United States Patent

[11] 3,592,990

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[33] **France**
[31] **160,855 and 6,906,513**

[54] **CROSSBAR SWITCHING NETWORK**
6 Claims, 26 Drawing Figs.

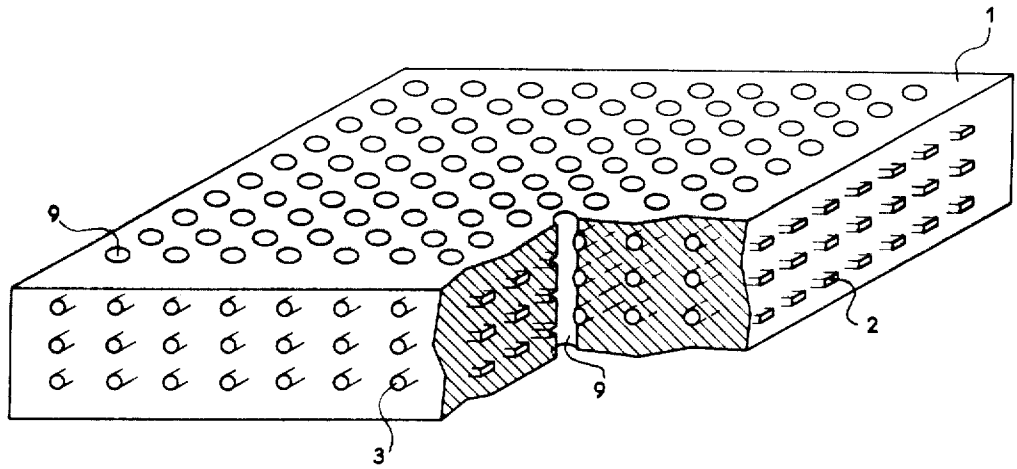
[52] **U.S. Cl.** **200/152,** 335/47
[51] **Int. Cl.** **H01h 29/00**
[50] **Field of Search** 200/152, 152.9

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Primary Examiner—Robert K. Schaefer
Assistant Examiner—H. J. Hohauser
Attorney—Holman & Stern

ABSTRACT: A switching arrangement comprising a block of insulating material provided with a first hole and a second hole intersecting the first hole, a third hole meeting the first and second holes at their intersection, liquid conducting medium contained in said first and second holes, a piston of insulating material which is slidably movable in the third hole, said piston being provided with a notch portion whereby, when the piston is positioned so that the notch portion overlaps the said first and second holes at their intersection, an electrically conducting connection exists between the medium in the first and second holes via the medium located in the notch portion, and, when the piston is positioned so that the notch portion does not overlap said first and second holes at their intersection, no electrically conducting connection exists between the medium in the first and second holes by virtue of the presence in the intersection of the plunger of insulating material.



