(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 393 927 A1**

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 90303945.1

(51) Int. Cl.5: H01R 23/66, H01R 9/07

(22) Date of filing: 11.04.90

(30) Priority: 21.04.89 US 341864
21.12.89 US 454656

(43) Date of publication of application:
24.10.90 Bulletin 90/43

(84) Designated Contracting States:
DE FR GB IT

(71) Applicant: AMP INCORPORATED
470 Friendship Road
Harrisburg Pennsylvania 17105(US)

(72) Inventor: Bennett, Glen Edward
5042 West Whispering Wind Drive
Glendale, Arizona 85310(US)
Inventor: Bermier, Frank Herbert, Jr.
1737 East Pebble Beach drive
Tempe, Arizona 85282(US)
Inventor: Daly, John Kevin
5438 North Granite Reef
Scottsdale, Arizona 85253(US)
Inventor: Grebe, Robert Karl
16239 North 63rd Street
Scottsdale, Arizona 85254(US)
Inventor: Kreinberg, Earl Raymond
16435 North 35th Street
Phoenix, Arizona 85032(US)
Inventor: Puerner, Dean Arnold
45244 Madison Avenue
Maricopa, Arizona 85239(US)
Inventor: Lu, Songchin Sidney
1510 Idaho Avenue
Santa Monica, California 90403(US)
Inventor: Rider, Frederick Herman
4510 West Marco Polo Road
Glendale, Arizona 85308(US)
Inventor: Szczesny, David Stanley
3913 W. Calle Lejos
Glendale, Arizona 85310(US)

(74) Representative: Warren, Keith Stanley et al
BARON & WARREN 18 South End Kensington
London W8 5BU(GB)

(54) **Electrical connector and method of interconnecting flat power cables.**

(57) A tap or splice connector especially useful for a pair of dual conductor flat power cables (12,14) includes two pairs of upper and lower structures (60,80) which are applied to the stacked in-line cables side-by-side and then enclosed in a housing (16,18). The upper and lower structures (60,80) each have a transverse array of cable-engaging wave-shaped bosses alternating with wave-receiving relief recesses when pressed together, so that the waves press trips of both cables in upper and lower arrays into the opposing recesses thus exposing conductor edges of the strips for electrical connection. Outer surfaces of the structures (60,80) are then staked (54,58) to urge the metal thereof laterally and tightly against the conductor edges adjacent thereto. The structures (60,80) preferably are self-locking upon being staked to secure the upper and lower structures (60,80) to each other and to the cables (12,14).

EP 0 393 927 A1

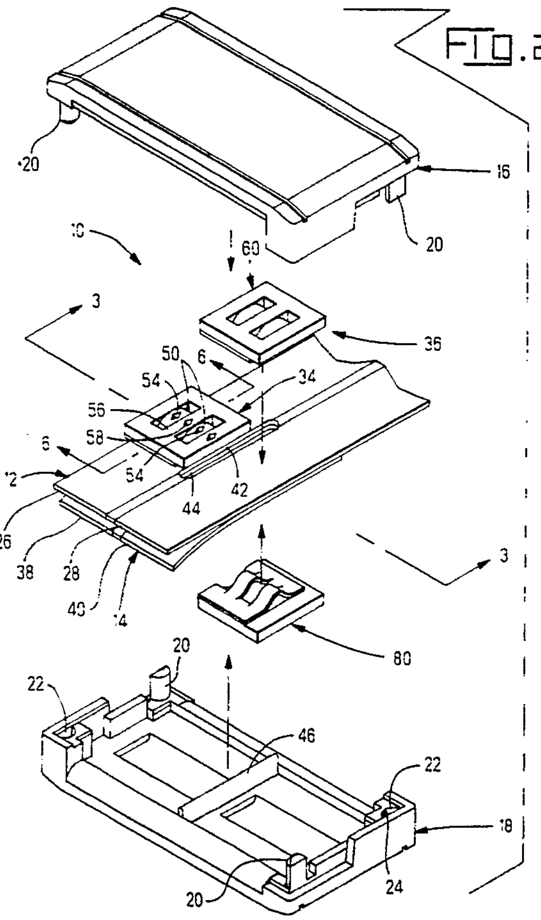

16
20
20
60
36
3
50
6
34
54
56
58
6
54
42
44
26
38
28
14
3
80
20
22
46
22
18
20
24

FIG.2

ELECTRICAL CONNECTOR AND METHOD OF INTERCONNECTING FLAT POWER CABLES

The present invention relates to the field of electrical connections and more particularly to interconnecting flat power cables.

U.S. Patent Nos. 4,859,204 and 4,867,700 disclose a transition adapter which is crimped onto 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 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 to 0.008 inches thick over each surface with the cable having a total thickness averaging about 0.034 inches. One embodiment of the transition adapter is stamped and formed of sheet metal and in one embodiment includes a pair of opposing plate sections disposed along respective major surfaces of the cable and including opposing termination regions extending transversely across the cable. Each terminating region includes a transverse array of alternating shearing wave shapes and relief recesses of equal width, the relief recesses defined by arcuate projections extending away from the cable-proximate side, and the wave shapes extending outwardly from the cable-proximate side and toward relief recesses in the opposed plate section. Each shearing wave shape has a transverse crest between parallel side edges, and the side edges of the corresponding relief recesses are associated with the wave side edges to comprise pairs of shearing edges, preferably with zero clearance. When the plate sections are pressed against a cable section disposed therebetween the crests of the wave shapes initiate cable shearing by their axially oriented side edges cutting through the cable insulation and into and through the metal conductor. The wave shapes extrude the sheared cable strips outwardly into the opposing relief recesses as the shears propagate axially along the cable for limited distances, forming a series of interlocking wave joints with the cable while exposing newly sheared edges of the cable conductor for electrical connection therewith.

Further with regard to the transition adapter of the above patents, fastened to the outwardly facing surface of the plate sections at the terminating regions are respective inserts of low resistance copper. The inserts have adapter-facing surfaces conforming closely to the shaped outer surface of the terminating region, with alternating wave shapes and apertures disposed outwardly of and along the adapter wave shapes and relief recesses. Upon termination the wave joints are within the insert apertures, and the sheared edges of the adjacent conductor strips and of the adapter wave shapes which formed the sheared strips are adjacent to side surfaces of the copper insert apertures. A two-step staking process is preferred: in a first step the wave joints are split axially so that portions of each arcuate shape of both adapter plate sections are forced inwardly against the adjacent sheared conductor strip of the respective wave joint to define spring fingers whose ends pin the conductor strip against the opposing wave crest to store energy in the joint; and in the second step a staking process deforms the insert between the sheared strips to deform the copper against the sheared conductor and wave shape edges, forming gas-tight, heat and vibration resistant electrical connections with the cable conductor and with the transition adapter, so that the inserts are electrically in series at a plurality of locations between the conductor and the adapter. A contact section is integrally included on the transition adapter enabling mating with corresponding contact means of an electrical connector, or a bus bar, or a power supply terminal, for example, and can include a plurality of contact sections to distribute the power to a corresponding plurality of contact means if desired. A housing or other dielectric covering can be placed around the termination as desired.

It is desired to provide a method for interconnecting especially dual conductor flat power cables by forming cable taps and splices.

It is also desired that such interconnection be relatively simple and provide for assured electrical connections which remain gas-tight and heat and vibration resistant over time.

It is further desired that connectors for such tap and splice interconnections be compact, comprise relatively few parts and be relatively easy to assemble.

The present invention provides for the electrical interconnection of one dual (or single) conductor flat power cable to another, forming a splice or a tap interconnection between the cables which mechanically joins the cables and electrically interconnects the respective ones of the pairs of cable conductors (or the single conductors to each other). In a first method, the cables are first prepared by punching a longitudinal slot along the medial strip (or center) of each cable at the desired interconnection site therealong; the cables are then stacked with the slots aligned and the associated conductors to be interconnected being adjacent each other in pairs. Two pairs of upper and lower wave shape structures are then aligned vertically with the respective associated pairs of conductors, the upper structures being aligned with the associated lower structures and the pairs being spaced from each other at the vicinity of the cable slot. The spaced-apart pairs of upper and lower wave shape structures are pressed together into the cable portion therebetween, shearing strips of the conductors to be interconnected and pressing alternating ones of the strips above and below the planes of the cables and exposing newly sheared conductor edges to be electrically interconnected by metal of the structures. Alternatively the wave shape structures would press previously tool-sheared conductor strips out of the cable planes.

Each wave crimp structure may comprise an adapter member and an insert member. The adapter member is disposed immediately against the insulated major cable surface, while an associated insert member is secured along the cable-remote surface of the adapter member. Each adapter member includes an array of wave shapes extending toward the cable surface and defining shearing members, alternating with arcuate shapes extending away from the cable surface defining relief recesses to receive thereinto the wave shapes of the opposing adapter member and the conductor strips pressed outwardly thereby upon shearing during the interconnection process. Each insert member is of low resistance metal such as copper and is secured to the cable-remote surface of the associated adapter member, and has an adapter-facing surface conforming closely to the cable-remote adapter surface and including corresponding wave shapes between which are relief apertures in which the arcuate relief shapes of the associated adapter member are disposed.

Upon cable interconnection, when the upper and lower structures of each pair are pressed together, the adapter wave shapes will shear the cables (unless the cables are previously sheared) and press the sheared conductor strips into the opposing relief recesses of the opposing adapter and also into the insert relief apertures in which the opposing arcuate relief shapes are disposed. The side walls of the relief apertures will thus be disposed adjacent the sheared conductor edges and also the side edges of the wave shape of the opposing adapter member, defining interlocking wave joints. Preferably the wave joints are split by being struck by blades of an apparatus extending through the relief apertures of the inserts; then the outwardly facing surfaces of the inserts are staked at the wave locations to deform the low resistance metal laterally outwardly and tightly against the adjacent sheared edges of the conductor strips forming gas-tight and heat and vibration resistant electrical connections therewith, as disclosed in U. S. Patent No. 4,859,204. The wave splitting and insert staking may optionally be performed simultaneously. The completed interconnections of the pairs of conductors by the pairs of structures at the interconnection site are then preferably placed within housing means such as a pair of housing covers secured together, providing protection of the terminations and also providing insulative structure around all exposed conductive surfaces to prevent inadvertent engagement therewith by other particles. The housing also preferably includes internal wall sections extending between the pairs of wave crimp structures and through the longitudinal cable slots to assure insulation between exposed metal of the interconnectors and the cable conductors, thus assuring that the interconnections remain assuredly isolated from each other.

In a second method, the cables need not be prepunched. The two upper structures are initially integrally joined by a spaced pair of ligatures of their adapter members extending across a medial region between the separate insert members, as are the two lower structures, which reduces by half the number of separate parts and simplifies handling, alignment and assembly. After being compressed together onto the pair of cables at the interconnection site, tooling of the apparatus punches the slots through the cables and simultaneously shears away the ligatures of both the upper and lower joined structures, thus separating and electrically isolating the cable-applied upper and lower structures into separate interconnecting structures, after which wave splitting and insert staking is performed as before.

