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(54) Apparatus for, and a method of, serially manufacturing electrical harness assemblies.

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Wires (22) are advanced through a wire insertion zone (222), slotted plate electrical connectors (4 and 6) are fed by a slide (152) into the zone (222) so that each wire (22) is aligned with a slotted plate terminal of each of the connectors (4 and 6), a wire insertion ram (74) is lowered to insert the wires (22) into the terminals and to cut out scrap parts of the wires (22) between the connectors (4 and 6), the ram (74) is raised, and a complete harness comprising a connector (4') applied during the previous cycle of the apparatus, and the connector (6) is removed from the apparatus and the wires (22) are advanced again.

For the reduction of manual operations, the wires (22) are advanced from wire spools by a wire advancing mechanism, through wire positioning means (90, 94) from which the wires (22) are driven by the ram (74) into the terminals of the connectors (4 and 6).

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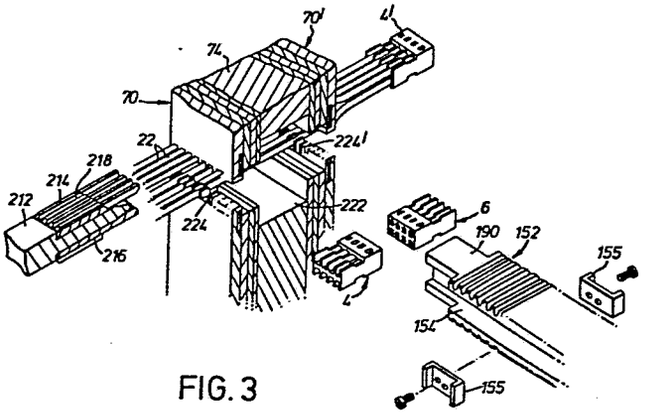

70'
4'
74
70
224'
22
218
214
212
216
224
222
6
190
152
155
154
155

FIG. 3

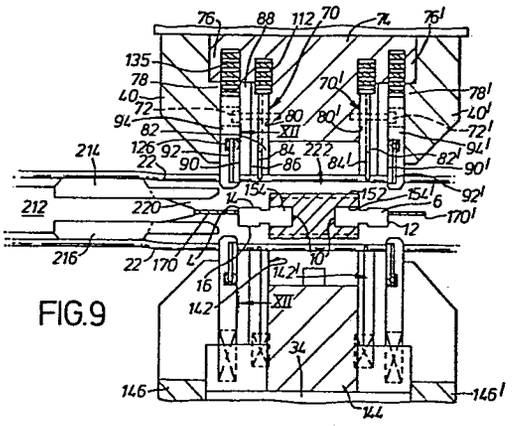

76
88
112
70
74
76'
135
78
40
72
94
82
126
92
22
90
214
212
220
216
22
170
4
16
142
XII
34
146
146'
144
70'
80
80'
84
222
86
84'
78'
40'
72'
94'
82'
90'
92'
154
152
154'
6
170'
12
10'
142'

FIG.9

0041815
9376

Apparatus for, and a method of, manufacturing electrical harness assemblies.

We have disclosed in US-A-3,909,935 and US-A-3,866,297, apparatus for serially manufacturing electrical harness assemblies each comprising first and second electrical connectors each having at least one row of electrical terminals therein, each terminal having a wire-receiving portion, an end of a wire being received in the wire-receiving portion of each terminal; the apparatus comprising, a wire insertion zone having first and second wire insertion stations; first and second connector locating means for locating a first and a second connector at the respective stations in parallel aligned relationship, with the wire-receiving portions of the terminals of the connectors in endwise alignment; first and second wire insertion tooling assemblies each comprising wire inserters which are normally spaced from the first and second connector locating means, and which are movable relatively there towards to move the wires towards the connector locating means and into the wire receiving portions of the terminals; and wire severing means between the first and second insertion tooling assemblies for severing the wires at positions between the first and second connector locating means.

The known apparatus, into which the wires and the connectors are loaded manually, produces harness assemblies each comprising two connectors which can be mated with one another, each connector having a single row of terminals and being terminated to an

individual array of wires.

The use of the known apparatus for producing harness assemblies each comprising a plurality of connectors terminated to a common array of wires would involve the performance of further manual operations. The present invention is directed to the achievement of a reduction in the number of manual operations required in the manufacture of such harness assemblies, as well as to the provision of harness manufacturing apparatus which can readily be adapted for use with connectors having two superposed rows of terminals; and to a method of producing most economically, harness assemblies comprising such connectors.

According to one aspect of the invention, apparatus as defined in the first paragraph of this specification is characterised in that for producing harness assemblies in which one end of each wire is received in a wire receiving portion of a terminal of the first connector and the other end of the wire is received in a wire receiving portion of a terminal of the second connector; the apparatus comprises wire positioning and retaining means in the insertion zone for locating a plurality of wires substantially in a common plane with the wires in lateral alignment with the wire receiving portions of the terminals of the first and second connectors when these are positioned in the respective first and second connector locating means, the wire positioning and retaining means being effective releasably to retain the wires until they are moved by the wire inserters towards the connector locating means; and by means for feeding the wires along a wire feed path from wire sources into the wire insertion zone, with the wires located in lateral alignment with the wire receiving portions,

by the wire positioning and retaining means.

Conveniently, for producing electrical harnesses in which each connector has two parallel, superposed rows of terminals, the wire receiving portions of the terminals of the rows opening in opposite directions; the wire positioning and retaining means are arranged to locate the wires in two substantially parallel planes, one on either side of the connector locating means, the wire insertion tooling assemblies comprising similar tooling positioned on either side of the connector locating means, for inserting the wires in the two planes, simultaneously into the wire receiving portions of all the terminals, and the wire severing means comprising tooling for severing the wires in each plane.

According to another aspect of the invention, a method of serially manufacturing electrical harness assemblies each comprising first and second electrical connectors each having at least one row of electrical terminals therein, each terminal having a wire receiving portion, an end of a wire being received in the wire receiving portion of each terminal; in which method; the first and second connectors are positioned in a wire insertion zone with the wire receiving portions of the terminals of the connectors in endwise alignment with one another; the wires are placed in the insertion zone so that each wire is in lateral alignment with a wire receiving portion of each connector; the wires are moved laterally of their longitudinal axes towards the connectors to insert each wire into the wire receiving portions with which it is in lateral alignment; and the connectors are subsequently removed from the wire insertion zone; is characterised in that for producing harness assemblies, in which each connector has two parallel

superposed rows of terminals, the wire receiving portions of the terminals of the two rows opening in opposite directions, and in which one end of each wire is received in a wire receiving portion of a terminal of the first connector and the other end of the wire is received in a wire receiving portion of a terminal of the second connector; the wires are fed from wire sources along a wire feed path in two substantially parallel, spaced planes, the feed path extending through and beyond the wire insertion zone, and the connectors are then positioned in the insertion zone so as to lie between the planes with each wire receiving portion opening towards one of the wires and with the second connector positioned downstream, along the wire feed path, with respect to the first connector, the second connector being removed from the insertion zone, subsequently to the insertion of the wires into the wire receiving portions and the severing of the wires, and the first connector being then moved lengthwise of the wire insertion path through, and a predetermined position beyond, the insertion zone, whilst maintaining the wires in their two planes, whereafter a further first and second connector are positioned in the insertion zone and the wires are inserted into the wire receiving portions of the terminals of the connectors in the manner aforesaid.

As described below, the apparatus and the method of the invention can be employed to manufacture harness assemblies each comprising more than two connectors.

The current state of the art is further exemplified by US-A-4,043,034, US-A-4,043,017 and US-A-3,136,440.

For a better understanding of the invention, reference will now be made by way of example to the

accompanying drawings in which:-

Figure 1 is a perspective view showing parts of a bench press provided with harness making apparatus mounted on a ram of the press, and also showing means for feeding connectors into an insertion zone of the harness making apparatus;

Figure 2 is an enlarged perspective view of an electrical harness assembly produced by the apparatus;

Figures 3 to 6 are fragmentary, diagrammatic, perspective views showing the insertion zone of the apparatus and some associated parts of the apparatus, and illustrating successive steps in the production of harness assemblies;

Figure 7 is a side view, shown partly in section, and as seen from the right hand side of the apparatus as shown in Figure 1;

Figure 8 is a view taken on the lines VIII - VIII of Figure 7;

Figure 9 is an enlarged fragmentary view, shown partly in section, of the insertion zone of the apparatus with the parts thereof positioned preparatory to the insertion of wires into electrical connectors of a harness assembly in the course of production;

Figure 10 is a view similar to that of Figure 9 but showing the positions of the parts after insertion of the wires into the connectors and after a first connector has been fed through the insertion zone;

Figure 11 is a partially exploded, perspective view, of upper wire insertion tooling of the apparatus, and also showing a tool support block for the tooling;

Figure 12 is a fragmentary view taken on the lines XII - XII of Figure 9 and showing details of wire retaining means of the upper and lower wire insertion tooling of the apparatus;

Figure 13 is a view taken on the lines XIII -

XIII of Figure 12;

Figure 14 is a plan view taken on the lines XIV - XIV of Figure 7 and showing a slide for loading connectors into the insertion zone, with the slide in an outer, retracted position;

Figure 15 is a view similar to that of Figure 14 but showing the slide in an inner, advanced position;

Figure 16 is a view taken on the lines XVI - XVI of Figure 14; and

Figure 17 is a diagrammatic perspective view of another electrical harness assembly.

Electrical harness assemblies 2 are produced in a manner illustrated in Figures 3 to 6 which show only some parts of harness making apparatus.

A harness assembly 2 (best seen in Figure 2) comprises first and second identical electrical connectors 4 and 6 each having an insulating housing 8 with a forward mating end 10, a rearward end 12, top and bottom (as seen in Figure 2) side walls 14 and 16, and laterally facing end walls 18. Each housing 8 contains a plurality of electrical terminals 20 each having an elongate, wire receiving, rearward end portion 21 connected to a wire 22. The portions 21 are arranged to receive the wires 22 upon movement thereof into the portions 21, laterally of the longitudinal axes of the wires 22, to establish electrical contact with the electrically conductive cores of the wires 22. The connectors 4 and 6, which are shown by way of example, are as described in US-A-4,243,288. The terminals 20 are arranged in two parallel superposed rows 24 and 26 in stalls 19 opening into the side walls 14 and 16, the wire receiving portions 21 of the terminals 20 of the two rows opening in opposite directions. Two rows of wires 22 can be connected to the terminals 20 by locating each wire in alignment

with the portion 21 of a terminal 20 with the housings 8 positioned between the two rows of wires 22 and moving the wires 22 towards the portions 21.

