

Dec. 10, 1957

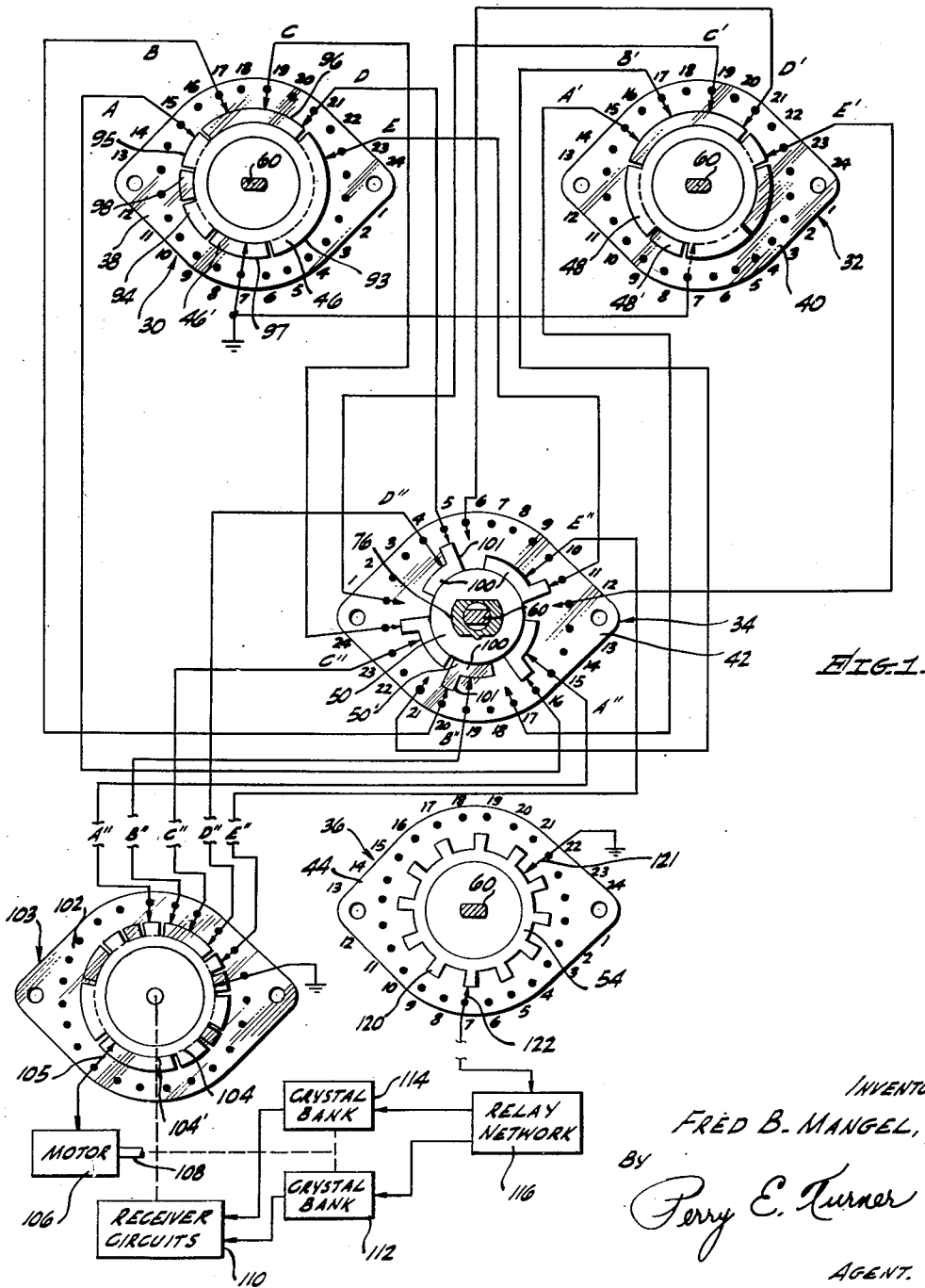
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2,816,183