Each wave crimp structure of the present invention may include integral means to lock the upper and associated lower structures of each pair together after cable interconnection. The inserts may have defined adjacent at least one of the relief apertures a pocket extending laterally therefrom, into which metal of an adjacent wave shape of the adapter of the opposing wave crimp structure will be deformed during the staking process, thus locking the structures together and providing mechanical integrity to the interconnection. In another embodiment the adapters have tabs to extend through corresponding recesses of the opposing adapters after which the tabs are bent over to lock behind the adapter of the opposing structure, thus locking the structures to each other about the cables. In yet another embodiment, flanges of the upper and lower structures extend outwardly beyond both lateral edges of the cables and converge, the rivets are placed through aligned holes through the pairs of adjacent flanges and staked to lock the structures to each other sandwiching the cables therebetween. The portions of the other cable conductors disposed between the structures but not being interconnected by the structure are unsheared by the structures but are preferably deflected out of the plane of the cables to relieve stress at the interconnection site.

Because each structure has a shearing half and a non-shearing half, each adapter has a shearing half and a non-shearing half; the shearing half of both the lower and upper adapters of the pair includes a transverse array of wave shapes extending toward the cable surface and defining shearing members, alternating with arcuate shapes extending away from the cable surface defining relief recesses to receive thereinto the wave shapes of the opposing adapter member and the conductor strips extruded thereby upon shearing during the interconnection process; the non-shearing adapter half of one of the lower and upper adapters includes a single continuous wave having a transverse width greater than the width of the conductor not to be sheared, to deflect a transverse portion of that conductor out of the plane of the cable, while the non-shearing half of the other adapter includes a single arcuate relief recess to receive thereinto the single wave of the opposing adapter and the nonsheared conductor portion deflected thereby.

It is an objective of the present invention to provide a connector for a splice or tap interconnection of dual (or single) conductor flat power cables which comprises a gas-tight, heat resistant and vibration resistant interconnection therebetween, which retains the circuits assuredly discrete.

It is another objective to provide a connector having a minimal number of separate parts and is relatively easy to assemble, requiring minimal cable preparation.

It is yet another objective to provide such a splice or tap interconnection which defines a compact envelope upon completion, having minimal height, width and length.

It is still another objective to provide such a splice or tap interconnection which compensates for at least a limited range of cable thicknesses.

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

FIGURE 1 is a perspective view of a completed, housed in-line tap connection between a main dual conductor flat power cable and a tap cable;

FIGURE 1a is a cross-section of a dual conductor flat power cable of the type being interconnected;

FIGURE 2 is a perspective view of the tap connection of Figure 1 with the housing members exploded from the tap connection, revealing one interconnecting structure of one embodiment of the present invention terminated to and interconnecting a respective pair of conductors of the main and tap cables after staking, and upper and lower members of another like structure about to be terminated to the other pair of cable conductors;

FIGURE 3 is a cross-sectional view across the cables taken generally along lines 3-3 of Figure 2, showing the array of wave joints interconnecting the conductors of the left side of the main and tap cables, and showing the upper and lower structures of the present invention on the right;

FIGURE 4 is a perspective view of the adapter members and insert members of the upper and lower interconnecting structures;

FIGURE 5 is a longitudinal section view through an interconnection site showing upper and lower adapter and insert members exploded from the two cables;

FIGURE 6 is a longitudinal section view through a wave joint and generally along lines 6-6 of Figure 2 showing the wave joint formed by an interconnecting structure of Figure 5 upon termination;

FIGURE 7 is an enlarged perspective view of one embodiment of insert of an interconnecting structure having a pocket along a side wall of a relief aperture used to generate a lock upon staking for enhanced mechanical securing of the upper and lower interconnecting structures to each other and to the cables;

FIGURES 8A, 8B and 8C are cross-sectional views of upper and lower interconnecting structures having the insert of Figure 7 upon being terminated to the cables, prior to application before and after staking respectively;

FIGURES 9A AND 9B are perspective views of upper and lower interconnecting structures having an embodiment of adapters for providing mechanical securing to themselves and to the cables, before and after termination to the cables;

FIGURES 10A, 10B and 10C are perspective views illustrating another method of interconnecting cables, wherein the upper structures are initially joined by ligatures, and the lower structures also initially joined, before and after application to the cables, after which the ligatures are sheared away and the medial slots punched through the cables;

FIGURES 11A and 11B are end views of another embodiment of housing members before and after being secured together about the cable interconnection site; and

FIGURE 12 is a tap connection similar to Figure 2, using structures of another embodiment having riveted flanges.

FIGURE 1 and 2 illustrate an interconnection of a first flat power cable with a second such cable, which may be single or dual conductor; the interconnection shown is a tap connection 10 between a main dual conductor flat cable 12 and a tap cable 14 of similar construction. The interconnection of the present invention may also be used to splice together a pair of flat cables. The housing assembly can comprise dielectric upper and lower housing members 16,18 which are secured together to at least provide insulation and physical protection of the cable interconnection site. Member 16,18 are shown being hermaphroditic and securable together by semicylindrical posts 20 at diagonally opposed corners force-fittable into corresponding semicylindrical apertures 22 of the other housing member, where apertures 22 include engaging ribs 24 protruding radially into the apertures which become plastically deformed to firmly hold the posts in the apertures, as disclosed in U. S. Patent No. 4,781,615. Housing members 16,18 may be molded for example of thermoplastic resin having heat resistant properties such as VALOX DR 48 resin sold by General Electric Company, Fairfield, Connecticut, or CELANEX 3112-2 ED 3002 polyester resin sold by Celanese Plastics & Specialties Company, Chatham, New Jersey. (Alternatively, housing members 16,18 may be securable together by means of latches as shown in Figures 11A and 11B.)

Figure 1A illustrates a typical cross-section of a dual conductor flat power cable 12 wherein a pair of flat conductors 26,28 have an insulative coating 30 extruded therearound and defining a medial strip 32 between the conductors; cable 14 has identical construction. While the present disclosure is shown and described with respect to dual conductor cables, it is easily seen that the same terminal and methods are usable with single conductor cables.

A first method of interconnection is shown and described in Figures 2 to 8C while a second method is shown in Figures 9A to 9C. In Figure 2 two interconnecting structure assemblies 34,36 are shown each of which interconnects respective ones of the conductors of the main and tap cables, while sandwiching both cables therewithin. Assembly 34 electrically interconnects conductor 26 of main cable 12 with conductor 38 of tap cable 14. Assembly 36 will electrically interconnect conductors 28,40 when pressed together against the cables. Cables 12,14 are previously prepared for termination by having punched therethrough vertically aligned elongate slots 42,44 therethrough along the medial strips thereof, removing at least most of the width of the medial strips. Medial slots 42,44 permit an axially extending barrier wall 46 of the housing members 16,18 to extend therethrough providing dielectric material between the interconnecting structures 34,36 after termination to assure electrical isolation of the circuits after interconnection. Barrier wall 46 may comprise respective wall sections of both members 16,18 slightly offset from center to permit passing by each other during assembly of housing members 16,18 about the interconnection site. Slots 42,44 also enable registration tooling of the termination apparatus (not shown) to accurately locate and hold the cables in position during termination. The interconnections occur at sides of each of a plurality of alternating upper and lower wave joints, upper wave joints 50 being visible in the Figure.

Figure 3 represents a simplified cross-section through interconnecting structure assembly 34, showing the plurality of upper wave joints 50 alternating and interlocking with lower wave joints 52. Wave joints 50,52 are similar to the type disclosed in U. S. Patent Nos. 4,859,204 and 4,867,700 which are incorporated herein by reference. Each wave joint 50,52 is preferably split axially as depicted at 54 in Figure 2 by a staking process which strengthens the joint. Across from and between the upper wave joints 50,52 are sections of bulk metal 56 of structure assembly 34 which sections are staked as depicted at 58 of Figure 2 which deforms the bulk metal laterally tightly against the sheared edges of the conductors 26,38 forming gas-tight joints therewith; the prior splitting of the wave joints at 54 imparts strong but compliant resistance to the staking of the bulk metal sections and also provides stored energy in the joint which helps maintain the gas-tight nature of the interconnections during in-service use which commonly involves elevated temperatures and vibration. After interconnection and during in-service use, adapter members 62,82 (Figure 4) assist in confining the relatively yielding conductors 26,38 thereby inhibiting stress relaxation which otherwise would reduce stored energy in wave joints 50,52.

Referring to Figures 3 through 6, upper interconnecting structure 60 is comprised of an upper transition adapter member 62 and an upper insert member 64, while lower interconnecting structure 80 is comprised of a lower transition adapter member 82 and a lower insert member 84. Adapter members 62,82 may be stamped and formed for example from a sheet of Olin Copper Alloy 197 in half hard temper about 0.025 inches thick which is nickel underplated and silver plated, preferably, and treated for tarnish resistance. Insert members 64,84 may be for example of dead soft Copper CDA 110 generally about 0.066 inches thick which is nickel underplated and silver plated, preferably, and treated for tarnish resistance. Adapter members 62,82 are designed to be hermaphroditic, as are insert members 64,84 and also housing members 16,18, thus simplifying inventory and assembly by requiring fewer different parts to establish the tap or splice connector 10. The interconnection regions of the upper and lower assemblies 34,36 are preferably intermatable with each other when opposed, with the wave shapes precisely offset and opposed from relief recesses when applied to the cables. Preferably each insert member is secured to its associated adapter member to be easily handled as a unit; such securing may be by force-fitting of the arcuate adapter relief shapes within the insert relief apertures; alternatively the inserts may be slightly prestaked as disclosed in U.S. Patent No. 4,859,204.

The interconnection region of upper adapter 62 includes a pair of downwardly protruding wave shapes 66 each including a wave crest 68, alternating with a pair of upwardly directed arcuate shapes 70 having widths identical to the width of a wave shape 66 and defining relief recesses 72. The array of wave crests 68 and alternating relief recesses 72 is to be oriented transversely with respect to the cables. The interconnection region of lower adapter member 82 is similar to upper adapter 62 but is configured to cooperate with upper adapter 62; lower adapter 82 includes a pair of upwardly protruding wave shapes 86 each including a wave crest 88, alternating with a pair of downwardly directed arcuate shapes 90 having widths identical to the width of a wave shape 86 and defining relief recesses 92. Each wave shape 66,86 is defined between a pair of parallel vertical side edges 100,102 extending axially with respect to the cable. Together edges 100,102 will cooperate during termination to comprise shearing edges to shear the cable conductors during termination, if the cables have not been previously tool sheared.

Upper insert member 64 includes an adapter-proximate surface which will be disposed against the cable-remote surface of upper adapter 62, and is shaped to conform closely therewith. Upper insert 64 includes a pair of wave shapes 74 separated by one of apertures 76 and having vertical side walls 78, with wave shapes 74 corresponding with wave shapes 66 of adapter 62 and apertures 76 receiving arcuate shapes 70 thereinto. Likewise lower insert member 84 includes a pair of wave shapes 94 separated by one of a pair of aperture 96 and having vertical side walls 98, with apertures 96 receiving thereinto arcuate shapes 90. In Figure 4 is seen a pair of cables 12′,14′ being spliced, identical in structure to cables 12 and 14.

