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(54) Harness making.

(57) Harness making apparatus has a wire insertion zone (16) in which there is located a connector locating means (18). Individual wires (6) are fed from reels (12) to the wire insertion zone (16) and the ends of the wires are inserted into the terminals in a connector (4) by inserters (76). The connector (4) is thereafter transported away from the insertion zone (16) and wire (6) is withdrawn from the reels (12). During movement of the connector (4), the wires (6) are cut to produce a harness assembly (2, 3, 5). The apparatus also has a second insertion zone and a second connector locating means therein. The apparatus can be operated in a mode such that a second connector is applied to the harness wires after the first connector has been moved away from the insertion zone.

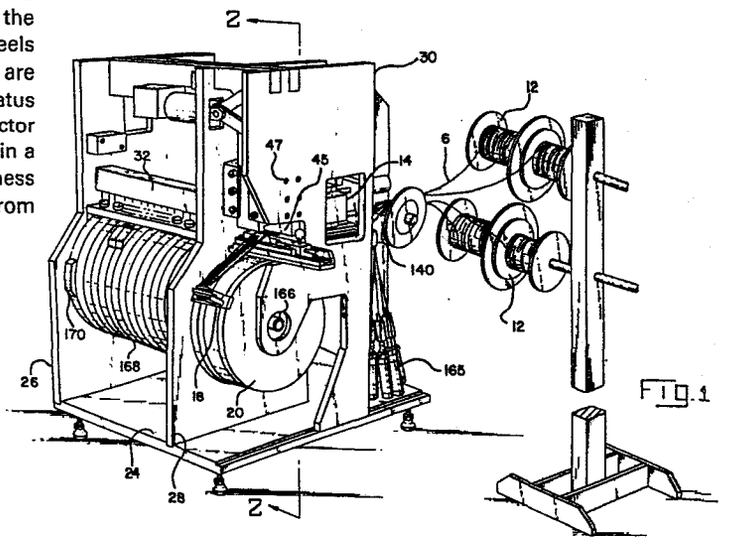

FIG.1

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HARNESS MAKING

This invention relates to machines and methods for producing electrical harnesses and harness subassemblies of the type comprising at least one electrical connector having wires secured to the terminals in the connector and extending from the connector.

It is now common practice in the electrical industry to produce electrical harnesses and harness subassemblies by means of semi-automatic or fully automatic machines of the type having locating means for locating a connector in an insertion zone, wire feeding means for delivering wires extending from reels or the like to the insertion zone, and insertion punches for pushing the wires into the wire-receiving portions of terminals contained in a connector housing. The resulting harnesses or harness subassemblies will thus consist of one or more multi-contact electrical connectors and wires extending from the terminals in the connectors. One type of harness subassembly commonly produced by known machines comprises a single connector having wires extending from the terminals with the wires being of varying lengths, if desired, and having the insulation stripped from their free ends. Another type of harness which is produced with presently available machines comprises two connectors with wires extending between the terminals in the connectors. It would be desirable also to produce harnesses of the type having two or more electrical connectors and wire extending between the two connectors and beyond one of the connectors with the free ends of the wires stripped of insulation. Most of the presently available harness making machines of the type under consideration

here are capable of producing the third type of harness described above.

The available harness making machine which are presently being used are, in general, proving to be satisfactory, although they do not fill all of the requirements of the industry. Particularly, presently available machines tend to lack versatility in that they are capable of producing only one of the three types of harnesses described above. Those machines which are capable of producing more than one type of harness require a substantial amount of adjustment and tooling changes when it is necessary to change the type of harness being produced. Finally, the presently available machines are relatively large and complex and their use can be justified on economic grounds only where a very high volume of production can be maintained for a protracted time period.

The present invention is directed to the achievement of a simplified and compact harness making apparatus which has a high degree of versatility in that it is capable of producing any of the three types of harnesses described above. The invention is further directed to the achievement of a machine which can be operated in any of its operating modes without the necessity of substantial adjustments or tooling changes in the machine.

A harness making apparatus in accordance with the invention has a wire insertion zone, a connector locator for locating a connector in a predetermined position in the insertion zone, a wire feeder for feeding wires in side-by-side parallel relationship from endless wire sources along a first path to position the wires in alignment with terminals in a connector in the connector locator, and a wire inserter movable along a second path towards and away from the connector in the locator. The apparatus is characterised in that a connector transporter is provided for transporting the connector from the connector locator along a continuation of the first path away from the insertion zone. A first wire cutter is provided on the first path and is located between the connector-locator and the wire

sources, the first wire cutter comprising individual sets of cutters for each of the wires. An actuator is provided which is effective to actuate the wire feeder thereby to feed the leading ends of the wires to the insertion zone to thereafter actuate the wire inserter to insert the leading ends of said wires into the terminals in the connector in the connector locator, and to thereafter actuate the connector transporter to move the connector from the insertion zone and thereby withdraw wire from the wire sources. The actuator is effective to actuate the individual wire cutters during transportation of the connector to produce wires of predetermined lengths extending from the connector.

In accordance with a further embodiment, the actuator has a program controller for cutting the wires at predetermined intervals after the beginning of transportation of the connector from the connector locator so that the harness will have wires of varying lengths extending from the terminals.

In accordance with a further embodiment, the apparatus has a second connector locator and a second wire inserter, the second connector locator being beside, and extending parallel to, the connector locator and being on the first path. A second wire cutter is associated with the second connector locator for cutting wires inserted into a connector located in the second connector locator so that the apparatus is capable of manufacturing harnesses having two connectors and wires connected to, and extending between the terminals in the two connectors. In accordance with a specific embodiment, the connector locator is mounted on a rotatable supporting wheel, the connector transportor being the wheel. The wire feeder may comprise a wire feed shuttle with the wires extending from the sources through the shuttle. Releasable clamps are provided on the shuttle for clamping the wires to the shuttle. The shuttle is movable between a retracted position, in which the shuttle is spaced from the wire insertion zone, and a forward position, in which the shuttle is proximate to the wire

insertion zone. The actuator is effective to engage the clamps with the wires during movement of the shuttle to the forward position and is effective to disengage the clamps from the wires during movement of the shuttle to the retracted position so that the wires are pulled from the sources during the forward stroke and the leading ends of the wires are delivered to the insertion zone.

In accordance with a further embodiment, the invention comprises a method of serially manufacturing electrical harnesses of the type comprising at least one electrical connector having contact terminals therein. The terminals are of the type having wire-receiving portions and the harnesses have wires connected to, and extending from, the terminals, the wires having free ends which are remote from the connector. The method is characterised by the steps of (a) locating one of the connectors in a wire insertion station, (b) positioning the leading ends of wires which extend from substantially endless wire sources such as spools, in alignment with the terminals in the connector at the insertion station and inserting the leading ends into the terminals, (c) transporting the connector along a predetermined path away from the insertion station and away from the wire sources and thereby pulling wires from the wire sources, (d) cutting the wires during transportation of the connector along the path at a fixed location between the insertion station and the wire sources and thereby producing one of the harness assemblies, and (e) repetitively carrying out steps (a) to (d) as set forth above to produce harnesses serially.

In accordance with a further embodiment, the wires are cut individually and at predetermined varying time intervals after the beginning of transportation of the connector along the predetermined path whereby the harness has wires of varying lengths extending from the terminals. A further embodiment is characterised by the step of stopping transportation of the connector along the predetermined path prior to cutting of the wires, locating a second connector in the insertion station, inserting the

wires into the terminals in the second connector, thereafter transporting the second connector and the connector along the path and then cutting the wires whereby the harness comprises two spaced-apart connectors and the wires extend from the second connector to the free ends of the wires.

Figure 1 is a perspective overall view of an apparatus in accordance with the invention.

Figure 2 is a sectional side view looking generally in the direction of the arrows 2-2 of Figure 1, this view showing the position of the parts at the beginning of an operating cycle and prior to insertion of wires into a first connector located in the first insertion zone.

Figures 3, 4, 5 and 6 are views similar to Figure 2 but showing the positions of the parts at different stages of the operating cycle and illustrating different modes of operation for producing different types of harness subassemblies.

Figure 7 is a sectional side view on an enlarged scale of the operating zone of the apparatus including the first and second insertion zones and showing the cutting means for cutting the wires, this view being taken along the section lines 7-7 of Figure 8.

Figure 8 is a view taken along the lines 8-8 of Figure 7 and is a frontal view of the apparatus looking towards the insertion zone.

Figure 9 is a view similar to Figure 7 showing the positions of the parts at the instant of insertion of the wires into a first connector in the insertion zone.

Figure 10 is a view similar to Figure 8 showing the positions of the parts at the instant of insertion.

Figure 11 is a frontal view of the lower portion of the apparatus showing a bank of cams which function to determine the lengths of the wires extending from the terminals in a harness subassembly.

Figure 12 is a view taken along the lines 12-12 of Figure 11.

Figure 13 is a perspective view on an enlarged scale

of the reciprocable wire feeding means for feeding wires from the reels to the insertion zone.

Figure 14 is a view taken along the lines 14-14 of Figure 2 showing details of a selective stop for the wire feeding means.

Figure 15 is a view similar to Figure 14 showing the positions of the stop for an alternative operating mode.

Figure 16 is a view taken with lines 16-16 of Figure 7 showing details of the wire cutting means.

Figure 17 is a view taken along the lines 17-17 of Figure 7 showing details of the connector for locating the second connector in the harness.

Figures 18, 19, and 20 are perspective views of different types of harnesses or harness subassemblies which are produced by the practice of the invention.

Figures 18-20 show the various types of harnesses or harness subassemblies which can be produced by the practice of the invention. The manufacture of harnesses as shown at 3 and 5, Figures 19 and 20, requires the operation of parts of the apparatus which are not required to produce a harness shown at 2 in Figure 18. The invention will first be described with reference to the production of harnesses of the type shown at 2 and the parts of the apparatus and the method steps required for the production of harnesses of the types shown at 3 and 5 will subsequently be described.

The harness or harness subassembly 2 comprises a suitable electrical connector 4 having an insulating housing which contains a plurality of terminals 10. The terminals are of the type which are adapted to receive wires 6 upon movement of the wires laterally of their axes and into the wire receiving portions of the terminals, these wire receiving portions being adjacent to the upper end 8 of the connector. The wires 6 are of varying lengths as shown, and have the insulation stripped from their free ends, as shown at 7.

The principles of the apparatus can be understood from a brief inspection of Figures 1 and 2, which show all of the essential parts of the apparatus. The wires 6 are fed

from reels 12 mounted on a suitable stand or support, the number of reels being equal to the number of wires extending from the connector 4. The wires are fed by a wire feeding means 14 to a wire insertion zone generally indicated at 16, Figure 2, which has a connector locating means 18 therein for locating a connector in alignment with insertion punches which will be described below. This locating means 18 is mounted on the rim of a wheel 20 which is capable of oscillation through an angle of about 270 degrees. After the wires have been inserted into the terminals in the connector, the wheel is rotated in a counter-clockwise direction from the position shown in Figure 2 to move the connector with the wires attached thereto, along a circular path and thereby draw wire from the reels 12. During movement or transportation of the connector, the individual wires are cut by wire cutting means 22. As explained below, a separate cutting means is provided for each wire and these separate cutting means can be actuated at any desired time during rotation of the wheel 20, so that wires 6 of varying lengths result.

The connector 4 may be of any desired type, the particular connector shown being described in detail in U.S. Patent 4,159,158 issued January 26, 1979.

The apparatus is mounted on a frame comprising primarily of a horizontal base plate 24 and three spaced-apart vertical plates 26, 28, and 30. A transverse support member 32 extends between the plates 26, 28 and additional transverse supports extend between the vertical plates, as will be subsequently described.

A connector locating means, for locating a first connector 4 in the insertion zone, comprises a generally L-shaped block 34, Figure 7, which has a base portion 36 secured in the rim of the wheel 20. A front plate 40 is mounted against the upstanding arm 38 of the block 34 and the opposed surfaces of this arm 38 and the plate 40 define a recess or cavity 44 which conforms to the profile of the connector 4 so that the connector can be simply slid into this cavity. The front plate 40 is held to the block 38 by suitable

fasteners as indicated at 42, Figure 8. It will be noted that the vertical plate 30 has a gap 45 therein on its left-hand edge, as viewed in Figure 1, to permit access to the connector locating means in the insertion zone.

