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(54) Apparatus and method for assembling terminated wires into electrical connectors to form harnesses.

(57) Insulated conductor wire (11) is fed in predetermined lengths in a "Y" direction (see Fig. 1) to a cutter (42) adjacent a termination station defined by a connector nest (21) mounted on an "X" axis displaceable table (25) in turn supported on a "Y" axis displaceable table (26). A wire insertion blade (33) movable in a "Z" direction to alternate depths of insertion, terminates each cut wire end in an insulation displacement terminal in a connector (24) positioned in the nest (21) with the terminal receiving slot (31) at the termination station. The terminals are arranged in spaced relation along two tiered rows (30, 37) of terminal slots (31) with adjacent slots (31) in each row interspaced by a slot (31) in the other row, whereby each terminal has a unique location in the "X" direction. Following the insertion of a wire in the first terminal slot (31) in the upper row (3), the "X" table is stepped one terminal slot (31) and the "Y" table is stepped one terminal slot (31) and the "Y" table is shifted to align the next adjacent slot (31) in the lower row (37) at the insertion station, and so on, the "X" table being shifted stepwise in a forward direction only, to carry terminated wires clear of the insertion station, and the "Y" table being shifted to-and-fro successively to align the upper and lower tiers (30, 37) of terminal slots (31) at the insertion station.

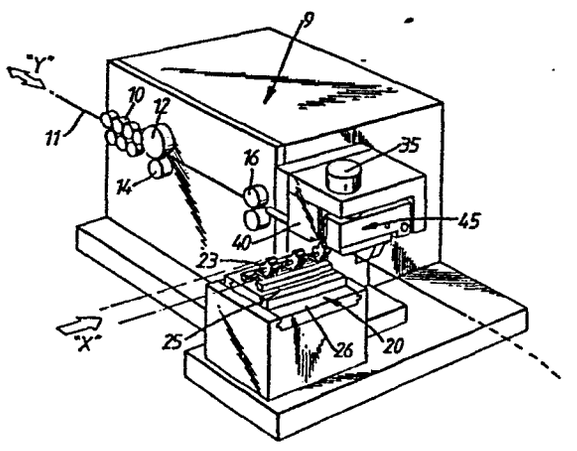

FIG.1.

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APPARATUS AND METHOD FOR ASSEMBLING TERMINATED WIRES INTO ELECTRICAL CONNECTORS TO FORM HARNESSES

The present invention relates to apparatus and method for assembling terminated wires into electrical connectors to form harnesses and concerns apparatus and method for the manufacture of electrical cable harnesses of the type including a connector electrically connected to a plurality of discrete wire conductors, the connector having a housing with a plurality of terminals mounted therein, the terminals having insulation displacing slot means for termination with said wire conductors.

In order to conduct electrical signals between printed circuit board assemblies or components by means of electrical conductors in electrically operated equipment and products, it is common to employ a harness of terminated wires assembled into a connector at at least one end, the wires being also terminated at their other ends.

It is already known to provide apparatus for the manufacture of electrical cable harnesses of the type described, comprising a termination station, means for indexing the connector in an "X" direction to present the terminals of said connector one at a time to said termination station, means for aligning in a

"Y" direction the free end of a wire conductor with a terminal presented to said termination station, and a terminator at said insertion station including a wire insertion blade for inserting said wire conductor free end in said insulation displacing slot means, said blade being mounted for movement along an insertion stroke of predetermined length in a "Z" direction perpendicular to said "X" and "Y" directions.

Such apparatus has been manually fed with discrete wire conductors by an operator positioning the free ends of the conductors in the "Y" direction one at a time at the termination station for alignment by the aligning means, the operator then operating the terminator to terminate the conductor in the connector in the "Z" direction.

The object of the present invention is to provide apparatus and method for assembling discrete wire conductors into a connector, one at a time, and at different levels in the connector to form a cable harness of the type described.