ROTARY SELECTOR SWITCH

Filed Dec. 12, 1955

2 Sheets-Sheet 1



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ROTARY SELECTOR SWITCH

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2 Sheets-Sheet 2

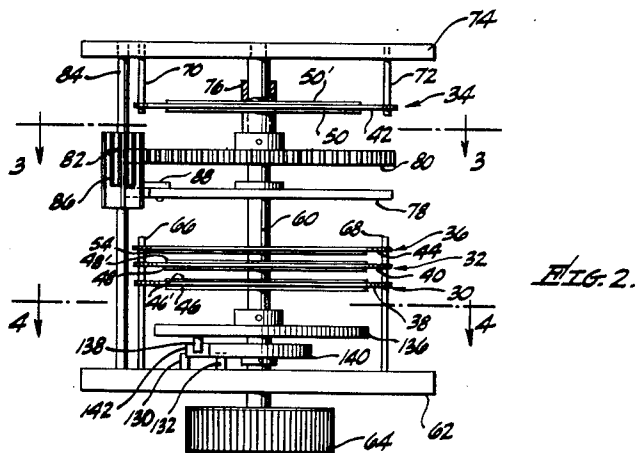


FIG. 2.

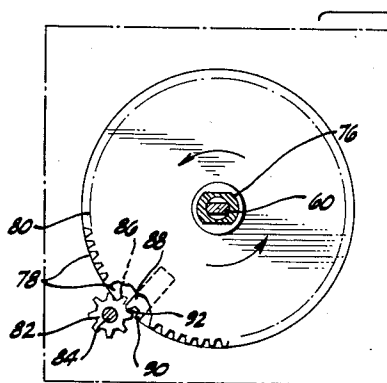


FIG. 3.

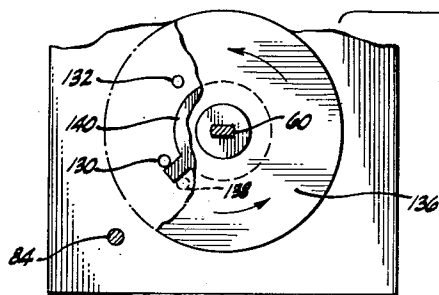
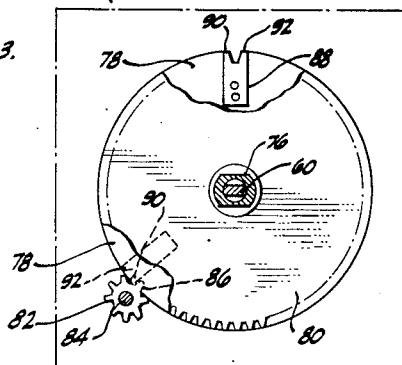
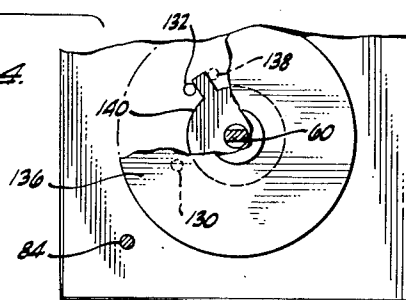


FIG. 4.



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2,816,183

ROTARY SELECTOR SWITCH

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6 Claims. (Cl. 200—14)

This invention relates to remote control switching mechanisms, and more particularly to an improved rotary selector switch of the type employing tap wafer switch plates having spaced contact points to which a rotatable contact member can be moved for controlling the operation of a device.

In many applications of rotary selector switches, the number of tap positions provided on the switch plates is determined largely by their size. Where a maximum size of switch plate is dictated by space requirements, the number of switch positions desired may require the use of a number of switch plates. In accordance with present practice, each switch plate and an associated contact member are mounted on an individual shaft to be turned by an individual control knob. Where a plurality of such individual switching arrangements must be employed, considerable difficulty is experienced in attempts to satisfy minimum space requirements. Further, the switching operations may have to be done by one who has a multitude of other problems requiring his attention, and the problem of determining the proper control knob to be turned to select a desired switch position may prove to be unduly burdensome. For example, the selector switch may be employed in an aircraft for switching a radio transmitter and/or receiver to different channels, and it often requires an undesirable amount of time for the already overburdened pilot to perform the necessary switching operations.

It is an object of this invention to provide a rotary selector switch in which switch positions on separate wafer switch plates can be selected by means of a single control knob.

It is another object of this invention to provide an improved rotary selector switch in which a greater number of switching operations can be controlled from a single control knob than has heretofore been possible.

It is another object of this invention to provide a multiple position rotary selector switch which comprises relatively few component parts of simple design and rugged construction, and which can occupy a given space and provide a greater number of switching operations with a single control knob than is possible with prior art switches of the same type.