The reciprocable portions of the apparatus which insert the wires into the connector are mounted in a press frame block 46, Figure 7, which is between the plates 28, 30 and above the gap 45, this block being held in position by suitable fasteners, as indicated at 47 in Figure 1. The block 46 has a vertically extending opening 49 extending therethrough, which is divided into two passageways by a central wearplate or divider 48. This divider thus defines two passageways for two rams 50 and 226. The ram 50 is confined by ram guides or gibs 52 secured by fasteners 54 to the face of the block 46. The ram 50 is reciprocated by a toggle mechanism comprising links 56, 58, Figure 8, and a piston rod 64. The link 56 is pivotally connected at 59 to the upper end of the ram 50 and the link 58 is pivoted at 61 to an eccentrically adjustable block 70 in a frame block 72. The overlapping ends of the links 56, 58 are pivoted at 60 to a yoke 62 on the end of the piston rod 64 which extends from a piston cylinder 66. It will be apparent that upon pressurization of the piston cylinder 66, piston rod 64 will move rightwardly from the position of Figure 8 to straighten the toggle mechanism, as shown in Figure 10, thereby driving the ram 50 downwardly. The stroke of the ram can be adjusted within precise limits by means of set screws 74 which extend into recesses 73 in the eccentric block 70 and bear against the surfaces of these recesses.

The leading ends of the wires 6, which are shown as positioned above the connector 4, are inserted into the terminals in the connector by insertion punches generally indicated at 76, Figure 7. In the embodiment shown, these punches 76 are shown as formed on two separate tooling blocks and are secured to the lower end of the ram 50 by suitable fastening means 78. It will be understood that the precise nature of the punches and their shape will depend upon the precise type of terminal contained in the connector 4.

In order to ensure that the connector 4 in the cavity 44 is precisely aligned with the punches, an L-shaped supporting and aligning block 80 is also mounted on the lower end of the ram. The depending arm of this block 80 has an inwardly directed surface 82, Figure 7, which moves over the leftwardly facing surface of the front plate 40 as the ram moves downwardly. This block 80 thus ensures that the connector locating means is precisely positioned so that the punches will be in alignment with the wires in the insertion zone. If the wheel 20, for example, is not properly positioned but is rotated by a very slight amount in a counter-clockwise direction from its proper position, the surface 82 will move over the block 30 and rotate the wheel through a very slight clockwise arc.

The wire feeding means generally located at 14 in Figure 2, comprises a reciprocable block 84, Figure 13, which is slideably mounted on spaced-part rails 86 which extend between the press frame block 46 and a suitable plate 88 at the right-hand end of the apparatus. Block 84 is reciprocated by a piston cylinder 90 having a piston rod 92 which is connected to the block 84 by a suitable clevice type arrangement, as shown at 93. A wire guide assembly is secured to the downwardly facing surface of the block 84 and comprises wire support plate 94 having spaced-apart parallel grooves in its upper surface 96 and a cover plate 97 for the plate 94. The cover plate 97 is provided with a central opening 99 above which there are located side-by-side individual wire clamping bars 98, each of which is aligned with a wire in one of the grooves 96. These individual clamping bars 98 can be moved downwardly from their raised position, as shown in Figure 13, by a pressure plate 100 to which the end of a piston rod 102 is connected. The piston rod extends from a piston cylinder 104 which is mounted in a fixed plate 108 by means of a mounting collar 106. The pressure plate 100 and the individual clamping bars 98 are contained in a central opening in the block 84 with the clamping bars and the plate being

slideable downwardly from the position shown in Figure 13. The plate 100 has depending flanges 112 which are inwardly turned at their lower ends and overlap outwardly extending flanges on the individual clamping bars 98. It is preferable to provide a resilient cushion of rubber or the like, as shown at 110, between the downwardly facing surface of the pressure plate and the wire clamping bars 98.

At the beginning of an operating cycle of the apparatus, the parts will be substantially in the positions of Figure 2, except that the leading ends of the wires will extend only to the opening 127 in a plate 126. The cylinders 90 and 104 are first pressurized to clamp the wires against the plate 94 of the slide 84 and advance the slide 84 into the insertion zone. The slide dwells in the insertion zone, the wires are unclamped and the cylinder 66 is then pressurized to drive the ram 50 downwardly thereby to insert the wires into the terminals in the connector 4 as shown in Figures 3 and 9. The wheel is then rotated, as shown in Figures 4 and 5, the cutting blades are actuated, wire is drawn from the spools and the finished harness subassembly is ejected as shown in Figure 5. The slide 84 retracts to the position of Figure 5 and the wheel returns to its normal position, Figure 2, and the next cycle can then be initiated. The cutting means and the programming means for this cutting means are described below.

The wire cutting means for cutting the wires and cutting the insulation of each wire, are shown best in Figures 2-6 and 7. Each wire has an associated cutting means which comprises fixed upper cutters 120, 122, which cut the wire and the insulation of each wire respectively, and two lower or movable cutters 130, 132. The upper cutters are secured to the plate 126 by suitable fasteners, as shown at 124 and the lower cutters for each wire are integral with an individual plate 128. These plates 128 are slideably contained between the leftwardly facing surface of the frame plate 126 and the surface 136 of an L-shaped

block 134, which is also secured to the frame plates of the apparatus. The plates 128 and, therefore, the cutters 130, 132 for each wire can be individually moved upwardly by means of levers 140 having reduced left-hand ends 138, which are received in recesses in the plates 128.

Each lever 140 is pivotally mounted on a pivot axis, as shown at 142, and is biased in a counter-clockwise direction, as viewed in Figure 2, by a cable 144 secured to a pin 146 on the lever and secured also to a spring 148, which is anchored on a rod 150 which extends between the frame plates 28, 30.

It will be apparent from Figure 2, that when one of the levers 140 is swung through a slight clockwise arc, the left-hand end of this lever will move upwardly thereby moving the associated plate 128, having cutters 130, 132 thereon, upwardly and cut the associated wire 6. The levers are selectively moved upwardly by means of a cable 152 associated with each lever. Each cable is secured, as shown at 156, to a bar 154 which extends between the frame plates 28 and 30 and each cable extends across an arcuate surface 158 on the right-hand end of its associated lever. From this surface each cable 152 extends to a coupling 160 on the end of a piston rod 162 of an associated piston cylinder 164. Each lever and, therefore, each movable cutter 128 has one of the piston cylinders 164 associated therewith, these piston cylinders being mounted as a cluster 165 on the base plate 24, as shown best in Figure 1.

It will be apparent from the foregoing that in order to achieve the variable wire lengths in the harness assembly 2 of Figure 18, it is necessary to selectively pressurize the cylinders 164 after the elapse of predetermined intervals following the beginning of movement of the connector from the insertion zone, Figure 3, and towards the ejector 200 which is described below. Accordingly, a programmable system is provided for pressurizing each cylinder at the appropriate time which will produce the desired wire lengths in the harness 2. This control means, as shown in Figures 11 and 12, comprises a plurality of cams 168 which are

freely mounted on a shaft 166 which extends between, and is journaled in, the frame plates 26, 28. Each cam 168 has a lobe 170 on its periphery with the remainder of the periphery being serrated, as shown at 172. The individual cams 168 can be locked in any desired position of adjustment to a support bar or clamping bar 176 which extends parallel to the shaft 166 and which is spaced from the peripheries of the cams. As shown in Figure 12, locking is achieved by means of a set screw 174 for each cam, which can be tightened against the serrated periphery of the cam. The bar 176 has arms 178 on its ends which extend radially towards the shaft 166 and the ends of these arms 180 are keyed, as shown at 182, to the shaft 166.

The previously identified wheel 20 is also mounted on the shaft 166 so that when this shaft is rotated, the arms 178, the bar 176, and the cams 168 will also be rotated as a unit. The lobes 170 of the individual cams will therefore be moved past the pivoted arms 188 of switches 184 that are mounted on the bracket 32. Each switch has two pivotal arms 186 and the arm 188, and the arrangement is such that when the cam lobe 170 moves in a clockwise direction from the position of Figure 12, the arms 186 will be swung upwardly towards the switch and thereby change the condition of the switch while reverse movement of the cam lobe past the arm 188 will not affect the arm 186. The arm 188 cannot be moved anti-clockwise from the position of Figure 12 but can be moved in a clockwise direction.

It will be apparent from the foregoing that the length of the individual wires 6 in the harness assembly 2 can be determined by simply loosening all of the set screws 174, rotating the cams 168 relative to the shaft 166 to the positions which will produce the desired wire lengths, and then tightening the set screws. During the operating cycle then, movement of the lobes 170 past the switches will cause the conditions of the switches 184 to be changed, thereby causing selective pressurization of the piston cylinders 164 and selective actuation of the movable cutters.

The shaft 166 may be oscillated during each operating cycle by any suitable actuating means, such as an electric motor with a mechanical coupling having a reversing mechanism and clutch therein. It is preferred, however, to use a rotary pneumatic actuator, as shown at 190, Figure 11, having an output shaft 192 on the end of which there is a sprocket 196. Sprocket 196 is coupled by a chain 194 to a sprocket 198 on the shaft 166. The actuator 190 may be of the known types described, for example, in U.S. Patents 2,936,737 and 2,974,646. Actuators of this type are available from Carter Controls Inc., of Lansing, Illinois, and are described in the Carter Bulletin RA-500 E. As will be explained in move detail below, an apparatus in accordance with the invention can be designed to use only compressed air and does not require electrical switches at any of the locations where switches are required.

When the wheel rotates in a counter-clockwise direction to the limit of its travel (Figure 5), the completed harness assembly 2 is automatically ejected by an ejector 200, Figure 2, in the form of a plate which extends normally from the surface of frame plate 28 and which is adjustably secured to the frame plate by a mounting plate 201 through which suitable fastening bolts extend. The upper edge 202 of the plate 200 functions as a cam surface and rises to an increasing extent above the surface of frame plate 28 along its length to a switch means 204. The edge 202 engages the connector 4 in the locating means 18 and pushes it from the connector locator means. Thereafter, the condition of the switch means 204 is changed and the air supply to the rotary actuator 190 is controlled in a manner to cause reversal of the actuator and return movement of the wheel 20 in a clockwise direction.

It is desirable to provide a guide roller 206, Figure 7, in the operating zone which extends transversely across the operating zone and adjacent to the previously identified L-shaped plate 34. This guide roller is slideably mounted on pins 208 having caps 209 and is upwardly biased towards

these caps 209 by springs 207, Figure 17, mounted in the block 134. This guide roller serves to guide the wires and maintain them in their spaced apart condition during movement of the connector away from the insertion zone and also cooperates with a wire clamping member 234 when the apparatus is operated in an alternative mode.

Control of compressed air to the piston cylinder 66 and to the piston cylinders 92 and 104 may be controlled by suitable pneumatic switches 210 and 212, as shown at Figure 8. The switch 210 is affected by the yoke 62 when it is moved to its retracted position and when the yoke is moved rightwardly, the position of this switch is changed. The switch 212 is engaged by the toggle knee joint when the ram reaches its lowermost position, as shown in Figure 10. Suitable pneumatic circuitry is provided to control the flow of compressed air to the piston cylinders when these switches are engaged by the moving parts of the apparatus.

The harness 3, Figure 19, has a connector 4 on each end thereof and wires 6 extend between corresponding terminals in the two connectors. Harnesses of this type are produced by applying the second connector 4 after the first connector has been moved away from the insertion zone and the parts are in the positions of Figure 4. After the parts have reached these positions and the required lengths of wire have been withdrawn from the reels, the wheel 20 is stopped and the second connector 4 is applied to the wires by means of a second set of insertion tools, which will now be described.

