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

(11) Publication number: **0 211 508**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **86304982.1**

(51) Int. Cl.⁴: **H 01 R 13/719**

(22) Date of filing: **26.06.86**

(30) Priority: **26.07.85 US 758711**
26.07.85 US 758712

(43) Date of publication of application:
25.02.87 Bulletin 87/9

(84) Designated Contracting States:
BE DE FR GB IT NL SE

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(54) Transient suppression device.

(57) An electrical connector (46) capable of suppressing voltages outside a specified level is disclosed. The connector (46) having a dielectric housing (54) with a series of passageways (55) extending therethrough, electrical terminal members (28) in the series of passageways (55) is characterized in that a dielectric substrate member (24) having a series of conductive paths (40) disposed thereon is associated with the dielectric housing member (54), a ground conductive area (26) is associated with the dielectric member, transient suppression devices (30) are electrically connected between respective conductive paths (40) and the ground conductive area (26), and electrical terminal members (28) are electrically connected to respective conductive paths (40). The transient suppression devices (30) will suppress voltages outside of a specified level as they are conducted through the terminal members (38), thus protecting the connector (46) from power surges.

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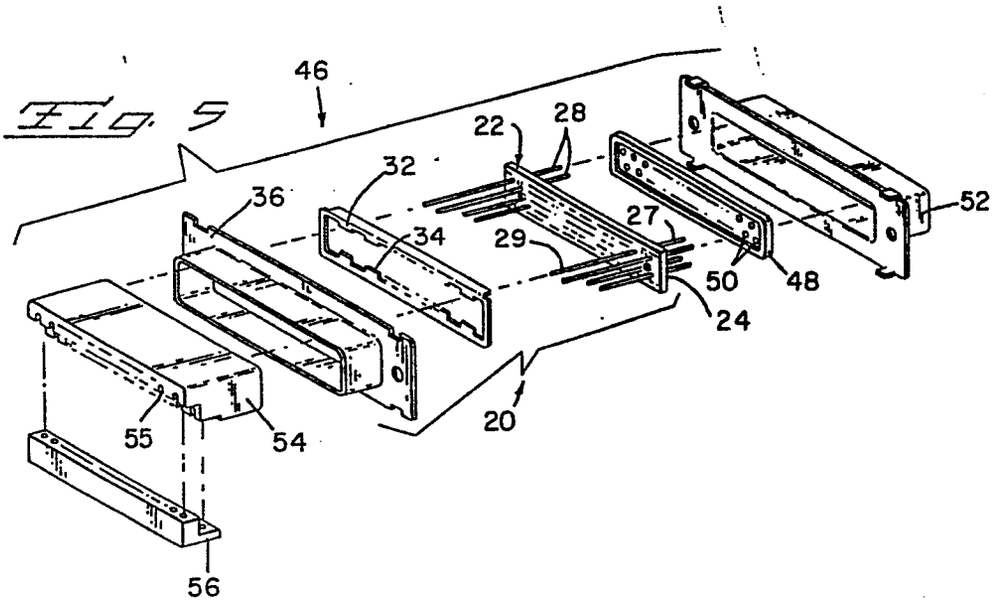
Fig. 5



TRANSIENT SUPPRESSION DEVICE

This invention relates to electrical connectors and more particularly to electrical connectors providing protection against electromagnetic interference, radio frequency interference and especially against power surges.

Electrical circuitry often must be protected from disruptions caused by electromagnetic interference (EMI) and radio frequency interference (RFI) entering the system. EMI energy can be generated outside of as well as inside the system and can occur anywhere in the electromagnetic spectrum. External EMI energy is an undesired conducted or radiated electrical disturbance that can interfere with the operation of electronic equipment, while internal EMI energy is the unwanted noise or unwanted interference generated by electrical or electronic circuitry within a system.

RFI is now used interchangeably with EMI but generally is limited to interference in the radio communication band. Connectors are particularly susceptible to EMI energy because of the numerous contact areas and openings for cable and external electrical contacts. The art, however, has developed sophisticated electrical connectors having substantial shielding effectiveness against EMI/RFI energy.

Another type of electromagnetic radiation, however, was observed with the development of nuclear explosives. The nuclear explosion, and in some circumstances large scale chemical explosions, produces a sharp (large impulse-type) of radio frequency (long wave length) electromagnetic radiation. Unlike EMI/RFI which are localized effects, the intense electric and magnetic fields created by electromagnetic pulse (EMP) energy can damage unprotected electrical and electronic equipment over a wide area. EMP energy consists of a broad spectrum of energies delivered in a fraction of a second. Peak field strengths can reach tens of kilovolts per meter within nanoseconds. These intense pulses induce high voltages and currents which generate a variety of complex electrical events within a system. Damage

can range from a momentary interruption of operation to total overload and burn-out of electronic circuits. Multiple EMP generates more damage since electronics can experience local damage, which degrades performance and degrades the device or circuits, so that the following pulse results in the complete destruction.

Within every new generation of electronics more components are packed into smaller spaces which makes the circuits more susceptible to EMP damage. This high device packaging-density inhibits the ability of the circuit to conduct away the heat which results from the typical intense, high voltage and current flows generated by an EMP. As a result, there is an increased demand for electrical connectors having protection against EMP and EMI energy threats.

In addition there is also need to protect electronic equipment from power surges owing to electrostatic discharges (ESD). The high voltage generated by ESD can damage voltage sensitive integrated circuits.

One means to protect against EMI, RFI, ESD and EMP energy is by the use of shielding. One such shielding means is disclosed in U.S. Patent No. 4,330,166. This patent discloses the use of a conductive spring washer seated in the plug portion of the connector so as to make electrical contact with the receptacle portion of the connector when the plug and receptacle are mated. One washer thus provides shielding for a multitude of electrical circuits. For adequate protection, it is essential therefore that there be no break in the continuity of the shielding.

Other means for protecting against power surges include the use of additional specialized circuitry within equipment, such as voltage variable resistors.

It is an object of the present invention to provide a transient suppression device for use with a variety of connectors. It is a further object to include means that can be used to protect each individual circuit from any transient signal.

Furthermore, it is an object to provide a minimum inductance ground path thus assuring minimum response time.

It is also an object to provide a transient suppression means that is to be used inside an electrical connector.

It is further an object of this invention to provide transient suppression means for protection of individual circuits on circuit boards. In addition it is an object of this invention to provide transient suppression means to retrofit or modify existing connectors.

The present invention is directed to a transient suppression device for use in an electrical connector. The device includes a dielectric substrate means having conductive path means thereon, electrical terminal means disposed on said substrate means and transient suppression means electrically connected between said electrical terminal means and said conductive path means for suppressing voltages outside a specified level as they are conducted through said terminal means. The device as disclosed herein can be incorporated within many standardized connectors thus enabling users to provide EMP protection by simply replacing an existing connector with a protected connector.

The present invention is further directed to a transient suppression means for protection of individual circuits on circuit boards or to retrofit or modify existing connectors. The transient suppression assembly is comprised of a dielectric substrate means having connector engaging means disposed thereon, a grounding means and transient suppression means electrically connecting said connector engaging means and said grounding means for suppressing voltages outside a specified level as they are conducted through said connector engaging means.

Some of the objects and advantages of the invention having been stated, others will appear as the description proceeds when taken in conjunction with the accompanying drawings.

FIGURE 1 is an exploded view of a connector subassembly having a transient suppression device therein;

FIGURE 2 is a cross-sectional view of the assembled device of Figure 1;

FIGURE 3 is an exploded fragmentary view of the transient suppression device;

FIGURE 4 is a fragmentary perspective view of the assembled device of Figure 2;

FIGURE 5 is an exploded view of an electrical connector having a transient suppression device therein;

FIGURE 5A is a cross-sectional view of the assembled connector of Figure 5;

FIGURE 6 is a cross-sectional view of an alternative embodiment of connector having the transient suppression device therein;

FIGURE 7 is a fragmentary perspective view of an alternative embodiment of the transient suppression device using unidirectional diodes;

FIGURE 8 is a fragmentary perspective view of an alternative embodiment of the device using leaded diodes;

FIGURE 8A is a cross-sectional view of an electrical connector having the device of Figure 8;

FIGURE 9 is a fragmentary exploded view of a further alternative embodiment of the transient suppression device in which the diodes are mounted to a ground plate;

FIGURE 9A is cross-sectional view of a connector having the device of Figure 9;

FIGURE 10 is a top view of a device for use in a circular connector;

FIGURE 10A is a cross-sectional view taken along line 10A-10A of Figure 10;

FIGURE 10B is a cross-sectional view of a connector using the device of Figure 10;

FIGURE 11 is a cross-sectional view of a filtered electrical connector having the transient suppression device therein;

FIGURE 12 is a fragmentary perspective view of a further embodiment of transient suppression device;

FIGURE 13 is an exploded view of the transient suppression assembly used with a modular jack connector;

FIGURE 14 is a bottom view of the dielectric substrate of Figure 13;

FIGURE 15 is a side elevation view partly broken away of the modular jack mounted to the assembly;

FIGURE 16 is a bottom view of the assembly and modular jack of view 15;

FIGURE 17 shows an alternative embodiment of the dielectric substrate and transient suppression means of the transient suppression assembly;

FIGURE 18 is an exploded view of an alternative embodiment of the transient suppression assembly used with a modular jack connector;

FIGURE 19 is a bottom view of the dielectric substrate of Figure 18;

FIGURE 20 is an exploded view of a further alternative embodiment of the transient suppression assembly;

FIGURE 21 is a top view of the dielectric substrate of Figure 20;

FIGURE 22 is a bottom view of the dielectric substrate of Figure 20;

FIGURE 23 is a side elevation view partly broken away with the transient suppression assembly mounted within the connector;

FIGURE 24 is a bottom view of the assembly and connector of view 23;

FIGURE 25 is a top view of another alternative embodiment of the transient suppression assembly; and

FIGURE 26 is a bottom view of the assembly of Figure 25.

Referring to Figures 1, 2, 3, 4, connector subassembly 20 is comprised of a transient suppression device 22, a grounding plate 32 and a shield member 36. The transient suppression device 22 is comprised of a substrate 24 having a conductive path means 26 thereon, electrical terminal means 28 and transient

suppression means 30. In the preferred embodiment the electrical terminal means is a plurality pin terminals which pass through terminal passageways 38 in the substrate 24. Said terminals have a first end 27 and a second end 29. A conductive pad 40 surrounds the terminal passageway 38. The transient suppression means in the preferred embodiment is a bi-directional diode 42 comprising two unidirectional diodes 43 which have been soldered together at 44. The conductive path means 26 is a grounding conductor. The transient suppression means are soldered at 45 to substrate 24 between the conductive path means 26 and the conductive pad 40. The transient suppression means 30 is made to provide a specific voltage value. The unidirectional diodes 43 are oriented before they are soldered together so that protection is provided for positive and negative voltage surges. The transient suppression means, therefore, conducts current associated with voltages beyond the predetermined value to ground thus protecting the electrical connectors in which the subassembly 20 is used. The subassembly 20 is assembled by placing a grounding plate 32 with grounding figures 34 extending therefrom against the substrate 24 so that the grounding fingers 34 engage the conductive path means 26. The ground plate 32 has an opening 33 therein through which the terminal means 28 pass. The subassembly 20 is completed by attaching a metal shield member 36 over the ground plate 32 and transient suppression device 22. As is shown particularly in Figure 2, the ground plate 32 is in contact with the conductive path means 26 and the shield member 36 is in contact with the ground plate 32.

It is to be understood that grounding may also be achieved by forming detents in the shield member 36 that will engage the conductive path means on the substrate 24, thus eliminating the need for the grounding plate 32. The transient suppression device 22 made in accordance with this invention enables one to protect each individual circuit within a system and also allows

the voltage control to be different for each circuit within the system.

It is to be further understood that pin terminals are used for purposes of illustration only. A variety of terminal means as known in the art may be used.

Referring now to Figures 5 and 5A, the transient suppression device 22 is intended to be used within electrical connectors such as 46. A housing member 54 having passageways 55 for accepting terminal means 28 is inserted into shield member 36 of the subassembly 20 so that the terminal means 28 enter the passageways 55 and extend therethrough. In the connector 46 a pin retaining member 56 is also used so that the second ends 29 of terminal means 28 may be bent at right angles to the housing 54. The first ends 27 of the terminal means 28 are inserted into a dielectric cover member 48 having openings 50 therein. The first ends 27 pass through the openings 50 and extend therefrom. Front shield member 52 is attached to the shield member 36 of the transient suppression subassembly 20.