The operation of the apparatus, will now be described in outline in relation to Figures 3 to 6.

At the beginning of an operating cycle of the apparatus, the wires 22 extend from wire spools (not shown) through a wire insertion zone generally referenced 222, with the wires 22 arranged in two rows in substantially parallel, spaced planes as shown in Figure 3. A connector 4' (identical with the connectors 4 and 6) was applied to the leading ends of the wires 22 during the next preceding operating cycle of the apparatus.

At the insertion zone 222 are first and second wire insertion stations 224 and 224' disposed between a ram of a press (described below) and a lower arm of the press,

An unwired first connector 4 is now positioned in the first station 224, an unwired second connector 6 being positioned in the second station 224'. The connectors 4 and 6 are located between the two substantially parallel planes in which the wires 22 lie, with the wire receiving portions 21 of the terminals 20 in the two connectors 4 and 6 in endwise alignment with each other and in lateral alignment with the wires 22. Insertion tooling, described below, is then brought into engagement with the wires 22 as shown in Figure 4, to insert each wire into a respective portion 21 of a terminal 20 of each connector 4 and 6 and each wire 22 is severed at two positions between the connectors 4 and 6, so as to remove scrap sections of wire which extend therebetween. The insertion tooling is then disengaged from the connectors 4 and 6 (Figure 5) and a completed harness assembly 2, comprising the

connectors 4' and 6, is removed from the appparatus (Figure 6). The connector 4 is then advanced through the insertion zone 222 until the desired amount of wire has been drawn from the wire spools. During movement of the connector 4 through the insertion zone 222, the wires 22 are maintained in the said two spaced planes so that during the next cycle of operation of the apparatus, a further connector 4 and 6 can be located between these planes. It will be apparent from the above description that two operating cycles of the apparatus are required to manufacture an individual harness assembly, although one harness assembly is produced during each cycle.

The apparatus will now be described in detail. The press mentioned above comprises a C-shaped press frame 30 having upper and lower arms 32 and 34 (Figures 7 and 8) extending from a neck portion 35 thereof. The frame 30 is mounted on a base plate 36 supported on a bench (not shown).

A ram assembly generally referenced 38 (Figures 7 and 8), mounted on the upper arm 32, is movable in reciprocating motion towards and away from the lower arm 34. The assembly 38 comprises side plates 40 and 40' which are disposed, as shown in Figure 8, against the sides of the arm 32, and braces 42 which extend across the upper surface of the arm 32 and are secured to the side plates 40 and 40' by means of bolts 43. A tooling support plate 44 is bolted to the lower edges of the side plates 40 and 40' beneath the arm 32, return springs 48 being interposed between the upper surface of the arm 32 and the braces 42 to bias the ram assembly 38 towards a raised position. the assembly 38 is depressed through a working stroke by means of an hydraulic piston-and-cylinder device comprising a piston 50 in a cylinder 52 drilled in

the arm 32 and closed by a cylinder head 54. The piston 50 is secured to the tooling support plate 44 and is depressed from its position of Figure 7 when hydraulic fluid is introduced into the cylinder 50 through a port 56 at the end of a passageway 58. The passageway 58 extends, as shown in Figure 7, through the press frame 30 to an hydraulic liquid reservoir 60 that extends to the upper surface of the frame 30. A pneumatic cylinder 62 mounted on the frame 30 has therein a piston 66 from which extends a piston rod 64 which is dimensioned to enter the reservoir 60. When compressed air is admitted through an inlet 68 to the cylinder 62, the piston 66 is depressed so that the piston rod 64 moves into the reservoir 60 so that hydraulic liquid is forced into the cylinder 52 depressing the piston 50 and thus the tooling support plate 44. The springs 48 return the ram assembly 38 to its normal raised pisition when the pressure in the cylinder 52 is relieved.

Identical upper insertion tooling assemblies 70 and 70' for the first and second insertion stations 224 and 224', respectively, serve simultaneously to insert the wires 22 into the portions 21 of the upper rows 24 of terminals 20 in each of the connectors 4 and 6 and identical lower tooling assemblies 142 and 142', serve simultaneously to insert the wires 22 beneath the connectors 4 and 6 into the portions 21 of the terminals 20 in the lower row 26 of each connector 4 and 6.

As best seen in Figure 11, the upper tooling assembly 70 comprises stacked, tooling members comprising a wire shearing plate 82, a comb-like wire separator plate 84, wire inserter plates 86 and 88, wire retainer plates 90 and 92 and a comb-like wire positioning plate 94. The parts of the tooling assembly 70' bear

the same reference numerals as those of the tooling assembly 70 but with the addition of a 'prime' symbol, and are similarly stacked. These stacks of tooling members are mounted against respective side surfaces 80 and 80' of a tooling mounting block 74 having lateral flanges 76 and 76' overhanging the stacks of tooling members, the stacks being secured to the block 74 by fasteners 72 and 72' (best seen in Figure 7) which extend through aligned openings 96 and 96' in some, but not all, of the tooling members. Since the tooling assembly 70' is identical with the tooling assembly 70 the tooling assembly 70' will not be further described.

The wire shearing plate 82 has spaced teeth 98 extending from its lower edge, the right hand (as seen in Figure 11) edges 97 of these teeth acting as movable shearing edges in co-operation with fixed shearing edges described below. The wire separator plate 84 is in the form of narrow bar having notches extending upwardly from its lower edge to define spaced teeth 100 for locating the wires 22 between them. The inserter plates 86 and 88 have teeth 102 and 104, respectively, for inserting the wires 22 into the portions 21 of the terminals 20.

The shearing plate 82 is immovably mounted against the surface 80, while the separator plate 84 is slidably disposed in a groove 110 extending across the adjacent face of inserter plate 86. Vertically extending, lateral recesses 108 in the plate 86 receive vertical guides 106 on the plate 84 which is urged downwardly to the limit of its movement in the groove 110 by means of helical springs 112 which bear against the upper edge of the plate 84 and against the underside of the flange 86 of the block 74. Clearance for the springs 112 is provided by channels 116 and 114, in the plates 82 and 86, respectively.

The wire retainer plates 90 and 92 co-operate with one another to provide releasable retaining means for the wires 22 prior to the wires being inserted into the terminals 20. The plates 90 and 92 are positioned against each other, being held in a recess 118 in a side face 120 of the wire positioning plate 94. The plates 90 and 92 have notches 122 and 124, respectively, in their upper edges, receiving a helical spring 126 (as shown in Figure 13), the notches 122 and 124 being offset from one another so that the spring 126 biasses the plate 92 rightwardly and the plate 90 leftwardly; as seen in Figure 13. The spring 126 is provided with clearance in the face 120 of the plate 94 by virtue of a recess 128 therein.

As best seen in Figure 12, wire receiving notches 127 and 129 are formed in the lower edges of the wire retainer plates 90 and 92, respectively. The plate 90 has wire retaining ears 131 which extend laterally rightwardly (as seen in Figure 12) at the entrance to each notch 127 while the plate 92 has laterally leftwardly (as seen in Figure 12) extending wire retaining ears 131' at the entrance to each notch 129. The ears 131 and 131' thus form constricted entrances 133 to the notches 127 and 129, the width of each entrance 133 being substantially less than the diameter of a wire 22. However, the wires 22 can be pushed out of the notches 127 and 129 when the entrances 133 to these notches are enlarged by relatively moving the wire retainer plates 90 and 92 lengthwise and in opposite directions so that the ears 131 and 131' are moved away from one another. The plates 90 and 92 are caused to be so moved by cam surfaces on fixed, plate aligning blocks 138 and 140 (Figure 1) described below. As the upper tooling assemblies 70 and 70' are depressed, the side edges of the plates 90 and 92

engage the cam surfaces of the blocks 138 and 140, which surfaces cause the plates 90 and 92 to move relatively in opposite directions, as mentioned above. The notches 127 and 129 are opened up to allow the wires 22 to be moved into the wire receiving portions 21 of the terminals 20. The plates 90' and 92' are similarly controlled by fixed, plate aligning blocks 138' and 140' (Figure 7) and the corresponding plates of the lower tooling assemblies are similarly controlled by fixed, plate aligning blocks 148 and 150, and 148' and 150' (Figures 14 and 15).

The wire locating plate 94 has notches 130 extending upwardly from its lower edge 132 (as best seen in Figures 11 and 12), for locating the wires 22 on the wire entry side of the tooling assembly 70. The plate 94 is spring loaded by means of springs 135 extending into openings in the flange 76 of the tooling mounting block 74 as shown in Figure 10.

The upper tooling assemblies 70 and 70' and the block 74 are retained against the support plate 44 by virtue of inwardly directed lower ends 78 and 78' (Figure 9) of the side plates 40 and 40', which ends extend under the downwardly facing surfaces of the flanges 76 and 76' of the block 74. Retaining plates 134 are fastened by screws 136 against the front and rear surfaces of the flanges 76 and 76' and overlap the side edges of the side plates 40 and 40' as best seen in Figure 7.

In order to maintain proper alignment of the insertion tooling, the aligning blocks 138 and 138', and 140 and 140' are fastened to the lateral edges of the side plates 40 and 40', and also act as guides for a slide which is described below and which is arranged to move into the insertion zone 222 beneath the upper insertion tooling assemblies 70 and 70'.

Since the lower first and second insertion tooling assemblies 142 and 142' are substantially the same as the tooling assemblies 70 and 70', the former tool assemblies will not be described in detail. The tooling assemblies 142 and 142' are mounted on a lower tooling mounting block 144 (as best seen in Figure 9) which is similar to the mounting block 74 and which is in turn supported on the lower arm 34 of the press frame 30. As shown in Figure 9, fixed lower side plates 146 and 146' are provided for the lower tooling assemblies 142 and 142', respectively, and serve the same purpose as the side plates 40 and 40'.

The first and second connectors 4 and 6 are positioned in the wire insertion zone 222 and are located between the upper and lower tooling assemblies by means of a connector feed slide (an overall view of which is shown in Figure 1), generally referenced 152, which is movable from a connector loading position (Figure 14) to a connector locating position (Figure 15) in which latter position it locates the connectors 4 and 6 in the insertion zone 222.

