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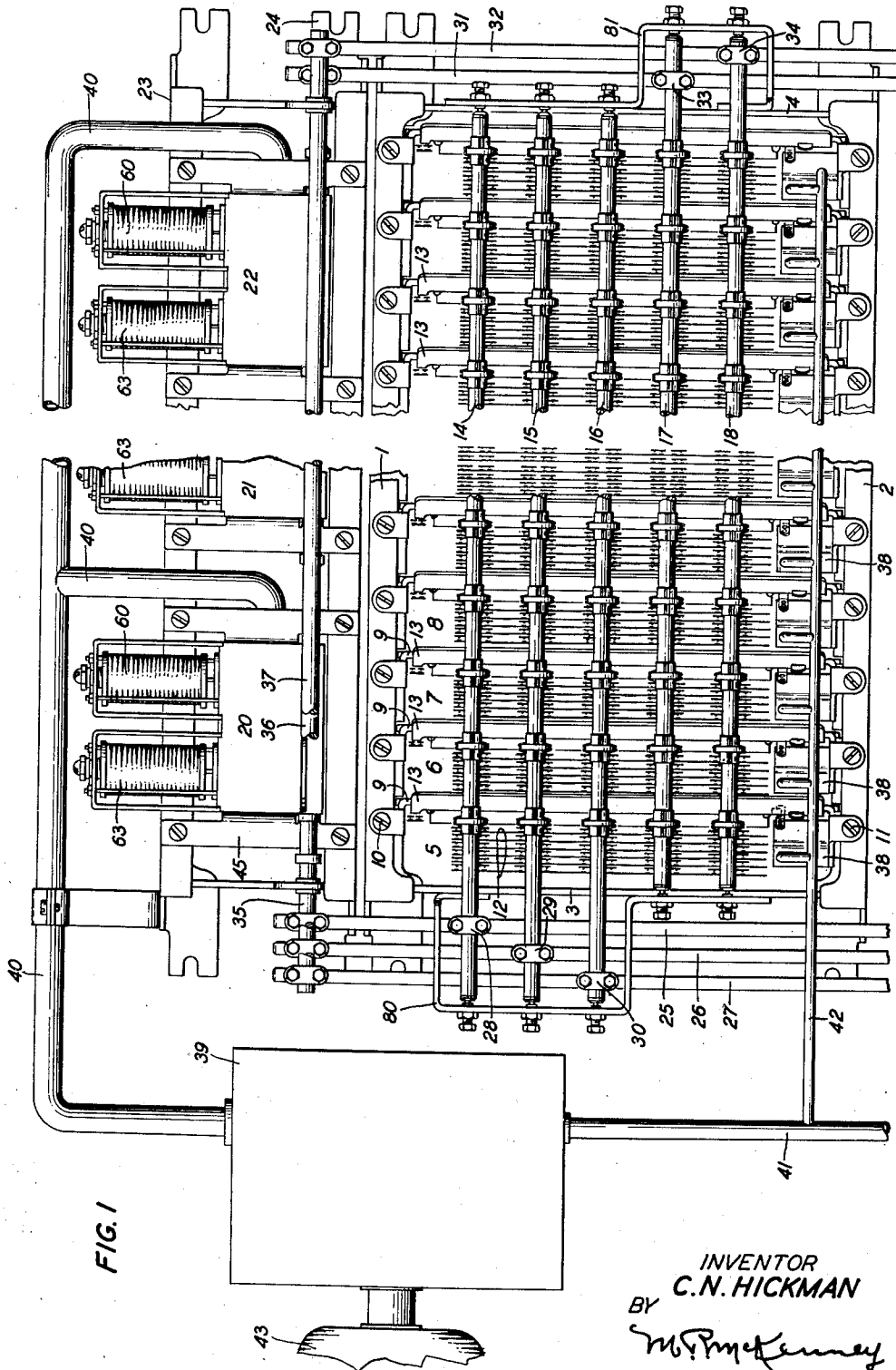
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2,185,374