Figure 6 shows an alternative embodiment 146 of an electrical connector. In this embodiment the second ends 29 of the terminal means 28 extend through the housing 154 but are not bent at right angles when they exit the housing.

Figure 7 shows an alternative embodiment 122 of the transient suppression device in which the transient suppression means 30 is comprised of a unidirectional diode 143 which is soldered at 45 to substrate 24. The device made in accordance with this embodiment 122 will therefore protect the circuit from voltages in one direction only. Figures 8 and 8A show a further alternative embodiment 222 of the transient suppression device. In this embodiment the transient suppression means 30 are leaded diodes 242. The diode 242 has leads 58 which are soldered to the conductive path 240 surrounding terminal passageways 238 in substrate 224 and to the conductive path means 226. Figure 8A shows a cross-sectional view of connector embodiment 246 which utilizes the leaded diode transient suppression device 222.

Figures 9 and 9A show a further alternative embodiment 322 of the transient suppression device in which diodes 342 are mounted to a metal ground plane 76 so that the diodes will electrically engage the conductive paths 340 surrounding the terminal passageways 338 in substrate 324 when the ground plane 76 is attached to substrate 324. In assembling this embodiment 346, as shown in Figure 9A, substrate 324 is sandwiched between ground plate 32 and ground plane 76.

Figure 10, 10A and 10B illustrate further embodiment 422 of the transient suppression device for use in a circular connector 446. In this embodiment the transient suppression means 30 are bi-directional diodes which are mounted at4 45 to one side of a circular substrate 424. The diodes intersect the conductive paths 440 surrounding terminal passageways 438 means and second conductive areas 60 surrounding plated-through holes 61 which electrically interconnect conductive areas 60 to the ground circuit 426 on the under surface of the circular substrate 424. Figure 10A shows a cross-sectional view of a portion of substrate 424 illustrating the terminal means 428 are joined with solder 25 to the substrate 424. The transient suppression means 30 is soldered at 445 to conductive paths 438 and the plated through hole 61 to interconnect with the ground conductive path 426. Figure 10B shows a fragmentary cross-sectional view of a typical circular connector 446 showing the position of the transient suppression device 424 within connector housing 454.

Figures 11 and 12 show the use of the transient suppression device in conjunction with filter means in electrical connectors. Figure 11 shows a cross-sectional view of further embodiment 546 of an electrical connector in which the transient suppression device 22 is inserted forward of the filter means 62. Filter means 62 is comprised of a ground plate 68 and filter sleeves 64. Filter sleeves are preferably of the type illustrated in U.S. Patent Re. 29,258. Figure 12 shows use of transient suppression device 622 having a planar filter element 624 as the substrate member. Terminal means 28 are inserted through

openings 638 in said filter element 624. Transient suppression means 30 are soldered onto the surface of planar filter element 624.

Referring now to Figures 13 and 14, transient suppression assembly 10 is comprised of a transient suppression means 51, a dielectric substrate means 59, and a ground means 77. Assembly 10 is intended to be used with an existing connector 82 for retrofitting that connector 82 to provide for protection against power surges. The connector 82 is generally comprised of a dielectric housing member 83 having passageways 84 therein for accepting conductors 85. In the preferred embodiment, the housing member 83 also has a ground plane engaging extension 86. The housing further has mounting plane engaging extension 86. The housing further has mounting legs 87 extending from the lower surface 88 of the connector 56 said legs 87 being used to mount the connector to a circuit board or other surface (not shown). A modular jack connector is used for purposes of illustration only. It is to be understood that other connectors may also be used with the transient suppression assembly.

The transient suppression means 51 is comprised of a bi-directional diode 53 having leads 57 extending therefrom. The dielectric substrate 59 has a first portion 63 which is profiled for insertion into a cavity 84 in connector housing member 83, and for engagement with conductors 85 therein, and a second portion 65 which remains external to said housing member 83. Conductors 85 are disposed within passageways 89 of said housing member 83. The conductors have first (not shown) sections 66 (not shown) and second contact sections 66'.

The dielectric substrate 59 has a first or upper surface 67 having a plurality of conductive paths 73 disposed thereon, and a second surface 69 having a ground conductive path 70 thereon. Substrate 59 further has a plurality of first and second apertures 71, 72 for mounting said suppression means 51, said apertures 71, 72 extending from the first surface 67 to the second surface 69. The first apertures 71 extend from a

dielectric area of surface 67 through substrate 59 and into the ground conductive path 70 on the second surface 69. The second apertures 72 extend from one end of each of the conductive paths 73, through said substrate 59 and into a dielectric area on surface 69. The transient suppression means 51 is mounted to the substrate 59 by inserting one of the leads 56 of each diode 53 into the first aperture 71 and the other lead 56 into the second aperture 72 as is best seen in Figure 3. The lead 56 in the first aperture 71 is thus electrically connected with ground conductor 70 and the other lead is electrically connected with conductive path 73.

As shown in Figures 13 and 14 substrate 59 further has connector engaging means thereon, said connector engaging means being comprised of a plurality of conductor receiving passageways 74 extending from the other ends of each of said conductive paths 73 through substrate 59 and into a dielectric area of surface 69, and a conductor engaging slot 75 which extends outwardly from each passageway 74 to an edge of the first substrate portion 63. When said first substrate portion 63 is inserted into the housing 83, slots 75 engage respective conductor members 85 in said housing member 83. When the first substrate portion 63 is fully seated in the housing member 83, second contact portions 66' of conductors 85 are in their respective conductor receiving passageways 74 and, therefore, electrically connected to conductive path 73 and transient suppression means 51.

The ground means 77 is comprised of a ground plate 78 having first portion 79 for engaging the substrate 59 and a second portion 80 for engaging the connector 82. The second portion 80 is profiled to accept connector 82. The grounding plate 78 is shaped so that the substrate engaging portion 79 will electrically interconnect with the ground conductor 70 on the undersurface 69 of the substrate 59 but will not engage the leads 57 that extend through apertures 72 and into the dielectric portion of the undersurface 69. This is best illustrated in

Figure 16. The connector engaging portion 80 of the ground plate 78 has arms 81 extending upwardly to engage the extension 86 on connector housing member 83, as is shown in Figure 15.

Figure 17 illustrates an alternative embodiment 100 of the transient suppression assembly. In this embodiment, the transient suppression means 151 is a surface mounted bi-directional diode 153. To facilitate mounting of the diode 153 conductive pads 90, 91 on substrate surface 167 surround the first and second apertures 171 and 172, said apertures extending respectively to the ground conductor 70 (shown in Figure 16) and dielectric portion of the substrate undersurface 69 in the same manner as previously described with embodiment 10. Diode 153 is soldered to interconnect respective pads 90 and 91. Since the diode 153 is unleaded, apertures 171 and 172 are electrically interconnected by means known in the art, such as by plating, solder, or the like, to provide electrical interconnection between the surfaces 167 and 179 of substrate 159. This embodiment 100 is inserted into the connector in the same manner as described above.

Figures 18 and 19 illustrate a further embodiment 200 of the transient suppression assembly in which the substrate 259 has ground conductive paths 92 as well as signal conductive paths 273 disposed on substrate surface 267. Ground conductive paths 92 are electrically interconnected via apertures 93 to ground conductor 270 on substrate undersurface 269 of substrate 259 by means known in the art. When substrate 259 is inserted into connector 282, said ground conductor paths 92 are electrically interconnected at 94 to connector ground conductors 95. The remaining conductor receiving passageways 74 electrically engage connector conductors 85 as previously described.

Figures 20 to 24 illustrate a further embodiment 300 of the transient suppression assembly comprised of a dielectric substrate 359, transient suppression means 351 and grounding means 377. In this embodiment bi-directional diodes 353 are surface mounted to substrate surface 367 and interconnect conductive

paths 373 to ground conductive path 96 on the upper surface 367. Aperture 97 is provided in-ground path 96 and electrically connected to ground path 370 on the substrate undersurface 369, as shown best in Figures 21 and 22.

As is shown in Figure 23, a portion of the bottom 388 of housing member 383 is profiled to receive assembly 300. Conductors 385 enter connector receiving passageways 374. The assembly 300 is inserted into the profiled opening so that edge 98 of the assembly 300 is essentially flush with back edge 99 of housing member 383. Once the substrate 349 has been seated in housing member 383, the ground plate 378 is attached. As is shown in Figure 24 the ground plate 378 is profiled to engage the ground conductor 370. Arms 381 engage the ground plate engaging extensions 386 on housing member 383. This embodiment is particularly useful where space is at a premium and there is no room for the substrate to extend beyond the housing.

Figures 25 and 26 illustrate the top and bottom surfaces 467, 469 respectively of a further alternative assembly embodiment 400. In this embodiment the assembly 400 is designed to be inserted into a connector in the same manner as assembly 300 described in Figures 20 to 24. This embodiment illustrates the use of ground conductive paths 492 disposed on surface 467, said paths 492 being electrically interconnected to corresponding ground conductors in a conductor (not shown), thus eliminating the need for a separate ground plate.

The invention disclosed herein provides superior performance in the suppression of transient voltages. The invention also provides a means for protecting circuit boards from transient voltages in that a connector having the means attached thereto may be mounted to a circuit board. The use of transient suppression means in close proximity to the individual terminal members provides a short, minimum inductance ground path for any transient signal. Minimum response time is thus assured. Furthermore, the use of surface mounted members instead of

leaded members reduces the space required for the transient suppression means and reduces the number of steps required to manufacture the assemblies and connectors.

In the drawings and specification, there have been set forth preferred embodiments of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only, and not for purposes of limitation.

CLAIMS:

1. An electrical connector (46) comprising a dielectric housing (54) having a series of passageways (55) extending therethrough, electrical terminal members (28) in the series of passageways (55), said terminals (28) having first contact sections (27) and second contact sections (29); characterized in that:

a planar substrate member (24) is associated with the dielectric housing member (54) and has a series of conductive paths (40) disposed on at least one surface thereof;

a ground conductive area (26) is associated with the planar member (24);

transient suppression devices (30) are electrically connected between respective conductive paths (40) and the ground conductive area (26) and

the electrical terminal members (28) are electrically connected to the respective conductive paths (40) whereby voltages outside a specified level are suppressed as they are conducted through said electrical terminal members (28).

2. An electrical connector (46) as defined in claim 1 wherein the substrate member (24) is contained within the electrical connector.

3. An electrical connector (82) as defined in claim 1 wherein at least a portion of the substrate member (59) is exterior to the dielectric housing (83).

4. An electrical connector (82) as defined in claim 1 wherein at least a portion (65) of the substrate member (59) extends outwardly from the electrical connector.

5. An electrical connector (46) as defined in claim 1 wherein the dielectric substrate member (24) has a series of terminal passageways (38) therethrough for receiving the electrical terminal members (28).

6. The electrical connector (46) as defined in claim 2, 3 or 5 wherein the ground conductive area (26) is disposed on the planar member.

7. The electrical connector as defined in claim 2, 3 or 5 wherein the ground conductor area is comprised of a ground plate member (76).

8. The electrical connector as defined in claim 2, 3 or 5 wherein the transient suppression devices (30) are surface mounted diode members.

9. The electrical connector as defined in claim 2, 3 or 5 wherein the transient suppression devices are leaded diode members (252).

