Aug. 28, 1951

L. S. WILLIAMS

KEYBOARD FOR ELECTRICALLY ACTUATED POSITIONING DEVICES

2,566,278

Filed Nov. 10, 1947

3 Sheets-Sheet 1

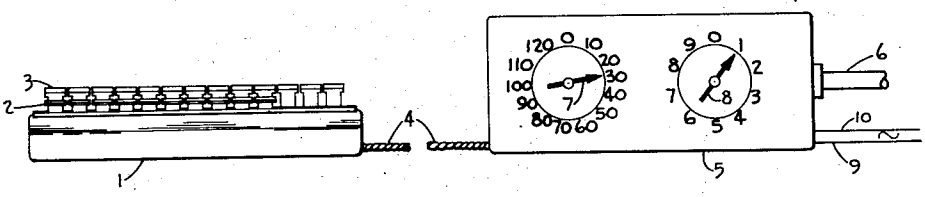


Fig. I

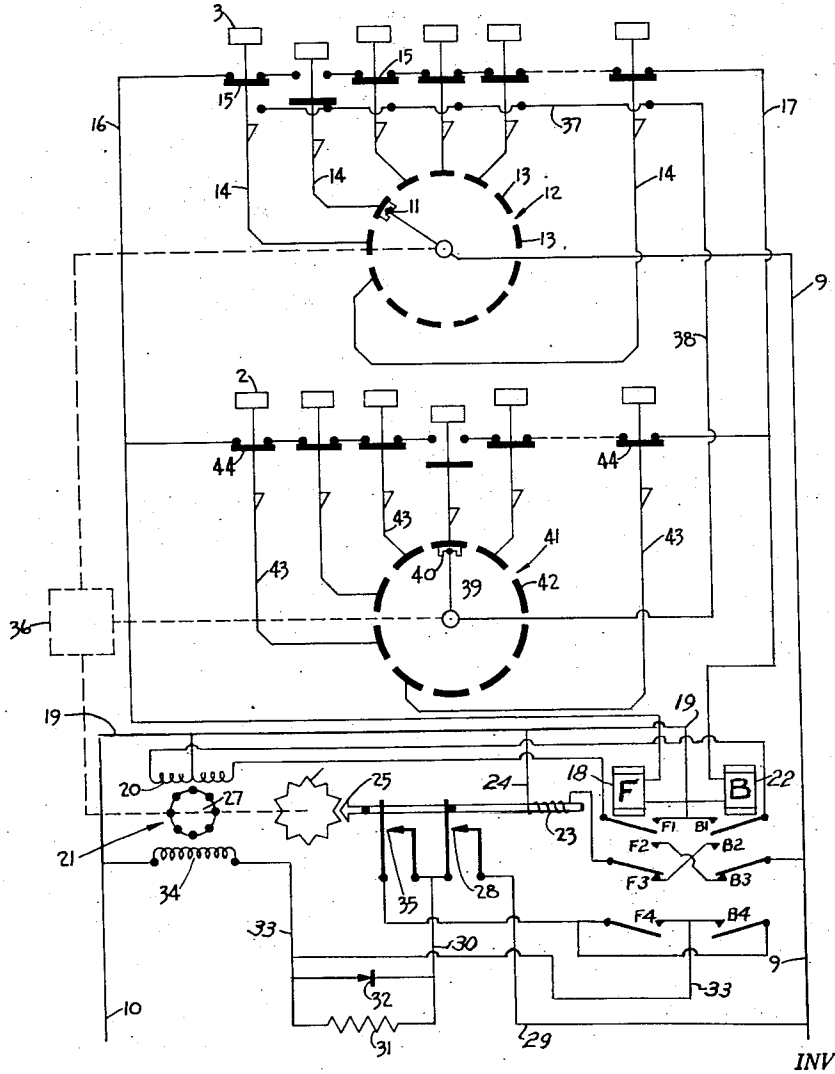


Fig. II

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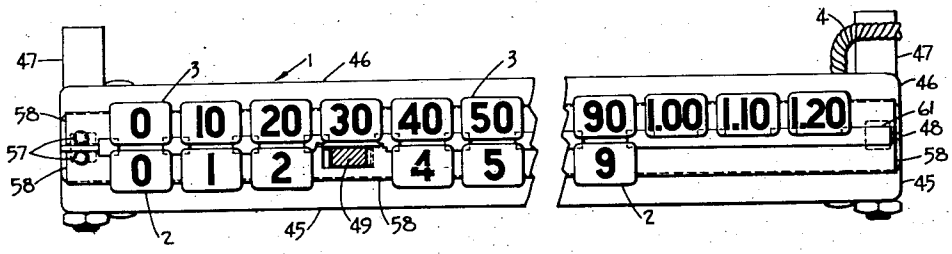


