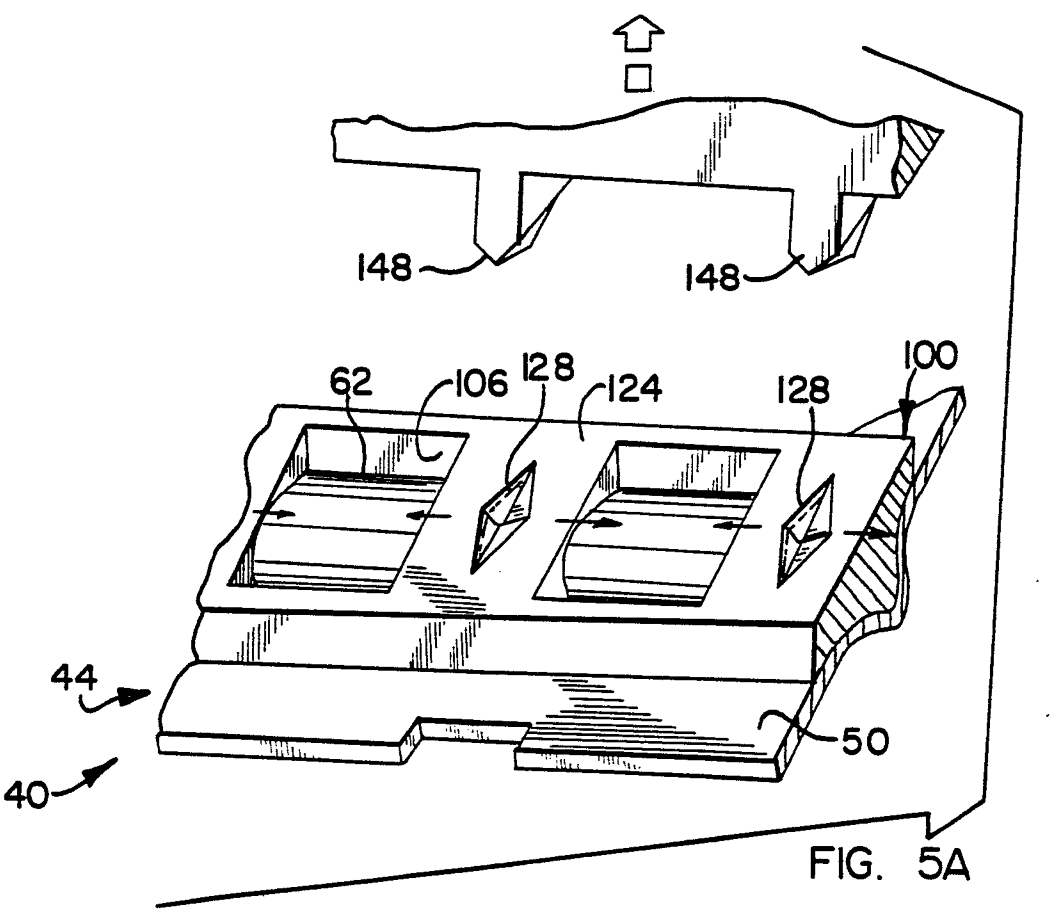
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FIG. 5A