10. The electrical connector as defined in claim 8 or 9 wherein the diode members are bi-directional diodes.

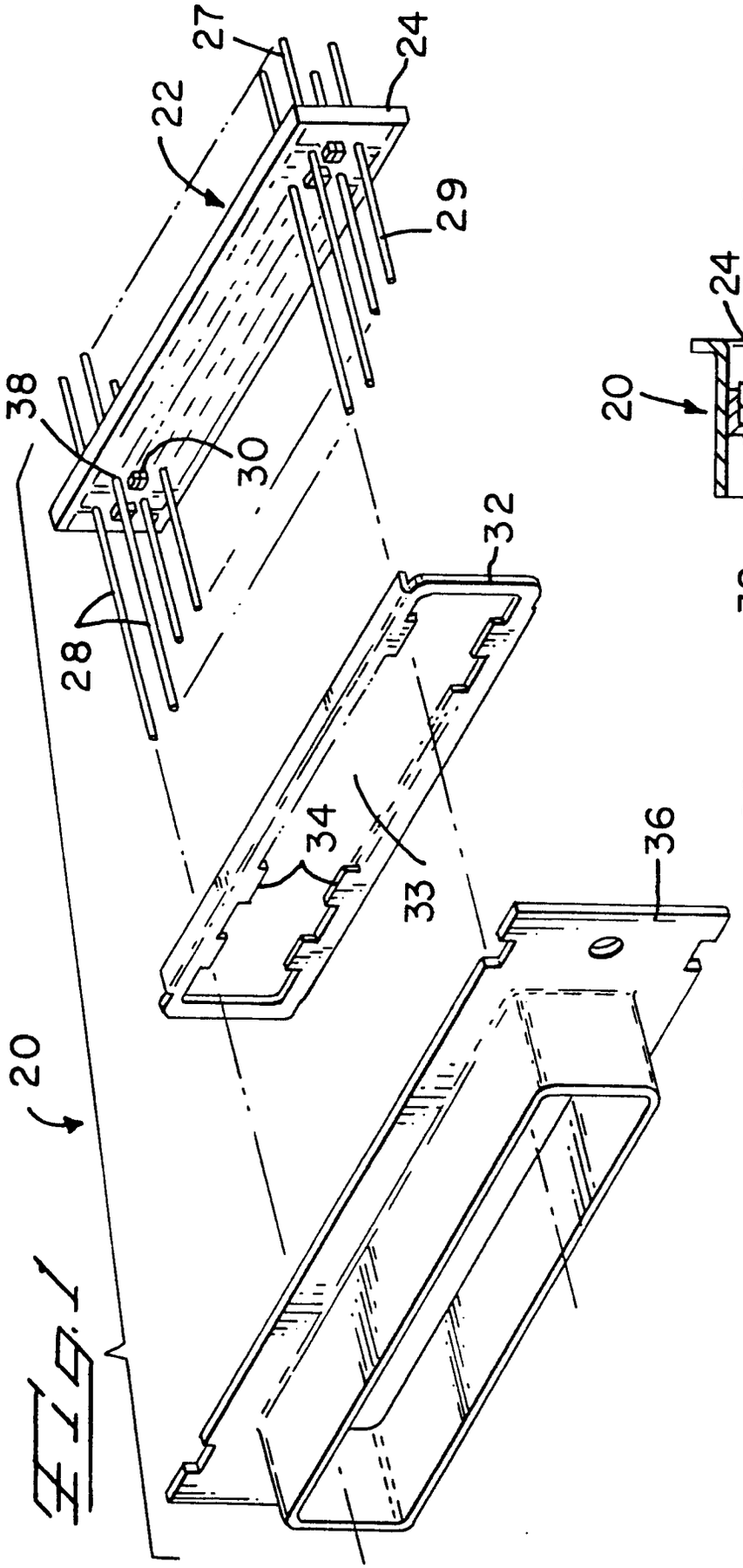


FIG. 1

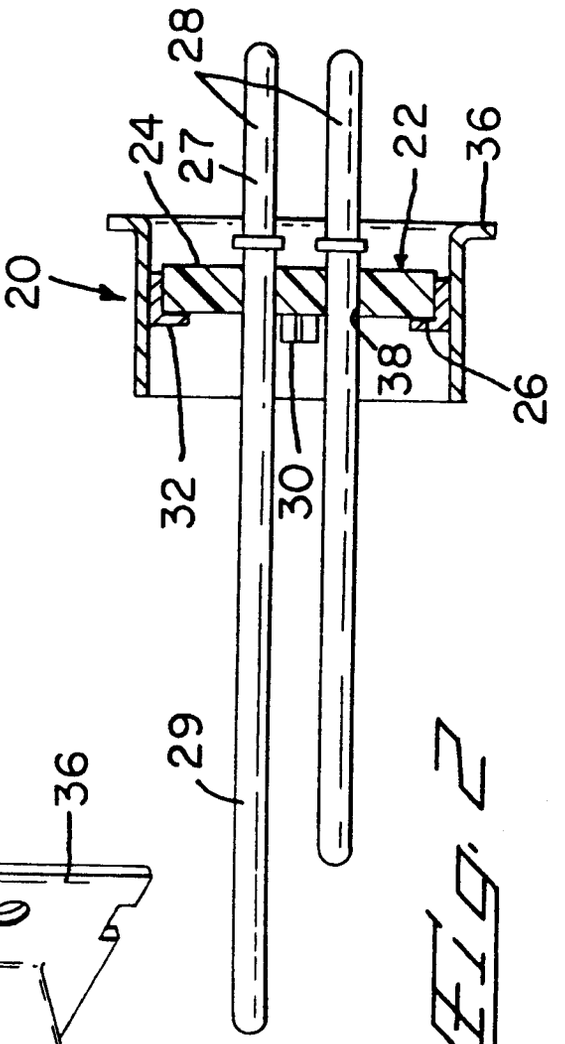


FIG. 2

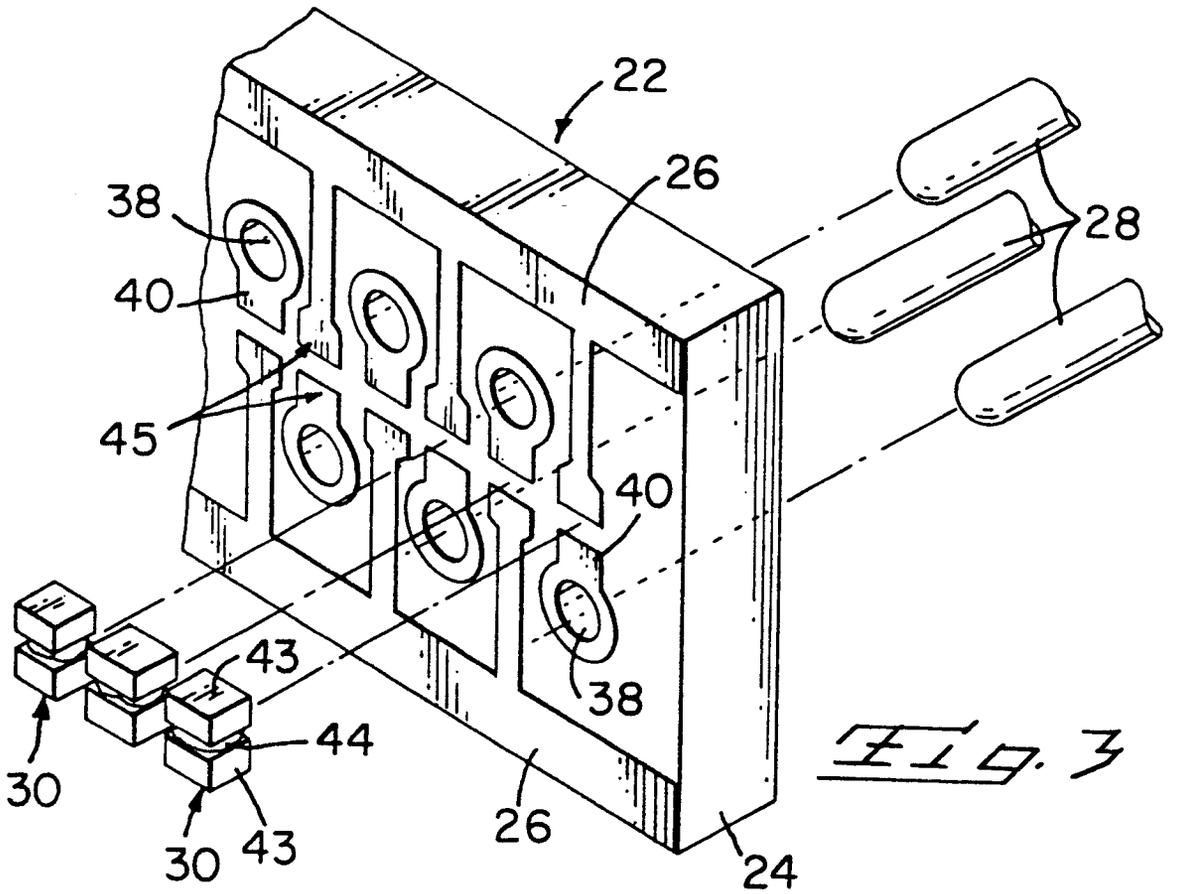

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Fig. 3

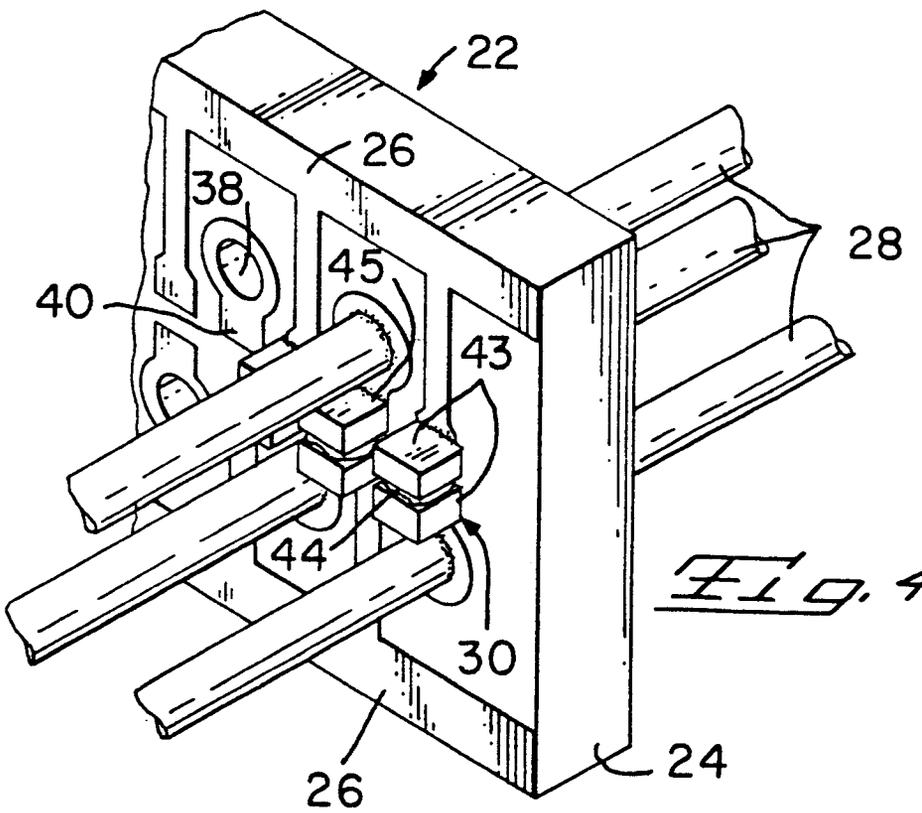
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Fig. 4

