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

(11) EP 0 964 092 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
15.12.1999 Bulletin 1999/50

(51) Int. Cl.^{6}: **D04B 15/78**

(21) Application number: **99110768.1**

(22) Date of filing: **04.06.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **04.06.1998 IT TO980484**

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(54) Modular device for piezoelectric selection of control elements, such as the needles of a knitting machine or similar

(57) The device has a number of selection levers (6) rotating about a corresponding number of parallel pivots (7), and a number of piezoelectric actuators (18) connected to the levers (6) and fitted to corresponding bases (23). The levers (6) and actuators (18) are housed in a casing (31) defined by a frame (13) for supporting the levers (6) and by two walls (26, 28) for supporting the actuators (18). The device is provided with adjusting means (64) for adjusting the relative position between the actuators (18) and the selection levers (6); and each actuator (18) carries a group of three rigid pins (38, 40, 41) which fit inside corresponding bushes (48) located on a printed-circuit board (47) and connected electrically to a number of other pins (46) of a multiple connector (35) in turn connected to the casing (31).

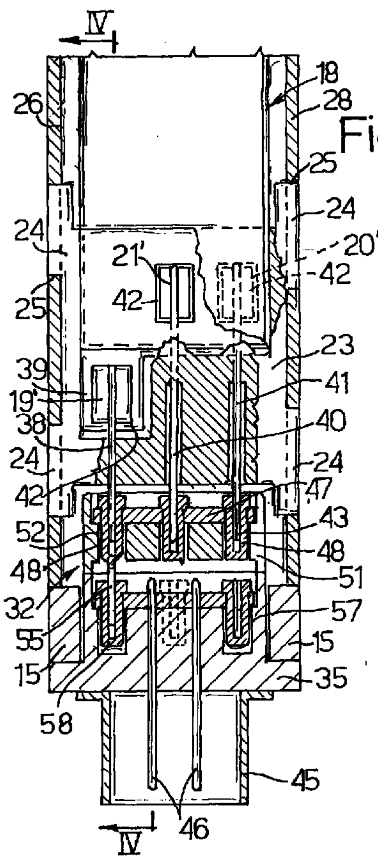

Fig.3

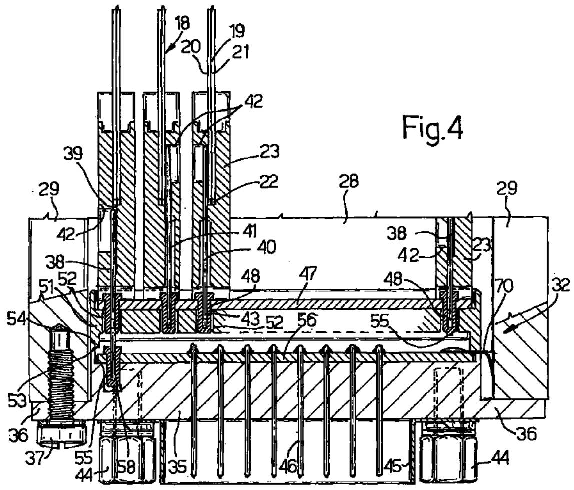
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Fig.4

Description

[0001] The present invention relates to a modular device for piezoelectric selection of control elements, such as the needles of a knitting machine or similar.

[0002] Knitting machines and similar normally comprise a number of parallel needles carried by a support movable back and forth parallel to the needles. Depending on the knitting pattern, the needles are selected to move or not with the support by means of a corresponding number of selection levers. Each lever is activated by a corresponding actuator to assume either of two positions, in which an appendix of the lever is engaged or not by the respective needle; and the levers are normally arranged to form a module enclosed in a respective casing for high-density packing the levers and respective actuators.

[0003] To reduce the size and response time of the actuators, selection devices of the above type have been proposed in which the actuator is piezoelectric with one end fixed to a respective base and the other end connected in articulated manner to the respective selection lever. Each actuator carries a central electrode and two lateral electrodes, which are connected to a drive circuit via an output connector.

[0004] As piezoelectric actuators, when not supplied, assume a neutral position, a drawback of known piezoelectric needle selection devices lies in the neutral position of the selection levers not normally being aligned with the actuators, on account of the manufacturing and assembly tolerances of the components. This results in asymmetric displacement of the levers between the two limit positions, which reduces the actuating rate and may result in incorrect needle selection.

[0005] Moreover, the electric connections to the output connector of known selection devices normally take a fairly long time to produce; when servicing or repairing a module, the component parts are difficult and expensive to replace; and, finally, the module casing is still invariably bulky.

[0006] It is an object of the invention to provide a modular device for piezoelectric selection of control elements, which is extremely straightforward and reliable, and eliminates the aforementioned drawbacks typically associated with known devices. In particular, it is an object of the invention to provide a selection device enabling maximum component miniaturization, and which is easy to produce and quick to assemble and disassemble with no special tools required.

[0007] According to the present invention, there is provided a modular device for piezoelectric selection of control elements, which comprises a number of selection levers rotating about a corresponding number of parallel pivots; a number of piezoelectric actuators, each having one end connected to one of said levers and another end fitted to a corresponding base, each of said actuators being energizable to selectively cause the corresponding lever to effect a given travel between a rest position in which the control element is not selected, and a work position in which the control element is selected; and a casing for said levers, said actuators and said bases; and which is characterized by comprising adjusting means carried by said casing and for adjusting the relative position between said actuators and said levers.

[0008] According to a further aspect of the invention, each of said actuators carries a central electrode and two lateral electrodes; said electrodes being defined by rigid parallel first pins fittable to corresponding bushes carried by an adapter to electrically connect said electrodes to a drive circuit for driving said actuators. In particular, said adapter comprises a multiple connector defined by rigid parallel second pins arranged differently from said first pins; said first pins and said second pins being connected to one another by means of at least one printed-circuit board to which said bushes are fitted.

[0009] Two preferred, non-limiting embodiments of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a partially sectioned front view of a first embodiment of a modular device for piezoelectric selection of control elements in accordance with the invention;
Figure 2 shows a larger-scale view along line II-II in Figure 1;
Figure 3 shows a larger-scale partial section along line III-III in Figure 1;
Figure 4 shows a partial section along line IV-IV in Figure 3;
Figures 5 and 6 show two top plan views of two printed-circuit boards of the selection device;
Figure 7 shows a partially sectioned front view of a further embodiment of a device for piezoelectric selection of control elements in accordance with the invention;
Figure 8 shows a section along line VIII-VIII in Figure 7;
Figure 9 shows a diagram of an electric circuit of a piezoelectric actuator of the selection device;
Figures 10a and 10b show the electromechanical behaviour of a piezoelectric actuator;
Figure 11 shows a graph of the electromechanical behaviour of the piezoelectric actuator.

[0010] Number 5 in Figure 1 indicates as a whole a modular device for piezoelectric selection of a number of control elements, e.g. the needles of a knitting machine or similar. Device 5 comprises a number of, e.g. eight, selection levers 6 aligned with one another and rotating about a number of parallel, equally spaced pivots 7. In particular, each lever 6 comprises a cam selection element 8 made of hardened steel and which is engaged by a corresponding needle 9 of the machine.

[0011] Each element 8 is molded to one end of a bar 10 made of plastic material, preferably thermoplastic resin with a low coefficient of friction and of high resistivity. The thermoplastic resin may be filled with glass fibers, and may comprise, for example, Nylon (registered trademark) or PPS with a Teflon (registered trademark) filler. Bar 10 has a hole 11 in which is inserted for rotation a fixed pin 12.

[0012] According to a first embodiment of the invention, device 5 comprises a metal frame 13, e.g. of light alloy or extruded aluminium, worked to comprise two top cross members 14 and two bottom cross members 15 connected by two sides 29. Pins 12 are force-fitted inside respective holes formed in cross members 14 and equally spaced 2 to 10 mm, e.g. 5 mm, apart. The end of bar 10 opposite the end fitted with element 8 comprises two fork-shaped appendixes 16, 17 between which is engaged in articulated manner one end of a piezoelectric actuator 18.