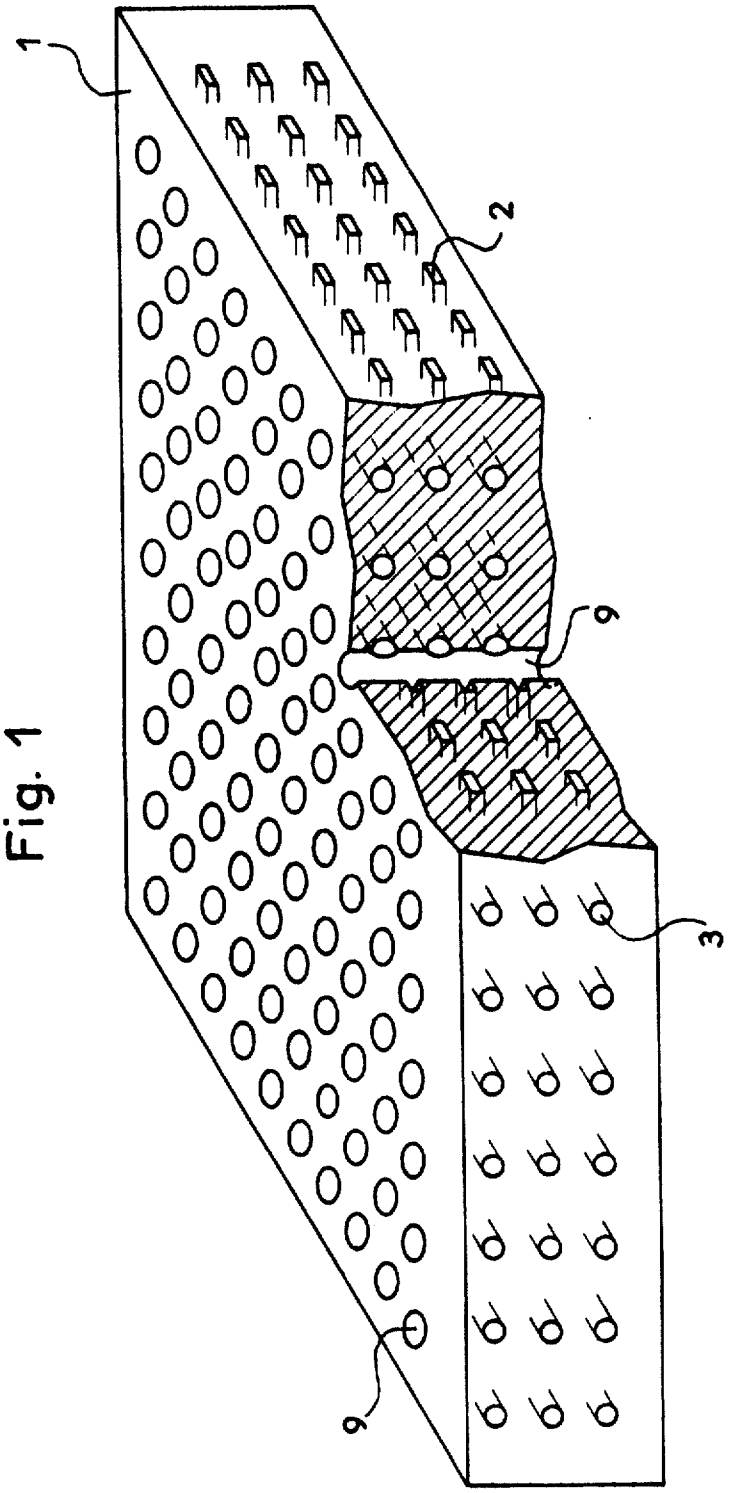


Fig. 1

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ATTORNEYS

Fig. 2

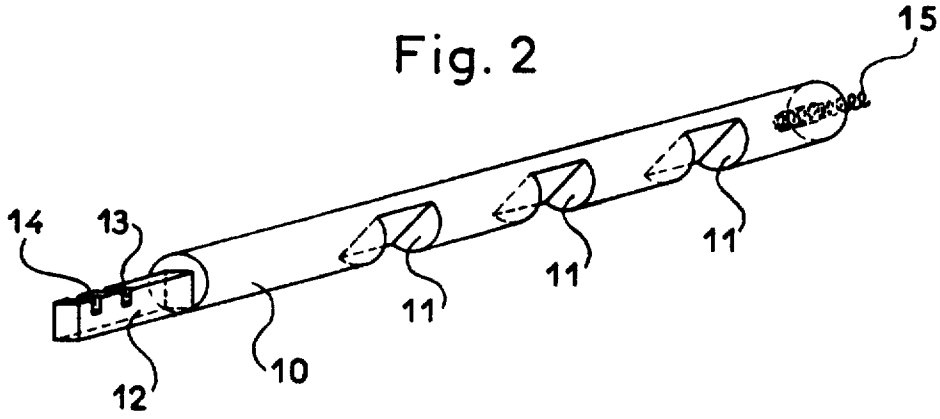


Fig. 3

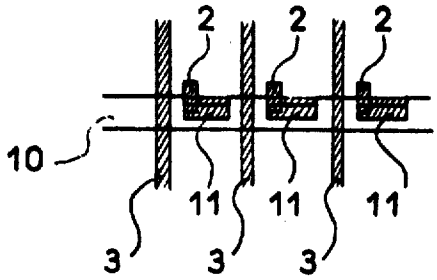


Fig. 4

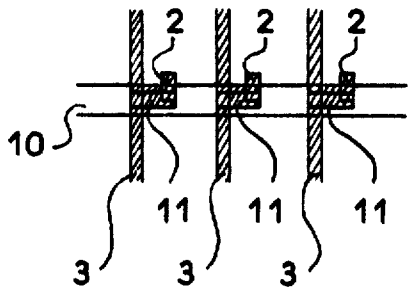


Fig. 5

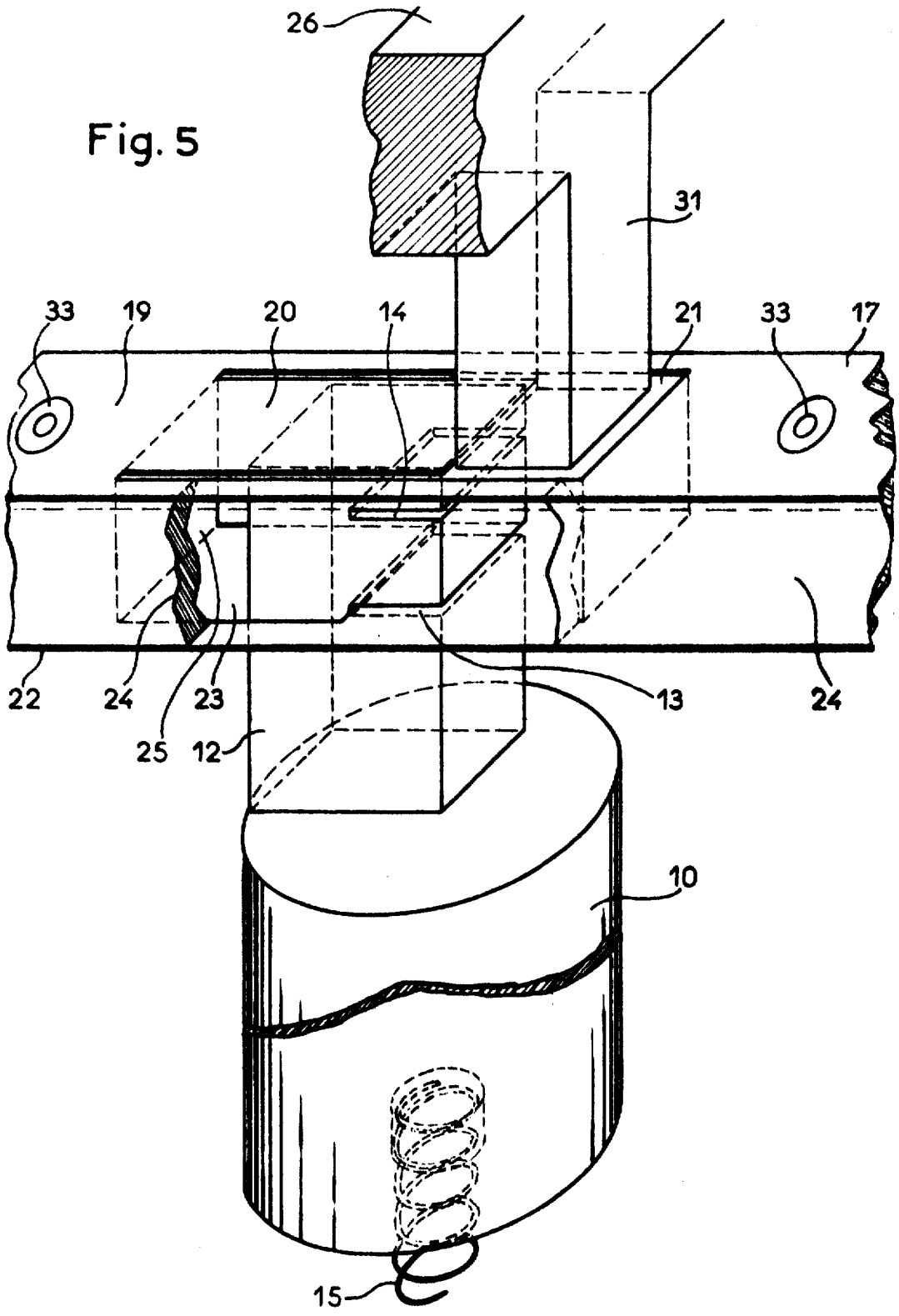


FIG. 6

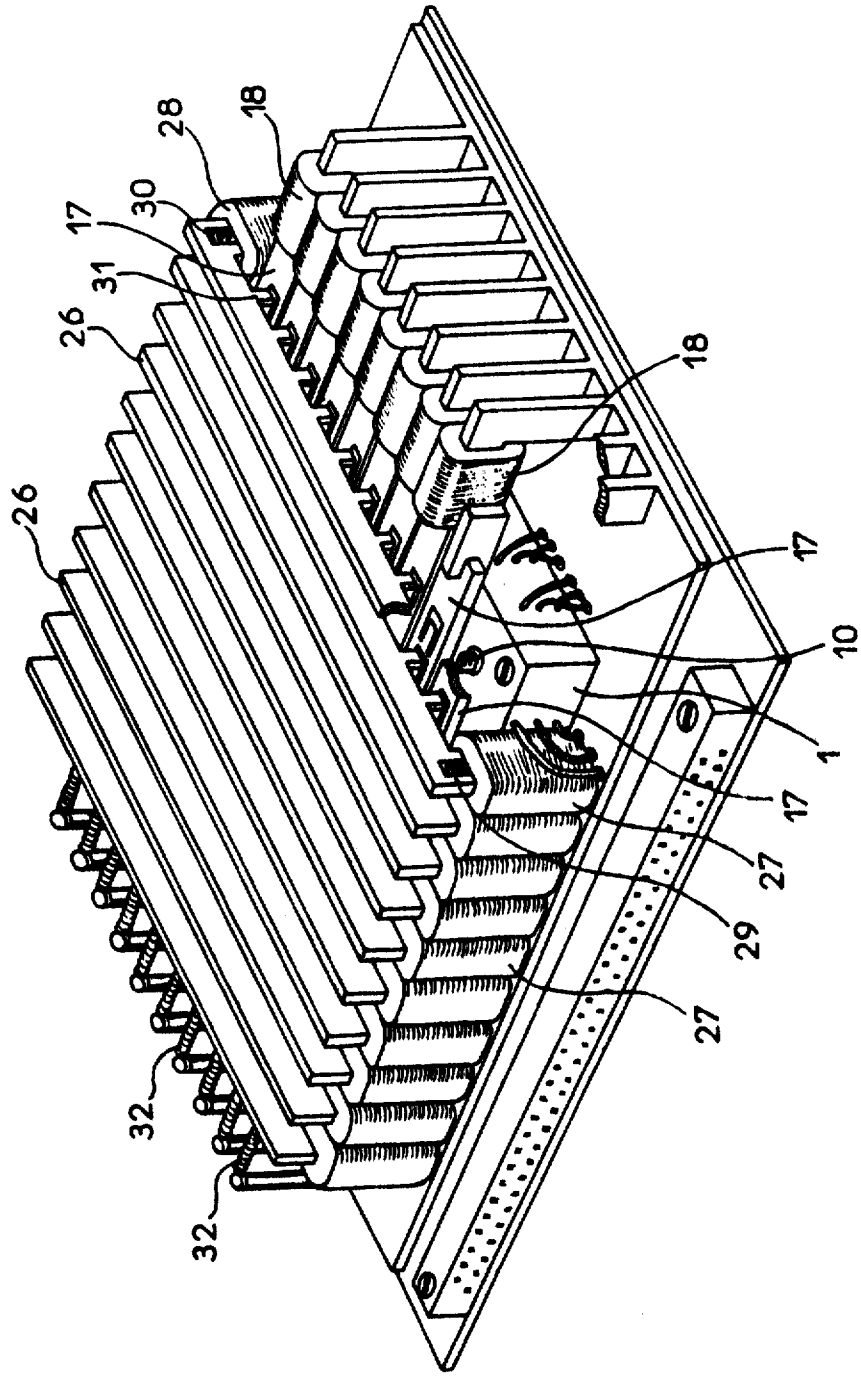


Fig. 7

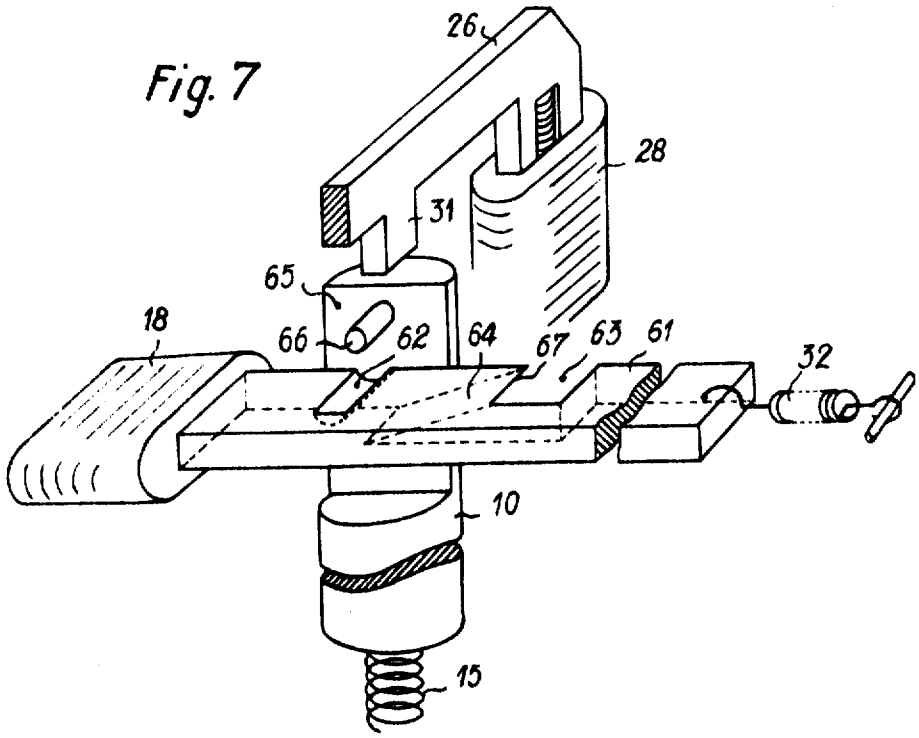

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Fig. 13

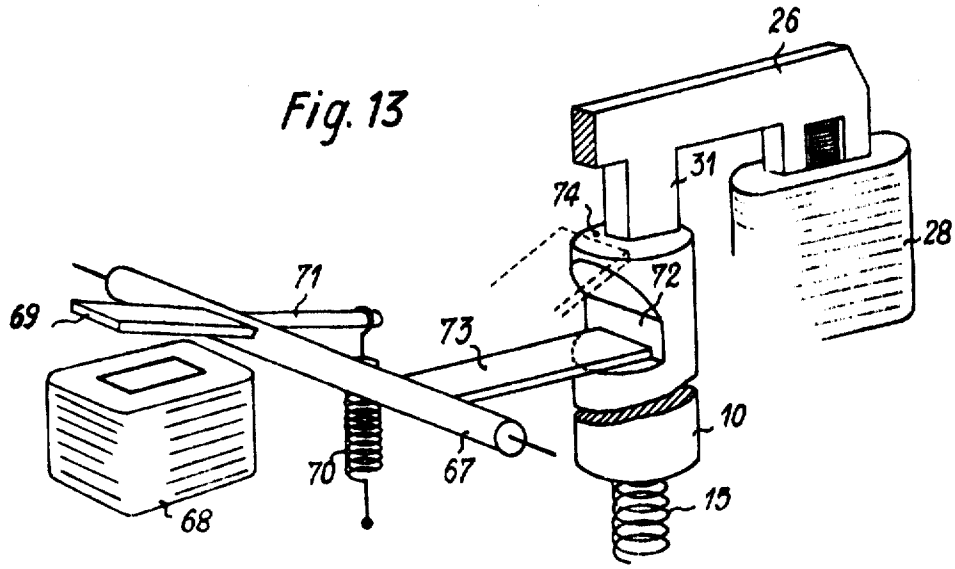