Figure 6 illustrates the structure of a wave joint 50, and also of a lower wave joint 52 (in phantom), after termination of upper and lower interconnecting structures to main and tap cables 12,14. Side edges 100,102 of wave shapes 66,86 have sheared conductors 26,38 into strips 104,106 and wave shapes 66,86 have pressed the sheared conductor strips into the opposing relief recesses 72,92 respectively within apertures 76,96. The wave crests 68,88 have been designed and dimensioned with respect to the nominal cable thicknesses so that the newly sheared edges 110 (see Figure 3) of the sheared conductor strips are moved past the vertical side edges of the wave shapes of the opposing wave shapes and past substantial vertical areas of the side surfaces of the wave shapes of the opposing inserts. This is indicated in Figure 6 by the wave overlap area 112, and is best seen in Figure 3 where newly sheared conductor edges 110 can best be identified. Especially after wave joint splitting and insert wave staking as in Figure 2 at 54 and 58 by blades of the terminating apparatus (not shown) after the shearing and pressing of the conductor strips out of the cable plane has occurred, as taught in U. S. Patent No. 4,859,204, assured gas-tight connections are formed between sheared conductor edges 110 and both the metal comprising the side walls 78,98 of insert apertures 76,96 and wave shapes 74,94 and the metal comprising the side edges 100,102 of the adapter wave shapes 66,86 at a plurality of locations across the terminating region, interconnecting the conductors 26,38, of the main and tap cables 12,14. Alternatively, the cables can be sheared by tooling at locations corresponding to wave shape edges to define the conductor strips which may then be pressed out of the plane of the cable by the adapter wave shapes for the previously sheared conductor edges to be disposed adjacent the metal side edges of the adapter wave shapes and the side walls of the insert wave shapes.

The interconnecting structures are preferably adapted to provide a positive self-locking means after termination, whereby the upper and lower assemblies positively lock to each other thus securing themselves tightly to each other with the cable portions clamped therebetween; the mechanical fastening attained by the self-locking means thus protects the terminations and their gas-tight interconnections against strain and vibration. Figure 7 to 9B illustrate several examples of such self-locking means. In Figures 7 to 8B the inserts are adapted to provide for metal of the opposing adapter waves to be deformed laterally thereinto during the wave splitting procedure. In Figures 9A and 9B the adapters are provided with tabs which extend through recesses in the opposing adapter to be bent over and against the far side of the opposing adapter.

In Figures 7 and 8A an inset 200 similar to insert 64 of Figure 6 includes a pair of insert wave shapes 202,204 alternating with a pair of apertures 206,208. Wave shape 202 is disposed closer to a lateral edge 210 of inset 200 and includes a pocket 212 of narrow width extending along vertical side wall 214 almost to the surface of the crest of the wave. Electrical interconnection 216 of Figure 8A uses upper and lower assemblies 218,220 which utilize a pair of inserts 200,222 with adapters 224,226 identical to adapters 62,82 of Figure 5. Also shown in Figure 7 is a chamfered corner 228 which provides a means for locating and orienting the insert in the application tooling along with a corresponding chamfer on the associated adapter to which it is secured, for assuring the appropriate precise alignment of the upper and lower assemblies of each interconnecting structure.

In Figure 8B it can be seen that each of pocket-adjacent and pocket-remote wave joints 230,232 of interconnection 216 extends deeply enough into the relief aperture 206,208 of the far insert for the wave crest 234 of wave joints 230 to be located within apertures 206, with side edges 236 thereof of the to be adjacent a pocket 212 in the vertical side wall 214 of the adjacent wave shape 202 of the respective far insert. In Figure 8C the waves 230,232 are split at 238 by staking tooling (not shown) as in U. S. Patent No. 4,859,204, to a greater depth inwardly from the blade-receiving surface of the arcuate relief shapes 240 in order to split the entire wave joint to assure splitting pocket-adjacent wave crests 234 to be split and the split portions 234a forced laterally in the same manner that the conductor strips 242 are split and the split portions forced laterally. A portion of wave crest 234 adjacent pocket 212 of the insert of the opposing assembly is deformed into pocket 212, defining a lock to hold the completed, staked interconnection 216 together after the remaining insert staking is performed as described with respect to Figure 2. With one of the upper and lower assemblies having the pocket near the outside cable edge and the other having its pocket near the cable slot, interconnection 216 is self-locked along both sides thereof. Additional insert staking at 244 preferably is preformed remote from pockets 212.

Referring to Figures 9A and 9B, another embodiment of adapter members 300,302 is shown which provides for the adapters to lock to themselves after termination. Adapter members 300,302 are actually identical in a reverse opposing orientation thereby being hermaphroditic. Each has a pair of tab sections 304 along one common lateral side 306 and a pair of tab-receiving recesses 308 along the other common lateral side 310, all disposed on respective end sections 312 extending axially from interconnection region 314 which contains an array of wave shapes 316 alternating with arcuate shapes 318 defining relief recesses. In Figure 9B interconnection 320 has been locked together after tab sections 304 of each of adapter members 300,302 have extended past inside and outside cable edges and through associated recesses 308, after which tab sections 304 have been bent over firmly against the outer surfaces of sections 312 of the opposed adapter member 302,300. The array of wave shapes and relief recesses are configured to be intermatable when the wave shapes oppose relief recesses, when the adapter members are opposed and aligned for cable application.

A second method of performing the tap or splice interconnection of the present invention, is illustrated in Figures 10A to 10C. In Figure 10A, cables 402,404 at interconnection site 400 need not be prepunched, and upper structure 406 and lower structure 408 extend transversely the full width of the cables. Upper structure 406 includes a pair of upper inserts 410,412 secured to respective sections 414,416 of a single upper adapter member 418. Similarly, a pair of lowr inserts 420,422 are secured to respective sections 424,426 of a single lower adapter member 428. As seen with respect to lower adapter member 428, its sections 424,426 are initially joined together by a spaced apart pair of ligatures 430,432; upper adapter member 418 is similarly constructed, having ligatures 434,436. In Figure 10B, upper and lower structures remain intact during application to cables 402,404 thus simplifying handling, alignment and assembly. In Figure 10C, tooling of the termination apparatus (not shown) strikes along the medial strip of the cables between upper inserts 410,412 and lower inserts 420,422 and simultaneously shears away ligatures 430,432,434,436 and also punch out medial cable sections 438 defining axially extending slots 440 through which wall sections of the housing members may extend. Removal of the ligatures thus physically and electrically separates and defines laterally spaced interconnecting structures 442,444 joining associated conductors of cables 402,404. Then upon wave splitting and insert staking the termination will be assuredly complete as in Figure 8C.

Another embodiment of housing members 502,504 is shown in Figures 11A and 11B being assembled together to enclose a terminated interconnection site 500. Cable-engaging sections 506,508 abut the adjacent outwardly facing surfaces of the cable or cables 12,14 exiting from the ends of the interconnection site 500. Cable-engaging sections 506,508 are stiffly resilient spring biased clamps firmly holding cable or cables 12,14 therebetween: cable-engaging platforms 510,512 are deflectable upon clamping into transverse relief slots 514,516 therebehind and remain integrally joined to housing members 502,504 by hinges 518,520 which are elastically deformable. Housing members 502,504 are secured together by latching projections 522 of latch arms 524 at diagonal corners of each housing latchable with corresponding latching recesses 526 of the other housing. In this manner housing members 502,504 of tap connection 10 of the present invention may compensate for one cable thickness or two cable thicknesses, and also for a range of cable thicknesses of from 0.014 to 0.034 inches and still attain cable clamping for vibration resistance and strain relief benefits.

In Figure 12 interconnection 600 includes upper and lower housing covers 602,604 and two interconnecting structure assemblies 606,608 are shown each of which interconnects respective ones of the conductors of the main and tap cables, while sandwiching both cables therewithin including the other ones of the conductors. Assembly 606 electrically interconnects conductor 26 of main cable 12 with conductor 38 of tap cable 14, while not interconnecting conductor 28 of main cable 12 and conductor 40 of tap cable 14. Conversely, assembly 608 electrically interconnects conductors 28,40 while not interconnecting conductors 26,38. Rivets 614 extend through centrally located apertures of opposing flanges 616 of upper interconnecting structure 610 and lower interconnecting structure 612 and lock the structures together to comprise structure assembly 608, and similarly structure 606. The rivets 614 join the flanges spaced laterally from side edges of the cable minimizing a tendency to disturb the wave joints during the process of heading the rivets.

The splice and tap connector of the present invention can be modified and varied as exemplified by the several embodiments of the various few parts of the connector contained herein.

Claims

1. A method of interconnecting a pair of flat power cables (12,14) each having at least one flat conductor (26,28;38,40) therein, comprising the steps of:
stacking a selected section of one flat cable (12) over a selected section of the other (14) with the at least one conductor (26,28) parallel to the at least one conductor (38,40) of the other and aligning the conductors in pairs (26,38;28,40) to be interconnected;
and
applying on each lateral side of said stacked cable sections a respective at least one pair (34,36) of upper (60) and lower (80) conductive interconnecting structures to the upwardly facing and downwardly facing surfaces of said stacked cables (12,14), for an array of conductor-engaging projections (66,74;86,94) of each upper (60) and lower (80) structure to at least deflect respective conductor strips out of the planes of the cabls (12,14) into respective opposing recesses (76,96) of the opposing structure and for side edges (78,98) of said projections (66,64;86,94) to simultaneously engage exposed edges (110) of the conductor strips thus entering electrical engagement with portions of the paired conductors (26,38;28,40) of upper and lower ones of said cables (12,14) to be interconnected, thus electrically interconnecting said associated conductors (26,38;28,40) of said cables (12,14), said respective at least one pair (34,36) of conductive interconnecting structures on each side of said stacked cables (12,14) being electrically disconnected from the pair on the other side thereof.

2. The method as set forth in claim 1 wherein said upper and lower interconnecting structures (60,80;218,220;300,302) of each pair include integral means (234,212;304,308) for being locked to each other securing said stacked cable sections therebetween.

3. The method as set forth in any of claims 1 and 2 further including the step of forming an axially extending slot (42,44) along the center of each said cable (12,14) at said selected sections prior to applying said interconnecting structures (34,36).

4. The method as set forth in any of claims 1 and 2 wherein said upper interconnecting structures (406) of each said pair have lateral sections (410,412) joined initially by ligature means (434,436) to extend transversely a width of a said cable (402) and said lower interconnecting structures (408) of each said pair have lateral sections (420,422) joined initially by ligature means (430,432) to extend transversely a width of a said cable (404) with said ligature means associated with a narrow medial region of said cable, said method further including the step of shearing and thereby removing said ligature means (430,432,434,436) and adjacent narrow medial portions (438) of said stacked cable sections thereby separating said lateral sections (410,412;420,422) of said upper and lower conductive interconnecting structures (406,408) and defining electrically isolated interconnecting means and forming aligned axially extending slots (440) along the centers of said stacked cables (402,404).

5. The method of any of claims 3 and 4 wherein said method further includes the step of applying housing means (16,18;502,504) about said interconnection enclosing said conductive interconnecting structures (34,36) and said portions of said associated conductors (26,38;28,40) so that a vertical portion (46) of said housing means (16,18;502,504) extends through said slots (42,44;440) between said conductive interconnecting structures (34,36), whereby the structures are electrically isolated by dielectric material of said housing means.

6. The method of any of claims 1 to 5 wherein said method further includes the step of applying housing means about said interconnection enclosing said conductive interconnecting structures (34,36) and said portions of said associated conductors (26,38;28,40) wherein said housing means comprises a pair of housing covers (16,18;502,504) securable together, the covers including cable-

clamping means for firmly clamping major side surfaces of each at least one said first and second cables (12,14) extending from said interconnection.

7. The method of claim 6 wherein said cable-clamping means is integral with respective opposing housing covers (502,504) and comprise cable-engaging platforms (510,512) deflectable outwardly against spring bias upon cable engagement into relief slots (514,516) therebehind upon said covers (502,504) being applied around said interconnection.

8. The method of any of claims 1 to 7 wherein each said flat cable (12,14) includes two flat conductors (26,28;38,40).

9. The method of any of claims 1 to 8 wherein said selected section of at least one said flat cable (12) is an intermediate section thereof.