The above and other objects and advantages of this invention will become apparent from the following description taken in conjunction with the accompanying drawings, in which a preferred embodiment of the invention is illustrated by way of example. The scope of the invention is pointed out in the appended claims.

In the drawings,

Fig. 1 is a plan view of wafer switch plates for a rotary selector switch, schematically illustrating electrical connections to provide a plurality of switch positions, in accordance with this invention,

Fig. 2 is a side elevation view of a rotary switch construction employing the wafers of Fig. 1, further in accordance with this invention, and

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Figs. 3 and 4 are plan views taken along respective lines 3—3 and 4—4 of Fig. 2, showing certain mechanical operations to aid in explaining the operation of the rotary selector switch of this invention.

Briefly, this invention comprises a pair of master wafer switch plates and a transfer switch, and electrical connections are made with each master switch plate in accordance with a binary code. The transfer switch is adapted to occupy either of two positions; in one position, circuit connections through one master switch plate are controlled through one revolution of a control shaft, while in its other position, circuit connections to the second master switch plate are controlled through another revolution of the control shaft. The position of the transfer switch is automatically controlled by the control shaft through gearing which is actuated at a predetermined position of the shaft.

Referring to Fig. 1, four wafer switch plates 30, 32, 34 and 36 are shown with electrical connections for one arrangement of a rotary switch in accordance with this invention. These switch plates are of the type employing conventional wafers 38, 40, 42 and 44 of non-conductive or insulating material. Three of the wafers 38, 40, 42 are located between respective pairs of metallic rotors or contact members 46—46', 48—48', and 50—50'; the remaining switch plate 44 employs one rotor 54 adjacent the front surface thereof. To better illustrate the respective sets of front and rear rotors 46—46', 48—48', 50—50', the associated wafers 30, 32, 34 are indicated as transparent; as a practical matter, the wafers could be made of a suitable transparent plastic. Two of the switch plates 30, 32 are master switch plates to effect electrical connections pursuant to predetermined codes, as will be made more evident hereafter.

Preparatory to explaining the electrical scheme of Fig. 1, and to aid in understanding the invention, reference will be made to Figs. 2—4 along with Fig. 1 to explain a preferred physical arrangement of the switch plates 30, 32, 34, 36. Three of the switch plates 30, 32 and 36 are spaced along a shaft 60 which projects through a housing 62 and is fixed to an external control knob 64. The wafers 38, 40, 44 are fixed to a pair of posts 66, 68 secured to the rear wall of housing 62. The rotors 46—46', 48—48', and 54 of switch plates 30, 32 and 36 are mounted on shaft 60. Wafer 42 of switch plate 34 is supported on posts 70, 72 which extend from the rear wall 74 of the instrument. Wafer 42 and rotors 50—50' also surround shaft 60, but its rotors are supported for rotation with a short sleeve or shaft 76 which constitutes a floating shaft mounted on shaft 60. The various rotors are insulated from their shafts, and for this purpose may be mounted on the periphery of non-conductive discs having central openings to receive the shafts.

For the purpose of explaining a particular embodiment of the invention, it will be assumed that the switch plates are limited in size and are of the type used for a 24-position switch. Thus, shaft 60 can be turned through a maximum of 24 positions in a revolution; for this purpose, a conventional detent mechanism (not shown) within housing 62 may be provided to permit shaft 60 to be releasably held in positions substantially 15° apart.

For the purposes of this invention, electrical connections from switch plates 30, 32 to remote apparatus are made through transfer switch plate 34, and the position of floating shaft 76, and hence the rotors of wafer 34, determines which connections are made, i. e., switch plate 34 is a transfer switching device. To accomplish this transfer, a disc 78 is fixed to shaft 60 and a conventional gear 80 is fixed to floating shaft 76. Disc 68 and gear 80 are substantially equal in diameter. A pinion 82 meshed at one end with gear 80 is mounted on a shaft 84 jour-

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nalled at its ends in the rear surface of housing 62 and the rear wall 74 of the instrument housing. At its opposite end, alternate teeth 86 of the pinion are shortened, thereby to provide a space to receive the edge of disc 78 (see Fig. 3). Thus, the edge of disc 78 is located between the longer teeth on either side of a short tooth to normally prevent turning of pinion 82.