[0013] Each actuator 18 (Figures 10a and 10b) is defined by a central metal plate 19 fitted with two rectangular layers 20 and 21 of a ceramic, e.g. bimorph ceramic, which deforms when energized electrically; and the two layers 20 and 21 each have an insulating layer with an opening by which to connect layers 20 and 21 electrically, so that each actuator 18 comprises a central electrode 19' carried by an appendix 39 (see also Figure 3) of plate 19, and two lateral electrodes 20', 21' formed by the openings in the respective insulating layers of layers 20 and 21.

[0014] The end of actuator 18 opposite the end engaging appendixes 16 and 17 is inserted inside a slot 22 (Figure 4) in a base 23 made of plastic material and to which the end of the actuator is fixed, for example, by means of glue. Base 23 is prismatic in shape for high-density packing, and comprises two pairs of appendixes 24 (Figure 3) which engage respective slots 25 in two walls 26 and 28 of stainless steel or plastic material. Walls 26 and 28 are fitted to the two sides 29 by means of four screws 30 (Figure 1) to form, with frame 13, a casing 31 housing levers 6, actuators 18 and bases 23.

[0015] Casing 31 is closed at the top by a sheet metal comb 27 connected to casing 31 by means of four screws 33; comb 27 comprises a number of slots 34 in which are inserted cam elements 8 of selection levers 6; and the width of slots 34 determines the travel of elements 8 between two limit positions which may be from 1 to 3 mm apart.

[0016] In Figure 1, the first lever 6 on the left is shown by the continuous line in a work position in which element 8 engages respective needle 9, and by the dash line in a rest position in which needle 9 is not engaged by element 8; and the other seven levers 6 are shown in the central, i.e. neutral, position corresponding to the nonenergized state of actuator 18.

[0017] The bottom end of casing 31 is closed by a support or multiple connector 35 made of insulating material and having two appendixes 36 connected to sides 29 of frame 13 by means of two screws 37. The three electrodes 19', 20', 21' of each actuator 18 are connected electrically to three rigid pins, i.e. a central pin 38 (on the left in Figure 3) welded to central electrode 19', and two lateral pins 40 and 41 (center and right in Figure 3) welded to lateral electrodes 20' and 21'. Pins 38, 40, 41 are welded in known manner to electrodes 19', 20', 21' at three openings 42 in base 23, and project from the bottom of base 23 by respective portions 43 of equal length. Therefore, the three groups of eight pins 38, 40, 41 of actuators 18 are arranged in three separate rows, the pins 38, 40 and 41 in each row being spaced with the same spacing as actuators 18.

[0018] Actuators 18 are driven by an electronic circuit 75 (Figure 9) described in detail later on, and which requires that lateral pins 40 and 41 be connected electrically to two common conductors, and that central pins 38 be electrically connected singly. Multiple connector 35 provides for connecting device 5 to the electronic drive circuit, and comprises a series of fifteen identical pins 46 (see also Figure 2) molded to the body of connector 35 so as to project upwards. Pins 46 are arranged in two rows with a predetermined or standard spacing, for example, of 2.5 to 3.5 mm, and, in each row, with a standard spacing, for example, of 2 to 3 mm, and are protected by a metal shield 45 connected to connector 35 by means of bolts 44.

[0019] Pins 38, 40, 41 are connected electrically to pins 46 by an adapter indicated as a whole by 32 and comprising at least one printed-circuit board 47 having a number of bushes 48 for receiving the ends of pins 38, 40, 41. Bushes 48 are of the type used to connect microchips on printed circuits, with an inside diameter of about 0.5 mm, and are welded individually to board 47 in known manner.

[0020] Bushes 48 corresponding to pins 40 and 41 are connected electrically by two corresponding printed-circuit conductors 49 and 50 (Figure 5), and bushes 48 corresponding to pins 38 are insulated electrically from one another. Board 47 with bushes 48 (Figures 3 and 4) is glued or ultrasonically welded to a support 51 made of plastic material and comprising a number of holes 52, each for housing a bush 48, and a bottom edge 53 for engaging an edge 54 of connector 35. Each of bushes 48 for the row of central pins 38 comprises a downward-projecting pin 55, whereas only one of bushes 48 for each row of lateral pins 40 and 41 comprises a projecting pin 55.

[0021] Adapter 32 also comprises a second printed-circuit board 56 having a number of bushes 58 (Figure 3) identical to the bushes 48 with no projecting pins 55; connector 35 comprises a number of dead holes 57 for housing bushes 58; board 56 is fitted to connector 35 in the same way as board 47 to support 51; and bushes 58 of board 56 may be fifteen in number, if all the pins 46 of multiple connector 35 are to be used. In the case of a selection device with eight actuators 18, however, ten bushes 58 for receiving pins 55 of bushes 48 are sufficient.

[0022] The top ends of pins 46 fit through board 56 and are welded on top to respective pads on the printed circuit. The printed circuit comprises two conductors 59 and 61 (Figure 6) for connecting the two bushes 58 of the rows of lateral pins 40 and 41 to the pads of two corresponding pins 46; a number of conductors 62 for connecting the bushes 58 of the row of central pins 38 (at the top in Figure 6); and a ground pad 60 to which is welded a cable 70 (see also Figure 4) electrically contacting frame 13. Ground pad 60 is connected by a conductor 63 to the pad of a further pin 46.

[0023] The two sides 29 (Figure 1) of frame 13 are connected to walls 26 and 28 by manual adjusting means comprising an eccentric pin 64 pivoting eccentrically on one of sides 29. The eccentricity of pin 64 may be 0.1 to 1 mm, and is preferably 0.3 mm; each of the two walls 26, 28 comprises a hole 69 engaged by pin 64; pin 64 comprises a head 65 engageable by a screwdriver; and rotation of pin 64 may be partially prevented by applying adhesive resin between pin 64 and hole 69.

[0024] Two holes in sides 29 are fitted with two elements or pins 66 projecting on both sides and each engaging a pair of guide slots 67 provided on walls 26 and 28. Slots 67 enable frame 13 to be moved with respect to walls 26, 28 and perpendicularly to actuators 18 to adjust at-rest alignment of actuators 18 with respect to selection levers 6. To fix walls 26 and 28 to frame 13, walls 26 and 28 are provided with holes 68 of such a diameter as to permit adjustment before tightening screws 30.

[0025] Modular device 5 for selecting needles 9 is assembled and adjusted as follows.

[0026] To begin with, bars 10 of levers 6 are placed between top cross members 14; pins 12 are inserted inside holes 11 in bars 10 and fitted into cross members 14 of frame 13; cam elements 8 are inserted inside slots 34 on comb 27; comb 27 is fitted to frame 13 by means of screws 33; and wall 28 is fitted to sides 29 of frame 13 without tightening down respective screws 30.

[0027] Actuators 18 are then inserted inside frame 13 by engaging two appendixes 24 of each base 23 inside slots 25 in wall 28, and the free end of each actuator 18 between appendixes 16 and 17 of respective bar 10; wall 26 is fitted to frame 13 so that the other two appendixes 24 of each base 23 are inserted inside slots 25 in wall 26; and wall 26 is fitted to sides 29 without tightening down respective screws 30.

[0028] To assemble adapter 32, board 47 with bushes 48 is first fitted to support 51 (Figure 4); board 56 with pins 46 and bushes 58 is fitted to connector 35; shield 45 for protecting pins 46 is fitted to connector 35; and support 51 is connected to connector 35 by inserting pins 55 of bushes 48 on board 47 inside bushes 58 on board 56 so that edge 53 of support 51 mates with edge 54 of connector 35. Support 51 may also be glued or welded to connector 35.

[0029] The assembly defined by connector 35 and support 51 is then inserted between sides 29 of frame 13 by inserting pins 38, 40, 41 of actuators 18 inside bushes 48 on board 47 so that appendixes 36 of connector 35 rest against sides 29 of frame 13; and connector 35 is fitted to sides 29 by means of screws 37.

