

July 23, 1957

J. P. GIACOLETTO ET AL

2,800,618

SEEKING SWITCH SYSTEM

Filed April 6, 1955

4 Sheets-Sheet 2

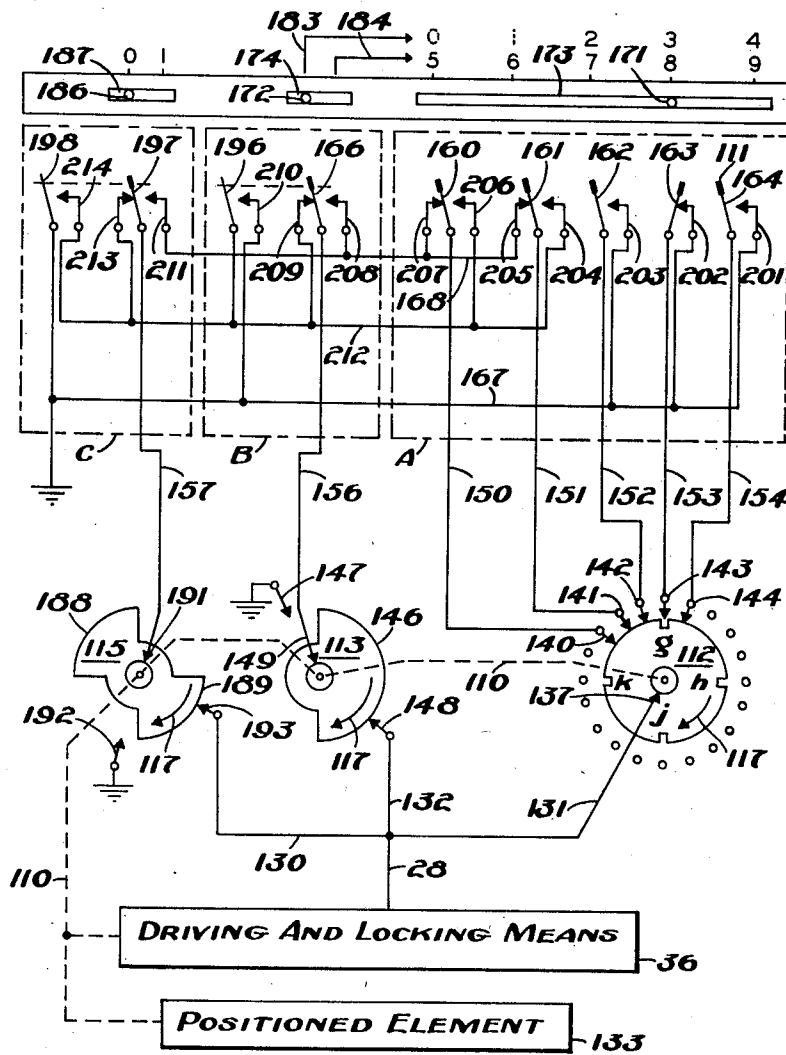


FIG. 2

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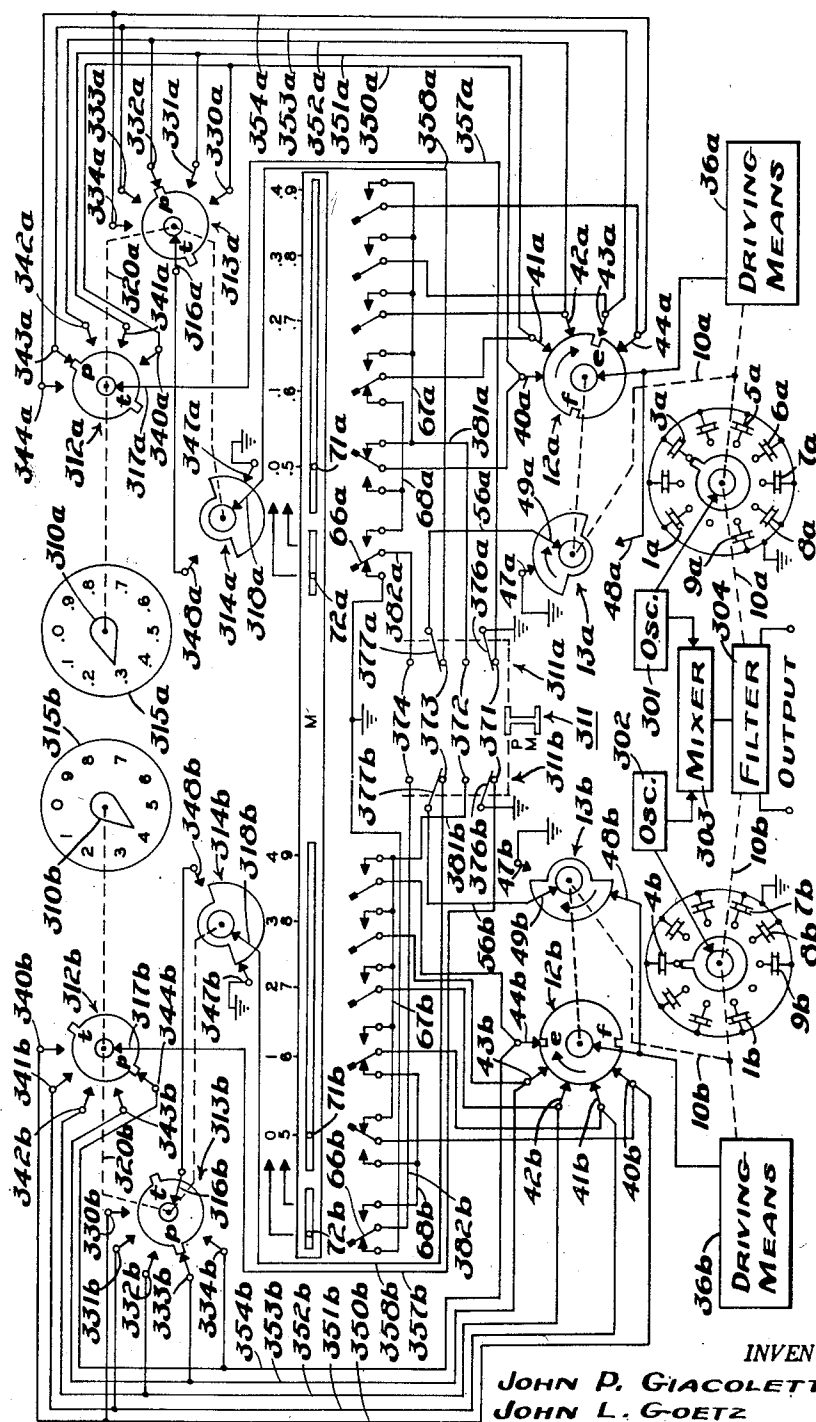
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4 Sheets-Sheet 3