Proceeding from the known apparatus described above, the apparatus of the present invention is characterised in that said terminals of said connector are arranged in two rows extending in said "X" direction and spaced apart from each other in said "Y" and said

"Z" directions, with the terminals of one row being offset from the terminals of the other row in said "X" direction; said indexing means including an indexable nest movable in said "X" and said "Y" directions, for receiving at least one of said connectors; means for selectively moving said indexable nest in said "X" and said "Y" directions to present a predetermined sequence of terminals one at a time to said termination station; and said insertion blade having at least two insertion strokes of different lengths, one stroke for each row of terminals, for inserting the free end of a wire conductor in said insulation displacing slot means of each terminal located in each of said rows.

The method of the present invention comprises the steps of presenting said connector at a termination station, indexing the connector in an "X" direction to present a terminal of one row of the connector at said termination station, aligning the free end of a wire conductor at a predetermined point over said terminal, and inserting the wire free end in said insulation displacing slot means of said terminal, and is characterised by the further steps of providing a connector with a second row of preloaded terminals, said first and second rows each extending in an "X" direction and spaced apart from each other in "Y" and

"Z" mutually-perpendicular directions with the terminals of one row being offset from the terminals of the other row in said "X" direction, indexing the connector in both said "X" and said "Y" directions to present another terminal taken from the second row at the termination station; and inserting another wire free end in said insulation displacing slot means of said other terminal.

Specific embodiments of the present invention embodying both its method and apparatus aspects will now be described by way of example, and not by way of limitation with reference to the accompanying drawings in which:

FIG. 1 shows part of an automatic machine for assembling terminated wires into a connector to form a harness;

FIG. 2 is a front elevation;

FIG. 3 is an end view showing the secondary wire gripper unit;

FIGS. 4, 5 and 6 are diagrammatic views showing a sequence of wire insertion steps, and

FIG. 7 is a cross-sectional view of part of the machine.

With reference now to the accompanying drawings, and first with reference to Figs. 1, 2 and 7, the machine comprises a horizontal wire feed unit 9 including a wire straightener 10 for wire 11 fed from a reel (not shown),

a wire length encoder wheel 12 and a wire presser wheel 14 and wire feed drive rolls 16. The wire feed unit 9 further includes an encoder and stepping motor and control and wire processing printed circuit boards, the latter permitting two functions:

(a) 35 (minimum) different lengths of wire, that can be programmed in sequence with termination after each wire,

(b) the same as above but with step feed operation: i.e. (i) a predetermined portion A1 of wire length A, e.g. 50 mm; (ii) operation of optional individual rotatable or retractable termination unit (not shown); (iii) wire clamp unit described below in semi-open (feed) position; (iv) remainder A2 of wire length A.

The machine further comprises a fixture unit 20 including a nest or fixture plate 21 to accomodate a horizontal feed at right angles to the wire feed, e.g. of a linked chain 23 (see Fig. 2) of insulation displacement terminal (IDT) connectors 24 formed as plug sockets and constructed as described in our Patent Application No. 84 30 6787.7. In this case, two extra machine units (not shown) are necessary, first a connector chain feed unit, off reel, and secondly, a connector separator unit which is placed on the opposite side of the machine to the connector chain feed unit outside of the wire insertion area described below. The connectors come off the reel

placed flat, with their terminal locating grooves and terminal, wire receiving slots, opening vertically upwardly.

Loose piece connectors such as 24 may alternatively be hand fed into the nest 21.

The fixture unit 20 further comprises an "X" movement table 25 mounted on a "Y" movement table 26. The nest 21 is mounted on the "X" movement table which is displaceable on an "X" axis in the direction of the connector feed. The "Y" movement table is displaceable on a "Y" axis at right angles to the direction of connector feed. Two cams 50 and 51 operate the "X" and "Y" tables respectively, the cams being mounted on a common shaft and operated by a stepping motor 53 (e.g. 8 x 45^{o} intervals) under the control of the control printed cirecuit board incorporated in the unit 9.