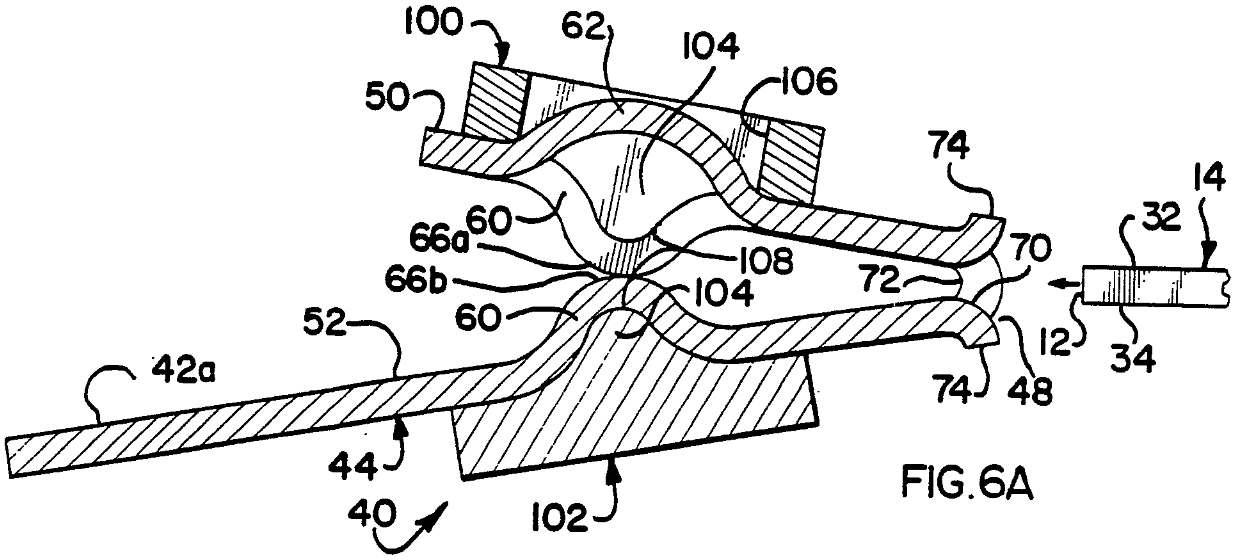


FIG.6A

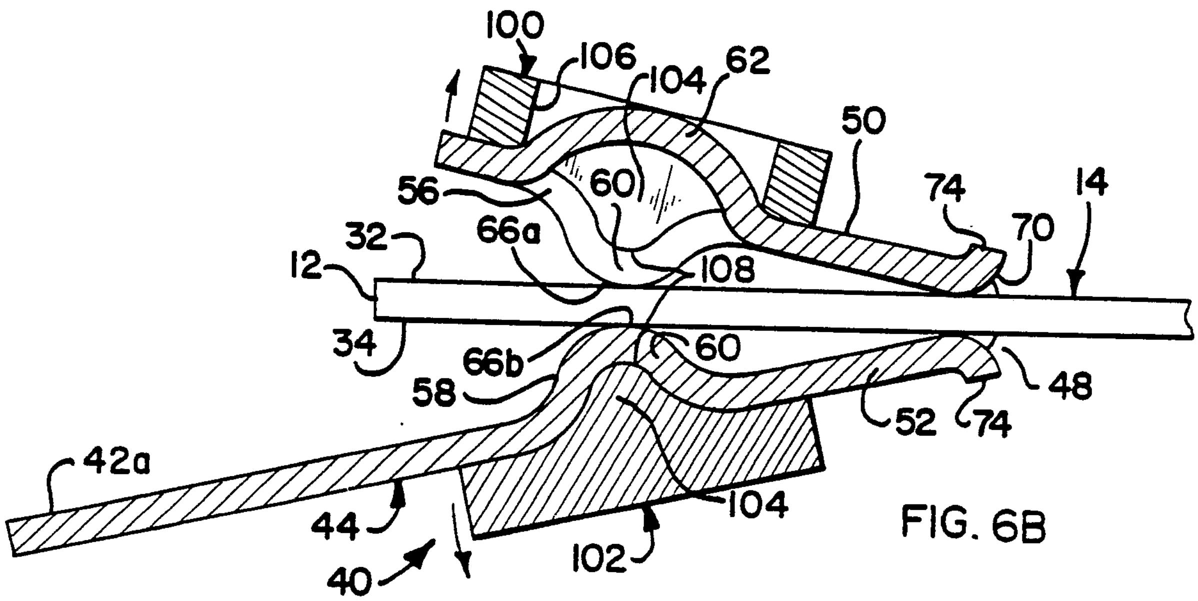


FIG. 6B

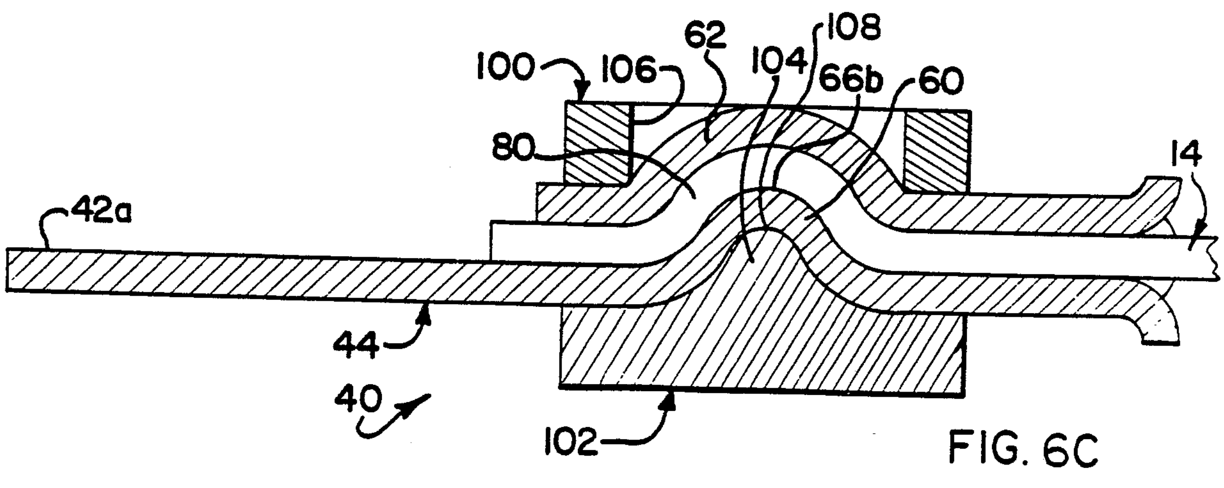
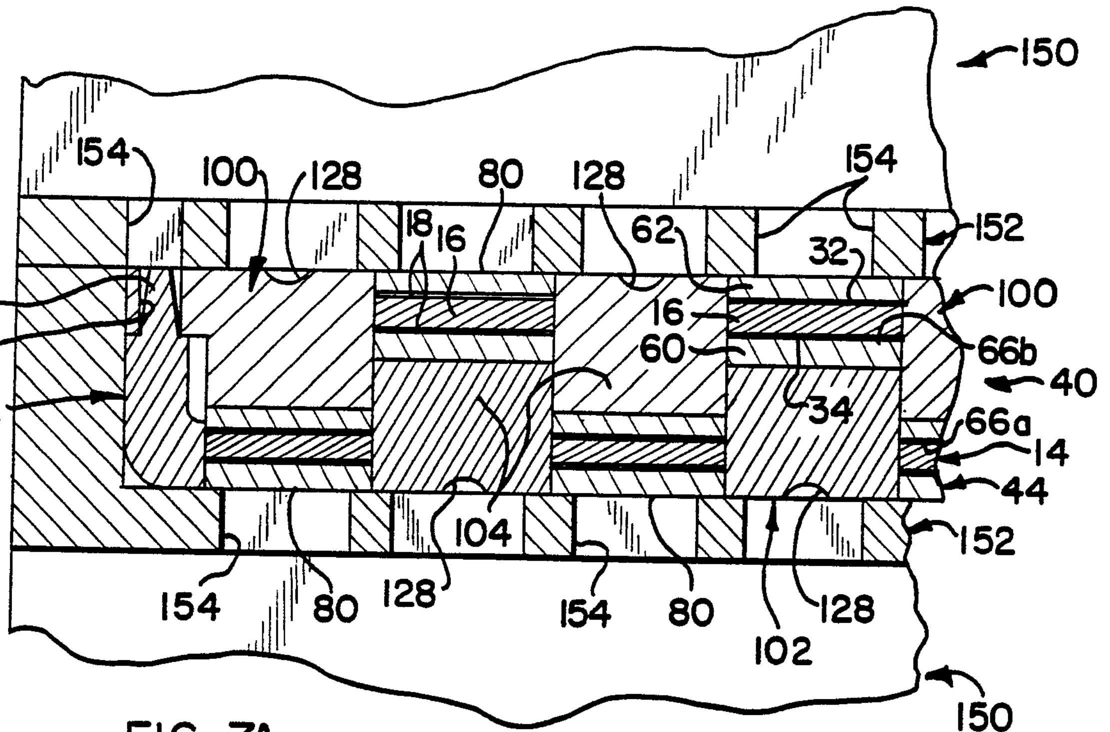