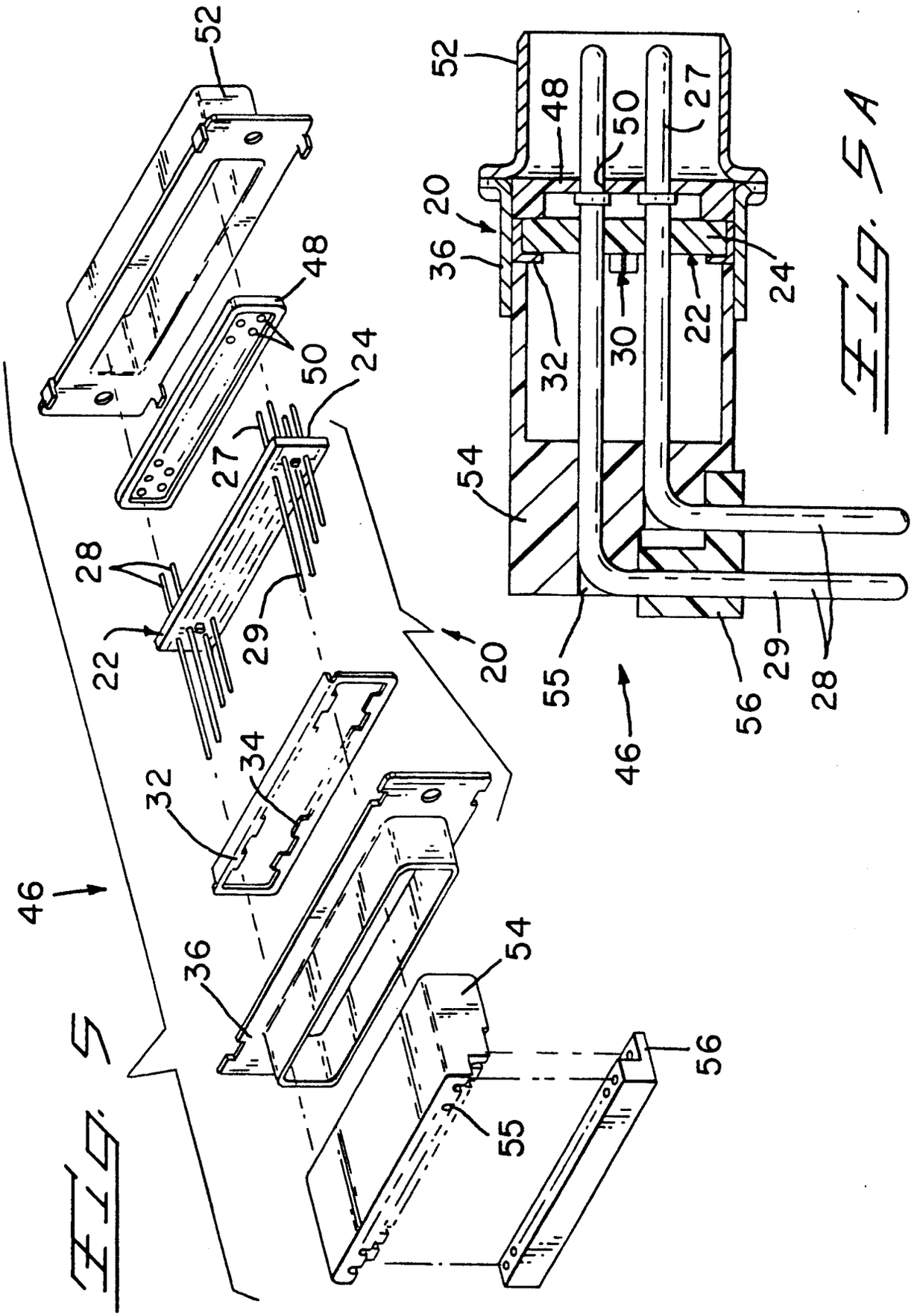

FIG. 5

FIG. 5A

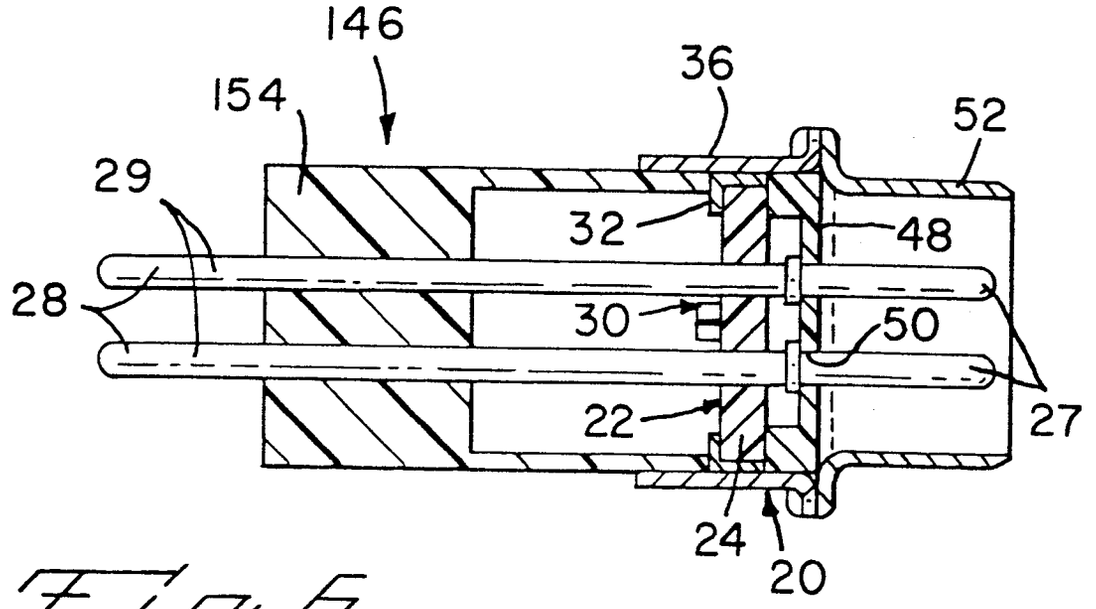
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Fig. 6

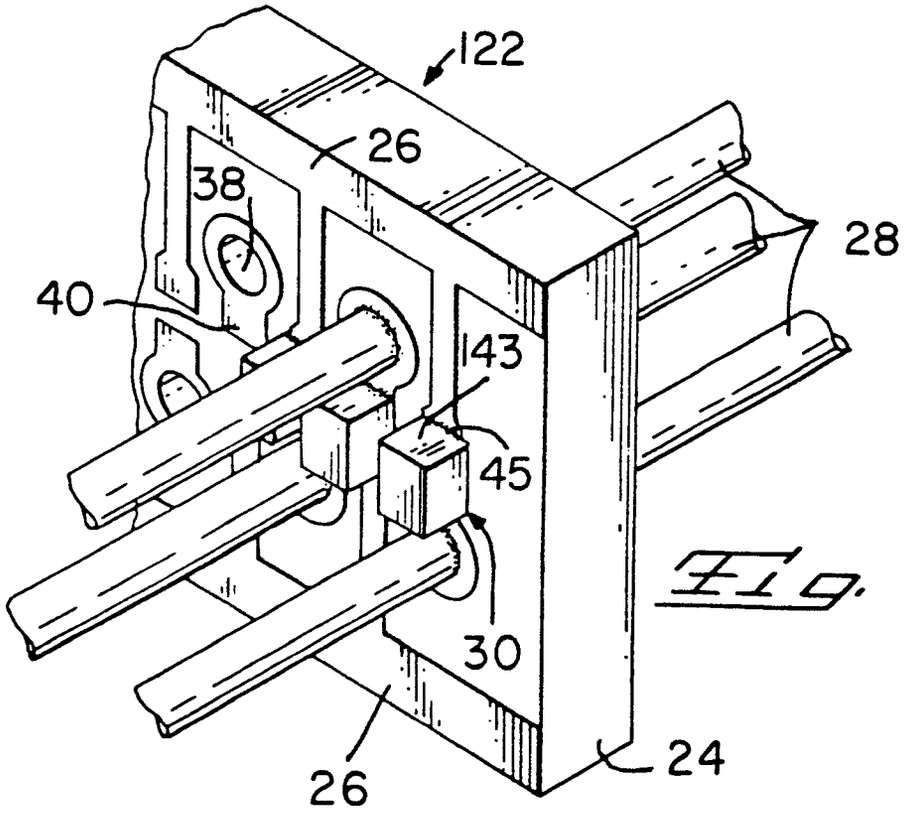
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Fig. 7

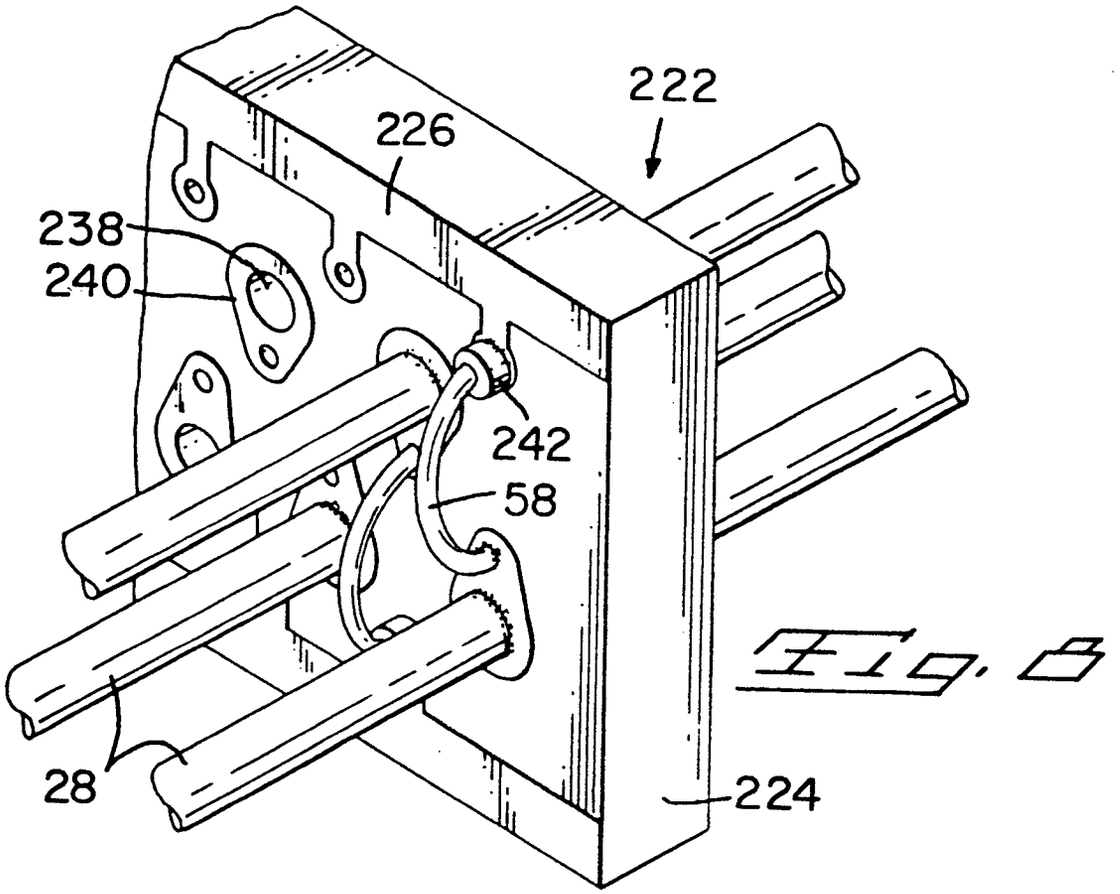
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Fig. 8

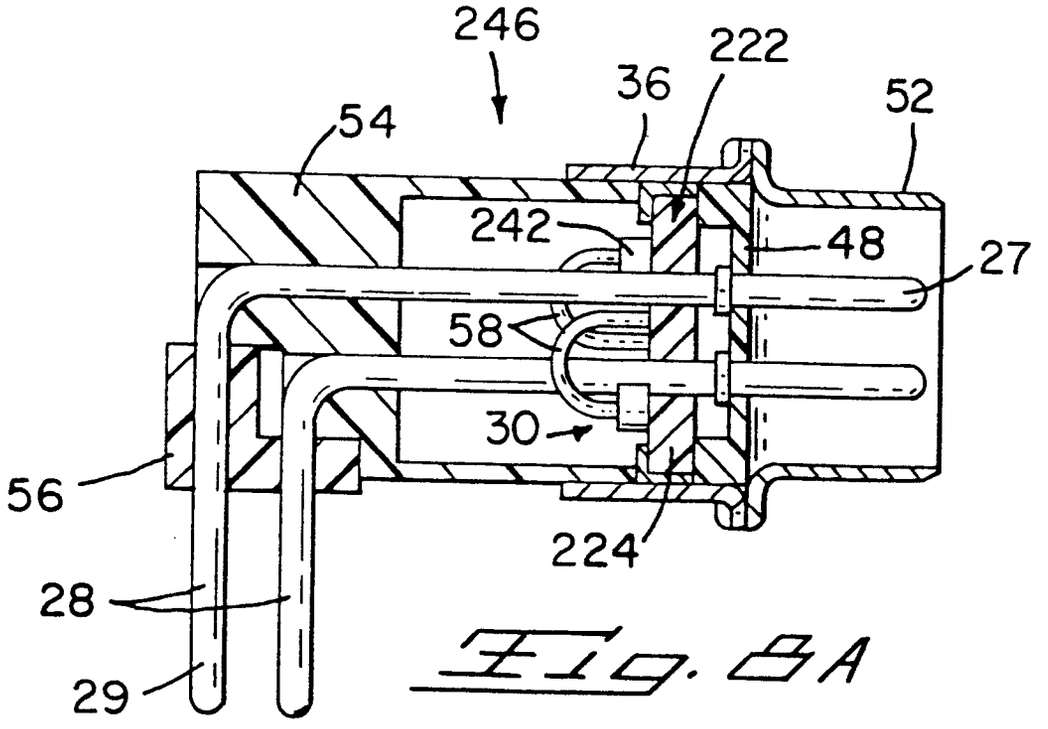
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Fig. 8A