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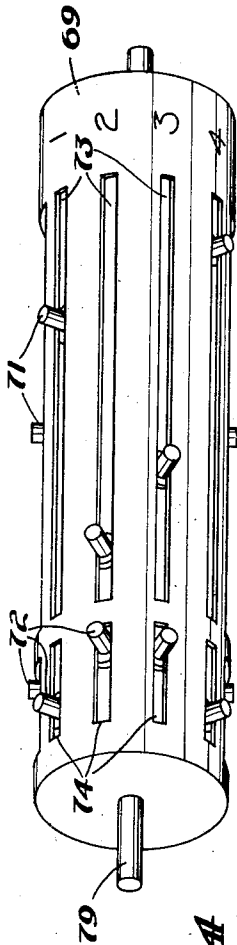


FIG-4

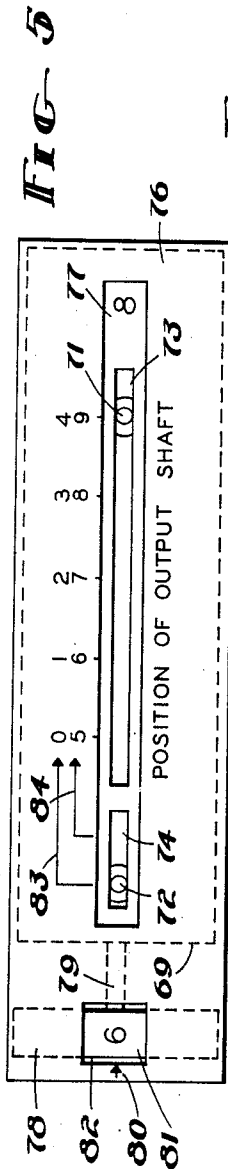
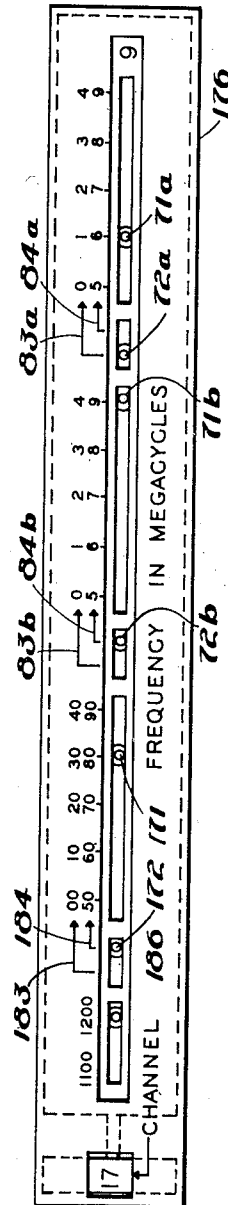


FIG-5

FIG-6



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SEEKING SWITCH SYSTEM

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Application April 6, 1955, Serial No. 499,696

12 Claims. (Cl. 318—33)

This invention relates generally to shaft positioning systems and more particularly to seeking switch types of shaft position apparatus. A seeking switch system has a motor that rotates a switch, called a seeking switch, until the seeking switch finds a null position that causes the motor to shut off. The null position can be remotely controlled by the seeking switch.

The invention concerns a seeking switch system of the so-called "wire-saving type," wherein the number of wires connecting a seeking switch to its control switch is smaller than the number of predetermined shaft positions provided by the seeking switch.

Other types of wire-saving seeking systems are described in Patents No. 2,476,673 to May and Schweighofer and No. 2,676,289 to Wulfsberg and Schweighofer, both assigned to the assignee of this invention.

The present invention overcomes a difficulty encountered with prior seeking switch systems when a number of seeking switches are used together in what is termed in this specification a "plural system." A "plural system" is defined herein as a system having a plurality of seeking switches where each seeking switch rotates a separate output shaft to a particular number of shaft settings. The purpose of a plural system is to obtain a large number of combinations of output shaft settings with relatively few individual shaft settings. The maximum number of shaft position combinations in a plural system equals the product of the numbers representing the maximum number of positions of the individual shafts. Accordingly, three output shafts each having ten rotational positions will provide 1000 combinations of shaft positions.

The invention provides a plural system that can be operated by a single control shaft which can select predetermined combinations of output shaft positions; and the number of preset combinations may be substantially less than the maximum possible number of combinations for the plural system.

The invention provides a simple method of adjusting a single preset input control for a plural system, which is rotated by the single control shaft, so that any of the possible shaft combinations may easily be obtained at a given setting of the control shaft. The invention is particularly adapted to use an input control comprising a drum with adjustable pins projecting from its surface and provides a very simple code for adjusting the pins so that they may easily be set up to correspond to any combination of output shaft positions.

The systems of the cited patents permit the use of a single control shaft to obtain predetermined shaft combinations. But unfortunately, those systems do not permit a simple code for an input control of the type used with the invention. Those systems require a code which is so complicated that it cannot be remembered by the average operator.

The present invention, on the other hand, provides a set-up code for the input control of a plural system that

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is simple enough for the average operator to remember without difficulty.

An example of a use for a plural system is one used to tune radio apparatus. For example, the radio apparatus may require precise crystal controlled tuning from 1120 megacycles to 1300 megacycles in increments of 0.1 megacycle. This requires 1800 discrete frequency settings which may be obtained with a plural system having three output shafts, where each shaft selects among oscillator crystals by its positional settings. One shaft has 18 positions to select among 18 crystals that have frequencies spaced at 10 megacycle increments. The second shaft has 10 positions to select among 10 crystals having frequencies spaced at one megacycle increments; and the third shaft also has 10 positions to select among 10 crystals, but having frequencies spaced by 0.1 megacycle increments. Each shaft selects one crystal at a time which controls the frequency of an oscillator; and frequency mixers are provided to add the three oscillator outputs. Hence, 1800 discrete frequencies spaced by 0.1 megacycle increments may thus be obtained, where each discrete frequency corresponds to a different one of the 1800 combinations of shaft settings among the three shafts. By selecting crystals that have proper frequencies and by providing suitable frequency multipliers, the gamut between 1120 to 1300 megacycles is covered in 0.1 megacycle steps by operation of the three output shafts.

However, over one period of time, it may not be necessary to use more than 20 out of the 1800 different frequencies; and furthermore, it may be required that any of the 20 frequencies (or channels) be readily obtainable by the setting of a single knob. This may be done by using a drum system with adjustable pins projecting from the drum surface, where there is provided 20 rows of pins, one row for each channel. The pins are used to actuate three control switches which individually control the three seeking switches. By varying the arrangement of actuating pins in the 20 rows, each row may be prefixed to actuate the control switches in the particular manner required to select any of the 1800 frequencies. A single control shaft is fixed to the drum and may be rotated by a knob having 20 indicated settings; and thus any of the 20 preselected channels may easily be chosen by moving the single control knob to any one of its 20 positions.

It is therefore an object of this invention to provide a seeking system capable of using a relatively simple set-up code with a pin-drum type of input control, where there is an easily remembered relationship between control pin positions and output shaft positions.

It is another object of this invention to provide a shaft positioning system capable of utilizing a pin-drum type of input control that is small in size and weight.