[0030] The position of actuators 18 with respect to selection levers 6 is adjusted by engaging head 65 (Figure 1) of eccentric pin 64 with a screwdriver, and appropriately rotating eccentric pin 64. As explained in detail later on, adjustment may be controlled by means of mechanical, electrical or electronic measuring devices. In which case, at least one of actuators 18 is energized to move the actuator from the neutral position to one and then the other of the two limit positions, and the displacement of element 8 is controlled on a monitor. Pin 64 must be rotated so that, as far as possible, element 8 moves by the same amount in both directions. Adjustment may also be controlled with reference to two or more actuators 18 to determine an average as similar a movement as possible of elements 8 in both directions. Once the adjustment has been made, screws 30 are tightened down to fix walls 26, 28 to frame 13.

[0031] In the Figure 7 and 8 embodiment, selection device 5 comprises a casing 31' housing sixteen piezoelectric actuators 18 equally spaced, for example, 4 mm apart. A bottom portion 76 of casing 31' houses electronic circuitry and the electric connections both to actuators 18 and to an electronic governor of the machine. In this case, each actuator 18 is connected directly to a terminal 77 contacting central electrode 19' of plate 19, and to two terminals 77 contacting lateral electrodes 20' and 21' of the two layers 20 and 21 of actuator 18, in the same way as pins 38, 40, 41 in Figure 3.

[0032] The three terminals 77 are carried by three cables 80 (Figure 8) terminating at a connector 81 welded to a printed-circuit board 82, which has drive circuits 75 (see also Figure 9), and an output connector 83 for connection to the governor of the machine. The base 23' of each actuator 18 is hinged by two pins 84 to two holes in walls 26', 28' of casing 31'.

[0033] To adjust the relative position between each actuator 18 and the corresponding selection lever 6, one end 86 of base 23' has a groove 87 housing an eccentric pin 88 rotating on walls 26', 28' and having a head 89 engageable by a screwdriver. Each base 23' also has a lock screw 90 for securing base 23' to casing 31' following adjustment, which is made individually for each base 23' in the same way as frame 13 in the Figure 1-6 embodiment.

[0034] The distance between groove 87 and pin 84 is substantially equal to the distance between pin 84 and fork-shaped appendixes 16, 17 of bar 10 of lever 6, so that, with a 0.3 mm eccentricity of pin 88, the articulated joint between actuator 18 and lever 6 may be moved 0.3 mm, which is sufficient for any adjustment of the relative position between actuator 18 and the corresponding lever 6.

[0035] Conventional drive circuits of a piezoelectric actuator 18 are normally such that a positive voltage of predetermined value is applied, for example, to electrode 21' to the right of central electrode 19' to move the corresponding selection lever 6 into the rest position (Figure 10a), and a negative voltage of the same value is applied to electrode 20' to the left of central electrode 19' to move lever 6 into the work position (Figure 10b).

[0036] The drive circuit 75 (Figure 9) of the invention is improved with respect to conventional drive circuits, and provides for connecting the right electrode 21' of actuator 18 permanently to a positive voltage, e.g. +200VDC, while the left electrode 20' is permanently grounded and the central electrode 19' is selectively connected to the positive voltage or grounded (see also Figures 10a and 10b). In the absence of positive voltage and in the presence of a command, actuator 18 assumes a neutral position as shown by the dotted line in Figures 10a and 10b.

[0037] Drive circuit 75 comprises an input IN supplied by the control unit with a command to select needle 9; and an output OUT connected to central pin 38 (Figure 4) or central terminal 77. Input IN is connected both to a LED cathode K of a solid-state relay 91 and to a network R1, C1; one terminal of capacitor C1 is connected to a logic ground 92; resistor R1 is connected parallel to a diode D1; and the other terminal of capacitor C1 is connected both to resistor R1 and to the input of a latch 93 for regenerating the signal edge.

[0038] The output of latch 93 is connected via a resistor R2 to a voltage +Vdc (e.g. +5V) and via a resistor R3 to the base of a transistor T1, the emitter of which is grounded; the LED anode A of relay 91 is connected via a resistor R4 to voltage +Vdc; relay 91 has an output collector C connected to positive voltage +200VDC; and the emitter E of relay 91 is connected via a resistor R5 to the collector of transistor T1 and to output OUT.

[0039] When needle 9 is not selected, input IN is at a high logic level, so that transistor T1 conducts and grounds central electrode 19'; and relay 91 is open and isolates transistor T1 from voltage +200VDC as shown in Figure 10b. To select needle 9, input IN is switched to a low logic level, so that transistor T1 is disabled and relay 91 closes to connect output OUT, and hence central electrode 19', to positive voltage +200VDC. When input IN switches back to a high logic level, transistor T1 begins conducting again with a given delay with respect to the opening of relay 91 to ensure resistor R5 is disconnected from the positive voltage.

[0040] Adjusting the position of actuators 18 with respect to selection levers 6 comprises adjusting the travel of levers 6 between the rest and work positions defined by the two edges of respective slots 34 of comb 27. With reference to Figure 11, curve 74 shows the passage from 0 to +200VDC of the voltage V at central electrode 19' of actuator 18 as a function of time t; and curve 71 shows the displacement of the end of cam element 8 of lever 6 produced by energizing actuator 18, which displacement S is detected by a known, e.g. magnetic, optical or capacitive, sensor.

[0041] As of the rest position of cam element 8 of lever 6, energizing of actuator 18 commences at a first instant t1, and cam element 8 reaches the work position at a second instant t2 with a first delay t2-t1 of about 2-3 ms indicated by 72 in Figure 11. Similarly, commencing deenergizing of actuator 18 at a third instant t3, at which the voltage V at central electrode 19' passes from +200VDC to 0, cam element 8 reaches the rest position at a fourth instant t4 with a second delay t4-t3 indicated by 73 in Figure 11.

[0042] A symmetrical condition, in which first delay 72 equals second delay 73, is the preferred adjustment condition between actuator 18 and the corresponding selection lever 6. To adjust the position, therefore, eccentric pin 64 (Figure 1) and eccentric pins 88 (Figure 7) must be rotated to get as close as possible to the above symmetric condition.

[0043] The method of adjusting the relative position between at least one selection lever 6 and the corresponding piezoelectric actuator 18 comprises the following steps.

[0044] A first step wherein actuator 18 is energized as of a first instant t1 to move lever 6 from the rest to the work position; a second step wherein a first delay 72 between first instant t1 and a second instant t2, at which lever 6 reaches the work position, is detected; a third step wherein actuator 18 is deenergized as of a third instant t3 to move lever 6 from the work to the rest position; a fourth step wherein a second delay 73 between third instant t3 and a fourth instant t4, at which lever 6 reaches the rest position, is detected; and a fifth step wherein the position of actuator 18 with respect to lever 6 is adjusted so that first delay 72 equals second delay 73.

[0045] The advantages, as compared with known devices, of selection device 5 according to the invention will be clear from the foregoing description. In particular, adjusting the position of actuators 18 with respect to levers 6 provides for eliminating various position errors caused by assembly and manufacturing tolerances. Moreover, the method of adjustment, by determining the delays of actuator 18, eliminates the need for complex mechanical measurements.

[0046] Moreover, device 5 in Figure 1 enables use of a standard connector 35, thus simplifying electrical connection to the drive circuits; adapter 32 between pins 38, 40, 41 of actuators 18 and pins 46 of connector 35 provides for troublefree fitment/removal of adapter 32 to/from device 5; and the structure of casing 31 with frame 13 and two walls 26 and 28 provides for troublefree assembly and disassembly of actuators 18 and levers 6, which may in fact be assembled and disassembled simply using a screwdriver.

[0047] Clearly, changes may be made to the selection device as described herein without, however, departing from the scope of the accompanying Claims. For example, changes may be made to the spacing of pins 46 of connector 35 or to the number of levers 6 and actuators 18 in the module; adapter 32 may comprise only one printed-circuit board, which in turn may comprise both circuits, one on each face, and both bushes 48 and pins 46; solid-state relay 91 of drive circuit 75 may be a transistor type or optoelectronic; actuators 18 may also be adjusted individually in the Figure 1-6 embodiment; and, finally, selection device 5 may be applied to other types of machines or equipment requiring high-frequency control element selection.