SELECTIVE SWITCH

Filed Nov. 13, 1936

3 Sheets-Sheet 1



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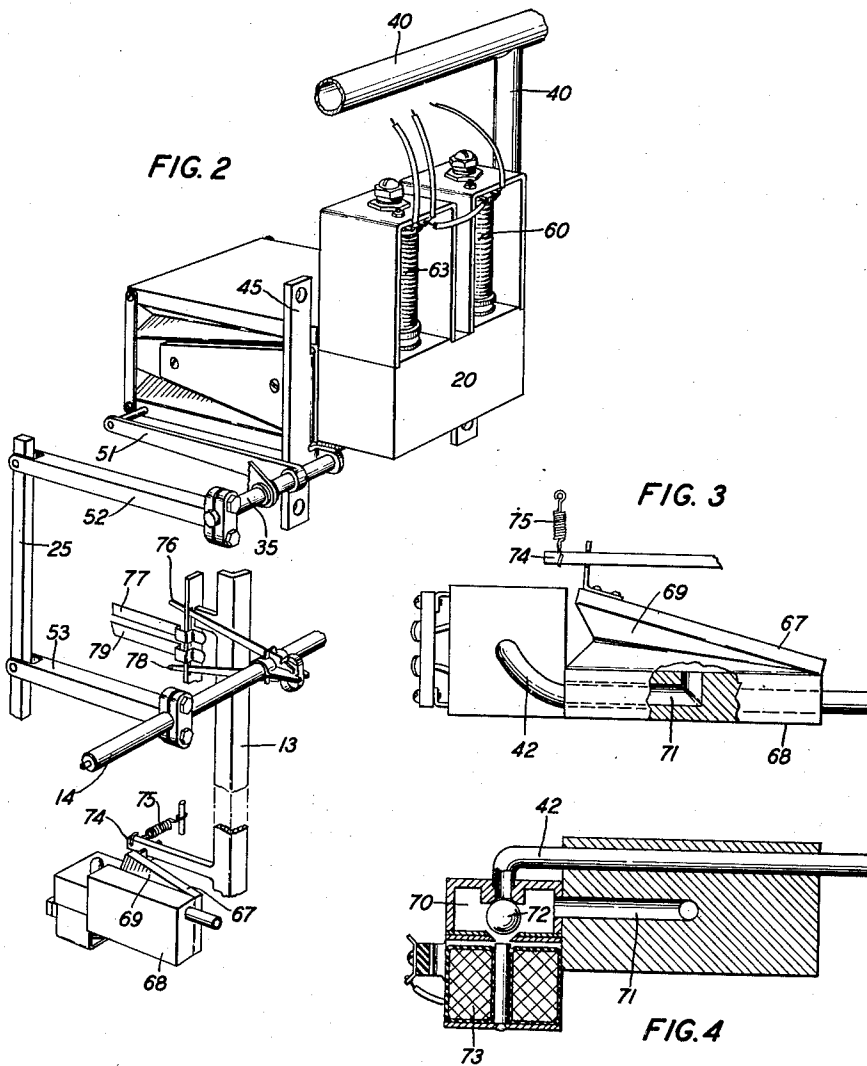
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SELECTIVE SWITCH