Connectors 24 are advanced in turn along the nest 21 to a "start" position or termination station in which the first of an upper tier 30 (see Fig. 4) of terminal wire receiving slots 31 is at an insertion station vertically below a vertically displaceable, "Z" movement wire insertion blade 33. The insertion blade is arranged to be driven downwardly by a pneumatically operable insertion cylinder 35 with a movable stop for two heights (or depths) of insertion of the blade, one

of which is illustrated in Fig. 5 (blade inserted in upper tier 30) of connector and the other of which is illustrated in Fig. 6 (blade inserted in lower tier 37) of connector. The terminal wire receiving slots 31 are all uniquely positioned along the tiers 30,37 in the "X" direction and adjacent slots 31 are positioned in the two tiers 30, 37 respectively. Following insertion of a wire in the first slot 31 the "X" table is stepped one slot by its cam 50 and the "Y" table is shifted by its cam 51 to align the next adjacent slot 31 in the lower tier 37 in the insertion station, and so on, the "X" table being shifted stepwise in a forward direction only, to carry terminated wires clear of the insertion station, and the "Y" table being shifted to and fro successively to align the upper and lower tiers of terminal wire receiving slots in the insertion station.

A wire feed guide 40 is incorporated on the wire feed side of a wire cutter blade 42 operated by the insertion cylinder each time the insertion blade 33 is driven downwardly.

In order to control the wire for cutting and each cut wire length for insertion and termination in the connector, the machine further comprises a wire gripper 45, details of which are shown in Fig. 3. The unit 45 is carried with the insertion blade 33 from the insertion

cylinder 35 and has a closed (wire gripping) position, a semi-open (wire guiding) position and a fully open (wire disengaging) position. The wire gripper 45 comprises an upper jaw member 47 which is fixed relative to the insertion blade 33, a lower pivoted jaw member 48 which swings away from

the fixed jaw member, first to the semi-open and then to the fully open position, and a duplex pneumatic piston and cylinder arrangement generally indicated at 50 for activating the clamp between its closed, semi-open and fully open positions. Air under pressure is supplied to opposite sides of the main piston 51 to close and fully open the clamp respectively. In the clamp closed position, air under pressure supplied to the underside of piston 51 holds a secondary piston 52 displaced in a cylinder 53 against springs 54 acting on the upper side of the piston 52. Reduction of the pneumatic closing force below the force of the springs 54 opens the clamp a predetermined amount controlled by the downward movement permitted to the piston 52. The piston 52 is held in engagement with the piston 51 by the springs 54. Air under pressure to fully open the clamp is supplied to the cylinder 53 and is communicated with the upper side of the piston 51 through a fluid port in the piston 52.

The cycle sequence of the machine is as follows.

A connector 24 is fed to position the first terminal wire receiving slot 31 at the insertion station. The wire gripper 45 is moved to its semi-open position. Wire feed is provided by the unit 9

for the first wire either in one single length A or in lengths A1 and A2 for termination of the leading end of the wire in an individual, rotatable or retractable termination unit (not shown) rotatable or retractable to enable the wire feed A2 to take place. The wire gripper 45 is then closed. The wire cutter blade 42 is then actuated and the wire is transferred and inserted by the insertion blade whilst being held by the wire gripper 45. The wire gripper 45 is then moved to its fully open position and the connector 24 is displaced by movement of the "XY" tables to align the second terminal wire receiving slot at the insertion station and the machine resets to repeat the cycle of operations described, the wire gripper 45 moving to its semi-open, i.e. feed position, to receive and guide the next wire length.

After six wire lengths have been stitched to the connector in this fashion, the chain 23 of connectors is fed forward to align a fresh connector at the insertion station. At the same time, or intermittently, a finished harness is chopped from the harness chain.

The "XY" movement tables, coupled with the dual height insertion unit, can be used on a "Megomat" ASM 1000 in the same manner as a standard press, substituting the ASM 1000 special right hand

wire gripper for the wire gripper 45 described.

The "XY" movement tables 24, 25 coupled with the dual height insertion unit 35 and wire gripper 45 may be used with the wire feed and measure unit 9 (Megomat) described to produce single harnesses and jack harnesses automatically or semi-automatically.

Use of the split wire feed feature as described permits the use of a supplementary stripper/crimper unit for individually terminating the individual opposite ends of harness wires or the use of an IDT press for double ended IDT.

