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(54) **Electrical bus interconnection system.**

(57) An electrical cable assembly comprises a main electrical bus (10, 82) to which branch electrical buses (12, 88) are electrical connected. The main bus and branch buses include a plurality of insulated electrical conductors (14, 18, 78, 84) extending crosswise to one another with electrical connectors (22, 22A, 90, 90A) electrically connecting selected electrical conductors of the buses together. The electrical connectors penetrate the insulation of the buses and make electrical connection with the electrical conductors. The terminated sections of the buses can be housed in housing members (32) providing strain relief and insulation. Shielding (52) can be applied onto the main bus (10, 82) and ground connections (54, 76) can be effected at the housing members (32).

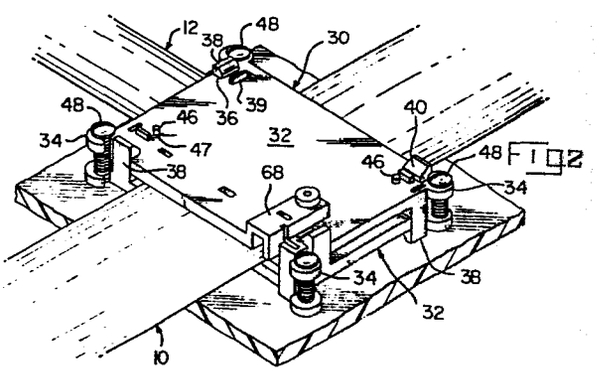

FIG 2

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TITLE MODIFIED
see front page

ELECTRICAL INTERCONNECTION SYSTEM

This invention relates to electrical connection systems and more particularly to electrical interconnection systems.

Electrical wiring harnesses are typically assembled from discrete electrical wires that are individually routed to preselected locations and subsequently bundled together. These harnesses are customarily assembled by manual application. Machines have been developed to automatically assemble harnesses. In either case, assembling such wire harnesses is time-consuming and expensive.

In accordance with the present invention, an electrical interconnection system comprises a main electrical bus to which branch electrical buses are electrically connected. The main bus and branch buses include a plurality of insulated electrical conductors extending crosswise to one another with electrical connectors electrically connecting selected electrical conductors of the buses together. The electrical connectors penetrate the insulation of the buses and make electrical connection with the electrical conductors. The terminated sections of the buses can be housed in housing members providing strain relief and insulation. Shielding can be applied onto the main bus and ground connections can be effected at the housing members.

According to another aspect of the present invention, a method of making an electrical interconnection system comprises the steps of extending a branch electrical bus across a main electrical bus, inserting electrical connectors into the crossed buses at selected locations electrically connecting certain electrical conductors of the buses together, and applying insulating housings over the crossed and interconnected buses. Insulation can be secured onto the main bus of the crossed buses thereby

covering the exposed sections of the electrical connectors and conductive shielding material is secured onto one surface of the main bus.

FIGURE 1 is a perspective and exploded view of a main electrical bus, branch electrical bus, connectors to selectively interconnect electrical conductors of the buses, and housing members to house the interconnected sections of the buses.

FIGURE 2 is a perspective view showing the elements of Figure 1 assembled.

FIGURE 3 is a perspective view of parts of crossed buses with electrical connectors exploded therefrom.

FIGURE 4 is similar to Figure 3 with one of the connectors in a terminated position and the other in a part-terminated position.

FIGURE 4A is a perspective view of an alternative embodiment of the electrical connector.

FIGURE 5 is a part cross-sectional view of a housing member showing a ground contact with interconnected buses and another housing member exploded therefrom.

FIGURE 6 is a view similar to Figure 5 in an assembled condition.

FIGURE 7 is a perspective view of another alternative embodiment of an electrical connector exploded from crossed buses.

FIGURE 8 is a cross-sectional view of the electrical connector of Figure 7 in a terminated condition with electrical conductors of the crossed buses.

FIGURE 9 is a perspective view of a further embodiment of an electrical connector exploded from crossed buses.

FIGURE 10 is a cross-sectional view of the electrical connector of Figure 9 in a terminated condition with electrical conductors of the crossed buses.

FIGURE 11 is a perspective view of a harness making operation for electrically interconnecting branch electrical buses to a main electrical bus.

FIGURE 12 is a large perspective view of the programmable terminating equipment of Figure 11.

FIGURE 13 is a flow diagram of the harness making operation of Figures 11 and 12.

Figures 1 through 6 illustrate an electrical interconnection system relating to a main electrical bus 10 to which is electrically connected branch electrical buses 12 to form an electrical harness for use in electronic controlled equipment or the like. Main electrical bus 10 is in the form of a multi-conductor cable with electrical conductors 14 disposed in an insulating jacket 16 so that electrical conductors 14 extend parallel to and insulated from one another. Electrical conductors 14 are typically of a size to carry electronic signals therealong in either direction and the conductors can either be stranded or single conductors. Branch electrical buses 12 are of the same construction with electrical conductors 18 covered by insulating jacket 20; branch buses 12 may not have as many conductors as main bus 10.

Part of the electrical conductors in main electrical bus 10 and branch electrical buses 12 can be larger for the purpose of supplying power to electronic equipment if desired.

Figures 3 and 4 best illustrate electrical connectors 22 for electrically connecting electrical conductors 18 of branch bus 12 to electrical conductors 14 of main bus 10. Electrical connectors 22 are stamped and formed from a suitable metal strip in strip form and they are formed into a body section 23 having a rectangular configuration with slots 24 located in opposing sides and slots 26 located in the other opposing sides. The entrances to slots 24 and 26 are beveled. Legs 28 have an L-shape in cross section and are located at each of the corners of electrical connectors 22. Electrical connectors 22 can have a round configuration if desired as shown in Figure 4A.

When it is desired to electrically connect selected ones of electrical conductors 18 of branch bus 12 with electrical conductors 14 of main bus 10, legs 28 of electrical connectors 22 are forced through insulating jacket 20 so that slots 24 displace the insulation surrounding electrical conductor 18 and legs 28 penetrate insulating jacket 16 while slots 26 displace the insulation surrounding electrical conductor 14 selected to be connected with electrical conductor 18 on each side of their selected crossing locations thereby electrically connecting the selected conductors together. In this way, electrical conductors of main bus 10 and electrical conductors of branch bus 12 can be selected for interconnection by electrical connectors

22 thereby resulting in a programmed interconnection therebetween in accordance with the needs of the electronic equipment to which branch bus 12 is to be electrically connected by means of a suitable electrical connector (not shown) terminated to the conductors of branch bus 12.