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3 Sheets-Sheet 2



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SELECTIVE SWITCH

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3 Sheets-Sheet 3

FIG. 5

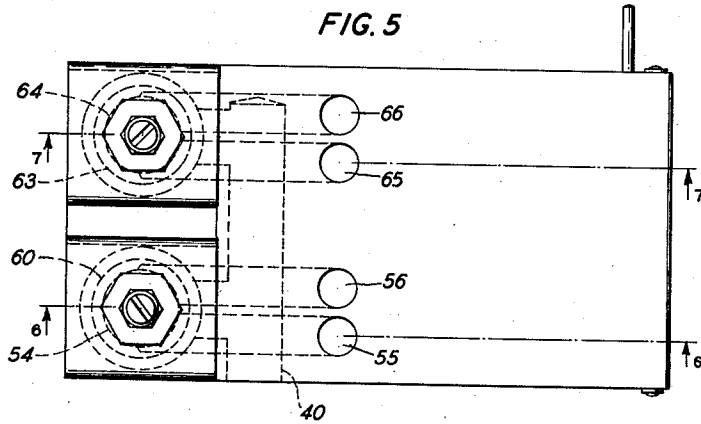


FIG. 6

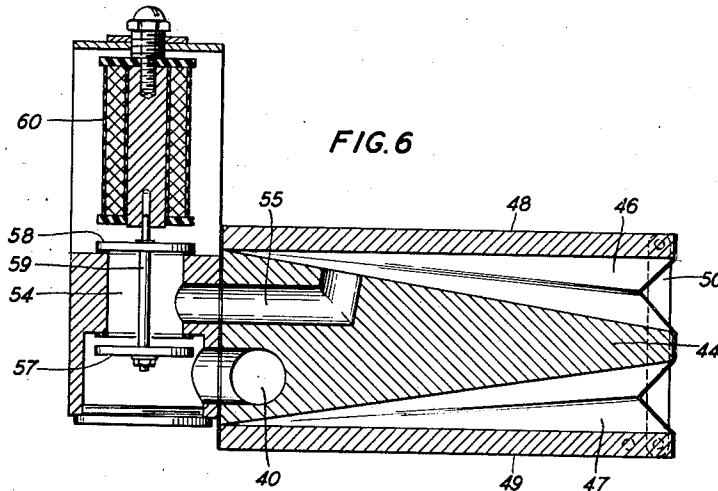
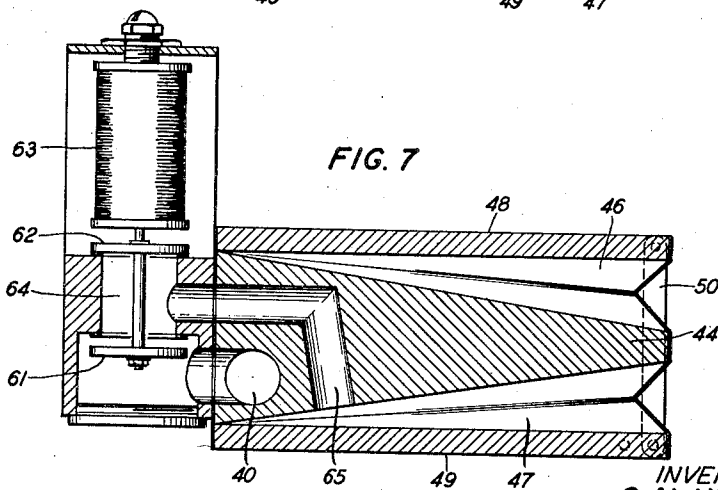


FIG. 7



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2,185,374

SELECTIVE SWITCH

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Application November 13, 1936, Serial No. 110,622

5 Claims. (Cl. 179—27.54)

This invention relates to selective switching mechanisms and particularly to those used in telephone systems.

5 The objects of the invention are to increase the speed of operation of automatic switches; to obtain wider ranges in the movement of the operating parts; to secure more power for operating the moving parts and to improve the distribution of the power available; to utilize common 10 mechanism for operating and restoring the actuating parts; to effect economy of operation; and otherwise to improve the construction and operation of apparatus of this character.

Several different kinds of motive power have 15 been suggested heretofore for operating the movable brush rods of automatic selector switches. These include electric motors, spring motors, gravity devices, electromagnets, solenoids and pneumatic devices. In automatic switches of the 20 cross-bar type the usual practice has been to use electromagnets for actuating the cooperating bars that effect the closure of the contact sets. And while electromagnets are well suited to this purpose, I have discovered that by utilizing 25 pneumatic power for operating the cross-bar members of these switches the foregoing objects of this invention are realized and distinct advantages are to be had over structures making use of the customary electromagnetic power. 30 The pneumatic power is particularly advantageous for cross-bar switches of the kind in which a single bar serves two rows of contacts and for this purpose is rotatable in both directions from its normal position.

35 Accordingly one of the more important features of this invention is a cross-bar switch in which pneumatic devices are provided for the respective select bars for selectively operating any desired one thereof, and in which pneumatic devices are also provided for the respective 40 hold bars, whereby any of these bars may be operated and held to effect the desired connection. In a switch operated in this manner a greater proportion of the power applied to the bar is available at the beginning of the stroke 45 when it is most needed. This permits the moving parts to be given greater ranges of movement, and it also increases the operating speed.