A small projection 88 on one surface of disc 78 is notched to provide two adjacent teeth 90, 92 at the periphery thereof. At one point during rotation of disc 78, one of the teeth 90, 92 engages the short tooth 86 under which the edge of the disc is located, whereupon pinion 82 is rotated to cause an adjacent longer tooth to be meshed between the teeth 90, 92. Normal gear action then causes pinion 82 to be further rotated until projection 88 moves past the pinion. Such an arrangement to effect periodic rotation of a pinion is well-known in mechanical counter mechanisms; however, reference may be made to Fig. 3 to observe the coaction of the parts where disc 78 is rotated counter-clockwise. When pinion 82 is turned, it rotates gear 80, and hence floating shaft 76 and rotors 50, 50', from one position to another. Preferably, the rotation of the floating shaft 76 from one to the other of its two positions is effected during rotation of shaft 60 between two successive stop positions. Depending upon the position of the rotors 50, 50', connections from one master switch plate 30 or the other master switch plate 32 will be made to remote apparatus, as will be more clearly explained hereafter.

Referring again to Fig. 1, the wafers of the switch plates are shown to be of the type used with 24-position switches; each has a circle of 24 small openings, numbered as indicated, corresponding to the number of stop positions for shaft 60 during a revolution. These openings provide positions at which contact clips or taps can be supported for connection to electric circuits. In the arrangement shown in Fig. 1, taps are schematically illustrated as provided at five alternate openings (15, 17, 19, 21 and 23) of both master switch plates 30, 32, where they are connected to respective sets of five wires A, B, C, D, E and A', B', C', D' and E'; the taps here are also adapted for wiping contact with both the front and rear rotors. An additional tap is provided at a different location (7) on each wafer to connect the rear rotors 46', 48' to ground potential at all times.

In accordance with preferred practice, the rotors of each master switch plate 30, 32 are shaped to connect the wires in circuits in accordance with a reentrant binary code. In the switch of this invention, the code is not only reentrant for each of these switch plates, but it is also reentrant for both switch plates so that the code followed on one switch plate leads into that followed by the other switch plate. This reentrant feature will be made more evident hereafter in connection with the operation of the invention. Where 5-wire connections are made as above described, the respective codes for switch plates 30 and 32 may be as follows:

	1 2	3 4	5 6	7 8	9 10	11 12	13 14	15 16	17 18	19 20	21 22	23 24
A-----	X		X			X	X	X	X			
B-----		X		X			X	X	X	X		
C-----			X		X			X	X	X	X	
D-----				X		X			X	X	X	X
E-----	X				X		X			X	X	X

	1 2	3 4	5 6	7 8	9 10	11 12	13 14	15 16	17 18	19 20	21 22	23 24
A'-----		X	X		X	X			X			
B'-----			X	X		X	X			X		
C'-----				X	X		X	X			X	
D'-----					X	X		X	X	X		
E'-----	X					X	X		X	X		X

For purposes of explanation, numbers 1 through 24

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correspond to the number of positions through which shaft 60 is turned during each revolution, the X's indicate in which positions connections are made by the front rotors 46, 48, and the blank spaces represent the wires which are grounded by the rear rotors 46', 48'.

The configuration of the rotors necessary to effect contact with wires A, B, C, D, and E in accordance with the above code can readily be ascertained from a study of the code. For example, one contact segment 93 of rotor 46 can effect contact with a maximum of four contact clips at once, and two other spaced segments 94, 95 are provided which make contact with only one clip at a time. In terms of the circle of 24 openings in wafer 30, segment 93 spans eight openings and segments 94, 95 each span two openings. Also, the segments are spaced in conformity with the blank spaces indicated in the code, i. e., segments 93 and 95 are separated by six openings, segments 93 and 94 are separated by four openings, and segments 94 and 95 are separated by two openings. Further, segments 96, 97 and 98 of the rear rotor 46' occupy the spaces separating the adjacent segments of the front rotor. In this manner, each of wires A, B, C, D, E is always connected to one or the other of the front and rear rotors 46, 46'. The rotors 48 and 48' of switch plate 32 are configured in accordance with the same considerations in its code.