10. The method of any of claims 1 to 9 wherein said projections (66,74;86,94) of each of said conductive interconnecting structures (34,36) are wave shaped and alternate across the array with ones of said relief recesses (76,96) of equal width adapted to receive thereinto respective wave-shaped projections of the opposing structure and conductor strips pressed out of the cable planes thereby, whereafter the structures (34,36) are staked (54,58) at and behind each projection (66,74;86,94) to deform the metal thereat locally laterally outwardly tightly against edges of the conductor strips therebeside.

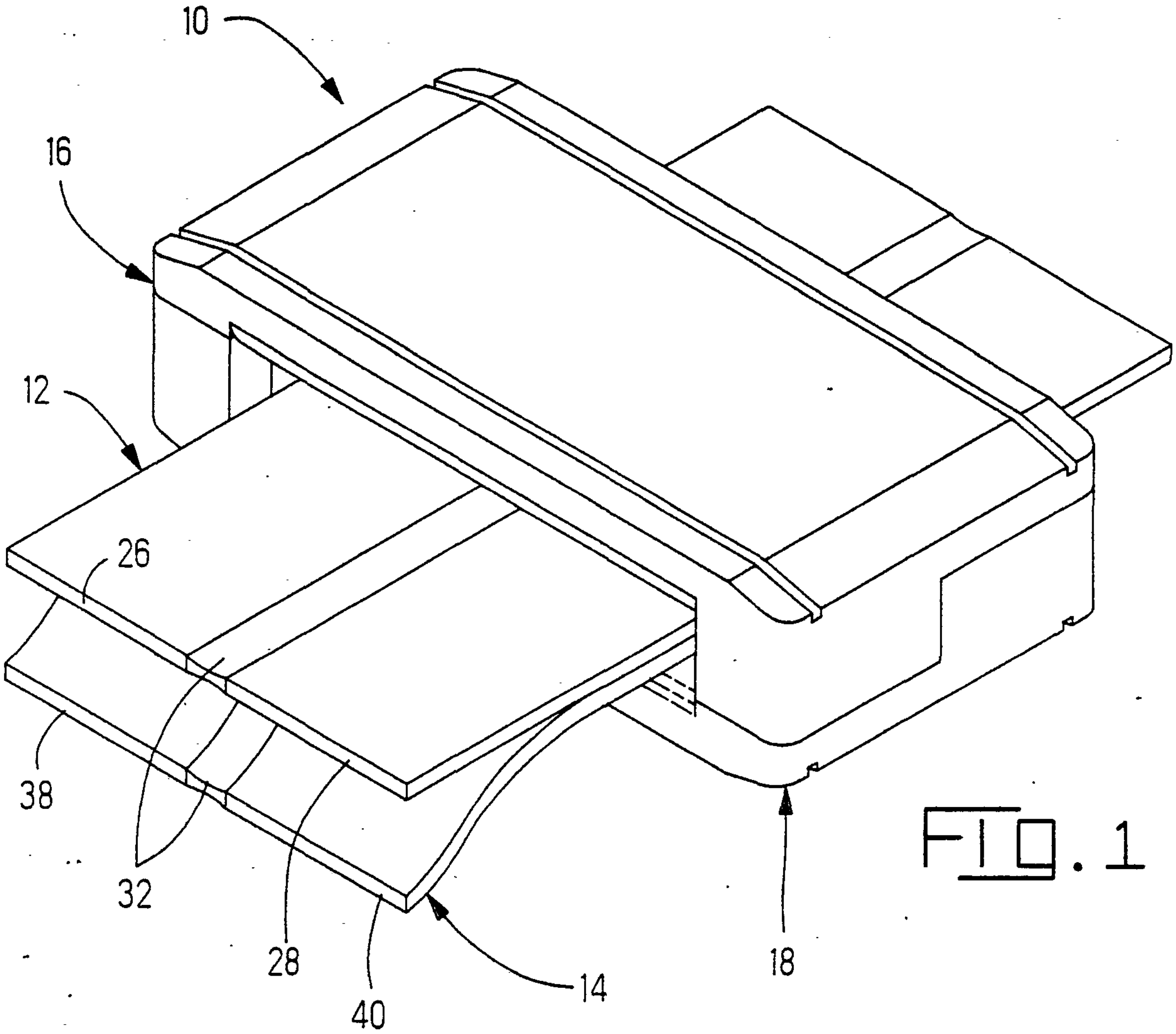


FIG. 1

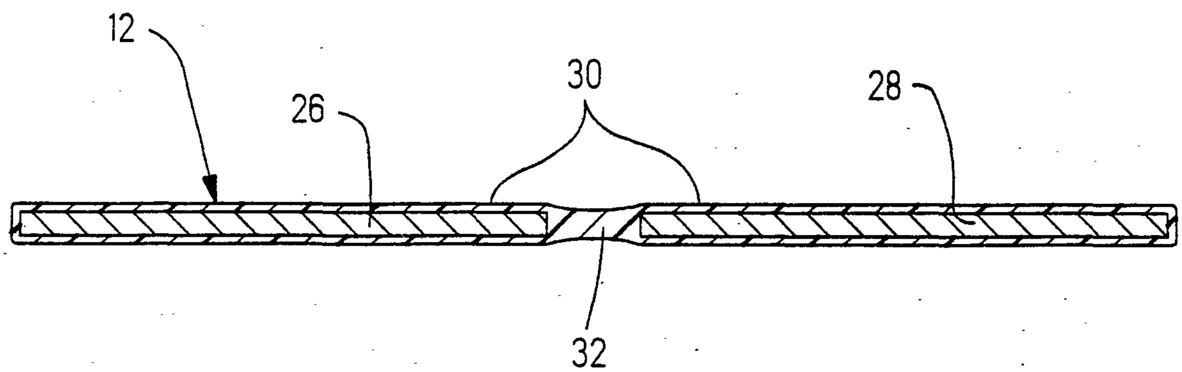


FIG. 1A

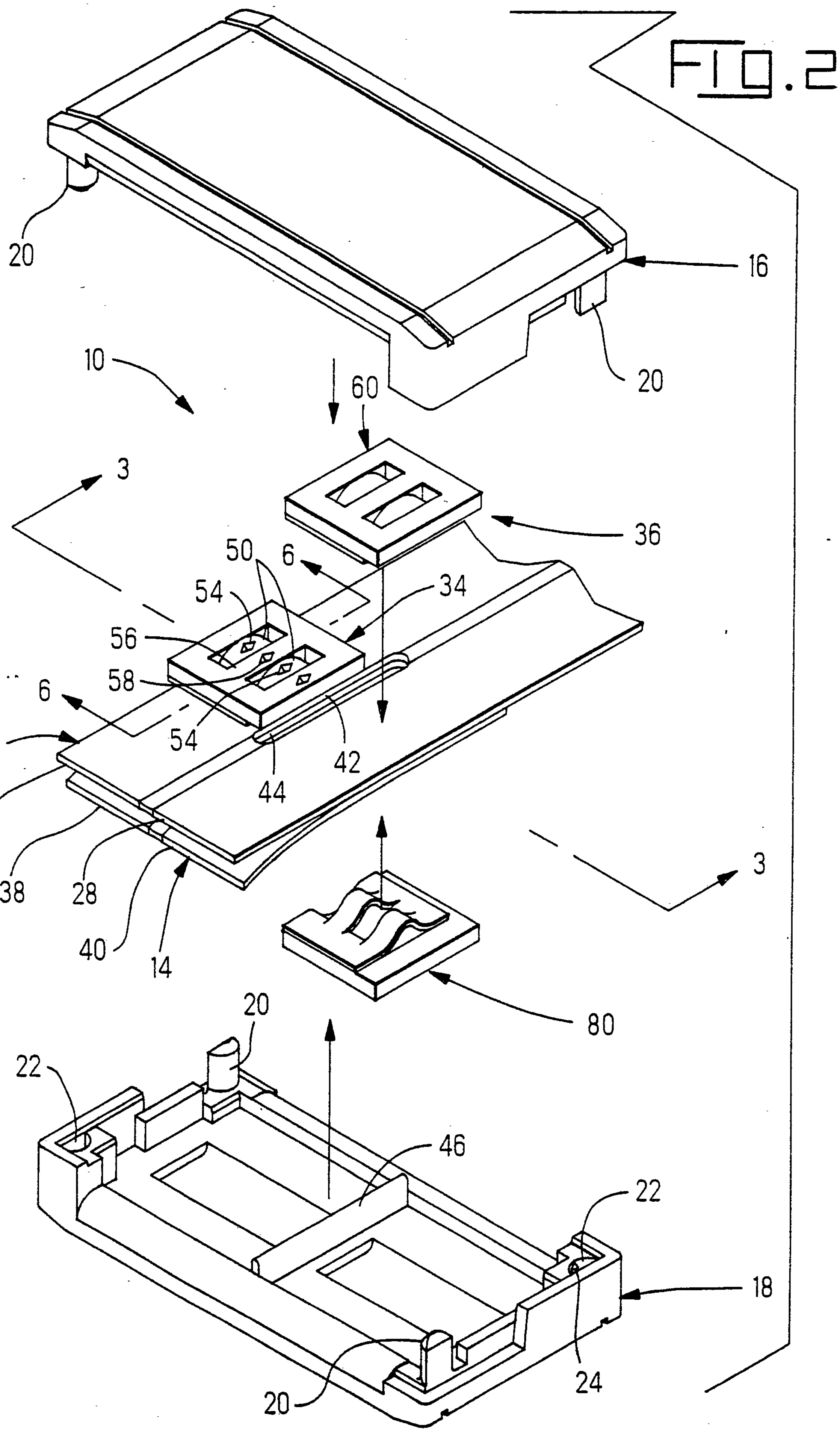
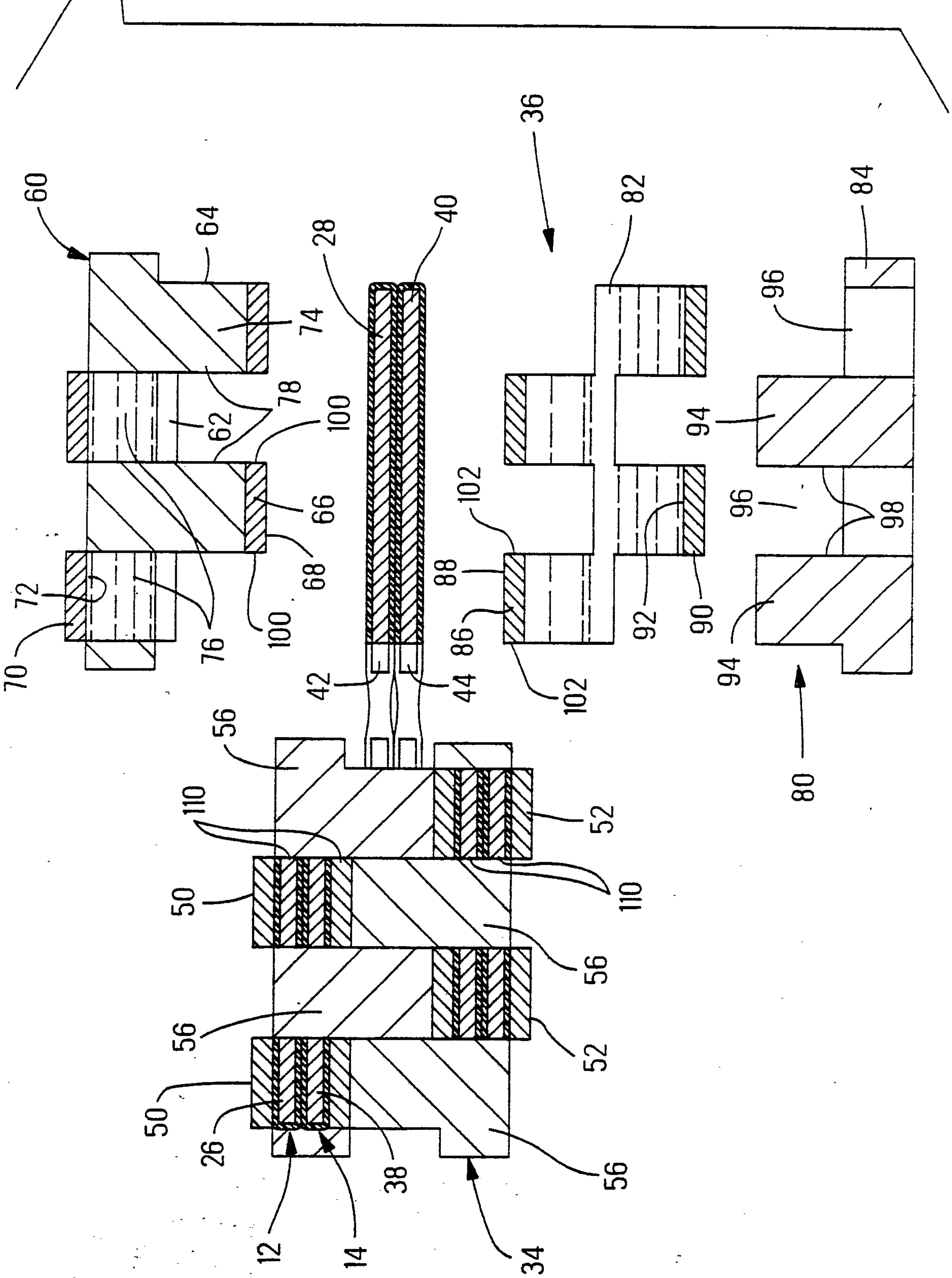