The slide 152 has connector receiving slots 154 and 154' in its sides, which receive the connectors 4 and 6 (as best seen in Figures 9 and 16). The mating ends 10 of the connectors 4 and 6 are positioned in the slots 154 and 154', respectively, so that a portion of each connector housing 8 adjacent to its mating end 10 is received in the slot, and the rearward portion of the connector 4 or 6 extends from the slot 154 or 154' so that wires 22 can be inserted into the wire receiving portions 21 of the terminals 20 in each of the rows 24 and 26. The connectors 4 and 6 must be precisely located in the slots 154 and 154' that the wire receiving portions 21 are in alignment with

the wires 22 in the insertion zone 222 when the slide 152 is advanced to its inner (Figure 15) position. In the present embodiment, precise location of the connectors 4 and 6 is achieved by means of stops 155 (Figure 3) secured by fasteners in the slots 154 and 154', respectively. When the slide 152 is moved from its outer retracted position (Figure 14) to its inner, advanced position (Figure 15), the leading end 190 of the slide 152 moves beyond the aligning blocks 140 and 140' and the lower ends of these aligning blocks act as additional stops for the connectors 4 and 6. Thus, the connectors 4 and 6 are located, when the slide 152 is in its inner position, between the lower ends of the aligning blocks 140 and 140' and the stops 155 which are secured in the slots 154 and 154'.

The slide 152 is slidably supported (as best seen in Figure 1) in a recess 153 in the upper surface 158 of a slide support 156 which extends laterally from the insertion zone 222. As shown in Figures 1 and 7, the slide support 156 has a depending flange 160 at its inner end adjacent to the insertion zone 222, which flange is contained between ears 162 and 162' (Figures 8 and 10) which extend from the side plates 146 and 146'. The flange 160 is slidably contained between the ears 162 and 162' by a front cover plate 164 (Figure 7), springs 166 acting between the lower end of the flange 160 and the base plate 36. The slide support 156 can thus be resiliently depressed while the wires 22 are being inserted into the portions 21 of the terminals 20, the connectors 4 and 6 on the slide 152 being thereby moved downwardly towards the lower tooling assemblies 142 and 142'. A guide 168 (best seen in Figure 1) is mounted on the upper surface 158 of the slide support 156, to guide the slide 152 into the insertion zone 222. When the ram assembly

38 is depressed, the guide 168 is engaged by the tooling support plate 44 thereby depressing the slide support 156.

The connectors 4 and 6 are lightly held in the slots 154 by means of retaining fingers 170 and 170' which are mounted on pivot pins 172 and 182' (as best seen in Figures 14 and 15) in a cover 178 movable with the slide 152. The fingers 170 and 170' which extend along each side of the slide 152, terminate in handles 174 and 174' beyond the outer end of the slide support 156. The fingers 170 and 170' are biased by means of springs 176, towards the sides of the slide 152, i.e. towards their position of Figure 14, so that they bear against the connectors 4 and 6. For reasons explained below, the connectors 4 and 6 should not be so firmly clamped by the fingers 170 and 170', that the slide 152 cannot move away from the insertion zone 222 (i.e. from the position of Figure 15 to that of Figure 14) after the wires 22 have been inserted into the portions 21 of the terminals 20, without dragging the connectors laterally from the insertion zone 222.

The springs 176, as well as the pivot pins 172 and 172', are contained in the cover 178, which is slidably mounted on the slide support 156. The cover 178 has side portions which depend beyond the sides of the slide support 156 and which have inwardly turned ears 180 (Figure 1) on their ends, to retain the slide 152 and the cover 178 on the upper surface of the slide support 156.

A switch 182 (best seen in Figure 7) mounted against the underside of the slide support 156, has a switch arm 184 on the end of which is a roller 186 which is engaged by an actuator block 188 in the slide 152 when it is in the position of Figures 7

and 14. As explained below the switch 182 controls a piston-and-cylinder unit 204 for advancing the first connector 4 from the insertion zone 222.

The leading end 190 of the slide 152 is of reduced width as shown in Figure 14, and moves between the aligning bars 150 and 150', when the slide 152 is in its position of Figure 15. The bars 150 and 150' serve, in co-operation with the leading end 190, to align the slide 152 and the connectors 4 and 6 therein, with the wires 22 prior to the movement of the tooling assemblies 70 and 70' towards the connectors 4 and 6. As will be apparent from Figure 7, during the advance of the slide 52, its leading end 190 moves over a support member 194 and finally engages a switch button 192 of a switch (not shown) mounted in the neck portion 35 of the press frame 30. The member 194 is supported on a spring 195 so as to be depressable against the action thereof as the slide 152 moves downwardly as described below. The switch must be actuated in order to initiate an operating cycle of the apparatus.

The wires 22 extend from the spools, mentioned above, to a wire guide assembly 196 (Figure 1) which serves to locate the wires 22 in the spaced substantially parallel planes mentioned above. The wires 22 are precisely located in their spaced planes by the comb-like wire positioning plates 94 and 94' and by the wire retainer plates 90 and 92, and 90 and 90', in the insertion zone 222.

As shown in Figure 1, the wire guide assembly 196 comprises a rectangular frame 198 having vertical side members which are slidably supported in spaced supports 200 on the base plate 36. The frame 198 is biased upwardly by springs 208 and is attached to the slide support 156 by a connecting arm 206 so

that the frame 198 is moved downwardly from the position shown in Figure 1 when the slide support 156 moves downwardly.

The frame 198 has a central plate 202 extending thereacross, and upon which is mounted a pneumatic piston-and-cylinder unit 204. The piston rod (not shown) of the unit 204 is connected to a horizontal wire guide plate 212 (as shown in Figure 9), which is moved towards the insertion zone 222 when the piston of the unit 204 is advanced. The wires 22 are guided between vertically extending rods 210 (Figure 1) in the frame 198, a light pressure being imposed on the wires 22 by pressure bars 211 loaded by springs on the rods 210.

The wires 22 extend across the upper and lower surfaces, (as seen in Figure 9) of the guide plate 212 and into spaced grooves (Figure 1) in the surface of upper and lower wire locating plates 214 and 216. The plates 214 and 216 extend beyond the outer end of the guide plate 212 so that a pocket 220 is provided which is dimensioned to receive the rearward end 12 of a connector 4 and carry that connector through the insertion zone 222 rightwardly (as seen in Figure 10).

The operation of the apparatus in carrying out the harness making method described above with reference to Figures 3 to 6, will now be described.

At the beginning of an operating cycle of the apparatus, the wires 22 extend, as shown in Figures 1 and 9, across the upper and lower surfaces of the guide plate 212 through the grooves in the upper and lower wire locating plates 214 and 216 and through the insertion zone 222 of the apparatus. The wires 22 in the upper plane of wires are precisely located in the insertion zone 222 by means of the wire positioning plates 94 and 94', by the wire retainer plates 90 and

92 and 90' and 92' and by the wire separator plates 84 and 84'. The wires 22 in the lower plane of wires are similarly located by the corresponding plates of the lower tooling assemblies 142 and 142'. Also, at the beginning of the operating cycle, the slide 152 is in its inner, advanced, position, connectors 4 and 6 being releasably held in the recesses 154 and 154' in the slide 152. The wires 22 extend beyond the insertion zone 222, their ends being connected to a connector 4' which was applied thereto during the previous operating cycle of the apparatus.

When compressed air is supplied to the cylinder of the unit 62 by engaging a pedal switch (not shown), hydraulic liquid is supplied to the cylinder 52 so that the ram assembly 38 is driven through a working stroke towards the lower tooling assemblies 142 and 142'. As the upper tooling assemblies 70 and 70' engage the connectors 4 and 6, the wires 22 are cut by edges 153' (Figures 1 and 5) of the slide 152, in co-operation with the cutting edges 97 of the wire shearing plates 82 and 82'. Also, the upper tooling assemblies 70 and 70' depress the slide 152 to bring the lower sides of the connectors 4 and 6 into engagement with the lower tooling assemblies 142 and 142' of the first and second stations 224 and 224'. The wires 22 extending beneath the connectors 4 and 6 are similarly severed and the wires 22 are then inserted into the wire receiving portions 21 of the terminals 20 when the ram assembly 38 reaches the end of its working stroke.

The ram assembly 38 is then moved through a return stroke to its raised position, by relieving the hydraulic liquid pressure in the cylinder of the unit 52, and the slide 152 is manually withdrawn from the insertion zone 222; i.e. the slide 152 is returned

from the position of Figure 15 to that of Figure 14. However, since the wires 22 are now connected to the terminals 20 in the connectors 4 and 6, the connectors 4 and 6 do not travel with the slide 152, and the fingers 170 and 170' slide over the rearward ends 12 of the connectors 4 and 6. A finished harness sub-assembly comprising a connector 6 applied to the wires 22 during the operating cycle under discussion, and a connector 4' applied to the wires 22 during the next previous operating cycle is removed from the apparatus, leaving the connector 4 in the insertion zone 222. The unit 204 is now energised to advance the wire guide plate 212 from the position of Figure 9 to that of Figure 10. During such advance movement, the connector 4 is received into the pocket 220 and is carried rightwardly to the position of Figure 10, thereby withdrawing further supplies of the wires 22 from their spools. The operator then grasps the connector 4 and pulls it further rightwardly, until, as shown in broken lines in Figure 10, the desired supply of wire has been withdrawn from the spools. The wires 22 are meanwhile guided by the guide assembly 196 and by the inserting tooling assemblies 170 and 170', the wires 22 being maintained in the notches 127 and 129 by virtue of the restricted entrances 133 of these notches in the wire retainer plates 90 and 92. The operator next loads the slide 152 with a further connector 4 and 6 by positioning them in the recesses 154 and 154' of the slide 152, after pressing the handles 174 and 174' towards one another. The slide 152 is then moved to the position of Figure 15 and the entire cycle of operation is repeated.

As mentioned above, a pedal switch is provided, in the present embodiment, to actuate the control circuit of the apparatus to initiate an operating

cycle thereof. The control circuit should be such that the switch button 192 is held in a depressed condition by the leading end 190 of the slide 152 before the unit 62 is placed under pressure. The switch provided with the switch button 192 thus serves to ensure that the ram assembly 38 is not moved through its working stroke until the slide 152 has moved fully to its inner position (Figure 15) and the connectors 4 and 6 carried by the slide 152 are properly positioned relative to the wires 22. The switch button 192 thus ensures that the tooling of the insertion tooling assemblies is not damaged as a result of its being lowered when the slide 152 has not been fully advanced into the insertion zone 222. Also, the switch arm 184 must be depressed before the unit 204 is placed under pressure, and the switch arm 184 is depressed by the actuator block 188 when the slide 152 has been moved to its fully retracted, outer, position. The switch 182 thus serves to ensure that the apparatus is not jammed or damaged by premature movement of the wire retainer plates 90, 92 and 90' and 92' into the insertion zone 222.