All the harnesses will use wire lengths cut from one single wire. To identify the different wire lengths a wire marking unit may be incorporated.

Whilst an automatic machine has been described, it will be appreciated that discrete wire conductors may be manually fed by an operator in the "Y" direction, one at a time, to the termination station for termination in successive slots 31 in the upper and lower tiers of each connector if desired, the successive slots 31 being aligned at the termination station and the wires terminated in the connector by operating the machine.

CLAIMS:

1. Apparatus for the manufacture of electrical cable harnesses of the type including a connector electrically connected to a plurality of discrete wire conductors, the connector having a housing with a plurality of terminals mounted therein, the terminals having insulation displacing slot means for termination with said wire conductors, said apparatus comprising:

a termination station,

means for indexing the connector in an "X" direction to present the terminals of said connector one at a time to said termination station,

means for aligning in a "Y" direction the free end of a wire conductor with a terminal presented to said termination station,

a terminator at said insertion station including a wire insertion blade for inserting said wire conductor free end in said insulation displacing slot means, said blade being mounted for movement along an insertion stroke of predetermined length in a "Z" direction perpendicular to said "X" and "Y" directions,

characterised in that

said terminals of said connector are arranged in two rows extending in said "X" direction and spaced

apart from each other in said "Y" and said "Z" directions, with the terminals of one row being offset from the terminals of the other row in said "X" direction;

said indexing means including an indexable nest movable in said "X" and said "Y" directions, for receiving at least one of said connectors;

means for selectively moving said indexable nest in said "X" and said "Y" directions to present a predetermined sequence of terminals one at a time to said termination station; and

said insertion blade having at least two insertion strokes of different lengths, one stroke for each row of terminals, for inserting the free end of a wire conductor in said insulation displacing slot means of each terminal located in each of said rows.

2. Apparatus as claimed in claim 1, further including means for feeding a predetermined length of said wire conductor in said "Y" direction mutually perpendicular to said "X" and "Z" directions and for cutting said wire conductor adjacent said termination station to form said wire free end, said moving means being operable to align each terminal to said wire free end.

3. Apparatus as claimed in claim 1 or 2,

wherein said indexing means includes an "X" table movable in an "X" direction, mounted on a "Y" table movable in a "Y" direction.

4. Apparatus as claimed in any preceding claim, wherein said predetermined sequence comprises a succession of terminals taken alternately from said two rows.

5. A method of manufacturing an electrical cable harness of the type including a connector electrically connected to a plurality of discrete wire conductors, the connector having a housing with a row of preloaded terminals mounted therein, the terminals having insulation displacing slot means for termination with said wire conductors, said method comprising the steps of

presenting said connector at a termination station,

indexing the connector in an "X" direction to present a terminal of one row of the connector at said termination station,

aligning the free end of a wire conductor at a predetermined point over said terminal, and

inserting the wire free end in said insulation displacing slot means of said terminal,