The second connector 4 is supported in a slide 216, Figure 17, which is supported on the previously identified L-shaped block 134 and which is retained on the block on a suitable gib. The slide 216 has a recess 217 on one side thereof and a positioning rod 219 extends into the slide and into the recess. This positioning rod can be adjustably located by a suitable set screw 221 in a desired position of adjustment for different sizes of connectors. The connector 4 is located with its one end against the end of the rod 219 and the slide is thereafter moved inwardly, or leftwardly, by means of a handle 220 thereon, from the position

of Figure 17. When the slide is moved inwardly, the connector is further positioned by means of an air cylinder 222 mounted on a bracket 223 on a frame plate 28, see Figure 8. The piston rod of this air cylinder imposes a light pressure upon the left-hand end of the connector so that the terminals in the connector will be in proper alignment with the insertion punches 228, shown in Figure 7. These punches are secured on the lower end of the ram 226 by suitable fasteners as shown, and one of the punches is provided with a shearing edge 230 which cooperates with a fixed shearing edge 232 on a shear bar 233 mounted in the L-shaped bracket 134. A clamping bar 234 for clamping the wires is also provided on the ram 226 and cooperates with the previously identified roller 206, as best shown in Figure 6. It will thus be apparent that upon downwardly movement of the ram 226 to the position of Figure 6, the wires will be cut by the fixed and movable shears 230, 232 and will be inserted by the inserters 228 into the terminals in the second connector which is positioned in the slide 216. The second connector is released after the ram moves upwardly to the position of Figure 7 by a second piston cylinder 224 which is also mounted on the bracket 223, see Figure 8. The piston rod of this piston cylinder returns the slide to its outer position, Figure 11, so that the second connector can be removed from the slide and the completed harness removed from the apparatus. The wheel 20 is rotated after insertion of the wires into the second connector so that the second connector can be removed by the ejecting means 200, 202.

The block 84 is stopped during its return stroke to the position on Figure 2 by the plate 88 which extends between the frame plates 28, 30, as shown in Figure 14. The block 84 has a mounting block 240 thereon into which is threaded a suitable screw 238. Thus, when the reciprocable block 84 is retracted, this stop screw abuts the plate 88. A slide member 244 is normally biased by springs 254 to a position such that the stop block 242 is effective to prevent return movement of the slide block 84 beyond the position of Figure 15. A piston cylinder 250 is mounted

on the upper side of the slide 244 and the piston rod 252 of this piston cylinder bears against the plate 30. Thus, if it is desired to operate the apparatus in a mode to produce harnesses as shown at 2, the piston cylinder 250 is pressurized, thereby driving the slide 244 towards the plate 28; in other words, to the position of Figure 14. In this position, the stop block 242 is moved towards the plate 28 and the feed block 84 is permitted to move to its fully retracted position of Figure 14. Thus, the piston cylinder 250 is maintained in a pressurized condition whenever harnesses, as shown at 2, are produced and if harnesses, as shown at 3 are being produced, the pressure is released from the piston cylinder 250. The slide 244 may be guided on the plate 88 by pins 248 which extend through an elongated slot 246 in the slide.

It will be apparent that the production of harnesses as shown at 5, Figure 20, involves the use of both the insertion stations. The third connector 4, in Figure 10 at the extreme right, being applied to the wires at the second insertion station. After this third connector has been installed on the wires, the apparatus is operated in the mode described above to produce wires of uneven lengths 6 extending from the third connector 4. Harnesses and harness subassemblies having some of the features of the harnesses 3 and 5 can also be produced. For example, a harness of the type shown in Figure 3, having additional connectors on the wires between the two end connectors, can also be produced by stopping the wheel and placing a connector in the second insertion station for each connector required.

As previously mentioned, the entire control and actuating system for the apparatus can be pneumatic rather than electric, or electric-pneumatic, if desired. Pneumatic logic controls and pneumatic control valves of types commonly known can be used for the system. Suitable logic control valves, for example, to control the sequential operation of the air cylinders of the apparatus may be of the type produced by Clippard Instrument Laboratories Incorporated of 7390 Colerein Road, Cincinnati, Ohio. The

totally pneumatic actuation system will also have suitable selector valves for selecting the different operating modes described above. The apparatus can be cycled either manually or automatically as desired, and again, suitable actuating valves can be provided to achieve either method.

Claims:

1. Harness making apparatus for serially manufacturing electrical harnesses (2, 3, 5) of the type comprising at least one electrical connector (4), the connector having contact terminals (10) therein of the type having at least one wire-receiving slot, the harness having wires (6) connected to, and extending from, the terminals (10), the apparatus being of the type having a wire insertion zone (16), a connector locator (18) for locating a connector (4) in a predetermined position in the insertion zone (16), a wire feeder (14) for feeding wires (6) in side-by-side parallel relationship from endless wire sources (12), such as spools, along a first path to position the wires in alignment with terminals (10) in a connector (4) in the connector locator (18), and a wire inserter (76) movable along a second path towards and away from the connector (4) in the locator (18), the apparatus being characterised in that:

a connector transporter (20) is provided for transporting the connector from the connector locator (18) along a continuation of the first path away from the insertion zone (16),

a first wire cutter (22) is provided on the first path, the first wire cutter (22) being located between the connector-locator (18) and the wire sources (12), the first wire cutter (22) comprising individual sets of cutters (120, 122) for each of the wires (6), and

an actuator (66, 90, 164, 190) is provided which is effective to actuate the wire feeder (14) thereby to feed the leading ends of the wires (6) to the insertion zone (16), to thereafter actuate the wire inserter (76) to insert the leading ends of said wires (6) into the terminals in the connector (4) in the connector locator (18), to thereafter actuate the connector transporter (20) to move the connector (4) from the insertion zone (16) and thereby withdraw wire

from the wire sources, and the actuator being effective to actuate the individual wire cutters during transportation of the connector to produce wires of predetermined lengths extending from the connector.

2. Harness making apparatus as set forth in claim 1 characterised in that the actuator has a program controller (168, 170, 184) for cutting the wires (6) at predetermined intervals after the beginning of transportation of the connector from the connector locator (18) whereby the harness will have wires (6) of varying lengths extending from the terminals.

3. Harness making apparatus as set forth in either of claims 1 or 2 characterised in that the apparatus has a second connector locator (134, 216, 233) and a second wire inserter (228), the second connector locator being beside, and extending parallel to, the connector locator (18) and being on the first path, and a second wire cutter (230) is associated with the second connector locator (134, 216, 233) for cutting wires inserted into a connector (4) located in the second connector locator (134, 216, 233) whereby the apparatus is capable of manufacturing harnesses (3, 5) having two connectors (4) and wires (6) connected to, and extending between the terminals in the two connectors.

4. Harness making apparatus as set forth in claim 3 characterised in that the connector locator (18) is mounted on a rotatable supporting wheel (20), the connector transportor (20) being the wheel (20).

5. Harness making apparatus as set forth in claim 4, characterised in that the wire feeder (14) comprises a wire feed shuttle (84), the wires (6) extending from the sources (12) through the shuttle (84), releasable clamps (98) being provided on the shuttle (84) for clamping the wires (6) to the shuttle (84), the shuttle being movable between a retracted position, in which the shuttle is spaced from the wire insertion zone (16), and a forward position, in which the shuttle is proximate to the wire insertion zone,

the actuator (66, 90, 104, 164) being effective to engage the clamps (98) with the wires during movement of the shuttle (84) to the forward position and being effective to disengage the clamps (98) from the wires (6) during movement of the shuttle to the retracted position whereby the wires are pulled from the sources (12) during the forward stroke and the leading ends of the wires are delivered to the insertion zone (16).

6. Harness making apparatus as set forth in claim 5 characterised in that the wheel (20) is mounted on a shaft (166), the program controller comprising cams (168, 170) on the shaft (166), the cams being effective selectively to actuate the individual sets of cutters (22).

7. A method of serially manufacturing electrical harnesses (2, 3, 5) of the type comprising at least one electrical connector (4), the connector (4) having contact terminals therein of the type having wire-receiving portions, the harnesses (2, 3, 5) having wires (6) connected to, and extending from, the terminals, the wires (6) having free ends (7) which are remote from the connector, the method being characterised by the steps of:

(a) locating one of the connectors (4) in a wire insertion station (16),

(b) positioning the leading ends of wires (6) which extend from substantially endless wire sources (12), such as spools, in alignment with the terminals in the connector (4) at an insertion station and inserting the leading ends into the terminals,

(c) transporting the connector along a predetermined path away from the insertion station (16) and away from the wire sources (12) and thereby pulling wires (6) from the wire sources,

(d) cutting the wires during movement of the connector (4) along the path at a fixed location between the insertion station (16) and the wires sources (12) and thereby producing one of the harness assemblies,

(e) repetitively carrying out steps (a) to (d) as set forth above to produce harnesses serially.

8. A method of serially manufacturing electrical harnesses as set forth in claim 7 characterised in that the wires are cut individually and at predetermined varying time intervals after the beginning of transportation of the connector (4) along the predetermined path whereby the harness (2, 3, 5) has wires of varying lengths extending from the terminals.

9. A method of serially manufacturing electrical harnesses as set forth in claim 8 characterised by the step of stopping transportation of the connector (4) along the predetermined path prior to cutting of the wires (6), locating a second connector (4) in the insertion station, inserting the wires (6) into the terminals in the second connector, thereafter transporting the second connector and the connector along the path and then cutting the wires whereby the harness comprises two spaced-apart connectors and the wires extend from the second connector to the free ends (7) of the wires (6).