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Fig. 8

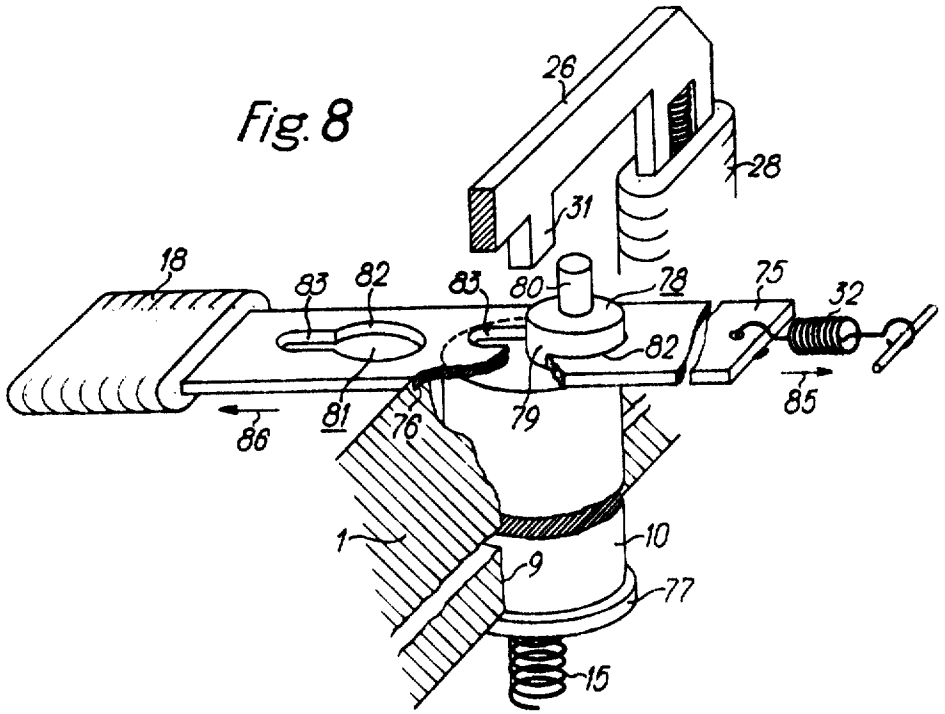


Fig. 9

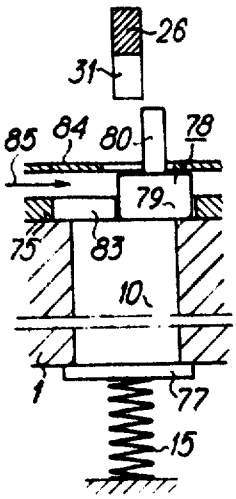


Fig. 10

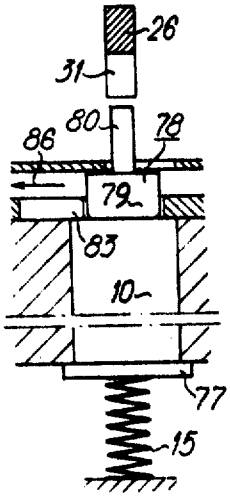


Fig. 11

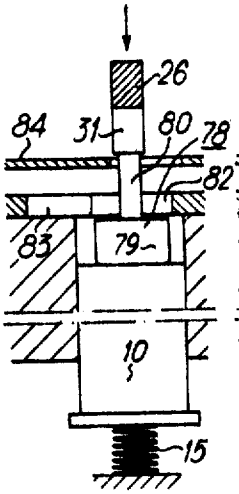


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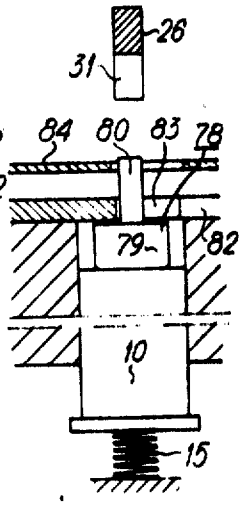


Fig. 14

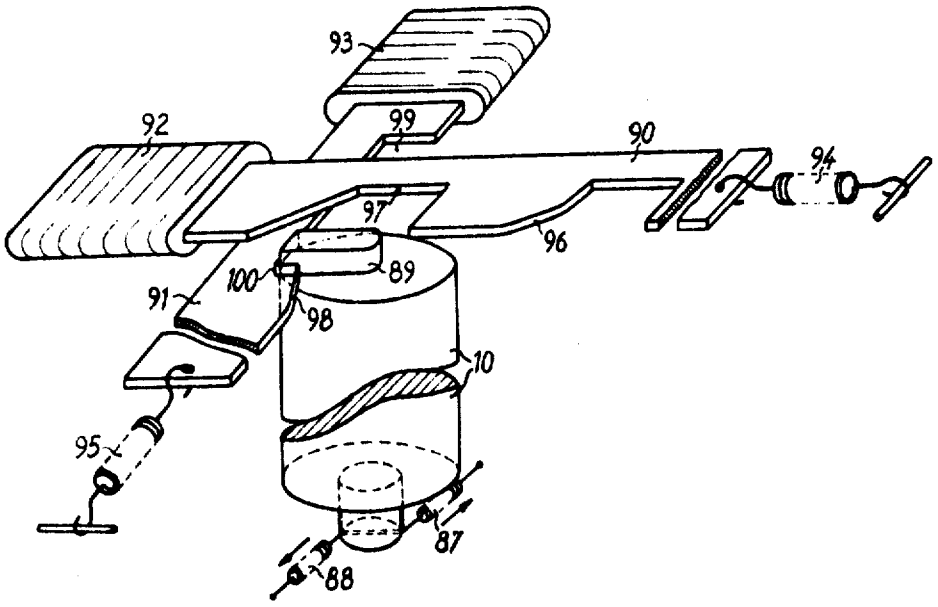


Fig. 15

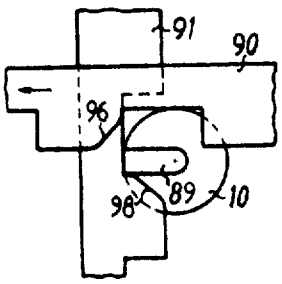


Fig. 16

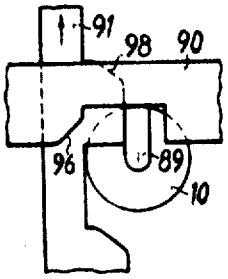