Fig. III

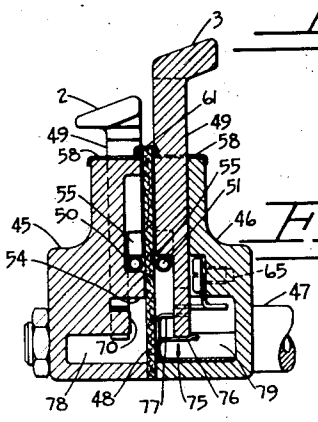


Fig. V

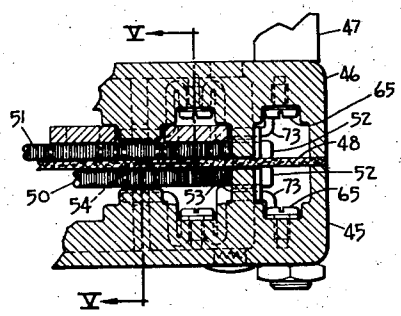


Fig. IV

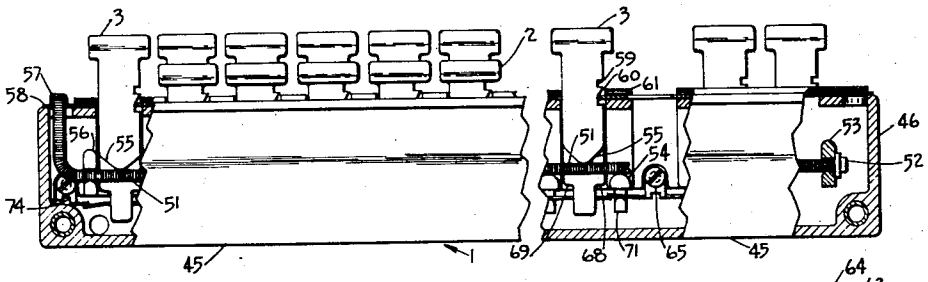


Fig. VI

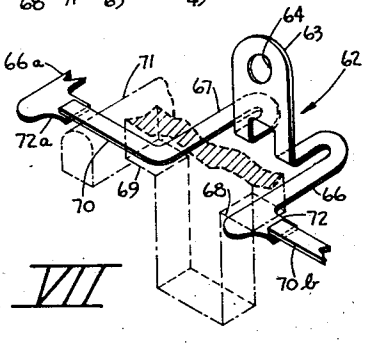


Fig. VII

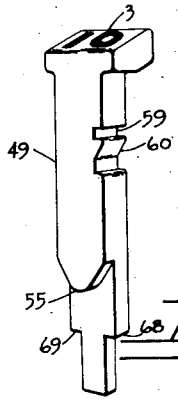


Fig. VIII

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KEYBOARD FOR ELECTRICALLY ACTUATED POSITIONING DEVICES

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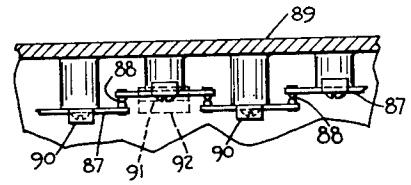