FIG. 6C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128
154
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16
62
32
110
16
100
114
60
66b
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102
34
66a
14
44
104
152
154
80
128
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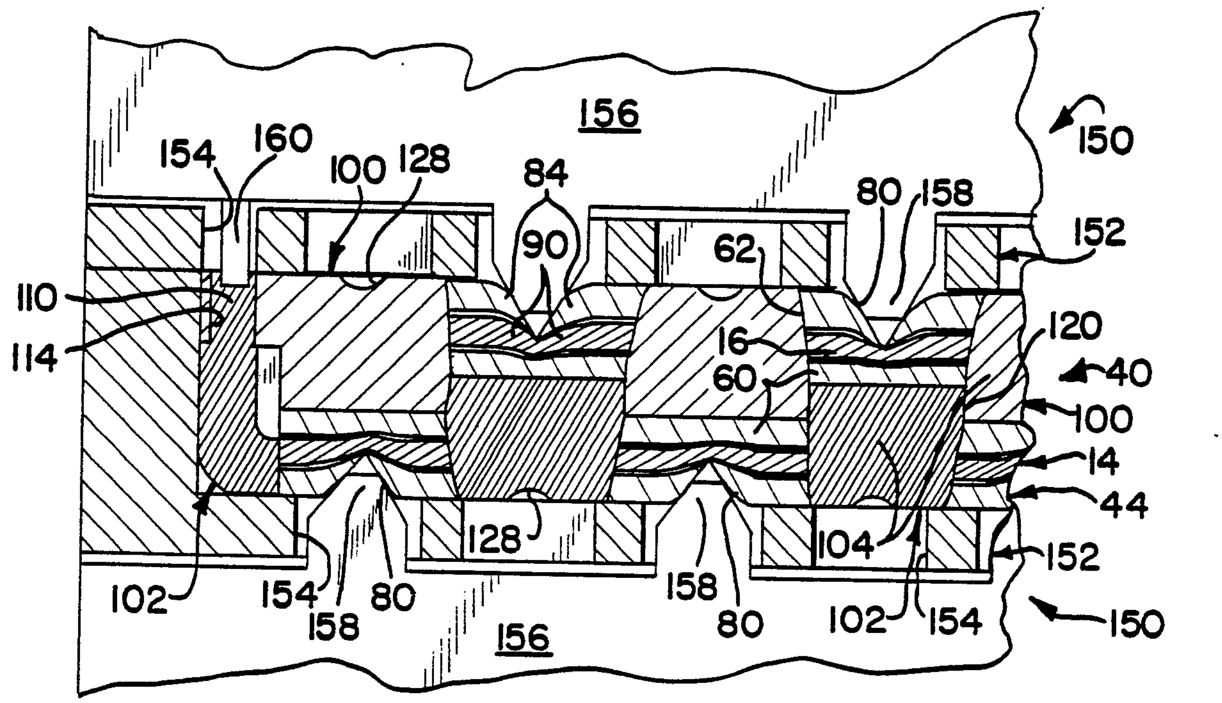
80
128
102
150

FIG. 7A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16
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156

