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(71) Applicant: **AMP INCORPORATED**
P.O. Box 3608 449 Eisenhower Boulevard
Harrisburg Pennsylvania 17105(US)

(72) Inventor: **Hamsher, Wilbur Arthur, Jr.**
1325 Oak Lane
New Cumberland PA 17070(US)

(72) Inventor: **Lockard, Joseph LaRue**
413 Bristol Drive
Harrisburg PA 17109(US)

(74) Representative: **Gray, Robin Oliver et al,**
BARON & WARREN 18 South End Kensington
London W8 5BU(GB)

(54) Double row electrical connector.

(57) An electrical connector (200,300) comprises a forward housing member (10,212) having rows of passageways (24,222) in which are disposed signal and ground terminals (22,214,216) terminated to signal (152,260) and ground (154,262) conductors of signal transmission cables or ribbon cable (150,218) with the terminals being secured to a dielectric contact-carrying means (42,238) and then overmolded after termination by dielectric cover means (30,220). The cover means seals the terminations and provides nondeforming cable strain relief. In one embodiment each row of terminals (22) is first secured on one side (46) of a separate contact-carrying member (42) with a ground plane (62) secured to the other side (58), and signal conductors (152) are terminated to respective signal terminals (22) and ground conductors (154) are terminated to the ground plane (62) which is electrically connected to selected ground ones of terminals (22) after which the subassembly (40) thus formed is overmolded with the dielectric cover (30). Two such overmolded assemblies (12) are securable together and secured to the housing member (10) with contact sections (20) of the terminals (22) secured in the housing passageways (24).

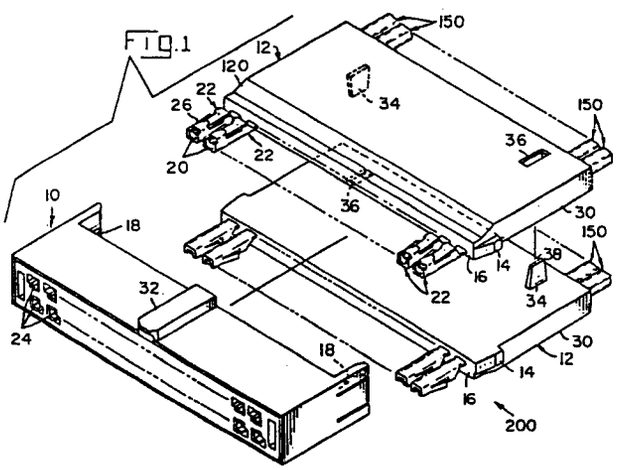

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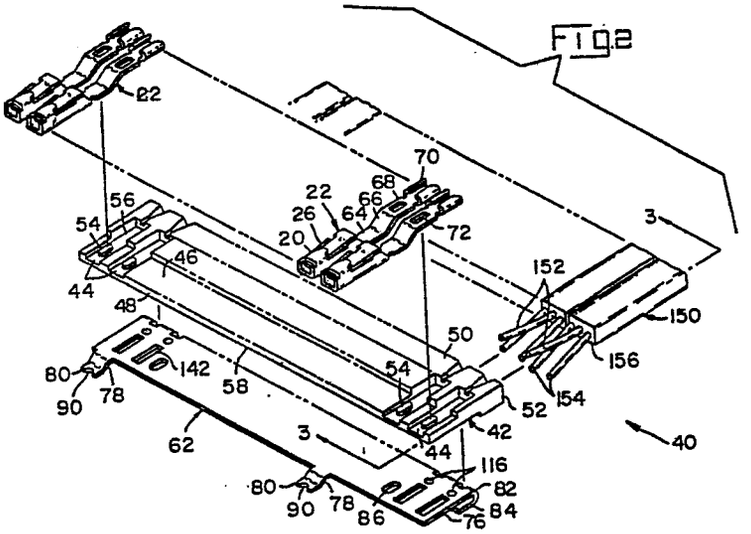
Fig.2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DOUBLE ROW ELECTRICAL CONNECTOR

The present invention relates to the field of electrical connectors and more particularly to the field of double row connectors for transmission cables.

Double row receptacle connectors are known for flat transmission cable, which comprise a connector assembly for mating with a two-row pin array. Such connector assemblies route adjacent closely spaced signal conductors of the flat cable to terminals on alternating sides of the connector while routing the respective ground conductors to a ground bus contained in the connector.

U.S. Patent No. 4,260,209 discloses such a connector for providing mass termination of a flat transmission cable, where the receptacle terminals for the signal conductors have slotted beam termination sections and are terminated to the conductors by insulation displacement. Similarly the ground conductors are secured in slotted beams of the ground bus. The receptacle terminals and ground bus are disposed along respective recesses of a housing, the conductors of the cable are terminated thereto, a cover is placed over the terminations, and a strain relief member is secured to the assembly. The connector provides for selective programming of ground terminals by connecting selected receptacle terminals to the ground bus instead of to signal conductors, by grounding bars or by sacrificed signal conductors.

U.S. Patent No. 4,269,466 discloses another double row receptacle connector for flat transmission cable wherein the terminals are disposed in channels along opposing sides of a housing member and respective signal conductors are terminated by insulation displacement to slotted beam termination sections. Cover members are placed against the sides of the housing, locking to the housing at its forward end and to each other at the rearward end providing cable strain relief. A ground bus bar engages the ground conductors by a plurality of slotted beam termination sections. To selectively program the ground

terminals of the connector, the ground bus bar can have selectively positioned termination sections to engage sacrificed signal conductors by insulation displacement which signal conductors then proceed forwardly to engage respective receptacle contacts which become ground terminals.

European Patent Application No. 83306740.8, Publication No. 0 112 019, discloses an electrical connector for individual transmission cables with minimized impedance discontinuities. The connector provides a row of plug contact sections extending forwardly from a dielectric contact-carrying member on one side of which are secured signal contacts terminated to signal conductors, and on the other side of which is secured a ground plane to which are terminated the ground conductors. An insulative cover is overmolded therearound which seals the terminations which are preferably laser welded, and also extends along the cables providing strain relief. Contact sections extend forwardly from the ground plane at selected locations aligned with the signal contact sections.

It is desirable to provide a double row receptacle connector with programmable grounds.

It is also desirable to provide such a connector for individual signal transmission cables.

It is still further desirable to provide such a connector for transmission of signals with high speed and high reliability by providing for minimized impedance discontinuities.

It is even further desirable to provide such a connector having a dielectric cover which seals the conductor/terminal connections and the adjacent lengths of insulated conductor cables, holds the terminals immobile, and spaces and provides strain relief for the cables without deforming them, and when individual cables are used provides spacing and support therefor.

The present invention is a double row receptacle connector for high speed signal transmission cables for mating with a pin array and includes a premolded forward housing member having

two rows of terminal-receiving passageways extending rearwardly from a mating face thereof to receive in the rearward ends thereof receptacle contact terminals. The terminals are secured to contact-carrying means after which they are terminated to signal conductors and ground conductors of the transmission cables, after which the terminations and lengths of the cable means are covered with dielectric cover means in a manner which seals the terminations, secures the cable means to the contact-carrying means, and provides nondeforming cable strain relief.

In a first embodiment of the present invention each of the terminals of a row are secured to a separate contact-carrying member. Terminals at those contact locations designated as signal locations are terminated to signal conductors of a row of respective transmission cables; terminals at ground locations are welded to a ground plane which is terminated to ground conductors of the cables; and the terminal subassemblies thus formed are then overmolded with a dielectric material. A contact section of each receptacle contact terminal extends forwardly of the overmolded covering to be received in a respective passageway of the forward housing member. When individual cables are used, the dielectric covering also provides spacing between the cables. Ribbon cable may also be used with the present invention.

Prior to overmolding to form the terminal assemblies of the first embodiment, the terminal subassemblies are completed in the following manner. The stripped ends of the signal conductors are routed along channels on one side of a dielectric contact-carrying member to which the terminals are affixed; and the signal conductors are then laser welded to respective signal terminals. The one or two stripped ground conductors associated with each respective signal conductor are routed along channels on the other side of the dielectric contact-carrying member to which a single ground plane is affixed; and the ground conductors are laser welded to the ground plane.

At pre-selected locations along the front end of the ground plane are electrical connections to terminals, forming ground terminals whose integral receptacle contact sections extend forwardly from the overmolded terminal assembly laterally aligned with the receptacle contact sections of the signal terminals and to be received in passageways of the forward housing member. The locations of the ground contact sections in one of the terminal assemblies is independent of the locations of the ground contact sections in the other assembly.

The terminal assemblies of the first embodiment can be secured to each other prior to assembly to the forward housing member by means of one or two projections from each assembly extending through slots in the other assembly between the conductors, whereafter the projections are cold-staked. The assemblies may have lateral latching projections at the forward ends which latchingly engage corresponding lateral latches of the forward housing member. Also, the receptacle contact sections may be retained in the terminal-receiving passageways such as by conventional rearwardly extending lances of the terminal, engaging forwardly facing stop surfaces on sidewalls of the passageways, and the forward terminal ends engaging rearwardly facing stop surfaces of the forward passageway ends. The assemblies can be removed if desired by a tool which has projections to extend inwardly from the mating surface to depress the terminal lances, and by the lateral housing latches being urged outwardly, whereafter the assemblies can be urged rearwardly.

Each terminal assembly of the first embodiment of the present invention provides minimized impedance discontinuity for each row of its conductors and terminals through providing apertures in the ground plane opposite each signal contact, embedding and holding the terminals immobile within the subassembly, and providing nondeforming cable strain relief which also precisely spaces the respective cables when individual cables are used. The present invention also provides high

integrity laser welding of conductors to contacts, and sealing and protecting of the terminations.

In a second embodiment of the present invention, the connector includes a premolded forward housing member having a contact-receiving portion and a contact-carrying portion extending rearwardly from the medial plane of the contact-receiving portion. Two rows of terminal-receiving passageways extend rearwardly from the mating face of the forward housing member through the contact-receiving portion of the housing; channels extend along the top and bottom surfaces of the contact-carrying portion of the housing aligned with the passageways.

Receptacle contact terminals are first secured in the housing with their contact sections secured in the passageways and body sections and termination sections disposed along the channels rearwardly therefrom, with the signal terminals alternating with ground terminals within each row. Each signal terminal is opposed by a ground terminal in the opposing row, to which are respectively terminated the signal conductor and the one or two ground conductors associated therewith, of a respective transmission cable. The signal conductor is preferably disposed along and held by interference fit within a slotted termination section of the signal terminal and then connected thereto by laser welding. The one or two ground conductors are similarly disposed along and held by interference fit within a slotted termination section of the ground terminal and then laser welded thereto. The transmission cables are arranged in a single row extending rearwardly from the housing member in the medial plane of the housing's contact-carrying portion.

Rearwardly of the contact-receiving portion of the housing, moldable dielectric material is then molded sealingly over the contact-carrying portion and the conductor/terminal terminations and along insulated portions of the transmission cables for strain relief, forming a dielectric cover means which seals the

terminations and holds the terminals immobile. When individual cables are used, preferably a transverse second strain relief is formed during the molding of the cover means and spaced rearwardly along the transmission cables a selected distance from the cover means, with longitudinally extending web sections at each end of the row of cables integrally joining the second strain relief and the cover means,

The strain relief provided by the present invention does not deform the transmission cables, like other conventional strain relief methoids. The providing of alternating and opposing signal and ground terminals minimizes impedance problems. The terminations are by high integrity laser welding and are sealed thereafter.

A plurality of double row connectors of the present invention can be placed side by side, each having a low profile to electrically mate with a multi-row pin array of a printed circuit board, or they can be placed end-to-end to mate a long double row of pins. The double row connector of the present invention may be used with a variety of transmission cables, such as ribbon cable, coaxial cable and two-lead cable.

FIGURE 1 is a perspective view of the connector with the two terminal assemblies exploded from the forward housing member.

FIGURE 2 is a perspective view of one of the terminal subassemblies showing the contact-carrying member, the signal terminals and the ground plane exploded therefrom and the cable ends exploded rearwardly therefrom, prior to termination and overmolding to become a terminal assembly.

FIGURE 3 is a longitudinal section view of the terminal subassembly taken through line 3-3 of Figure 2.

FIGURES 4 is a longitudinal section view of the terminal subassembly of Figure 3 after terminals are secured and conductors connected thereto.

FIGURE 5 is an enlarged perspective view from below of a terminal welded to a ground plane tab.

FIGURES 6A and 6B are top partial views of a signal conductor before and after welding to a signal terminal in a terminal subassembly.

FIGURE 7 is an enlarged perspective view of a pair of ground conductors routed along merging channels in the carrier and terminated to the ground plane at a single weld, in a terminal subassembly.

FIGURE 8 is a longitudinal section view of the overmolded terminal assembly.

FIGURES 9 and 10 are longitudinal section views of a pair of terminal assemblies of Figure 8 secured together for insertion into the forward housing member, and after insertion, respectively.

FIGURES 11A and 11B illustrate the latching of the terminal assemblies into the housing.

FIGURE 12 is a perspective view of another embodiment of the connector assembly of the invention, with the terminals exploded from the housing and the prepared transmission cables exploded from the terminals, prior to termination assembly and overmolding.

FIGURE 13 is a perspective view of the assembled connector assembly of Figure 12 after overmolding.

FIGURE 14 is a longitudinal section view of the housing and terminals taken along line 14-14 of Figure 12.

FIGURE 15 is a longitudinal section view of the terminals in the housing and the cable conductors to be terminated thereto, taken along line 15-15 of Figure 12.

FIGURE 16 shows the conductors terminated to the housed terminals of Figure 15.

FIGURE 17 shows the terminated subassembly of Figure 16 after overmolding, with the mold shown in phantom.

FIGURES 18 to 21 are part plan views of adjacent signal and ground terminals exploded from the housing, secured in the housing to receive signal and ground conductors, terminated to

the respective conductors, and overmolded respectively, with the top of the housing broken away.