Fig.2
20
16
20
10
60
3
36
50
6
54
34
56
58
6
54
12
42
44
26
38
28
3
40
14
80
20
22
46
22
18
24
20

FIG. 3


60
64
74
78
62
100
66
68
72
70
76
28
40
42
44
36
82
84
96
94
98
102
88
86
92
90
80
56
110
50
52
26
38
12
14
34

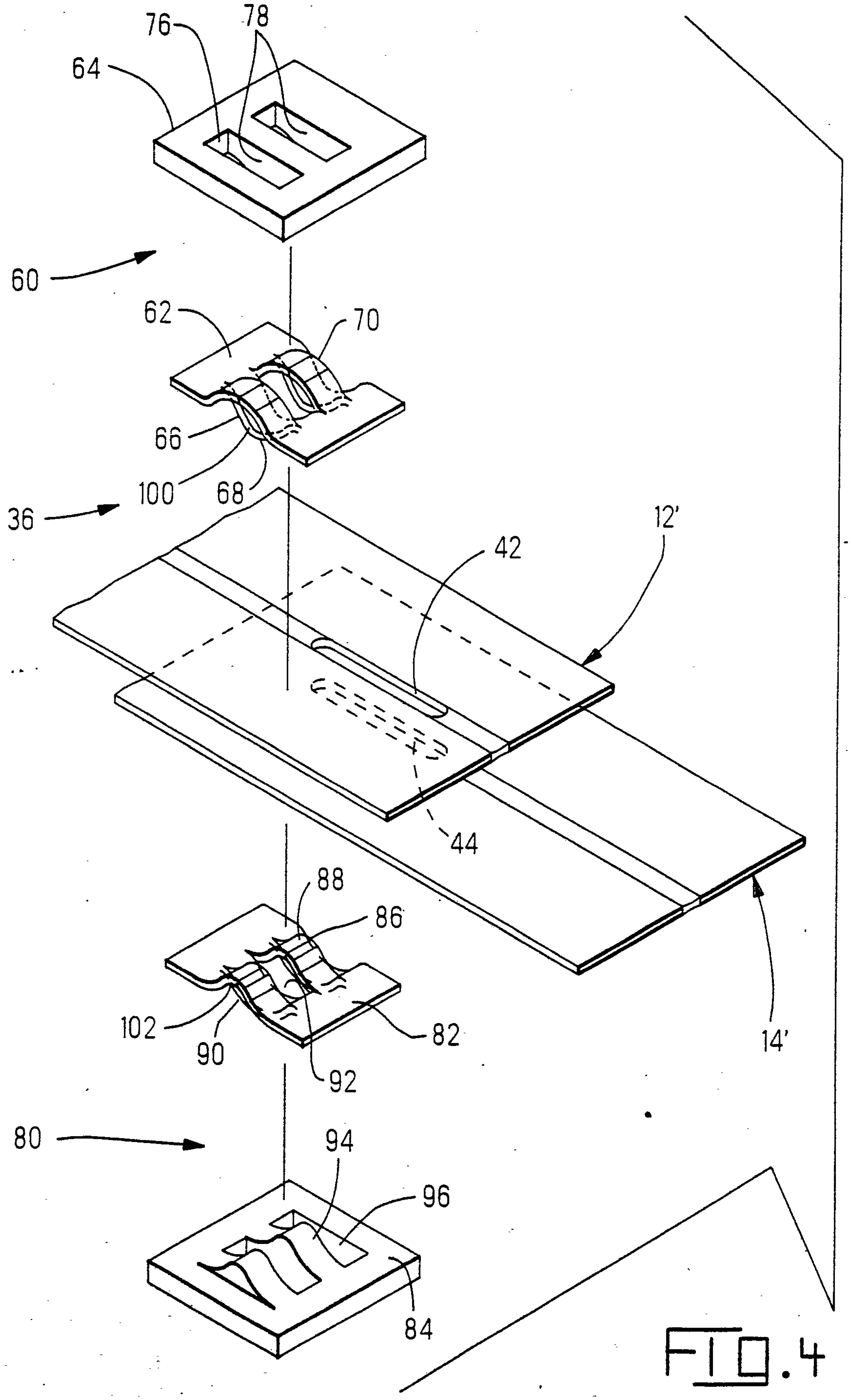

76
78
64
60
62
70
66
100
68
36
12'
42
44
88
86
102
90
82
92
14'
80
94
96
84

FIG.4

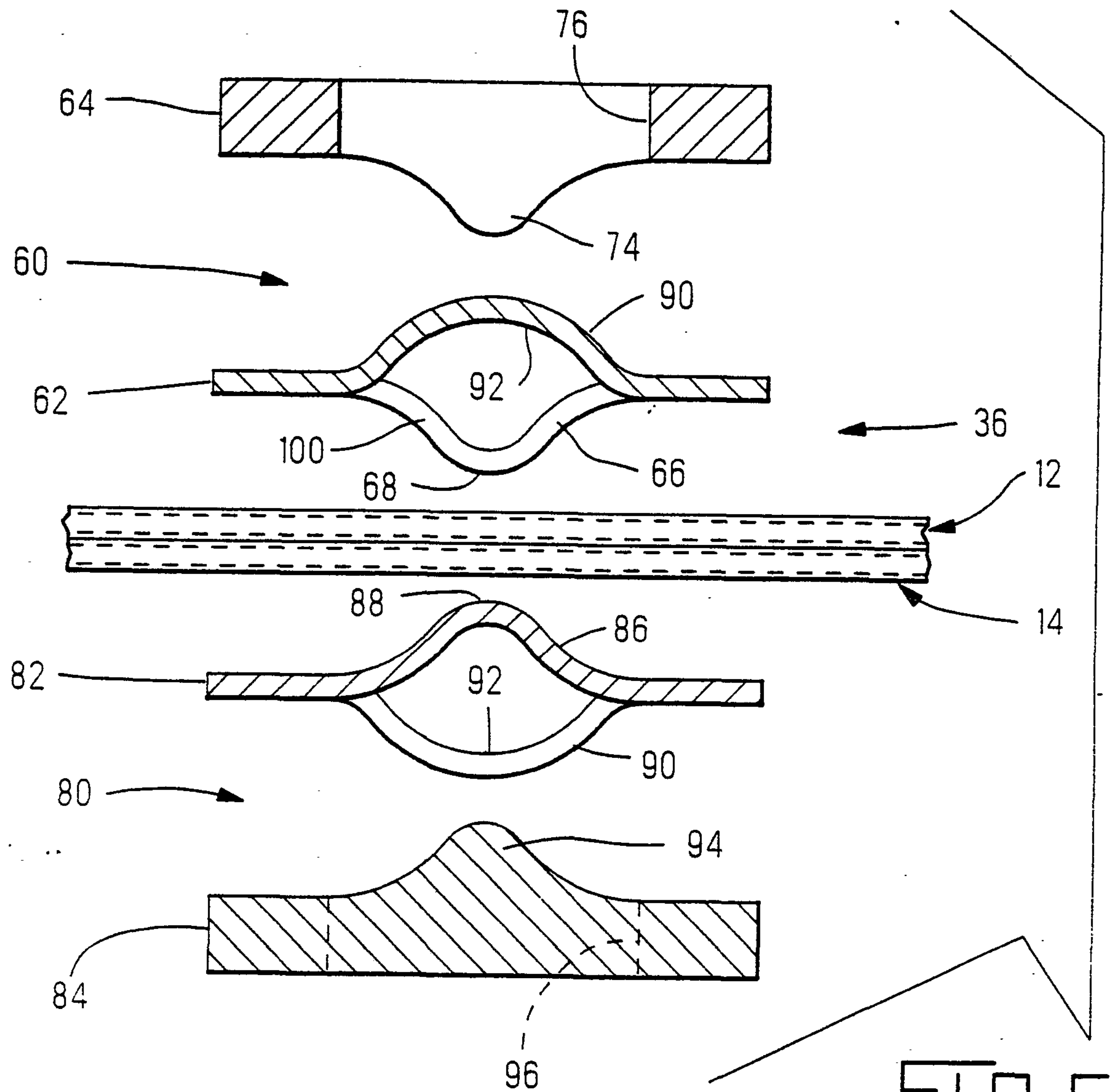

76
64
74
60
90
92
62
36
100
66
68
12
14
88
86
82
92
90
80
94
84
96

FIG.5

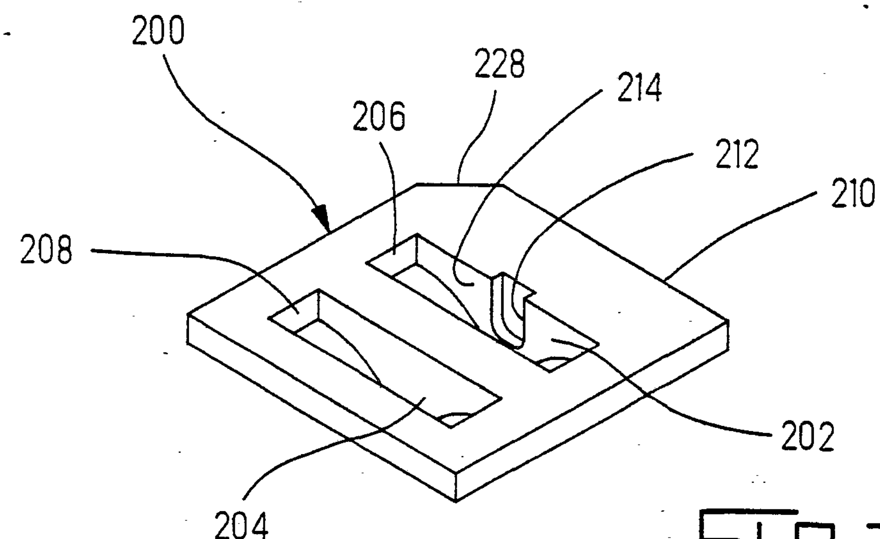

200
228
214
206
212
210
208
202
204

FIG.7

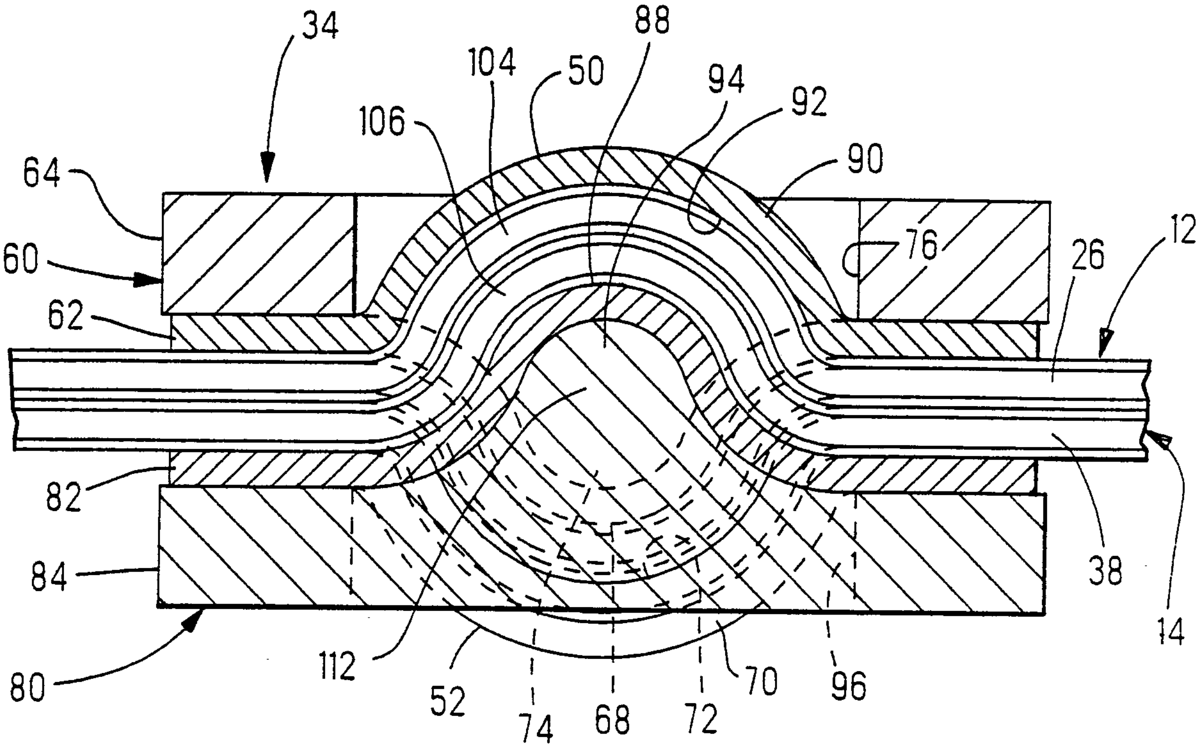

34
88
104
50
94
92
106
90
64
76
12
60
26
62
82
38
84
14
112
80
52
70
96
74
68
72

FIG.6

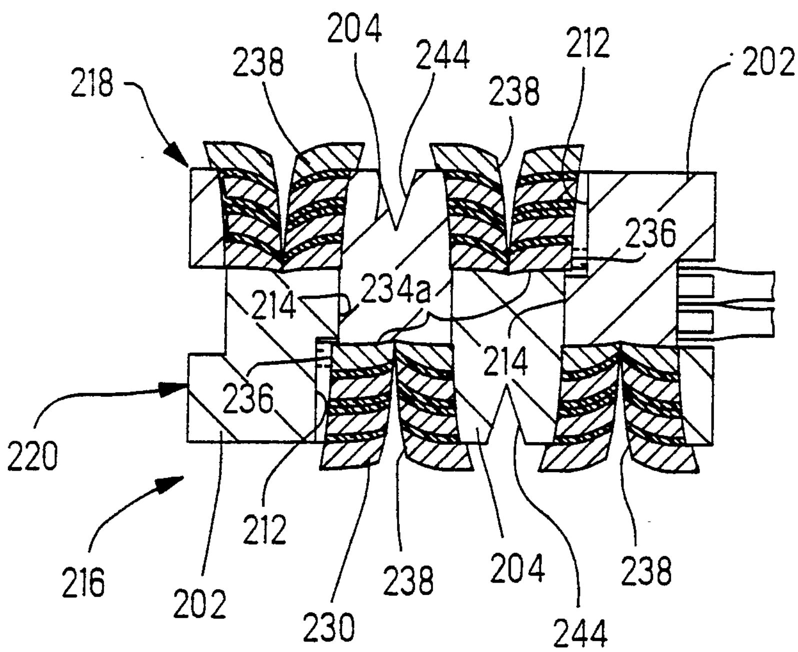

204
244
212
218
238
202
238
236
214
234a
214
236
220
212
216
202
230
238
204
238
244

FIG.8 C

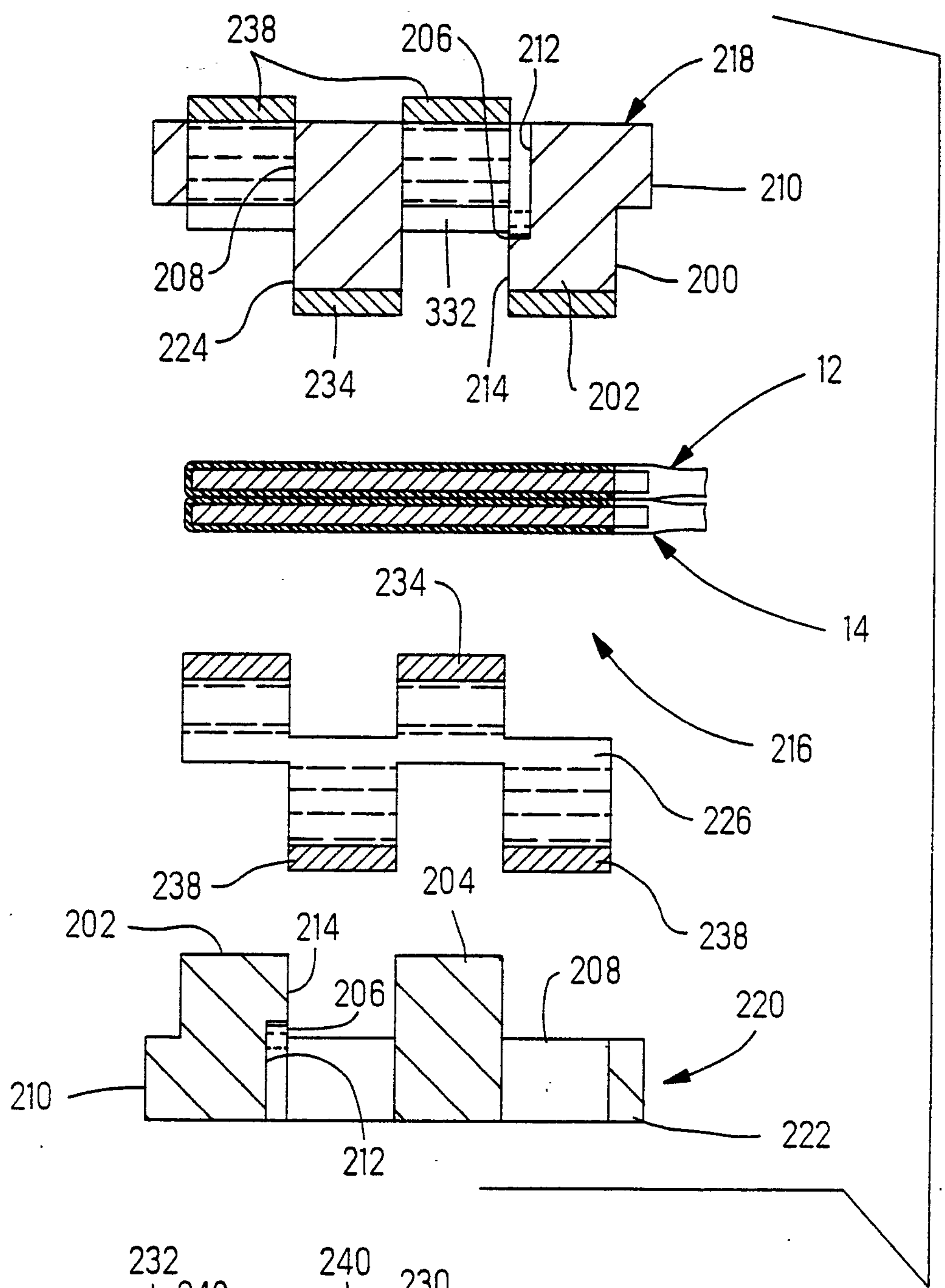

238
206
212
218
210
208
200
224
332
234
214
202
12
14
234
216
226
238
204
238
202
214
206
208
220
210
212
222

FIG. 8A

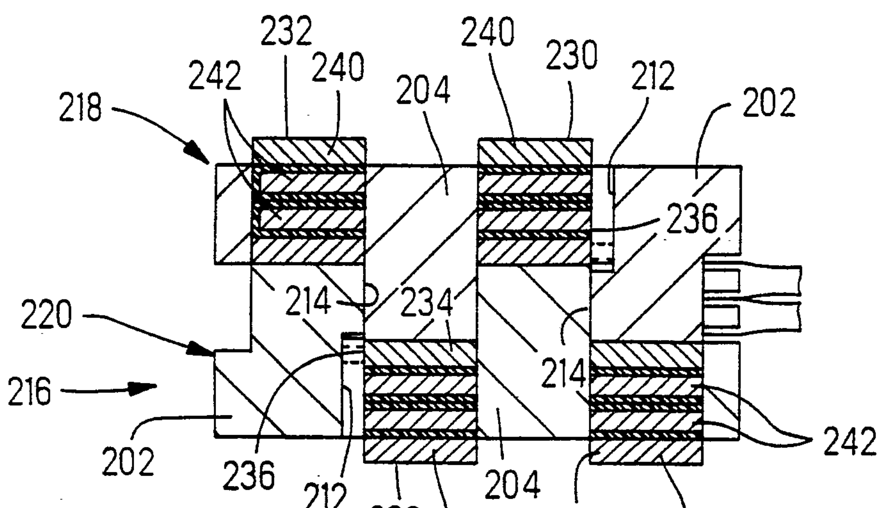

232
240
242
240
230
204
212
202
218
236
214
234
220
214
216
242
202
236
212
230
204
240
240
232