characterised by the further steps of

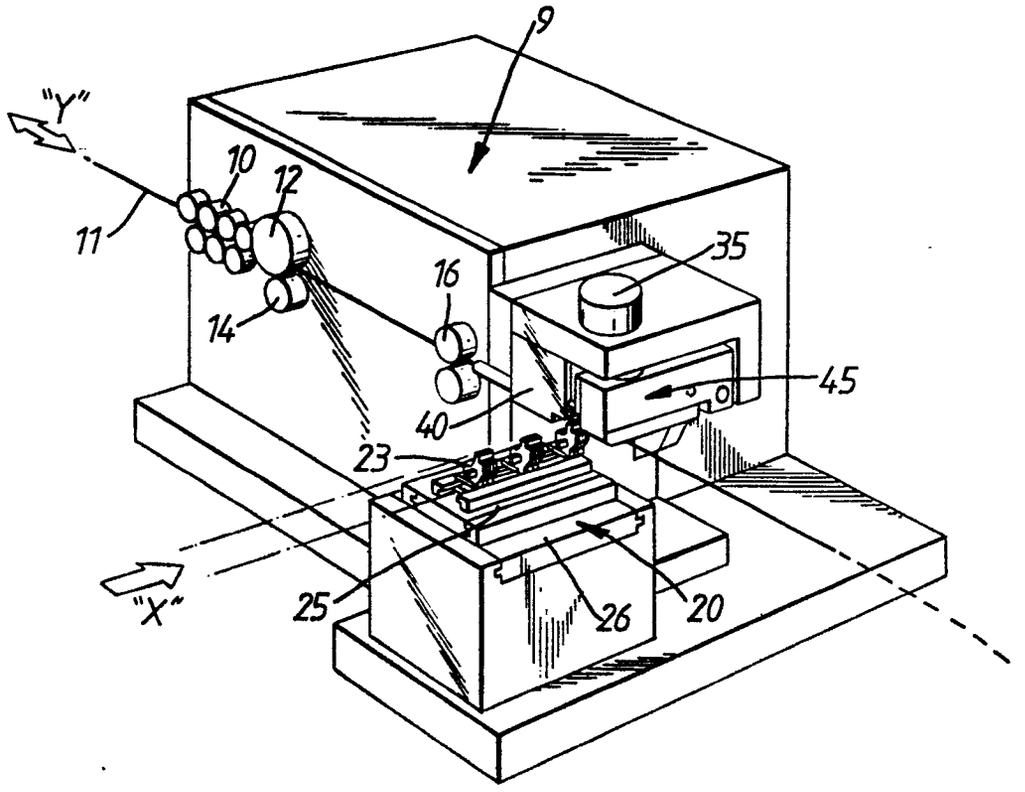
providing a connector with a second row of preloaded terminals, said first and second rows each extending in an "X" direction and spaced apart from each other in "Y" and "Z" mutually perpendicular directions with the terminals of one row being offset from the terminals of the other row in said "X" direction,

indexing the connector in both said "X" and said "Y" directions to present another terminal taken from the second row at the termination station; and

inserting another wire free end in said insulation displacing slot means of said other terminal.

6. The method of claim 5 further comprising the step of feeding a predetermined length of said wire conductor in a "Y" direction mutually perpendicular to said "X" and said "Z" directions, and cutting said wire adjacent said termination station to form said wire conductor free end at said predetermined point.

7. The method of claim 5 further comprising the step of alternately presenting the terminals of one row with the terminals of the other row for termination as said connector is advanced in said "X" direction.


9
"Y"
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12
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16
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14
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40
23
"X"
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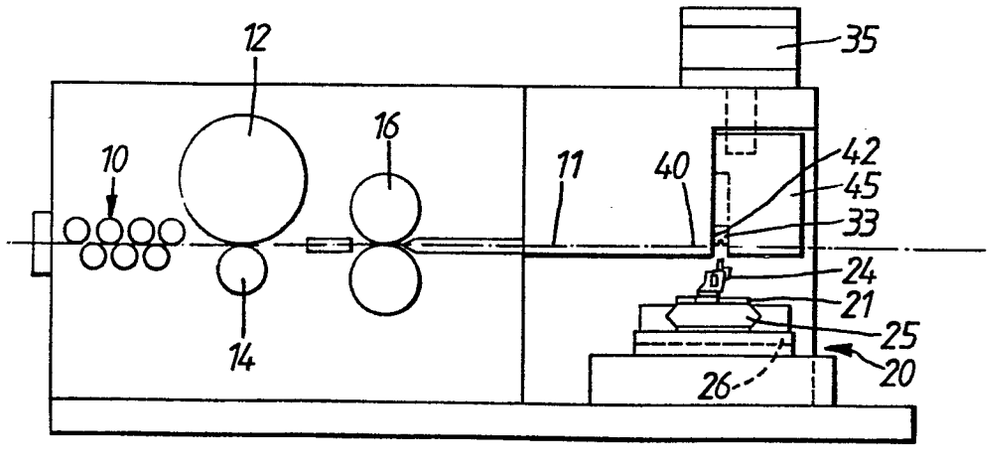
20

FIG.1.


12
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26

FIG.2.