As described above, by way of example, the harness assembly shown in Figure 2 consists of two eight-way connectors, one at each end of the wires 222. It will be understood, however, that many types of harnesses or harness assemblies can be produced by the practice of the invention. A plurality of connectors can be positioned in each of the insertion stations during each operating cycle of the apparatus to produce a wide variety of harness assemblies. For example, Figure 17 shows a harness assembly 250 comprising a longer connector 228 to which is connected a plurality of shorter connectors 230 by means of wires 22. The connector 228 may, for example, comprise

forty terminals arranged in two rows of twenty terminals each, each of the connectors 230 having eight terminals therein.

As shown in Figure 17 the wires extending between the connectors 230 and the connectors 228 are of varying lengths. A harness of this type is frequently used, when for example, it is desired to provide connections between a junction box and a plurality of components or other devices which are at varying distances from the junction box. The harness shown in Figure 17 can be produced in the following manner.

A plurality of the eight-way connectors 230 are positioned in the first insertion station 224 and a single connector 228 is positioned in a second insertion station 224', at the beginning of the operating cycle. The individual connectors 230 are advanced after wiring, by different distances from the first insertion station, through the apparatus and beyond the insertion zone. The cycle of operation is then repeated by placing a single connector 228 in the first insertion station and a plurality of connectors 230 in the second insertion station.

The apparatus may, however, be adapted for use with connectors (not shown) comprising only one row of terminals in which case the lower tooling described above is not required.

Claims:

1. Apparatus for serially manufacturing electrical harness assemblies (2 or 250) each comprising first and second electrical connectors (4 and 6, or 228 and 230) each having at least one row of electrical terminals (20) therein, each terminal (20) having a wire-receiving portion (21), an end of a wire (22) being received in the wire-receiving portion (21) of each terminal (20); the apparatus comprising; a wire insertion zone (222) having first and second wire insertion stations (222 and 224'); first and second connector locating means (154 and 154') for locating a first (4 or 228) and a second (6 or 230) connector at the respective stations (222 and 224') in parallel aligned relationship, with the wire receiving portions (21) of the terminals (20) of the connectors (4 and 6, or 228 and 230) in endwise alignment; first and second wire insertion tooling assemblies (70 and 70') each comprising wire inserters (86 and 86') which are normally spaced from the first and second connector locating means (154 and 154'), and which are movable relatively theretowards to move the wires (22) towards the connector locating means (154' and 154) and into the wire receiving portions (21) of the terminals (20); and wire severing means (82 and 82') between the first and second insertion tooling assemblies (70 and 70') for severing the wires (22) at positions between the first and second connector locating means (154 and 154'); characterised in that for producing harness assemblies (2 or 250) in which one end of each wire (22) is received in a wire receiving portion (21) of a terminal (20) of the first connector (4 or 228) and the other end of the wire (22) is received in a wire receiving portion (21) of a terminal (20) of the second connector (6 or 230); the apparatus comprises wire

positioning and retaining means (90, 94 and 90', 94') in the insertion zone (222) for locating a plurality of wires (22) substantially in a common plane with the wires (22) in lateral alignment with the wire receiving portions (21) of the terminals (20) of the first and second connnectors (4 and 6; or 228 and 230) when these are positioned in the respective first and second connector locating means (154 and 154'), the wire positioning and retaining means (90, 94 and 90', 94') being effective releasably to retain the wires (22) until they are moved by the wire inserters (86 and 86') towards the connector locating means (154, 154'); and by means (196, 204) for feeding the wires along a wire feed path (22) from wire sources into the wire insertion zone (222), with the wires located in lateral alignment with the wire receiving portions (21), by the wire positioning and retaining means (90, 94 and 90', 94').

2. Apparatus according to Claim 1, characterised by means (212) for pushing the first connector (4 or 228) from the position in which it is located by the first connector locating means (154') out of the insertion zone (222) in the direction in which the wires (22) are fed by the wire feeding means (196, 204), when the wires (22) have been inserted into the terminals (20) of the first connector (4 or 228).

3. Apparatus according to Claim 2, characterised in that the pushing means (212), which is movable parallel to the wire feed path, into the insertion zone (222), is provided with wire guides (214 and 216) for guiding the wires (22) from the wire sources to the wire positioning and retaining means (90, 94 and 90', 94') during the movement of the first connector (4 or 228) outwardly of the insertion zone

(222).

4. Apparatus according to Claim 1, 2 or 3, characterised in that for producing electrical harnesses (2 or 250) in which each connector (4 and 6, or 228 and 230) has two parallel, superposed rows (24 and 26) of terminals (20), the wire receiving portions (21) of the terminals (20) of the rows (24 and 26) opening in opposite directions; the wire positioning and retaining means (90, 94, 90', 94', 142 and 142') are arranged to locate the wires (22) in two substantially parallel planes, one on either side of the connector locating means (154', 154), the wire insertion tooling assemblies (70, 70' and 142, 142') comprising similar tooling positioned on either side of the connector locating means (154, 154'), for inserting the wires (22) in the two planes, simultaneously into the wire receiving portions (21) of all the terminals (20), and the wire severing means (82, 82' and 142, 142') comprising tooling for severing the wires (22) in each plane.

5. Apparatus according to any one of the preceding claims, characterised by a connector feed slide (152) movable along a connector loading path extending transversely of the wire feed path, the first and second connector locating means (154' and 154) being provided in the slide (152) in spaced relationship transversely of the path of movement thereof, the slide (152) being movable along the connector loading path, between a connector loading position in which the connector locating means (154' and 154) are withdrawn from the wire insertion zone (222) and a wire insertion position in which the connector locating means (154' and 154) are aligned with the wire insertion tooling (70, 70' and/or 142, 142') for the insertion of the wires (22) into the connectors (4 and 6, or 228 and 230)

when these are positioned in the connector locating means (154' and 154).

6. Apparatus according to Claim 5, characterised in that the connector locating means comprises connector receiving openings (154' and 154) in opposite sides of the slide (152), the connectors (4 and 6, or 228 and 230) being releasably retainable in the openings (154' and 154) by fingers (170 and 170') mounted on pivots (172, 172') which are movable with the slide (152).

7. Apparatus according to any one of the preceding claims, characterised in that the wire severing means comprises a wire shearing plate (82 and 82') proximate to each of the first and second wire insertion tooling assemblies (70 and 70' and 142, 142'), a spring loaded comb-like wire separator plate (84 or 84') being received between each shearing plate (82 or 82') and an adjacent wire inserter plate (82 or 82').

8. A method of serially manufacturing electrical harness assemblies (2 or 250) each comprising first and second electrical connectors (4 and 6, or 228 and 230) each having at least one row of electrical terminals (20) therein, each terminal (20) having a wire receiving portion (21), an end of a wire (22), being received in the wire receiving portion (21) of each terminal (20); in which method; the first and second connectors (4 and 6, or 228 and 230) are positioned in a wire insertion zone (222) with the wire receiving portions (21) of the terminals (20) of the connectors (4 and 6 or 228 and 230) in endwise alignment with one another; the wires (22) are placed in the insertion zone (222) so that each wire (22) is in lateral alignment with a wire receiving portion (21) of each connector (4 and 6 or 228 and 230); the wires (22) are moved laterally of their longitudinal axis, towards the

connectors (4 and 6 or 228 and 230), to insert each wire (22) into the wire receiving portions (21) with which it is in lateral alignment; and the connectors (4 and 6 or 228 and 230) are subsequently removed from the wire insertion zone (222); characterised in that for producing harness assemblies (2 or 250), in which each connector (4 or 6 or 228 and 230) has two parallel, superposed rows (24 and 26) of terminals (20), the wire receiving portions (21) of the terminals (20) of the two rows (24 and 26) opening in opposite directions, and in which one end of each wire (22) is received in a wire receiving portion (21) of a terminal (20) of the first connector (4 or 228) and the other end of the wire (22) is received in a wire receiving portion (21) of a terminal (20) of the second connector (6 or 230); the wires (22) are fed from wire sources along a wire feed path in two substantially parallel, spaced planes, the feed path extending through and beyond the wire insertion zone (222), and the connectors (4 and 6 or 228 and 230) are then positioned in the insertion zone (222) so as to lie between the planes with each wire receiving portion (21) opening towards one of the wires (22) and with the second connector (6 or 230) positioned downstream, along the wire feed path, with respect to the first connector (4 or 228), the second connector (6 or 230) being removed from the insertion zone (222), subsequently to the insertion of the wires (22) into the wire receiving portions (21) and the severing of the wires (22), and the first connector (4 or 228) being then moved lengthwise of the wire insertion path through, and a predetermined position beyond, the wire insertion zone (222), whilst maintaining the wires (22) in their two planes, whereafter a further first and second connector (4 and 6 or 228 and 230) are positioned

in the insertion zone and the wires (22) are inserted into the wire receiving portions (21) of the terminals (20) of the connectors in the manner aforesaid.

9. A method according to Claim 8, characterised in that each wire (22) is severed adjacent to each of the wire receiving portions (21) into which it has been inserted.

10. A method according to Claim 8 or 9, characterised in that the first connector (4 or 228) is moved along the feed path through, and beyond, the insertion zone (222) by pushing the first connector (4 or 228).