The invention provides a seeking system that uses a seeking switch with a plurality of rotors coupled to an output shaft that is to be positioned by operation of a control switch, which may be remotely located. One of the seeking switch rotors has a periphery of conducting material which is separated at intervals by notches or pieces of insulating material. The intervals may be symmetrically spaced and vary in number from a minimum of two according to the following formula:

$$K=2^{(n-1)} \quad (1)$$

where K is a number of intervals and n is an integer greater than one and is the number of rotors used in a seeking switch made according to this invention. A set of stator contacts engage the first rotor and generally are equally spaced and have a total angular spacing of less than the angle between two adjacent insulating intervals on the rotor periphery.

The second, third, etc., rotors, that are coupled to the same output shaft as the first rotor, are formed in a binary manner as taught in Patent No. 2,676,289 cited above.

The seeking switch is controlled by a control switch comprised of a plurality of lever actuated component switches, where the levers are operated by pins that project from a pin-drum type of input control. The levers are arranged in a row so that only a single row of pins can actuate the control switch at one time. The component switches of a control switch are divided into groups; and when actuated by a row of drum pins, only one pin actuates the component switches of a single group. Accordingly, the actuating pins in a single row are equal in number to the groups of component switches; and a simple code is provided for setting up the pins to obtain required shaft positions.

Further objects, advantages and features will be apparent to a person skilled in the art upon further study of the specification and drawings, in which:

Figure 1 is a schematic diagram showing one arrangement of the invention,

Figure 2 is a schematic diagram of another form of this invention which contains an electrical interlock to avoid certain shaft positions,

Figure 3 is a schematic diagram of another form of this invention illustrating a plural system that includes both a single preset input control and a multiple knob control,

Figure 4 is a perspective view of a control drum which might be used in this invention,

Figure 5 illustrates panel code designations which might be used with the form of the invention shown in Figure 1; and,

Figure 6 illustrates panel code designations which might be used with another form of the invention.

Now referring to the invention in more detail, Figure 1 shows a simplified form of the invention where a single output shaft 10 is controlled by a control switch comprising groups A and B of single-pole component switches that are actuated by levers 11.

Output shaft 10 is coupled to a pair of rotors 12 and 13 which comprise the seeking switch portion in Figure 1.

Output shaft 10 is rotated by a motor 14 through a clutch 16 in a single direction as indicated by arrows 17. A notched stop-wheel 18 is also coupled to shaft 10 and is engaged by a pawl 19 to lock output shaft 10 and the rotors in any of ten positions. A spring 21 is connected between pawl 19 and the supporting structure 22 to bias the pawl toward the stop-wheel.

A relay 23 actuates pawl 19 to disengage it from the stop-wheel when relay 23 is energized. Relay 23 also has a pair of normally open contacts 26 that are connected with motor 14 and a power source 27 that has one end grounded. The coil of relay 23 is connected at one end to power source 27 and is connected at the other end to leads 31, 28 and 32 that connect to the seeking switch. Output shaft 10 drives a positioned element 33 which might be a tuning element in radio apparatus. A dial 34 indicates the position of output shaft 10.

The combination of motor 14, clutch 16, stop-wheel 18, pawl 19, and relay 23 are well known and hereafter will be designated as a unit called driving and locking means 36, enclosed by dashed lines in Figure 1.

First rotor 12 has a periphery of conducting material with two diametrically located notches *e* and *f*. A sliding contact 37 connects to lead 28 and engages first seeking rotor 12 and always connects electrically to the conducting periphery of the rotor. The stator of first rotor 12 has five equally spaced contacts 40 through 44 capable of engaging the conducting periphery of rotor 12; and they are spaced about the rotor within an angle that is less than the angle between notches *e* and *f*.

The second seeking rotor 13 has a semi-circular outer

periphery 46 of conducting material; and its stator has a pair of diametrically opposite contacts 47 and 48 capable of engaging conducting periphery 46. Stator contact 47 is grounded, while the other contact 48 connects to lead 32. A second sliding contact 49 maintains a continual electrical connection to the conducting periphery 46.

Five wires 50, 51, 52, 53, and 54 connect respectively at one end to the five contacts 40, 41, 42, 43, and 44 of the first seeking stator. A single wire 56 connects at one end to sliding contact 49 of the second seeking rotor. The opposite ends of these six wires connect to the control switch.

Groups A and B of the control switch are composed of component single-pole switches; wherein group A includes five switches where at least two are double-throw switches. The remaining switches in group A may be single-throw switches. Group B includes a single-pole double-throw switch. The poles 60—64 of the component switches in group A are connected respectively by wires 50—54 to stator contact 40—44. The pole 66 of the switch in group B is connected to the opposite end of lead 56.

Each of the component switches in both groups has one contact connected to a ground bus 67; while the remaining contacts in the double-throw switches in both groups are connected to another bus 68.

Each of the poles is coupled to one of the levers 11. The levers are aligned side by side across the top of a pin-drum 69 of the type shown in Figure 4. The levers are considered normally in a leftward position in Figure 1 and are actuated to the right when engaged by a pin of drum 69. A rightward actuation of the lever will close the switch contacts; and if the switch is a double-throw type, the normally leftward position will close its other contact.

Drum 69 in Figure 4 has ten longitudinal rows of pins and each row has two pins 71 and 72. Pin 71 is capable of actuating the lever of any component switch in group A; while the second pin 72 is capable of actuating the lever of the switch in group B. The pins are supported in separate slots 73 and 74, longitudinally arranged in a single row. Each pin is slidable along the length of its slot, but detent means (not shown) is generally provided to maintain them at certain desired positions along the slot. Pin 71 may be set at any one of five positions in long slot 73 to actuate any of the five levers in group A; and pin 72 may be set to either of two positions in short slot 74 to either actuate or not actuate the single lever of group B, depending upon which of its two positions are selected.

In Figure 5, drum 69 is rotatably supported behind a panel 76, which is formed with a slot 77 through which a single row of drum pins is visible. A knob 78 is fastened to drum 69 by means of a control shaft 79; and drum 69 may be manually rotated by knob 78. A portion 81 of knob 78 extends through an opening 82 in panel 76, and portion 81 may be engaged manually to rotate drum 69. A series of numbers from 1 to 10 are engraved on knob 78 and the number opposite arrow 80, painted on panel 76, indicates the row of pins that is engaging the levers.

Another series of numbers from 1 to 10 are engraved on the right side of drum 69 in Figure 4 beside the respective rows of pins and indicates the number of the row that is visible through panel slot 77 in Figure 5. Each row is represented by a single number, whether it be the number on knob 78 or the number on drum 69; and the apparent difference is only due to the fact that a row engages the levers in a position different from that position where it becomes visible through slot 77.

Figure 1 shows a single row of pins 71 and 72 set up to obtain output shaft position 4, indicated on dial 34. Pin 71 engages the lever of pole 64 in group A; and pin

72 is positioned where it does not engage the lever of pole 66 in group B.