Another feature is a pneumatic operating device 50 arranged to exert an operating force in either of two directions upon the switch bar and to restore to its neutral position following its operation to either of its advanced positions. This is accomplished by providing the device with 55 two bellows chambers coupled to each other me-

chanically and to the switch bar. Normally both chambers are connected through valve-controlled ports to a low-pressure air chamber, and the chambers assume a balanced state which is the neutral position, and in which position the switch 5 bar is held in its neutral position. By controlling the pressure in either chamber, the bellows is made to move in the corresponding direction, and the switch bar is correspondingly moved to its set position in that direction. Since the bellows 10 restores the bar to its normal position, no restoring springs are required for this purpose.

Other features and advantages of the invention will be described more fully in the following 15 detailed specification.

In the drawings accompanying the detailed specification:

Fig. 1 is a plan view of a cross-bar switch equipped with pneumatic devices for operating the select and hold bars of the switch; 20

Fig. 2 is a perspective view showing the operating devices for the cross-bars and illustrating the contact operating mechanism;

Fig. 3 is a top view, partly in section, of the pneumatic device for operating one of the hold 25 bars;

Fig. 4 is a side view in section of the pneumatic device shown in Fig. 3;

Fig. 5 is a plan view of one of the pneumatic devices for operating the select bars; and 30

Figs. 6 and 7 are side views showing two different sections of the device of Fig. 5.

This invention is applicable to cross-bar switches in general and particularly to switches of the type in which the select bars are movable 35 from neutral positions to either of two set positions. A switch of this kind is disclosed in the patent to Reynolds 2,021,329 of November 19, 1935, and reference is made to this patent for an understanding of the details of construction and operation which may not be disclosed in full detail 40 in the present drawings.

Referring now to the drawings herein, the frame of the switch on which the various parts are mounted comprises upper and lower frame 45 members 1 and 2 and side frame members 3 and 4. These frame members are secured together in any suitable way, and the frame thus formed may be mounted on racks as is usually done with equipment of this kind. Mounted on the switch 50 frame are a plurality of vertical units 5, 6, 7, 8, etc. Each one of these units comprises a mounting plate 9 which is secured to the frame members 1 and 2 by screws 10 and 11. The mounting plate 9 carries a set of vertical contact 55

strips 12 and a vertical or hold bar 13. The bar 13 is right-angular in its formation and is mounted on the plate 9 so as to rotate about the edge of the plate as a pivot bearing. While the number of vertical units 5, 6, 7, 8, etc., may vary in accordance with the desired capacity of the switch, it is convenient in many cases to provide the switch with twenty of these units. Thus twenty separate circuits may appear in the switch, each of which extends throughout the vertical length of the switch and constitutes a vertical row of switch contacts.

In order that connections may be made between these vertically extending circuits and other circuits, horizontal rows of cooperating switch contacts are also provided. These latter contacts are also mounted in any suitable way on the vertical mounting plates 9 and extend to the rear of the switch where they are multiplied in a horizontal direction. That is to say, the several sets of contacts which cooperate respectively with the several sets of vertical contact strips 12 are connected together in multiple to form a single horizontal row of contacts. In the switch shown there are ten of these horizontal rows of contacts, giving a capacity of ten circuits, any one of which may be connected to any one of the twenty circuits appearing in the respective vertical rows of contacts.

The horizontal rows of contacts are arranged in pairs, and each pair is provided with a horizontal or select bar for preparing the contacts for operation. The five select bars 14, 15, 16, 17 and 18 are mounted on the switch frame as seen in Fig. 1. These bars are supported by means of end bearing screws between the brackets 28 and 31. The bar 14, for instance, serves the two uppermost horizontal rows of contacts. The bar is rotated through a slight distance in one direction to select the contacts in the uppermost horizontal row and is rotated similarly in the other direction to select the contacts in the next horizontal row. And the same is true of the remaining select bars 15, 16, 17 and 18.