FIG. 8B

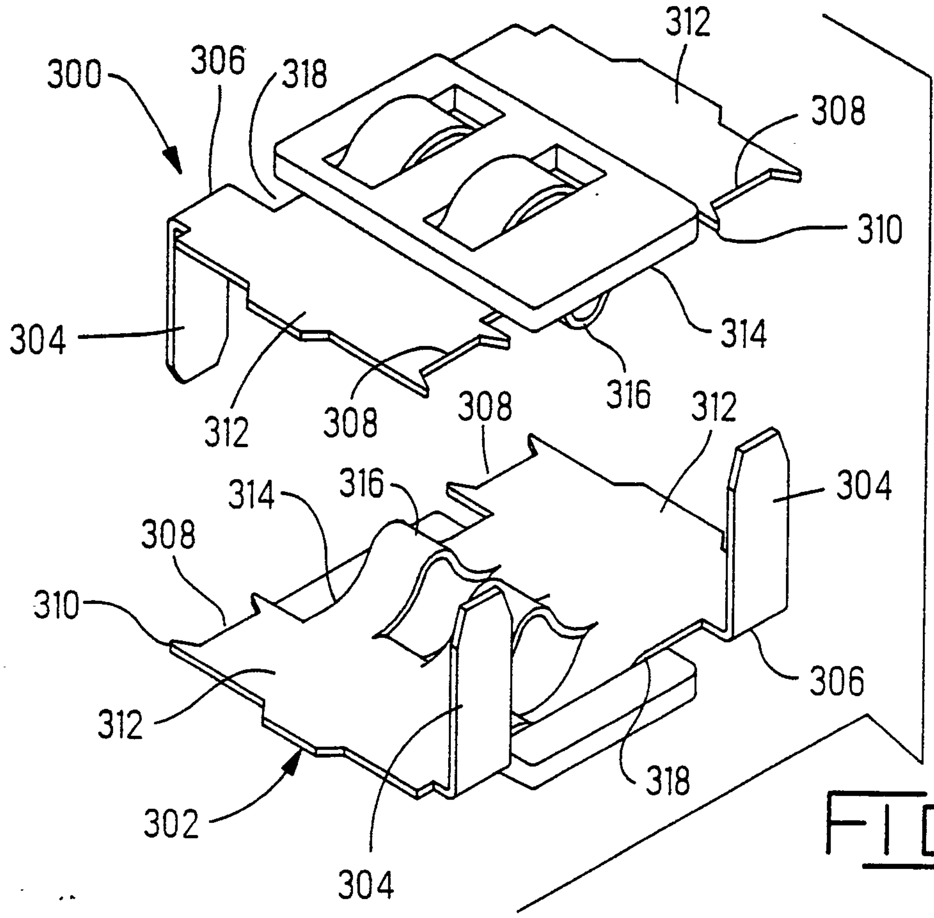

300
306
318
312
308
310
314
304
316
312
308
308
312
304
314
316
308
310
312
306
318
302
304