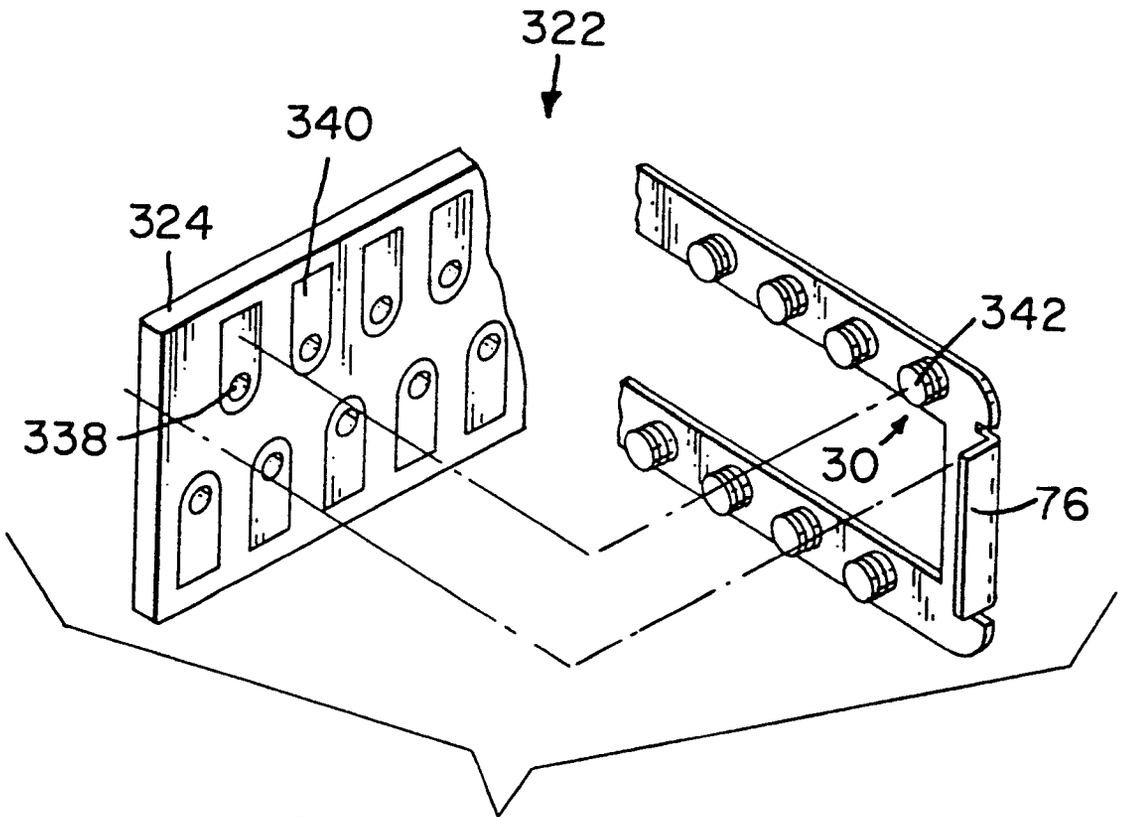

Fig. 9

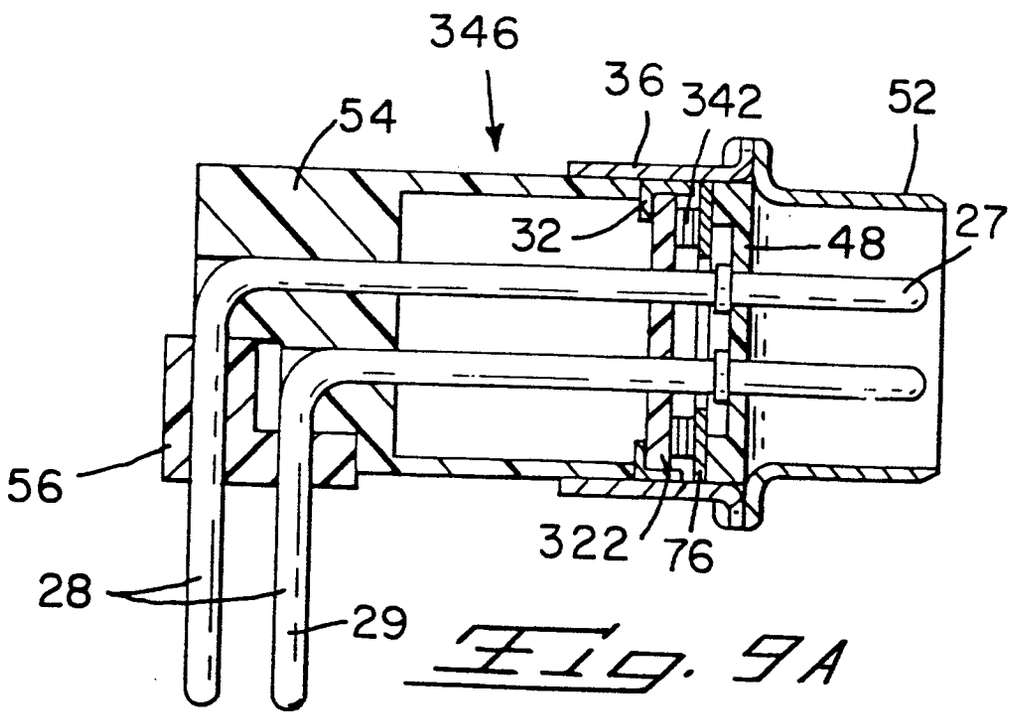

Fig. 9A

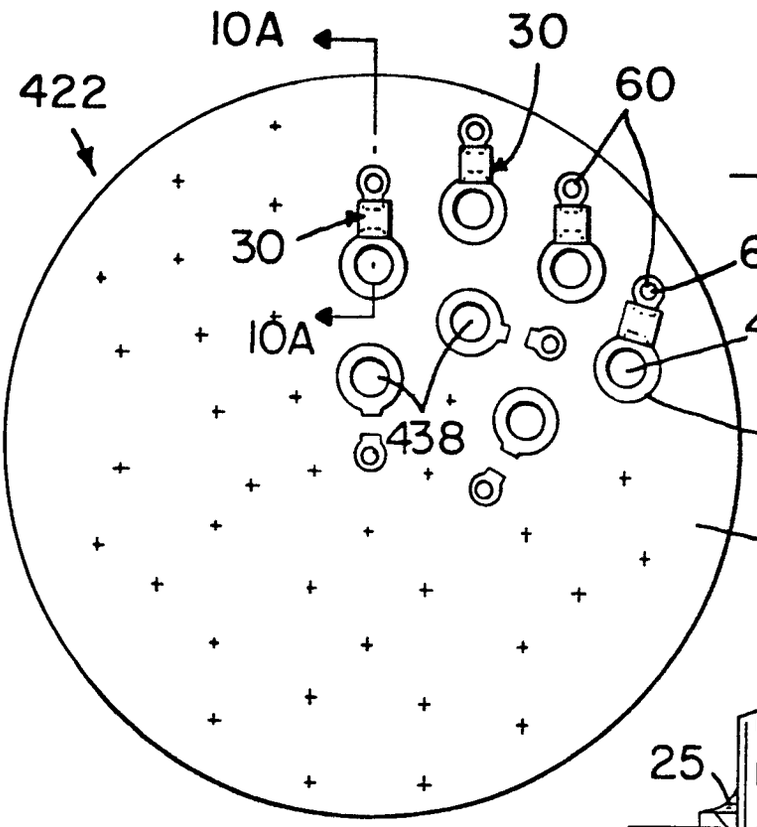

Fig. 10

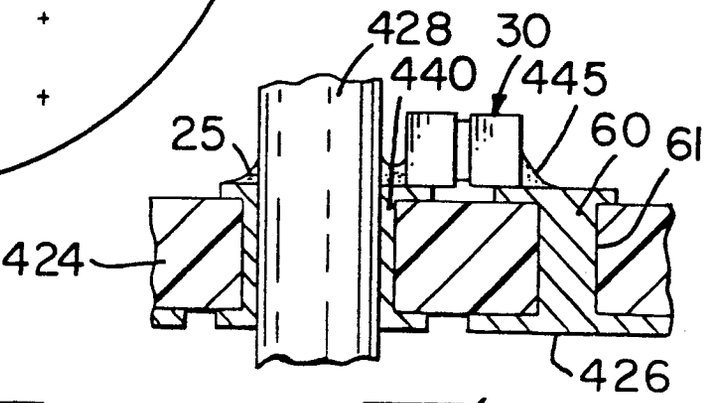

Fig. 10A

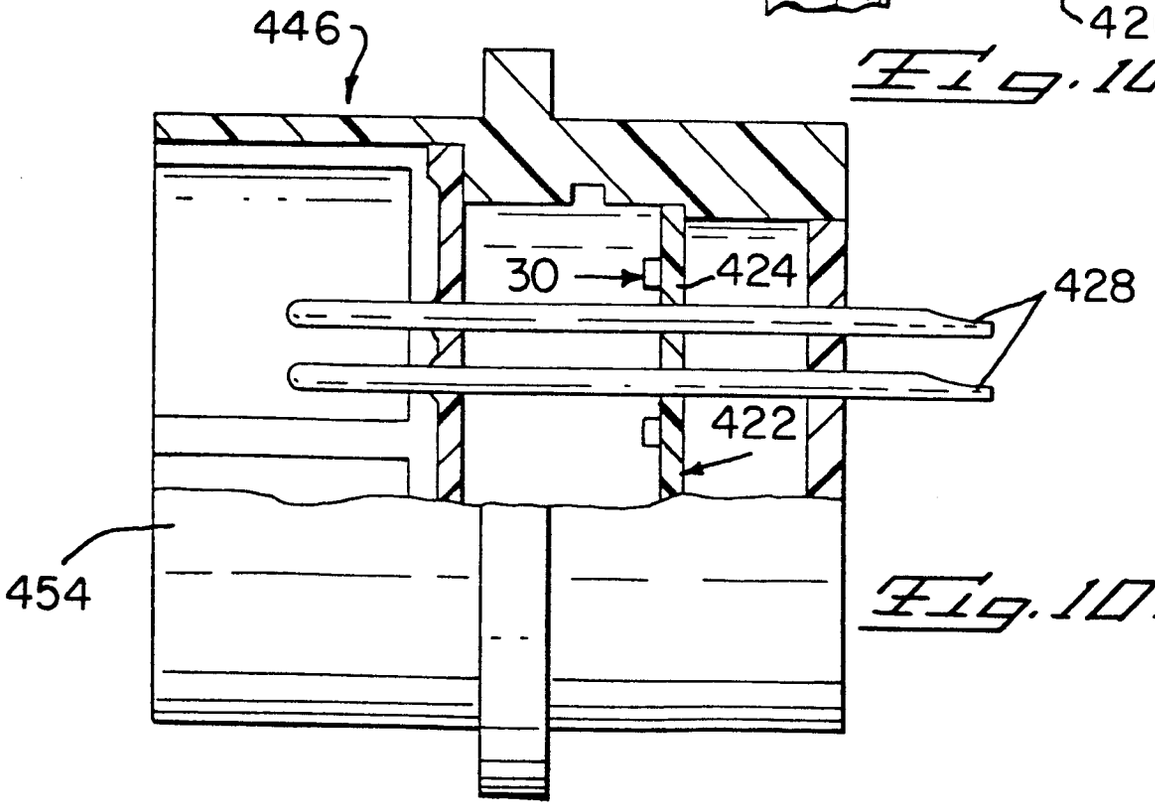

Fig. 10B

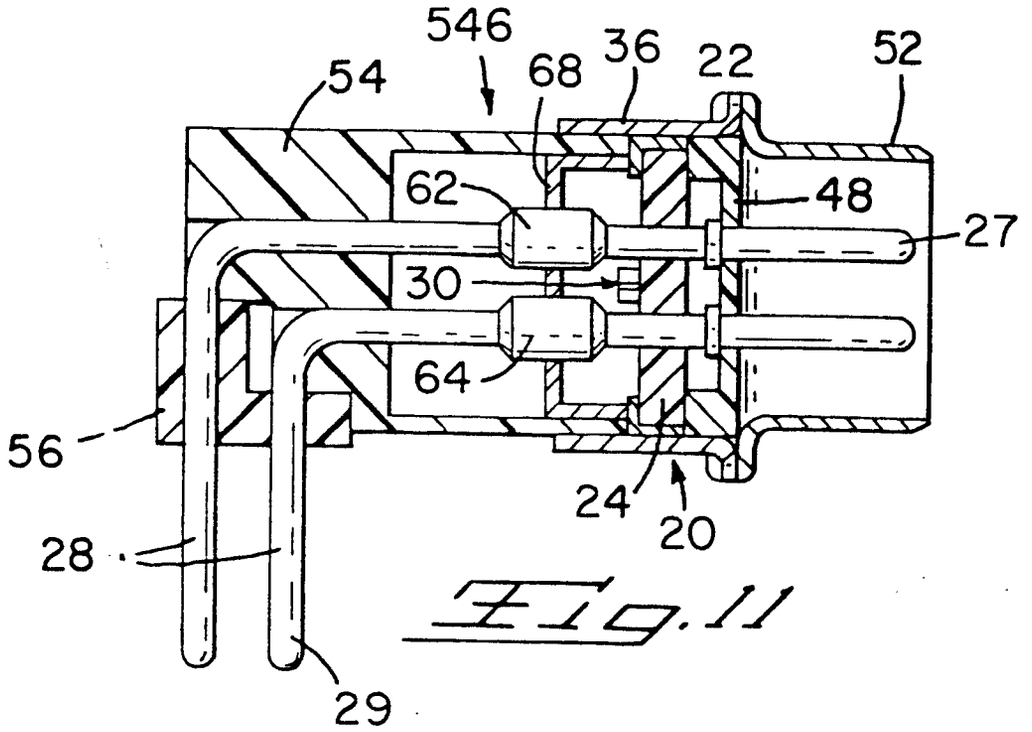
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Fig. 11