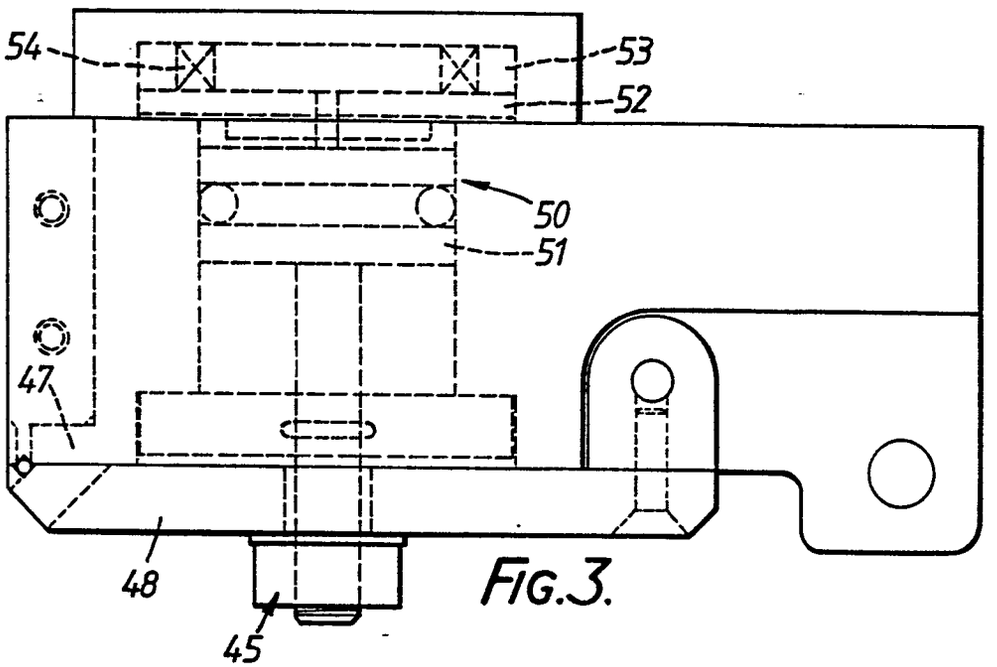

FIG.3.

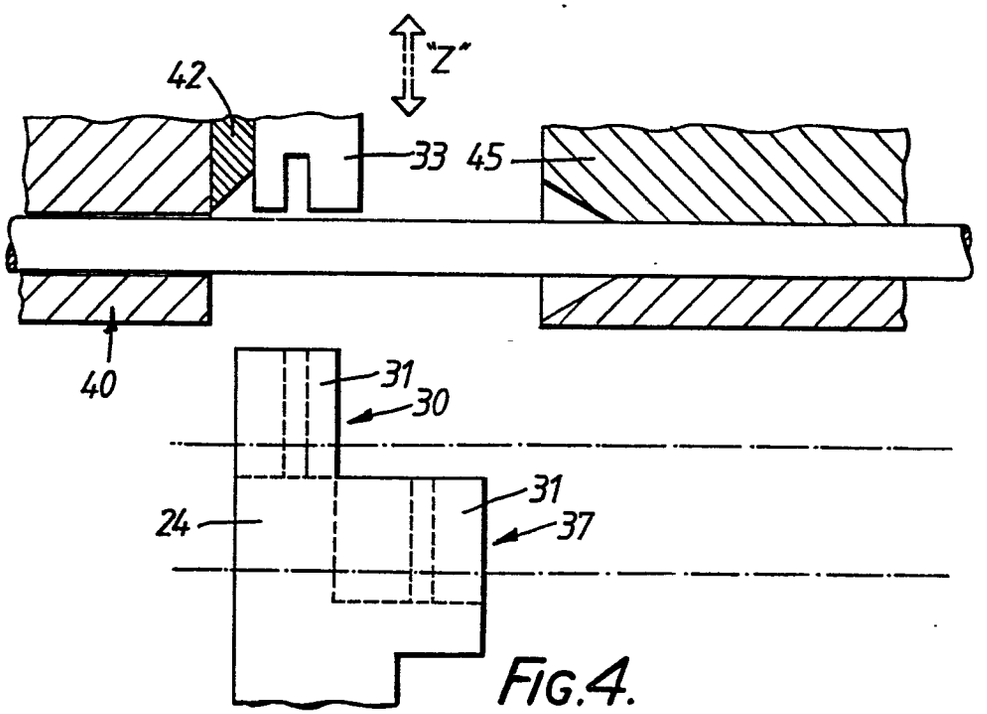

FIG.4.