Claims

1. A modular device for piezoelectric selection of control elements, comprising a number of levers (6) for selecting said control elements (9), said levers (6) rotating about a corresponding number of parallel pivots (7); a number of piezoelectric actuators (18), each having one end connected to one of said levers (6) and another end fitted to a corresponding base (23, 23'), each of said actuators (18) being energizable to selectively cause the corresponding lever (6) to effect a given travel between a rest position in which the control element (9) is not selected, and a work position in which the control element is selected; and a casing (31, 31') for said levers (6), said actuators (18) and said bases (23, 23'); characterized by comprising adjusting means (64, 66, 67, 69; 87, 88) carried by said casing (31, 31') and for adjusting the relative position between said levers (6) and said actuators (18).

2. A device as claimed in Claim 1, characterized in that said casing (31) comprises a frame (13) carrying said pivots (7), and two opposite walls (26, 28) fitted removably to said frame (13); said bases (23) having appendixes (24) engaging corresponding slots (25) on said walls (26, 28); and said adjusting means (64, 66, 67, 69) being provided between said frame (13) and at least one of said walls (26, 28).

3. A device as claimed in Claim 2, characterized in that said adjusting means (64, 66, 67, 69) comprise a pin (64) pivoting eccentrically on said frame (13) and engaging a hole (69) in each of said walls (26, 28) to adjust the position of said actuators (18) with respect to that of said levers (6).

4. A device as claimed in Claim 3, characterized in that said adjusting means (64, 66, 67, 69) also comprise at least one element (66) carried by said frame (13) and for engaging a guide (67) carried by each of said walls (26, 28) to enable displacement of said frame (13) perpendicularly to said actuators (18).

5. A device as claimed in Claim 1, characterized in that said adjusting means (87, 88) comprise a groove (87) formed in one end (86) of said base (23'), and an eccentric pin (88) operatively connected to said groove (87); each actuator (18) being adjusted by rotating said pin (88) inside said groove (87).

6. A device as claimed in Claim 4, characterized in that rotation of said pin (64) is partially prevented by the application of an adhesive resin between said pin (64) and said hole (69).

7. A device as claimed in Claim 4, characterized in that said given travel ranges between 1 and 3 mm; and in that the eccentricity of said pin (64) ranges between 0.1 and 1 mm; said actuators (18) being equally spaced with a spacing ranging between 2 and 10 mm.

8. A device as claimed in one of the foregoing Claims, characterized by also comprising at least one lock screw (30, 90) for locking the relative position so adjusted.

9. A device as claimed in Claims 5 and 8, characterized in that said lock screw (90) is located on each of said bases (23') and provides for locking the corresponding base (23') with respect to said casing (31').

10. A device as claimed in one of the foregoing Claims, wherein each of said actuators (18) carries a central electrode (19') and two lateral electrodes (20', 21'); connecting means (35, 46, 47, 51, 56; 77, 80-83) being provided to connect said electrodes (19', 20', 21') electrically; characterized in that each of said actuators (18) is energized by an electronic drive circuit (75) for supplying a positive voltage to one of said lateral electrodes (20', 21'), a zero voltage to the other of said lateral electrodes (20', 21'), and selectively said positive voltage and said zero voltage to said central electrode (19').

11. A device as claimed in Claim 10, characterized in that said electronic drive circuit (75) comprises a solid-state relay (91) for selectively supplying said positive voltage to said central electrode (19').

12. A device as claimed in Claim 10 or 11, characterized in that said central electrode and said lateral electrodes (19', 20', 21') are connected to corresponding rigid, parallel first pins (38, 40, 41) insertable inside corresponding bushes (48); said connecting means (35, 46, 47, 51, 56) comprising an adapter (32) carrying said bushes (48).

13. A device as claimed in Claim 12, characterized in that said connecting means (35, 46, 47, 51, 56) also comprise a multiple connector (35) comprising rigid, parallel second pins (46) arranged differently

from said first pins (38, 40, 41); said first pins (38, 40, 41) and said second pins (46) being connected to one another by means of at least one printed-circuit board (47) to which said bushes (48) are fixed.

14. A device as claimed in Claim 13, characterized in that the lateral said first pins (40, 41) of said actuators (18) are connected electrically to two of said second pins (46) by two common conductors (49, 50) of said printed-circuit board (47); the central said first pins (38) of said actuators (18) being connected to as many second pins (46) by individual conductors of said printed-circuit board (47).

15. A device as claimed in Claim 14, characterized in that said second pins (46) are arranged in two rows in said multiple connector (35); said common conductors (49, 50) electrically connecting said bushes (48) relative to said lateral first pins (40, 41).

16. A device as claimed in Claim 15, characterized in that said adapter (32) comprises a further printed-circuit board (56) over which said at least one printed-circuit board (47) is superimposed; at least some of said bushes (48) each comprising a pin (55); and said further printed-circuit board (56) comprising further bushes (58) for receiving said pins (55).

17. A device as claimed in Claim 16, characterized in that said further printed-circuit board (56) comprises conductors (59, 61, 62) for connecting the bushes (58) of said further printed-circuit board (56) to said second pins (46).

18. A device as claimed in Claim 17, characterized in that said bushes and said further bushes (48, 58) are welded to the respective printed-circuit boards (47, 56); said printed-circuit boards (47, 56) each being fitted to a corresponding support (51, 35).

19. A device as claimed in Claim 17 or 18, characterized in that said casing (31) comprises a frame (13) carrying said pivots (7), and two opposite walls (26, 28) fitted removably to said frame (13); said bases (23) having appendixes (24) engaging corresponding slots (25) on said walls (26, 28).

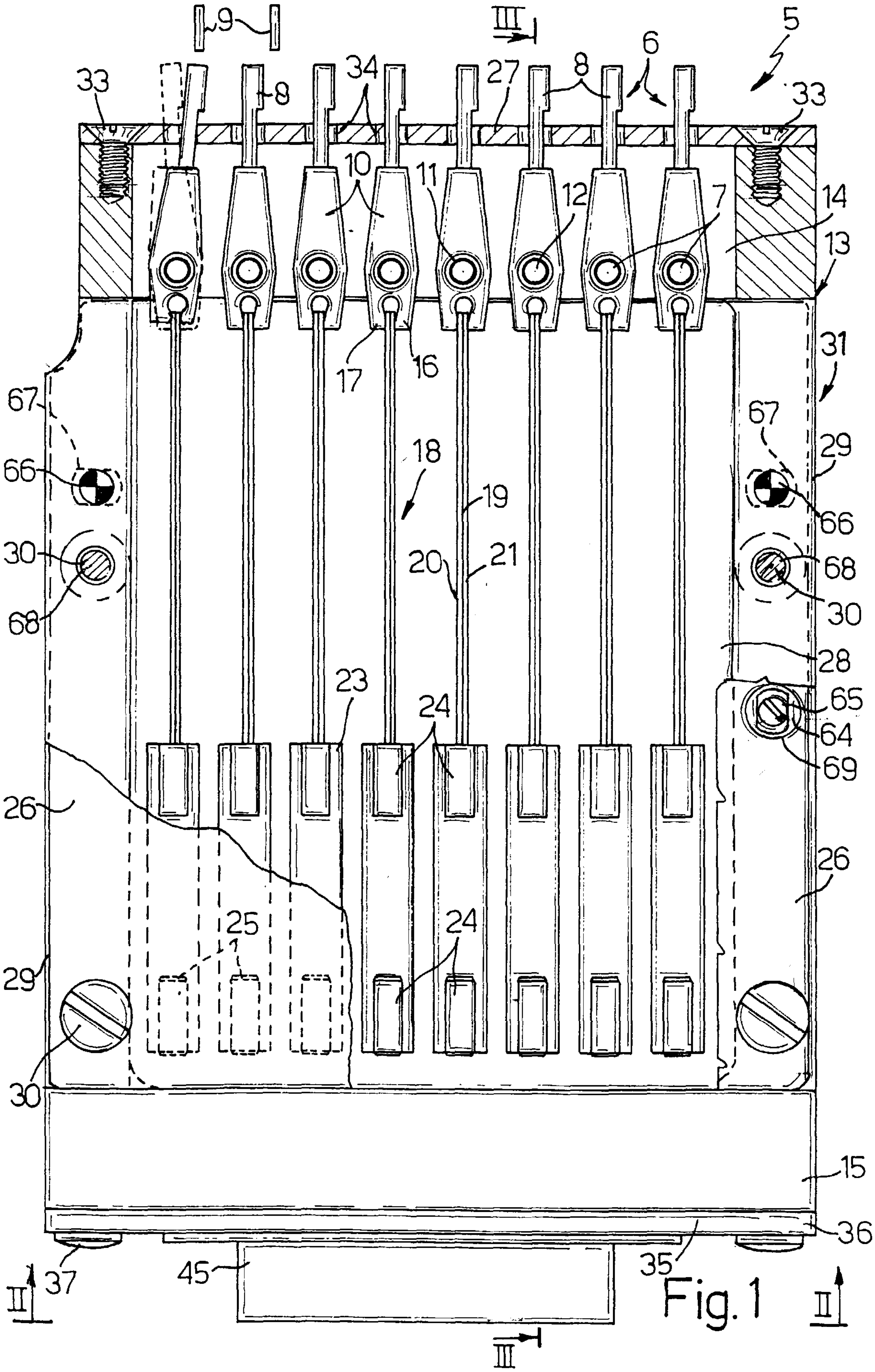
20. A device as claimed in one of the foregoing Claims, characterized in that each of said levers (6) comprises a bar (10) injection molded from a thermoplastic resin having a low coefficient of friction and high electrical resistivity; said bar (10) having a first end molded to a metal insert (8), and a second end having two fork-shaped appendixes (16, 17) cooperating in articulated manner with the corresponding piezoelectric actuator (18).