Fig. 17

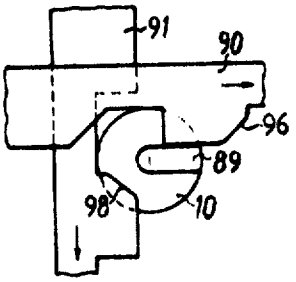


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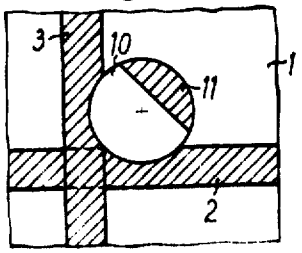


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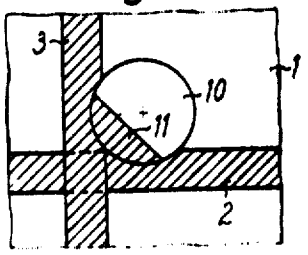


Fig. 20

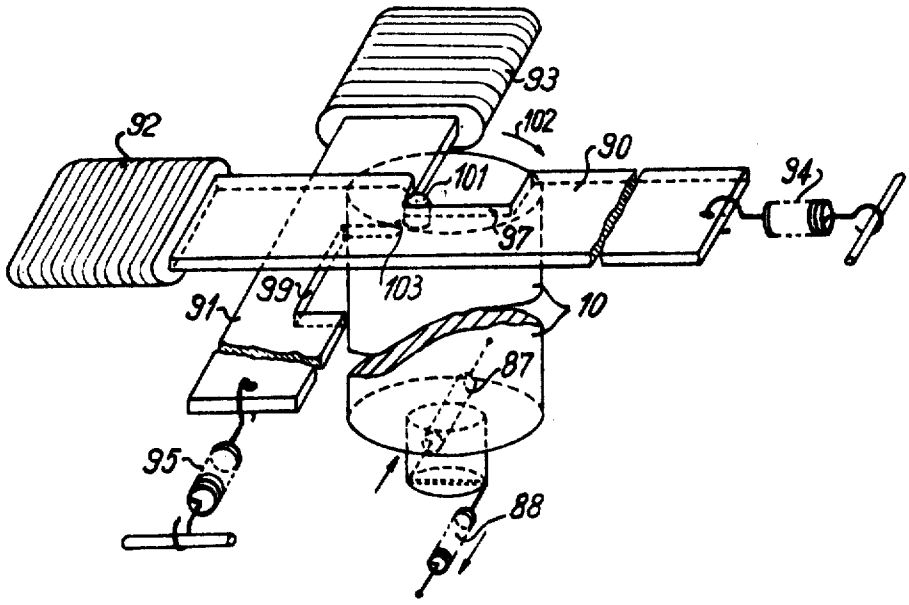


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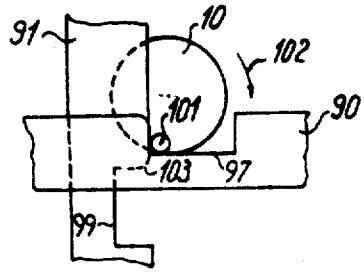


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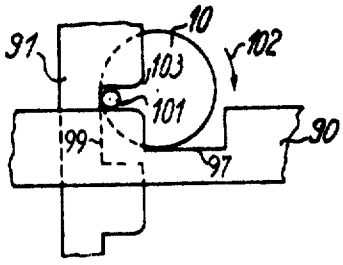