Electrical connectors 22 in a strip form can be inserted into a terminated position by a program-operated applicator of the type illustrated in Figures 11 and 12, legs 28 penetrate through insulating jackets 20, 16 of buses 10, 12 and respectively straddle electrical conductors 18, 14 with slots 24 displacing the insulation covering conductors 18 and making electrical connection with the conductors, whereas slots 26 displace the insulation covering electrical conductors 14 and also make electrical connection therewith as illustrated in Figure 4. In this way, selected conductors 18 of bus 12 are electrically connected with selected conductors 14 of bus 10 thereby programmably interconnecting these electrical conductors together in accordance with an established program.

The terminated sections of branch buses 12 to main bus 10 are preferably encased in housing member 30 to protect the terminations and to provide a strain relief, as well as to secure the housing members in position to the equipment or within the equipment itself. Housing member 30 comprises hermaphroditic cover members 32 molded from a suitable dielectrical material. Each cover member 32 includes hook members 34 at each corner with slots 36 and latching members 38 adjacent thereto. Latching members 38 have beveled surfaces 40 and latching surfaces 42. A rectangular wall 44 extends outwardly from an inside surface of cover member 32 and is spaced inwardly from slots 36 and latching member 38. Aligning members 46 also extend outwardly from the inner surface of cover members 32 at opposite corners of wall 44 and they are insertable into holes 47 as cover members 32 are latchably mated together and they serve to align latching members 38 with their respective slots. Bus 10 and buses 12 extend through housing member 30 when cover members 32 are latchably secured together with the terminated areas of the buses disposed within the area defined by walls 44.

In operation, a section of branch bus 12 terminated to main bus 10 via electrical connectors 22 is positioned within wall 44 of cover member 32, then another cover member 32 is latchably connected to cover member

32 via latching members 38 positioned in respective slots 36 with latching surfaces 42 engaging the outer surfaces of cover members 32, aligning members 46 and holes 47 aligning respective cover members 32 relative to one another and latching members being aligned relative to respective slots 36 to enable the cover members to be latched together so that bus 12 and bus 10 extend through housing member 30 with the terminated areas thereof and electrical connectors being protected and insulated by housing member 30. If desired, screws or bolts 48 engage hook members 34 to secure housing 30 in position as illustrated in Figure 2. Beveled surfaces 40 facilitate movement of latching members 38 outwardly as cover members 32 move together in a latched condition. Projections 39 are spaced inwardly from respective slots 36 and they serve as a surface against which a screwdriver or the like is positioned to apply a force against latching members 38 to move them from a latched position.

After branch electrical buses 12 are terminated to main electrical bus 10 at selected locations therealong via electrical connectors 22, main bus 10 can be shielded if desired to provide a shielded electrical harness that will comply with Federal Communications Commission regulations. To shield main bus 10, a piece of insulating tape 50 is secured onto main bus 10 covering legs 28 of connectors 32 that extend therethrough to insulate them. Thereafter, a sheet of conductive foil 52 having the same width as bus 10 is adhered to bus 10 thereby supplying a shield therefor. Conductive foil can also be applied to branch buses 12.

Each housing member 30 can have secured thereto a grounding contact 54 to ground conductive foil 52 at each of housing members 30 or selected ones thereof as desired. Ground contact 54 comprises an elongated member 56 having securing members 58 that are wedgingly secured in slots 60 located in one side of wall 44. Spring contact fingers 62 are bent back over elongated member 56 for electrical connection with conductive foil 52 when the terminated sections of buses 10, 12 are housed in housing member 30 within the walls 44 as illustrated in Figure 6.

Spring ground contact 64 extends outwardly from elongated member 56 and is positioned along an inside surface 66 of a channel section 68 of cover members 32 with spring ground contact 64 extending between an outer end of an extension 70 of wall 44 which also extends between the

sidewalls of channel section 68. A vertical section 72 of contact 64 extends along extension 70. The free end of contact 64 is almost located coincident with the axis of hole 74. A ground wire 76 is inserted into hole 74 through the beveled entrance thereto and is forced against the inner end of channel section 68 by the spring action of spring ground contact 64 as illustrated in Figure 6 thereby biting into ground wire 76 and securely maintaining ground wire 76 in electrical engagement therewith. Ground wire 76 can then be appropriately connected to a suitable ground. In this way, a number of ground connections can be made for appropriately grounding conductive foil shield 52 at a number of locations.

Figures 7 through 10 illustrate alternative embodiments of electrical connectors for use in conjunction with electrically connecting flat conductors 78 insulatively positioned in a parallel orientation in insulating jacket 80 with flat electrical conductors 84 disposed in a parallel orientation in insulating jacket 86 of a branch electrical bus 88, flat electrical conductors 78, 84 crossing one another. Electrical connector 90 illustrated in Figures 7 and 8 has a circular body section 92 from which depends legs 94 that are pointed at their outer ends. Triangular shaped members 96 are located centrally of body section 92 and they extend parallel to the axis thereof.

Electrical connectors 90 have been formed in accordance with conventional metal stamping and forming practices in strip form if desired and legs 94 are inserted through the insulating jackets of overlapping buses 82, 88 with conductors 78, 84 extending normal to one another so that legs 94 straddle such conductors at a selected point of interconnection so that when electrical connector 90 is moved to a terminating position, legs 94 clear the crossed electrical conductors at such terminating location with triangular shaped members 96 penetrating through insulating jacket 86 into penetrating engagement with conductor 84 and the pointed ends of legs 94 are directed inwardly toward the axis of connector 90 penetrating insulating jacket 80 and penetrating into conductor 78 as illustrated in Figure 8 thereby electrically connecting these conductors together and also breaking down any oxides therebetween.

Electrical connector 90A of Figures 9 and 10 is identical in configuration to electrical connector 90 of Figures 7 and 8 except that

body section 92A is rectangular in configuration rather than circular; otherwise electrical connector 90A is identical to electrical connector 90 and the termination thereof to terminate conductors 78, 84 is the same as that disclosed in relation to the termination of electrical connector 90 of Figures 7 and 8 except that pointed ends of legs 94A are not directed towards the axis of electrical connector 90A.