Fig. X

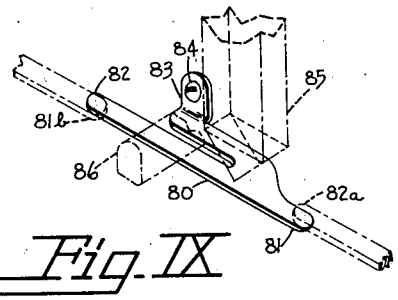


Fig. IX

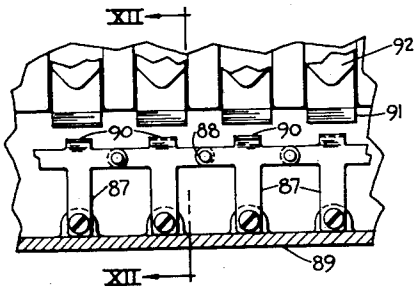


Fig. XI

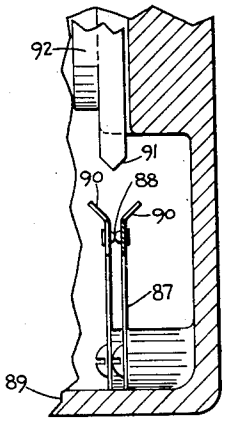


Fig. XII

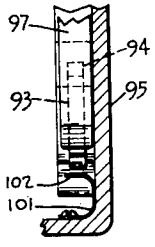


Fig. XIV

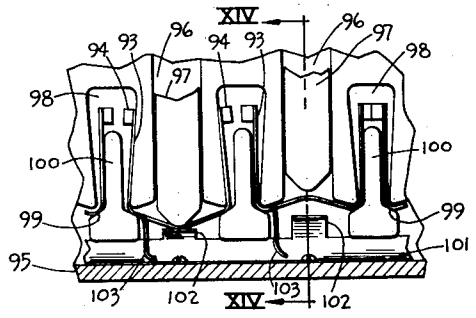


Fig. XIII

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UNITED STATES PATENT OFFICE

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KEYBOARD FOR ELECTRICALLY ACTUATED POSITIONING DEVICES

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Application November 10, 1947, Serial No. 785,140

8 Claims. (Cl. 318—33)

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This invention relates to an electrically operated positioning apparatus and in particular to a keyboard and contact arrangement for use in such a positioning device.

If a keyboard is used to select the positions to which an electrical motor drives a remotely located device the keyboard must be arranged to open or close a great number of circuits. As a result of the great number of electrical contacts in the keyboard mechanism these mechanisms have been expensive and difficult to manufacture. The object of this invention, therefore, is to provide a keyboard mechanism consisting of a relatively small number of easily manufactured parts. Another object of the invention is to provide a novel form of contacting element in which contact between two successive elements is broken by movement of either of two operating keys.

A still further object of the invention is to provide a novel form of contacting element which through the manipulation of a single key breaks a first circuit at each of two points and in addition completes another circuit.

These and more specific objects and advantages are attained according to the invention examples of which are illustrated in the accompanying drawings.

In the drawings:

Figure I is a front elevation of a keyboard mechanism and a remote device having parts that are positioned according to the keys which are selected in the keyboard mechanism.

Figure II is a circuit diagram illustrating the circuits employed in the remote positioning device and that are controlled by the manipulation of the keys.

Figure III is a plan of the improved keyboard device.

Figure IV is a horizontal section taken through the right end of the keyboard device.

Figure V is a vertical section taken along the broken section line V—V of Figure IV.

Figure VI is a front elevation with parts broken away and parts shown in section of the improved keyboard device.

Figure VII is a perspective view of one of the improved contacting elements.

Figure VIII is a perspective view of one of the keys of the improved keyboard device.

Figure IX is a perspective view of a modified form of contacting device suitable for use in the improved keyboard.

Figure X is a fragmentary plan of still another form of contact element suitable for use in the improved keyboard.

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Figure XI is a fragmentary front elevation of the contact elements shown in Figure X.

Figure XII is a fragmentary vertical section taken along the line XII—XII of Figure XI.

Figure XIII is a fragmentary elevation showing still another form of contacting elements.

Figure XIV is a fragmentary vertical section taken substantially along the line XIV—XIV of Figure XIII.

These specific figures and the accompanying description are intended merely to illustrate the invention but not to impose limitations upon the claims.

The invention consists in a keyboard the contacts of which provide, in each decade, a continuous circuit from one end of the decade to the other which circuit, when a key is depressed, is broken at each side of the key. The improved contacts are further adapted to complete a circuit to another element if such is required for the operation of the positioning circuit.

The improved contacts are constructed so that each contact element contacts each of its neighbors as well as being permanently connected to another lead. When a key is depressed the contact element is actuated so that it is isolated from each of its neighbors. This permits an extremely small number of elements to control a relatively large number of circuits.

Referring to the accompanying drawings Figure I shows a front elevation of a keyboard mechanism 1 having a plurality of units keys 2 disposed in a first bank and a plurality of tens keys 3 disposed in a second bank. The keyboard mechanism 1 may be located at any desired location and is connected through an electrical cable 4 to a remote positioning device 5 that contains mechanism to drive an output shaft 6 and position-indicating hands 7 and 8. The positioning mechanism 5 is supplied with electrical power through leads 9 and 10.