The wires A, B, C, D, E are connected to switch plate 34, through which they may be connected to remote apparatus. As illustrated, the front and rear rotors 50, 50' of switch plate 34 are not conductive rings; instead, these rotors provide a separate contact segment for each pair of corresponding wires A—A', B—B', C—C', D—D', E—E', each comprising an arcuate body portion 100 having a small radial portion 101. A tap connection to each wire of a pair is provided on wafer 42 for wiping contact with the radial portion 101 of the associated contact segment. An additional tap connection in wiping contact with the body portion 100 of each contact segment is connected to a corresponding lead or wire which is coupled to a remote circuit. The additional wires are designated A'', B'', C'', D'', E''. Thus, in one position of rotors 50, 50', and as illustrated in Fig. 1, the wires A, B, C, D, E are connected through radial portions 101 and body portions 100 to the corresponding wires A'', B'', C'', D'', E''. Movement of rotors 50, 50' to a position in which the radial portions 101 contact the wires A', B', C', D', E', effects connection of these wires with wires A'', B'', C'', D'', E''. Thus, switch plate 34 constitutes a transfer switch for making connections from master switch plates 30, 32 to remote apparatus.

The rotors of master switch plates 30, 32 are illustrated in the positions they occupy at the beginning of the codes, i. e., the front rotors 46, 48 respectively are connected to the associated wires A, E and E'. As previously indicated, the rotors of switch plate 34 remain in the same position throughout a revolution of the control shaft 60. At the end of this revolution, the floating shaft 76 (Figs. 1 and 2) is turned, as previously explained, to move these rotors to their second position; in this second position, the rotors 48, 48' of switch plate 32 are positioned for connection to wires A', B', C', D', E' in accordance with the beginning of the associated code.

To further the explanation of the operation of the switch of this invention for remote control purposes, reference is made to Fig. 1 wherein the wires A'', B'', C'', D'', E'' are shown coupled to respective ones of successive taps on the wafer 102 of a remote switch plate 103. The rotors 104, 104' of this wafer are shaped so that, upon being turned through 24 successive positions, the combinations of wire connections made will follow both the aforementioned codes in succession. It will be recognized that it is conventional practice to use a single remote switch plate having rotors suitably shaped to follow the sequence of electrical connections made with the remote

control switch; a study of the complete code reveals the configuration required of the rotors 104, 104'. As in the case of the front and rear rotors of the switch plates 30 and 32, the wiping contact segments of the rotors 104, 104' are complements, whereby each of the five wires is always connected to one or the other of these rotors. The rear rotor 104' is connected to ground.

A tap contact 105 to the front rotor 104 is electrically connected to a motor 106. The shaft 108 of the motor is adapted to mechanically adjust various receiver circuits 110 and crystal banks 112, 114 to effect receiver operation on different channels, all in a conventional manner. Motor shaft 108 is also adapted to turn the rotors 104, 104' of switch plate 103, as schematically illustrated. Since the switching arrangement follows a reentrant scheme, motor 106 will be operated when connections to ground are completed. For example, in the positions of the various rotors shown in Fig. 1, there is no direct current path or connection between the front and rear rotors of either switch plate 30, 36, or between the front rotor of one switch plate and the rear rotor of the other; thus, motor 106 will not operate.

Assume that the control shaft 60 is turned through two stop positions so that the wire B is connected to the front rotor 46, and wires A, C, D and E are connected to the rear rotor 46'. At this instant, wires A'', E'' are still connected to the front rotor 104, and wires B'', C'', D'' are still connected to the rear rotor 104'. Connections from the motor to ground are thereby established, and the motor will operate. Motor shaft 108 moves the adjustment controls of the receiver circuits and the crystal banks to new positions, and simultaneously moves rotors 104, 104' until the front rotor 104 contacts wire B'' and the rear rotor 104' contacts the remaining wires A'', C'', D'', E''; here an open circuit exists and the motor 106 will stop. In this manner, the motor and the adjustment to the receiver circuits are made to follow the rotation of control knob 64 and shaft 60.

A study of the codes and the above described switch arrangement reveals that only twelve different combinations of wire connections are made for each 24 positions, i. e., a combination effected in an odd position of the control shaft is maintained in the succeeding even position thereof. Therefore, the positions of the motor shaft 108 and the adjustment mechanisms for the receiver circuits and crystal banks, as established in each odd position of the control shaft, remain the same during the succeeding even positions of the control shaft.