Figure 5 illustrates the setup code for the pins. Five small equally spaced indicating lines are drawn on the panel 76 adjacent to long drum slot 73 and each indicating line has two numbers opposite it. Numbers 0-4 are arranged in an upper horizontal row and numbers 5-9 are arranged in a lower horizontal row. Also, two indicating lines are drawn on the panel adjacent short drum slot 74. The indicating line on the left is connected by an arrow 83 to the upper horizontal row of numbers 0-4, and the other indicating line is connected by another arrow 84 to the lower horizontal row of numbers 5-9.

The numbers 0-9 on the panel indicate the ten possible positions for output shaft 10; and the code provided by the invention for the selection of any of these positions operates as follows:

1. Move pin 71, which actuates the switches in group A, to the number representing the desired shaft position; and

2. Move the other pin 72, which actuates the switch in group B, to the arrow representing the horizontal row which contains the number of the desired shaft position.

A simple setting of pins 71 and 72 obtains any of the ten shaft positions. For example, if it is required to set the pins in drum row 8 to obtain position 4, as shown in Figure 1, pin 71 is moved to numeral 4, and pin 72 is moved to arrow 83 that points to the horizontal row containing numeral 4. Thereafter, when drum 69 is rotated so that pins in row 8 engage the levers of the control switch, output shaft 10 will move to position 4. Thus, any of the ten rows of pins can be easily set for any of the ten positions of output shaft 10.

The circuit shown in Figure 1 is in a steady-state position, and there is an open circuit in series with each of the six connecting wires 50, 51, 52, 53, 54, and 56. Pins 71 and 72 are set at position 4 and engage the levers of the control switch to actuate them as shown in Figure 1. Only pole 64 is actuated; and output shaft 10 is at position 4, which is obtained when notch *e* of rotor 12 is at stator contact 44 and rotor 13 is disconnected from stator contact 48.

However, assume that another row of pins, which, for example, is set for position 3, engages the levers of the control switch. Consequently, the lever of pole 63 will be the only one engaged, and lead 53 will be connected to ground-bus 67. Accordingly, an electrical circuit is provided through relay 23 which disengages pawl 19 from stop-wheel 18 and causes motor 14 to operate and thereby rotate output shaft 10 in the direction of arrows 17. The circuit comprises power supply 27, relay 23, leads 28 and 31, rotor 12 and stator contact 43, lead 53, and pole 63 to ground-bus 67. After approximately 144 degrees of rotation, notch *f* aligns with stator contact 43 and opens the circuit through grounded wire 53. However, another circuit to ground is provided through the other rotor 13, because it also has rotated approximately 144 degrees where its stator contact 48 engages the conducting periphery 46 to complete a circuit to ground through lead 56 and pole 66 to ground. Once notch *f* on first rotor 12 rotates by stator contact 43, the circuit to ground through contact 43 is resumed; and rotation of the rotors continues for another 180 degrees until notch *e* aligns with stator contact 43 to again open the circuit through lead 53. At this shaft position, the circuit through second rotor 13 is also open, since conducting periphery 46 has rotated another 180 degrees and no longer engages stator contact 48.

Any of the other positions of output shaft 10 may be obtained by setting the pins on drum 69 according to the code described above. The new circuits caused by other pin settings, which result in other shaft positions, may be traced in the same manner as described above.

Figure 2 shows another form of the invention which includes an electrical interlock. The interlock limits the

operation of the system to preselected output shaft positions within the maximum number possible for a single seeking switch. Such limitations are necessary to prevent ambiguities in certain applications of a system. The interlock excludes two particular settings of the output shaft from the twenty positions possible with a system of the type illustrated in Figure 2; and it excludes positions 0 and 1 of the twenty possible positions to permit actuation of the system only when the control switch is operated for positions 2 through 19.

The control switch in Figure 2 has three groups, A, B, and C, of component switches that are actuated by the pins of a control drum that has three pins per longitudinal row rather than the two pins shown in Figure 1. However, in both cases, only one pin actuates a single group at one time. Added group C multiplies the previous ten output shaft settings by two to provide a maximum of twenty settings for this type system.

The seeking switch has three rotors 112, 113, and 115 which are equal in number to the component groups in the control switch. The number of notches of first rotor 112 may be determined by Formula 1, given above, in which *n* is the number of component groups in the control switch. Rotor 112 has a sliding contact 137 which connects to a lead 131 that is an extension of lead 28 from driving and locking means 36.

The adjacent stator of rotor 112 has five equally spaced contacts 140 through 144 which are confined within an angular space slightly less than the angle between two adjacent notches on rotor 112.

Second rotor 113 is shaped similarly to second rotor 13 in Figure 1, and its stator contacts 147 and 148 and its sliding contact 149 are similarly arranged. Contact 148 is connected to lead 132, and contact 147 is grounded.

A third rotor 115 has a pair of outer conducting peripheries 188 and 189 which are situated opposite each other. They each encompass approximately ninety degrees of arc; and a sliding contact 191 is also provided which connects continuously of both conducting peripheries. A pair of stator contacts 192 and 193, capable of engaging the conducting peripheries of third rotor 115, are spaced angularly apart by approximately ninety degrees. The second and third rotors are shaped as taught in Patent No. 2,676,289 cited above.

Driving and locking means 36 in Figure 2 is the same as described in regard to Figure 1, except that the stop-wheel may have twenty equally spaced notches to provide a maximum of twenty different positions for output shaft 110, but for the electrical interlock.

Leads 150-154 connect respectively at one end to the five stator contacts of first rotor switch 112 and connect at their opposite ends to poles 160-164 of the five component switches in group A.

Sliding contact 149 of seeking rotor 113 is connected by a lead 156 to pole 166 of the double-throw single-pole switch in group B which also includes a single-throw switch with a pole 196 that is mechanically interlocked to the lever of pole 166.

Similarly, sliding contact 191 of third rotor 115 is connected by a lead 157 to the pole 197 of a double-throw single-pole switch in group C which likewise has a single-throw switch with a pole 198 that is mechanically interlocked to the lever of pole 197.

The single-throw switches in groups B and C are utilized to obtain the electric interlock feature which prevents the system from being activated when the pins are set to undesired positions, as will be explained below.

Ground-bus 167 connects to contacts 201, 202, 203, 210, and pole 198. Another bus 168 connects to contacts 205, 207, 208, and 211; and an additional bus 212, called the interlocking bus, connects to contacts 204, 206, 209, pole 196, and contacts 213 and 214.

The construction in Figure 2 provides an electrical interlock at positions 0 and 1 to prevent operation of the system if a row of pins is accidentally set to these posi-

tions. Thus, output shaft 110 only has 18 predetermined positions with the interlock, and the positions are represented digitally by numbers 2 through 19.

The interlocking system is particularly useful in the frequency schemes of certain types of radio apparatus. For example, the shaft system may be used in a radio transmitter to obtain frequency bands from 2 through 19 megacycles in one megacycle step; and it may not be desirable for the system to have bands beginning at either zero megacycles or one megacycle. Thus, the interlock prevents these settings and only permits output settings from 2 through 19 megacycles.