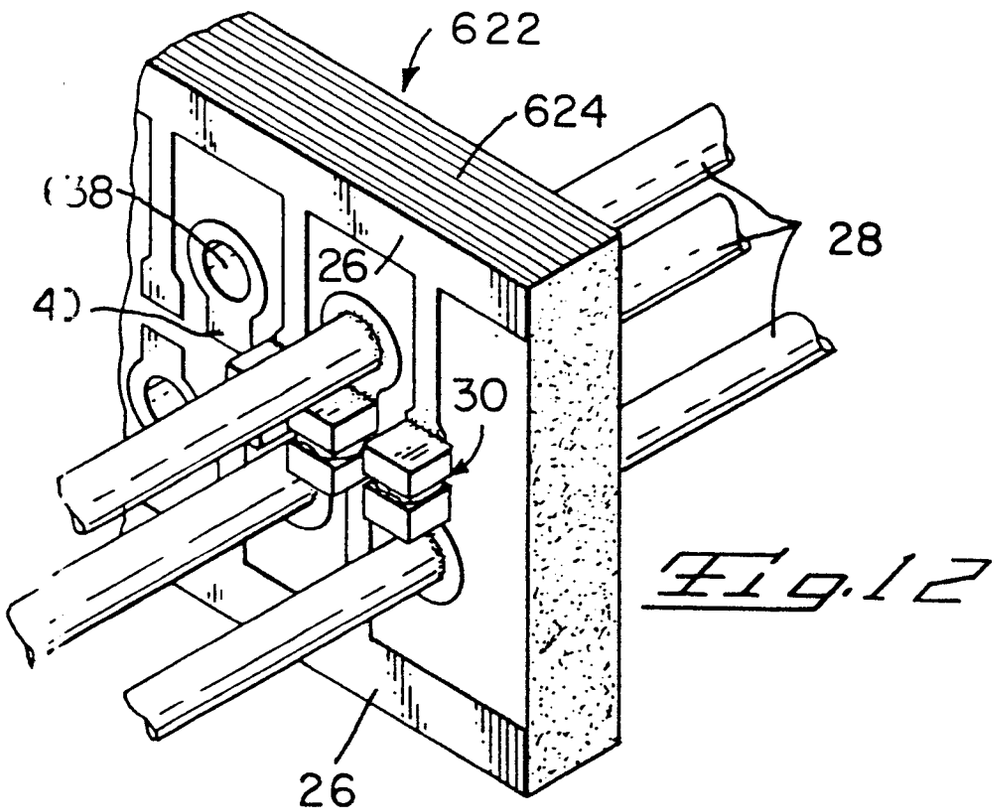
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Fig. 12

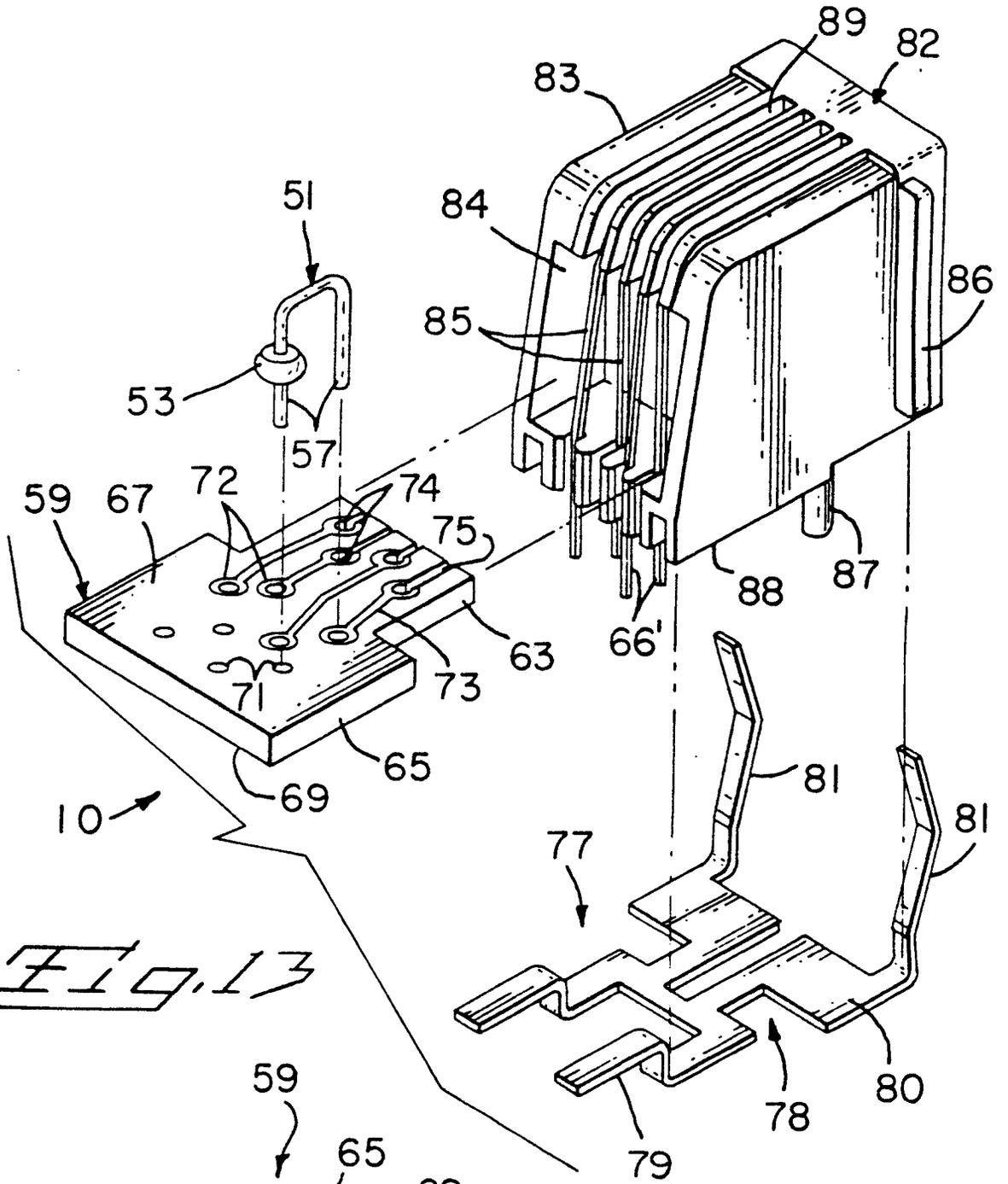
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Fig. 13

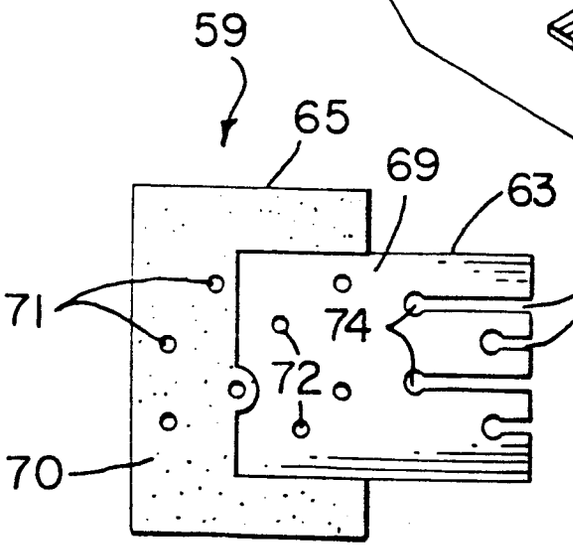
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Fig. 14

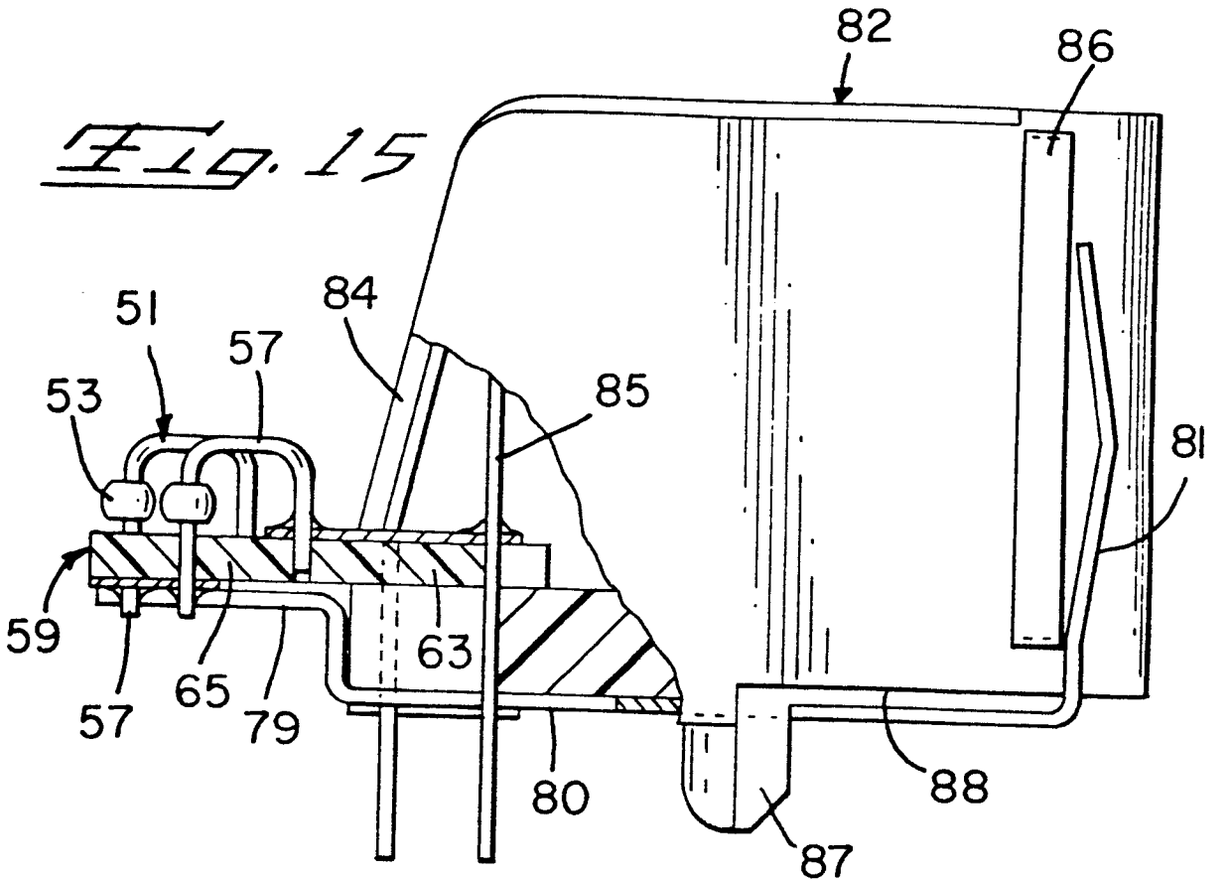
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Fig. 15