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FIG. 1

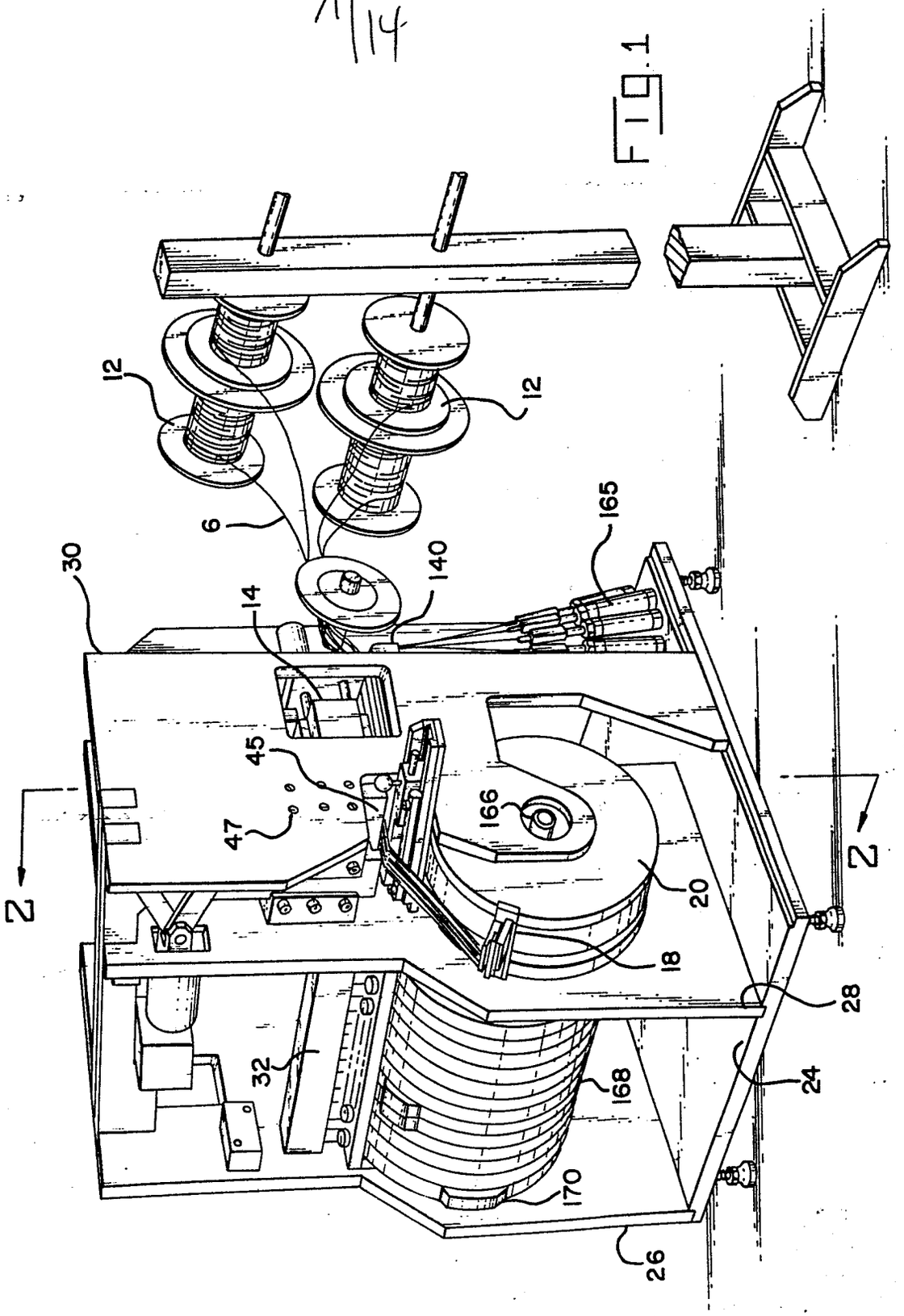
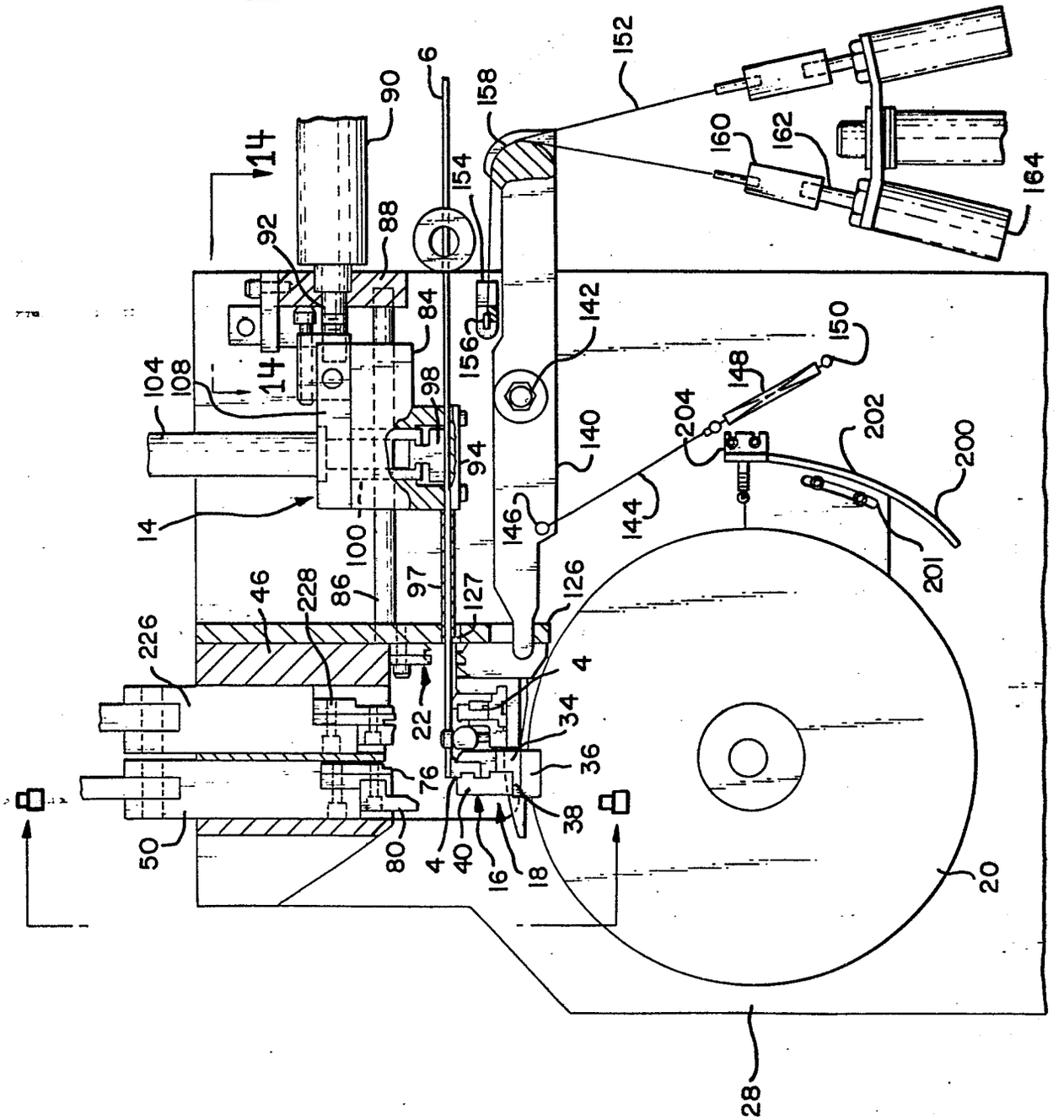


FIG. 2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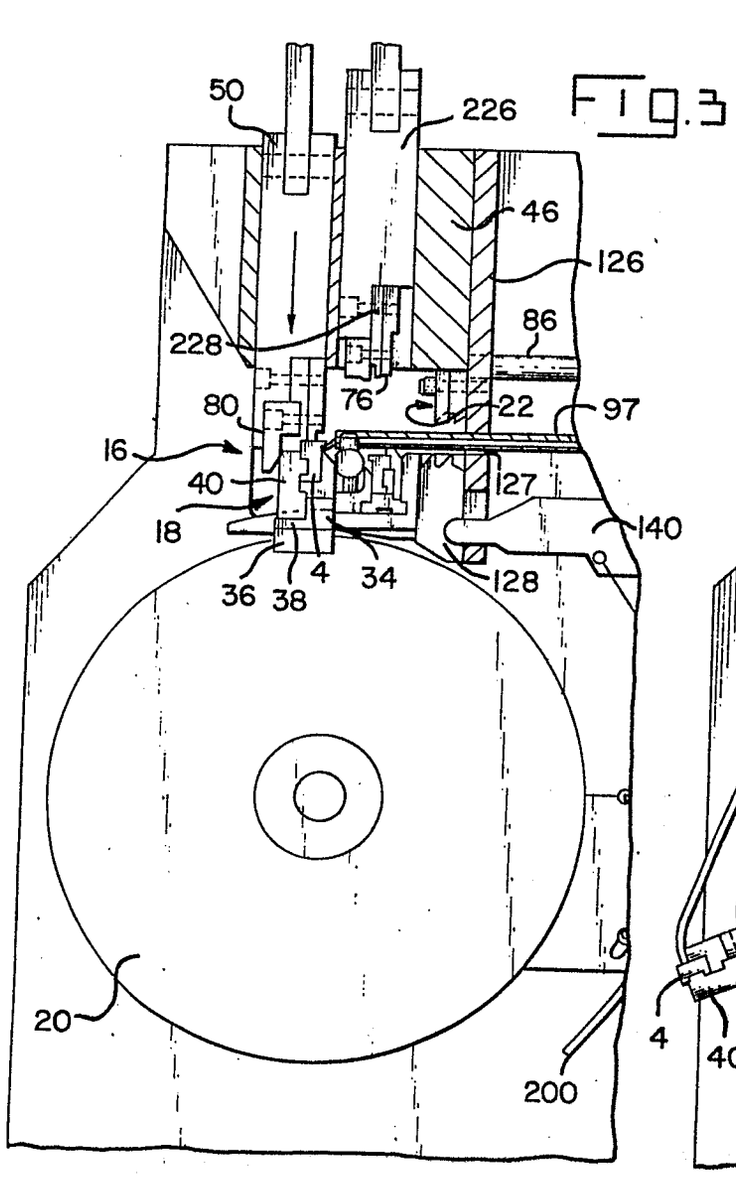