FIG. 1

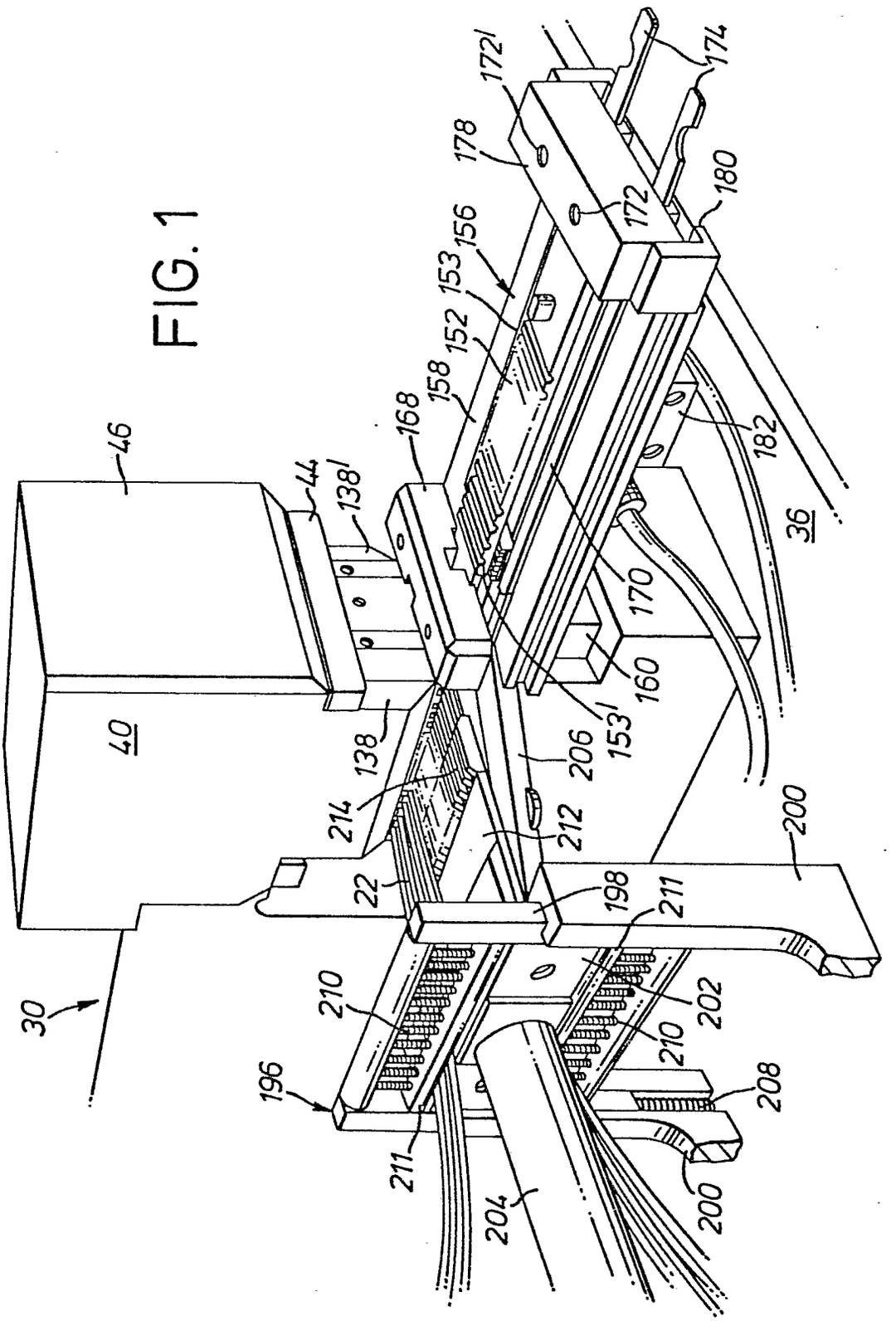
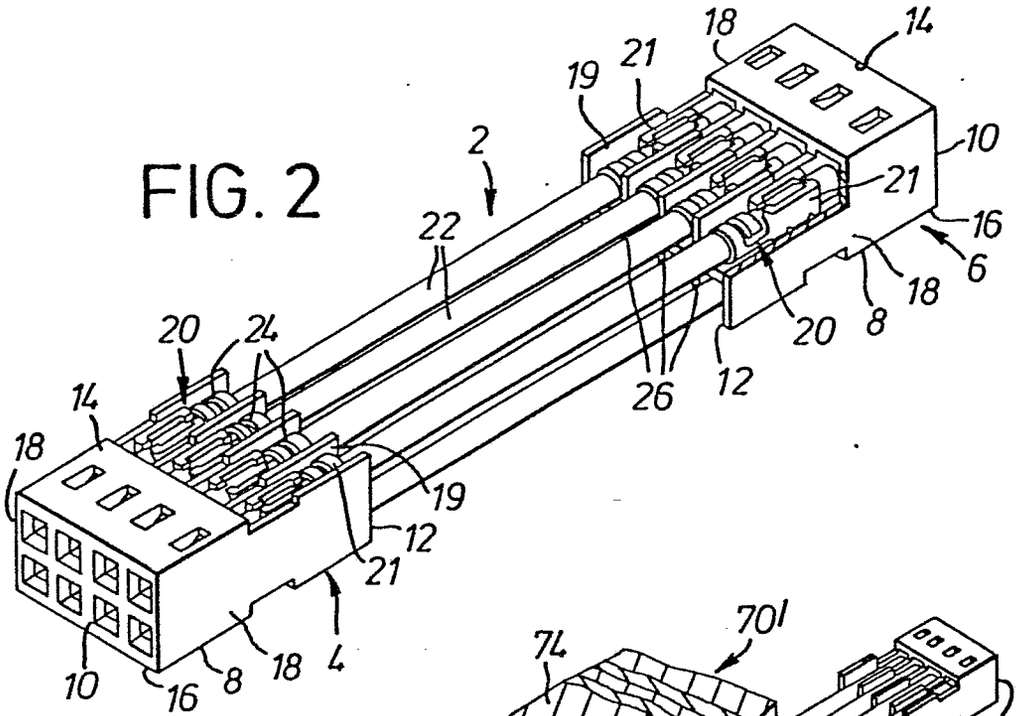

46
44
138'
168
158
152
153
156
172'
178
174
180
172
182
36
170
160
153'
206
138
214
212
200
22
198
211
210
202
210
208
196
211
204
200
30
40

FIG. 2


18
14
19
21
2
10
21
16
6
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8
20
12
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22
20
24
14
18
19
12
21
4
10
16
8
18