It can readily be seen that there may be other frequencies which may not be required in a transmitter. The interlocking feature provided by this invention may be extended to any undesired frequency in the range from 0 to 19 in the system of Figure 2, and the interlocks at digits 0 and 1 are illustrative only.

It is presumed in Figure 2, as in Figure 1, that all of the levers are in a leftward position when not engaged by a pin. The lever of poles 166 and 196 can only be actuated to the right when pin 172 is by arrow 184; while in group C, the lever poles 197 and 198 can only be actuated rightwardly when pin 186 is at digit 1.

The single-throw switches in groups B and C provide the only connection from interlocking bus 212 to ground-bus 167. Thus, interlocking-bus 212 is grounded only when either of the single-throw switches in group B or C is closed; and this can only occur when either pin 172 is by arrow 184 or pin 186 is by digit 1. Furthermore, contacts 204 and 206 of the double-throw switches in group A can be grounded only when pins 172 or 186 are by arrow 184 or digit 1, respectively, since these contacts are connected to interlocking-bus 212.

The interlock operates as follows when the control switch levers are actuated by pins set to position 0. There, only the lever of pole 160 is lifted to connect lead 150 to intermediate-bus 212. However, poles 196 and 198 in groups B and C are open, and no ground connection is provided. Hence, the driving means is not activated and output shaft 110 remains stationary.

Also, bus 168 is not connected to ground; and it can only be grounded through leads 156 or 157 by the grounded stator contacts 147 or 192, respectively, of the second and third rotors. However, at their zero positions, pins 172 and 186 are set so that they cannot close contacts 208 or 211; and no ground can be obtained by bus 168 through leads 156 and 157. Therefore, the complete circuit is inactive when the control drum is set to position zero.

When the control drum is set at position 1, pin 171 actuates only pole 161 of the other double-throw switch in group A to connect lead 151 to intermediate-bus 212. But no circuit is closed since poles 196 and 198 are open and bus 212 remains ungrounded.

However, at all control drum settings from 2 through 19, a circuit may be completed to ground, since at these settings at least one of the levers of poles 164, 163, 162, 166, or 197 is engaged by a pin to either provide a direct connection to ground through the single-throw switches in group A or through the switches in group B or C.

The interlocking action may be obtained at any position within the maximum gamut of positions for a seeking switch by providing in the control switch double-throw component switches at the undesired pin setup points in group A with their contacts connected respectively to buses 168 and 212 and also by connecting the otherwise grounded contacts of the double-throw switches in the remaining groups (B, C, etc.) to intermediate-bus 212. Furthermore, an additional single-pole single-throw switch is provided in each remaining group (B, C, etc.) with its pole mechanically coupled to the pole of the double-throw switch in the same group; and its contacts connect respectively to intermediate-bus 212 and ground,

where each switch cannot be closed by drum pins that are set at the undesired positions.

It is noted in Figure 1 that six connecting wires 50, 51, 52, 53, 54, and 56 are required in a ten position system, and it is noted in Figure 2 that seven connecting wires 150, 151, 152, 153, 154, 156, and 157 are required to obtain a maximum of twenty shaft positions. The numerical relationship between connecting wires and shaft positions, for a single output shaft seeking system, made according to this invention, may be defined as follows:

$$S = W2^X \quad (2)$$

where S is the maximum number of shaft positions for the output shaft, W is the number of leads connecting to the multi-notched first seeking switch rotor, and X is the number of remaining connecting wires that connect to the remaining seeking switch rotors. In any system, fewer than the maximum number of positions may be used; and the above described interlock will limit the positions to a smaller number.

Figure 3 illustrates a form of the invention that provides two types of control over the output of a plural seeking system used in radio apparatus. A plural system has two or more output shafts, and its control means must select particular combinations of output shaft positions. The plural system shown in Figure 3 uses two output shafts that are each controlled by a unit seeking system of the type shown in Figure 1.

In Figure 3, like component parts of the two unit systems will have the same reference numeral; but the suffix *a* is added to the reference numerals of the unit system of one output shaft and the suffix *b* is added to the reference numerals of the unit system of the other output shaft.

The plural system in Figure 3 has two output shafts 10a and 10b. Each shaft has ten positions, and this system therefore provides one hundred combinations of positions between the shafts. A particular combination of positions between shafts 10a and 10b selects a particular frequency in the radio apparatus, and the 100 shaft combinations are utilized to select 100 discrete frequencies, which may have a range from 0 megacycles to 10 megacycles in steps of 0.1 megacycle. This may be done with 18 crystals; where shaft 10b selects among nine crystals 1b-9b having frequencies from one through nine megacycles in steps of one megacycle, and shaft 10a selects among nine crystals 1a-9a having frequencies from 0.1 through 0.9 megacycle. The first position of each shaft represents zero frequency and does not have a crystal.

The output frequency of the system is the sum of the frequencies provided by crystal (except for zero position) selected by shaft 10a and a crystal (except for zero position) selected by the other shaft 10b. Thus, any discrete frequency from zero through 9.9 megacycles may be obtained by the 100 shaft combinations.

The crystals control the respective frequencies of a pair of oscillators 301 and 302, which have their outputs mixed in a mixer 303. A filter 304 selects the summed output frequency of any pair of crystals and is tuned to that frequency by the position of output shafts 10a and 10b.

It is required in many types of radio apparatus that frequency selection be obtained with a single control shaft which may be operated by a single control knob. The invention provides single shaft input means for plural output shaft systems by connecting the single control shaft to a pin-drum of the type described above.

In some types of radio equipment, only a few channels may be required over a known period of time. This is the case in aircraft where only a few channels may be used during a single flight; and for example, a pin-drum having twenty channels may be very adequate. Of course, the twenty channels may easily be set in the

invention to any of the possible frequencies of the system.

In Figure 3, a multiple knob control, which can select among all available frequencies, is provided in addition to the preset control, that selects among the twenty preset channels. A selector switch 311 selects whichever control is desired. The pin-drum has an extra row designated as M in addition to its twenty rows that provide the twenty present channels. The extra row is marked M on control knob 81 and has pins fixed to engage the lever of any double-throw switch in each group A; and in Figure 3, they engage the levers at positions zero. Control knob 81 in Figure 5 is therefore set to M position before the multiple knob control is used.

The pin-drum in Figure 3 has four pins in each of its other twenty rows; and in each row, pins 71a and 72a control the position of output shaft 10a, and pins 71b and 72b control the position of output shaft 10b. The four pins in these rows are set according to the simple code provided by this invention to any of the 100 output frequencies provided by the system.

Since it may occasionally be necessary to obtain a frequency without disturbing the twenty prefixed drum channels, the multiple control, utilizing a plurality of control knobs, is provided to select among other possible frequencies. In Figure 3, knobs 310a and 310b are provided and will obtain any of the 100 frequencies.

Selector switch 311 has two positions designated as M and P and selects one of the two types of control for the plural seeking system. When switch 311 is set at position M, the system is controlled by multiple knobs 315a and 315b; and when the selector switch is set at position P, the system is controlled by the preset drum. Also, the pin-drum should be set at position M when selector switch 311 is set to position M, as shown in Figure 3.