Figure II is a schematic circuit diagram of the circuits contained within the keyboard mechanism 1 and the remote positioning device 5. For convenience in illustrating the circuit the location of the elements as being in the keyboard mechanism 1 or in the remote positioning device 5 is disregarded. The circuits contained in the keyboard mechanism 1 and the positioning device 5 consist of a selecting portion and a motor control portion. The selecting portion of the circuit consists of contacts that are operated by the units keys 2 and 3 and the tens keys of com-

mutators contained within the positioning device 5 that in combination with the keys select the desired position for the positioning device. In the selecting circuit current that enters along the lead 9 goes to a wiper 11 of a commutator 12 having a plurality of stationary segments 13. From the wiper 11 the current flows through the contacting segment 13 to one of a number of leads 14 connecting the segments 13 with contact elements 15 contained within the keyboard mechanism 1 and actuated by the tens keys 3. From that one of the contact elements 15 that is then energized by current flowing through the wiper 11 the current flows through adjacent contacts to one or the other of leads 16 or 17.

If none of the tens keys 3 are depressed the leads 16 and 17 are both energized because regardless of which one of the commutator segments 13 is energized through the wiper 11 current may flow to one of the contact elements 15 and from it in each direction through the adjacent contact elements to the leads 16 and 17. If one of the tens keys 3 is depressed it breaks the circuit on each side of the key-actuated one of the contacts 15 so that only one of the leads 16 or 17 is energized. If the electrically energized element 15 corresponds to a key that is less in value than the depressed key, current flows to the lead 16 while if the electrically energized contact element 15 corresponds to a higher valued key than the one depressed current flows to the lead 17. In the event that the energized element 15 corresponds to the depressed key neither of the leads 16 or 17 is energized.

If the position of the wiper 11 in relation to the commutator 12 is such that the lead 16 is energized current flows through a coil 18 of a relay hereinafter referred to as the forward or F relay. From the relay coil 18 current flows through a lead 19 to the return lead 10. When current flows through the relay coil 18 that relay closes its normally open contacts and opens its normally closed contacts. The normally open contacts include a set of contacts F—1 that serve to close the circuit of a wound shading coil 20 of a shaded pole motor 21. The forward relay also includes a normally open contact F—2 and a normally closed contact F—3 that are connected in series with a normally closed contact B—3 and a normally open contact B—2 of a reverse relay B having a coil 22 that is energized through the lead 17.

When the forward relay F is energized it closes its normally open contact F—2 so that a circuit is then completed from the lead 9 through the normally closed contact B—3 of the reverse relay B, through the now closed contact F—2 of the forward relay to an energizing coil or solenoid 23 and a lead 24 to the return lead 10. When the solenoid 23 is actuated it retracts a positioning latch 25 from engagement with a star wheel 26 mounted on the shaft of the armature 27 of the motor 21. When the positioning latch 25 starts to retract it closes contacts 28 so that a circuit is completed from the lead 9 through a lead 29, the now closed contacts 28, a lead 30, and a parallel combination of a resistance 31 and a half-wave rectifier 32 to a lead 33 that is connected to a field coil 34 of the motor 21. Because of the action of the half-wave rectifier 32 the current flowing through this path to the field 34 of the motor consists of a combination of alternating and direct current. This combination of current causes the motor to operate at a relatively low speed and in a direction determined by the closed shading coil 20.

As the positioning latch 25 is further retracted it finally closes a pair of contacts 35 which are in series with contacts of the relays F and B. These latter contacts include normally open contact F—4 of the forward relay and normally open contact B—4 of the reverse relay B. Since it was assumed that the forward relay was actuated the contact F—4 is now closed and the half-wave rectifier 32 is shorted out by the connection through the contacts 35 and the relay contacts. Shorting out the half-wave rectifier 32 removes the direct current component from the current flowing through the field 34 of the motor so that it now operates at full speed.

The direction of rotation of the motor 21 is selected so that the motor 21, driving through a mechanical gear train including a gear reduction box 36 drives the wiper 11 of the commutator 12 toward that one of the segments 13 which is connected to the key-actuated one of the contact elements 15. When the wiper 11 reaches the selected one of the segments 13 the lead 16 or 17 is disconnected and the relays F or B in the absence of a units bank of contacts would then be deenergized to cause the motor to stop.