Fig. 22

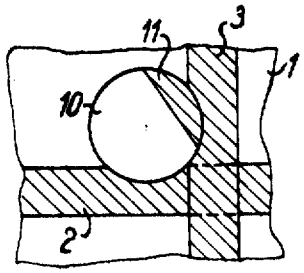


Fig. 24

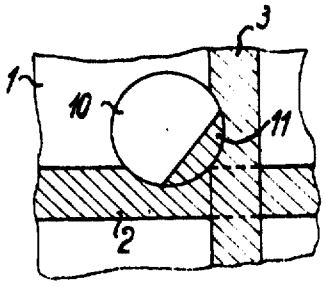


Fig. 25

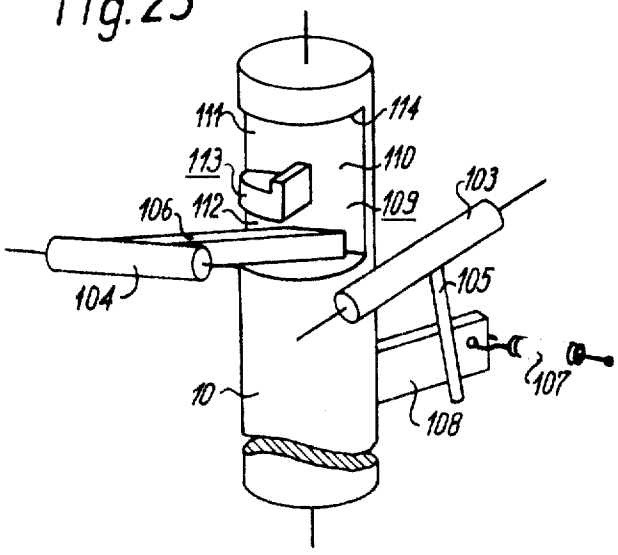
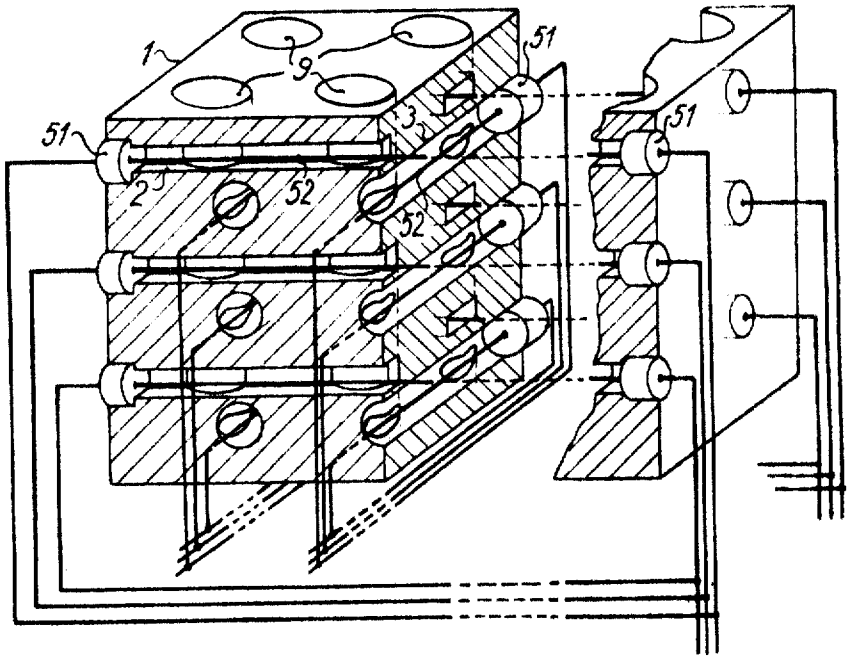

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Fig. 26


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CROSSBAR SWITCHING NETWORK

The present invention relates to switching arrangements and finds a particular application in switching matrixes of the crossbar type.

As known, the crossing points of the selection matrixes of crossbar switches commonly consist of sets of mechanical contacts formed by fixed metal blades ganged along one coordinate and by movable metal blades ganged along another coordinate. These sets of contacts are controlled by means of flexible selection tappets allocated to each of the said contacts, by handling rectangular coordinate bars situated in parallel planes.

Crossbar matrixes are also known in which the points of intersection are reed relays carried by a set of bars whereas the bars of a second set of bars at right angles carry permanent magnets. To actuate a point of intersection, one bar of the first set and one bar of the second set are manipulated in such manner as to place a permanent magnet and a reed relay close to each other.

An object of the present invention is to improve the electrical qualities of the points of intersection of electrical paths, in particular to reduce contact resistance and disconnection capacity.

Another object of the invention is to produce points of intersection which do not rebound upon connection and disconnection.

Another object of the invention is to facilitate the production of a large number of points of intersection.

The improvements forming the objects of the present application relate to:

the structure of the conductors forming the matrix with X and Y coordinates;

the structure of the point of intersection ensuring the electrical contact between the coordinates X_p–Y_q of the matrix of the switching unit employing selection by coordinates;

the arrangement of the mechanical system for selection and maintenance of the points of intersection.

According to the invention, the matrix comprises an insulating block in which are cut two sets of rectangular passages filled with mercury and not intersecting each other, and cylindrical holes at right angles to the first two sets of passages and intersecting these, and pistons displaceable in the said cylindrical holes and comprising drops of mercury imprisoned within cavities cut into the pistons and closed by the holes forming slideways for the pistons, the said pistons having two positions in one of which the drops of mercury they contain are insulated or at least in contact solely with the mercury in the passage of a single set, and in the other of which these drops of mercury are in contact simultaneously with the mercury in a passage of the first set and with the mercury in a passage of the second set.

The invention will now be described in detail with reference to the accompanying drawings, in which:

FIG. 1 illustrates the matrix of points of intersection employing mercury;

FIG. 2 illustrates a piston for controlling the points of intersection of the matrix;

FIGS. 3 and 4 correspondingly illustrate an open point of intersection and a closed point of intersection;

FIG. 5 illustrates a first mechanism for control of the crossbar matrix employing mercury;

FIG. 6 is an overall view of the matrix, of the pistons and of their crossed control bars;

FIG. 7 illustrates a second mechanism for control of the matrix in which the displacements of the bars and the displacement of the piston are translatory displacements;

FIGS. 8 to 12 illustrate a third mechanism for control of the matrix in which the displacements of the bars and the displacement of the piston are translatory displacements;

FIG. 13 illustrates a fourth mechanism for control of the matrix in which the displacements of the bars are, respectively, a translatory displacement and a rotary displacement, and the displacement of the piston is a translatory displacement;

FIGS. 14 to 19 illustrate a fifth mechanism for control of the matrix in which the displacements of the bars are translatory displacements and the displacement of the piston is a rotary displacement;

FIGS. 20 to 24 illustrate a sixth mechanism for control, of the type of that of FIGS. 14 to 19, in which the rotary displacement of the piston has a small angular amplitude;

FIGS. 25 illustrates a seventh mechanism employing rotation of the bars and rotation and translation of the piston;

FIG. 26 illustrates a matrix unit with mercury-filled passages comprising means of reducing the electrical resistance of the passages.

According to the invention, the selection matrix comprises:

a parallelepipedal block 1 having a rectangular base, made of plastic material in which are drilled or cast in unit, narrow passages 2 and 3 intended to receive mercury to form electrical conductors. These passages 2 and 3, numbering m and n respectively, are at right angles to each other and situated in planes parallel to the base of the block. They have a circular or rectangular section. They form a matrix of rectangular coordinates apt to produce (m×n) points of intersection. The switching unit for selection by coordinates comprises a number of plane matrixes identical to the preceding and parallel and equidistant from each other. They form part of the same parallelepipedal block of plastic material and are positioned one above another.

At each intersection of passages 2_p and 3_q (p being a line number and q a column number) of a coordinate matrix, is drilled or cast in unit a cylindrical hole 9_{pq} intended to render it possible to establish an electrical contact between the mercury-filled passages 2_p and 3_q by application of a drop of mercury as will be set forth in the following.