A dial 315a cooperates with knob 310a and is calibrated in frequencies 0 to 0.9 megacycle which correspond to the frequency selections of output shaft 10a among crystals 1a—9a. Similarly, a dial 315b, which is calibrated from 0 to 9 megacycles, indicates the frequency selection of output shaft 10b among crystals 1b—9b. The dial indications are operative only when selector switch 311 is set at position M.

Each seeking switch in a plural system is separately controlled by one of the multiple control knobs, which are equal in number to the output shafts. Thus, multiple knob control becomes increasingly complex as the number of output shafts is increased.

The advantage of the preset control becomes apparent, for example, in a system having ten output shafts where ten multiple knobs must be adjusted to obtain a particular frequency. Yet, only one preset knob is required to obtain the frequencies preset on a pin-drum, regardless of the number of output shafts.

Each multiple knob 310 is coupled by a shaft 320 to a rotary switch which has three rotors 312, 313, and 314. First and second rotors 312 and 313 are substantially the inverse of first seeking rotor 12; and these control switch rotors each have only two diametrically opposite conducting members *p* and *t* on their periphery capable of engaging their stator contacts, 330—334 and 340—344, which are arranged in the same manner as the stator contacts for rotor 12. However, first and second control rotors 312 and 313 are coupled to shaft 320 with an angular spacing between them that may be any multiple of the angle between two adjacent stator contacts; and in Figure 3, projection *p* of the first rotor 312 engages stator contact 343 while projection *p* of second rotor 313 engages stator contact 332.

The stator contacts of first and second control rotors 312 and 313 are respectively connected to each other and to the stator contacts of seeking rotor 12 by five leads 350 through 354.

Third control switch rotor 314 is substantially identical with second seeking switch rotor 13 and similarly has

stator contacts 347 and 348 of which contact 347 is grounded and contact 348 is connected to a sliding contact 316 of rotor 313 that continuously connects to its conducting projections *p* and *t*.

Selector switch 311 includes two sets 311a and 311b of double-pole double-throw contacts with their poles mechanically interlocked.

A separate set of double-pole double-throw contacts is used for each seeking switch in a plural system; and each set of contacts is connected in an identical manner to its unit system. Thus, the connection of selector switch set 311a to unit system *a* is identical to the connection of selector switch set 311b to unit system *b*. In regard to each set of contacts, contact 371 connects to the slidable contact 317 of rotor 312 by a lead 357, and another contact 372 connects to bus 67 of the prefixed switch by a lead 381. Contact 373 connects to lead 358, which connects to sliding contact 318 of rotor 314; while the remaining contact 374 connects to pole 66 of the preset control switch by a lead 382. One pole 376 is connected to ground and the other pole 377 is connected to sliding contact 49 of seeking rotor 13 by lead 56.

When selector switch 311 is moved to preset position P, the circuitry of each unit system *a* and *b* is substantially as shown in Figure 1. Thus, bus 67 is grounded through lead 381, selector contact 372, and grounded pole 376; while rotor sliding contact 49 is connected to pole 66 through selector contact 374 and pole 377.

However, when selector switch 311 is moved to M position, the ground to bus 67 and the connection to pole 66 are disconnected, which disables the prefixed control switch; and the multiple control switch is activated by having sliding contact 317 connected to ground through lead 357, selector contact 371 and grounded pole 376, while another control switch sliding contact 318 is connected through leads 358 and 356 to seeking rotor sliding contact 49 by selector contact 373 and pole 377.

The following example illustrates the electrical operation of one multiple control switch and is typical of the operation of the other multiple control switch. Assume that knob 310a is moved from 0.3 megacycle to 0.2 megacycle on dial 315a, while selector switch 311 and the preset drum are each at position M. Projection *p* of control rotor 312a then is moved to engage stator contact 342a, and projection *p* of rotor 313a engages stator contact 331a. A circuit is thereby completed from control rotor sliding contact 317a, which is grounded through selector contact 371, through stator contact 342a, lead 352a, and seeking rotor contact 42a to driving means 362, which rotates the seeking rotors in the indicated direction. The desired position is obtained when notch *e* is at stator contact 42a. However, when notch *f* is adjacent stator contact 42a, the driving means remains energized to rotate the rotors, because a circuit is completed through seeking rotor 13a due to its rotation; and the circuit is from driving source 36a through contact 48a, seeking rotor 13a, lead 56a, selector contact 373a, lead 358a, and control rotor 314a to grounded contact 347a. When notch *e* rotates to stator contact 42a, an open circuit occurs and the shaft stops at that position. There is no second circuit to ground through the other seeking rotor 13a because further rotation has disengaged it from energized stator contact 48a. In this manner, either multiple knob 310a or 310b can position its respective output shaft to any of its ten positions and thereby obtain the 100 shaft position combinations.

In practice, it may be necessary to use a plural system with more output shafts than shown in Figure 3. For example, it may be required to provide frequency selection from 1120 to 1300 megacycles in steps of 0.1 megacycle as discussed in the example given near the beginning of this specification. This may be done with three output shafts, where one is controlled by an interlocked eighteen position seeking system of the type shown in

Figure 2 and the other two output shafts are each controlled by ten position seeking systems of the type shown in Figure 1.

The two ten position seeking systems are united as described in connection with Figure 3, and the eighteen position system is added to them in the same manner. The eighteen position shaft may select among eighteen crystals spaced at ten megacycle increments; while one of the ten position shafts may select among ten crystals spaced at one megacycle increments, and the other ten position shaft may select among crystals spaced by 0.1 megacycle increments. Suitable frequency multipliers and mixers provide the 1800 frequencies within the 1120 to 1300 megacycle range.

A single drum is provided which has seven pins in each row to provide single knob control over the system. Three pins control the eighteen position system which is as illustrated in Figure 2, and four pins control the two ten position systems and each is as shown in Figure 3. The invention provides a simple code to set up the seven pins.

Figure 6 shows a coded panel 176 for the seven pin-per-row drum of this plural system. The simplicity of the code for setting the pins to any of the 1800 possible frequencies of the system is obvious. For example, 1289.1 megacycles may be set up by moving pin 186 to 1200, pin 172 to arrow 184, pin 171 to 80, pin 72b to arrow 84b, pin 71b to 9, pin 72a to arrow 83a, and pin 71a to 0.1.

It is therefore apparent that this invention provides a seeking switch system capable of being controlled by a pin-drum having a simple setup code. It is further apparent that the invention provides a simple code that may be utilized in plural systems to obtain single knob control without a corresponding increase in control complexity. The invention further permits an alternate control switching arrangement for a plural system; whereby a small pin-drum permits ease of selection among a few preset shaft position combinations, and a multiple control shaft arrangement permits selection among any of the possible combinations. Also, the invention provides an electrical interlock which prevents actuation of a system at certain predetermined digital settings of the control drum.