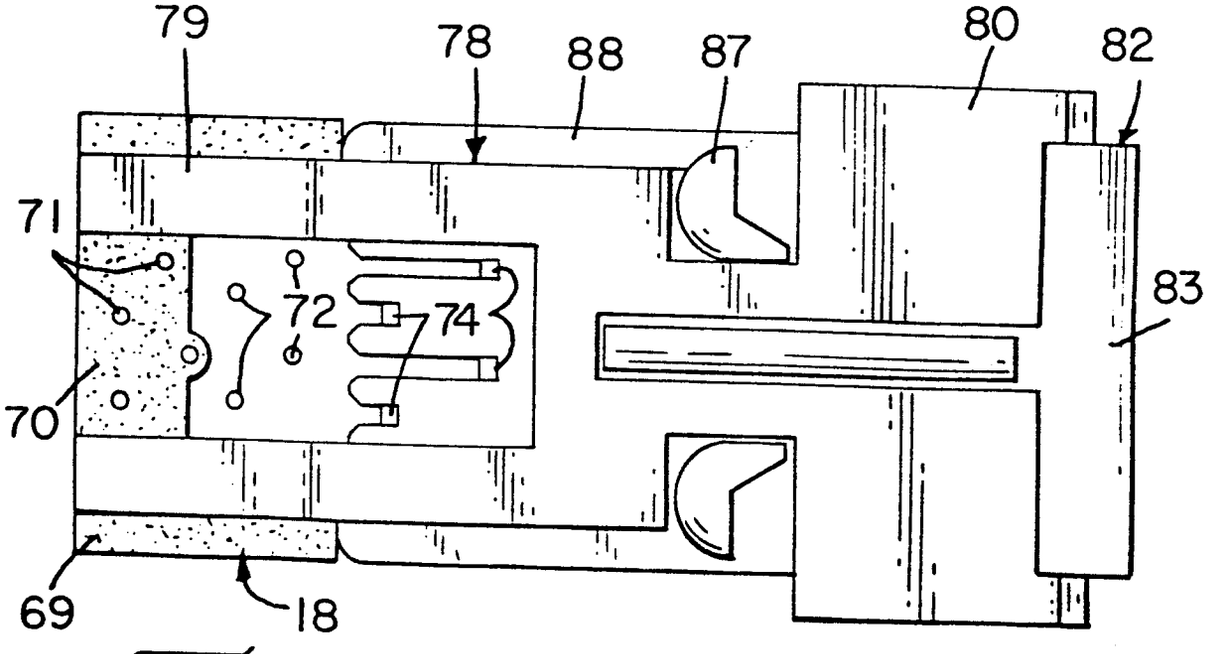
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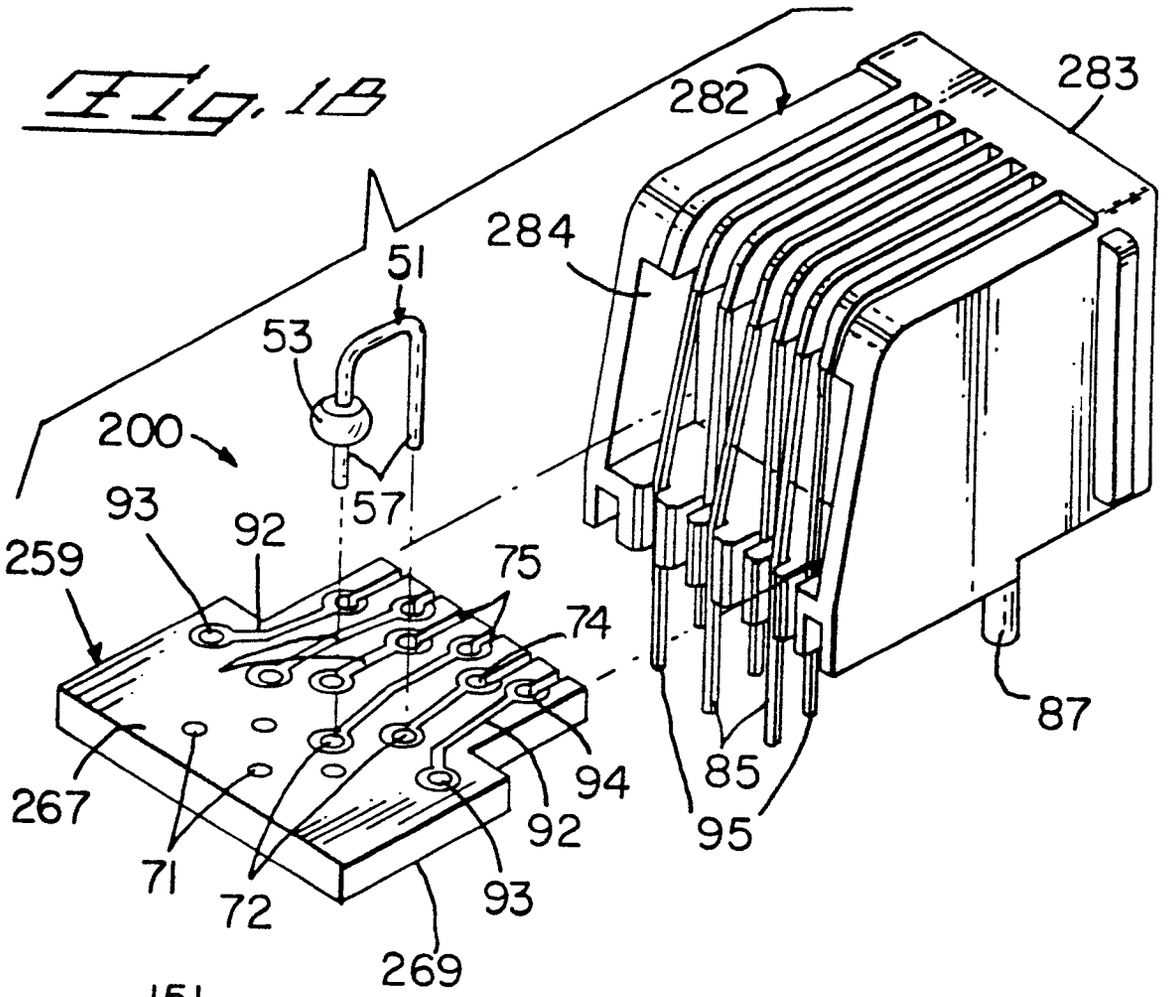
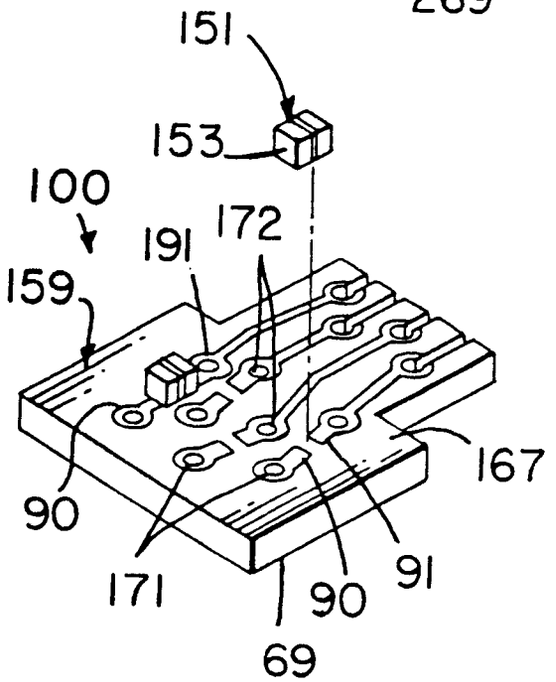
Fig. 16