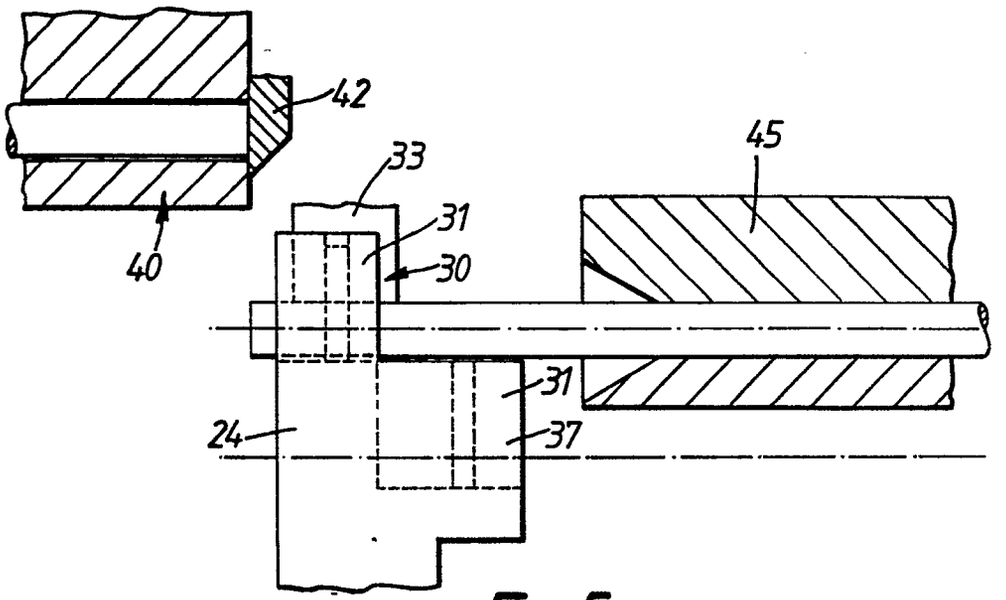

FIG.5.

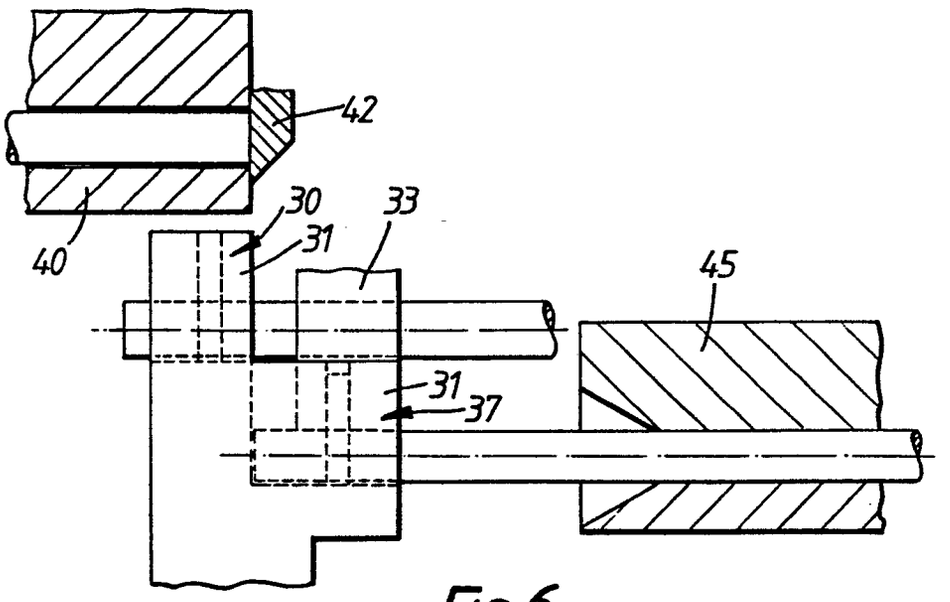

FIG.6.