The rectangular coordinate matrixes being identical and placed one above another, the holes 9_{pq} at the intersections of the passages 2_p and 3_q of all the plane matrixes form a single cylindrical hole 9 traversing the block of plastic material 1. There are thus (m×n) holes 9 for the switching unit as a whole.

In each hole 9 is situated a piston 10 according to FIG. 2, sliding without play in a hole 9. It is produced by machining or moulding an insulating plastic material possessing a high surface tension against mercury to prevent seepage of the mercury between the piston and the hole.

In its middle portion, this piston comprises a number of identical notches 11 corresponding to the number of levels of passages 2 and 3. At its upper end, a shank 12 possessing slots 13 and 14 ensures the locking of the piston in the idle position and in the operating position as will be set forth hereinafter. A return spring 15 situated at the lower end returns the piston to the idle position upon disconnecting the point of intersection.

The principle for establishing the contact between a mercury passage 2_p having the coordinate X_p and a mercury passage 3_q having the coordinate Y_q consists of displacing a drop of mercury imprisoned in the notch 11 of the piston 10, in the hole 9.

As shown by FIG. 3, in the idle position of the piston, the drop of mercury 16 is in contact only with the mercury passage 2_p having the coordinate X_p, the cylindrical part of the piston 10 insulates the same from the mercury passage 3_q having the coordinate Y_q; the electrical circuit formed by the passages 2_p and 3_q is open. Moreover, the dimensions of the notch of the piston and the distance which separates the passages 3_i from each other have the result that, in the idle position of the piston, the passage 2_p remains electrically insulated from the passage 2_{q+1}.

In the operating position of the piston, the drop of mercury 16 is displaced towards the right as shown by FIG. 4 by means of the notch 11 of the piston in which it is imprisioned. The drop of mercury then places in communication the mercury passages 2_p and 3_q having the coordinates X_p and Y_q and merges with the mercury of these passages. Owing to this merging, the contact resistance disappears, becoming virtual. The only remaining resistance is the very low resistance of the passages with combined mercury lines, caused by the resistivi-

ty of the mercury. Thanks to this merging moreover, there is no mechanical impact between solid metal parts, resulting in a total absence of rebounds, an absence of interference oscillations and an absence of "spitting and sparking" upon establishing electrical continuity, and a correlative increase in the disconnection capacity.

To ensure the simultaneous connection, the c points of intersection X_p-Y_q corresponding to the superposed matrix levels placed on above another, the piston comprising c notches imprisoning c drops of mercury. The displacement of the piston into the operating position ensures the simultaneous connection of the c points of intersection as has been set forth in the foregoing.

The piston being in the operating position, when the system for locking the connection bars, whose function will be described further on, is released, the return spring **15** pushes the piston **10** and restores it to the idle position. This has the result of breaking the continuity of the merged mercury passages 2_p and 3_q, having the coordinates X_p and Y_1, by imprisoning the mercury drops in the notches **11** which are displaced towards the mercury passages 2_p. When the piston has returned to its idle position under the action of the return spring, the point of connection X_p-Y_q as a whole is again in the condition shown in FIG. **3***a*.

The system for selection and locking is to operate a piston 10_{pq} having coordinates X_p-Y_q predetermined by the chronologically conjugated action of a "hold" bar X_p and of a selection bar Y_q. The piston 10_{pq} remains in the operating position by locking the shank on the hold bar. It remains in this operating position until the release of the shank is caused by lateral freeing of the gold bar, which has the result of allowing the return spring **15** to push the piston into the idle position.

The selection and locking system according to the invention comprises:

a. a set of M double hold bars **17** which are parallel and equidistant from each other and parallel to the plane of the block containing the mercury conductors. Each of them has as its coordinate X_p ($1<p<m$) corresponding to the coordinates X_p of the aligned mercury passages. These hold bars **17** are displaced laterally from left to right under the action of electromagnets **18** positioned in the extension of the bars and from right to left under the action of a return spring **32**.

Each of the double hold bars **17** corresponds to FIG. **5**. Cut from steel blades, it has:

in the upper part, a blade **19** of steel of appropriate elasticity comprising n strips **20** corresponding to the n selection bars. These strips **20** are displaceable from the top downwards under the thrust of the selection bars as will be set forth in the following. In the free extremity of the strips, an opening **21** in the blade **17** provides a passage for the tappets or lifters of the selection bars in the $(m-1)$ hold bars remaining at rest.

in the lower part, a blade **22** of steel of appropriate elasticity comprises n rectangular openings **23** situated under the n strips **20**. These openings **23** are intended to lock, in the idle position and in the operating position, the pistons **10** corresponding to a hold bar **17** by means of the shanks **12** of the pistons.

in the middle part, a bar of plastic material **24** comprising n openings **25** aligned with the n strips **20** firmly connects the blades and imparts rigidity to the aggregate of the hold bar. Metal rivets **33** ensure this connection.

b. an assembly of n selection bars **26** which are parallel to each other and equidistant, parallel to the plane of the block containing the mercury passages and at right angles to the assembly of the m hold bars **17**. Each of these bars has as its coordinate Y_q ($1<q<n$) corresponding to the coordinates Y_q of the mercury passages in alignment. These selection bars are placed above the m connection-cutoff bars and can be displaced downwards each under the action of two electromagnets **27** and **28** situated at their extremities and can be displaced upwards under the action of return springs **29** and **30** when the supply to the electromagnets is interrupted.

These n selection bars each have m tappets **31**. Under the action of the two electromagnets situated at the extremities of the selection bars, these m tappets engage freely in the openings **21** of the hold bars **17** and these are at rest. By contrast, if one of the hold bars is operative, that is to say displaced towards the right under the action of the corresponding electromagnet, the strip **20** corresponding to the tappet positioned at the intersection of the bars **17** and **26** having the coordinates X_p and Y_q, is positioned under the same. In this case, a downward displacement of the tappet in question has the result of transmitting this motion to the corresponding piston owing to the presence of the strip between the tappet and the piston.

The selection and locking system according to the invention operates in the following manner:

It is intended to establish an electrical connection of the p^{th} passage having the coordinate X_p of the assembly m of these passages, with the q^{th} passage having the coordinate Y_q of the assembly n of these passages.

A first current pulse is fed into the electromagnet 18_p of the bar 17_p with the result of displacing this bar towards the right. All the n strips **20** of the bar 17_p are positioned under the tappets **31** of the n selection bars **26**. Moreover, the n pistons **10** are positioned under the bar 17_p, being unlocked and remaining in the idle position owing to the displacement of the openings **23** of the blade **22** of the bar 17_p.

During the presence of the first pulse, but with a small time shift to allow the bar 17_p to assume its working position, a second pulse is fed into the electromagnets **27** and **28** of the selection bar 26_q. This results in a downward displacement of the bar **26** and of its m tappets **31**. Only one of these m tappets **31** encounters a strip **20** under it, being that which is positioned at the intersection of the bars 17_p and 26_p. In its downward displacement, this tappet **31** causes the insertion of the corresponding piston **10** owing to the presence of the strip.

The first pulse is chronologically calibrated to terminate when the aforesaid piston has reached its operating position, that is to say at the bottom dead center of its stroke. The cancellation of this pulse allows the return spring **32** to return the bar 17_p to its idle position by locking the (strip) blade **22** in the slot **24** of the shank **12** of the piston **10**. The second pulse then terminates and the selection bar 26_q rises to its idle position under the action of its springs **29** and **30**.

Only the piston 10_{pq} remains locked on the blade **22** of the bar 17_p and establishes an electrical continuity between the conductive mercury passages 2_p and 3_q by means of the mercury drops imprisoned in the c notches **11** of the piston 10_{pq} in the manner described in the foregoing.