21. A method of adjusting the relative position between at least one selection lever (6) and a corresponding piezoelectric actuator (18) in a device (5) for piezoelectric selection of control elements (9), said lever (6) performing a given travel between a rest position in which the corresponding control element (9) is not selected, and a work position in which said control element (9) is selected; the method being characterized by the following steps:

- energizing said actuator (18) as of a first instant (t1) to move said lever (6) from said rest position to said work position;
- determining a first delay (72) between said first instant (t1) and a second instant (t2) at which said work position of said lever (6) is reached;
- deenergizing said actuator (18) as of a third instant (t3) to restore said lever (6) from said work position to said rest position;
- determining a second delay (73) between said third instant (t3) and a fourth instant (t4) at which said rest position of said lever (6) is reached; and
- adjusting said relative position to achieve a condition of equality between said first delay (72) and said second delay (73).

22. A method as claimed in Claim 21, characterized in that adjustment is made by rotating an eccentric pin (64, 88), located between a casing (31, 31') of said device (5) and a base (23, 23') of said actuator (18), to achieve said condition of equality.

23. A method as claimed in Claim 21 or 22, characterized by locking said relative position in said condition of equality.


9
III
5
6
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33
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27
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64
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24
29
30
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36
37
45
35
II
III
II

Fig.1

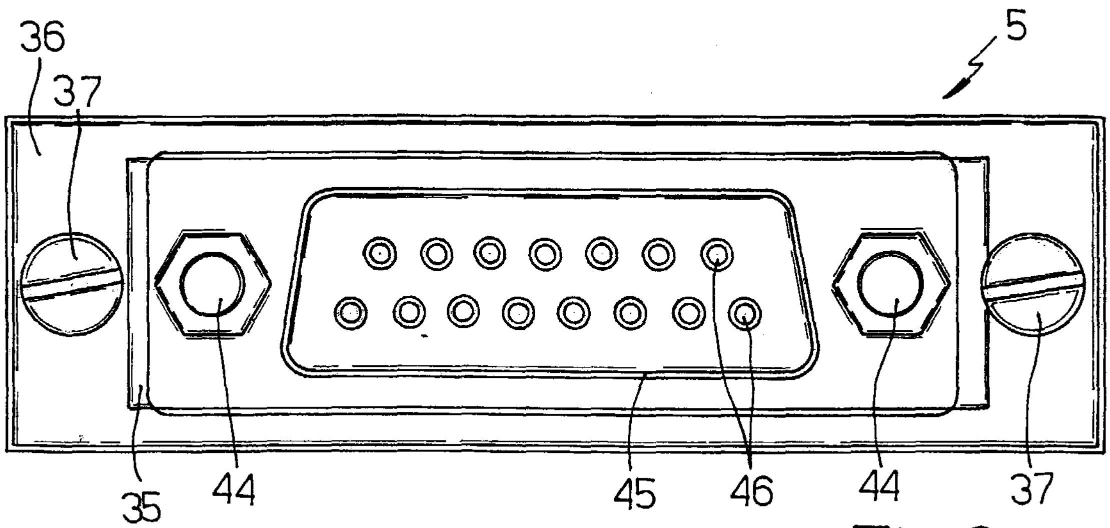


Fig.2

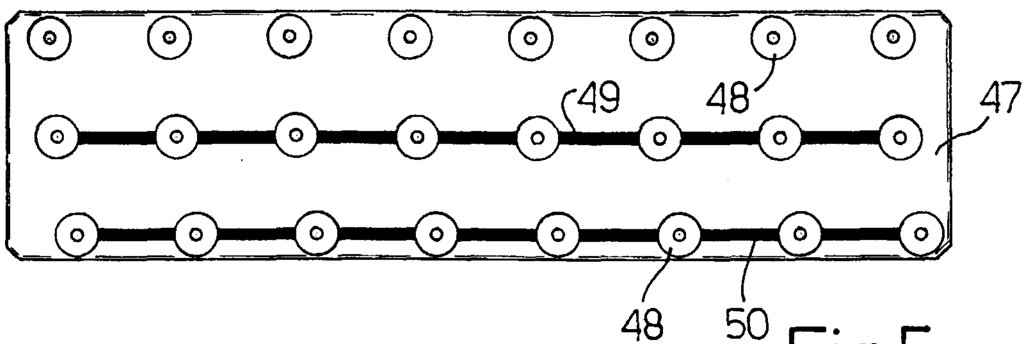


Fig.5

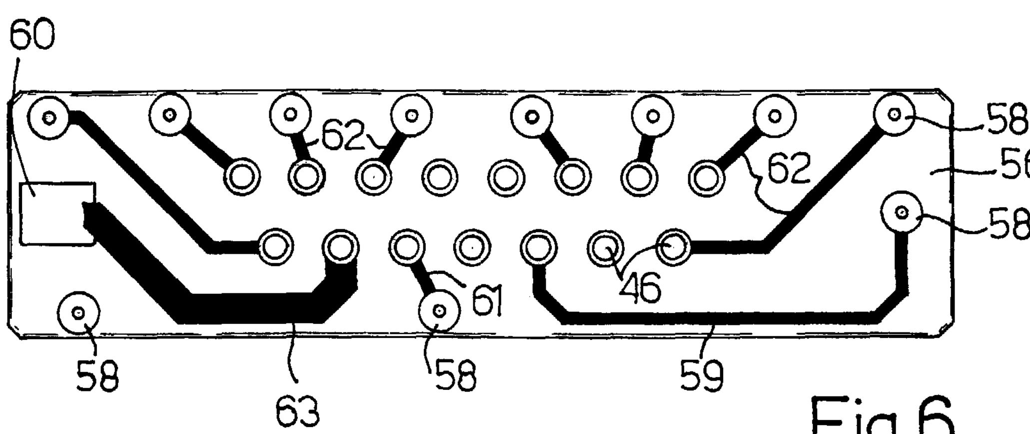


Fig.6

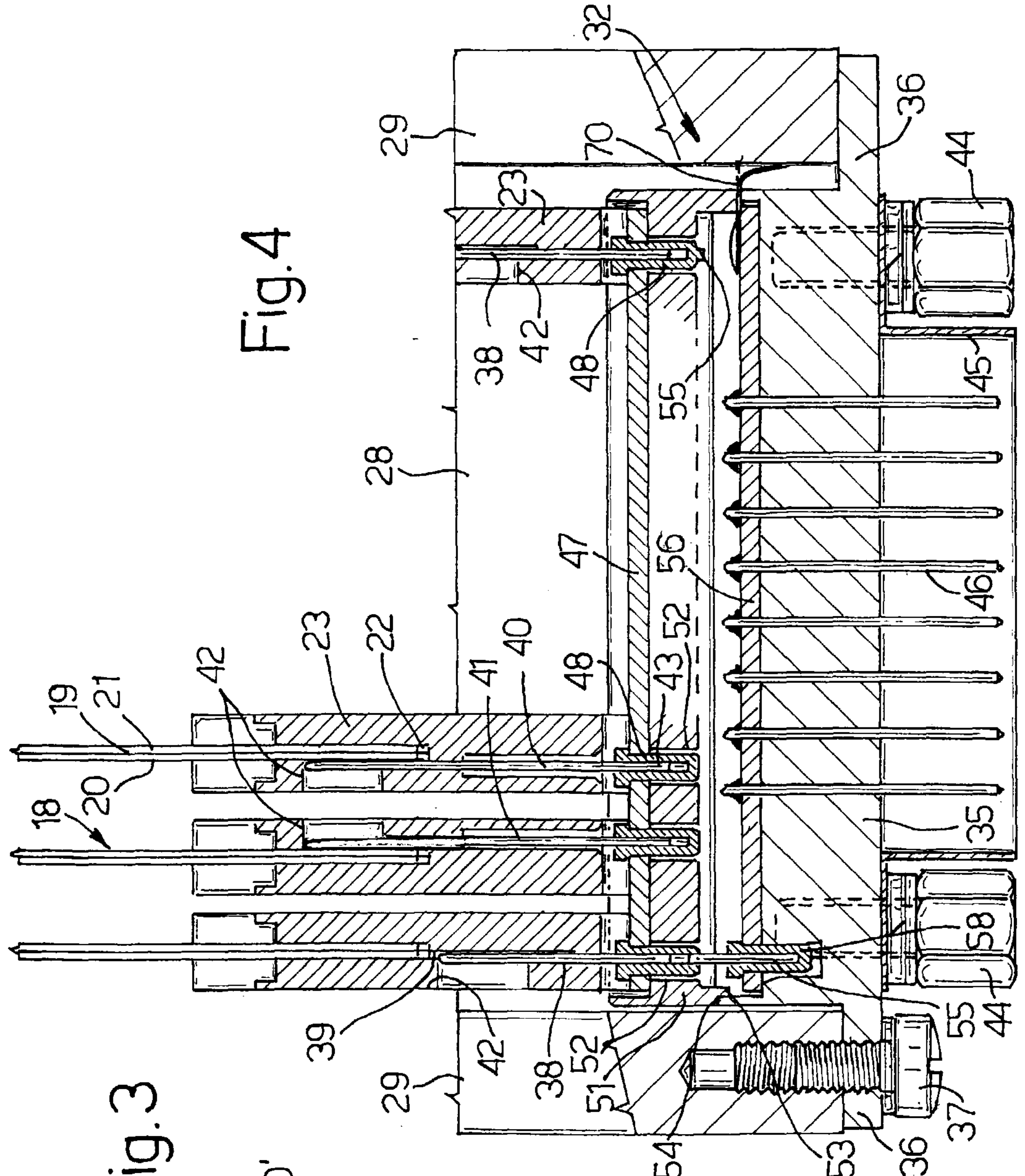


Fig.4

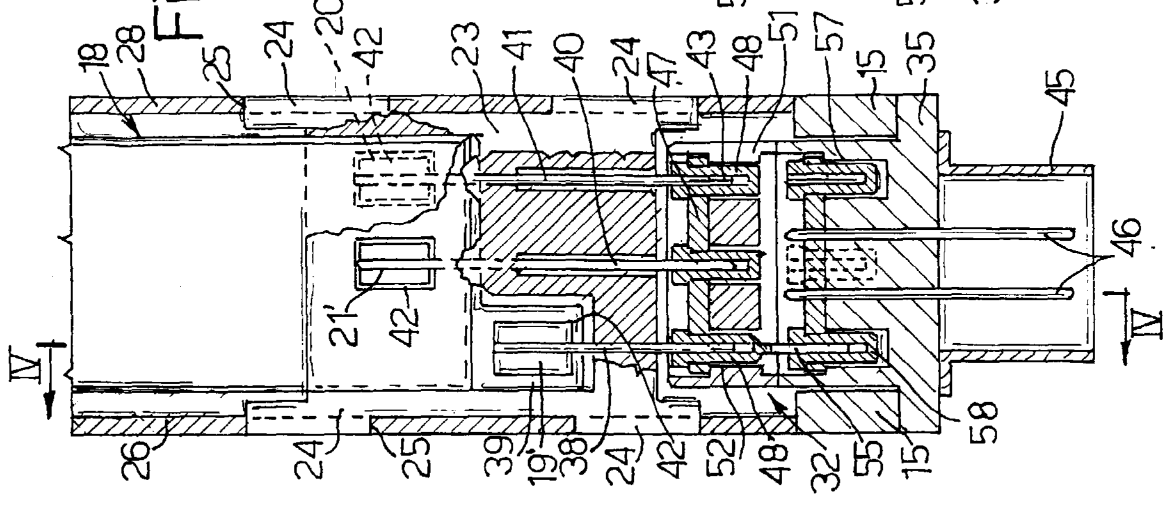


Fig.3

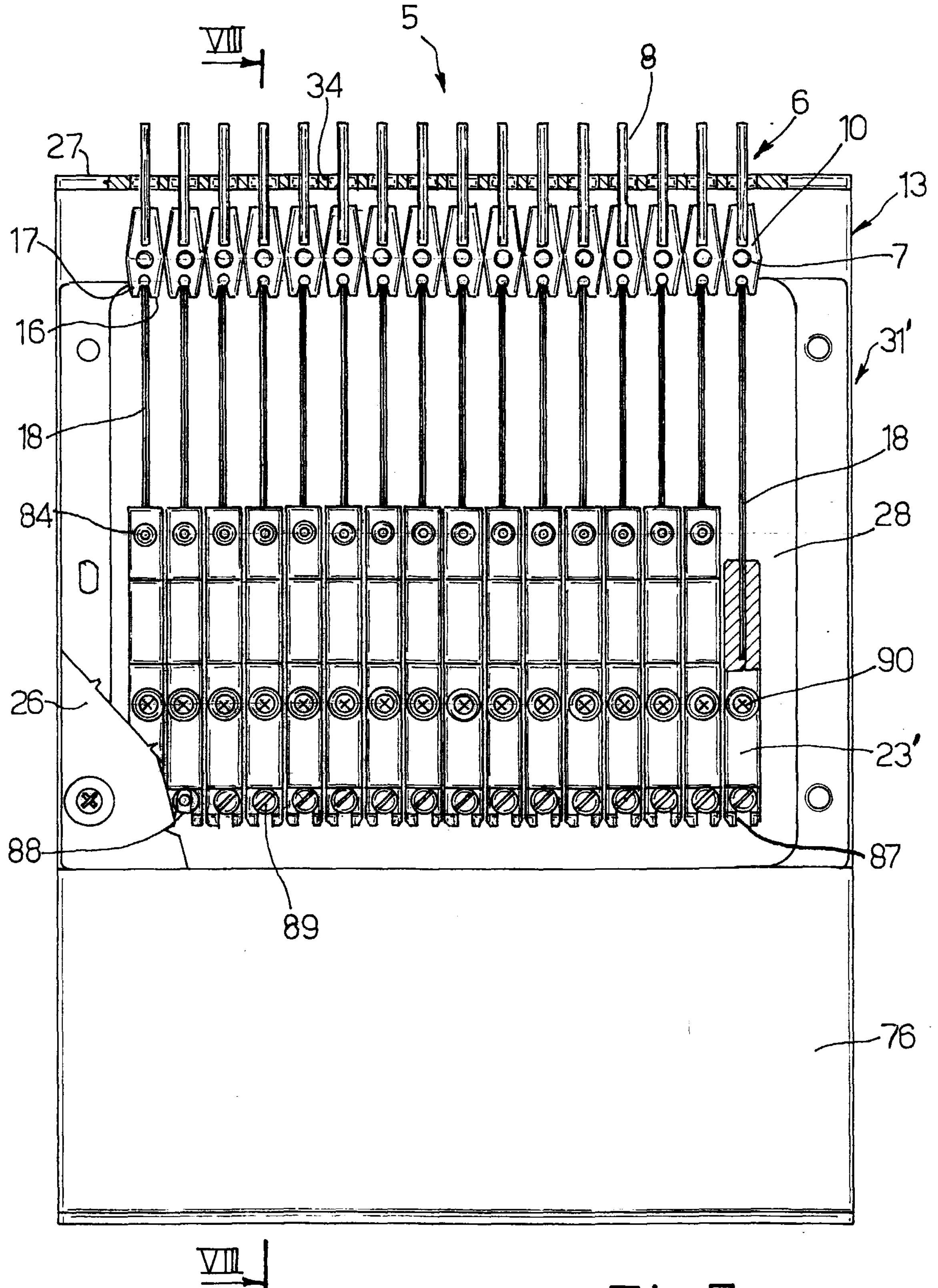


Fig. 7

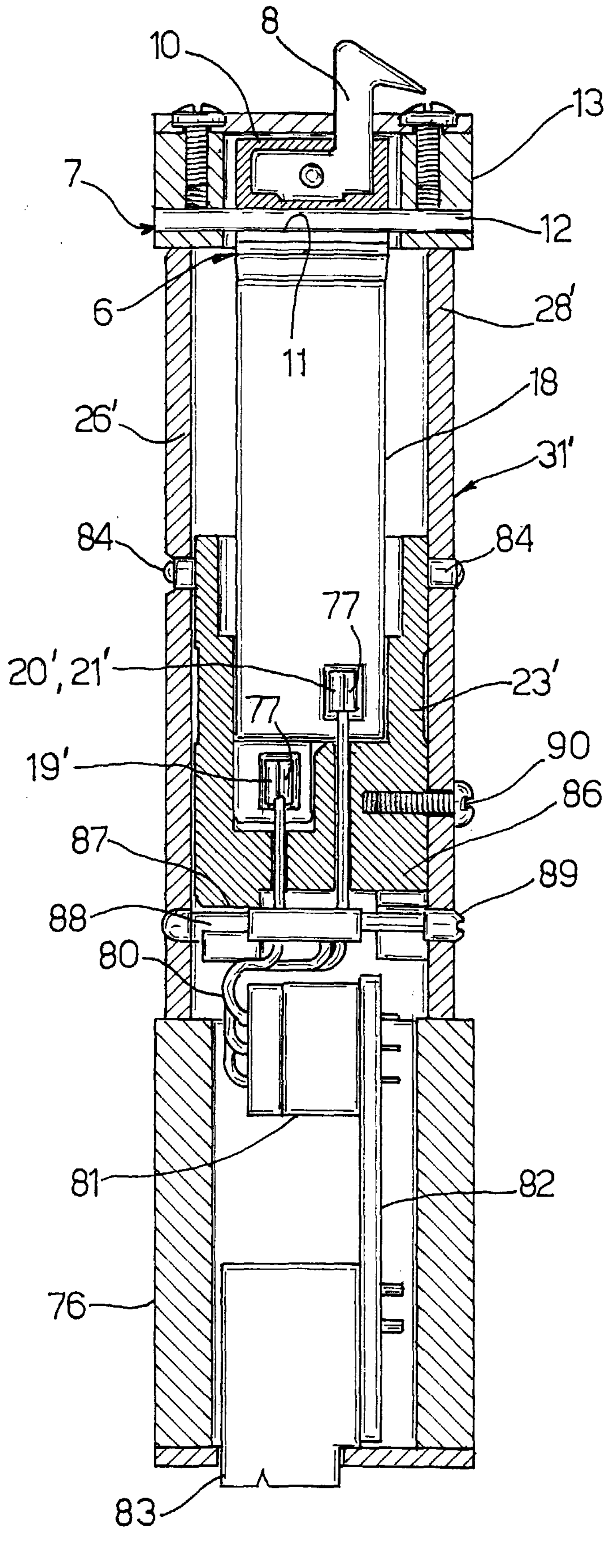
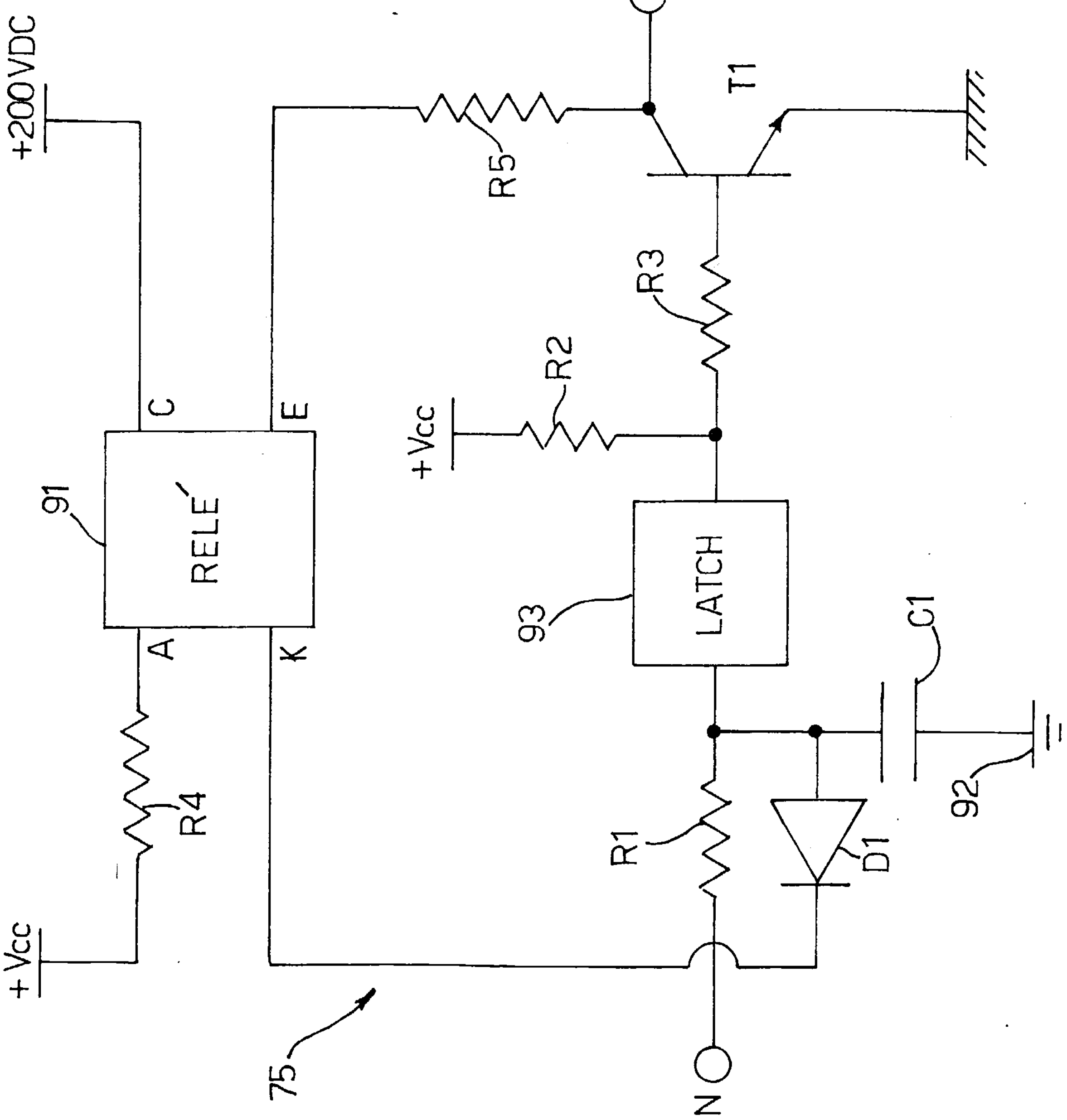

8
10
13
7
12
6
11
28'
18
26'
31'
84
84
77
20',21'
23'
77
90
19'
86
87
89
88
80
81
82
76
83