The power for operating the select and hold bars of the switch is obtained from pressure controlled devices. These pneumatic motors consist of small bellows equipped with electromagnetically operated valves for controlling the pneumatic pressure within the bellows chambers. The five select bars of the switch are operated in either of the two directions by five corresponding pneumatic devices 20, 21, 22, etc. These five pneumatic devices are mounted on frame members 23 and 24, which in turn may be secured at the top of the mounting rack on which the cross-bar switches are mounted. Since it is sometimes desirable to operate the select bars of several switches simultaneously, advantage is taken of the power obtainable from these pneumatic operating devices and from the convenience with which they can be coupled to the bars on a plurality of switches to secure this desired result. For example, a mounting rack in a telephone exchange can be equipped with a plurality of cross-bar switches similar to the one shown in Fig. 1, the switches being mounted on the rack one above the other in a vertical manner. Above the top switch the pneumatic units 20, 21, 22, etc. are mounted and are coupled, as will be explained presently, to the select bars on all of the cross-bar switches on the rack below. The three select bars 14, 15 and 16 on the switch shown and the three corresponding bars on each of the remaining switches in the group are driven by the op-

erating rods 25, 26 and 27. That is, the rod 25 is joined to the select bar 14 by the coupling 28 and similarly to the corresponding select bar on each of the other cross-bar switches in the group. Likewise, the rods 26 and 27 are joined to the select bars 15 and 16, respectively, by couplings 29 and 30, and to the other corresponding select bars in the remaining switches of the group. The operating rods 31 and 32 for the other two select bars 17 and 18 are located as shown on the other end of the switch and are coupled to these bars, respectively, by the couplings 33 and 34. The five vertical operating rods 25, 26, 27, 31 and 32 are coupled in turn to five corresponding horizontal rods mounted at the top of the frame near the pneumatic units 20, 21 and 22. For example, the vertical rod 25 is coupled to the horizontal rod 35, and this horizontal rod is in turn coupled to the movable part of the pneumatic unit 20. The detail of this construction is more clearly seen in the perspective view of Fig. 2. In a similar manner the vertical rods 26 and 27 are coupled to the horizontal rods 36 and 37, each of which is in turn coupled to corresponding pneumatic operating devices at the top of the frame.

Each of the vertical bars 13 of the switch is provided with an individual pneumatic operating device 38. The pneumatic devices 38 are mounted in any suitable way on the bottom frame member 2 of the switch, as seen in Fig. 1 of the drawings.

A common pressure tank or reservoir 39 is connected by tubes to all of the pneumatic operating devices. For example, the tank 39 is connected to the pneumatic devices 20, 21 and 22 by means of the pipe 40 and the pneumatic devices for the vertical bars are controlled by the tank 39 through the pipes 41 and 42. The bellows elements of the pneumatic devices, which depend for their operation upon the difference between the external and internal pressures, may be designed to operate either on pressure exceeding normal atmospheric pressure or on sub-atmospheric pressure. In the first case the supply tank 39 would be used as a reservoir for compressed air to supply the bellows elements with air above the normal external atmospheric pressure. In the latter case the pressure within the tank 39 is reduced below the atmospheric pressure and serves to correspondingly reduce the pressure within the different bellows elements when it is desired to operate a corresponding pneumatic unit. A system of this kind is known as a "suction system" for the reason that the main pneumatic tank 39 with its sub-atmospheric pressure tends to exhaust the bellows chambers when they are placed in direct communication with the tank. In either event the pressure within the tank 39 is controlled by a suitable motor-driven pump 43. In the present disclosure the pneumatic units are designed to operate on the suction principle. This plan has some advantages over the pressure system. One advantage is that the flexible parts of the pneumatic system, such as the bellows, are less likely to develop leaks when sub-atmospheric pressures are used. While any suitable pressure may be used for operating the pneumatic units, it has been found that a reduced pressure within the tank 39 corresponding to one pound per square inch gives satisfactory operation.

A detailed description will now be given of the pneumatic operating devices which are shown more clearly in Figs. 2 to 7 inclusive. The select bar pneumatic unit, shown in Figs. 2, 5, 6 and 7, comprises in general a bellows and two electromagnetically controlled valves. A stationary bel-

lows board 44 is rigidly secured to the frame members 23 and 24 by means of the bracket 45 to which it is attached by screws. The stationary board 44 serves as a partition between the two bellows chambers 46 and 47. The upper bellows chamber 46 is enclosed on the top by a movable bellows board 48 and is enclosed on the sides by any suitable flexible material such as rubberized cloth. Similarly, the lower bellows chamber 47 is enclosed on the lower side by the movable board 49 and is enclosed on the sides by flexible bellows material. The two movable boards 48 and 49 are connected to each other by a link 50 so that any movement up and down by one board is participated in by a corresponding movement of the other board. A link 51, interconnecting the lower board 49 with the operating rod 35, serves to transmit any upward or downward movement of the bellows boards into a corresponding rotary movement of the rod 35. The rod 35 in turn is connected through links 52 and 53 and the vertical rod 25 to the select bar 14 of the switch. Thus an upward movement of the bellows boards causes a rotation of the select bar 14 in one direction, and a downward movement of the bellows boards causes a rotation of the bar 14 in the opposite direction.