FIG. 7B

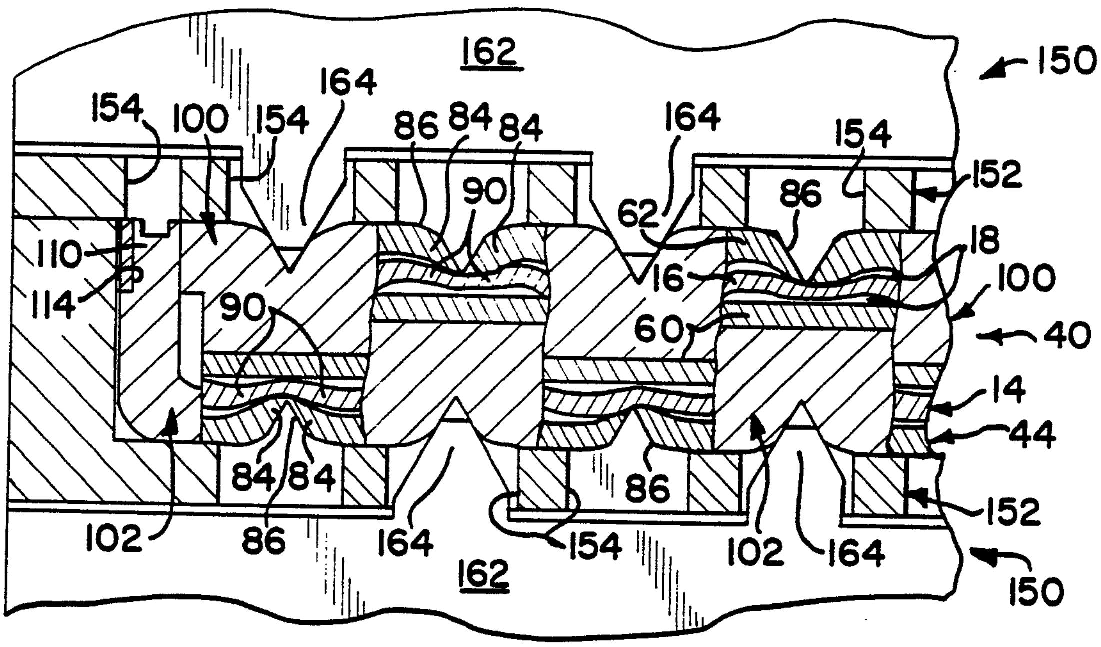


FIG. 7C

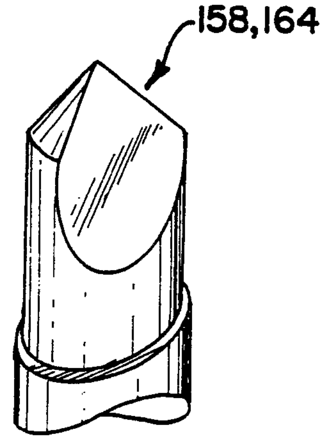


FIG. 8A

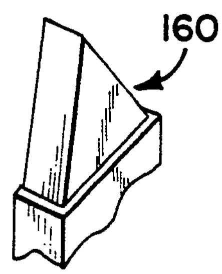
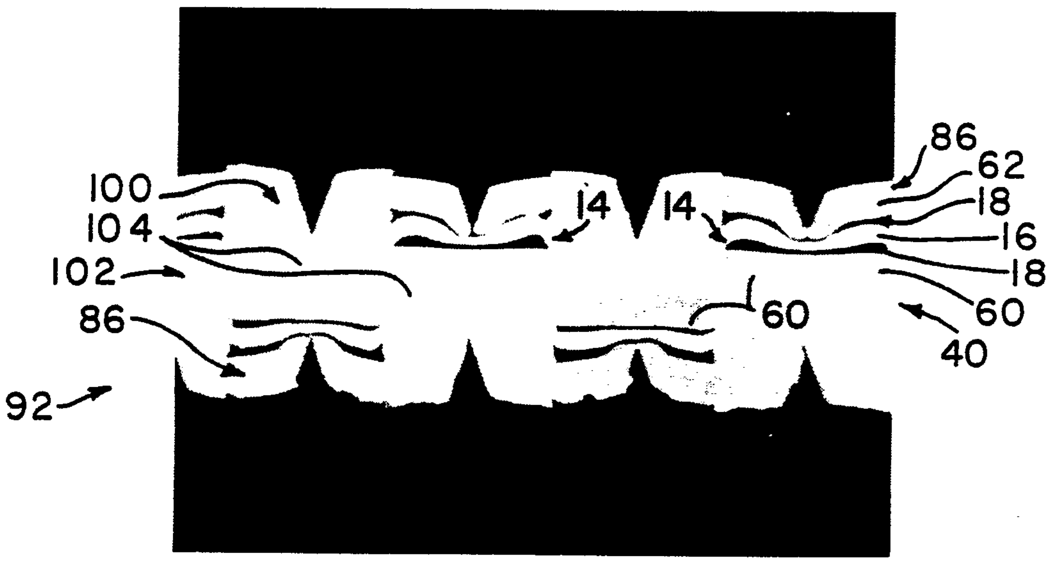
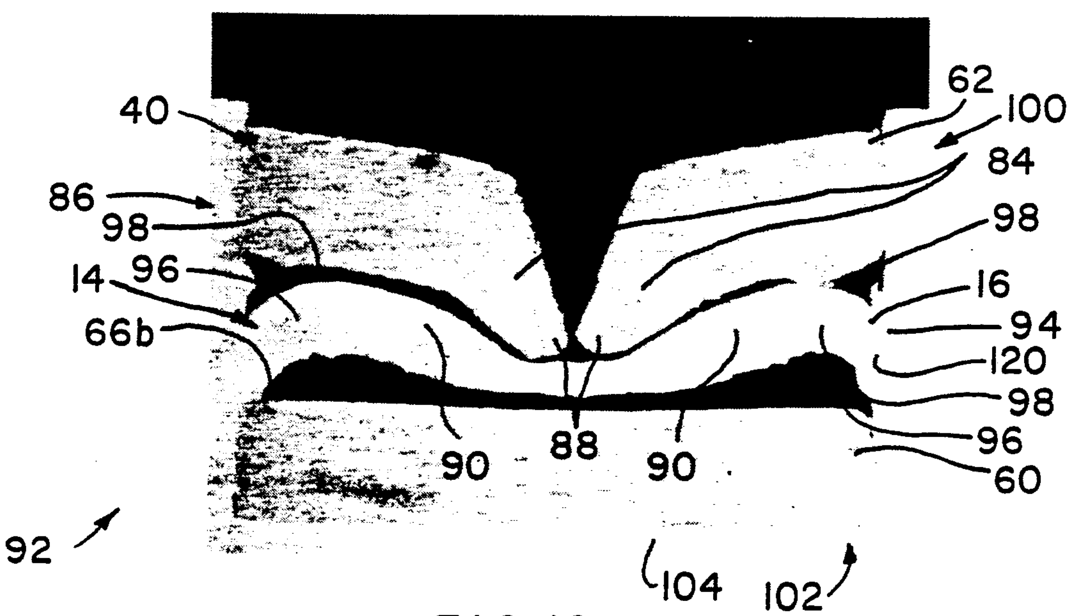


FIG. 8B



86
62
100
18
104
14
14
16
102
18
60
60
86
40
92

FIG. 9



62
40
100
84
86
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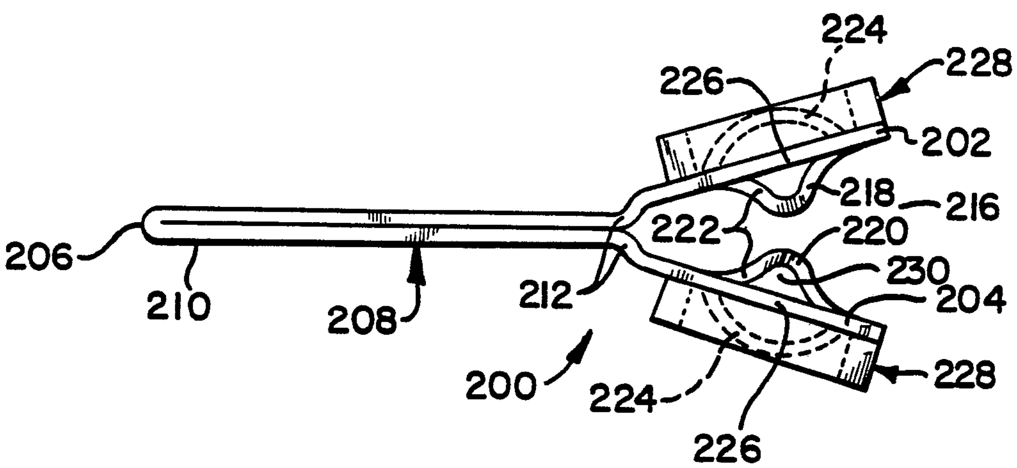
96
16
14
94
66b
120
98
88
96
90
90
60
92
104
102

FIG. 10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208
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224
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FIG. 11