The connector assembly 200 of the present invention is shown in Figure 1 and comprises a forward housing member 10 and a pair of terminal assemblies 12. Assemblies 12 are securable to housing 10 by latching projections 14 on each assembly 12 at the forward end 16 and laterally thereof engaged by latching arms 18 of housing 10. Box-type receptacle contact sections 20 of electrical contact terminals 22 extend in a row forwardly of forward end 16 of each assembly 12, to be received within terminal-receiving passageways 24 of housing 10 and preferably secured therewithin such as by locking lances 26 engaging stop surfaces 28 within passageways 24, as shown in Figures 9 and 10.

A row of electrical transmission cables 150 extends rearwardly from each assembly 12 with their signal and ground conductors terminated to terminals 22. Each terminal assembly 12 has a cover means 30 molded over a terminal subassembly comprising the terminals 22, the terminations of the signal and ground conductors thereto, and end portions of the transmission cables 150, all of which will be described with greater particularity below. Connector assembly 200 is matable with two rows of pin contacts of a pin array of a printed circuit board (not shown), and a keying feature 32 is shown on forward housing member 10 for proper mating with a shroud member around the pin array.

Terminal assemblies 12 are preferably first secured to each other prior to latching into housing 10, by means of one or more relatively vertical projections 34 on each assembly entering into axial slots 36 in the respective other assembly with free ends 38 extending beyond the remote surface thereof after which the projections' free ends 38 are cold-staked or deformably enlarged against the remote surface, as seen better in Figure 11A.

Figure 2 shows the terminal subassembly 40, from which a terminal assembly 12 is formed when subassembly 40 is

overmolded by cover means 30. A dielectric contact-carrying member 42 is molded from a suitable material and has spaced channels 44 located on relatively top surface 46 and extending rearwardly from front end 48 to conductor-positioning section 50 at the rearward end 52 of contact-carrying member 42. Terminal-securing projections 54 extend upwardly from bottom channel surfaces 56 near front end 48. Relatively bottom surface 58 of contact-carrying member 42 is planar forwardly of conductor-positioning section 50, with securing projections 60 extending downwardly spaced across planar bottom surface 58 proximate front end 48; such a securing projection 60 is shown in Figure 3. Ground plane 62 is to be secured to bottom surface 58 by projections 60 as will be explained later.

In Figures 2 to 4, terminals 22 are stamped and formed, preferably of Copper Alloy 725. Each terminal 22 has, proceeding rearwardly from contact section 20, intermediate section 64, relatively upwardly angled section 66, and securing section 68, with conductor-connecting section 70 at the rearward end thereof. Securing section 68 and conductor-connecting section 70 of each terminal 22 is disposed in a respective channel 44. Securing section 68 has a hole 72 therein corresponding to securing projection 54 in channel 44 through which projection 54 extends. Projection 54 is cold-staked (or heat-staked, as desired) to enlarge the end of projection 54 over securing section 68 and thus secure terminal 22 to top surface 46 of contact-carrying member 42 by enlarged end 74. Thus angled section 66, intermediate section 64 and contact section 20 of each receptacle terminal 22 extend forwardly of front end 48 along the longitudinal axis of terminal 22 and channel 44 while conductor-connecting section 70 is disposed proximate and forwardly of conductor-positioning section 50 of contact-carrying member 42.

In Figures 2 to 4, ground plane 62 has an elongated planar section 76 from which tab sections 78 extend forwardly at a slight angle downwardly with short tab ends 80 extending

horizontally forwardly therefrom. Tab sections 78 are formed at preselected locations as will be explained later. Along the rearward end of ground plane 62 is a conductor-connecting section 84 preferably comprising a bent-back portion of the metal blank from which ground plane 62 is stamped and formed, the rearward end being a bight section 82. Proximate the forward end of ground plane 62 and thereacross are disposed a plurality of holes 86 corresponding to securing projections 60 on bottom surface 58 of contact-carrying member 42. Ground plane 62 is secured onto bottom surface 58 by securing projections 60 extending through holes 86 and their ends 88 being enlarged by cold-staking (or heat-staking, as desired) to deform them against the bottom of ground plane 62. Tab sections 78 extend forwardly of front end 48 of contact-carrying member 42 in subassembly 40. It is preferable to have apertures 142 which will be opposed from securing sections 68 of the plurality of terminals 22 after forming terminal subassembly 40; such apertures 142 assist in impedance matching by increasing the insulative distance between signal terminals and ground plane in the finished terminal assembly.

Connector assembly 200 can have ground contacts at any desired location in either row, and the ground locations in one row are independent of the ground as signal locations in the other row, thus providing for independently programmable grounds. Referring to Figures 2 and 5, tab sections 78 of ground plane 62 are integral therewith and positioned at those selected locations forwardly of which a ground is desired in the connector assembly 200. Preferably such positioning is accomplished by forming tab sections at all locations and striking off those not wanted for grounds. Rearwardly of those ground locations no signal conductor will be located which is intended to be used for signal transmission. In a ribbon cable, for example, although a signal conductor will be disposed at those ground locations it would not be used for signal transmission and, hence, is sacrificed. Where individual electrical cables are used

such as in the example shown, no cable is located at such ground locations. However, a terminal 22 will be located at such ground locations secured to top surface 46 of contact-carrying member 42 and its intermediate section 64 welded to a tab end 80, as shown in Figure 5. Tab end 80 preferably has a semicircular recess 90 to enhance the strength of the weld 92. Thus such terminal 22 will provide the ground contact section to electrically connect ground plane 62 to respective ground pins of the pin array. In Figure 4, terminal 22 is not welded nor in engagement with ground plane 62 at tab section 78 or tab 80 but is laterally spaced therefrom.

Cables 150 as shown herein are tri-lead transmission cables having a signal conductor 152, two ground conductors 154 spaced laterally therefrom, and outer insulative jacket 156 having a rectangular cross section. Other types of transmission cable are usable with the present invention, such as round individual cables, coaxial cables having one ground conductor, tri-lead cables having an inner jacket around the signal conductor and a foil shield within the outer jacket and around the ground and insulated signal conductors, and also ribbon cable having a plurality of signal and associated ground conductors. Cables 150 are prepared for termination by removing the insulative outer jacket 156 from end portions thereof, exposing the signal and ground conductors.

As seen in Figures 4 and 6B, cables 150 are disposed in the plane of contact-carrying member 42, and signal conductors 152 are diverted relatively upward and ground conductors 154 relatively downward. Signal conductors 152 are disposed along respective signal channels 94 of conductor-positioning section 50 and forwardly proximate upper surface 46 of contact-carrying member 42 to and along respective conductor-connecting sections 70 of signal terminals 22 for termination thereto. Signal channels 94 have an upwardly sloping bottom surface 96 proceeding forwardly from rearward end 52. Lead-in 98 has

chamfered corners to facilitate placement of a respective signal conductor 152 into and along channel 94.

Conductor-connecting section 70 of each signal terminal 22 preferably includes a narrow conductor-receiving slot 100 as seen in Figure 6A. Slot 100 preferably is narrower than the diameter of signal conductor 152 such that signal conductor 152 may be press fit thereinto and held in interference fit thereby prior to laser welding of the conductors to the terminal. Slot 100 is preferably formed by opposing spaced end surfaces 102 of stamped tabs extending laterally from sides of the terminal blank whose free ends are bent around toward each other proximate the top surface of the blank during forming of the terminal. A length of signal conductor 152 is then held in interference fit proximate the top of slot 100 by slight spring action by and between end surfaces 102 and is then welded to conductor-connecting section 70 by weld 104, as seen in Figure 6B. The top edges of slot 100 preferably are smoothed to facilitate receipt of the conductor thereinto, and a tapered lead-in 106 to slot 100 is also preferred.

Similarly and preferably simultaneously the pair of ground conductors 154 are diverted relatively downward and forwardly along a pair of respective ground channel portions 108 extending forwardly from rearward end 52 of contact-carrying member 42, as shown in Figure 7. Each pair of ground channel portions 108 converge into a single wider main ground channel 110 in conductor-positioning section 50 along bottom surface 58. Each pair of now-adjacent ground conductors 154 is disposed side by side forwardly along main ground channel 110 to and along a respective portion of conductor-connecting section 84 of ground plane 62 for termination thereto. Conductor-connecting section 84 of ground plane 62 preferably comprises a plurality of slots 112 which are in communication with respective openings 114 in rearward bight section 82 which neck down as they merge with slots 112. The width of each slot 112 is preferably narrower than twice the diameter of a ground conductor 154 such that the

pair of ground conductors 154 may be press fit thereinto and held in interference fit thereby prior to laser welding of the pair of ground conductors to the ground plane. It is preferred to have formed a dimple-like projection 116 extending from planar section 76 of ground plane 62 towards and to each slot 112 centrally thereof to facilitate precisely locating the pair of adjacent ground conductors 154 within the slot adjacent the outer surface of conductor-connecting section 84 for welding to ground plane 62 by weld 118. It is preferable that the top edges of slots 112 are smoothed to facilitate receipt of the pairs of conductors thereinto. Placement of two ground conductors in a single slot 112 halves the number of such slots needed, and the number of separate weld joints to be made.

The signal conductors and ground conductors are preferably laser welded to the respective conductor-receiving sections of the terminals and ground plane. Laser welding is generally known and is discussed extensively in Materials Processing Theory and Practices, Volume 3: Laser Materials Processing, (edited by M. Bass, North-Holland Publishing Company, 1983) especially Chapter 3, "Laser Welding," J. Mazumder, pp. 113-200. In particular, laser welding in electronics is described in Electronics, September 22, 1981 in an article by Henderson on pages 149-154 entitled "Dual Lasers Speed Termination of Flexible Printed Wiring."

Referring now to Figure 8, terminal subassembly 40 is placed in a mold cavity with contact sections 20 and cables 150 extending outwardly therefrom. Moldable dielectric material is injected into the mold cavity and dielectric cover means 30 is molded over contact-carrying member 42. Cover means 30 sealingly secures and protects end portions of cables 150, signal conductors 152 and their terminations to conductor-connecting sections 70 of terminals 22 at welds 104, ground conductors 154 and their terminations to conductor-connecting section 84 of ground plane 62. Cover means 30 also sealingly secures and protects the entirety of ground plane 62 and welds 92 of tab

ends 80 with those terminals 22 selected to be grounds, and the entirety of terminals 22 beginning just rearwardly from contact sections 20 centrally of intermediate sections 64. By sealing and embedding end portions of the transmission cables 150, cover means 30 supports them and provides strain relief therefor. Also formed during the overmolding process are downwardly extending projections 34 and corresponding slots 36, and lateral latching projections 14. It may optionally be desirable to form transverse bars for second cable strain relief as shown in Figure 13, joined by web sections to cover means 30, or as in the aforesaid European Patent Application No. 83306740.8. It is preferred to form a downwardly tapered surface 120 on cover means 30 proximate forward end 16 of terminal assembly 12 extending laterally thereacross.

Figures 9 to 11B demonstrate the final steps in assembling connector assembly 200. A pair of terminal assemblies 12 are secured together by projections 34 of each assembly 12 extending through corresponding slots 36 of the other assembly and their free ends 38 being enlarged such as by cold-staking. The pair of assemblies 12 is moved forwardly into housing member 10, with contact sections 20 of terminals 22 entering corresponding terminal-receiving passageways 24 wherein the contact sections are individually secured such as by locking lances 26 each extending rearwardly to engage a forwardly facing stop surface 28 on a corresponding wall of the respective passageway 24. Forward end 112 of each contact section 20 is engageable with rearwardly facing stop surfaces 124 proximate forward end 126 of passageway 24 which communicates with mating face 128 of housing member 10. Tapered surface 130 of lateral latch 14 facilitates riding over corresponding housing latch arm 18 having beveled surface 132 and urging it outwardly. Latching surface 134 of lateral latch 14 latches behind corresponding latching surface 136 of latch arm 18. Cavities 138 extending rearwardly from mating surface 128 of housing 10, facilitate molding of latching surface 136. Tapered surfaces 120 on the upper and

lower surfaces of the secured pair of assemblies 12 engages corresponding tapered housing surfaces 140 to facilitate insertion and provide a slight interference fit of assemblies 12 in housing member 10. The pair of terminal assemblies 12 could be removed, if desired, from housing 10 by unlatching all locking lances 26, and by unlatching latch arms 18, and pulling assemblies 12 rearwardly.

It is possible to provide a connector having more than two rows of contacts with independently programmable grounds, by stacking together a like plurality of single-row terminal assemblies with contact sections extending forwardly into a forward housing member to be mated with mating terminals. It is also possible to provide a plug connector where the forward housing number is a shroud and the contact sections are plug sections or are pin contact sections. Further, it is possible to stack together a plurality of connectors of the present invention to mate with more than two rows of a pin array, because of the low profile of the present connector, by not providing a keying feature 32 thereon.

Figure 12 illustrates the components comprising the terminal subassembly 210 of another embodiment of the present invention, including a premolded dielectric forward housing 212, receptacle signal terminals 214, receptacle ground terminals 216, and transmission cables 218 with a signal 214 and an opposing ground 216 terminal associated with each cable 218. Figure 13 shows the completed connector assembly 300 of the present invention after dielectric moldable material is overmolded into an insulative, sealing cover means 220 over the terminal subassembly 210 of Figure 12 after the terminals 214, 216 have been secured in passageways 222 of housing 212 and respective conductors of cables 218 terminated to terminals 214, 216. Housing 212 may have a keying feature 268 for proper mating with a pin shroud (not shown) on the printed circuit board surrounding the pin array to which connector assembly 300 is to be mated.

In Figures 12 and 14, receptacle terminals 214, 216 are stamped and formed preferably of Copper Alloy 725 and have identical box-type contact sections 224, identical planar body sections 226 and similar conductor-connecting sections 228, 230 respectively. Contact sections 224 are received in terminal-receiving passageways 222 of housing 212 which communicate with and extend rearwardly from mating face 232 thereof. Planar body sections 226 are disposed along bottom surfaces 234 of channels 236 in contact-carrying portion 238, which is integral with housing 212 and extends rearwardly from contact-receiving portion 240 thereof. Bottom channel surfaces 234 each extend continuously rearwardly from inside wall 242 of a respective passageway 222, best seen in Figure 14.