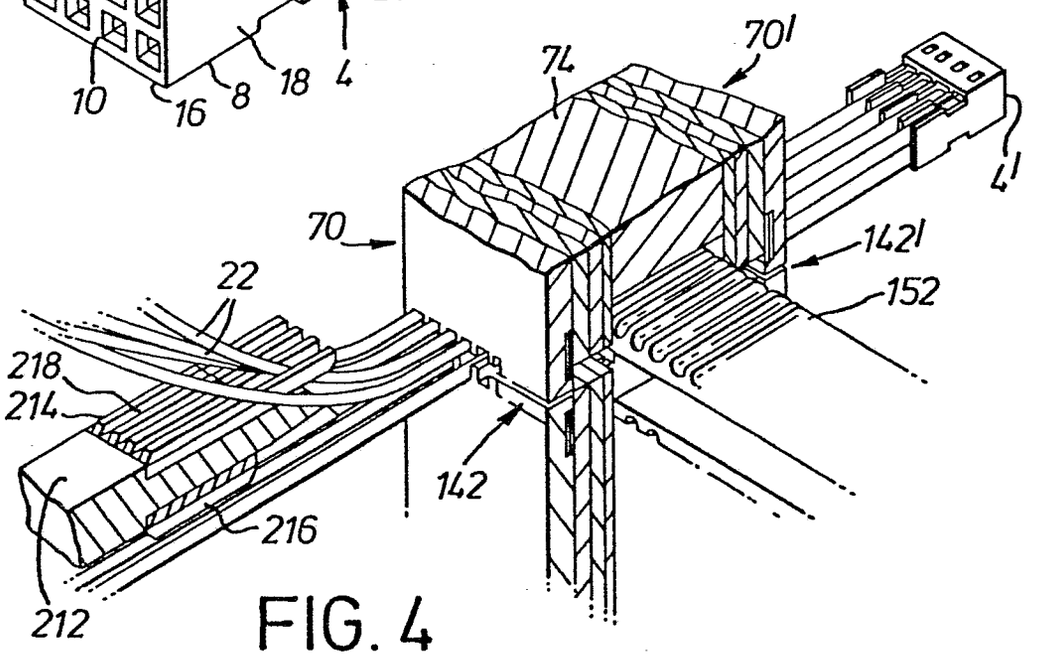

70l
74
41
70
142l
152
22
218
214
142
216
212

FIG. 4

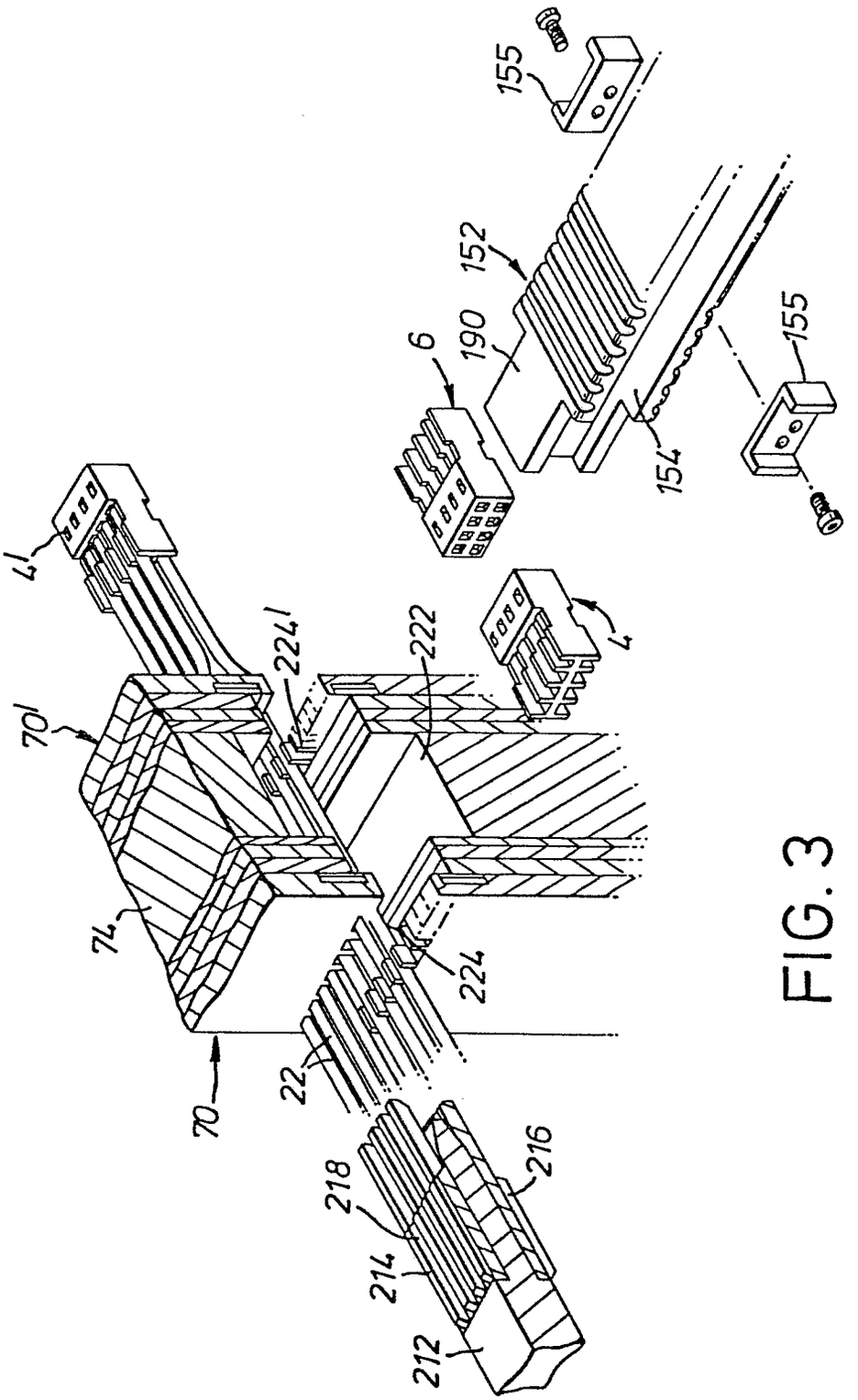


FIG. 3

FIG.5

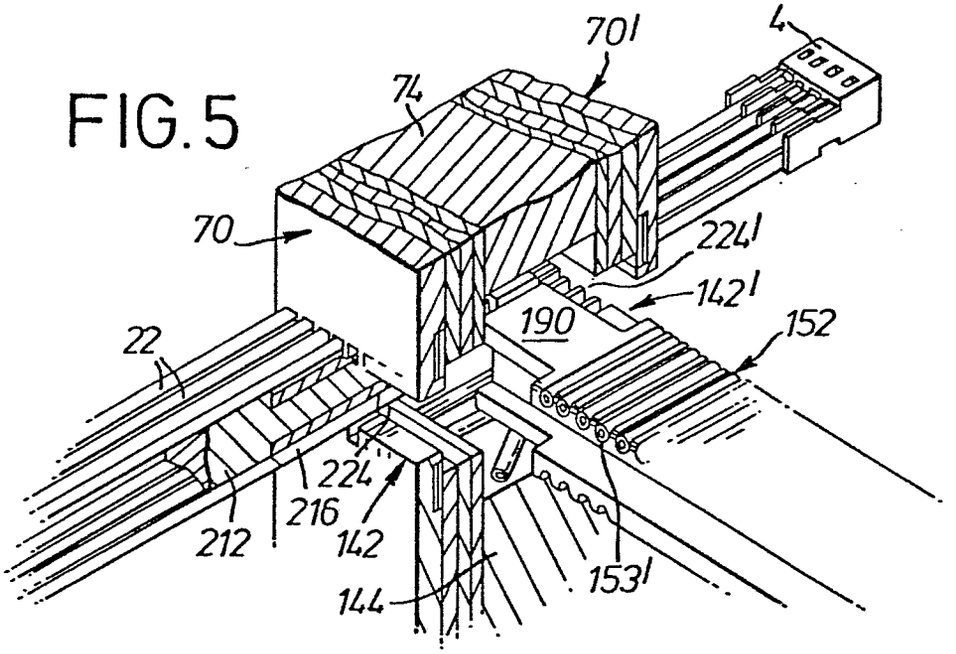

701
4
74
70
224'
142'
190
152
22
224
216
142
212
144
153'

FIG. 6

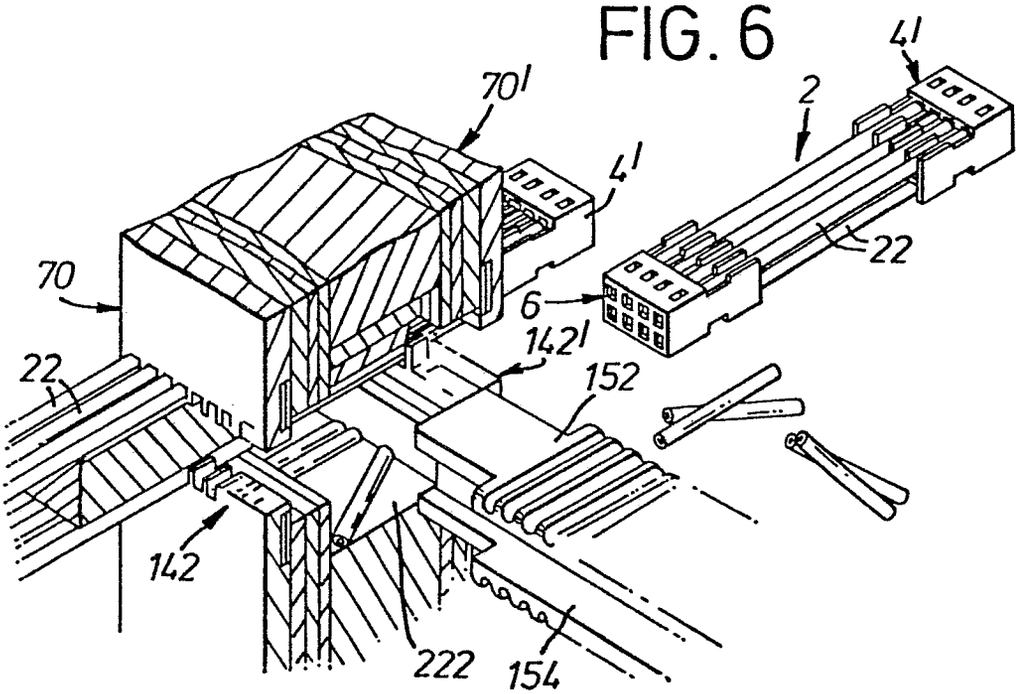

41
701
2
41
70
22
6
142'
152
22
142
222
154

FIG. 7

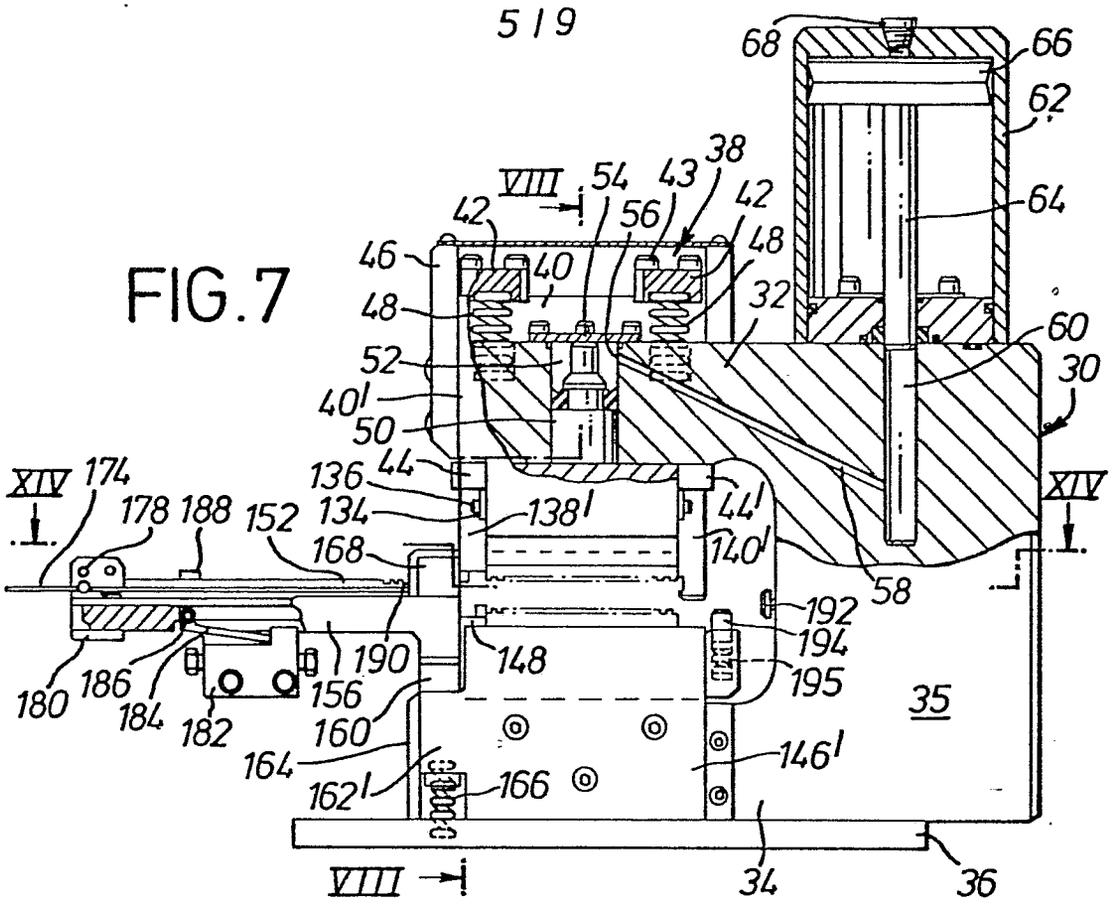
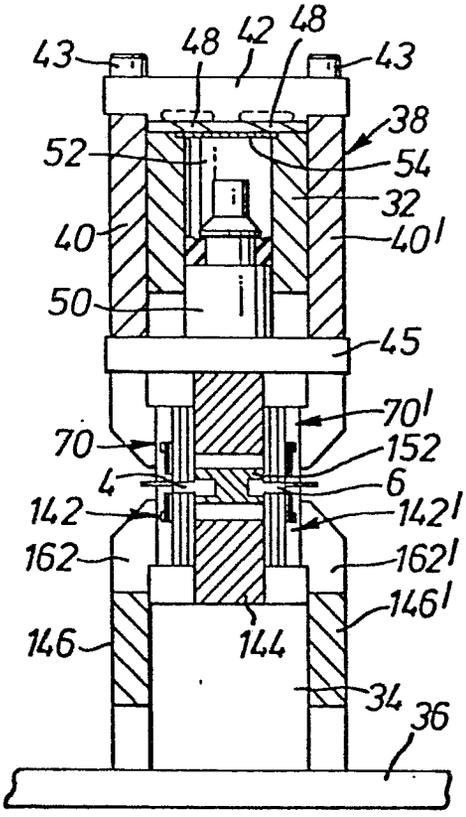

68
66
62
64
VIII
54
43
38
42
56
42
48
46
40
48
32
60
52
30
40'
50
44
136
134
138'
44'
140'
XIV
174
178
188
152
168
58
192
194
195
148
190
180
186
184
182
156
160
164
162'
166
146'
35
VIII
34
36

FIG. 8


43
48
42
48
43
38
52
54
32
40
40'
50
45
70'
70
152
4
6
142
142'
162
162'
146'
146
144
34
36