The upward and downward movements of the bellows boards are produced by controlling the pressure within the chambers 46 and 47 relative to the external atmospheric pressure. This is accomplished by means of the valve-controlled ports interconnecting the bellows chambers with the pressure tank 39. The upper bellows chamber 46 communicates with the valve chamber 54 by means of two ports 55 and 56. The valve chamber 54 is in direct communication with the pneumatic tank 39 by way of supply tube 40 when the lower valve 57 is open, as seen in Fig. 6 of the drawings. The valve chamber 54 also has direct communication with the external atmosphere by way of the upper valve 58. With the upper valve 58 resting on its seat, as seen in Fig. 6, communication is closed between the bellows chamber 46 and the external atmosphere. Thus for the position of the double valve 57 and 58 illustrated in Fig. 6, the upper bellows chamber 46 is in communication only with the reservoir 39, and the pressure within this bellows chamber is reduced below the normal atmospheric pressure. The valves 57 and 58 are mounted on a stem 59 which projects upwardly and into the field of a solenoid 60. By energizing the solenoid 60 the valves are moved upwardly, opening at valve 58 the passage between the external atmosphere, the valve chamber 54, ports 55 and 56 and the bellows chamber 46, and closing at valve 57 the connection between the supply tube 40, valve chamber 54, ports 55 and 56 and the bellows chamber 46. By deenergizing the solenoid 60 the valves 57 and 58 resume their normal position, closing the bellows chamber 46 to the external atmosphere and exposing it to the low pressure of the tank 39. The lower bellows chamber 47 is controlled in a similar manner by valves 61 and 62 and solenoid 63. The valve chamber 64 communicates with the bellows chamber 47 by way of ports 65 and 66. When the valves 61 and 62 are in their normal position, as seen in Fig. 7, communication between the bellows chamber 47 and the external atmosphere is closed at the valve 62, and the bellows chamber 47 is placed in direct communication with the supply tank 39 through the

supply pipe 40, the open valve 61, valve chamber 64 and ports 65 and 66.

The hold bar pneumatic unit, shown in Figs. 3 and 4, is considerably smaller than the one above described for the reason that it is called upon to operate only a single bar whereas the select bar unit may be required to operate a bar on each of several switches. This hold bar unit consists of a simple single-chamber bellows having a movable bellows board 67, which is joined by flexible bellows material to the stationary board 68. The bellows chamber 69 is interconnected with the valve chamber 70 by a port 71. The valve chamber 70 communicates with the supply tank 39 by way of supply pipes 42 and 41. The valve chamber 70, through its lower valve opening, is also in direct communication with the external atmosphere. The upper and lower valve openings are controlled by a ball 72 of some suitable magnetic material. The position of the ball 72 is controlled by a solenoid 73. When the solenoid 73 is deenergized, the low pressure or suction in the pipe 42 draws the ball 72 upwardly against the seat of the upper valve. This closes communication between the low pressure tank 39 and the bellows chamber 69 and opens communication between the bellows chamber and the external atmosphere. When the solenoid circuit 73 is energized, it attracts the ball 72 and draws it down to close the lower valve opening. In this position of the ball, the bellows chamber is closed to the external atmosphere and is exposed to the low pressure of the supply tank 39. The movable bellows board 67 is connected to the hold bar 13 through the lever 74 projecting from said bar. Through this lever 74 the movement of the bellows board 67 produces a corresponding rotary movement of the bar 13. When the upper opening of the bellows valve is closed, as seen in Fig. 4, and the bellows chamber is exposed to atmospheric pressure, the hold bar 13 is free to restore to its normal position under the control of any suitable spring, such as the coil spring 75.