Figures 11 and 12 illustrate a harness making operation for making an electrical harness in an automatic manner under program control. As shown in Figure 11, main electrical bus 10 is fed from a reel 98 through a cable length sensing station 100 to sense the length of cable that is to be removed from reel 98. Bus 10 is fed to a terminating station 102 at which is located a table 104 along which bus 10 moves and is held in position thereon by hold-down members 106 that can be actuated by electromagnetic means or air- or fluid-operated means. Branch bus 12 is fed from reel 108 across main bus 10 along table 104 with bus 12 passing by cable length sensing station 110 that senses the length of cable that is desired to be removed from reel 108. A program-controlled terminating device 112 operates through an opening 114 in table 104 to automatically insert electrical connectors 22, 90 or 90A from a strip of connectors 116 fed to terminating device 112 from a supply reel (not shown) thereby interconnecting the conductors of buses 10, 12 in accordance with a programmed termination scheme. Electric motors 118 are operationally connected to terminating device 112 to move the terminating dies thereof to their programmed locations for insertion of the electrical connectors into the crossed buses electrically connecting selected electrical conductors together.

After bus 12 has been terminated to bus 10, bus 12 is cut from its supply and bus 10 is moved to insulation applying station 120 at which insulating tape 50 is applied to bus 10 covering the exposed legs of the connectors. Bus 12 is then moved to shield applying station 122 where conductive foil 52 is adhesively secured to the bottom surface of bus 10 whereafter housing member 30 is positioned onto the terminated sections of buses 10, 12.

After other branch buses 12 have been terminated to main bus 10, insulating tape 50 applied onto bus 10, conductive foil 52 secured thereto,

and housing members 30 secured in position over the terminated sections of the buses, bus 10 is then cut from supply reel 98 and a completed harness has now been made. If desired, only housing member 30 can be positioned onto the terminated sections of the buses without applying insulating tape or conductive foil. Insulating tape and foil may be applied to both sides of the main and branch cables.

Figure 13 depicts a flow diagram for making a harness in accordance with the equipment illustrated in Figures 11 and 12, and the harness making operation can be under the control of a programmable controller that is microprocessor operated. Insulating tape can be applied onto main bus cable and branch bus cable if conductive foil is to be adhesively secured onto both sides of the main bus cable. If conductive foil is secured onto the main bus cable, then grounding contact 54 is included in the housing member.

CLAIMS:

1. An electrical cable assembly comprising a main electrical bus (10, 82) having a multiplicity of insulated electrical conductors (14, 78), electrical branch bus members (12, 88) each having a multiplicity of insulated electrical conductor members (18, 84) crossing the main electrical bus (10, 82) at spaced locations along the main electrical bus (10, 82), electrical connectors (22, 22A, 90, 90A) penetrating through crossed insulated electrical conductors (14, 78) and electrical conductor members (18, 84) at selected crossing locations electrically connecting them together as connected sections, and dielectric housing members (32) covering the connected sections of the main electrical bus and branch electrical bus members, characterized in that

said housing members (32) are hermaphroditic and have continuous walls (44) within which the connected sections are disposed, the outer ends of walls (44) being spaced from each other enabling the main electrical bus (10, 82) and branch electrical bus members (12, 88) to extend outwardly from respective sides of the housing members (32), latching members (28) of housing members (32) latchably engaging each other maintaining housing members (32) together, said electrical connectors (22, 22A, 90, 90A) having leg members (28, 94, 94A) penetrating the insulated electrical conductors (14, 78) and insulated conductor members (18, 84) on each side of their selected crossing locations at which the electrical connections are made between conductors (14, 78) and conductor members (18, 84).

2. An electrical cable assembly as set forth in claim 1, characterized in that the conductors (14) and conductor members (18) are round and the electrical connectors (22, 22A) include opposed slots (24) in which electrical conductors (14) are disposed and other opposed slots (26) in which conductor members (18) are disposed.

3. An electrical cable assembly as set forth in claim 1, characterized in that the conductors (78) and conductor members (84) are flat and the electrical connectors (90, 90A) include triangular-shaped members (96) penetrating through the insulated electrical conductor members (84) and into electrical engagement with conductor members (84) while leg members (94, 94A) extend through the insulation of conductors

(78) and conductor members (84) with pointed ends of the leg members (94, 94A) penetrating back through the insulation of conductors (78) into electrical engagement with conductors (78).

4. An electrical cable assembly as set forth in claims 2 or 3, characterized in that insulation (50) covers the parts of the electrical connectors (22, 22A, 90, 90A) protruding through main bus (10, 82) and conductive foil (52) is secured to main bus (10, 82) covering insulation (50).

5. An electrical cable assembly as set forth in claim 4, characterized in that a ground contact member (54) is mounted on one of housing members (32) in electrical engagement with the conductive foil (52).

6. A method of making an electrical cable assembly comprising a main electrical bus (10, 82) having a multiplicity of insulated electrical conductors (14, 78) and electrical branch bus members (12, 88) each having a multiplicity of insulated conductor members (18, 84) crossing the main electrical bus (10, 82) at spaced locations along the main electrical bus (10, 82), characterized by the steps of

feeding the main bus (10, 82) to a terminating station (102);

feeding a length of branch bus member (12, 88) across the main bus (10, 82);

selectively applying electrical connectors (22, 22A, 90, 90A) to the crossed conductors (14, 78) and conductor members (18, 84) electrically connecting them together;

cutting the branch bus member (12, 88) at a cutting station (120) to a selected length; and

applying insulating housing members (32) onto the terminated sections of the main bus (10, 82) and branch bus members (12, 88).

7. A method as set forth in claim 6, characterized by the further steps of

applying insulation (50) over exposed sections of sections of the electrical connectors (22, 22A, 90, 90A); and

securing a conductive foil (52) onto the main bus (10, 82) and the insulation (50).

8. A method as set forth in claim 7, characterized by the further step of

interconnecting the conductive foil (52) with a ground contact (54) in the housing members (32).