The tens selecting circuit may not have positioned the driven device to a position corresponding to that selected by the units keys 2. Therefore the actuated one of the contacts 15 is arranged to contact a bus bar 37 which through a lead 38 is connected to an arm 39 and wiper 40 of a commutator 41 corresponding to the units dial and indicator 8. The gearing in the gear box 36 is such that the arm 39 and wiper 40 travel a complete revolution while the wiper 11 passes from one segment 13 to the next adjacent segment. The commutator 41 has segments 42 that are connected through leads 43 to contact elements 44 that are actuated by the units key 2. If the wiper 40 is on a segment 42 corresponding to a key less in value than the depressed key the circuit is completed from the wiper 40 through the segment and one of the lead 43 to a corresponding element 44 and through the adjacent contact elements to the lead 16 and then to the relay coil 18 which through its contacts serves to energize the motor so that it runs in the forward direction to drive the wiper 40 toward that one of the segments 42 corresponding to the selected key. If the wiper 40 is contacting one of the segments 42 that is connected to one of the contact elements 44 corresponding to a key higher in value than that depressed the circuit is completed to the lead 17 and thus through the coil 22 of the reverse relay B so that the motor reverses and, again, drives the wiper 40 toward the segment 42 corresponding to the depressed key. When the wiper 40 reaches the selected segment current no longer flows through the relay coils 18 or 22 so that they return to their normal positions thus breaking the circuit to the solenoid 23 to release the positioning latch 25. The first portion of the travel of the latch 25 opens the contacts 35 and thus places the rectifier 32 in series with the motor. The resulting direct current flowing in the motor acts as a brake to stop the motor and thus reduce the shock of the engagement of the positioning latch 25 with the star wheel 26. When the latch 25 is fully seated the contacts 28 are opened and the motor is completely deenergized.

In the event that no key is depressed in one of the banks both of the relays F and B are energized

but there is no resulting energization of the motor because while the contacts F—2 and B—2 are closed the contacts F—3 and B—3 are open.

Thus if the remote device fails to respond to the selection of keys it is a warning to the operator that he has failed to depress a key in one or the other of the banks.

The mechanical construction and the cooperation of the parts of the keyboard mechanism 1 is illustrated in Figures III to VIII inclusive. The framework o fthe keyboard mechanism 1 consists of two molded plastic pieces 45 and 46 that are identical in shape and that are clamped in back-to-back relation by hollow bolts 47 passing through holes in the lower corners of the frame pieces 45 and 46. The frame pieces 45 and 46 are separated by a thin flat sheet of material 48. The frame members 45 and 46 are provided with vertical channels which in cooperation with the separator 48 provide guides for the intermediate shank portions 49 of the units keys 2 or tens keys 3. The units keys 2 and tens keys 3 are urged toward their upper position by a pair of long tight-wound coil springs 50 and 51. Each of the springs is anchored near one end of the frame members 45 and 46 with a cap 52 engaging a molded projection 53 of the frame member. From the molded projection 53 the spring 51 passes alternately over molded projecting portions 54 of the frame members and under steps 55 of the keys. At the other end of the frame member 45 and 46 the springs 50 and 51 pass through molded projecting pieces 56 that are the counterparts of the projecting portions 53 and then the springs turn upwardly so that their ends which are covered by caps 57 extend through holes in key latching bars 58. The key latching bars 58, one for the units keys 2 and one for the tens keys 3 have holes to receive the shank portions 49 of the keys and cooperate with notches 59 and 60 to hold the selected key in depressed position and to release a previously selected key when another key in the same decade is pressed. To resist the upward force exerted by the springs 50 or 51 the latching bars 58 are engaged under a T-shaped bead 61 extending along the upper edge of the flat separating member 48 in the regions between the keys. Furthermore, the edges of the latching bars 58 are turned down to overhang the sides of the frame members 45 and 46 to both stiffen and guide the latching bars. The cooperation between the series of springs support 54 and the steps 55 of the keys is such that as long as the keys are in their upper position the springs 50 and 51 are straight while if a key is depressed the cooperating spring is both bent and stretched in the region between the adjacent supports 54.