Many changes including widely differing embodiments can be made in the above construction of this invention by a man skilled in the art without departing from the scope of the invention. It is therefore intended that all the matter contained in the above description and shown in the accompanying drawings should be interpreted in an illustrating sense and not in a limiting sense.

What is claimed is:

1. A wire saving seeking switch system providing a predetermined number of positions for an output shaft, wherein the positions can be selectively obtained by input control means having a relatively simple encoding method, the system including a seeking switch having a plurality of rotors coupled to said output shaft, the first rotor having a conducting periphery formed with a pair of oppositely situated insulating notches, a first stator member having a plurality of contacts engaging the periphery of the first rotor, the second rotor member having a semi-circular outer periphery of conducting material, a second stator member having a pair of oppositely situated contacts for engaging the conducting periphery of the second rotor with one of the contacts connected to ground, first and second sliding contacts engaging respectively the first and second rotors and conductively connecting to their peripheries, electrical driving means coupled mechanically to the output shaft, a power source included with the driving means and connected serially with the sliding contact of the first rotor and serially with the ungrounded stator contact of the second rotor, a control switch comprising at least two groups of component single-pole switches, the first group having at least two double-throw

component switches, the second group having at least one component double-throw switch, the poles of the component switches in the first group connectable respectively to the stator contacts of the first rotor, the pole of the double-throw switch in the second group connectable to the sliding contact of the second rotor, one of the contacts of each component switch in the first and second groups connectable to ground, and the other contacts of the double-throw switches in the first and second groups connectable together, whereby each of the predetermined positions of the output shaft is obtained by selectively actuating the component switches in a manner that actuates not more than one component switch in each group to obtain a particular position.

2. A wire saving seeking switch system capable of plural types of digital control for an output shaft, the system including a control arrangement comprising n number of groups of control switches, the first group having W number of component single-pole switches that include at least two double-throw switches, the remaining groups including at least one component single-pole double-throw switch, the component switches in all groups each having one contact connectable to ground, the opposite contact in each double-throw component switch connectable together; a seeking switch including n number of rotors coupled to said output shaft, the first rotor having a conducting periphery formed with a plurality of notches defined by the formula:

$$K=2^{(n-1)}$$

where K is the number of notches, each remaining rotor having a periphery formed into conducting segments in a binary sequence, a first stator adjacent to the first rotor having W number of contacts capable of engaging the conducting periphery of the first rotor, a separate stator provided for each remaining rotor, each separate stator having two contacts spaced angularly by the approximate angular length of one of the conducting segments on the adjacent rotor, one of the two contacts of each separate stator connected to ground, a plurality of sliding contacts with a different contact engaging each rotor and connecting conductively with its conducting periphery; a driving means to rotate the output shaft and having an electrical connection in series with the sliding contact of the first rotor and the ungrounded contacts of the remaining rotors, W number of connecting means for connecting the first stator contacts respectively to the poles of the component switches in the first group, and X number of conducting means for connecting respectively the sliding contacts of the remaining rotors to the poles of the double-throw switches in the remaining groups, whereby selective actuations of the component switches provide a maximum number of rotational positions for the output shaft defined by the formula:

$$S=W2^X$$

where S is the maximum number of predeterminable positions of the output shaft, and W and X are defined as given above.

3. A rotary seeking switch for selecting any one of a number of predetermined positions for an output shaft, wherein the rotary switch is coupled to the output shaft and includes a plurality of rotors, the first rotor having a conducting periphery with a plurality of notches that are determined by the formula:

$$K=2^{(n-1)}$$

where K is the number of notches and n is an integer greater than one, the remaining rotors having conducting peripheries formed into segments in a binary sequence, a first stator having at least W number of contacts capable of engaging the periphery of the first rotor, a separate remaining stator provided for each remaining rotor, each remaining stator having a pair of stator contacts supported adjacent to its remaining rotor and

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capable of engaging its conducting periphery with the pair of contacts spaced angularly by approximately the angular length of one adjacent conducting periphery segment, and a plurality of sliding contacts with one sliding contact supported adjacent to each rotor and electrically connecting to the conducting periphery of its rotor.

4. A seeking system having dual control, wherein either of a pair of cooperatively connected control arrangements may select among predetermined positions of an output shaft, the control arrangements comprising, preset control means, and secondary control means, the preset control means comprising, first and second groups of component single-pole switches, and a pin-drum to actuate the component switches in a preset manner, the first group including at least two double-throw switches, and the second group including at least one double-throw switch with one contact connected to ground, a first control shaft coupled to the pin-drum to position it relative to the first and second groups, the pin-drum having plural rows of pins that sequentially actuate the groups as the drum is moved by the first shaft, each row having at least two pins with one pin situated to actuate one of the switches in the first group and with the second pin capable of actuating the switch in the second group; a seeking switch including, a first seeking rotor coupled to the output shaft, the first rotor having a conducting periphery formed with a pair of notches, a first seeking stator having a plurality of contacts capable of engaging the periphery of the first seeking rotor, a second seeking rotor coupled to the output shaft and formed with a semi-circular conducting periphery, a second seeking stator with a pair of contacts oppositely situated and capable of engaging the conducting periphery of the second rotor, one of the second seeking stator contacts connected to ground, first and second sliding contacts respectively engaging the first and second seeking rotors, an electrical driving means coupled to the output shaft, the driving means serially connected to the first sliding contact and the ungrounded second stator contact so that the driving means is actuated when a closed circuit connection is provided to the driving means to thereby rotate the output shaft; the secondary control means including first, second, and third control rotors, the first and second control rotors each having a pair of conducting projections extending from the opposite sides of its periphery, the third control rotor having a semi-circular outer conducting periphery, a second control shaft coupled to the three rotors, a pair of stators adjacent respectively to the first and second rotors with each stator having the same plurality of active contacts, a third stator for the third control rotor having a pair of oppositely situated contacts with one contact grounded, a pair of sliding contacts engaging respectively the first and second rotors and serially connecting to their projections, another sliding contact engaging the third control rotor and connecting to its conducting periphery, the sliding contact of the second control rotor connected to the ungrounded stator contact of the third control rotor; a selector switch having at least double-pole double-throw contacts with one pole connected to ground, one contact of each component switch in the first group connected to one selector switch contact that is engageable by the grounded pole, the other selector switch contact engageable by the grounded pole connected to the sliding contact of the first control rotor, the second pole of the selector switch connected to the sliding contact of the second seeking rotor, a selector switch contact engageable with the second selector switch pole connected to the pole of the component switch in the second group, and the other selector switch contact engageable with the second pole connected to the sliding contact of the third control rotor; a plurality of wires respectively connecting the first seeking stator contacts to the poles of the component switches in the first group, a plurality of wires respectively connected at one end to the contacts of the first and second

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control stators and connected at the other end to the poles of the component switches in the first group, the first and second control rotors angularly displaced from each other by their coupling to their control shaft, whereby the predetermined positions of the output shaft may be obtained by either the preset control means or the secondary control means according to the setting of the selector switch.