Fig. 3

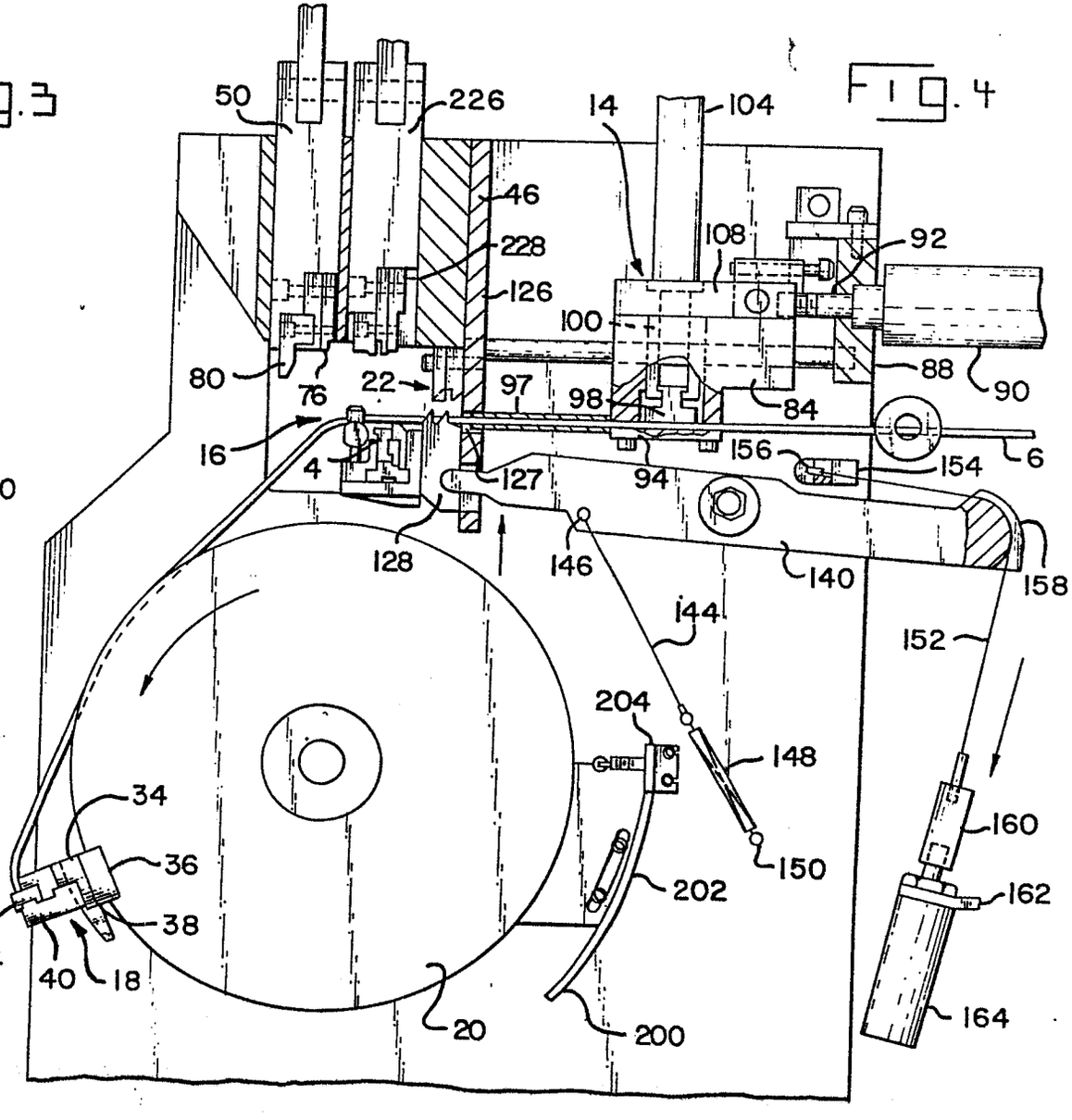

Fig. 4

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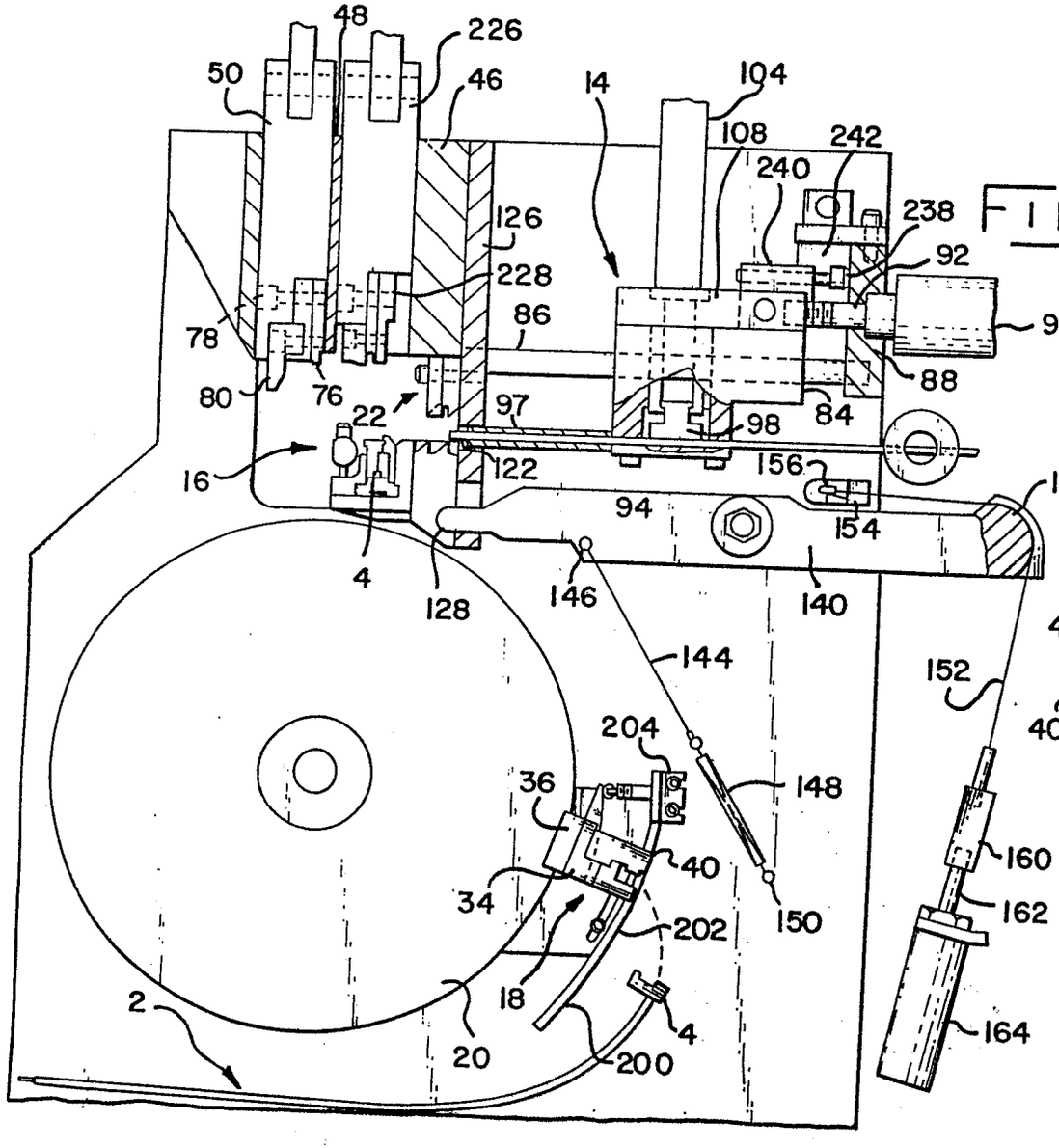

Fig.5

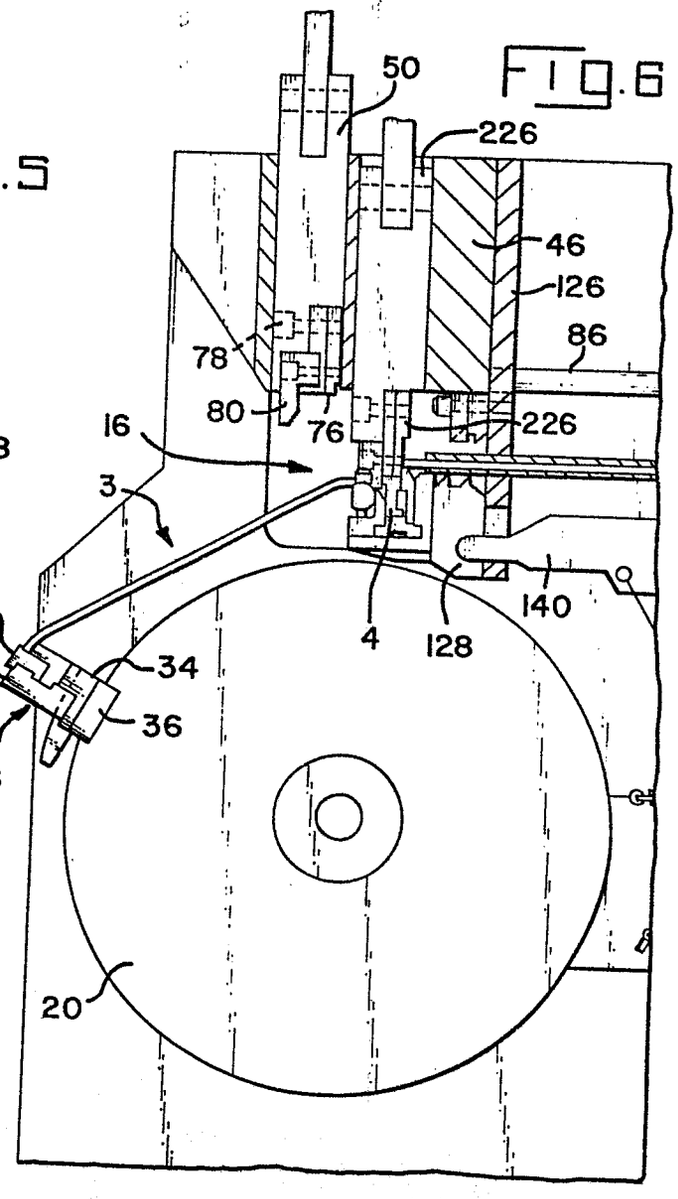

Fig.6

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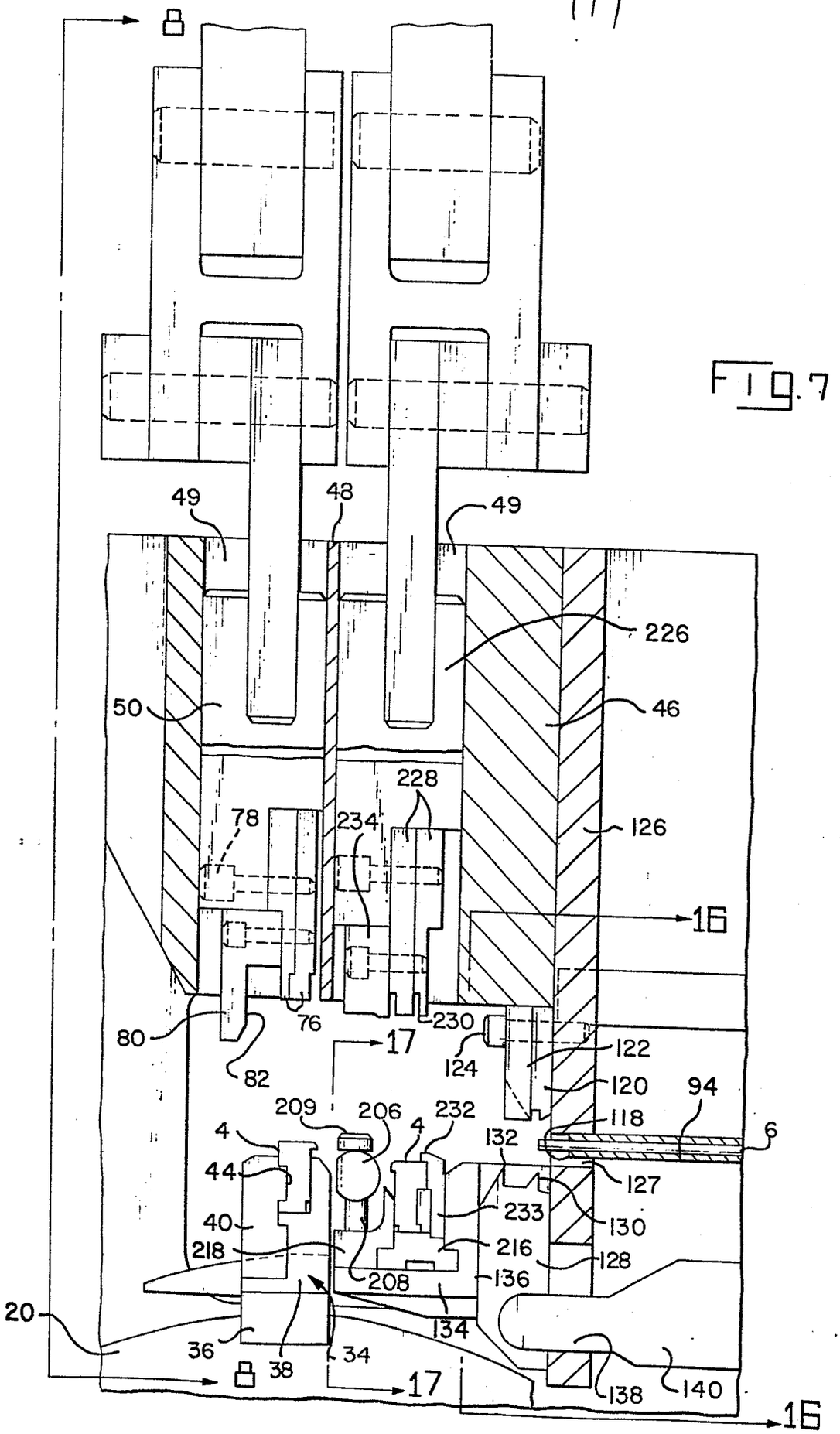
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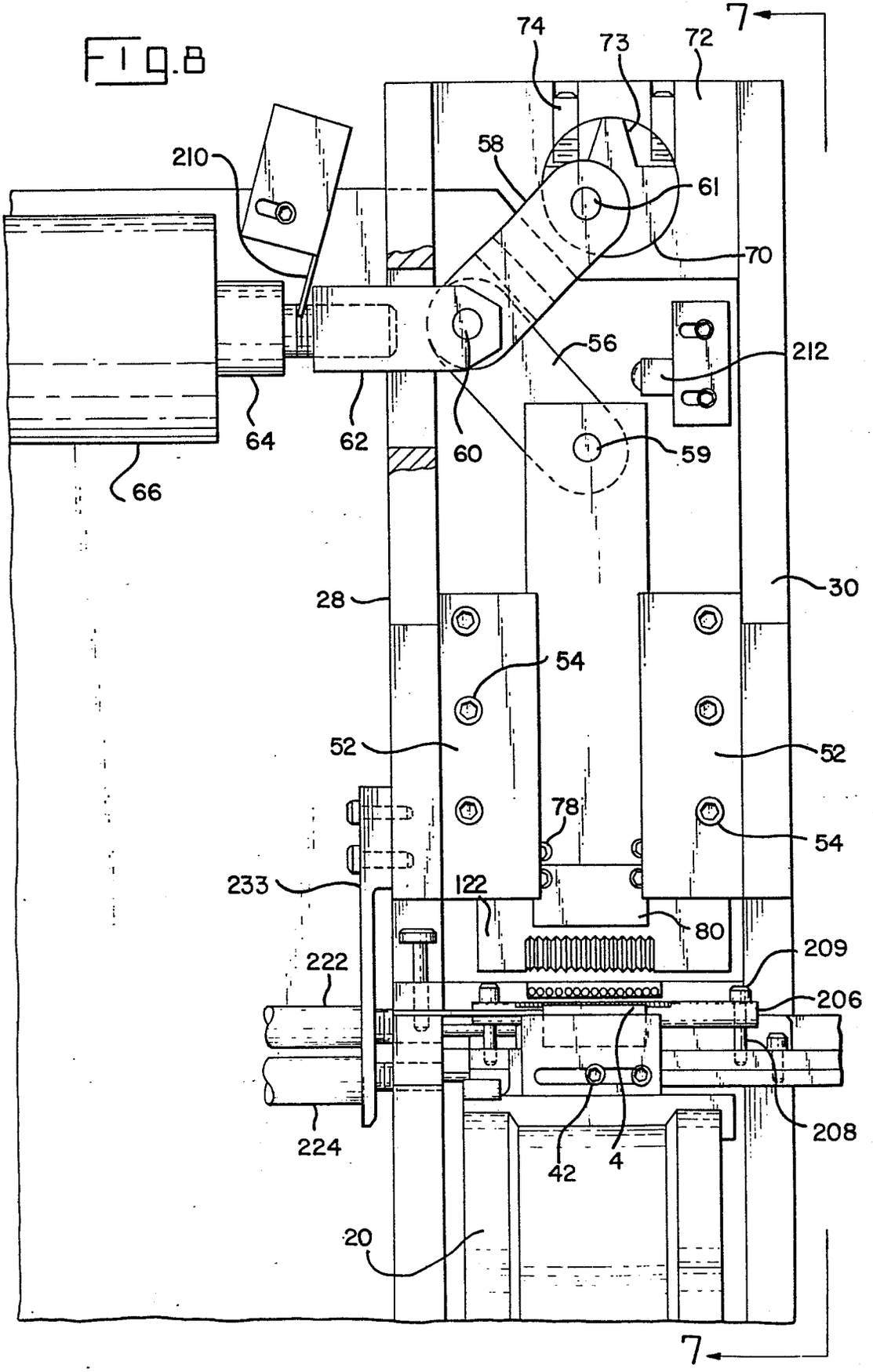
FIG. 7