Receptacle terminals 214, 216 are secured in respective passageways 222 by means of locking lances 244 on contact sections 224 which extend rearwardly and outwardly therefrom at a selected angular location. Upon full insertion of a terminal 214, 216 its locking lance 244 engages a forwardly facing stop surface 246 along a respective selected passageway sidewall 248, as shown best in Figures 18 and 19, to prevent axially rearward movement of terminal 214, 216. Forward end 250 of terminal 214, 216 engages rearwardly facing stop surfaces 252 of passageway 222 proximate its forward end 254 to prevent further axially forward movement of terminal 214, 216. Forward passageway end 254 is beveled to provide a lead-in for insertion of a respective square pin (not shown) of a pin array such as on a printed circuit board, which pin is electrically matable with a respective receptacle signal terminal 214 or ground terminal 216. A recess 256 is molded along selected passageway sidewall 248 forward of stop surface 246 both to facilitate molding of stop surface 246 and to receive a tool to unlatch locking lance 244 of a terminal 214, 216 should it be desirable to remove the terminal during assembly. At the rearward end of each passageway 222 is a rear recess 258 for receiving a mold core pin, discussed later.

Signal terminals 214 and ground terminals 216 are alternated along each row during insertion of the terminals in passageways 222 of housing 212, with a signal terminal 214 of one row opposing a ground terminal 216 of the other row. Each pair of signal terminals 214 and ground terminals 216 is associated with each transmission cable 218. Each cable 218 has a signal conductor 260 and two ground conductors 262, one on each side of the signal conductor and spaced therefrom, with an insulative outer jacket 264 therearound having a rectangular cross-section. Each cable 218 is prepared for termination by its outer jacket 264 being stripped from an end portion to expose the signal 260 and ground 262 conductors.

The terminal subassembly 210 is formed as shown in Figures 15 to 17. In Figure 15 a signal terminal 214 has been secured in the upper passageway 222A to receive a signal conductor 260 of a cable 218 in conductor-connecting section 228 thereof, and a ground terminal 216 in the lower passageway 222B to receive both the ground conductors 262 of cable 218 in conductor-connecting section 230 thereof. The signal conductor 260 is diverted relatively upward from a medial plane extending through contact-carrying portion 238 of housing 212 and cable 218, along a tapered surface 266 at the rearward end of a respective upper channel 236A and forwardly into a narrow slot 270 in conductor-connecting section 228 of signal terminal 214, as shown in Figures 16 and 20. Slot 270 preferably is narrower than the diameter of signal conductor 260 such that signal conductor 260 may be press fit thereinto and held in interference fit thereby prior to laser welding of the conductor to the terminal. Slot 270 is preferably formed by opposing spaced end surfaces 272 of stamped tabs extending laterally from sides of the terminal blank, whose free ends are bent around toward each other proximate the top surface of the blank during forming of the terminal. A length of the signal conductor is then held in interference fit proximate the top of slot 270 by slight spring action by and between opposing end surfaces 272, after being

disposed along slot 270, and then is welded to conductor connecting section 228 by weld 274, as seen in Figures 20 and 21 regarding cable 218A. The top edges of slot 270 preferably are smoothed to facilitate receipt of the conductor thereinto, and a tapered lead-in 276 to slot 270 is also preferred.

Similarly and preferably simultaneously the pair of ground conductors 262 are diverted relatively downward from the medial plane and along a tapered surface 278 at a rearward end of lower channel 236B opposed from upper channel 236A. The pair of ground conductors 262 are brought together (best seen in Figures 19 to 21 regarding cable 218B) to extend forwardly and together are disposed along slot 280 of conductor-connecting section 230 of ground terminal 216. Slot 280 is dimensioned to be narrower than twice the diameter of a ground conductor, such that the pair of ground conductors 262 may be held in interference fit proximate the top of slot 280 by slight spring action by and between opposing spaced end surfaces 282 forming slot 280, as shown in Figures 16 and 20 and preferably laser welded to conductor-connecting section 230 by weld 284.

Terminal subassembly 210 as shown in Figure 16 is then placed in a mold 400, shown in phantom in Figure 17, for the overmolding of cover means 220 therearound to form the electrical connector assembly 300. Mold 400 has core pins 402 at the relatively forward end of the mold cavity, and core pins 404 located near the rearward end of the main cavity portion 406. Forward core pins 402 enter rear recesses 258 in the upper and lower walls of housing 212 and engage planar body sections 226 of terminals 214, 216, holding them against bottom channel surfaces 234 during the overmolding process. Forward core pins 402 extend fully between the sides of recesses 258 and act to prevent insulative material from entering the receptacle contact sections 224 of terminals 214, 216. Rearward core pins 404 engage cables 218 from above and below, holding them in position during the overmolding process.

In Figure 17, the major portion of contact-carrying portion 238 of housing 212 is disposed in main cavity portion 406, and also conductor-connecting sections 228, 230 of terminals 214, 216 and the terminations of conductors 260, 262 thereto, and insulated end portions of cables 218.

Insulative material such as preferably polypropylene is injected into the mold cavity and molded around the termination section of terminal subassembly 210, forming dielectric cover means 220 thereover rearwardly from contact-receiving portion 240 of housing 212. Cover means 220 seals the terminations of the conductors to the terminals, especially welds 274 and 284. Cover means 220 also firmly embeds the terminals and thereby prevents movement of the terminals in connector assembly 300. Cover means 220 also extends rearwardly along insulated portions of cables 218 providing strain relief therefor without deforming the cables such as occurs in conventional strain relief methods when the cables are clamped tightly or are bent around axially normal projections of housing members.

When individual cables are used, a second strain relief preferably is provided by a transverse bar 286 spaced rearwardly along the cables 218 from cover means 220 and joined integrally thereto by by axially extending webs 288, seen best in Figures 13 and 21. Webs 288 are located at ends of the row of cables 218 and preferably between at least several of the cables near the row ends and are formed by axial cavity portions (not shown), and transverse bar 286 is formed by rear cavity portion 408. Cables 218 interior of the end ones adjacent webs 288 are disposed in mold channels 410 which serve to maintain alignment thereof. Second strain relief bar 286 serves as a gripping feature during mating and unmating of connector assembly 300 to and from a pin array, thus relieving strain on the individual cables 218.

Figures 18 through 21 illustrate a top section view showing the assembly of connector assembly 300. In Figure 18 a signal 214 and ground 216 terminal are inserted into respective adjacent

passageways 222 and channels 236 of housing 212. In Figure 19, signal terminal 214 is secured in passageway 222 by locking lance 244 against stop surface 246 and is about to receive a signal conductor 260 of end cable 218A; portions of ground conductors 262 are visible behind signal conductor 260. Ground terminal 216 is similarly secured in passageway 222 to receive a pair of ground conductors 262 of second cable 218B. In Figure 20 signal conductor 260 of cable 218A is disposed in slot 270 and is welded at weld 274 to conductor-connecting section 228 of signal terminal 214; and ground conductors 262 of cable 218B are disposed in slot 280 and are welded at weld 284 to conductor-connecting section 230 of ground terminal 216 to form terminal subassembly 210.

In Figure 21, terminal subassembly 210 has been overmolded with cover means 220 rearwardly from contact-receiving portion 240 of housing 212 to form connector assembly 300. Cover means 220 seals the terminations and end portions of cables 218A, 218B. Cover means 220 is also joined to transverse bar 286 by webs 288 extending along cables 218A, 218B. A portion of planar body section 226 of another signal terminal 214 is visible in the aperture formed by a core pin 402 of mold 400 rearwardly from rear recess 258 of housing 212; and a portion of a third cable 218 is visible in the aperture formed by a core pin 404 near the rearward end of cover means 220.

A connector assembly of the present invention may also be terminated to the other ends of the cables to form a wire harness. The connector assembly can be terminated to a variety of transmission cables including round individual cables, flat ribbon cable having a plurality of signal conductors and associated ground conductors, coaxial cables, and cables having only one ground conductor for each signal in which case the ground terminals usable therewith should have slots formed to receive a single ground conductor. The present invention is also useful with tri-lead cables having an inner jacket around

the signal conductor and a foil shield within the outer jacket and around the ground and insulated signal conductors.

A variety of features may be molded into or onto the outer surfaces of the cover means. Receptacle contact sections may have a different structure from that shown. Without departing from the spirit of the present invention or the scope of the claims, other variations may be devised in light of the teachings hereof.

CLAIMS

1. An electrical connector (200,300) for signal conductor means (152,260) and ground conductor means (154,262) of electrical cable means (150,218) for use in transmitting electrical signals with high reliability and uniformity, and having a housing member (10,212) having rows of passageways (24,222) therein to receive respective terminals (22,214,216) securably therein, said terminals (22,214,216) being terminated to either the signal conductor means (152,260) or the ground conductor means (154,262), and dielectric cover means (30,220) protecting the terminations, characterized in that:

said terminals (22,214,216) are secured to a side of a contact-carrying means (42,238) and then terminated respectively to either said signal conductor means (152,260) or said ground conductor means (154,262);

contact sections (20,224) are secured in respective said passageways (24,222); and

said cover means (30,220) covers said terminations, said contact-carrying means (42,238) and end lengths of said cable means (150,218) sealing said terminations and providing nondeforming strain relief to said cable means (150,218).

2. An electrical connector (200,300) as set forth in claim 1, further characterized in that said contact-carrying means (42) comprises two separate members (42), one row of terminals (22) are secured to one side (46) of each said member (42), a ground plane (62) is secured to the other side (58) thereof and electrically connected to selected ones of said terminals (22) which become ground terminals, said signal conductor means (152) are terminated to signal ones of said terminals (22) which become signal terminals, said ground conductor means (154) are terminated to said ground plane (62), and contact sections (20) extend forwardly of each said contact-carrying member (42) forming separate terminal subassemblies (40);

dielectric material is sealingly secured over the signal and ground terminations and around terminals (22) and ground plane

(62) of each terminal subassembly (40), rearwardly from contact sections (20), and around end portions of said cable means (150), forming terminal assemblies (12) each having one row of terminals (22) having respective contact sections (20) extending forwardly thereof;

said termnal assemblies (12) are securable to said housing member (10) with said contact sections (20) secured in respective said passageways (24), forming said connector (200).

3. An electrical connector (200) as set forth in claim 2 further characterized in that pairs of said terminal assemblies (12) are first securable together by securing means comprising at least one projection (34) extending from a side surface of said cover means (30) of at least one said terminal assembly (12) toward the other thereof and received into and through a respective slot (36) in said other terminal assembly (12) and extending to a remote side thereof, whereafter the end (38) of said at least one projection (34) is deformably enlarged against the surface of said remote side of said other terminal assembly (12).

4. An electrical connector (200) as set forth in either of claims 2 or 3 further characterized in that said plurality of terminal assemblies (12) are securable to said housing member (10) by latching projections (14) extending laterally from said terminal assemblies (12) being latchingly engaged by corresponding latching arms (18) of said housing member (10).

5. An electrical connector (200) as set forth in any of claims 2 to 4 further characterized in that each said ground plane (62) has tab sections (78) extending forwardly thereof and towards corresponding ground ones of said terminals (22) and to intermediate sections (64) thereof whereto tab ends (80) of tab sections (78) are welded respectively.

6. An electrical connector (200,300) as set forth in claim 1 further characterized in that said contact-carrying means (42,238) comprises a contact-carrying portion (238) of said housing member (212) extending rearwardly therefrom medially

between adjacent rows of said passageways (222), a row of terminals (214,216) is disposed against one of the upper and lower surfaces of said contact-carrying portion (238) such that contact sections (224) thereof are secured in respective said passageways (222) and conductor-connecting sections (228,230) thereof are disposed proximate the rearward end of said contact-carrying portion (238), and said terminals (214,216) are arranged in opposing pairs, said signal conductor means (260) are terminated to respective signal ones (214) of said terminals and said ground conductor means (262) are terminated to ground ones (216) of said terminals forming a terminal subassembly (210) upon which is sealingly secured said cover means (220).

7. An electrical connector (300) as set forth in claim 6 further characterized in that said ground ones (216) of said terminals each receive a pair of said ground conductors (262) of said cable means (218) force fit along a slot (280) thereof for termination.

8. An electrical connector (300) as set forth in either of claims 6 or 7 further characterized in that where said cable means (218) comprises a plurality of cables (218), said cover means (220) includes joined thereto by web sections (288) a transverse bar (286) spaced rearwardly from the main portion of said cover means (220) and molded around the cable means (218) spacing, supporting and providing strain relief to said cable means (218).

9. A method of making the electrical connector (200) of claims 1 through 5 comprising the steps of:

selecting signal locations and ground locations in each row;

securing a ground plane (62) to one side (58) of each contact-carrying means (42) with tab sections (80) extending forwardly thereof at said ground locations;

securing a plurality of terminals (22) to the other side (46) of said contact-carrying means (42);

electrically connecting said tab sections (80) to ground ones of said terminals (22);

terminating ground conductor means (154) of cable means (150) to said ground plane (62) and signal conductor means (152) of said cable means (150) to respective signal ones of said terminals (22) forming respective terminal subassemblies (40);

securing a dielectric cover means (30) over the terminations and end portions of said cable means (150) of each terminal subassembly (40) forming single-row terminal assemblies (12); and

securing together said single-row terminal assemblies (12) forming an electrical connector (300) having at least two rows of terminals (22).