Referring now to Figure VII in particular, each of the contact elements 15 or 44 of Figure II consists of a formed spring metal stamping 62 which, in the flat, is shaped substantially like a lower case written "*w*" and which is formed by bending the center section 63 of the "*w*" up and out of the plane of the remainder of the stamping 62. The center section 63 is punched to provide a mounting hole 64 through which mounting screws 65 (Figures V and VI) are passed to secure the stamping in the frame members 45 or 46. The normally vertical side lines of the written "*w*" appear as legs 66 and 67 of the stamping 62 extending horizontally when the stamping is mounted in the molded frame member. The stampings 62 are located in the frame members with the free ends of the legs 66 and 67 positioned beneath shoulders 68 and 69 of the units keys 2 or the tens keys 3. A laterally directed extension 70 of the stamping 62 extending from the end of the leg 67 extends over a molded projection 71 of the frame member 45 or 46 and engages a laterally directed tip 72*a* of the leg 66*a* of a laterally adjacent stamping. Similarly a contact 72 of the leg 66 of the stamping 62 rests under and supports an extension 70*b* of the other laterally adjacent stamping.

In this arrangement when a key is depressed the shoulders 68 and 69 engage the legs 66 and 67 of the *w*-shaped stamping 62 and force these legs downwardly. This downward motion depresses the contact element 72 to break contact with the adjacent contact 70*b* thereby breaking the circuit at that point. The depression of the end of the leg 67 forces the extension 70 downwardly into contact with the molded projecting support 71 so that the end of the extension 70 is tipped upwardly away from contact with the section 72*a* of the adjacent stamping thereby breaking the circuit at the second point.

In these figures the electrical wiring to the contact elements is not shown but it is to be understood that the wiring will include a connection to each of the up-turned center sections 63 of the stampings 62. Such connection may be made by means of a soldering terminal that is held under the screws 65. Furthermore, suitable connections in the form of modified stampings 73 and 74 (Figures IV and VI) are included in the arrangement to complete the circuit from the engaged contacts to the leads 16 and 17 as shown in Figure II.

Referring to Figure V, a bus bar 75 having a spring portion 76 engaging the lower surface of the molded projecting supports 71 also has spring tabs 77 that extend upwardly into position to contact the ends of the legs 66 or 67 of the stamping 62 when the associated key is depressed. The bus bar 75 which is used only in connection with a tens decade or, in the event that more than two decades are used, with all of the decades except the units serves to connect the key-actuated contact stamping 62 to the lead 38 and thus serves as the common connection 37 shown in Figure II.

As mentioned previously the electrical wiring is not shown in these figures it being understood that such wiring will be used and will be located in longitudinally extending channels 78 and 79 of the frame members 45 and 46.

Other forms of contacting elements may be arranged to operate in substantially the same manner as the contacts shown in Figures III to VIII. For example, referring to Figure IX the stamping may be in the form of a long narrow U-shaped piece 80 having a contact element 81 at the bottom of a U-shaped portion, another contact element 82 at the end of one of the legs of the U-shaped section, and a turned-up lip 83 at the end of the remaining leg of the U-shaped section. The turned-up lip 83 provides space for a mounting screw 84 for securing the contact element in place. When the associated key such as a key 85 is not depressed the contact element 81 rests against the lower side of a contact element 82*a* of a next adjacent assembly. Likewise the contact 82 at the end of the leg of the U-shaped section rests on a contact 81*b* of the next adjacent contact assembly. When the key 85 is pressed it engages the legs of the U-shaped section 80 somewhere near their junction point and in so doing forces the contact element 81 away from its cooperating element 82*a*. At the same time the key 85 presses the longer leg of the U-shaped section down against a fixed support 86 so that the

end of the leg carrying the contact 82 is tipped upwardly to break contact with the contact element 81b. The contact assembly 80 thus provides substantially the same operation as that provided by the stamping 62 as shown in Figure VII.

Another form of contact element suitable for use in the circuit shown in Figure II is illustrated in Figures X, XI and XII. Referring first to Figure XI each of the contact elements consists of a cross-shaped stamping 87 having contact points 88 at the ends of its horizontal arms and having a hole at the lower end of its vertical arm by which it may be mounted in a framework 89. The upper end 90 of the vertical arm is bent out of the plane of the remainder of the stamping so that it serves as a cam surface to cooperate with a lower wedge-shaped tip 91 of a key 92.