Fig.8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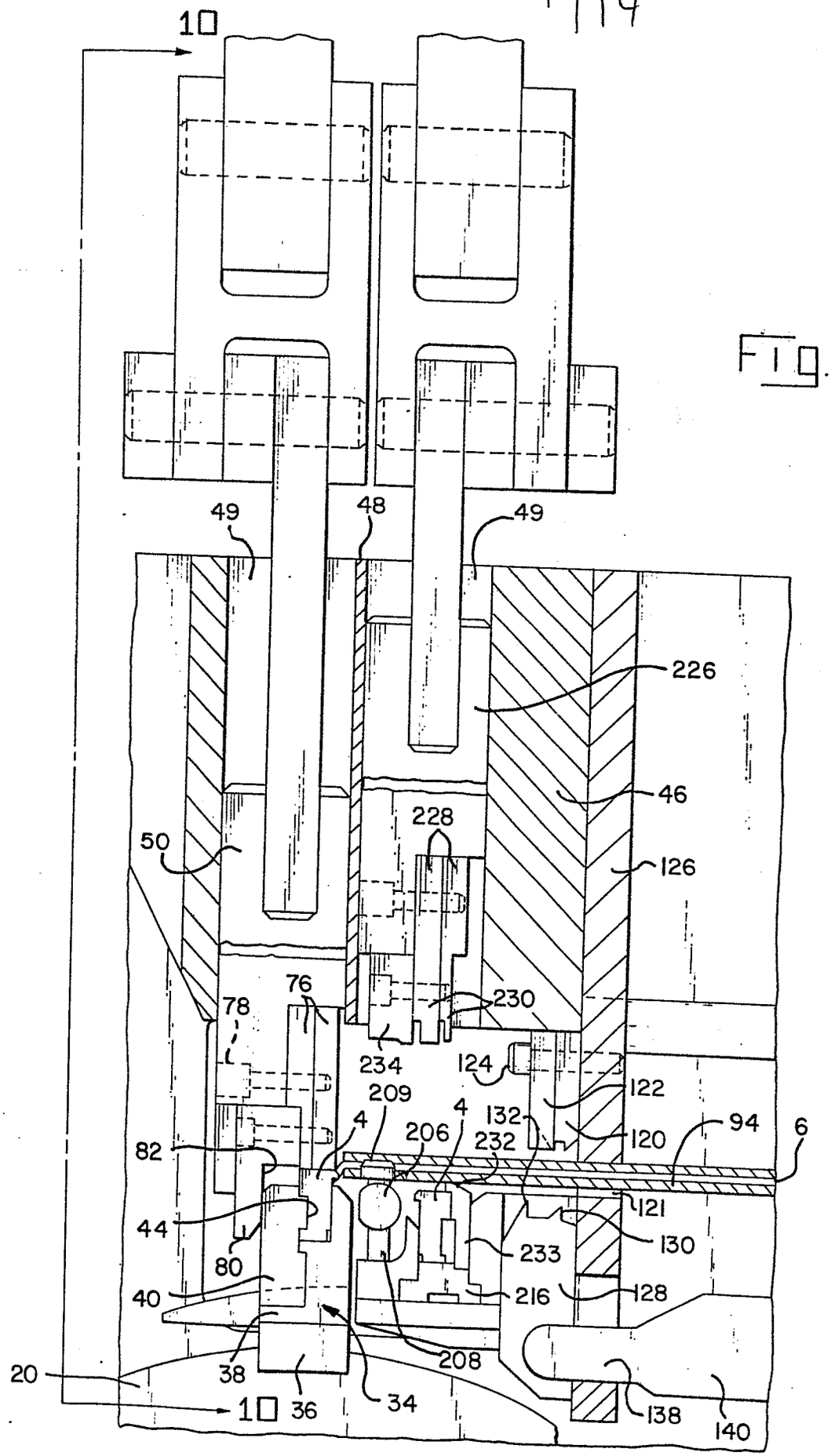
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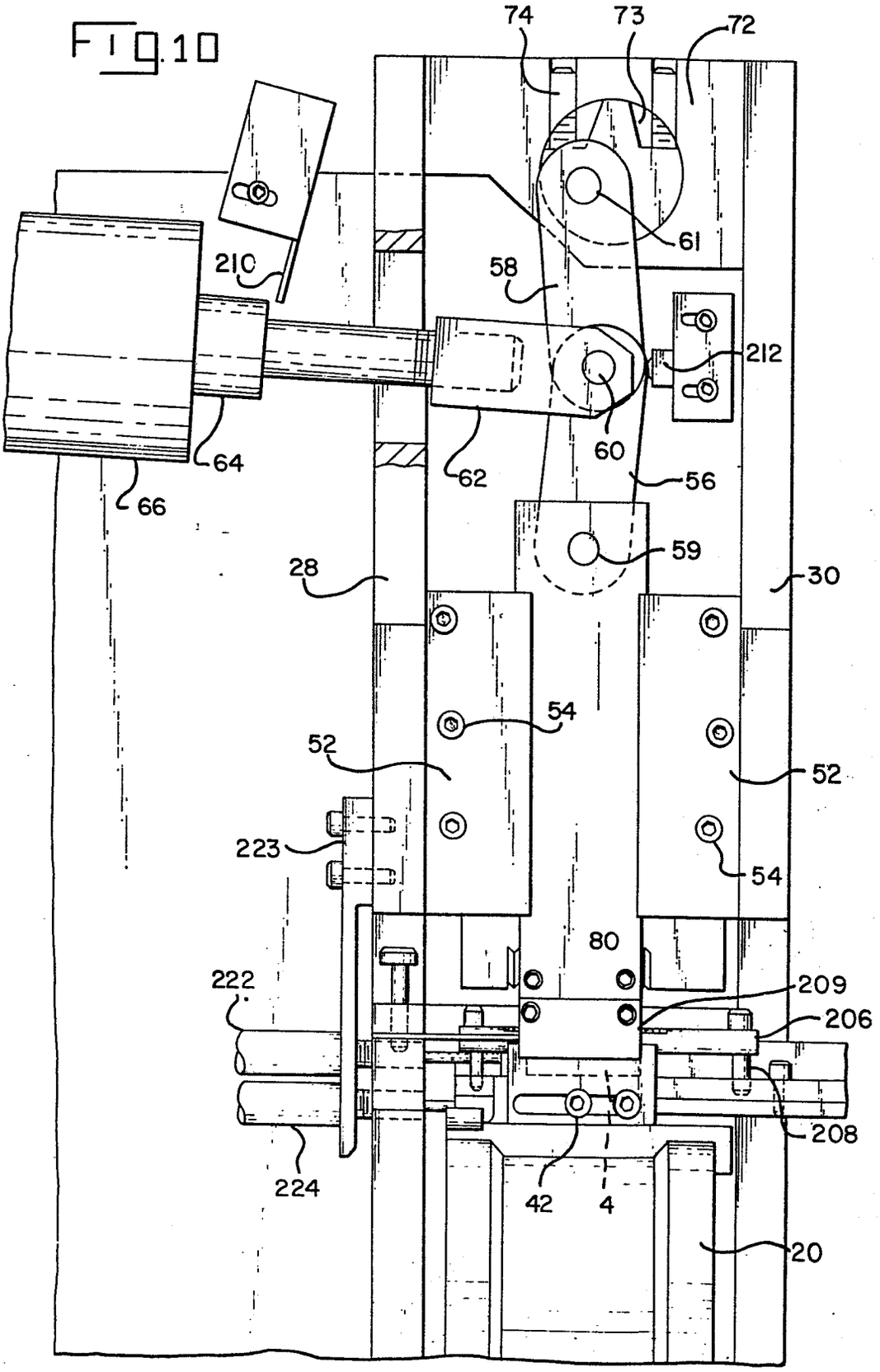
Fig.9

Fig.10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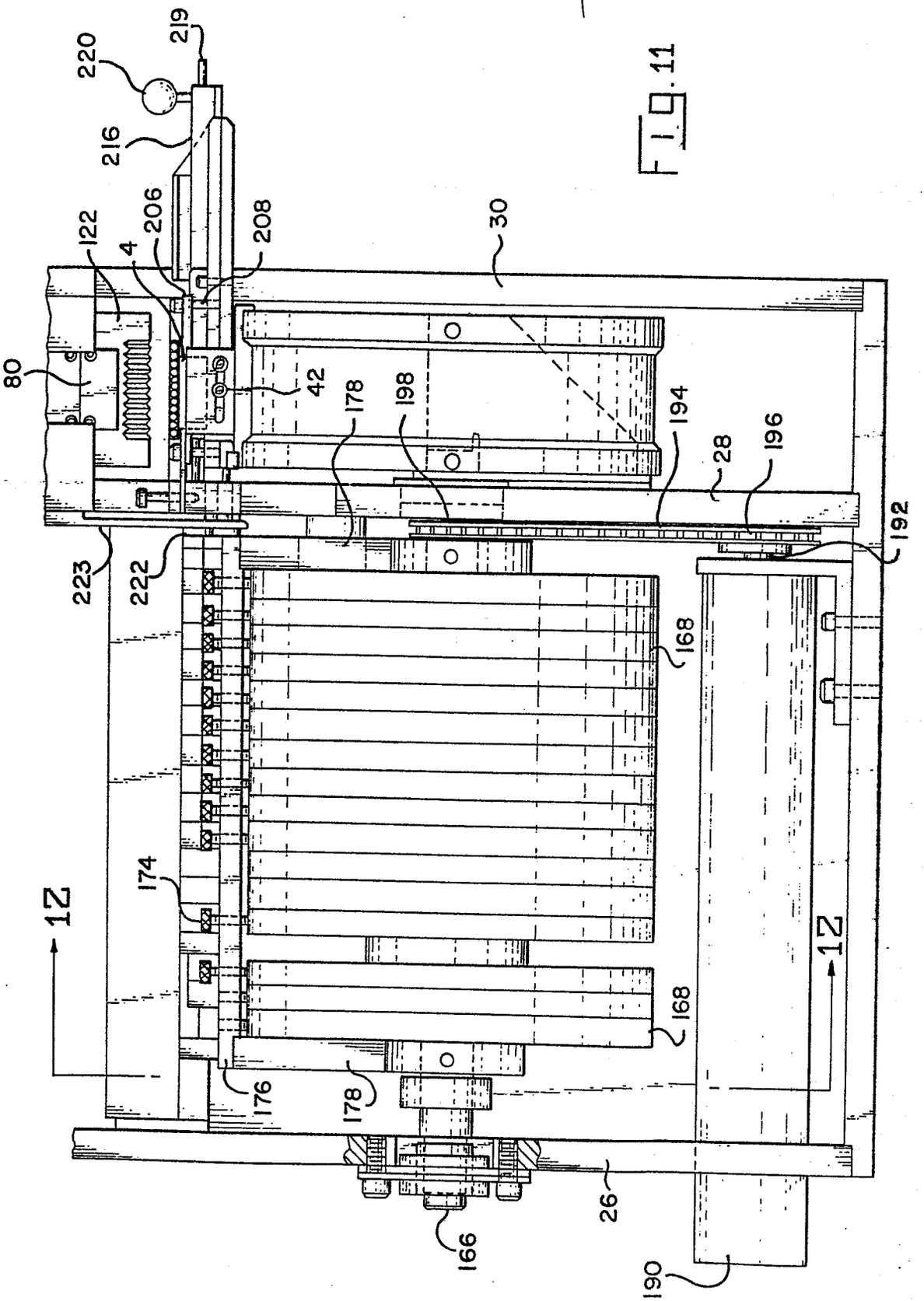
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FIG. 11