The operation of the switch will now be described. Assume for this purpose that it is desired to establish a connection between the circuit appearing in the vertical row of contact strips 12 at the extreme left of the switch in Fig. 1, and a circuit appearing in the uppermost horizontal row of contacts in the switch. To effect closure of the contacts joining these circuits, it will be necessary to rotate the select bar 14 downwardly so that the select bar finger 76 is opposite the operating spring 77 individual to the desired set of contacts. It will then be necessary to rotate the corresponding hold bar 13 to effect the closure of the selected set of contacts and to hold them in the closed position to permit the subsequent release of the select bar 14. Assume also that before the connection is to be established all of the pneumatic operating devices are in their normal positions and that the solenoids controlling the valves of these devices are deenergized. The select bar 14 to be used in the establishment of the desired connection is controlled by pneumatic device 20, the one shown at the extreme left of Fig. 1 and shown in perspective in Fig. 2. Since both solenoids 60 and 63 of the unit 20 are deenergized, the corresponding valves are in the positions shown in Figs. 6 and 7, and both upper and lower bellows chambers 46 and 47 are closed to the external atmosphere and exposed to the low-pressure system. Accordingly, the pressure with-

in both chambers is the same and is below that of the external atmosphere. Under these conditions the joined bellows boards 42 and 49 take up their neutral position, namely, the position in which the areas of the two bellows chambers exposed to the external atmospheric pressure are substantially equal. As the bellows boards 48 and 49 thus assume automatically their neutral or central position, the select bar 14, and the other select bars linked to the rod 25, take up their neutral positions. Thus, it is unnecessary to provide restoring springs for restoring the select bars 14 to their normal positions. Similarly, the solenoid 73 of the hold bar unit is deenergized, the bellows chamber 69 is closed to the low pressure system and exposed to the external atmosphere, and the hold bar 13 is maintained in its normal position by the retractile spring 75.

To bring about the desired selection, a circuit is first closed for energizing the solenoid 63. Solenoid 63 moves the valves 61 and 62 to their alternate positions. Valve 61 closes communication between the low pressure system and the lower bellows chamber 47, and valve 62 opens communication between the external atmosphere and said lower bellows chamber. Since the pressure within the lower chamber 47 is now at that of the normal atmosphere and the pressure within the upper chamber 46 is below that of the normal atmosphere, the bellows boards 48 and 49 are moved downwardly, causing the select bar 14 to rotate the select finger 76 downwardly and opposite the contact operating spring 77. Next a circuit is closed for energizing the solenoid 73 individual to the associated hold bar 13. The solenoid 73 attracts the ball 72 against the lower seat, thus closing communication between the bellows chamber 69 and the surrounding atmosphere and placing the bellows chamber in communication with the low-pressure system. The establishment of the low pressure within the bellows chamber causes the bellows board 67 to move toward the stationary board 68 and to thereby rotate the hold bar 13 against the tension of the retractile spring 75. The bar 13 advances the positioned finger 76 against the spring 77, which in turn causes the closure of the corresponding set of contacts. For a more detailed description and illustration of the contact operating mechanism, reference is made to my copending application Serial No. 96,573, filed Aug. 18, 1936, issued as Patent 2,120,403, dated June 14, 1938. Following the closure of the selected set of contacts, the solenoid 63 is deenergized, permitting the valves 61 and 62 to restore to their normal positions, as seen in Fig. 7. This causes the restoration of the normal sub-atmospheric pressure in the bellows chamber 47, and the bellows boards 48 and 49, together with the select bars 14, restore to their normal neutral positions. The connection through the operated set of contacts is maintained by the continued operation of the hold bar 13 under the control of the associated pneumatic device. When it is finally desired to release the operated set of contacts, the solenoid 73 is deenergized, permitting the restoration of normal atmospheric pressure within the bellows chamber 69 and the return of the hold bar 13 to its normal position by the action of the retractile spring 75. The spring 75 in restoring the bar 13 to its normal position also moves the bellows board 67 and opens the bellows chamber 69, ready for the next operation.