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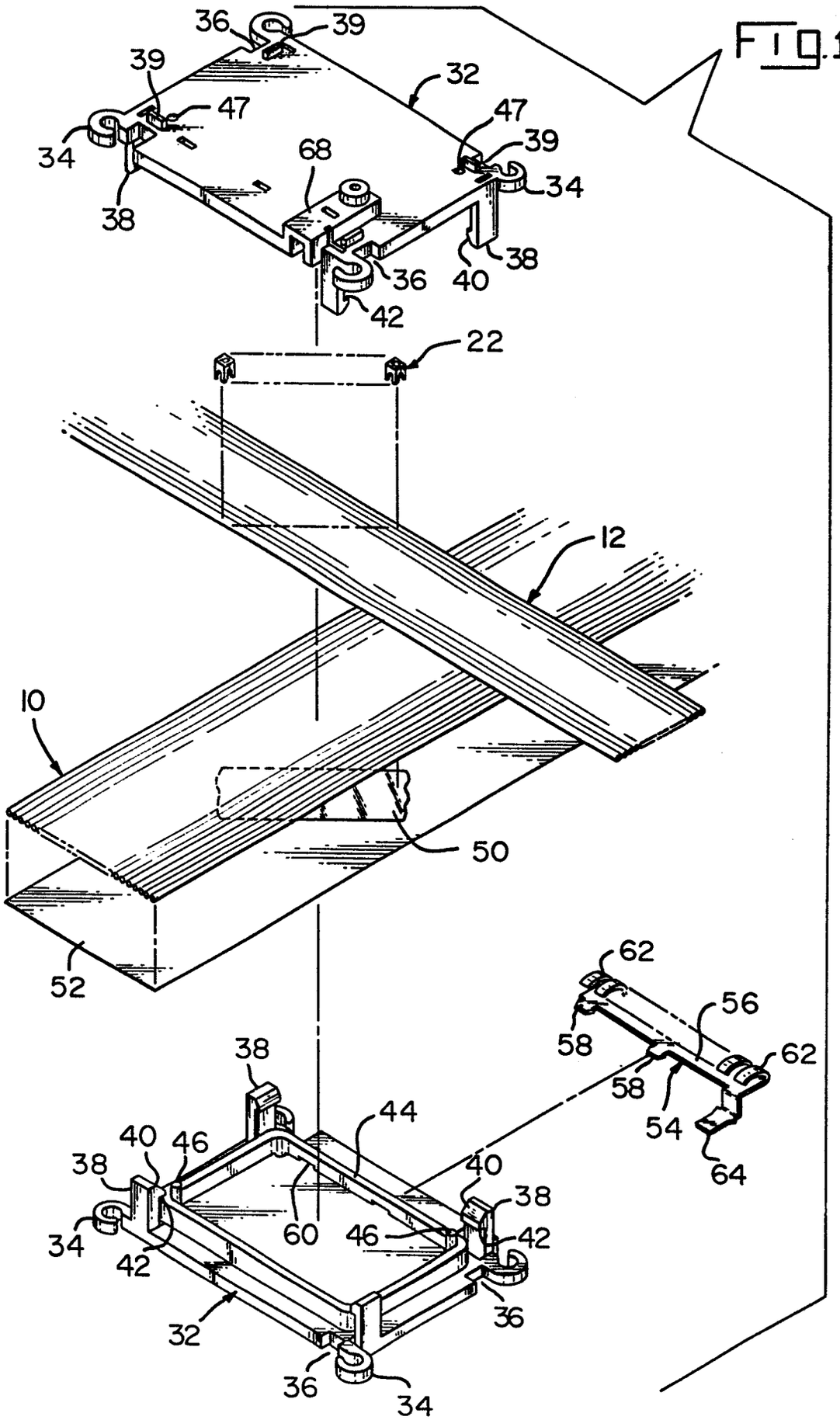
Fig.1



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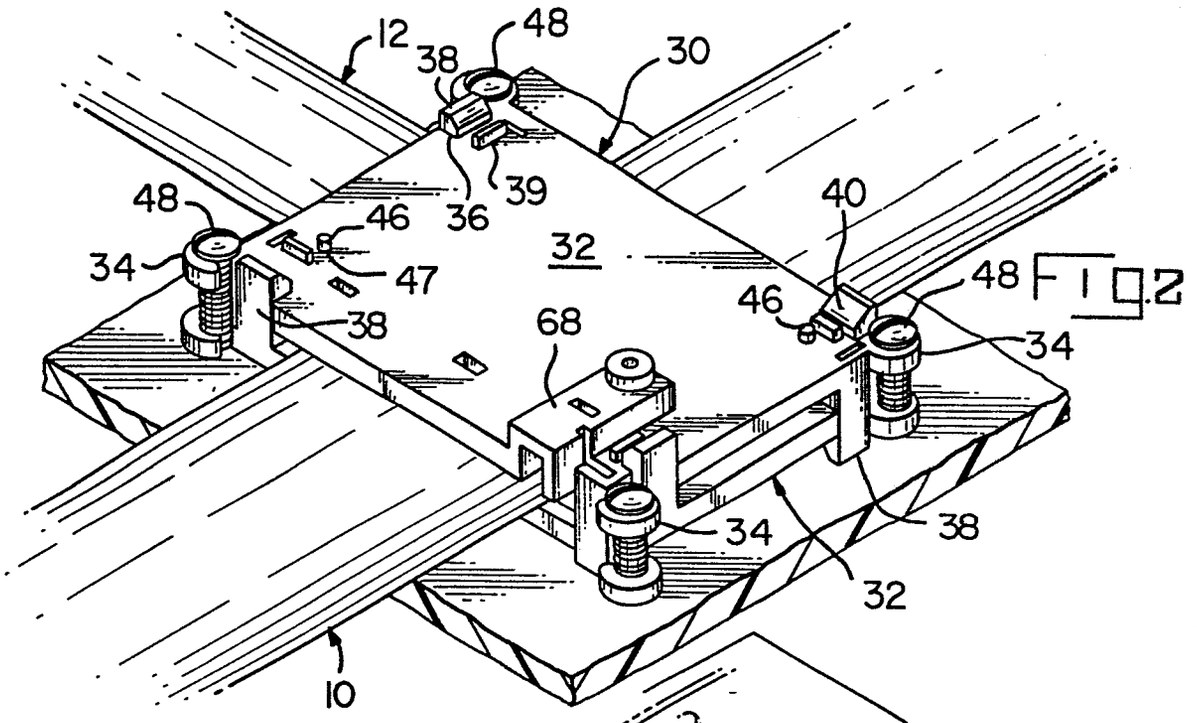