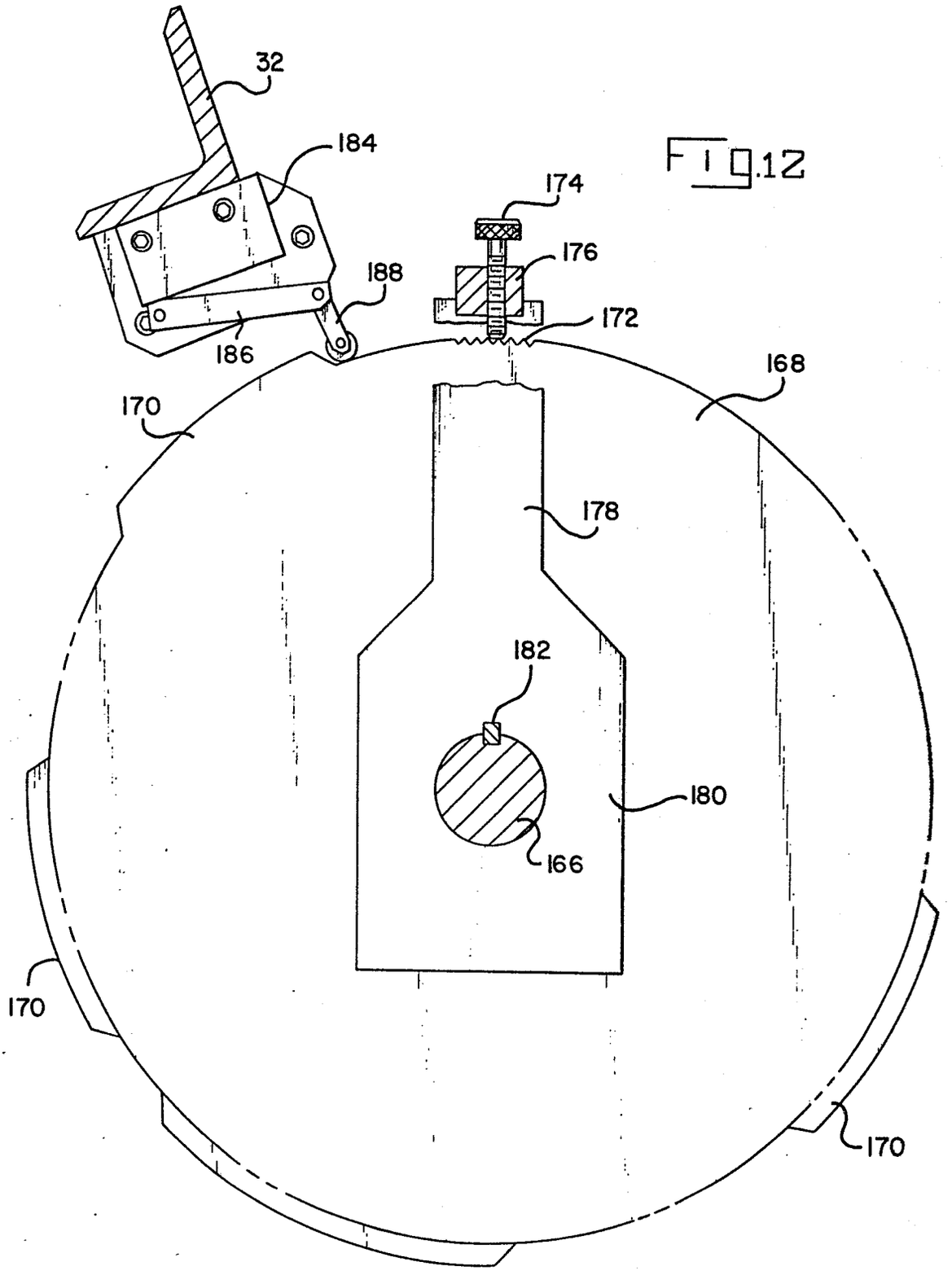
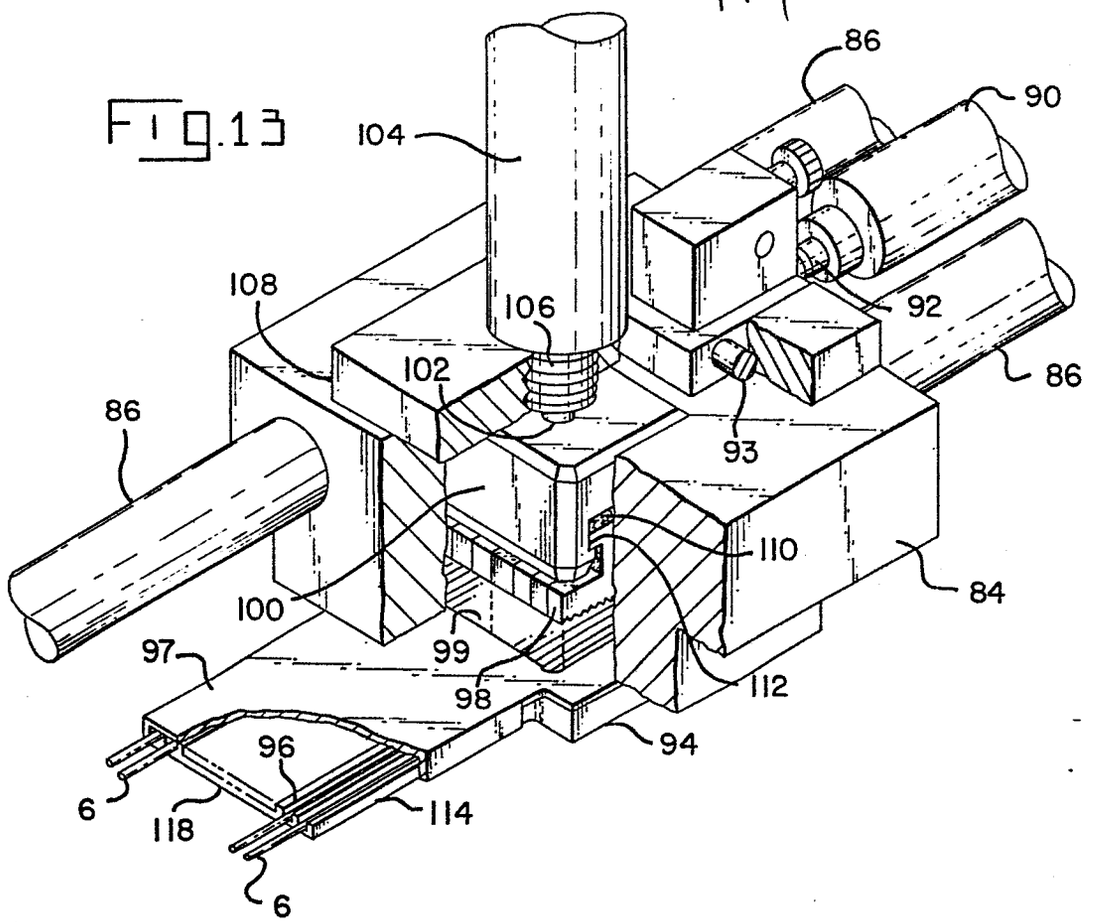


FIG.12

Fig.13



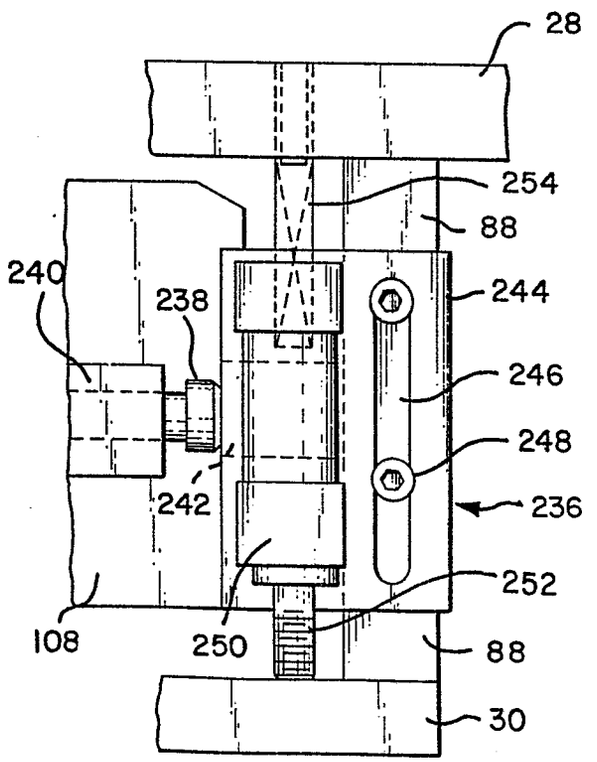


Fig.15

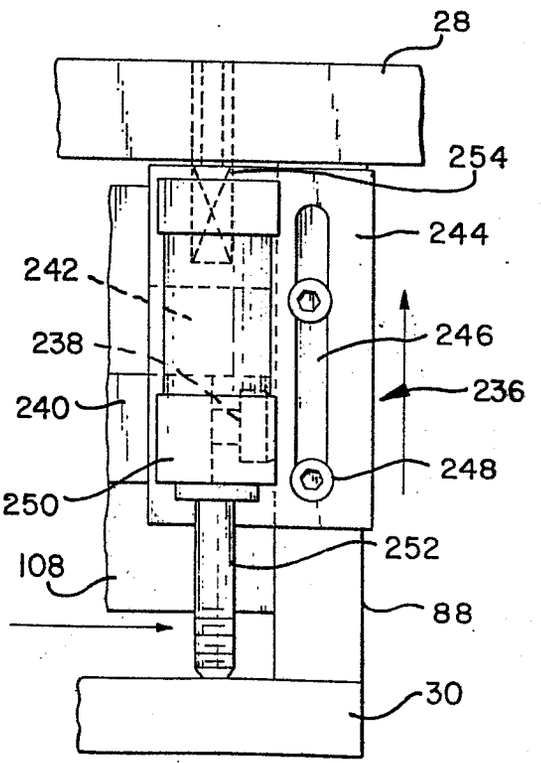


Fig.14

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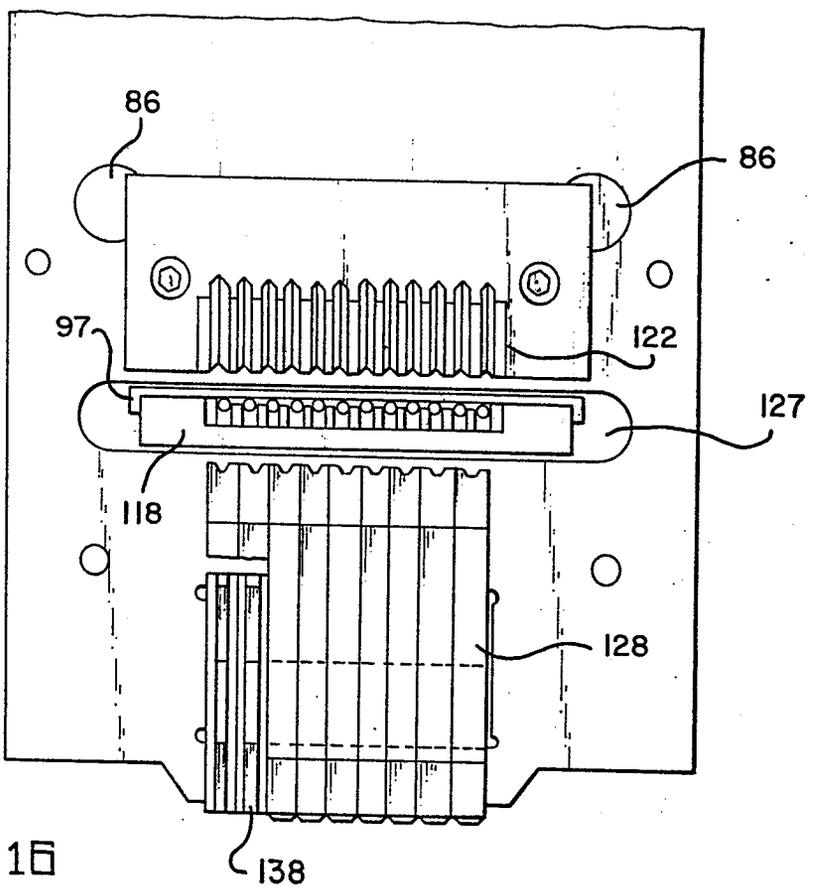