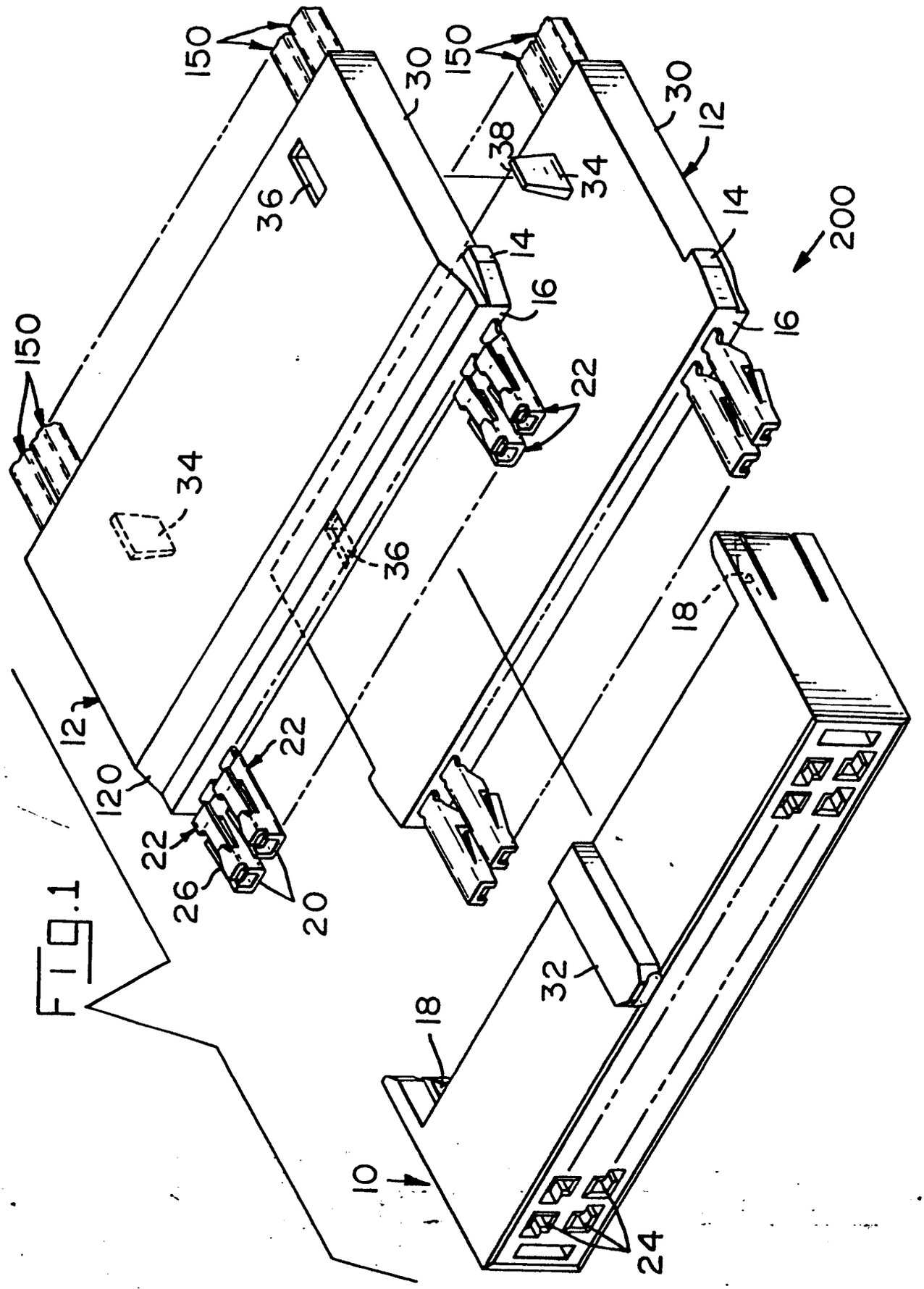
10. A method of making the electrical connector (300) of claims 1 and 6 through 8 comprising the steps of:

securing a plurality of terminals (214),216) to respective sides of a rearwardly extending contact-carrying portion (238) of a housing member (212) with contact sections (224) of said terminals (214,216) disposed in respective passageways (222) of said housing member forwardly of said sides of said contact-carrying portion (238);

terminating signal conductor means (260) of cable means (218) to respective signal ones (214) of said terminals and ground conductor means (262) thereof to ground ones (216) of said terminals forming a terminal subassembly (210);

placing said terminal subassembly (210) into a mold (400) having first core pins (402) associated with each said terminal (214,216), and closing said mold (400) such that said first core pins (402) extend to said terminals (214,216) and hold them against said sides of said contact-carrying portion and close off rearward ends of said passageways (222); and

molding a cover means (220) over said terminal subassembly (210) rearwardly of said passageways (222) sealing the terminations and extending along end portions of said cable means (218) forming a nondeforming strain relief.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12
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34
36
14
200
16
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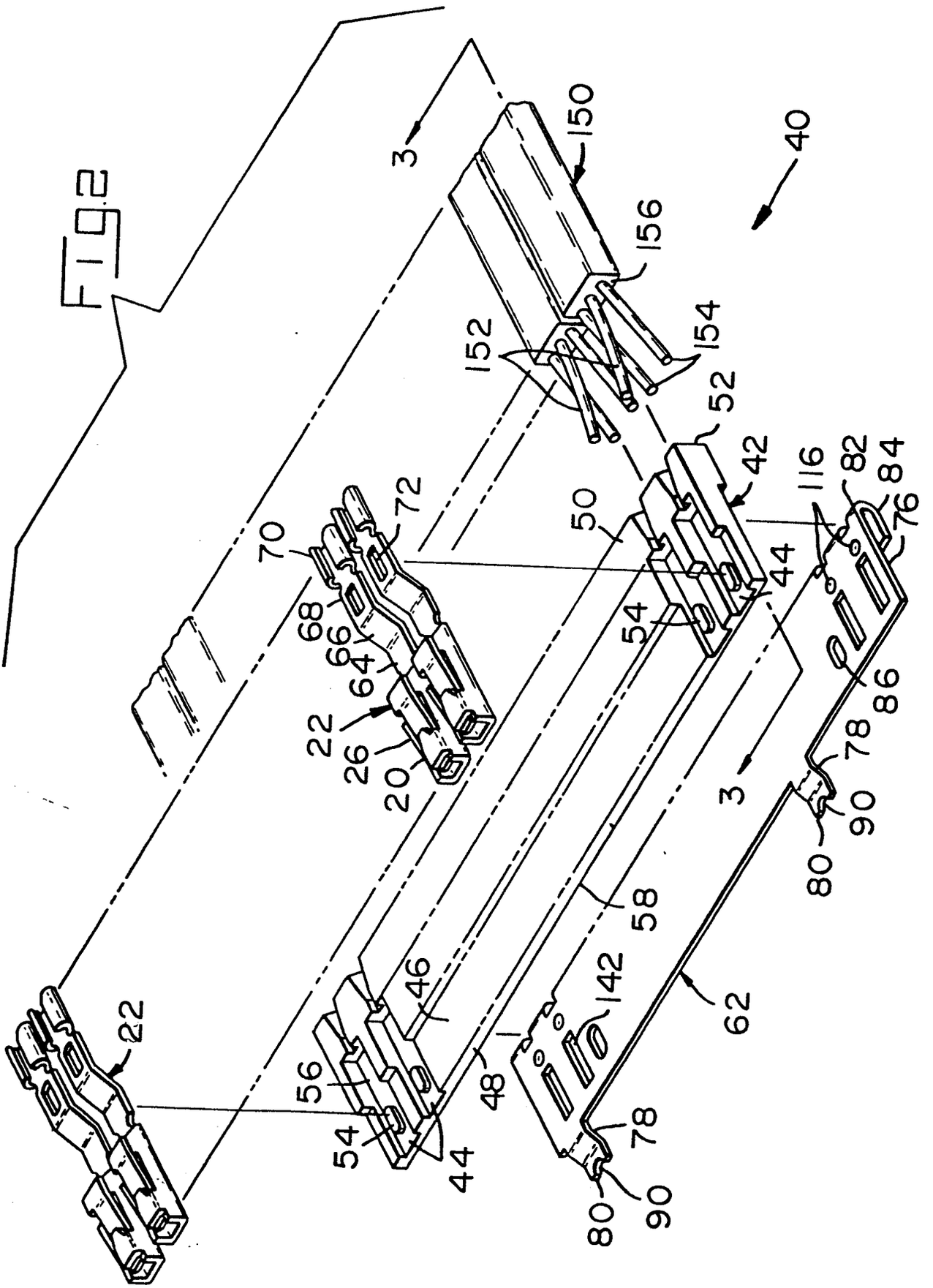
26
20
32
18
10
24

FIG.1

FIG 2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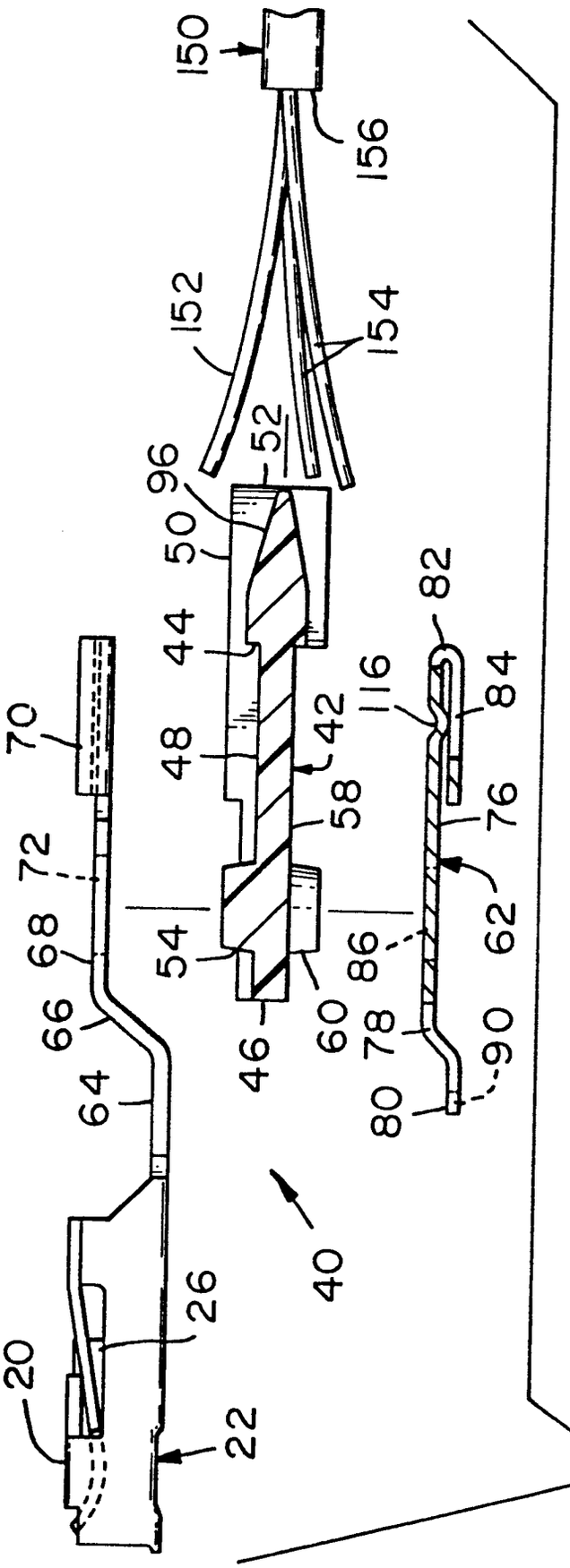
80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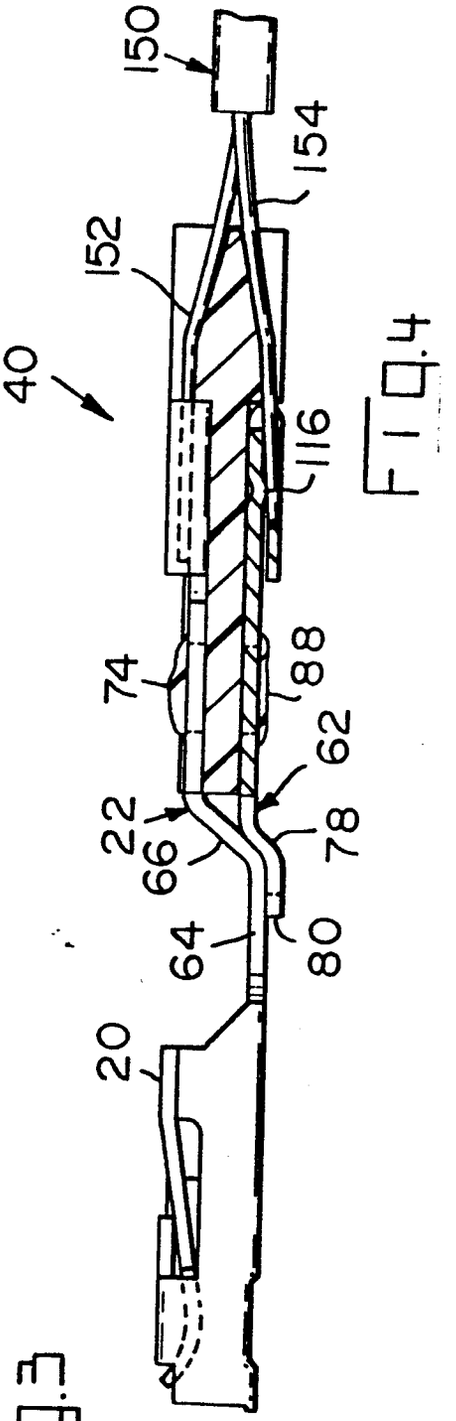
90

FIG. 3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80
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FIG. 4