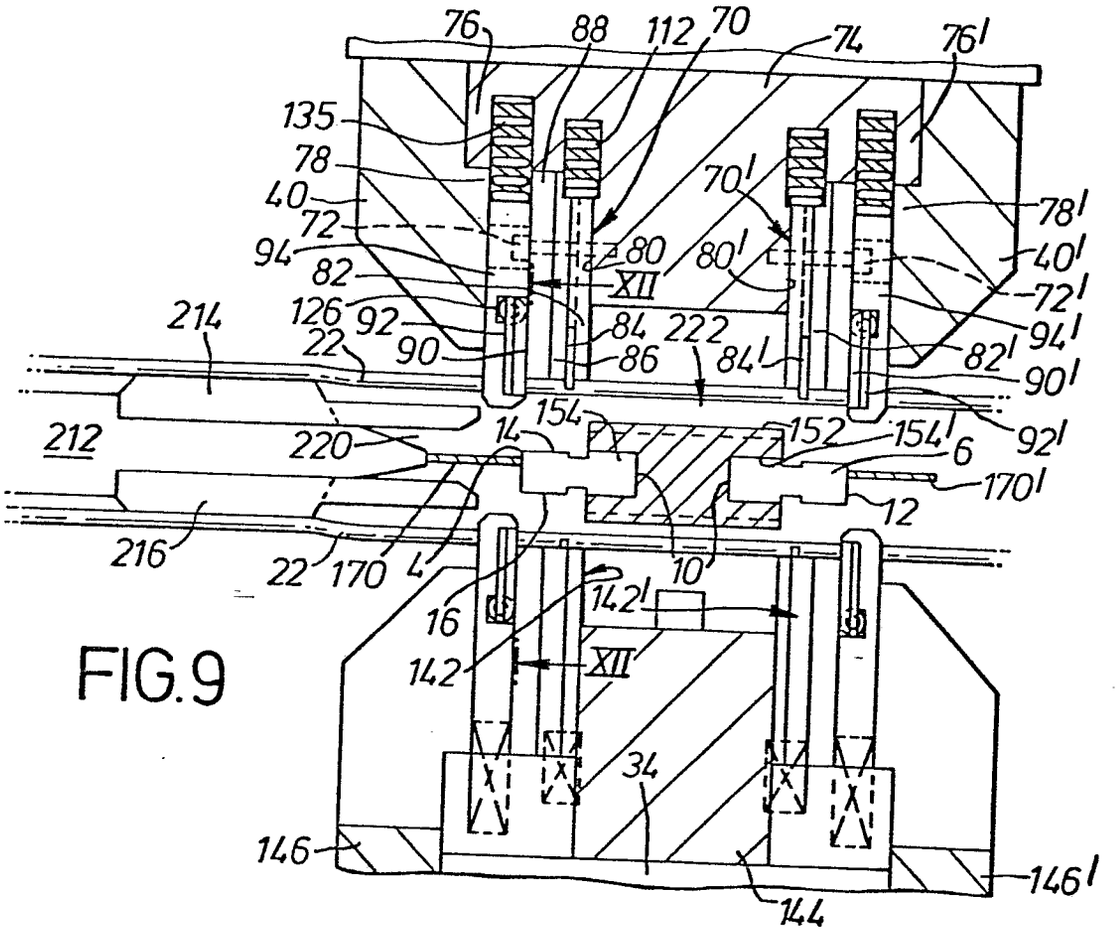

76
88
112
70
74
76'
135
78
40
72
94
82
126
92
90
22
214
212
220
216
22
170
4
14
154
152
154'
6
170'
12
10
16
142'
142
XII
34
146
144
146'
80
80'
70'
78'
40'
72'
94'
82'
90'
92'
84
86
222
84'

FIG.9

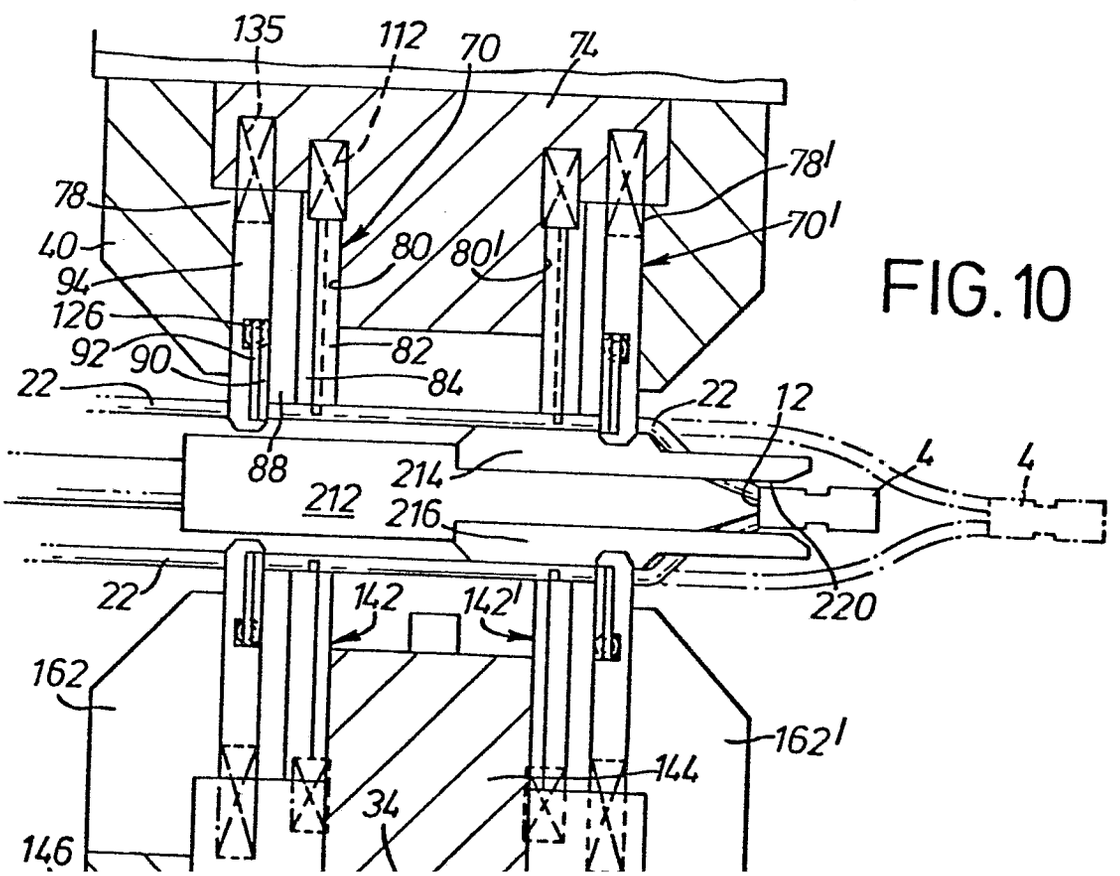
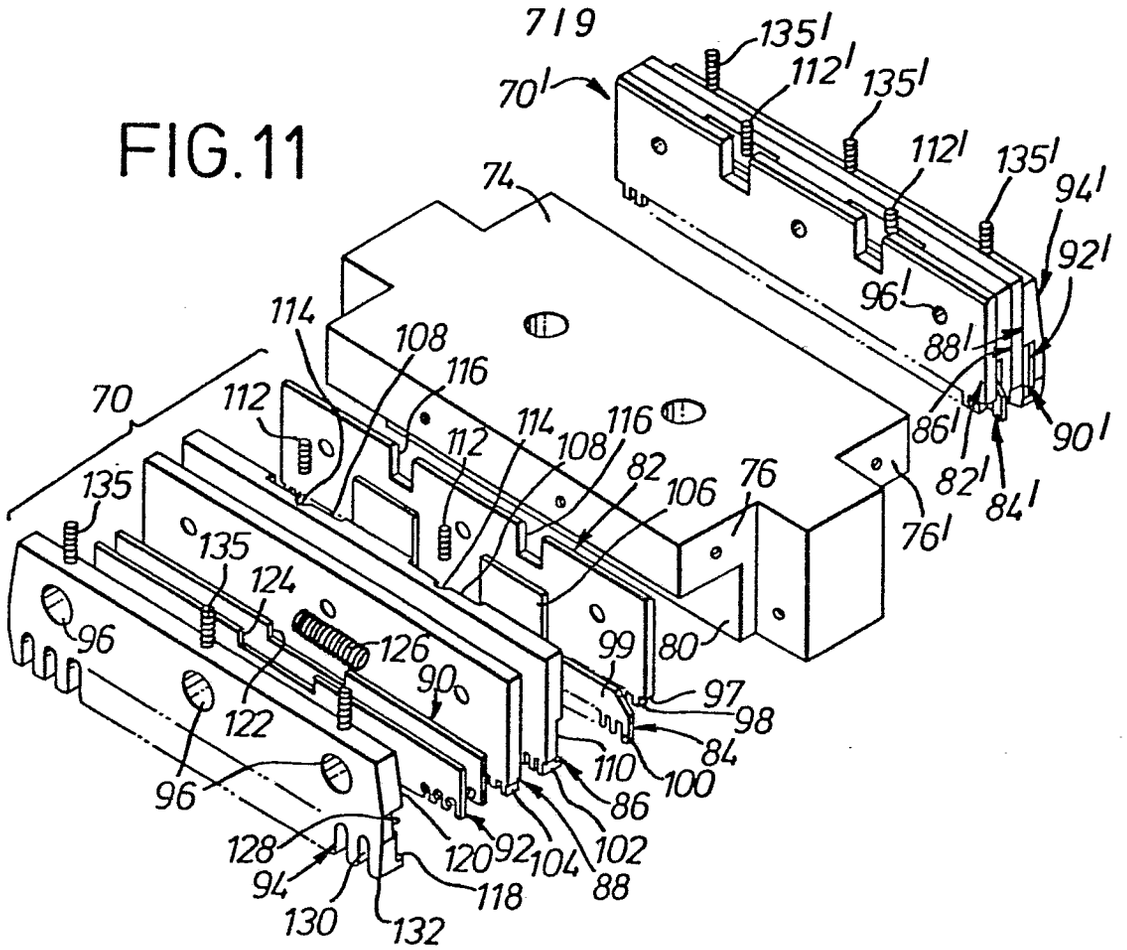

135
112
70
74
78'
70'
78
40
94
126
92
90
22
80
80'
82
84
88
214
212
216
22
12
4
4
220
142
142'
162
162'
144
34
146

FIG.10

FIG.11


71'
135'
112'
135'
70'
112'
135'
94'
92'
74
96'
88'
86'
90'
82'
84'
76'
114
108
116
70
112
114
116
112
108
82
106
76
135
135
124
126
96
99
80
90
97
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96
86
128
120
92
104
102
94
118
88
130
132