To interrupt the electrical connections thus made, it is sufficient to a current pulse calibrated in intensity and duration, to the electromagnet of the hold bar 17_p. This pulse displaces the bar 17_p towards the right, thus unlocks the blade **22** from the slot **14** and the piston 10_{pq}, under the action of its spring **15**, rises to its idle position. The notches **11** interrupt the electrical continuity of the conductive mercury passages by upwardly entraining the drops of mercury.

Referring to FIG. **2***b* this time, the block **1** of passages sectioned along a plane parallel to the line passages **2**, is visible in section. As in FIG. **1**, the reference numeral **9** denotes the holes in which the pistons slide. Each passage **2** or **2** filled with mercury is closed by two hermetic plugs **51** and along the passage is arranged a metal wire **52** immersed in the mercury and through a sealed bushing traversing the plugs **51**. The wire **52** is formed in the form of a loop to reduce the resistance of the passage seen from the outside of the matrix.

With reference to FIG. **7**, which relates to a system employing two translatory displacements of the bars and translatory displacement of the piston, a bar **26** having the coordinate Y has been illustrated, which is precisely of the type shown in FIGS. **5** and **6** and comprises tappets **31**. The bar **61** having the coordinate X, has a different form from that in FIGS. **5** and **6**, but is controlled in the same manner by means of an electromagnet **18** and restored to idle condition by means of a spring **32**.

The bar 61 has the shape of a blade and comprises a seat 62 for a peg, an opening in the form of a crenellation 63 and a ramp 64 starting from the edge of the crenellation 63. The piston 10 has a cylindrical shape and is profiled with a flat 65 at its upper extremity; this flat 65 has a peg 66 secured to it. The remainder of the piston 10 is analogous to that shown in FIG. 2; in particular it is returned to the high disconnection position by a spring 15 operating under compression.

The operation is the following:

Under the action of the electromagnet 18, the bar 61 is drawn towards the left through a distance such that the peg 66 of the piston 10 is placed in alignment with the crenellation 63. Under the action of the electromagnet 28, the tappet 31 exerts thrust on the top of the piston 10 causing the same to descent through a stroke such that the peg 66 is placed below the edge 67 of the ramp 64. This stroke is insufficient to bring the point of intersection into operation.

When the electromagnet 18 releases, the bar 61 returns to its idle position, impelled by the return spring 32. The ramp 64 causes the piston to descent through the additional stroke needed to bring the point of intersection into action.

For disconnection, the bar 61 returns towards the left under the action of the electromagnet 18, allowing the peg 66 to escape from the ramp 64 and the piston 10 rises under the action of the compression spring 15.

The seats 62 serve the purpose of receiving the pegs of the pistons cooperating with the same bar having the coordinate Y 26 and whereof the bars 61 having the coordinate X have not been selected.

Referring to FIGS. 8 to 12 which relate to another system employing two translatory displacements of the bars and a translatory displacements of the bars and a translatory displacement of the piston, a bar 26 having the coordinate Y has been illustrated which is precisely of the type shown in FIGS. 5 and 6, and comprises tappets 31. This bar is controlled by means of two electromagnets situated at its extremities and of which only one, 28, is illustrated in FIG. 8.

The bar 75 having the coordinate X slides in a groove 76 wrought in the matrix unit 1 and is actuated by an electromagnet 18 in one direction and by a return spring 32 in the other direction. In FIG. 8 there recur the passages 9 intended to receive the pistons 10 but a part of the matrix unit has been left out to avoid having to illustrate the mercury passages and the notches of the piston. The piston 10 is housed in a passage 9; it is displaced upwards by the compression spring 15 and a flange 77 coming into abutment against the underside of the matrix unit limits its upward vertical stroke.

On the upper face of the piston 10 is situated a control knob 78 formed by a circular base 79 and by a cylindrical stud 80 at right angles to the base at its center this stud extending upwards. The bars 75 are perforated by openings 81 having the shape of a circle 82 extended by a slot 83 of lesser width than the diameter of the circle. The base 79 can be inserted into the circle 82 and the stud 80 can be inserted and slide in the slot 83.

A cover 84, not illustrated in FIG. 8 but illustrated in FIGS. 9 to 12, holds the bars 75 and the control knobs 78 in position.

FIG. 8 illustrates one piston only, but it is understood that an opening 81 is present before each piston.

The operation is described with reference to FIGS. 9 to 12.

At rest (FIG. 9), the piston 10 is in the top position, its flange 77 bearing on the matrix unit 1 owing to the action of compression of the spring 15. The bar 26 is in the top position and the bar 75 drawn by the spring 32 in the direction of the arrow 85, is in the right-hand position. The knob 78 is in its seat and the stud 80 is not in alignment with the tappet 31.

For connection, the bar 75 is drawn by the electromagnet 18 to the left-hand position in the direction of the arrow 86 (FIG. 10); the control know 78 is entrained and the stud 80 is positioned under the tappet 31. The bar 26 is lowered by the electromagnet 28 and the piston 10 is lowered by means of the tappet 30 and of the control know 78 (FIG. 11). The vertical stroke is such that the base 79 of the knob 78 emerges completely from the circular opening 82. The bar 75 returns to the right-hand position, the base of the knob remaining comprised between the crown of the piston and the underside of the bar 75. The stud 80 penetrates into the slot 83 of the opening 81. The piston is thus held in the operative position even when the bar 26 rises (FIG. 12).

For disconnection, the bar 75 is displaced towards the left again, and the knob 78 rises under the action of the spring 15, its base 79 penetrating into the circular part 82 of the opening 81. The bar 75 then returns to the right-hand position, and the control knob returns to the idle position of FIG. 9.

With reference to FIG. 13, which relates to a system employing a translatory and rotary displacement of the bars and a translatory displacement of the piston, a bar 26 having the coordinate Y has been illustrated, which is precisely of the type shown in FIGS. 5 and 6 and comprises tappets 31. This bar is controlled by means of two electromagnets situated at its extremities and of which one only, 28, is illustrated in FIG. 13.

The bar 67 having the coordinate X is no longer animated by a translatory displacement but by a rotary or swiveling displacement under the action of the electromagnet 68 acting on the tongue 69. The bar 67 is returned to the idle position by the spring 70 fastened to the lever 71 and causing the bar to turn against the direction of the electromagnet 68.

The piston 10 comprises a notch 72 in which may operate a lever 73 firmly joined to the bar 67.

The operation is the following:

Under the action of the electromagnet 68, the bar 67 swivels through an angle such that the lever 73 emerges completely from the notch 72 of the piston 10. Under the action of the electromagnet 28, the bar 26 is thrust downwards and the tappet 31 thrusts the piston 10 downwards, its stroke being insufficient however to connect the point of intersection.

When the electromagnet 68 releases again, the bar 67 returns to the idle position under the action of the spring 70 and the lever 73 bears on the upper face 74 of the piston and, during the additional stroke thus obtained, the point of intersection is brought into operation.

For disconnection, the bar 67 again turns under the action of the electromagnet 68, which releases the lever 73. The piston rises again under the action of the spring 15. When the electromagnet 68 releases, the lever 73 drops again into the notch 72 without touching the piston 10.

The pistons 10, whose bars 67 have not been selected, are subjected by the bar 26 to a displacement which is insufficient for connection of the corresponding points of intersection.

With reference to FIGS. 14 to 19, which relate to a system employing two translatory displacements of the bars and a rotary displacement of the piston, the piston 10 can turn in its passage 9 but cannot undergo a translatory displacement. It is recalled towards an idle azimuth by the springs 87 and 88 and on the other hand it carries a control knob 89 on its upper face.