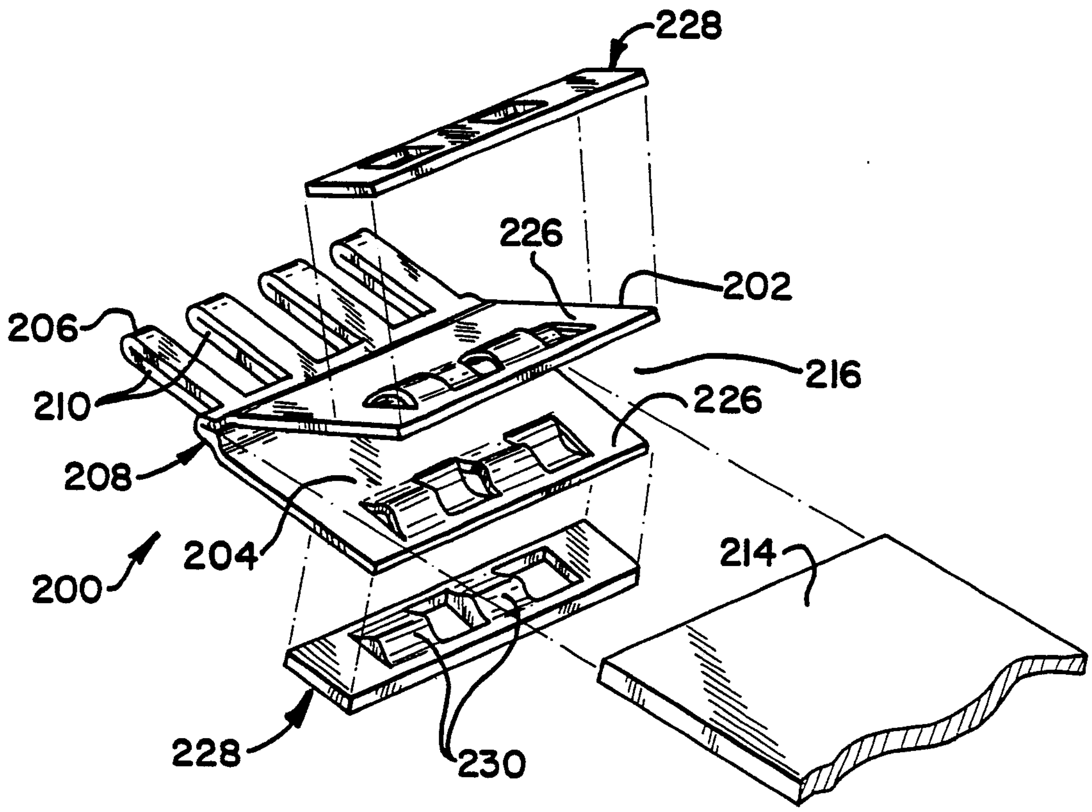
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FIG. 12