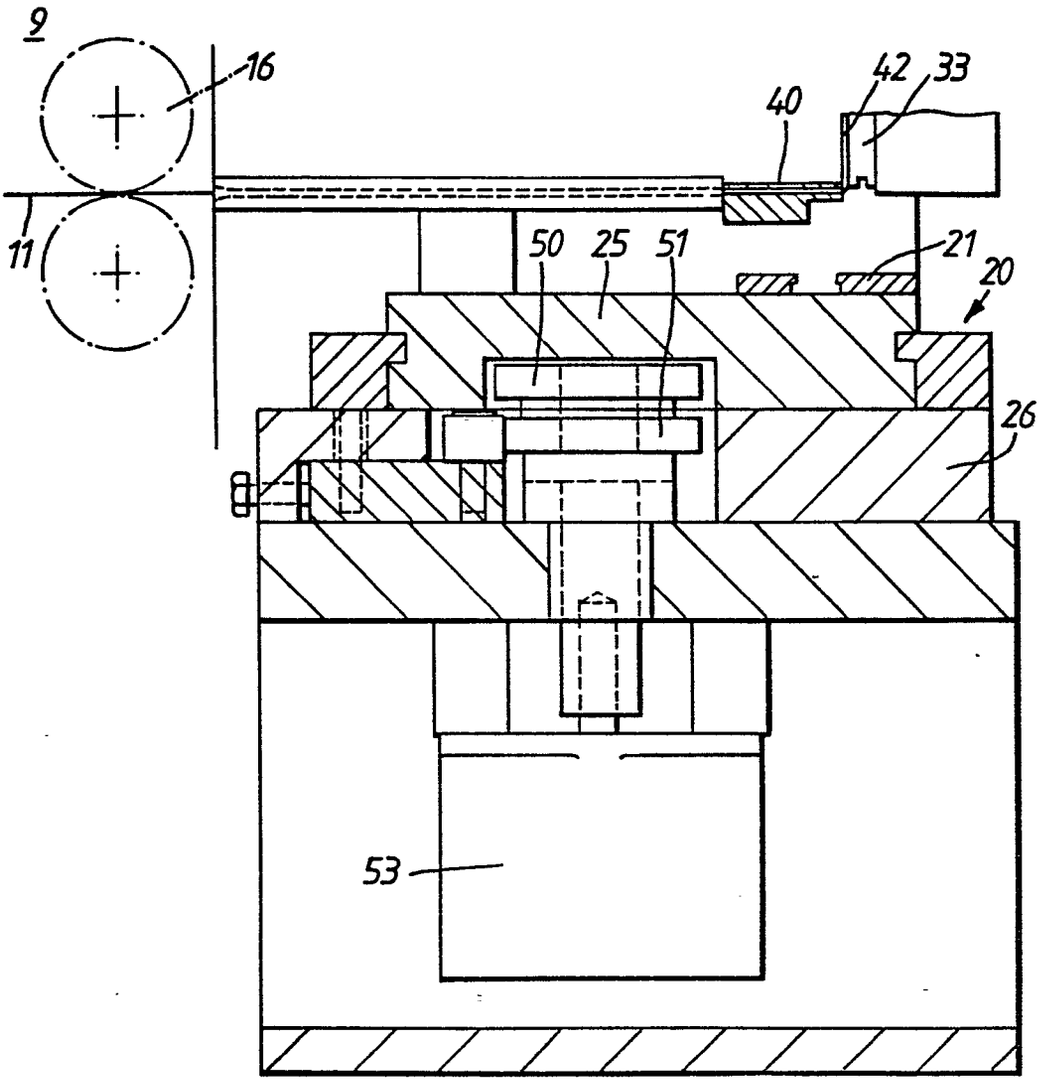

FIG.7.