Fig.16

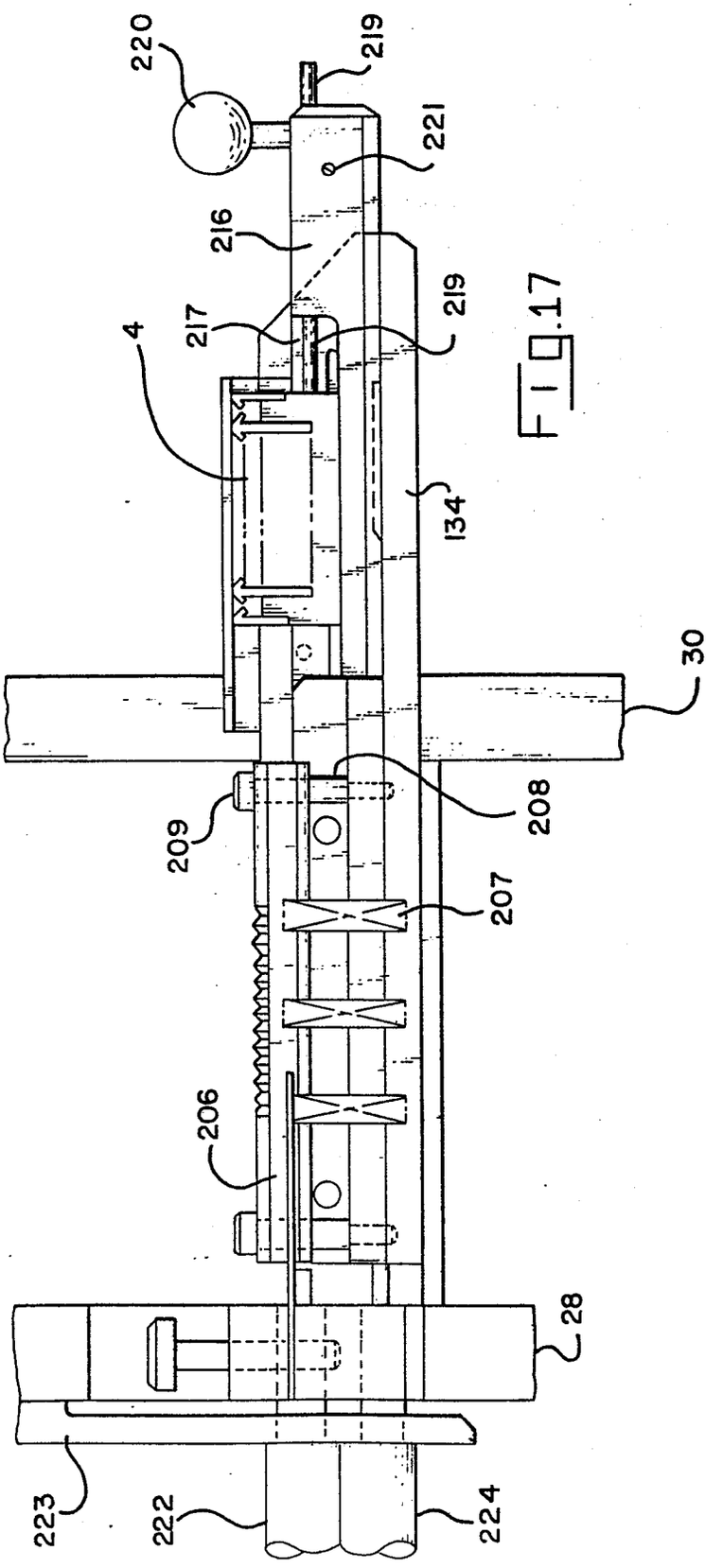

FIG.17

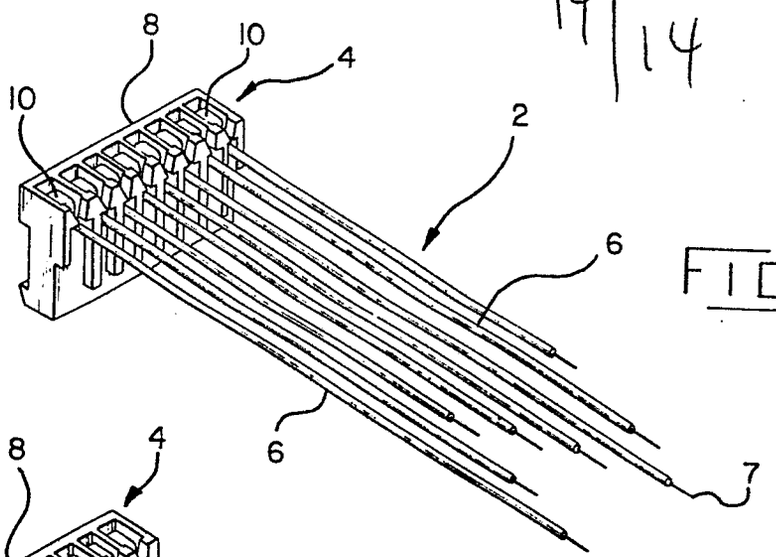

FIG. 18

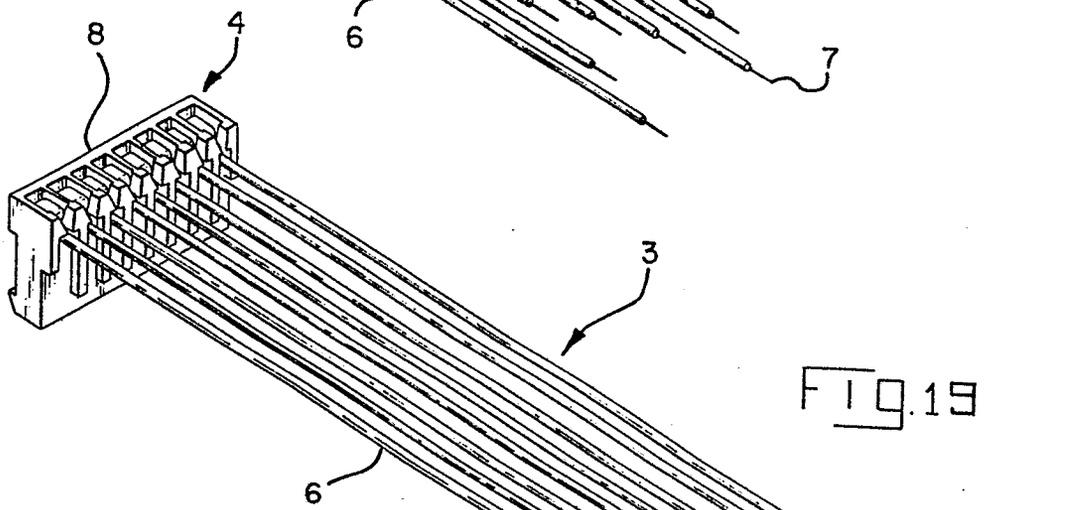

FIG. 19

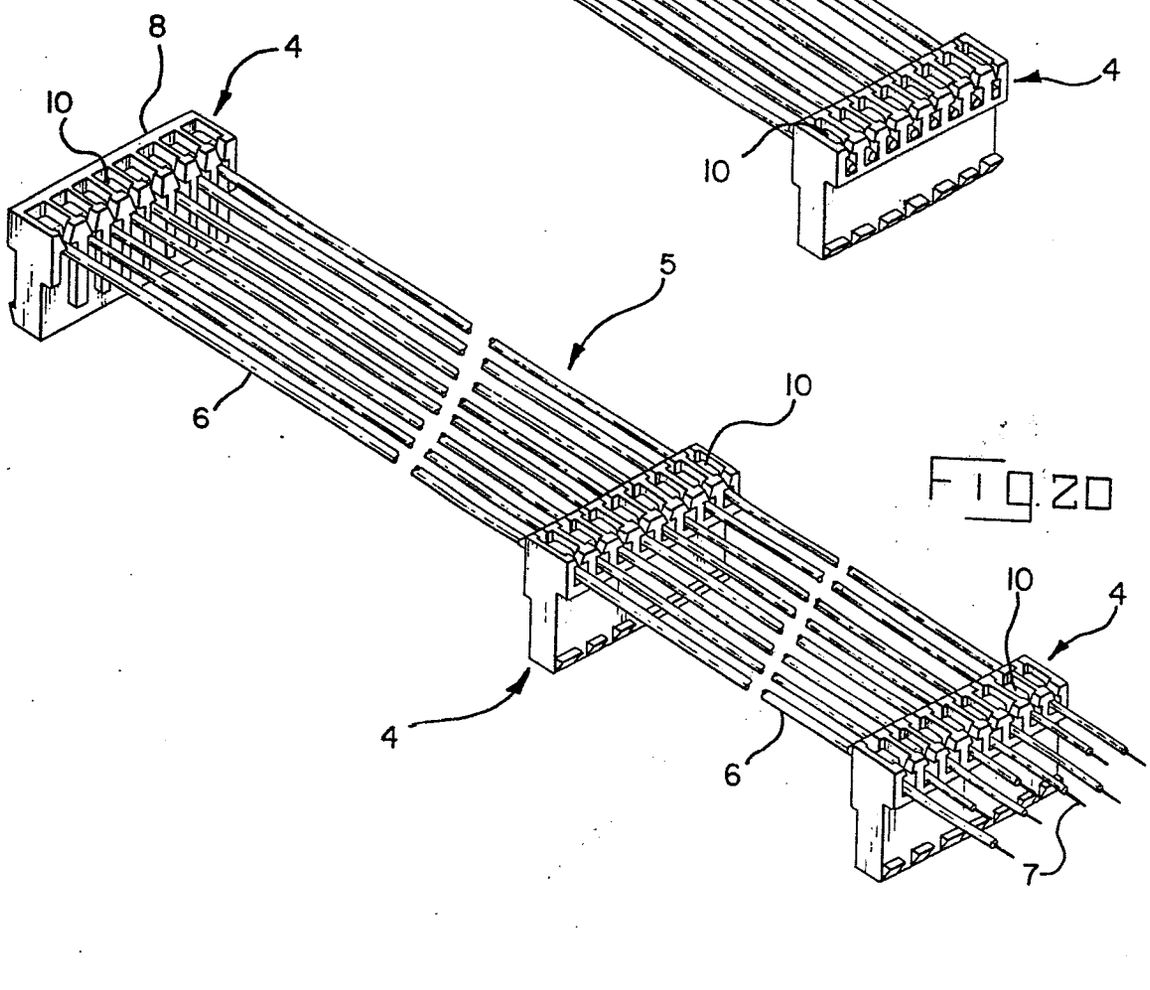

FIG. 20

0111601

European Patent Office

Application number

EP 82 30 6687

EUROPEAN SEARCH REPORT

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	EP-A-0 066 391 (AMP)		H 01 R 43/00
A	US-A-4 043 494 (AMP)		
A	US-A-4 235 015 (MOLEX INC.)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

H 01 R 43/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-08-1983	MOBOUCK G.C.

CATEGORY OF CITED DOCUMENTS

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D : document cited in the application
L : document cited for other reasons

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