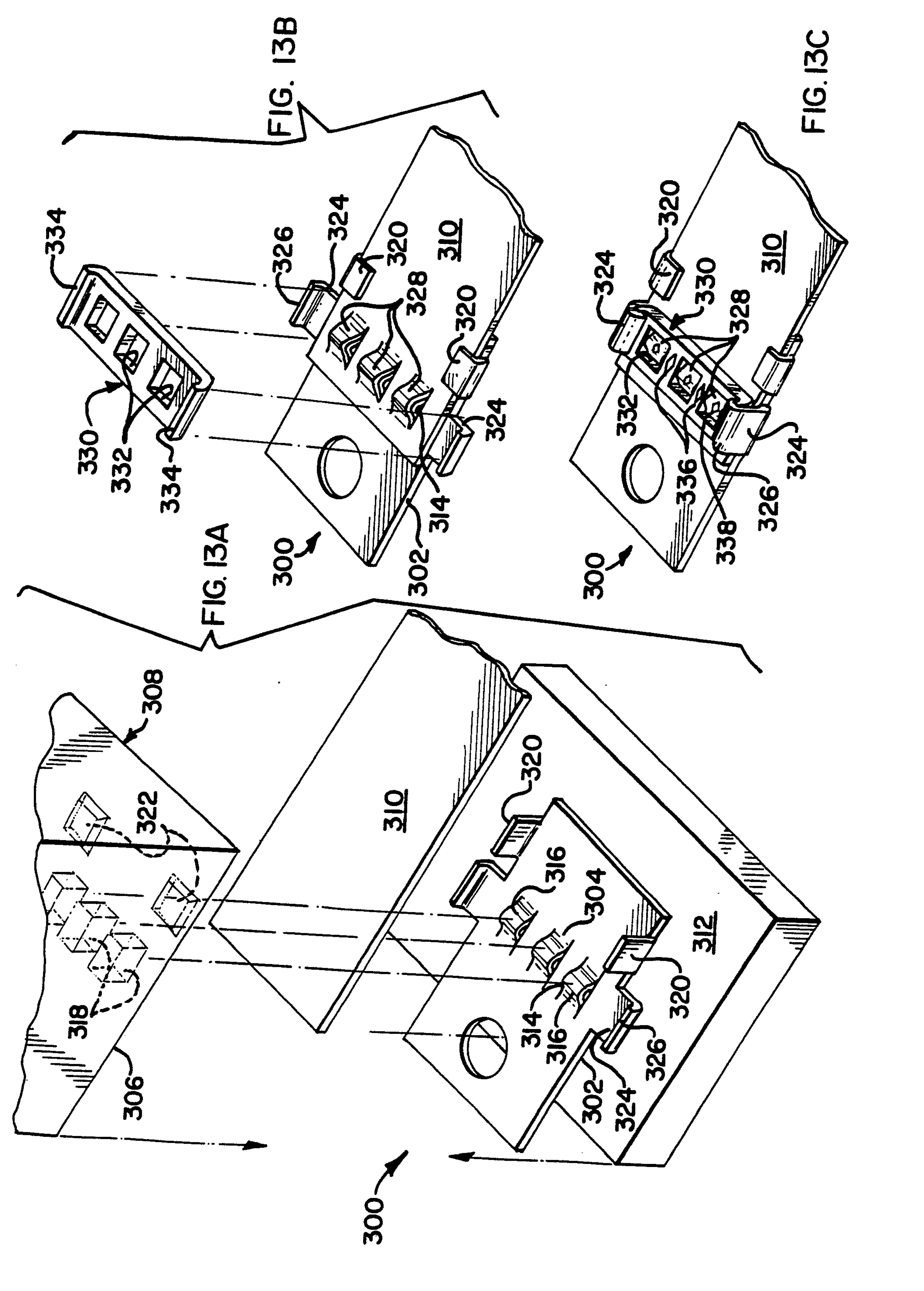

FIG. 13A

FIG. 13B

FIG. 13C

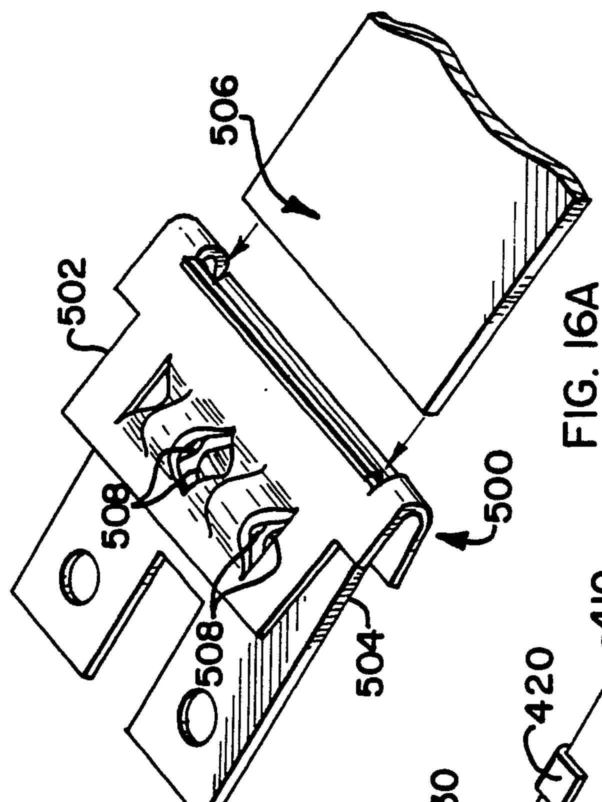

FIG. 16A

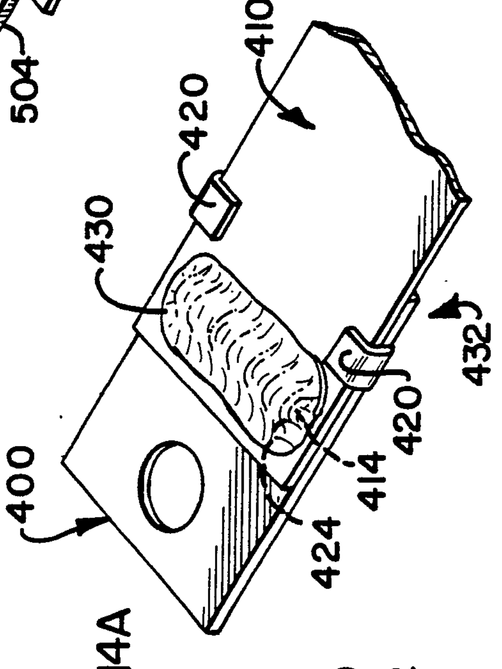

FIG. 15

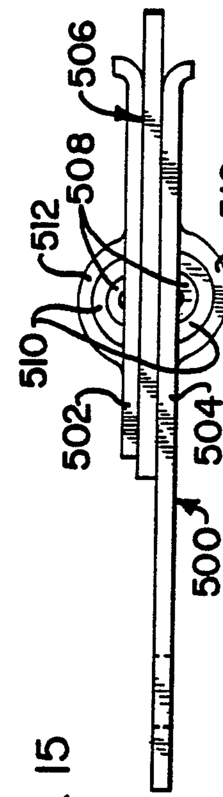

FIG. 16B

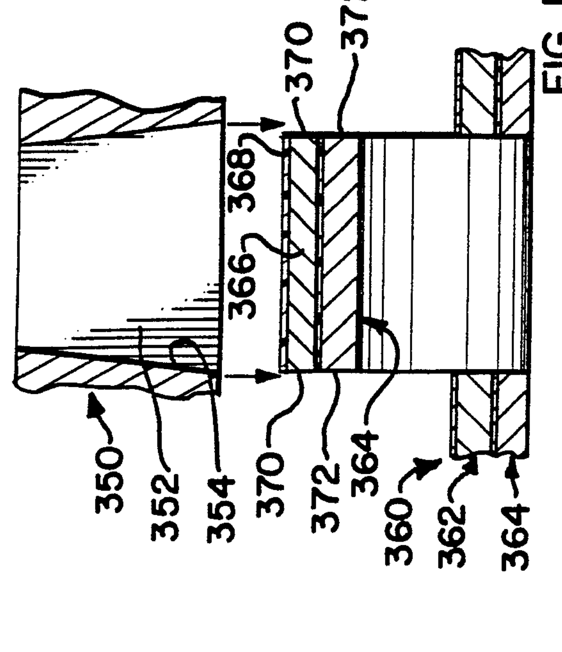

FIG. 14A

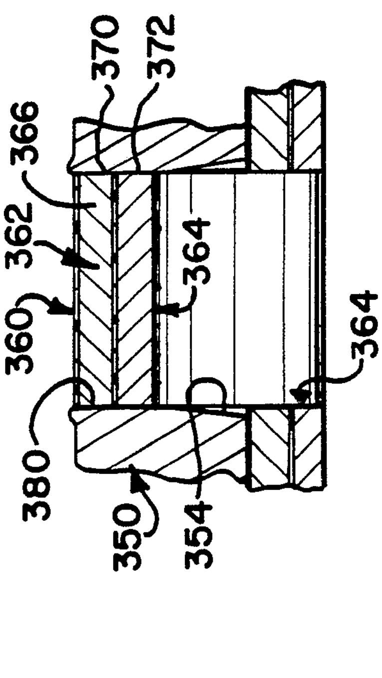