As seen in Figures X and XII the stampings 87 are assembled in offset relation with alternating ones placed forward of the plane containing the others and with the center line of the keys located mid-way between the planes containing the contact stampings 87. When one of the keys 92 is depressed its lower wedge-shaped tip 91 engages the bent cam surface 90 of the associated contact stamping 87 and bends that stamping away from its neighbors so as to break the circuit at each of two points. If it is necessary to make a third circuit a common bus bar may be run along behind the contact stampings 87 in a position such that the keys 92 force the stampings into contact with the bus bar.

Still another example of contact elements suitable for use in the improved circuit and keyboard mechanism is illustrated in Figures XIII and XIV. In this arrangement a plurality of U-shaped springs 93 carry contact elements 94 on their ends. The U-shaped springs 93 are formed from flat stock having the contact elements 94 assembled on their ends and are then bent to the desired configuration. These U-shaped contact springs 93 are mounted in a molded plastic framework 95 that has a plurality of channels 96 for receiving and guiding keys 97. Between the channels 96 there are generally wedge-shaped cavities 98 that are narrow at their bottom ends and relatively wide at their tops as seen in front elevation. Also molded into the framework 95 are shelf-like supports 99 that serve to engage and support the corners of the U-shaped springs 93. A divider 100 extends upwardly from between the shelves 99 and into the cavity 98. The U-shaped springs 93 are supported on the shelf-like portions 99 with one end including its contact 94 in one of cavities 98 and its other end in an adjacent cavity. The springs 93 thus extend across the channels 96 so that the keys 97 when pressed may engage the springs to force them downwardly in the space between the shelves 99.

As long as a key is not depressed the contact elements 94 of each of the springs 93 contacts its neighbors and the springs are merely guided in the recesses. When one of the keys is depressed and it engages the center of the spring 93, it bends that center downwardly so that the upwardly extending legs of the spring 93 are bent back until they lie along the edges of the recesses 98 with the contact elements 94 separated from the adjacent contacts. The separator 100 extending up into each of the recesses prevents the adjacent one of the springs 93 with their contact elements 94 from following the engaged spring as it is deflected by the cooperating key. While Figure XIV shows the springs 93 to be relatively narrow they may be made equal in width to the depth of the cavity so that they will be more adequately guided against undesired deflection.

A bus bar 101 is located in the bottom of the framework 95 and has upwardly directed spring tabs 102 located to engage the contact springs 93 when they are depressed by the keys 97.

Since the springs 93 are not clamped or otherwise rigidly attached to the framework 95 the wiring connections may preferably be soldered to the springs as is indicated by the fragmentary leads 103 shown soldered to the springs adjacent the shelves 99.

The various examples of spring contact elements illustrated in the drawings cooperate with latchable keys to control the connections in a plurality of circuits. In each example each of the contact elements is arranged to break a circuit at two points when the cooperating key is depressed and in some of the examples a contact element further completes another circuit to a common bus bar so that not only are two circuits broken but a third circuit is completed. This cooperation or multiple function of each of the contact elements provides a relatively simple keyboard mechanism for electrically controlling the position of a remote device. Each of the contact elements is very simple to construct and the framework in which it is mounted may be made as a simple plastic molding so that the manufacture of the improved keyboard is relatively simple.

Various arrangements and circuits may be constructed using the principles of multiple contacts disclosed in the examples without departing from the spirit and scope of the invention.

Having described the invention, I claim:

1. In a remote positioning device, in combination, a reversible electric motor for driving mechanism to be positioned, a plurality of switching commutators driven at related speeds by said motor and each having segments cooperating with a slider, a key mechanism located at a control station, a plurality of key actuated conductors mounted in the key mechanism with each conductor electrically connected to a commutator segment, said conductors being arranged in banks with one bank for each commutator, said conductors of each bank being arranged to each contact each of its neighbors except for end conductors of each bank that contact leads connected to control the motor, said conductors each breaking contact with each of its neighbors when actuated by a key, and a bus bar adjacent a bank of conductors corresponding to one commutator for connecting the then actuated conductor to the slider of the next faster moving commutator, whereby a circuit is completed from the slider of one of said commutators through the conductors connected thereto until the motor drives the slider to that segment connected to the then actuated conductor, and thereafter through the bus bar to the slider of the next commutator and conductors connected thereto.