Fig.8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+Vcc
R4
91
RELE
C
E
A
K
R5
OUT
T1
+Vcc
R2
R3
93
LATCH
C1
92
R1
D1
75
IN

Fig.9

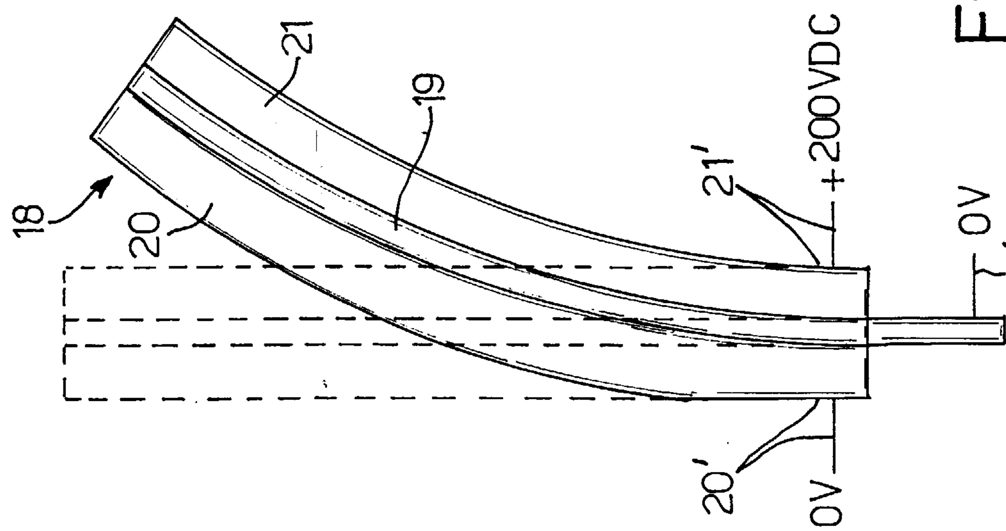

Fig.10b

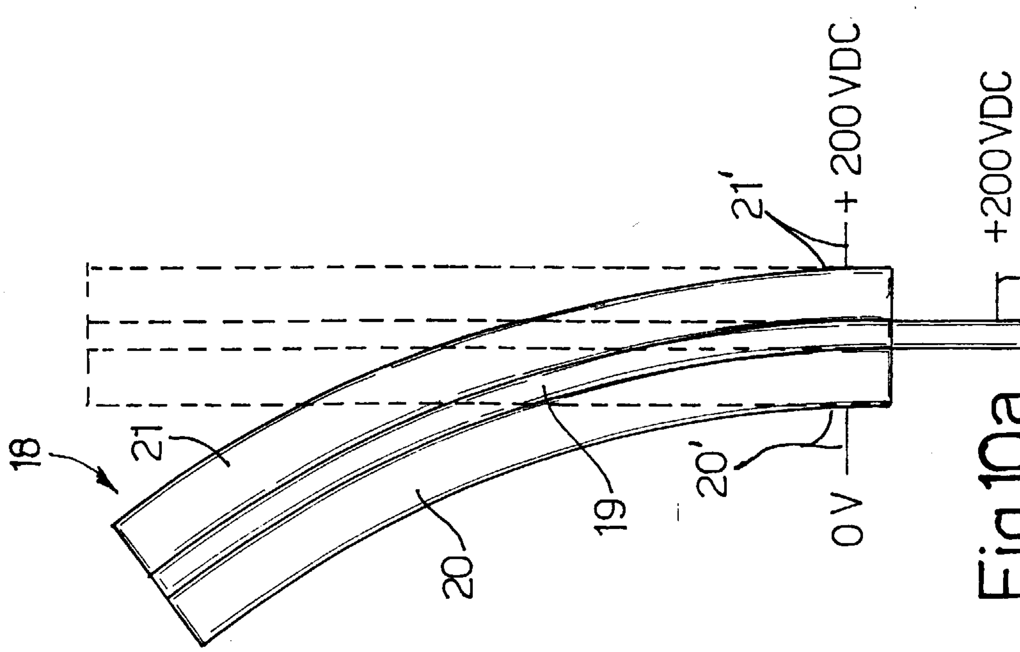

Fig.10a

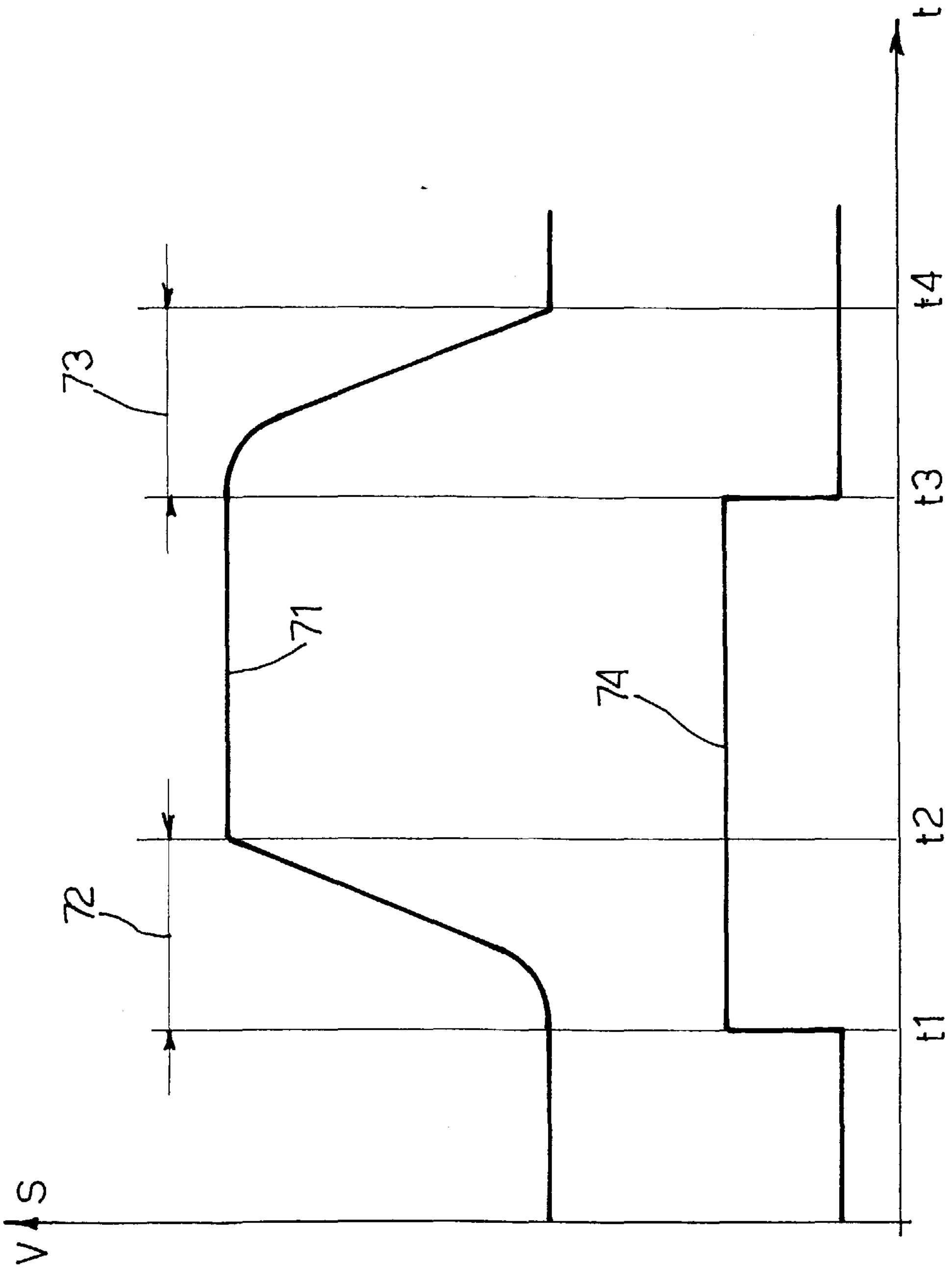

Fig. 11