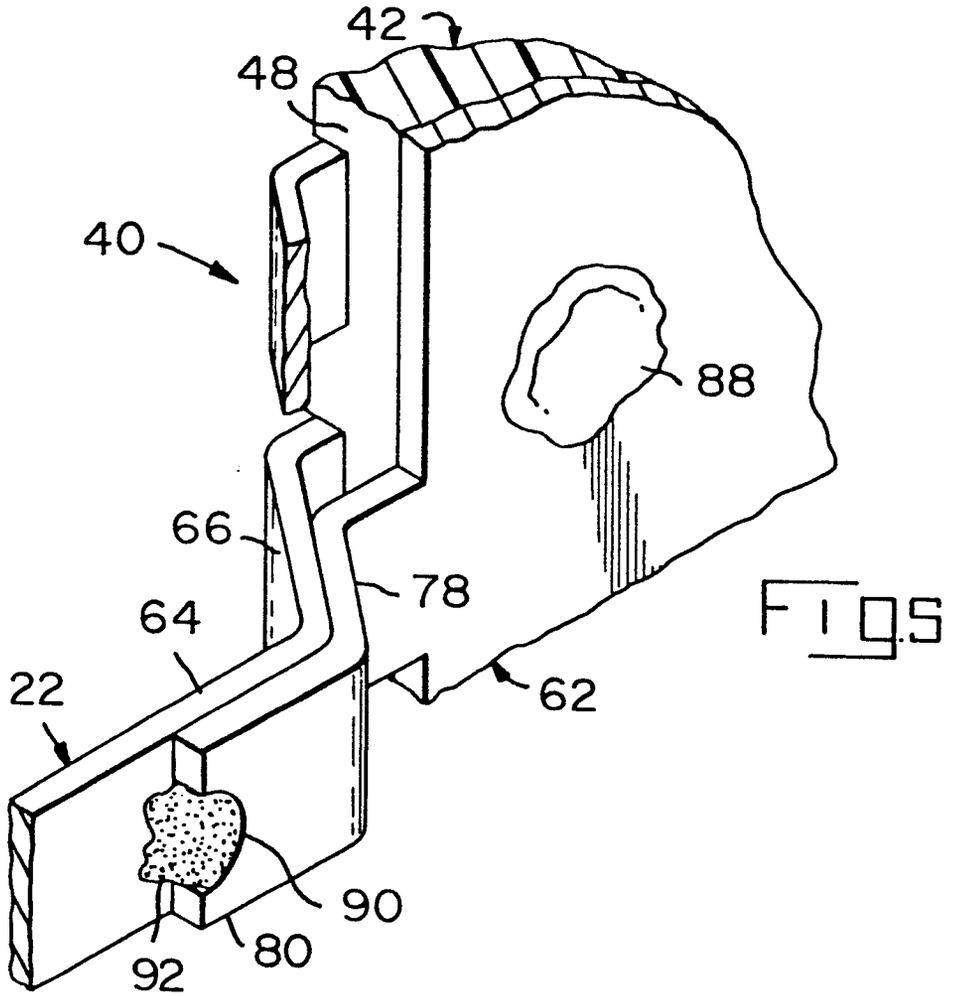
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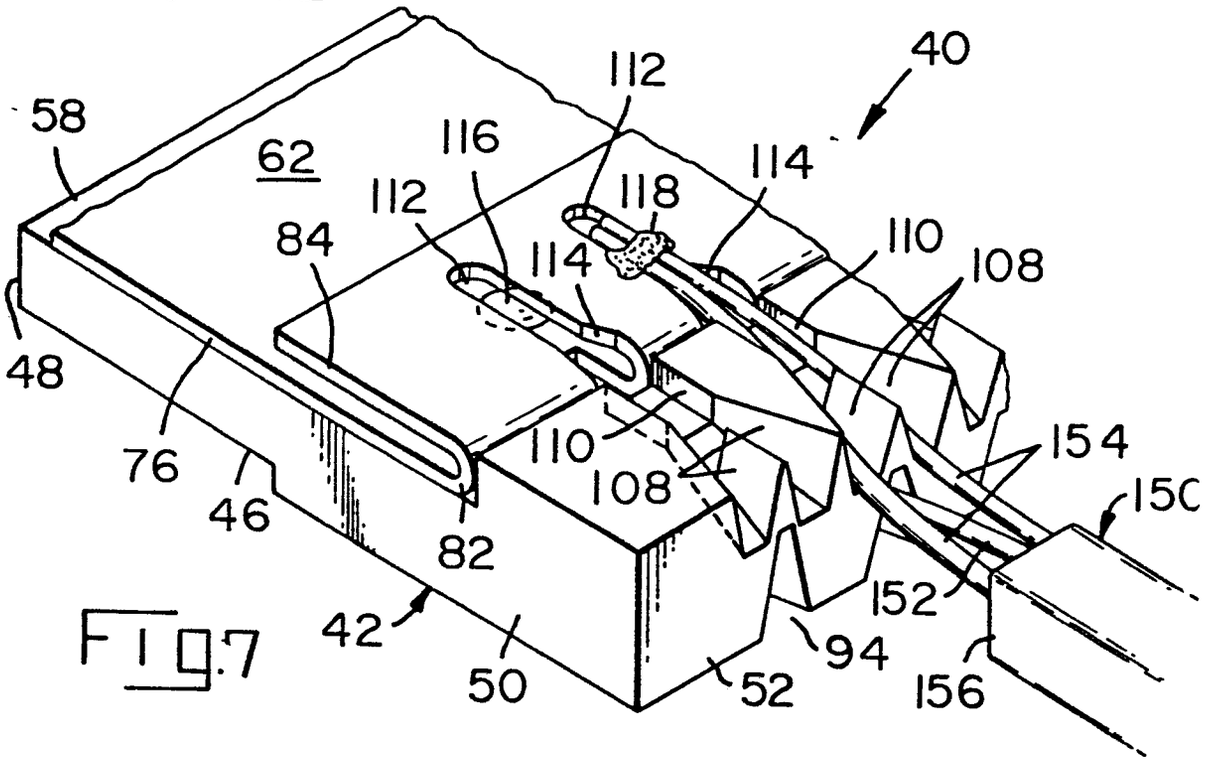
Fig.5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42
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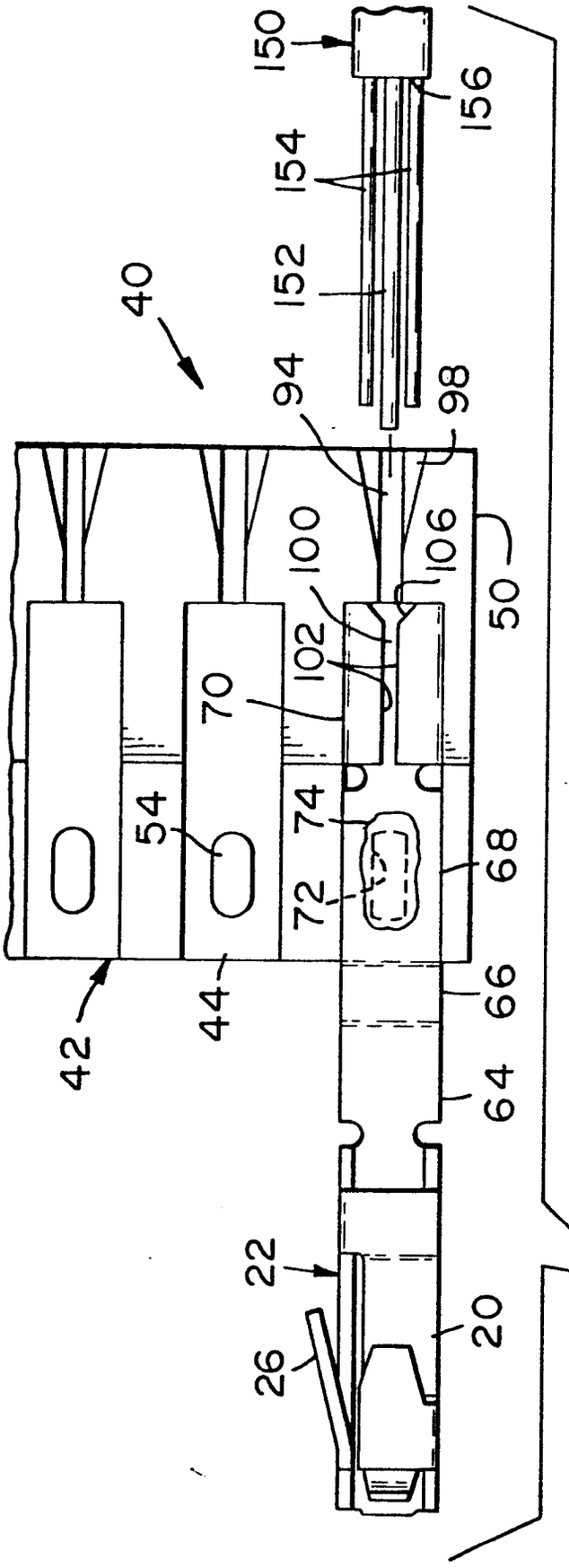
50
52
156

Fig.7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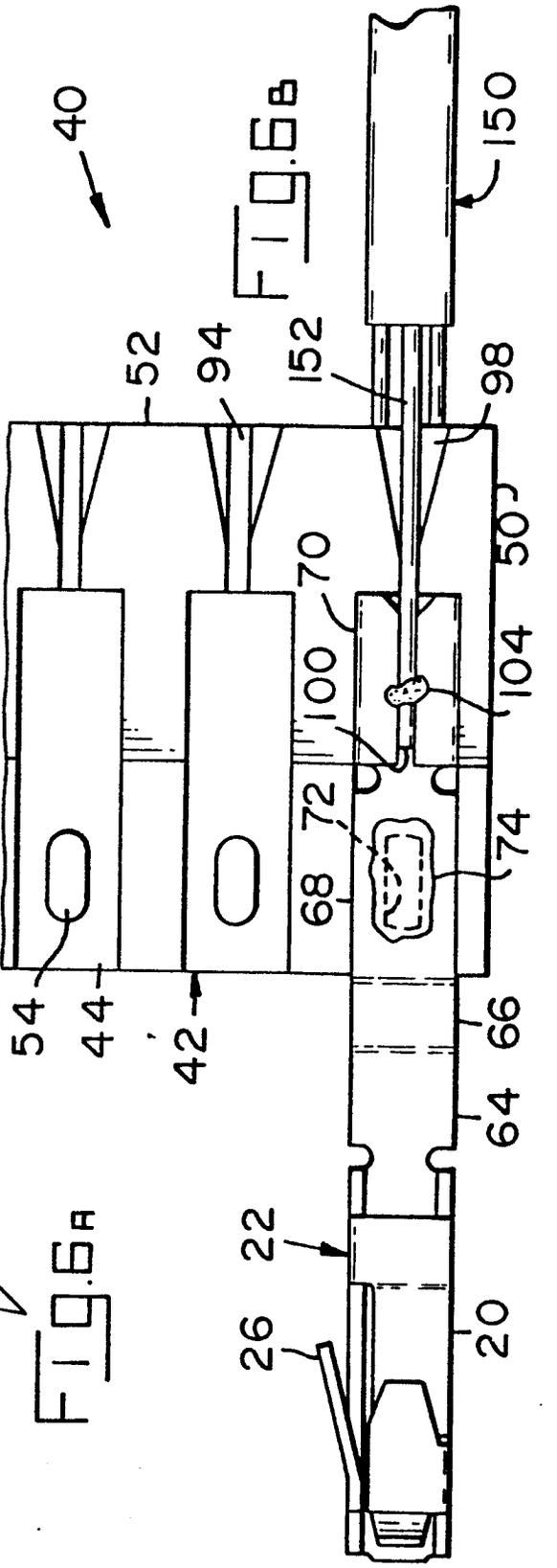
26
20