2. In an electrical switching mechanism for a positioning device, in combination, a frame, a plurality of electrical conductors mounted in the frame with each conductor connected to an independent circuit, each conductor being arranged to contact the upper surface of the first of its neighbors and to contact the lower surface of the other of its neighbors, a fixed support for the conductor adjacent the first of its neighbors, and a plurality of manually operable keys, each key when operated serving to deform the cooperating conductor to depress the portion of the conductor contacting such other of its neighbors to break

that contact and in cooperation with the fixed support serving to raise the portion of the conductor contacting the first of its neighbors away from such neighbor.

3. In an electrical switching mechanism for a positioning device, in combination, a frame, a plurality of electrical conductors mounted in the frame and serving as the terminals for a plurality of circuits, each of the conductors having one portion rigidly attached to the frame and another portion supported by the frame, each of the conductors having at least an upper and a lower contacting surface for contacting corresponding portions of the neighboring conductors to form a continuous circuit, and a plurality of keys mounted in the frame and cooperating with the conductors, each key being adapted to engage the cooperating conductor near the supported portion to depress one end and elevate the other end of the conductor, whereby the engaged conductor is electrically isolated from its neighbors.

4. In an electrical switching mechanism for a positioning device, in combination, a molded frame having a plurality of guideways, a plurality of keys slidably mounted in the guideways, a tension spring extending longitudinally of the frame, supports molded into the frame intermediate the guideways for supporting the spring, a downwardly directed step on each key for engaging the spring, a latch bar extending longitudinally of the frame arranged to engage notches in each of the keys to hold a depressed key and release a previously depressed key, said spring having a laterally deflected end engaging the latch bar to urge it into engagement with the notches in the keys.

5. In an electrical switching mechanism for a positioning device, in combination, a frame, a plurality of conductors each connected to an independent circuit, each conductor having two contact points one contacting each of its neighbors to connect the conductor in series circuit, and a key for each conductor for actuating the conductor to move each of its contact points out of contact with the contact points of the neighboring conductors.

6. In an electrical switching mechanism for a positioning device, in combination, a molded frame having a plurality of pockets and guideways, a key in each guideway, a latch for holding a selected key depressed, a generally U-shaped spring spanning the space at the end of each guideway with its ends entering the adjacent pockets and with its corners supported at the pockets, and contact elements on the ends of the U-shaped spring for normally contacting adjacent contact elements, each of said springs being deflected upon depressing a key, such deflection serving to break the electrical connection to each of its neighbors and to urge the depressed key toward its non-depressed position.

7. In an electrical switching mechanism for a positioning device, in combination, a frame, a lead for each position to be selected, a manually operable key mounted in the frame for each position to be selected, a switch conductor for each position, said conductors being mounted in the frame for cooperation with the keys, each conductor being connected to one of the leads, and a pair of contact points on each conductor, each contact point being in electrical contact with a corresponding contact of a neighboring conductor whereby the conductors are connected in series circuit relation, each of the contact points on a conductor being movable upon actuation of the corresponding key whereby contact between the conductor and each of its neighbors is broken upon actuation of the corresponding key.

8. In a remote positioning device, in combination, a reversible electric motor for driving mechanism to be positioned, at least a first and a second switching commutator each having segments, wipers for the commutators, said wipers being driven by said motor with the second wiper turning faster than the first, a remotely located selecting mechanism, a plurality of switching conductors mounted in the selecting mechanism, said conductors being arranged in a plurality of banks one for each switching commutator, said conductors each having a pair of contact points that contact similar points of adjacent conductors of the bank whereby the conductors of each bank are connected in series, a key for each conductor which upon operation separates the conductor from contact with each of the adjacent conductors, a lead from each conductor to a corresponding switching commutator segment, a forward control circuit for the motor, a reverse control circuit, a connection from one end of each bank of conductors to the forward control circuit, a connection from the other end of each bank of conductors to the reverse control circuit, a connection from a source of electrical power to the first one of the wipers, a bus bar adjacent the bank of conductors associated with the first commutator which bar is contacted by the operated one of the conductors of that bank, a connection from the bus bar to the second wiper, and a connection from the control circuits to the return side of the power line, whereby the control circuits are selectively energized through the first wiper and associated bank of conductors until the first wiper is driven to the commutator segment connected to the operated conductor and thereafter through the bus bar, second wiper, commutator segments and associated bank of conductors until the second wiper reaches the segment corresponding to the selected conductor.

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