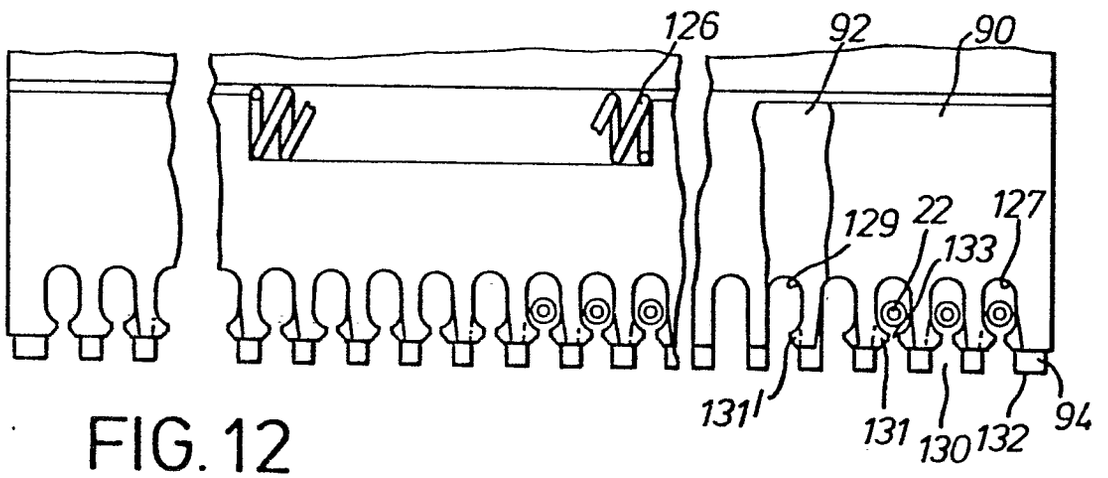

126
92
90
129
22
127
133
131'
131
130
132
94

FIG.12

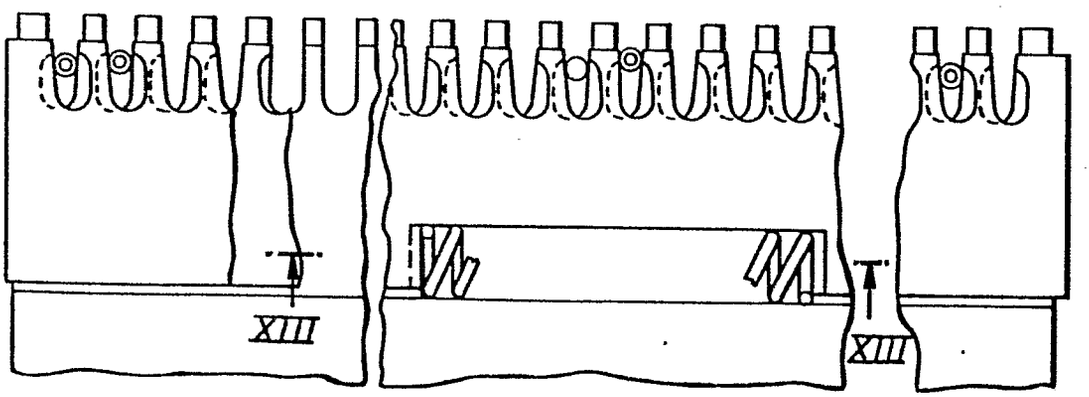

XIII
XIII

FIG.13

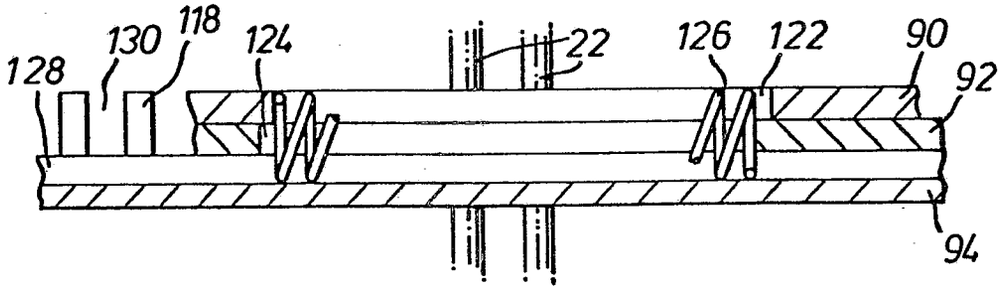


FIG.14

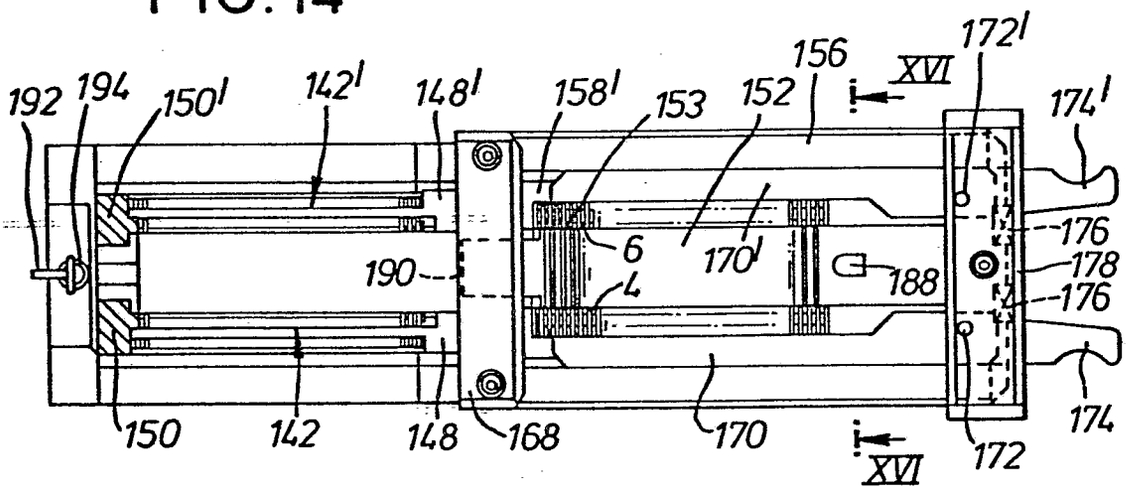
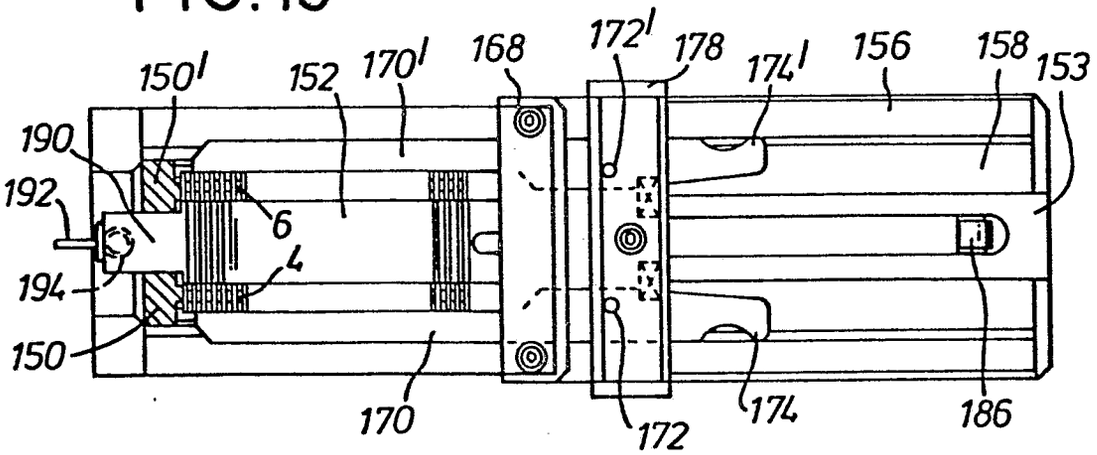


FIG.15



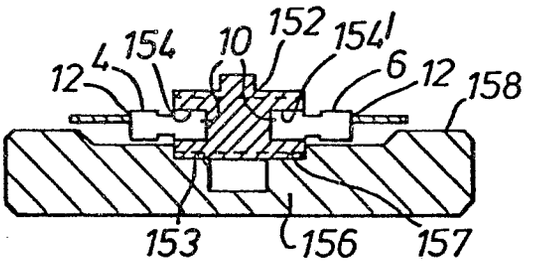

154
10
152
154'
12
4
6
12
158
153
156
157

FIG. 16

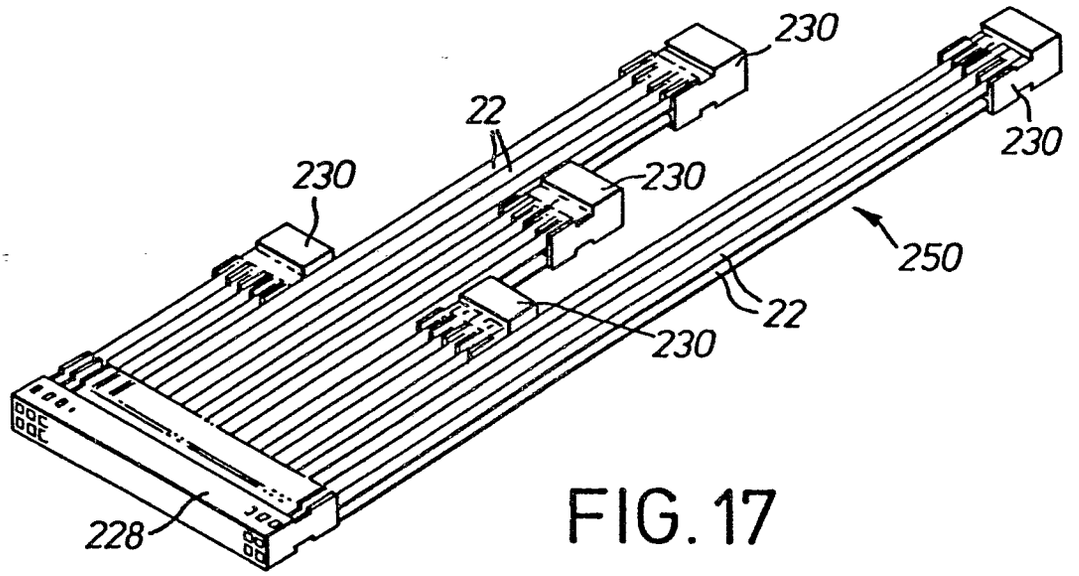

230
22
230
230
230
250
22
230
228

FIG. 17

0041815

Application number

EP 81 30 2427.0

European Patent Office

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A,D	US - A - 4 043 017 (FOLK et al.) * column 2, lines 32 to 42; column 3, line 5 to column 7, line 27; fig. 2 to 14 *	
A	US - A - 3 999 270 (WITTE) * column 5, line 61 to column 6, line 2; fig. 1, 9 *	
A,D	US - A - 4 043 034 (SUCHESKI et al.) * claims; fig. *	

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

H 01 R 43/00

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

H 01 R 43/00
H 01 R 43/04
H 05 K 13/06
H 01 B 13/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	07-09-1981	HAHN