Fig. 18





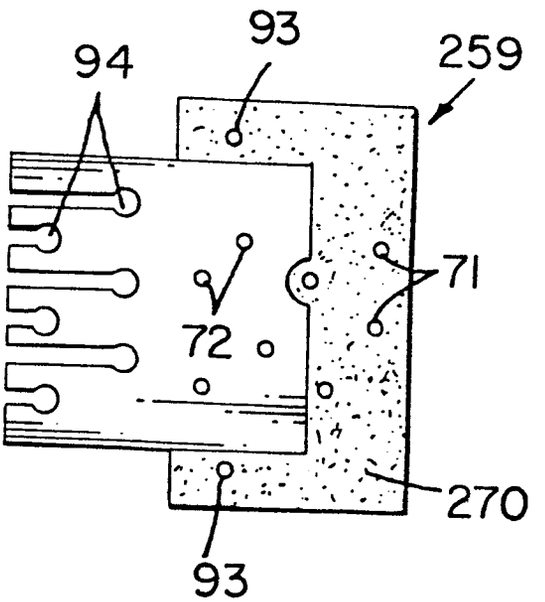


Fig. 17

Fig. 19

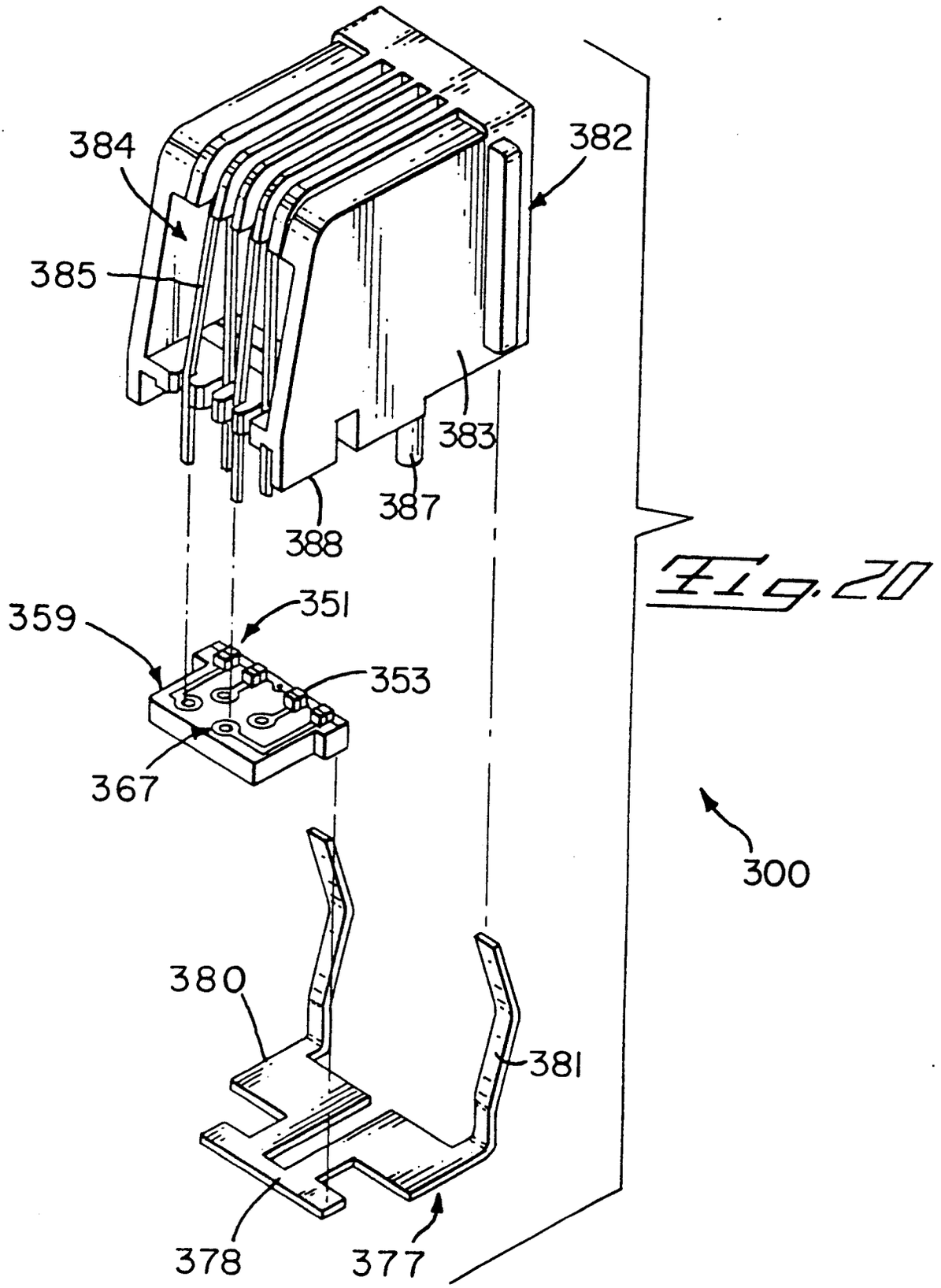


Fig. 20

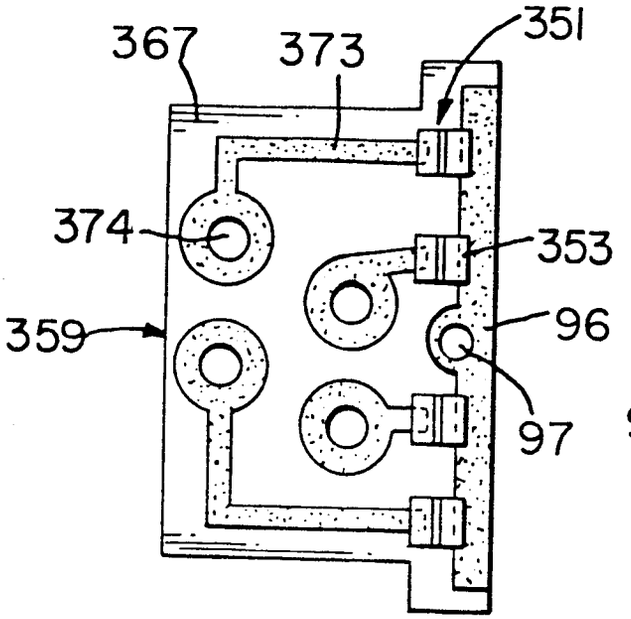


Fig. 21

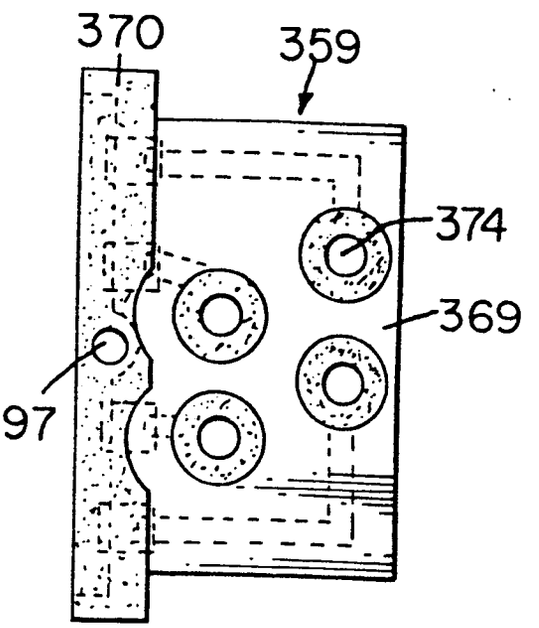


Fig. 22

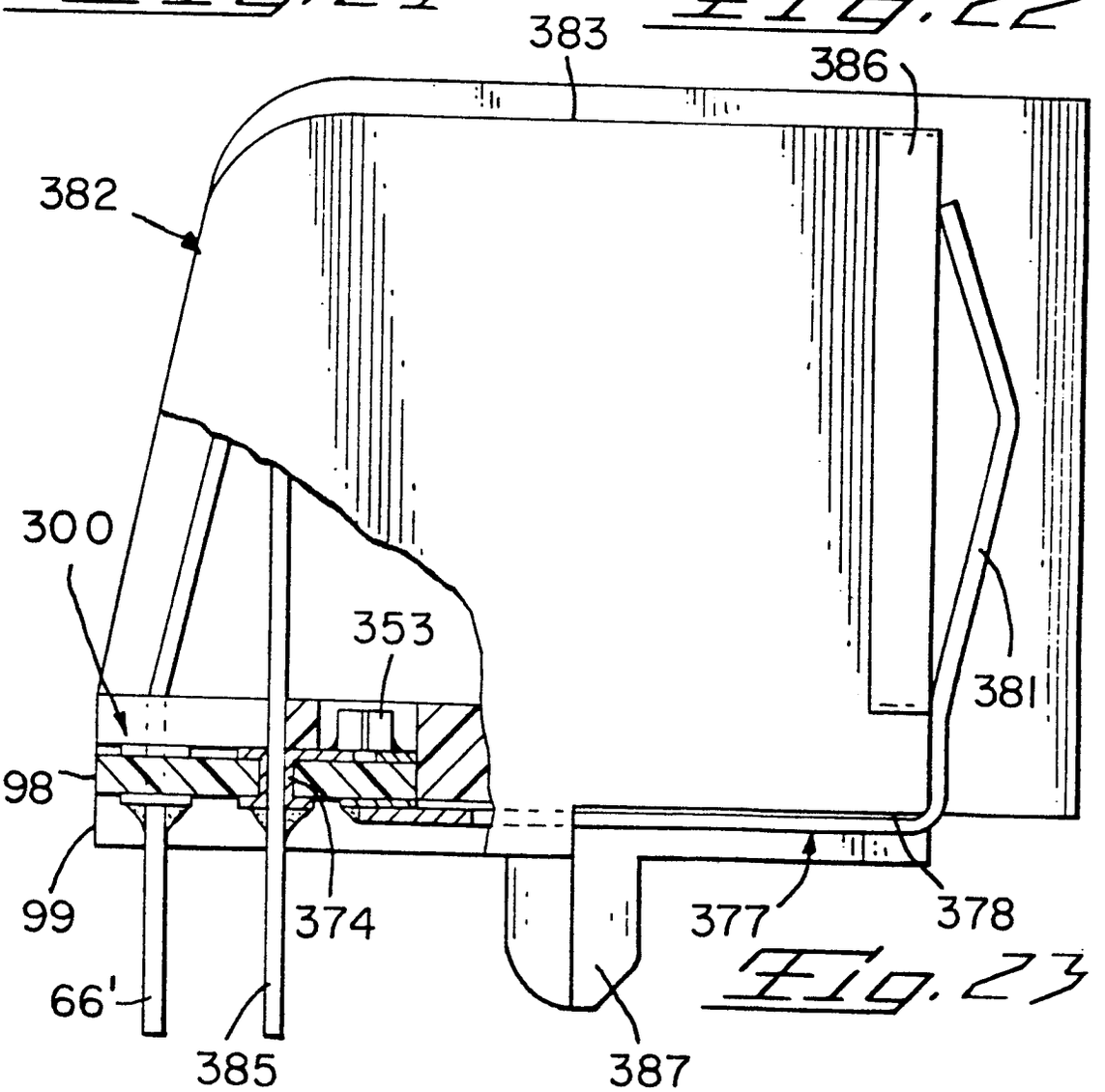


Fig. 23

Fig. 24

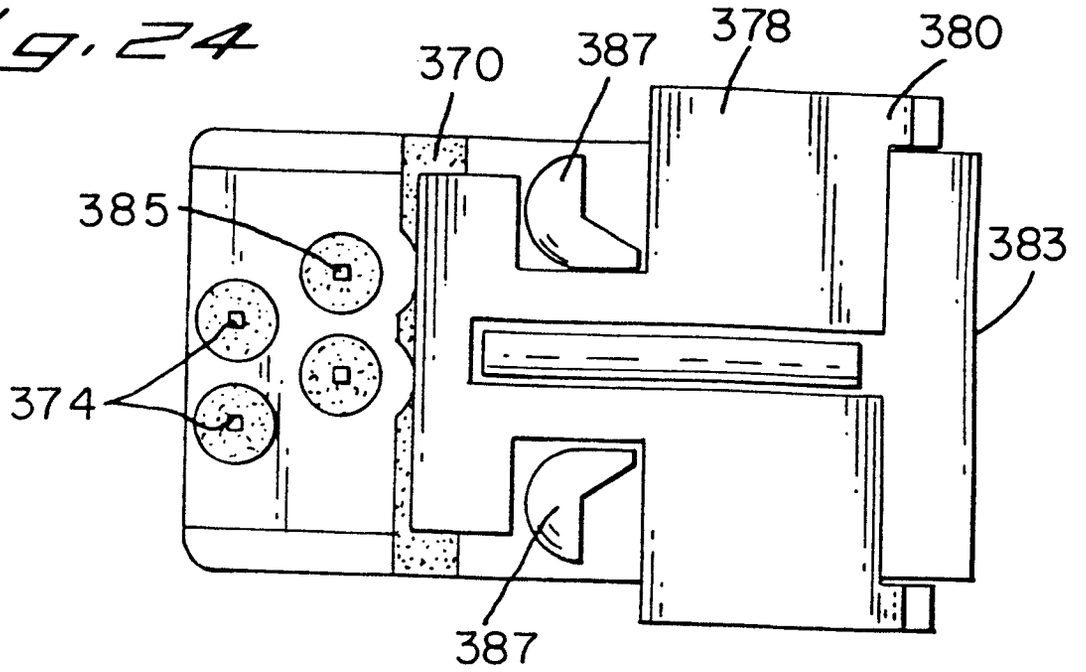


Fig. 25

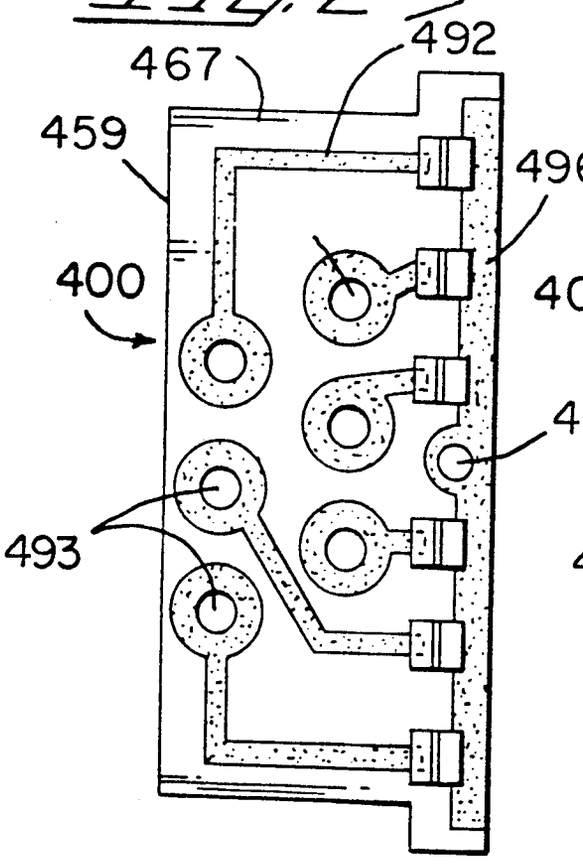
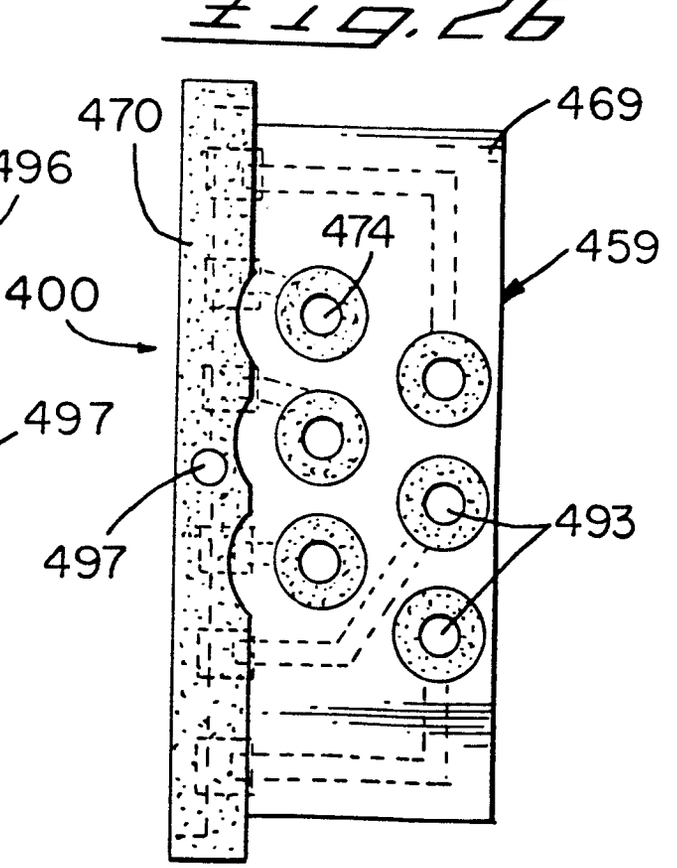


Fig. 26



0211508

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EUROPEAN SEARCH REPORT

Application number

EP 86 30 4982

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)
Y	US-A-4 198 613 (BUNKER-RAMO) * Column 2, line 67 - column 7, line 43 *	1,2,5-10	H 01 R 13/719
Y	DE-A-3 311 410 (DEUTSCHE ITT) * Page 9, line 26 - page 10, line 20 *	1,2,5-7	
Y	US-A-3 452 252 (MAPHAM) * Column 2, line 66 - column 3, line 32 *	8-10	
Y	US-A-4 365 282 (BRAINARD) * Column 3, lines 28-48 *	7	
A	US-A-4 070 084 (HUTCHINSON) * Abstract *	5,6	TECHNICAL FIELDS SEARCHED (Int. Cl 4) H 01 R 13/00 H 01 R 23/00 H 01 R 9/00
D,A	EP-A-0 024 193 (AUTOMATION-INDUSTRIES) & US-A- 4 330 166		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08-10-1986	BERTIN M.H.J.

CATEGORY OF CITED DOCUMENTS

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