Should it be desired to operate the other set

of contacts located at the point of intersection of the select bar 14 and the same hold bar 13, this may be accomplished by causing the select bar 14 to rotate in the opposite direction. To do this the solenoid 60 is energized to shift the valves 67 and 68 to their alternate positions. The valve 68 connects the upper chamber 46 with the external atmosphere and the valve 67 closes the connection between the low-pressure system and the upper chamber 46. Since the lower chamber is at reduced pressure and the upper chamber is at atmospheric pressure, the bellows boards 48 and 49 are moved upwardly and, through the connecting linkage, cause the select bar 14 to rotate and lift the lower select finger 76 to the set position opposite the contact operating spring 79 associated with the desired set of contacts. In the manner already described, the hold bar 13 is next rotated to cause the closure of the selected set of contacts. Thereafter the solenoid 60 is deenergized, permitting the bellows boards 48 and 49 to restore the select bar 14 and all other connected select bars to their neutral normal position. The operated set of contacts may be released at any time by deenergizing the solenoid of the pneumatic mechanism individual to the hold bar 13.

What is claimed is:

1. The combination in a switch of a plurality of contact sets, a pneumatic reservoir, a stationary member, two movable members forming with said stationary member two opposed bellows chambers, a bar connected to said movable members and operable in response to the movement thereof, pneumatic tubes interconnecting said reservoir and said bellows chambers, means effective normally for maintaining a balanced pressure relation between said chambers to hold said bar in its normal position, means for unbalancing the pressure relation between said chambers to cause the movement of said movable members and said bar, and means controlled by said bar for causing the selective operation of said contact sets.
2. The combination in a switch of a plurality of contact sets, a pneumatic reservoir, a stationary bellows board, two movable bellows boards forming with said stationary board two opposed bellows chambers, a switch bar, a mechanical linkage joining said bar and both of said movable boards for transmitting the movement of said boards to said bar, conduits interconnecting said reservoir and said bellows chambers for maintaining the pressure in both of said chambers substantially equal to the pressure within said reservoir, valve mechanism for closing the passage between said reservoir and either one of said chambers to produce a pressure difference between the two chambers and a corresponding movement of the movable boards and said switch bar, and means controlled by the movement of said bar for selectively operating one of said sets of contacts.
3. The combination in a switch of a plurality of contact sets, a pneumatic reservoir, means for maintaining a pressure in said reservoir below that of the normal atmosphere, two movable bellows boards, a stationary board interposed between said movable boards and forming therewith two bellows chambers, a link interconnecting said movable boards for causing both boards to move in either of two directions in response to the movement of either board under the control of its bellows chamber, a switch bar, mechanical means interconnecting said movable boards and

said switch bar, pneumatic conduits connected to said reservoir for maintaining the pressure within both of said chambers substantially the same as that of the reservoir, valves controlling said conduits selectively operable to disconnect either chamber from said reservoir and for exposing the disconnected chamber to atmospheric pressure to cause both bellows boards and said switch bar to move in the corresponding direction, and means controlled by the operated switch bar and depending upon the direction of its operation for selectively operating one of said sets of contacts.

4. The combination in a switch of a plurality of separately operable contact sets, a unitary bellows structure comprising two movable bellows boards and a stationary board interposed between said movable boards and forming therewith upper and lower bellows chambers, a rigid member interconnecting said movable boards to impart to either one any movement of the other, a contact controlling switch bar, mechanical means interlinking said movable boards and said switch bar for moving said bar from its normal position in either of two directions depending upon the direction of movement of said bellows boards, a

pneumatic reservoir, conduits interconnecting said reservoir and said bellows chambers for maintaining a uniform pressure within both upper and lower chambers to hold said movable bellows boards and said switch bar in a neutral position and to restore said movable boards and switch bar from either operated position to the neutral position, valves for both of said chambers, means for selectively operating said valves to unbalance the pressure condition in said chambers causing the movement of both bellows boards and said switch bar in the corresponding direction from the neutral position, and selective means controlled by said switch bar in either of its operated positions for causing the operation of a corresponding set of switch contacts.

5. The combination in a switch having a plurality of sets of contacts, a bar having a normal position and movable therefrom in either of two directions to either of two corresponding set positions, a pneumatic device for operating said bar to either of its set positions and for restoring it to its normal position, and means controlled by said bar for causing the operation of said contact sets.

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