In each of the positions to which they are adjusted, the receiver circuits are capable of receiving signals on two adjacent channels. Of course, a separate oscillator crystal is required for each of the two channels. Conventional arrangements are used wherein one of these crystals is in each crystal bank. The selector switch of this invention is adapted to place the crystal from one crystal bank into operative relation with the receiver circuits in an odd position of the control shaft, and to switch in a crystal from the other crystal bank in the succeeding even position of the control shaft. To accomplish this, use is made of a conventional relay network 116 having respective outputs connected to crystal banks 112, 114, and which in respective conditions determines which crystal bank has a crystal operatively coupled to the receiver circuits. The condition of relay 116 is controlled through switch plate 36. This switch plate employs a rotor 54 mounted on control shaft 60 and having twelve spaced wiping contact segments 120. Rotor 54 is grounded at all times by a suitable tap connection 121. A second tap 122 adapted for wiping contact with segments 120 is connected to relay network 118. In each of the odd positions of the control shaft 20, one of the contact segments 120 is in engagement with tap 122, thereby connecting relay 116 to ground. In this connection, relay 116 connects a crystal in one bank, such as crystal bank 112, in operative relation with the receiver circuits.

In the even positions of control shaft 60, rotor 54 does not contact tap 122, whereby the ground connection to the relay is broken. In this condition, relay 116 causes a crystal from the other crystal bank to be operatively coupled to the receiver circuits.

It will be obvious that switch plate 36 constitutes an "on-off" switching device for selecting crystals from each of the crystal banks for operation of the receiver. Since it will permit selection of twenty-four crystals during each revolution of control shaft 60, it will be apparent that a total of forty-eight channel selections can be made in two successive revolutions of the control shaft. Half the channels are selected while switch plate 30 is conductively coupled to switch plate 103, and the other half are selected while switch plate 32 is conductively coupled to switch plate 103.

It may be desirable to utilize more channels than can be selected in one revolution of the control shaft, but less than the total number of positions in two revolutions. Whatever the number, suitable limit stop means must be provided to prevent rotation of the control shaft through more than the total required positions.

Figs. 2 and 4 illustrate means to limit the rotation of control shaft 60 to less than two revolutions in either direction. Two spaced stops 130, 132 of substantially equal length are secured to the rear wall of housing 62 at equal distances from the center of shaft 60. A disc 136 is fixed to shaft 60 and carries a lug projection 138 at substantially the same distance from the axis of shaft 60 as stops 130, 132. Lug 138 can pass over the stops without touching them. A floating disc 140 is mounted on shaft 60 between disc 136 and housing 62, and a radial finger 142 on disc 136 extends to the circumferential line on which stops 130, 132 are located. Finger 142 is of sufficient size to extend across the space separating lug 138 and the stops 130, 132.

With stop means as above provided, it will be observed in Fig. 4 that shaft 60 can be turned in one direction, e.g., clockwise, until finger 142 is pressed against stop 130 by lug 138, and in the other direction (counter-clockwise) until lug 138 presses finger 142 against stop 132. Further, shaft 60 will turn through one complete revolution and part of a succeeding revolution in rotating from one extreme position to the other. Shaft limit-stop arrangements of this type are well known; for example, such arrangements are treated in "Instrumentation Breadboard Parts," Catalog RICO-10 (Reeves Instrument Corp., New York, N. Y., 1951).

Preferably for the switch of this invention, rotation of shaft 60 through the first complete revolution from one extreme position, such as the position shown in Fig. 3, causes wire connections made by the rotors 46, 46' to follow the associated code. At the end of this revolution, the rotors of the transfer switch are moved as previously explained, and the sequence of wire connections made by the rotors 48, 48' of switch plate 32 follow the associated code to stop position.

Obviously, if the control shaft is to be allowed to rotate through two complete revolutions, only one stop 130 need be used.

Disc 136 may be replaced by a gear which can be adapted in a conventional manner to drive the input shaft of a mechanical counter in synchronism with the control shaft 60. In this manner, the counter can be arranged to present to an observer a direct reading of channel selections corresponding to the various positions of the control shaft.

It will be obvious that switching means to control the operation of the relay need not be operable by the control shaft 60. Any "on-off" switch suitable for this purpose may be employed and, in fact, may be separate from the rotary selector switch and manually operable.

Motor 106 represents merely one device to be driven when the necessary connections are made. Other suitable means, such as stepping solenoids of well-known design,

may be employed. It will further be apparent that the receiver circuits and crystal banks are merely illustrative of remote means to be controlled; other known uses for remote control switches will suggest themselves for the improved switch of this invention.

Although one particular embodiment of a rotary selector switch has been described, it will be apparent that various modifications can be made without departing from the scope of this invention. For example, it will be apparent that different codes can be devised for the master switch plates, and the rotors of such switch plates shaped according to the particular codes. This will be understood when one considers that with a 5-wire arrangement as above described, a maximum of thirty-one (2^5-1) different combinations of electrical connections can be made. Where less than this maximum number are used, code variations are made possible.