FIG.9A

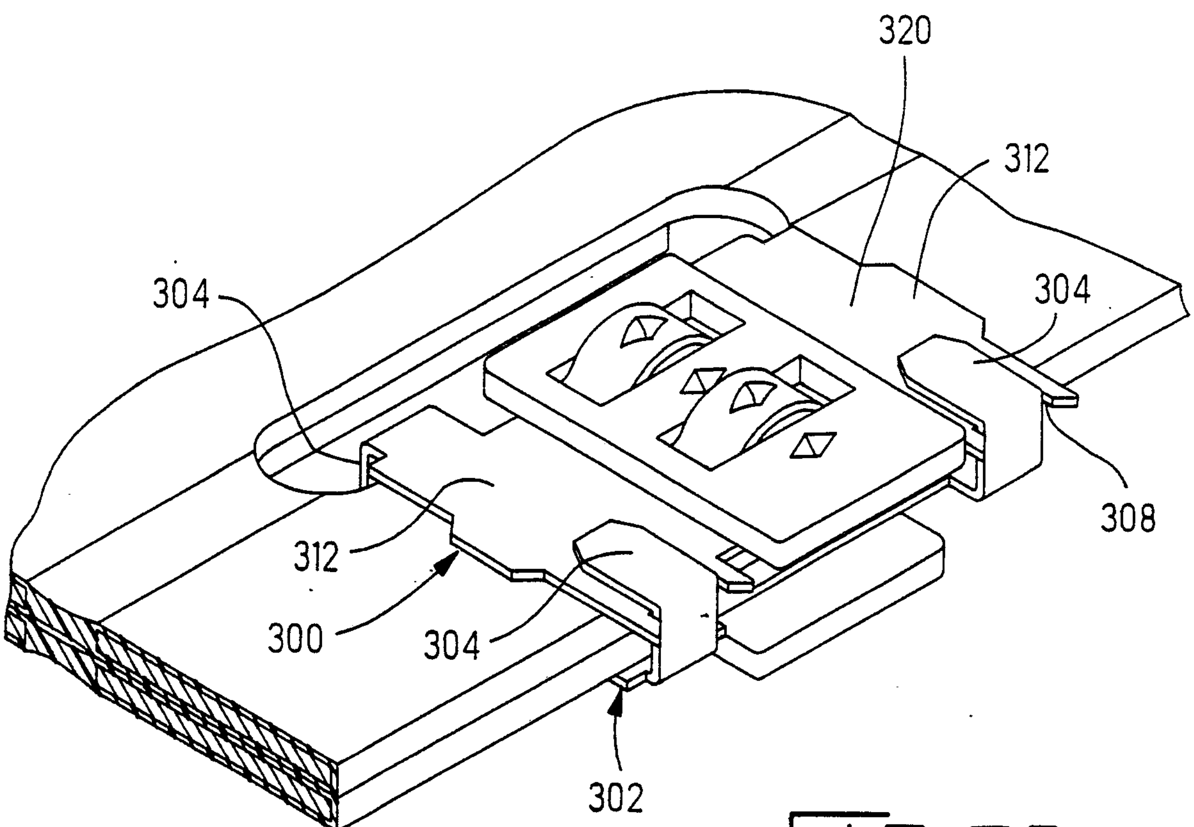

320
312
304
304
308
312
300
304
302

FIG.9B

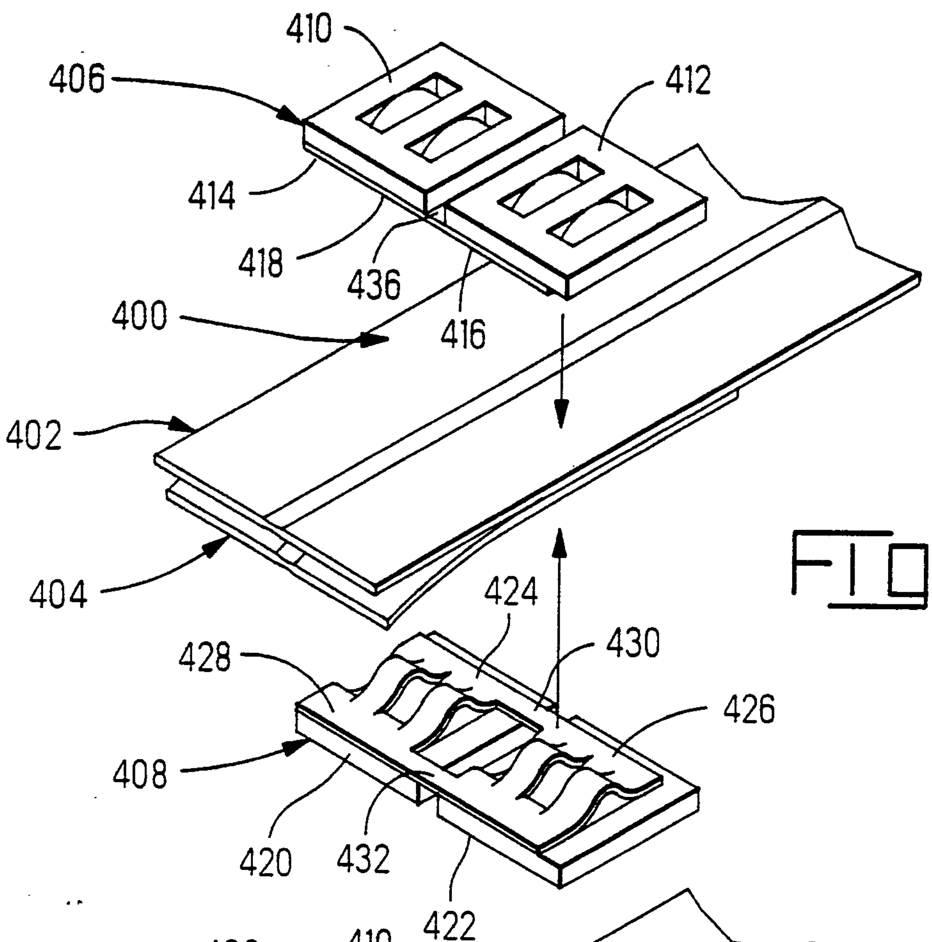


FIG. 10A

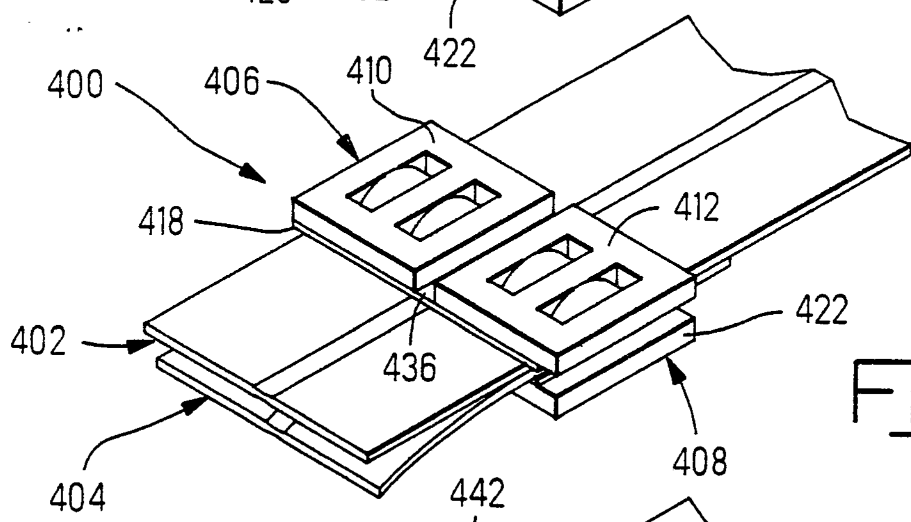


FIG. 10B

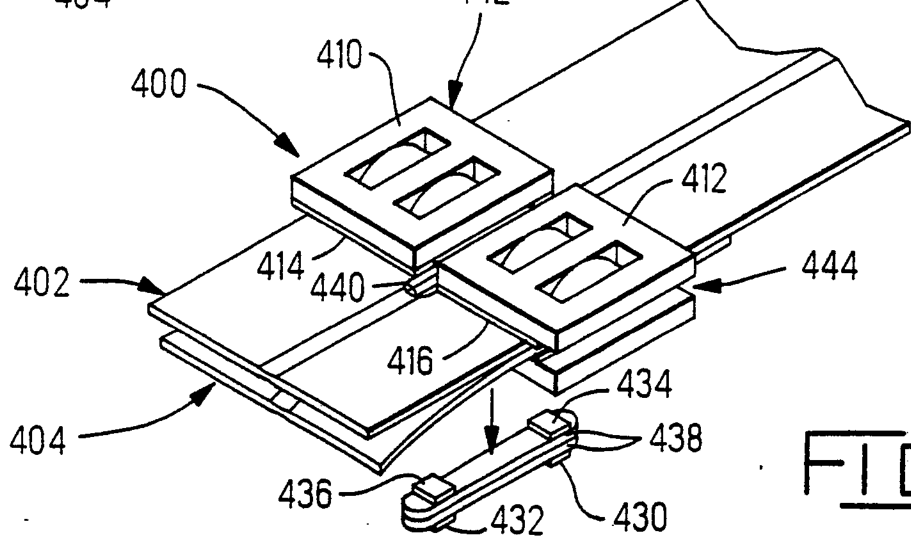


FIG. 10C

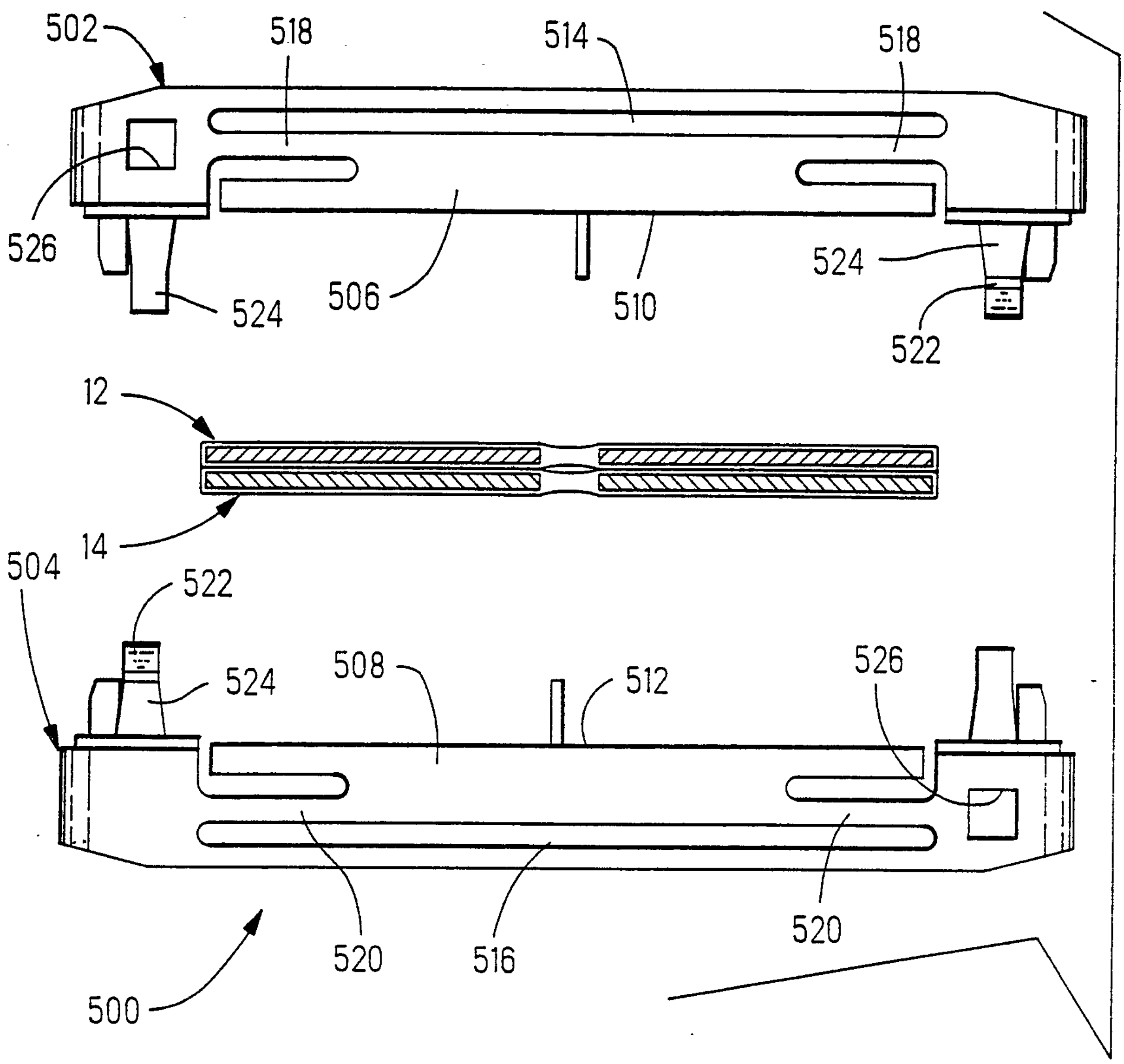


FIG.11A

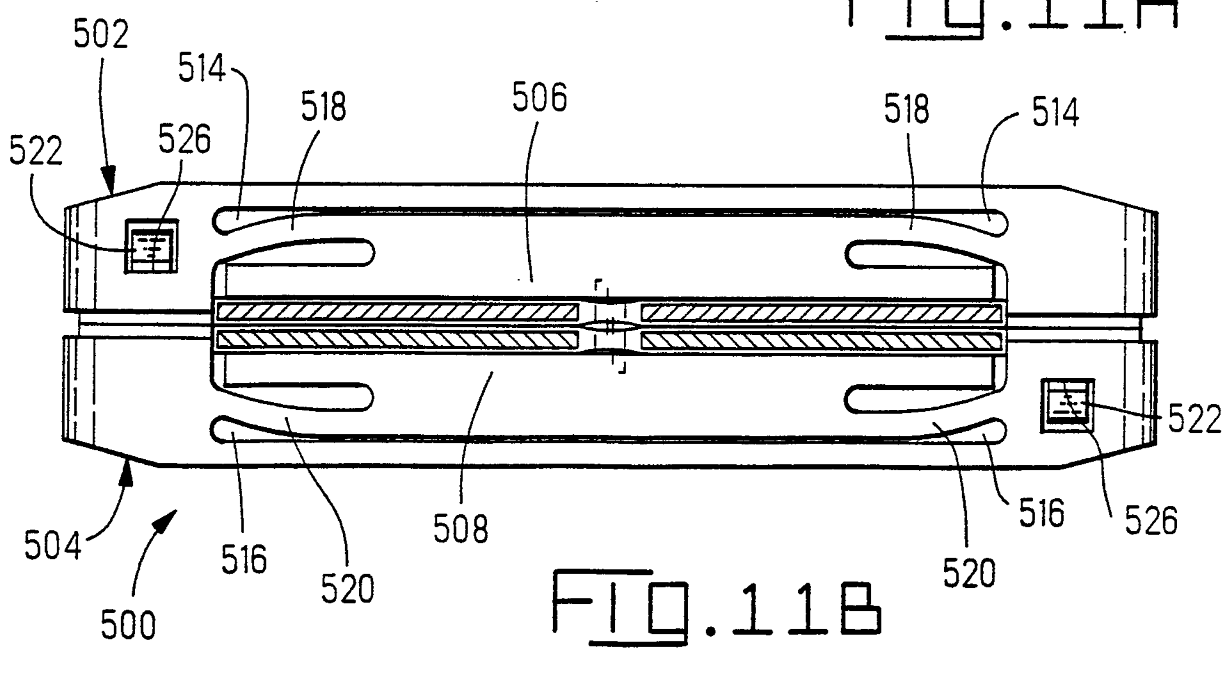


FIG.11B

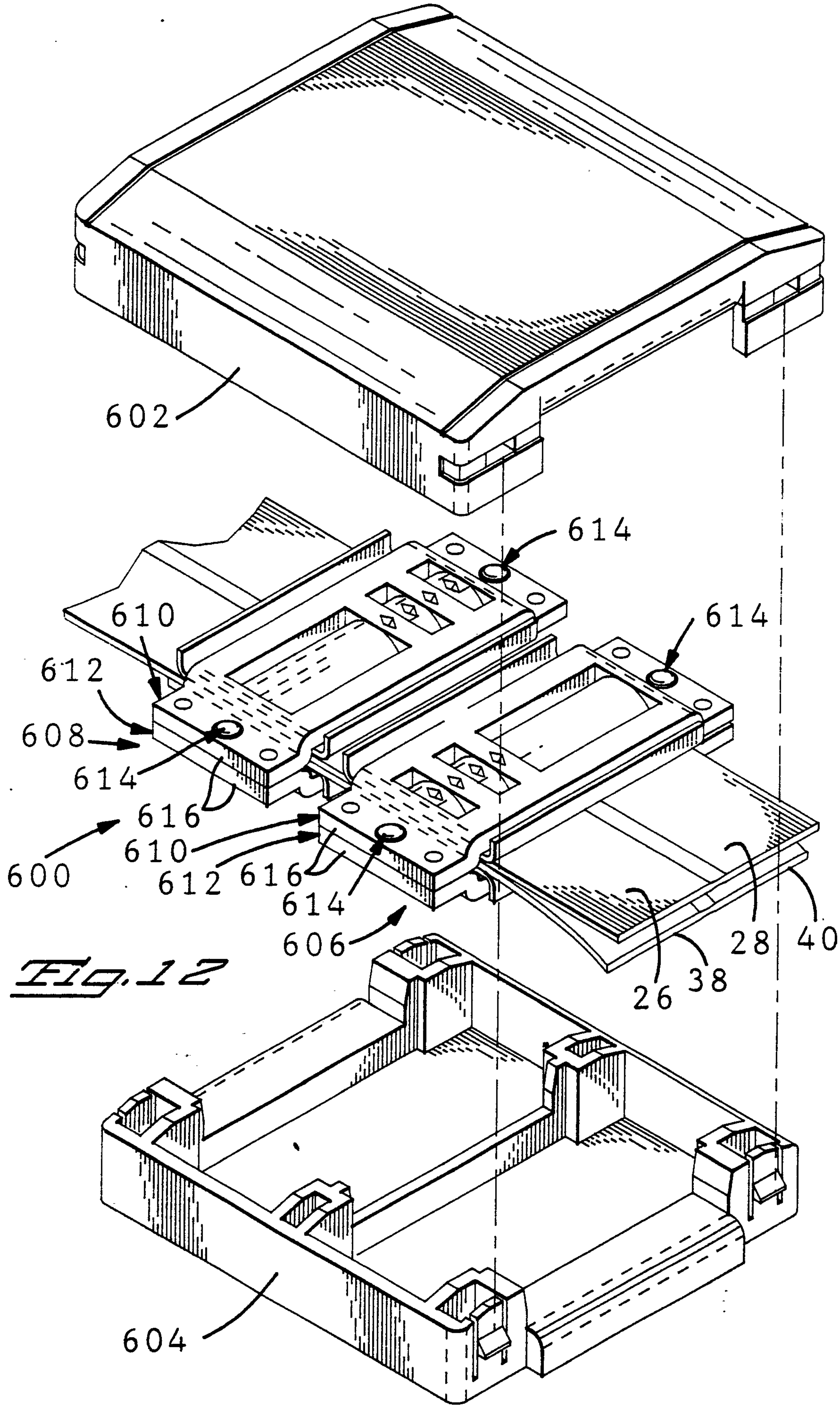

602
614
610
614
612
608
614
616
600
610
612
616
614
606
26
38
28
40
604

Fig.12

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 90303945.1

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.5)
A	US - A - 4 669 798 (DAUM et al.) * Claim 1; fig. 5-11 * --	1	H 01 R 23/66 H 01 R 9/07
D,P, A	US - A - 4 859 204 (DALY et al.) * Fig. 3,12,13C * --	1-10	
A	DD - A1 - 233 692 (TECHNISCHE HOCHSCHULE LEIPZIG) * Totality * --	1	
A	EP - A1 - 0 014 081 (THE POST OFFICE) ----		
			TECHNICAL FIELDS SEARCHED (Int Cl.5)
			H 01 R 23/00 H 01 R 9/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	11-07-1990	SCHMIDT

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO Form 1503 03.82