FIG. 14B

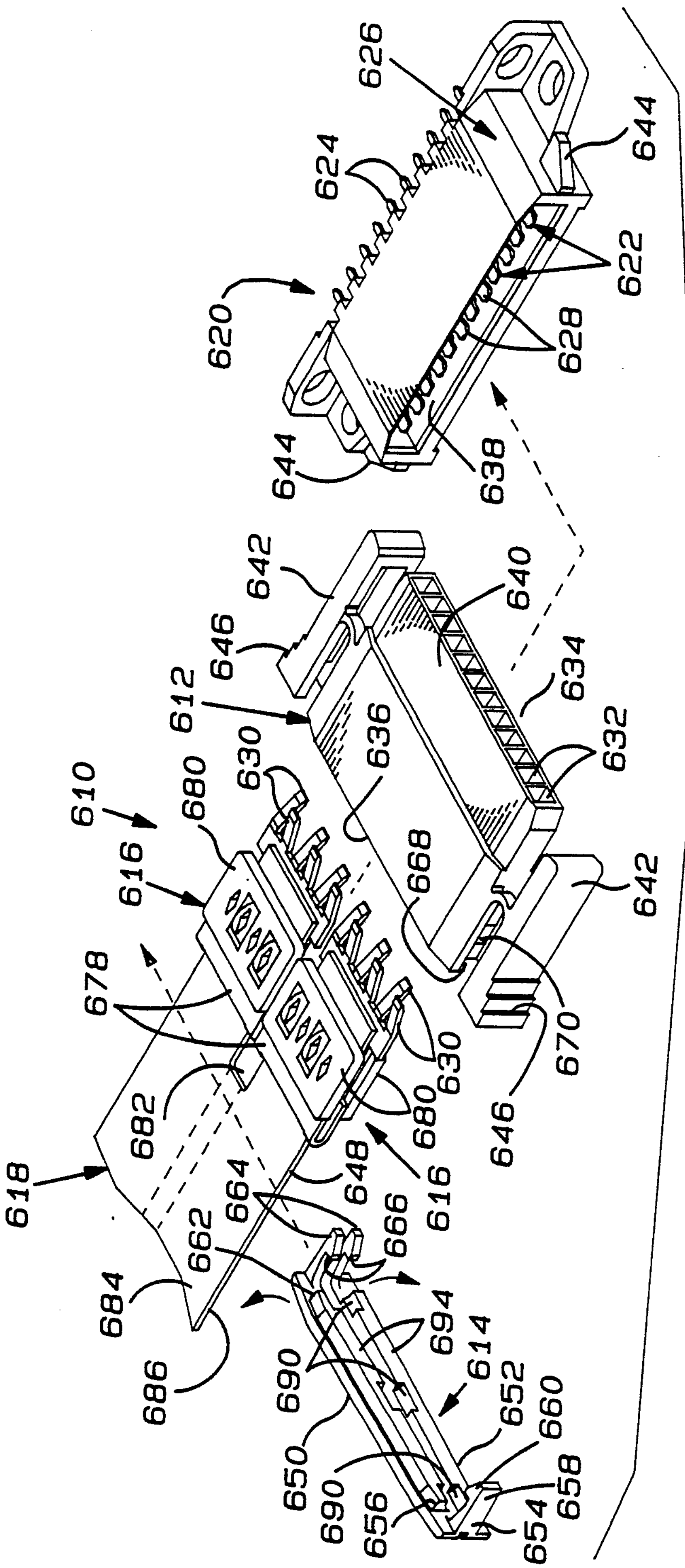

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FIG.17

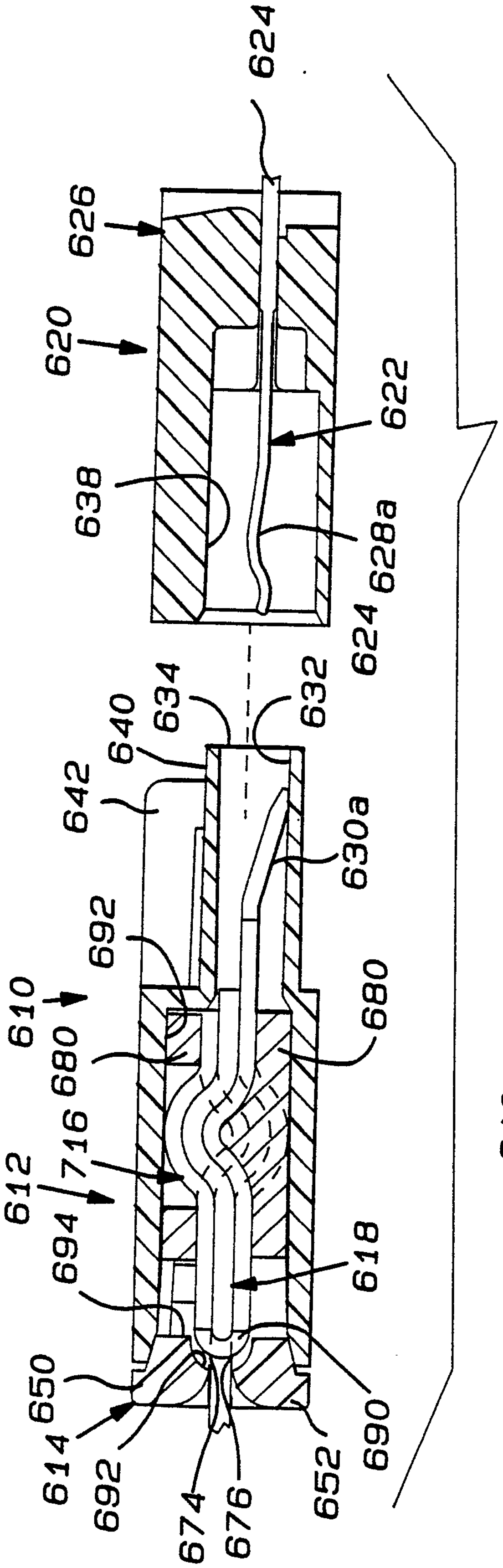
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FIG. 18

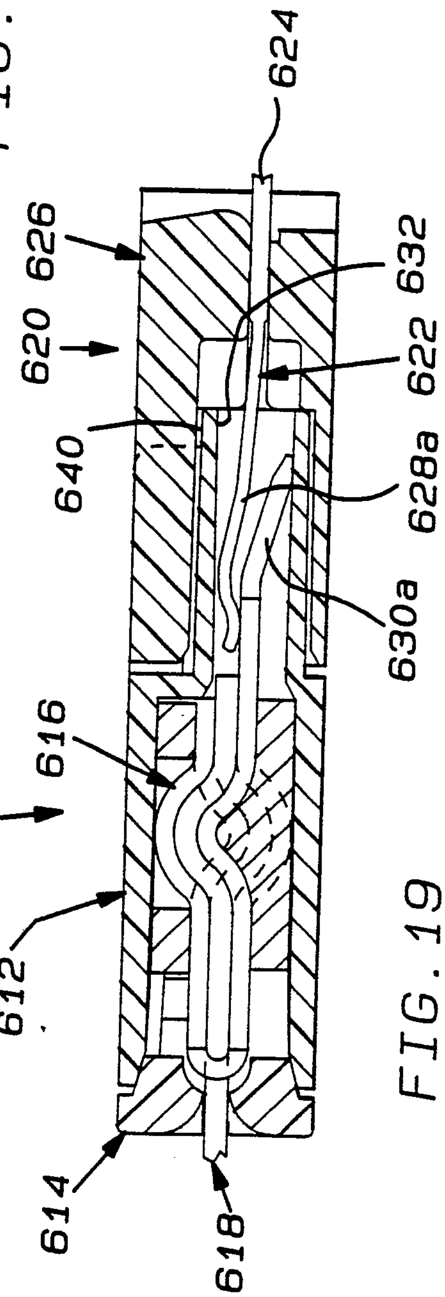
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FIG. 19