FIG.2

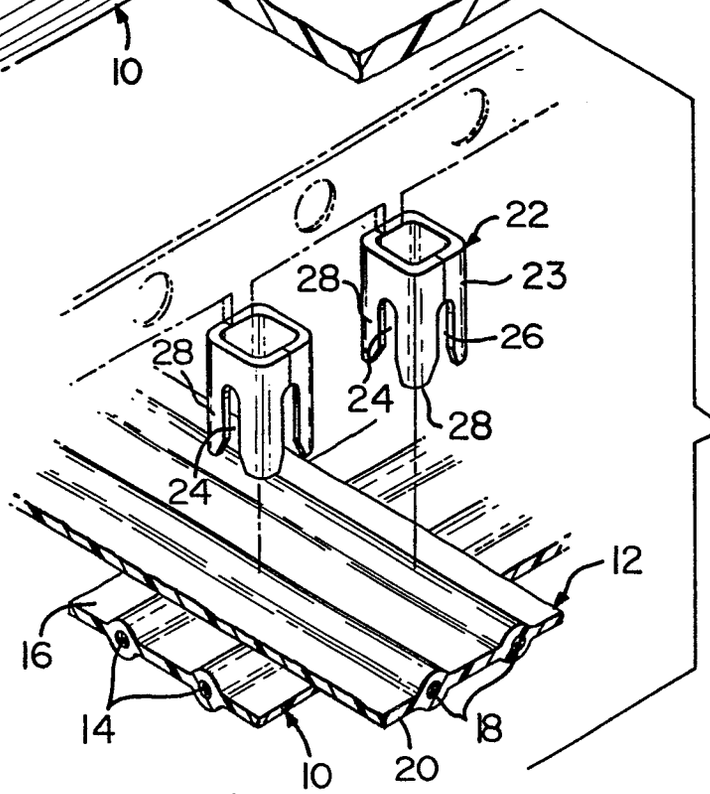

FIG.3

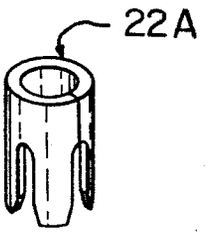

FIG.4A

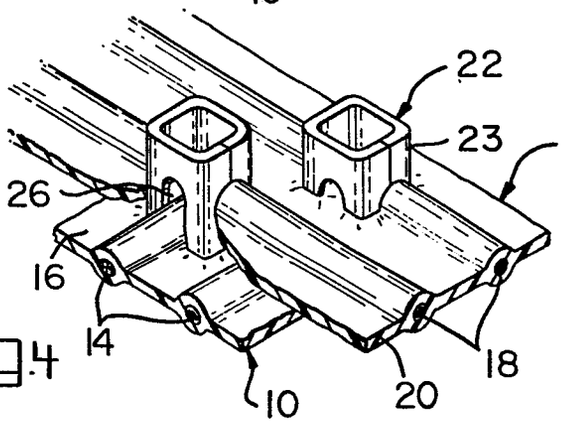

FIG.4

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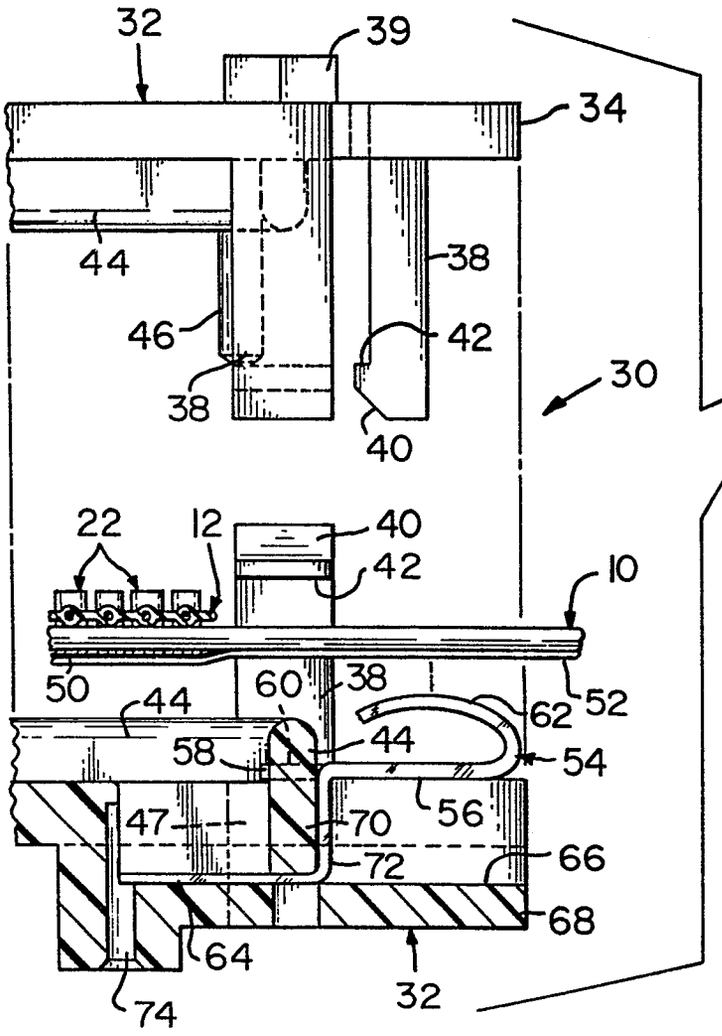