FIG.6A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20

FIG.6B

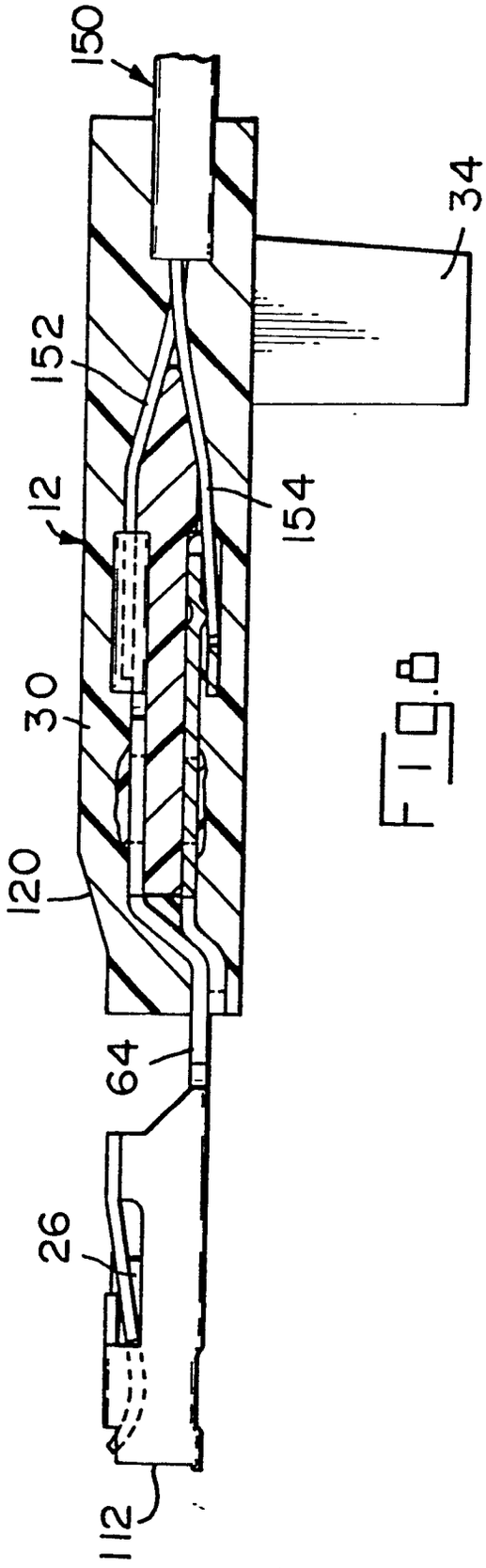


FIG.8

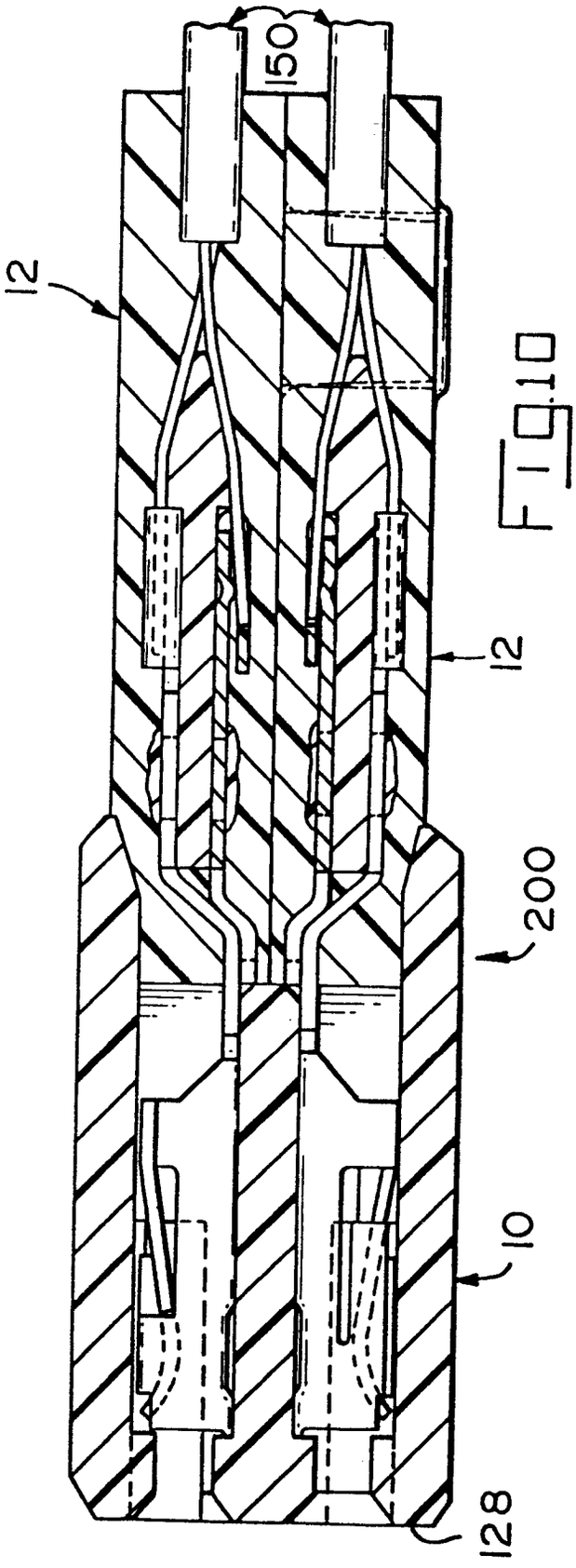
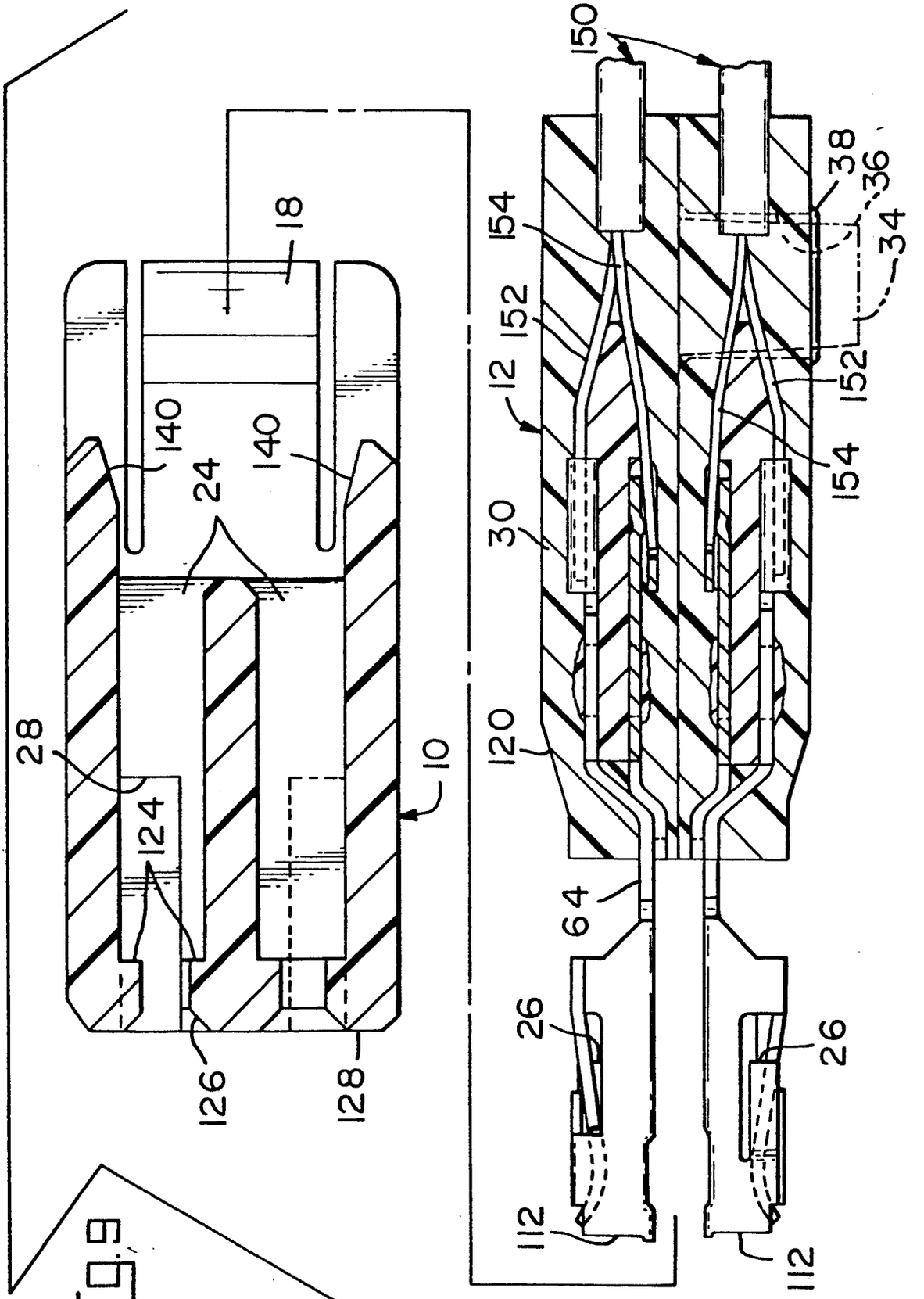


FIG.10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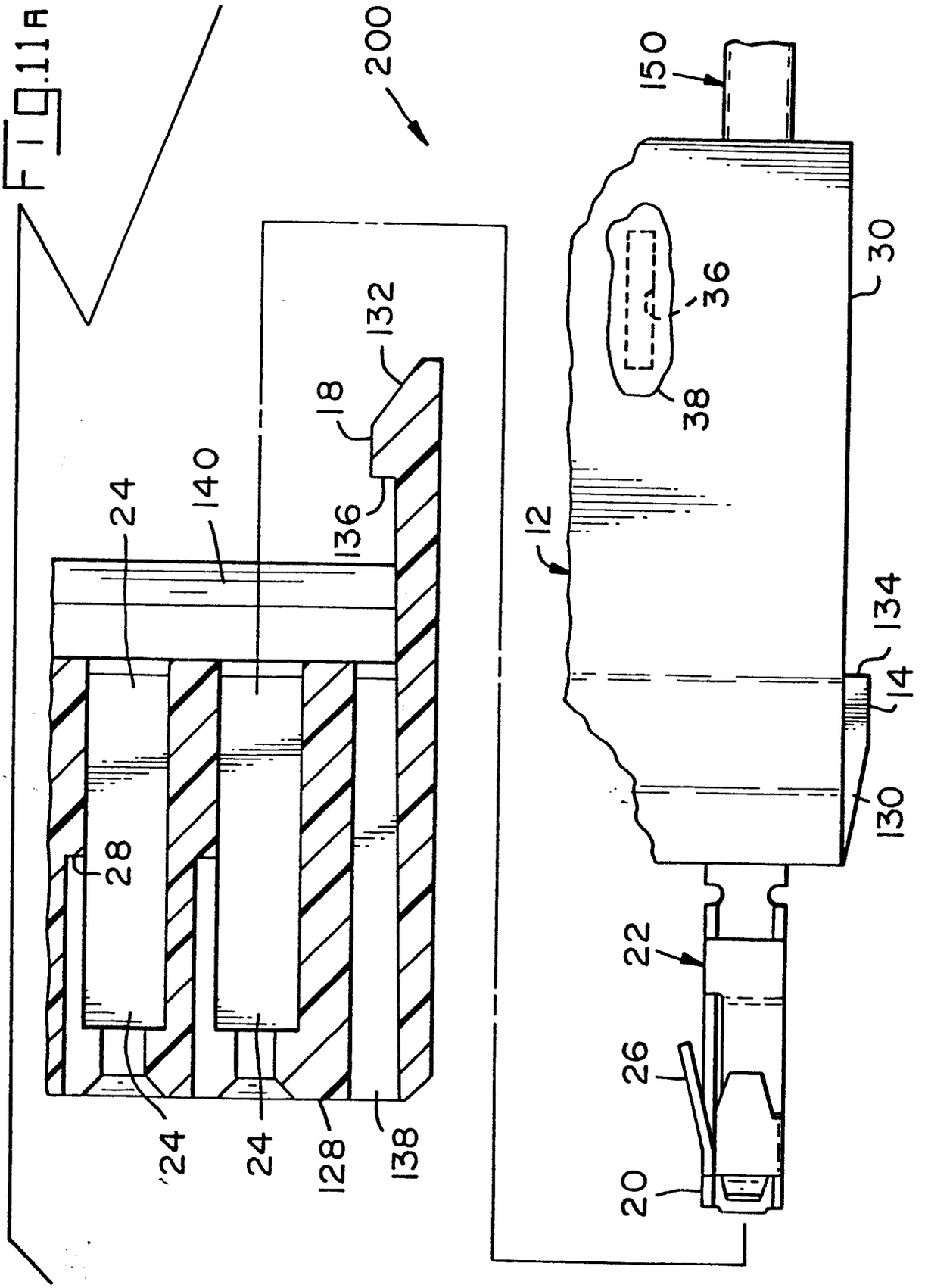
112

FIG. 9

FIG.11A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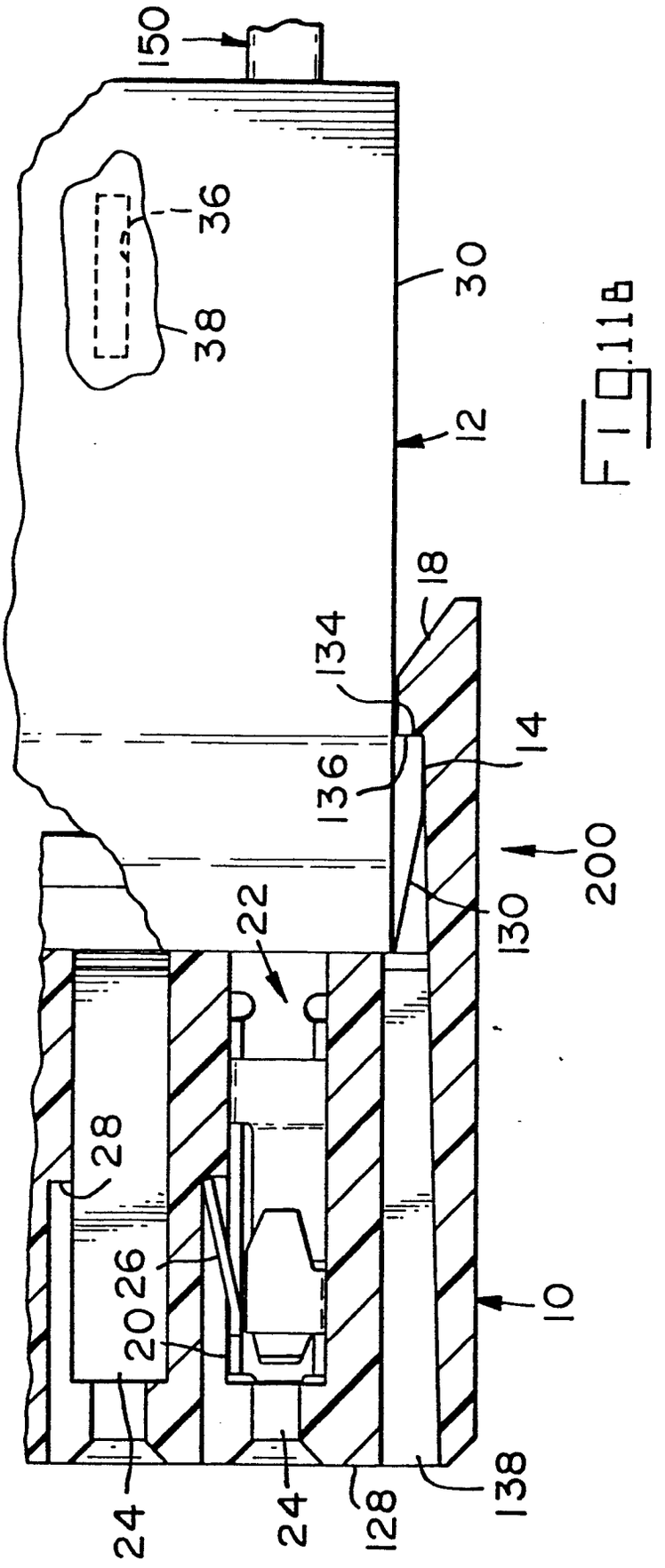