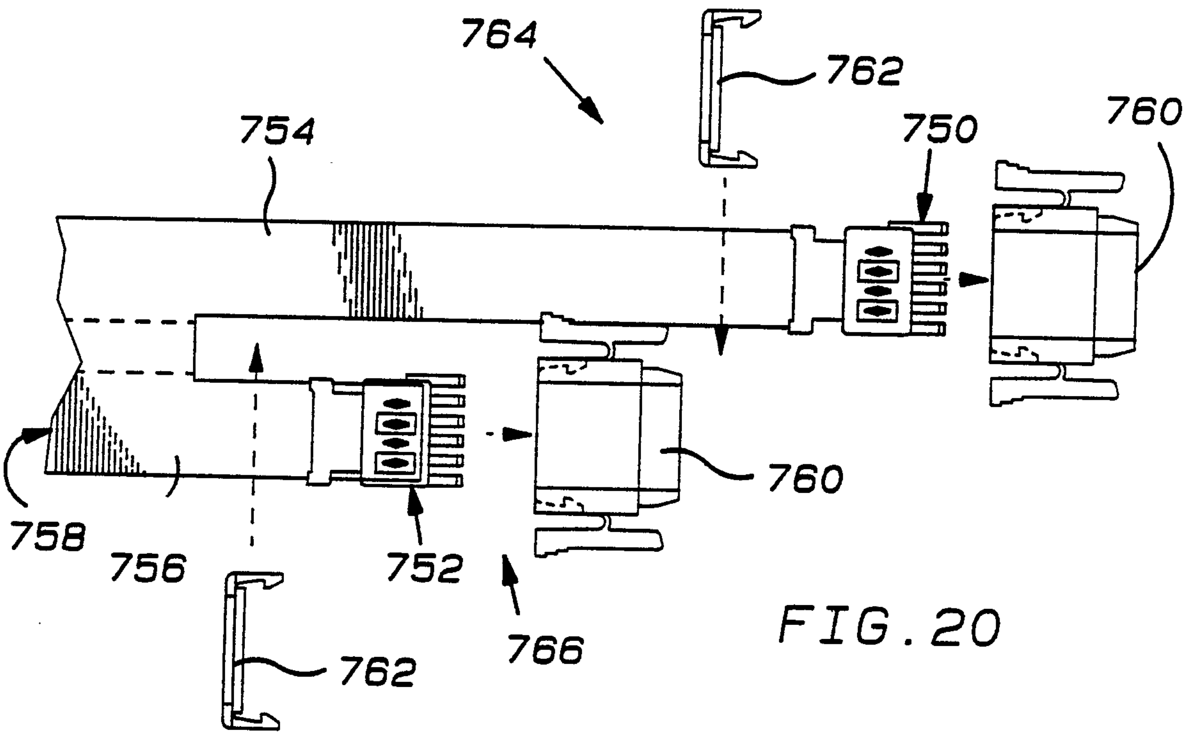

FIG. 20

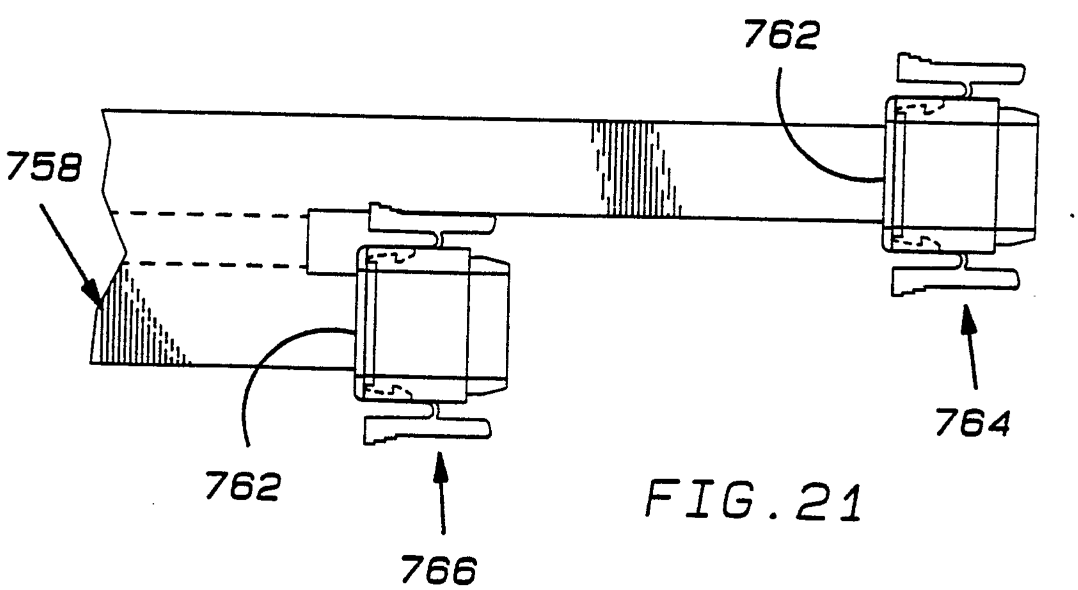

FIG. 21

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 4804

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	DE-A-1957183 (AMP) * page 3 - 4; figures 1-3 *	1-4	H01R11/11 H01R43/01
A	DE-U-7239900 (THOMPSON) * page 9, line 16 - page 13, line 4; figures 1-4 *	1-5	
A	US-A-3754204 (RAITPORT ET AL.) * column 1, line 24 - column 2, line 7; figures 1-6 *	1	
A	US-A-3706121 (GILLESPIE) * column 2, line 11 - column 3, line 17; figures 1-7 *	9, 10	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 AUGUST 1989	TAPPEINER R.

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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L : document cited for other reasons

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