FIG.5

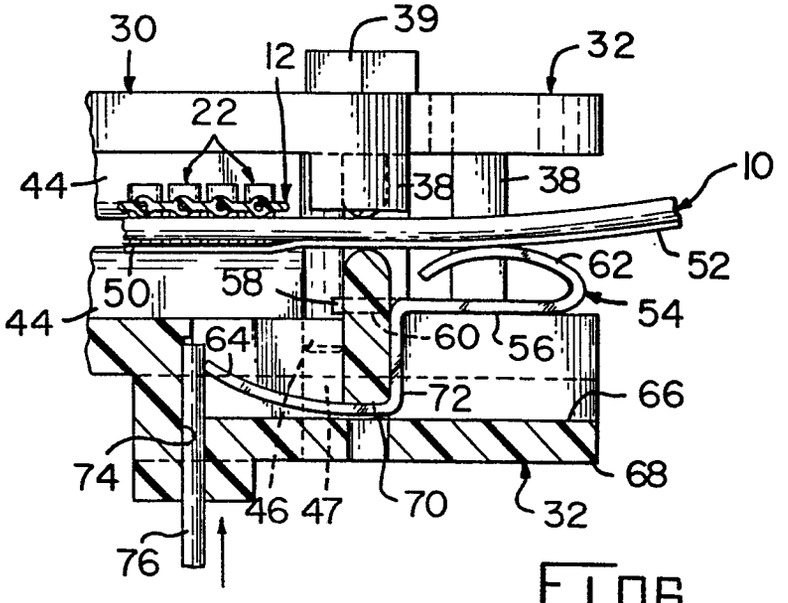


FIG.6

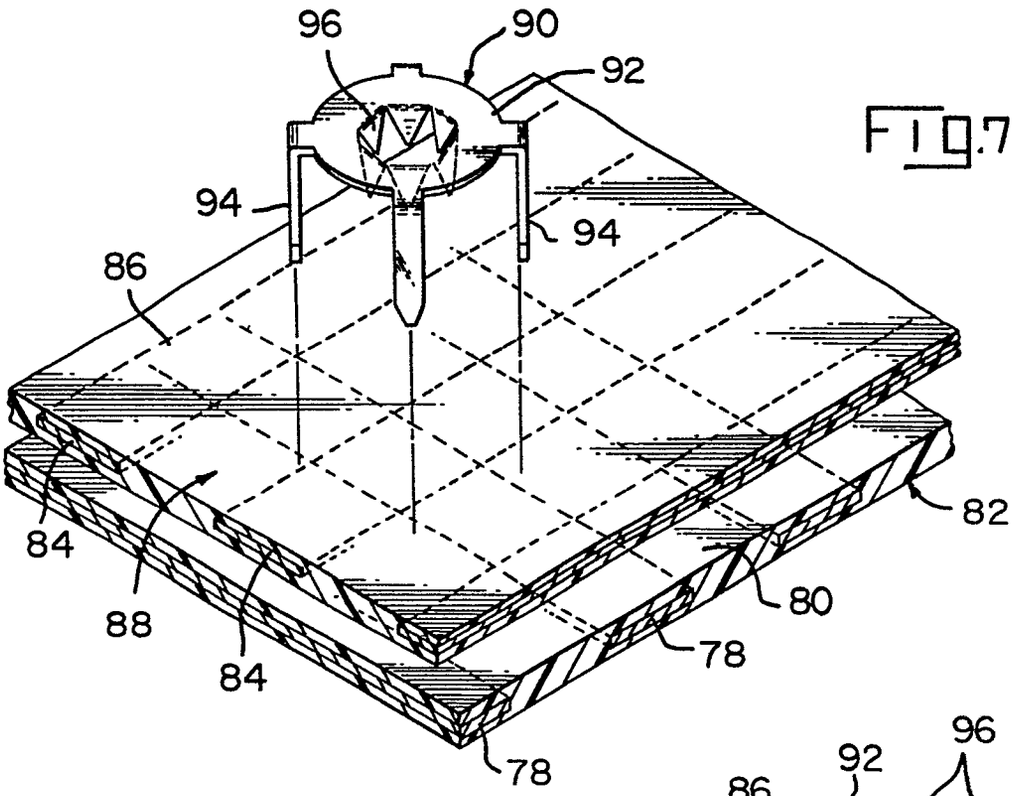


FIG.7

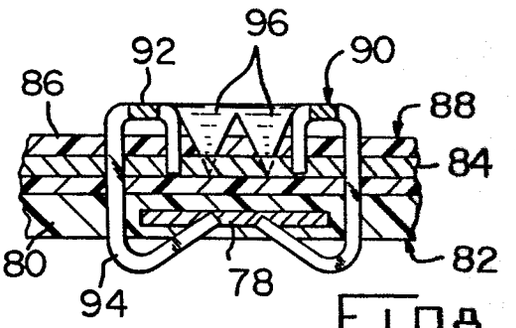
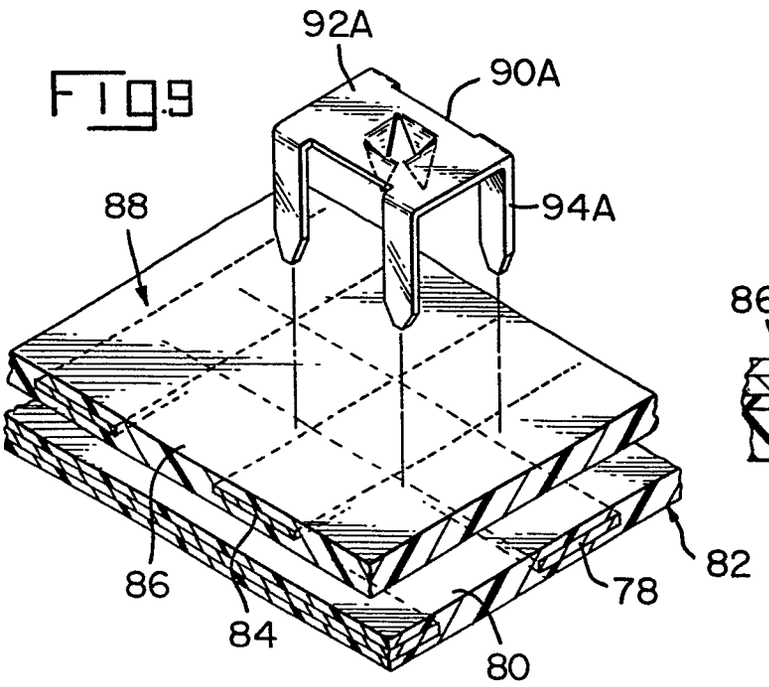