The bars 90 and 91 are actuated, respectively, by means of the electromagnets 92 and 93 and are returned to the idle position by springs 94 and 95. The bar 90 comprises a cam 96 and a notch 97 and the bar 91 comprises a cam 98 and a notch 99, the cam forming one of the edges of the notch. In the idle position the extremity of the knob 89 rests on the edge 100 of the cam internal to the notch.

The connection is made by two consecutive displacements of the piston, each of a quarter-turn.

The electromagnet 92 draws the bar 90 in then manner that the cam 96 is drawn back from the piston (FIG. 15). The electromagnet 93 then draws the bar 91, and the cam 98 causes the piston 10 to turn through a first quarter-turn by means of the knob 89 (FIG. 16). The electromagnet 92 releases and the bar 90 returns to the idle position under the action of the spring 94. The cam 96 causes the piston 10 to turn through a second quarter-turn. The contacts are made, the piston having been turned through half a turn. The electromagnet 93 then releases and the bar 91 returns to the idle position, drawn by

the spring 95. The pistons it had entrained through a quarter-turn return to the idle position except for that which has described a second quarter-turn (FIG. 17).

For disconnection, the bar 90 comes into operation and the cam 96 frees the knob 89 and the piston turns to the idle position under the action of the springs 87 and 88.

The notches 97 serve the purpose of providing a passage for the knobs 89 of the pistons 10 entrained through a quarter-turn by the bar 91 and whose coordinated bar 90 has not been selected.

It is apparent from FIG. 18 that the drop 11 is not in contact with any passage whereas in FIG. 19, after turning through 180°, it is in contact with the passages 2 and 3.

FIGS. 20 to 24 show another system employing two translatory displacements of the bars and a rotary displacement of the piston. In these figures, the same reference numerals denote the same elements as those of FIGS. 14 to 19: bars 90 and 91, electromagnets 92 and 93, springs 94, 95, 87 and 88, piston 10. The knob 89 is replaced by a peg 101.

In this system, the rotation of the piston amounts to 75° instead of 180°; the stroke of the bars and the period taken for connection and disconnection, are thus reduced.

FIG. 21 illustrates the idle position of the piston seen from above, and FIG. 22 the position of the drop of mercury 11 with respect to the mercury passages 2 and 3 in the idle position. FIG. 23 illustrates the operating position of the piston seen from above and FIG. 24 the position of the drop of mercury 11 relative to the mercury passages 2 and 3 in the operating position. It is apparent that, in FIG. 22, the drop 11 is not in contact except with the passage 3, whereas after being turned through 75°, it is in contact with the passages 2 and 3, in FIG. 24.

In the idle position, the springs 87 and 88 tend to cause the piston to turn in the direction of the arrow 102 but the peg 101 being engaged simultaneously in the corner of the notch 97 of the bar 90 and in contact with the edge of the bar 91, is prevented from turning by these two obstacles.

For connection, the bars 90 and 91 are attracted by their corresponding electromagnets 92 and 93. The stud 101 is no longer held at all by the side of the notch 97, nor by the bar 91 which then confronts it with its notch 99; it follows the contour of the cam 103 and the piston turns until the stud is stopped by the side of the notch 99. The electromagnets then release; the bar 90 returns to the idle position but the bar 91 is held by the stud 101 bearing on the side of the bar 90 (FIG. 23).

The other pistons coordinated with the bar 90 and whereof the coordinated bar 91 has not been displaced, have not been turned since they were held back by the edge of the bar 91.

For connection, the bar 90 is displaced again towards the left which releases the stud 101. The bar 91 no longer being abutted by the stud 101, itself abutted by the bar 90, returns to the idle position under the action of the spring 95 whilst entraining the stud 101 against the springs 87 and 88; the elements are returned to the position of FIG. 21.

FIG. 25 relates to a system employing a rotary displacement of the bars and a translatory and rotary displacement of the piston.

The bars 103 and 104 are bars swiveling around their axes and each equipped with a plurality of levers or lifters 105 and 106 respectively. The means of causing the bars to turn have not been illustrated; as in FIG. 13 for example, they are formed by an electromagnet like 68 and by a tongue in unit with the bar, like 69.

The piston 10 can turn in its passage 9. It is returned to the idle position by the spring 107 fastened to the frame and to the radial lever 108. The tappet or lifter 105 cooperates with the radial lever 108 to cause the piston to turn. At the other side from the lifter 108, the piston has a notch 109 of U-shape formed by a longitudinal slideway 110 and by two tangential slideways 111 and 112. A cam 113 is situated between the two slideways 111 and 112.

The idle position of the piston is the top position, and the bottom position is the operating position.

For connection, the bar 104 is swiveled and the lifter 10 arrives above the level of the cam 113. The bar 103 swivels and the lifter 105 acting on the lever 108 causes the piston to turn. During the rotation of the piston, the extremity of 106 passes into the slideway 111. The bar 104 returning to the idle position, the lifter 106 bears on the cam 113 causing the piston to be lowered. The underside of the lifter 106 comprises a crenellation engaging with the corresponding crenellation of the cam 113. As a result, when the bar 103 returns to the idle position, all the pistons in the idle position undergo a rotation under the action of their spring 107 whereas the piston in operation is locked in rotation by means of the lever 116 in engagement with the cam 113.

For disconnection, the bar 104 is turned and the piston is lifted by the face 114 of the notch. The engagement between 106 and 113 is interrupted and the piston turns backwards under the action of the spring 107.

We claim:

1. A crossbar-type switching arrangement comprising a block of insulating material provided with a first set of holes extending in a first common direction and arranged at intervals in a plurality of parallel planes, a second set of holes extending in a second common direction perpendicular to said first direction and arranged in said plurality of parallel planes so that each hole of said second set of holes intersects a plurality of holes pertaining to said first set of holes, a third set of holes extending in a third direction perpendicular to said first and second directions and each intersecting at least one hole in said first set and one hole in said second set of holes, liquid conducting medium contained in each one of said holes of said first and second sets of holes, a piston of insulating material slidably movable in each hole pertaining to said third set of holes, said piston being provided with at least a notch portion, whereby, when said piston is so positioned that its notch portion overlaps a first and second hole respectively pertaining to said first and second sets at their mutual intersection, an electrically conducting connection exists between the medium in latter said first and second holes through the medium located in said notch portion, and, when said piston is so positioned that said notch portion does not overlap latter said first and second holes at their mutual intersection, no electrically conducting connection exists between the medium in latter said first and second holes by virtue of the presence in said intersection of the insulating material of the piston; said arrangement further comprising mechanical control means controlled by electric control means and including a set of connection-deconnection bars parallel to and in number equal to said first set of holes, a set of selection bars parallel to and in number equal to said second set of holes, a means for selectively locking and unlocking each piston in a working position by the motion of one of said connection-deconnection bars, means for selectively causing each piston to slidably move in said third direction between a rest and said working position by the motion of one of said selection bars, and a return spring for returning latter said piston to its rest position.

2. A switching arrangement as claimed in claim 1 in which said liquid medium is liquid mercury.

3. A switching arrangement as claimed in claim 1, in which each piston is provided with a plurality of notches disposed along its length for simultaneously making conducting connections between a plurality of pairs of holes respectively belonging to said first and second sets of holes.

4. A switching arrangement as claimed in claim 1, in which the bars of at least one of said sets of bars are slidable along their length direction.

5. A switching arrangement as claimed in claim 1, in which the bars of at least one of said sets of bars are rotatable around their length direction.

6. A switching arrangement as claimed in claim 1, in which said control means consist of electromagnets.