FIG.11B

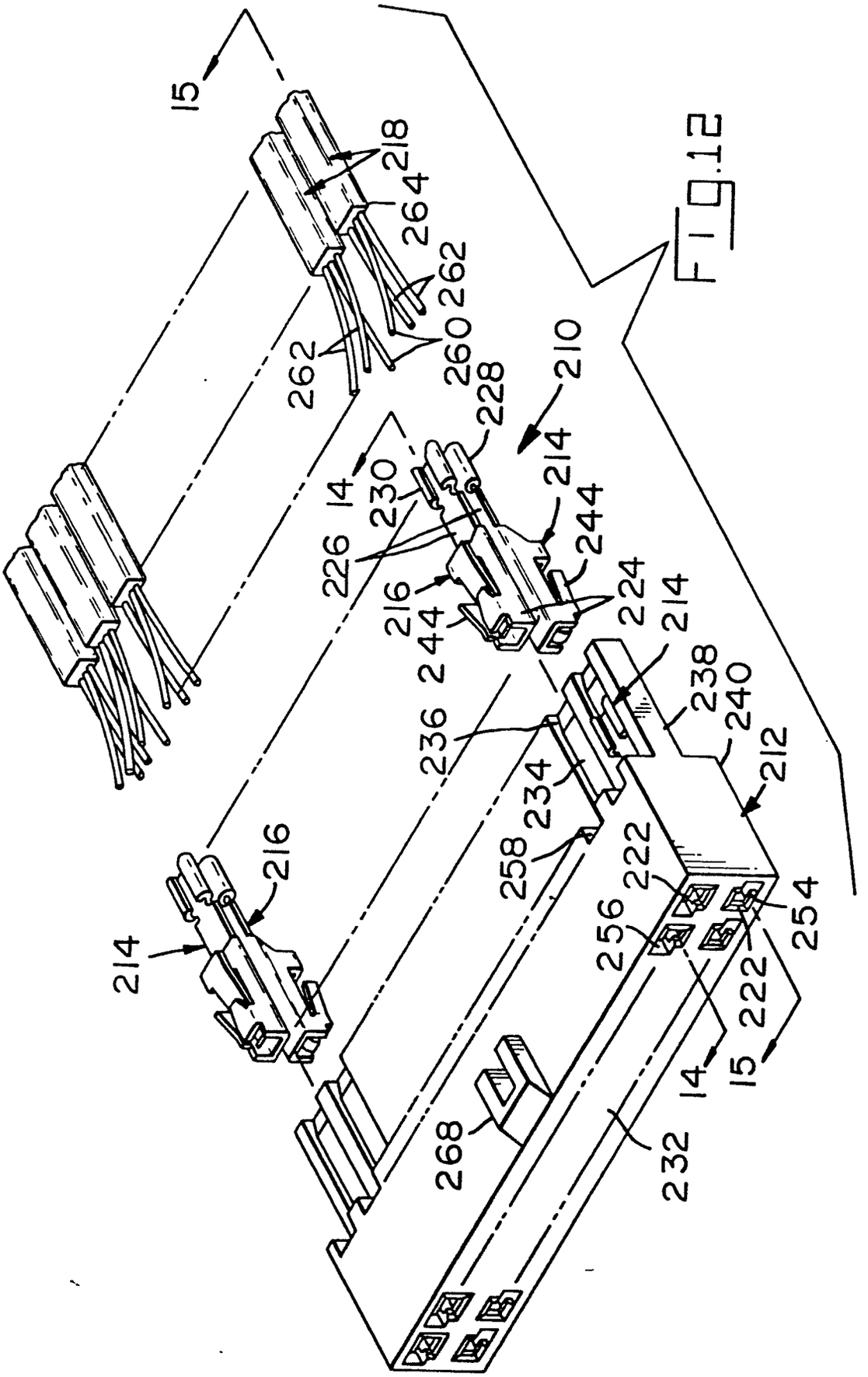
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FIG.12

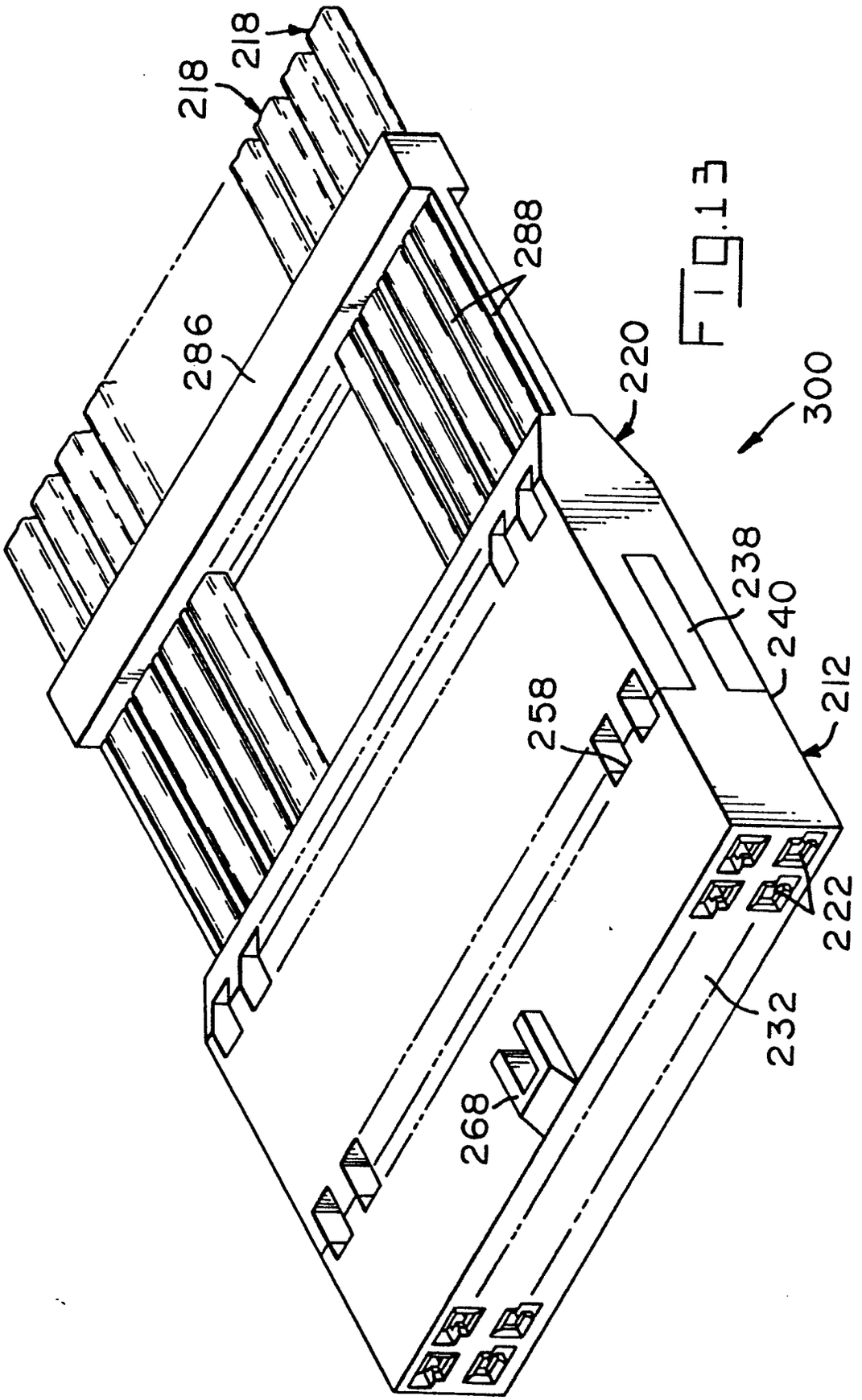
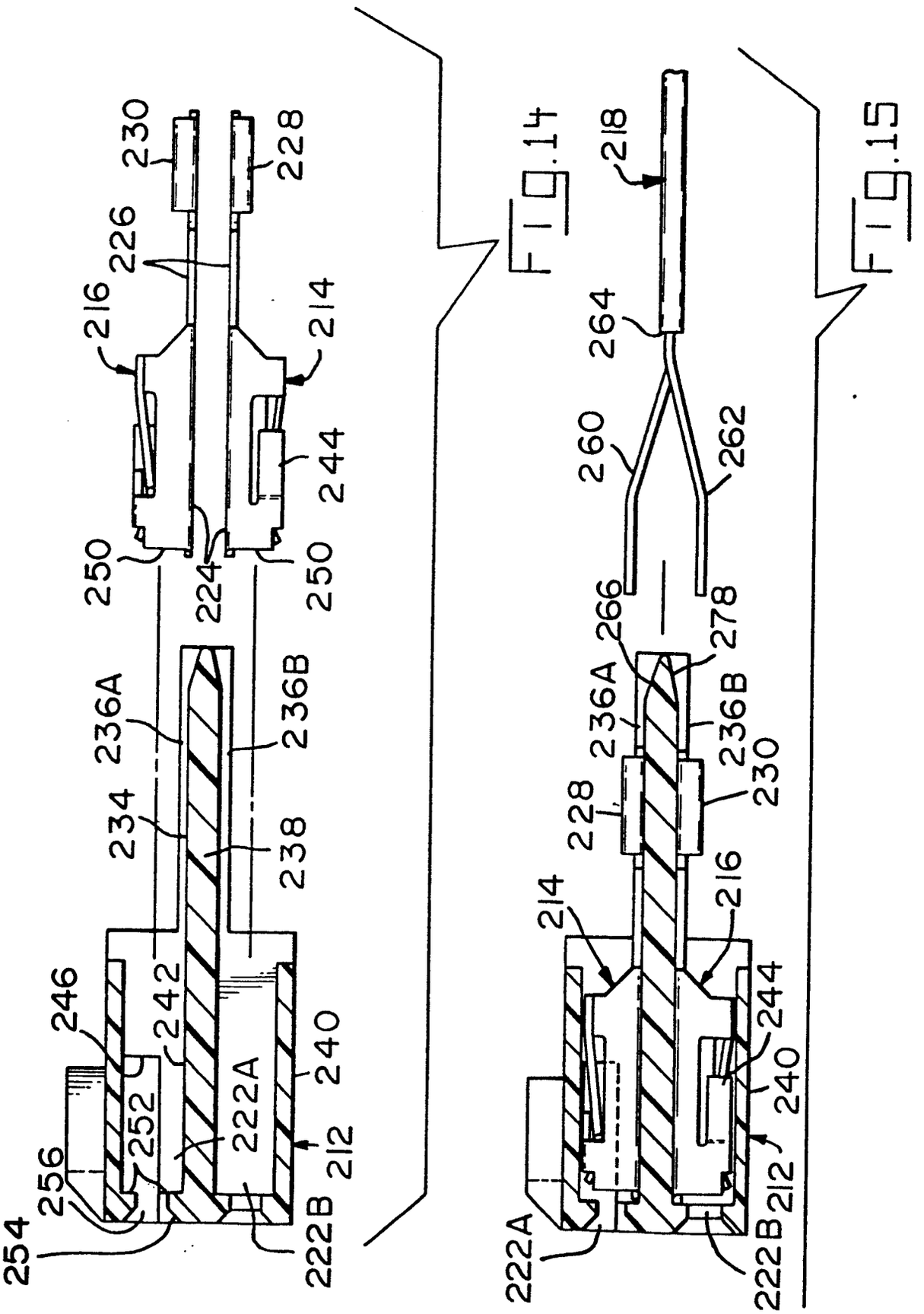


FIG.13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222B
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222B

FIG.14

FIG.15

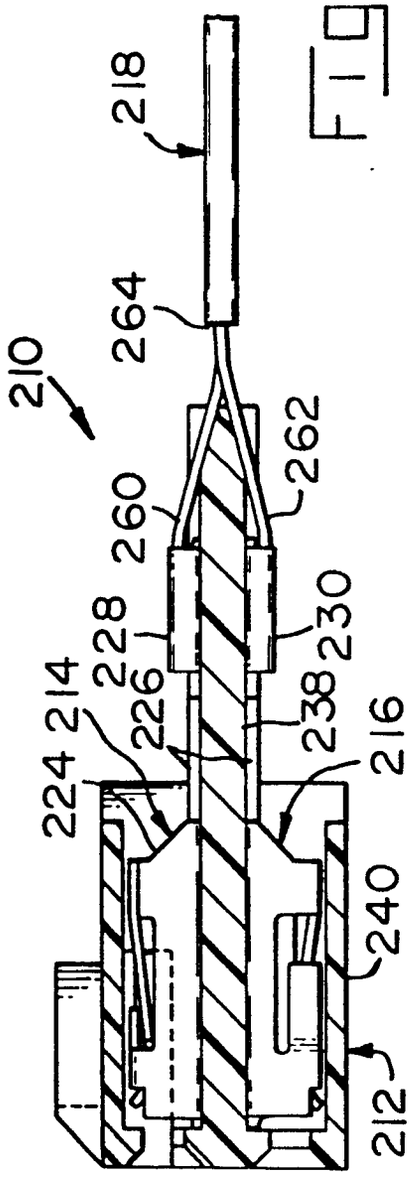
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FIG.16