FIG.8

FIG.9



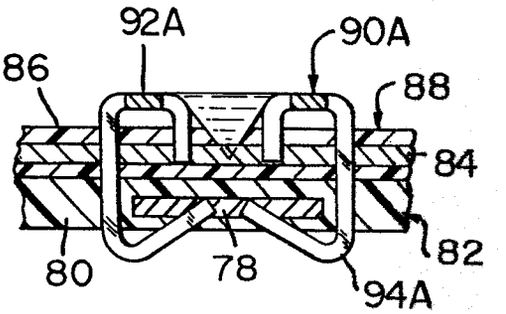


FIG.10

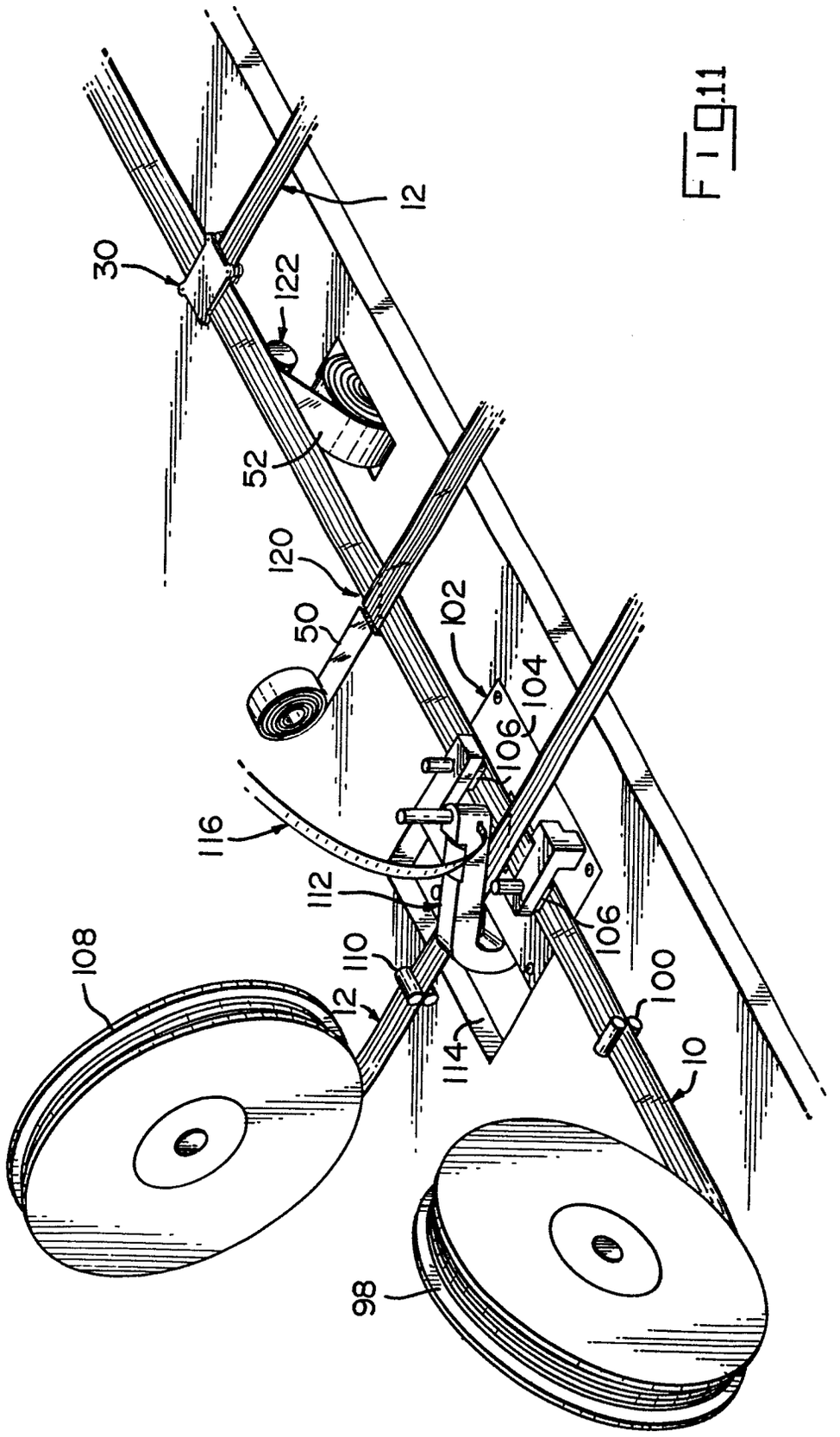

12
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FIG.11

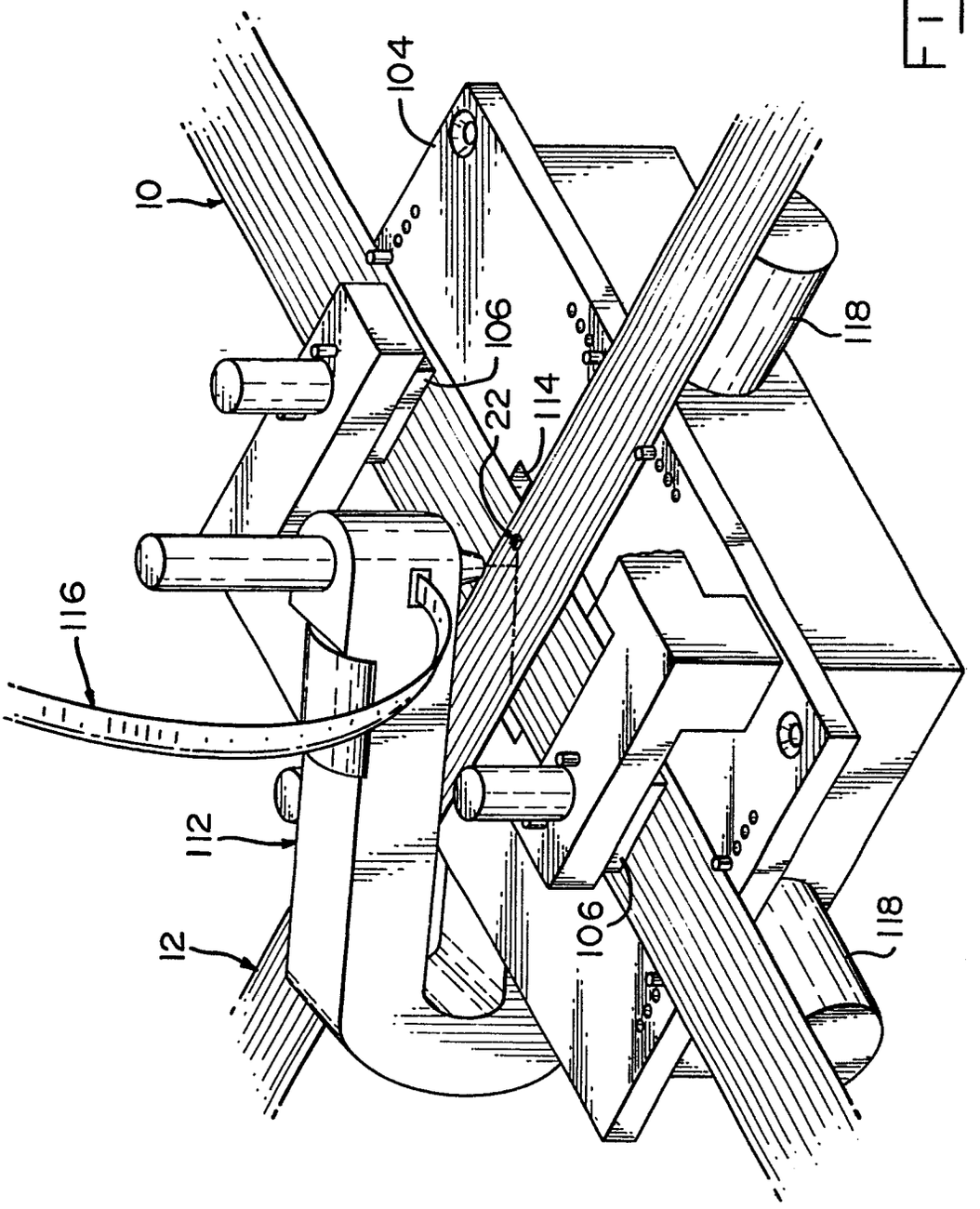

FIG 12

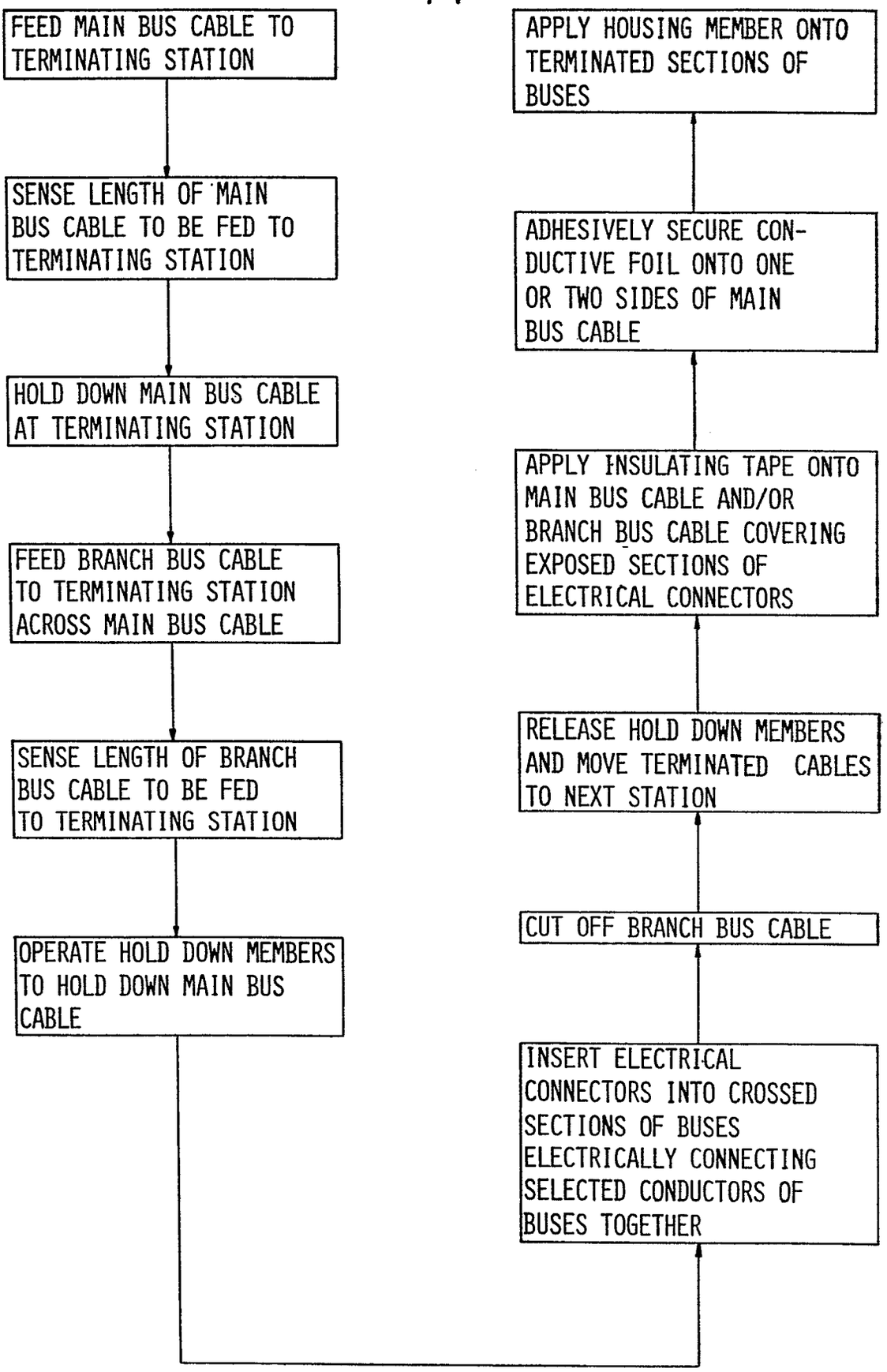
FEED MAIN BUS CABLE TO TERMINATING STATION
SENSE LENGTH OF MAIN BUS CABLE TO BE FED TO TERMINATING STATION
HOLD DOWN MAIN BUS CABLE AT TERMINATING STATION
FEED BRANCH BUS CABLE TO TERMINATING STATION ACROSS MAIN BUS CABLE
SENSE LENGTH OF BRANCH BUS CABLE TO BE FED TO TERMINATING STATION
OPERATE HOLD DOWN MEMBERS TO HOLD DOWN MAIN BUS CABLE
INSERT ELECTRICAL CONNECTORS INTO CROSSED SECTIONS OF BUSES ELECTRICALLY CONNECTING SELECTED CONDUCTORS OF BUSES TOGETHER
CUT OFF BRANCH BUS CABLE
RELEASE HOLD DOWN MEMBERS AND MOVE TERMINATED CABLES TO NEXT STATION
APPLY INSULATING TAPE ONTO MAIN BUS CABLE AND/OR BRANCH BUS CABLE COVERING EXPOSED SECTIONS OF ELECTRICAL CONNECTORS
ADHESIVELY SECURE CONDUCTIVE FOIL ONTO ONE OR TWO SIDES OF MAIN BUS CABLE
APPLY HOUSING MEMBER ONTO TERMINATED SECTIONS OF BUSES

FIG.13

European Patent Office

EUROPEAN SEARCH REPORT

0100602
Application number

EP 83 30 3834

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. ³)
A	DE-A-2 254 395 (BBC) * Page 6, last paragraph - page 10, paragraph 1; figures 1-8 *	1,2	H 01 R 9/07 H 01 R 4/24
A	DE-A-2 264 216 (BBC) * Page 6, paragraph 2 - page 7, paragraph 3; figures 1-4 *	1,2	
A	DE-A-2 031 215 (ERNSTING) * Page 9, last paragraph - page 11, paragraph 4; figures 1-10 *	1,2	
A	GB-A-1 372 401 (PRESSAČ) * Page 2, line 22 - page 3, line 70; figures 1-4 *	1,3	
A	GB-A-2 052 181 (THOMAS & BETTS) * Page 2, line 11 - page 4, line 19; figures 1-8 *	1,3	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

H 01 R 9/00
H 01 R 4/00
H 01 R 23/00
H 01 R 43/00
H 01 B 7/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28-10-1983	LOMMEL A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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