5. A dual control arrangement for a seeking switch system, wherein either of a pair of control arrangements may select among predetermined positions of an output shaft, the control arrangements including preset control means, and secondary control means, the prefixed control comprising first, and second groups of component single-pole switches, and a pin-drum to actuate the component switches in a preset manner, the first group including at least two double-throw switches, and the second group including at least one double-throw switch with one contact connected to ground, a first control shaft coupled to the pin-drum to actuate it relative to the groups of switches, the pin-drum having plural rows of pins that sequentially engage the groups as the drum is actuated by the first shaft, each row having at least two pins with one pin situated to actuate one of the switches in the first group and the second pin capable of actuating the switch in the second group; the secondary control means including first, second, and third control rotors, the first and second control rotors each having a pair of conducting projections extending from opposite sides of its periphery, the third control rotor having a semi-circular outer conducting periphery, a second control shaft coupled to the three rotors, a pair of stators adjacent respectively to the first and second control rotors with each stator having the same number of active contacts, a stator for the third control rotor having a pair of oppositely situated contacts with one contact grounded, a pair of sliding contacts engaging respectively the first and second rotors and serially connecting to their projections, another sliding contact engaging the third control rotor and connecting to its conducting periphery, the sliding contact of the second control rotor connected to the ungrounded stator contact of the third control rotor; a selector switch having at least double-pole double-throw contacts with one pole connected to ground, each component switch in the first group having a contact connected to one selector switch contact that is engageable by the grounded pole, the other selector switch contact engageable by the grounded pole connected to the sliding contact of the first control rotor, the second pole of the selector switch connected to the sliding contact of the second seeking rotor, a selector switch contact engageable with the second pole connected to the pole of the component switch in the second group, and the other selector switch contact engageable with the second pole connected to the sliding contact of the third control rotor; a plurality of wires respectively connected at one end to the contacts of the first and second control stators and respectively connected at the other end to the poles of the component switches in the first group, the first and second control rotors angularly displaced from each other by their coupling to their control shaft, whereby the predetermined positions of the output shaft may be obtained by either the preset control means or the secondary control means according to the setting of the selector switch.

6. A control arrangement in a seeking system for providing a decimal code for selecting among a number of predetermined positions of an output shaft, the control arrangement comprising, a first switch group having five component single-pole switches including at least two double-throw switches, a second group having at least one double-throw switch, a drum having a plurality of longitudinal rows of pins projecting above its surface, each row including at least two pins where one pin is capable of actuating one of the component switches in the first group and the other pin is capable of actuating the component switch in the second group, whereby the first pin can

be set to actuate any switch in the first group to obtain any one of five output shaft positions when the second pin actuates the switch in the second group and to obtain any one of five additional output shaft positions when the second pin does not actuate the switch in the second group.

7. A control arrangement for a seeking system providing a digital code for selecting sequentially among a number of predetermined positions for an output shaft, and including first, second, and third rotors, the first and second rotors each formed with a pair of conducting projections extending from opposite sides of its periphery, the third rotor having a semi-circular outer conducting periphery, a control shaft coupling the three rotors, first and second stators adjacent to the first and second rotors respectively and each stator comprising a corresponding set of contacts, the contacts of the first and second stators occupying an angular space less than the angle between adjacent rotor projections, corresponding contacts of the first and second stators connected sequentially together, the stator of the third rotor including a pair of oppositely situated contacts with one contact grounded, a pair of sliding contacts engaging the first and second rotors and respectively connecting to their projections, another sliding contact engaging the third rotor and connecting to its conducting periphery, and the first and second rotors displaced from each other with respect to their stators so that their projections are not connected together through the sequential connections for the corresponding contacts of the first and second stators.

8. A control arrangement in a seeking system that provides a relatively simple code for selecting any one of a number of predetermined positions for an output shaft and that comprises a plurality of groups of single-pole switches, the first group including at least two double-throw component switches, and each remaining group including at least one double-throw switch, a drum having plural rows of pins projecting above its periphery, the pins in each row capable of actuating said single-pole switches at a predetermined position of the drum, a given row of pins actuating only one single-pole switch in the first group at one time, and the remaining groups of switches respectively actuated by a pin only as required to provide a given setting for the output shaft, whereby a digital code can be provided between the output shaft positions and the pin settings of the drum.

9. A control arrangement as in claim 8 in which one of the contacts of each component switch is connectable to ground, and the other contacts of the double-throw component switches are connectable together.

10. A control switching arrangement having an electrical interlock for use in a seeking system, wherein the interlock prevents actuation of the system at undesired settings of the control switching arrangement, which includes a first group of component single-pole switches including at least two double-throw switches, a second group of component single-pole switches including at least a single-throw switch and a double-throw switch with their poles mechanically coupled together, first conducting means for connecting together one contact of each double-throw switch in all of the groups, intermediate conducting means for connecting together the opposite contact of each double-throw switch in all the groups and one of the

contacts of each single-throw switch in the second group, and grounded conducting means for connecting together one contact from each remaining single-pole switch in the first group and the remaining contacts of the single-throw switches in the second group, whereby actuation of the double-throw switches in the first group will not cause a grounded connection unless a preselected actuation of the second group is provided.

11. A control switching arrangement having an electrical interlock for use in a seeking system, wherein the interlock prevents actuation of the system at undesired settings of the control switching arrangement, which includes a first group of component single-pole switches including at least two double-throw switches, a second group of component single-pole switches including a single-throw switch and a double-throw switch with their poles mechanically coupled together, a third group of single-pole switches including a single-throw switch and a double-throw switch with their poles mechanically coupled together, first conducting means for connecting together one contact of each double-throw switch in all of the groups, intermediate conducting means for connecting together the opposite contact of each double-throw switch in all the groups and one of the contacts of each single-throw switch in the second and third groups, and grounded conducting means for connecting together one contact from each remaining single-pole switch in the first group and the remaining contacts of the single-throw switches in the second and third groups, whereby actuation of the double-throw switches in the first group will not cause a grounded connection unless preselected actuations of the second and third groups are provided.

12. A control switching arrangement having an electrical interlock for use in a seeking system, wherein the interlock prevents actuation of the system at undesired settings of the control switching arrangement, which includes a first group of component single-pole switches including at least two double-throw switches, a second group of component single-throw switches including a single-throw switch and a double-throw switch with their poles mechanically coupled together, a third group of single-pole switches including a single-throw switch and a double-throw switch with their poles mechanically coupled together, a drum having plural rows of pins, the pins of each row actuating at one time only one switch in the first group and capable of actuating the switches in the second and third groups, first conducting means for connecting together one contact of each double-throw switch in all of the groups, intermediate conducting means for connecting together the opposite contact of each double-throw switch in all the groups and one of the contacts of each single-throw switch in the second and third groups, and grounded conducting means for connecting together one contact from each remaining single-pole switch in the first group and the remaining contacts of the single-throw switches in the second and third groups, whereby actuation of the double-throw switches in the first group will not cause a grounded connection unless preselected actuations of the second and third groups are provided.

No references cited.