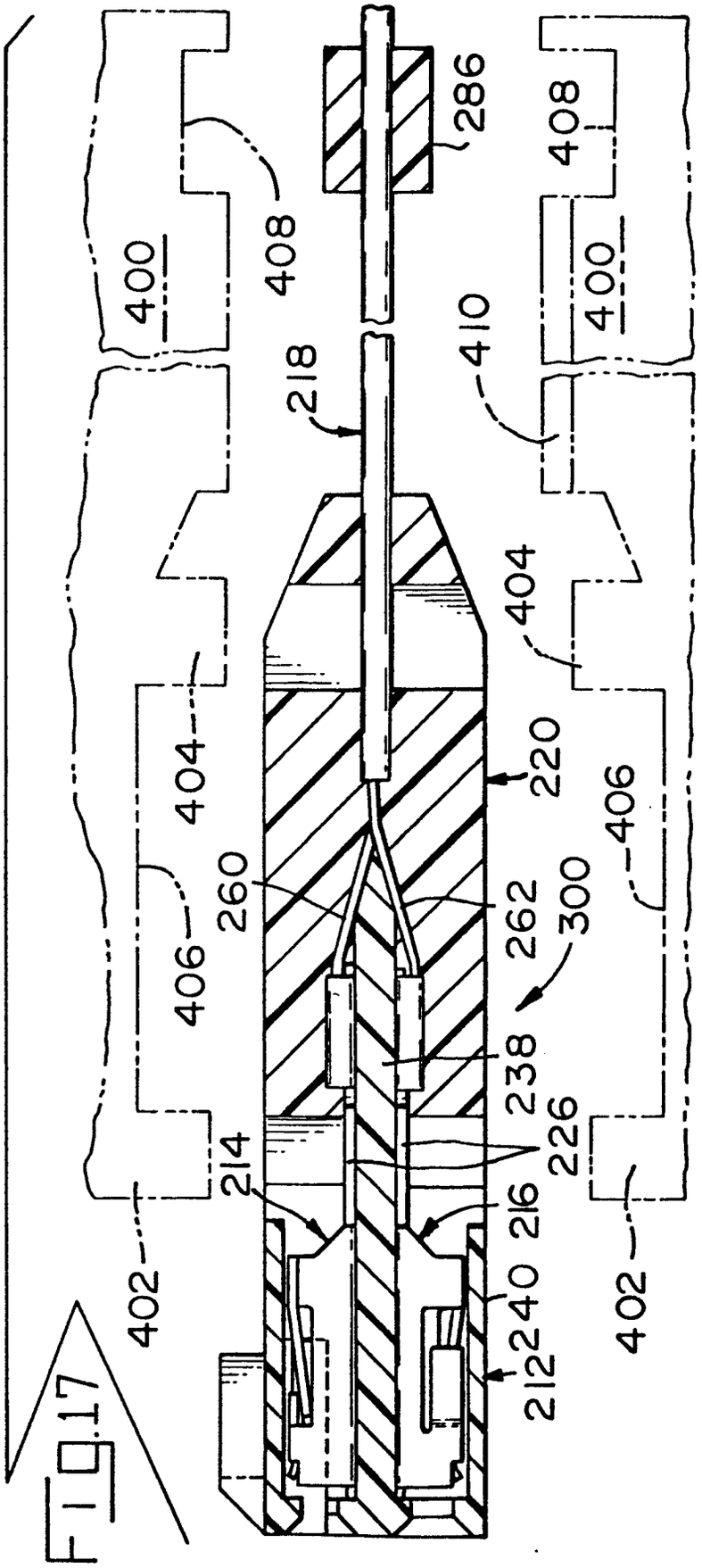
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FIG.17

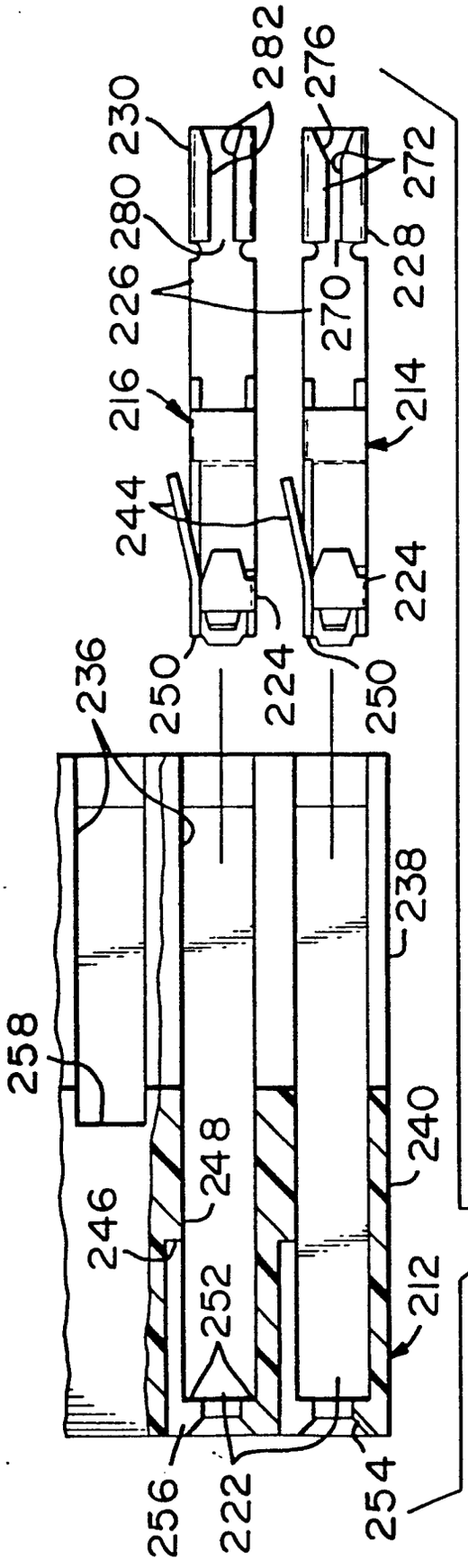
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FIG. 1B

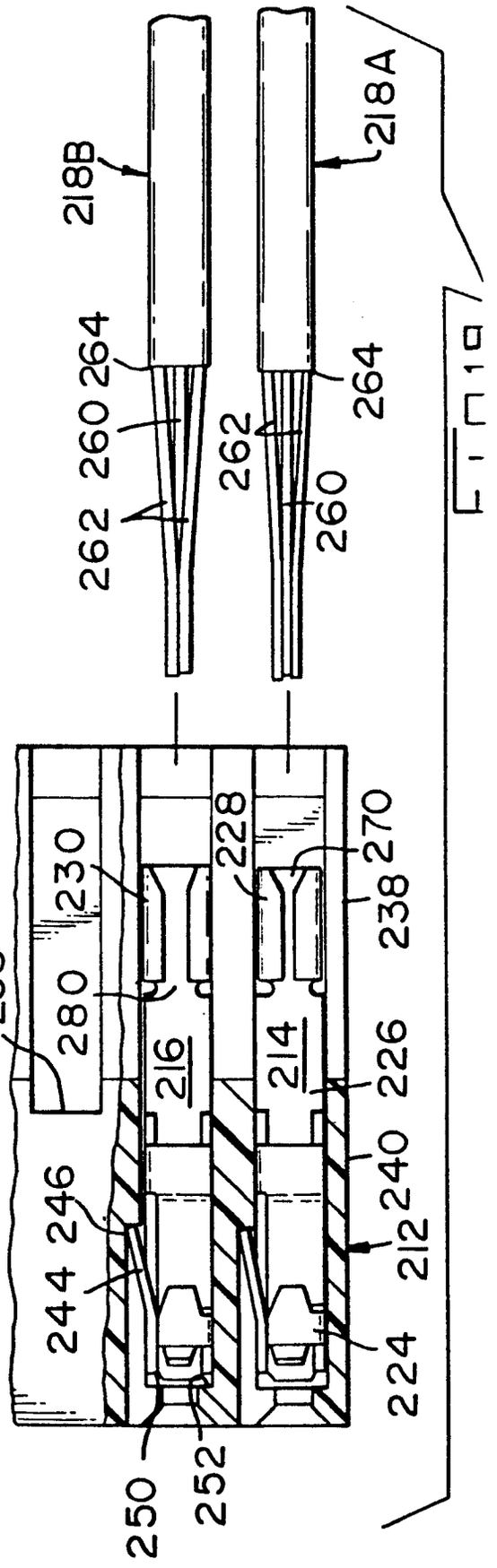
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FIG. 1A

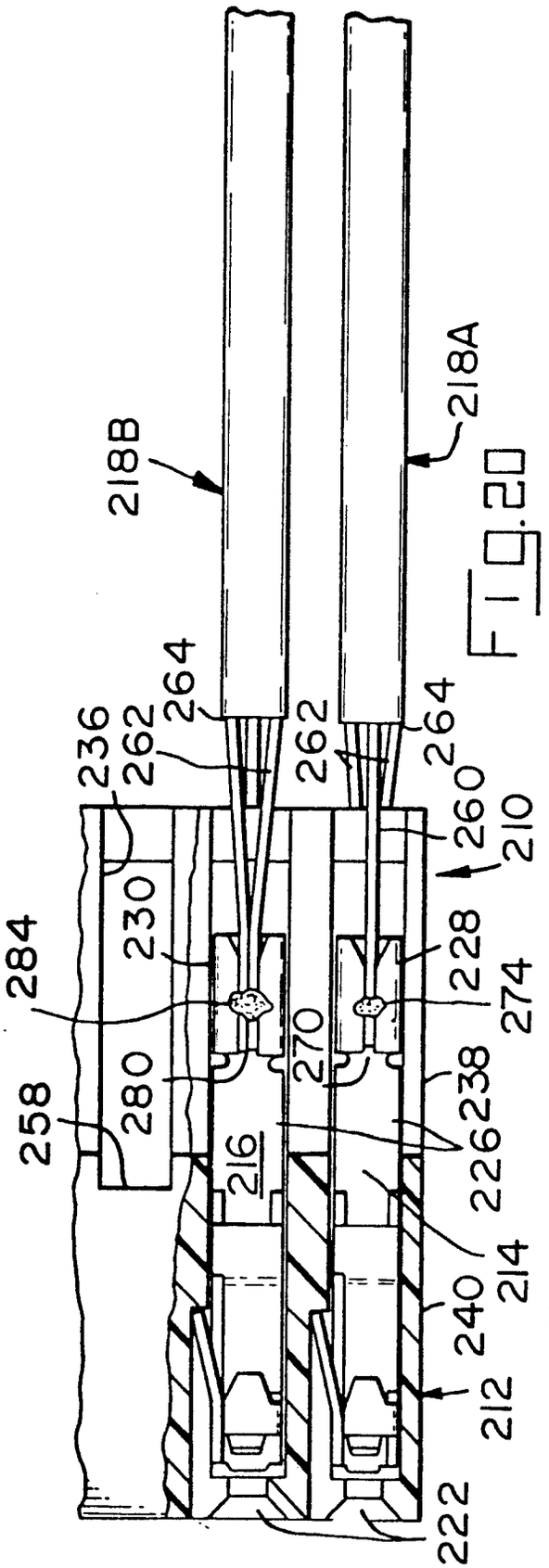
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FIG.20

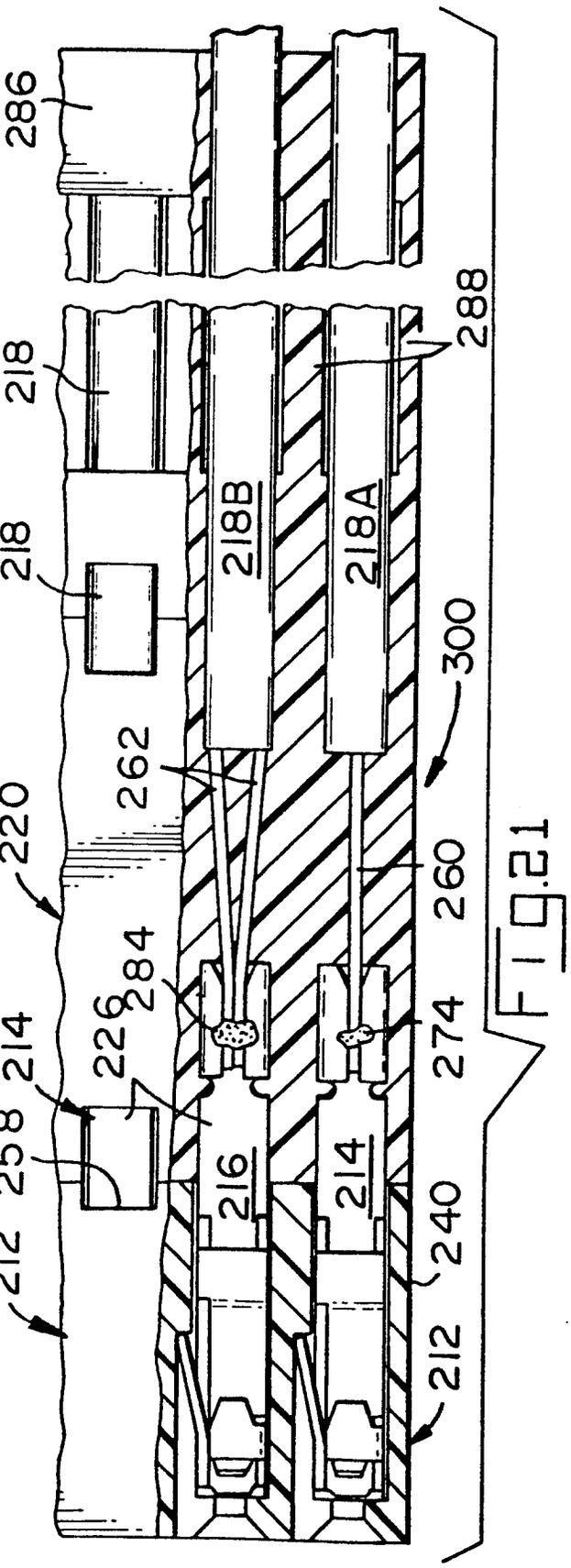
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FIG.21

0211496

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 86 30 4786

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)
X	EP-A-0 147 080 (AMP) * page 3, line 16 - page 4, line 20; figure 1 *	1,6	H 01 R 23/66
X	EP-A-0 023 936 (AMP) * figures 1, 2; page 4, line 22 - page 5, line 27 *	1	
A	EP-A-0 018 160 (AMP) * page 8, lines 3-10; figures 2, 10 * & US - A - 4 269 466 (Cat. D,A)	8	
D,A	EP-A-0 112 019 (AMP) * the whole document *	1,2,4, 5,7,9, 10	
A	EP-A-0 009 337 (AMP) * claims 1-3 * &	9-10	TECHNICAL FIELDS SEARCHED (Int. Cl.4) 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
BERLIN	06-10-1986	LEOUFFRE M.

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

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