It will also be apparent that additional coded master switch plates can be employed, thereby to extend the number of switching operations controlled by the single control shaft. In the 24-position mechanism above described, for example, a third master switch plate may be mounted in the manner of switch plates 30, 32, and additional stop means provided to permit rotation of the control shaft through three revolutions. At the end of the second revolution, the rotors of the transfer switch plate 34 would be automatically moved to a third position. Wire connections from the additional master switch plate to the transfer switch plate could be made in the manner of those described so as to be conductively coupled to remote apparatus in the third position of the rotors of the transfer switch plate. Further, if desired, separate transfer switch plates could be used in conjunction with the master switch plates, thereby to permit synchronous control of different types of remote apparatus.

From the foregoing, it will also be apparent that to properly utilize three switch plates of the type having 24-position tap wafers, at least a 6-wire arrangement would be employed; this would provide enough different combinations (2^6-1 , or 63) to exceed the total combinations which could be made with two of the switch plates. In such a case, three codes would be established, each of which would lead into one another.

This invention obviously embraces switches using other than 24-position tap devices, as well as different combinations of wire connections to be made for controlling remote apparatus. What is essential, however, is that electrical connections from different sets of connections be completed to remote apparatus through a transfer contact device at selected positions of a single control shaft.

What is claimed is:

1. A rotary switching device comprising a control shaft, a floating shaft supported on said control shaft, first, second and third tap wafers of non-conductive material spaced along said control shaft, said third tap wafer having first, second and third sets of tap connections, each of the tap connections of said first set being directly connected to a respective tap connection on said first wafer, each of the tap connections of said second set being directly connected to a respective tap connection on said second wafer, the tap connections of said third set being adapted for connection to a remote mechanism, respective first and second tap contact rotor means for said first and second wafers fixed to said control shaft and rotatable therewith to effect wiping contact with the associated tap connections, third tap contact rotor means for said third wafer fixed to said floating shaft, said floating shaft having a first position in which said third rotor means is in

wiping contact with said first and third sets of tap connections and a second position in which said third rotor means is in wiping contact with said second and third sets of tap connections, and means mechanically coupled to said floating shaft and operable in one predetermined position of said control shaft to rotate said floating shaft from one to the other of its two positions.

2. The switching device of claim 1, wherein said first and second rotor means are shaped to effect wiping contact with different combinations of the associated tap connections in predetermined sequence during rotation of said control shaft in one direction.

3. A rotary selector switch comprising a control shaft, a plurality of master switch plates, each of said master switch plates including a tap wafer, said wafers being located between respective pairs of flat tap contact rotor elements, said rotor elements being fixed to said control shaft, one of the rotor elements of each pair being connected to a point of reference potential, a plurality of taps on each of said wafers, each rotor element being shaped to effect wiping contact with different predetermined combinations of the taps on the associated wafer during rotation of the control shaft, a transfer switch plate including at least one tap wafer having a plurality of taps, a floating shaft on said control shaft, a tap contact rotor element fixed to said floating shaft, individual conductive connections from the taps on the wafers of said master switch plates to respective taps on the wafer of said transfer switch plate, connections from selected taps on the wafer of said transfer switch plate for connection to remote apparatus, the rotor element of said transfer switch plate having a plurality of positions in each of which it conductively connects said selected taps to tap connections of the wafer of a respective master switch plate, and means mechanically operable by said control shaft at a predetermined position during each revolution thereof to move said rotor element of said transfer switch plate to a different one of its plurality of positions.

4. The rotary selector switch defined in claim 3, wherein the rotor elements of each pair fixed to said control shaft are shaped to effect contact with the taps on the associated wafers in accordance with a respective binary code.

5. The rotary selector switch defined in claim 3, further including an additional tap wafer having a tap contact rotor element fixed to said control shaft, a tap on said additional wafer for connection to a second remote apparatus operatively related to the first-mentioned remote apparatus, and the rotor for said additional wafer being configured for alternate make and break contact with the associated tap during rotation of said control shaft through successive positions, thereby to provide "on-off" switching of the second remote apparatus.

6. The rotary selector switch defined in claim 5, wherein each combination of taps connected to said selected taps in one position of said control shaft is maintained in the next succeeding position of said control shaft, whereby for each such combination the rotor of said additional wafer is connected to and disconnected from the second remote apparatus.

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