

Filed April 26, 1946

2,470,567

4 Sheets-Sheet 1

Fig. 1.

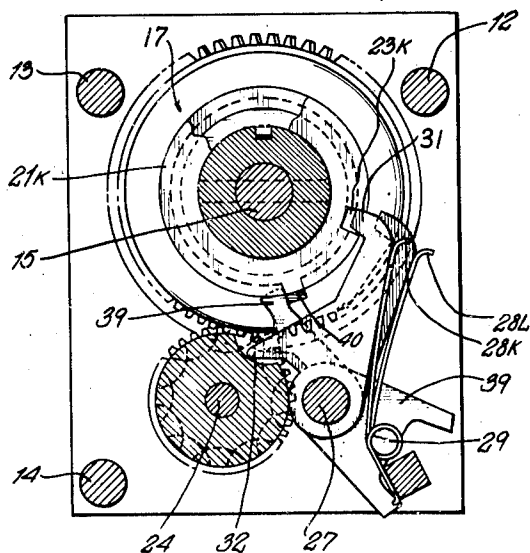
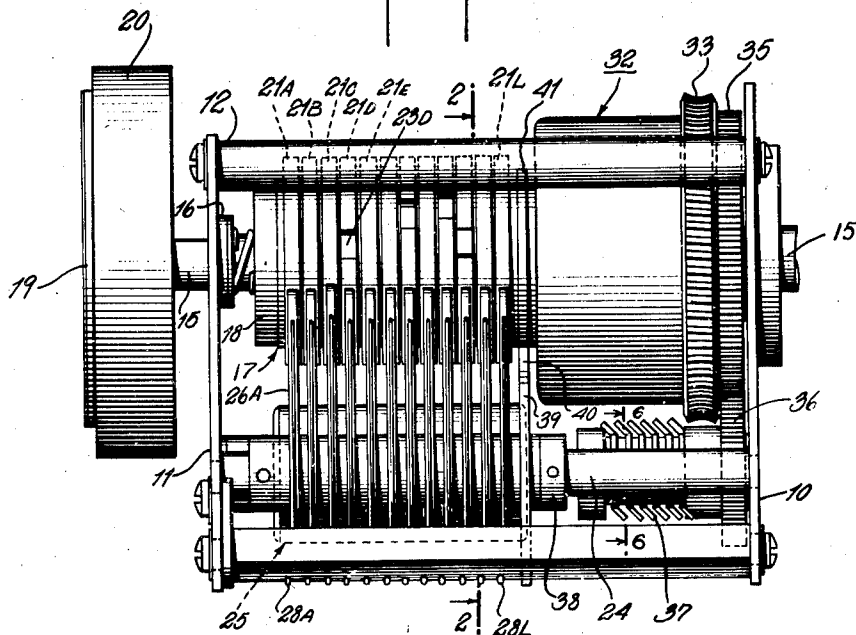


Fig. 2.

INVENTOR.
RICHARD W. MAY
BY John J. Logan
ATTORNEY

Filed April 26, 1946

2,470,567

4 Sheets-Sheet 2

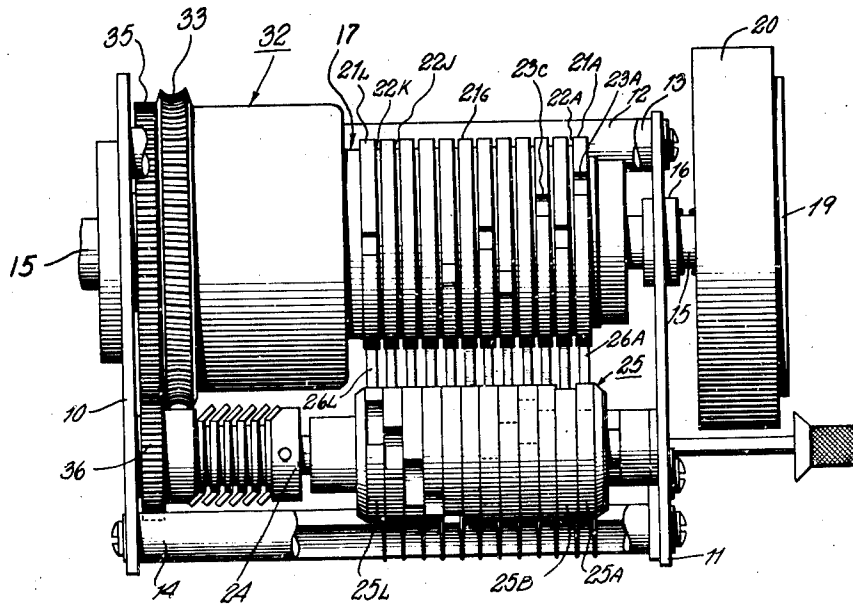


Fig. 3.

INVENTOR.
RICHARD W. MAY
BY John J. Hogan
ATTORNEY

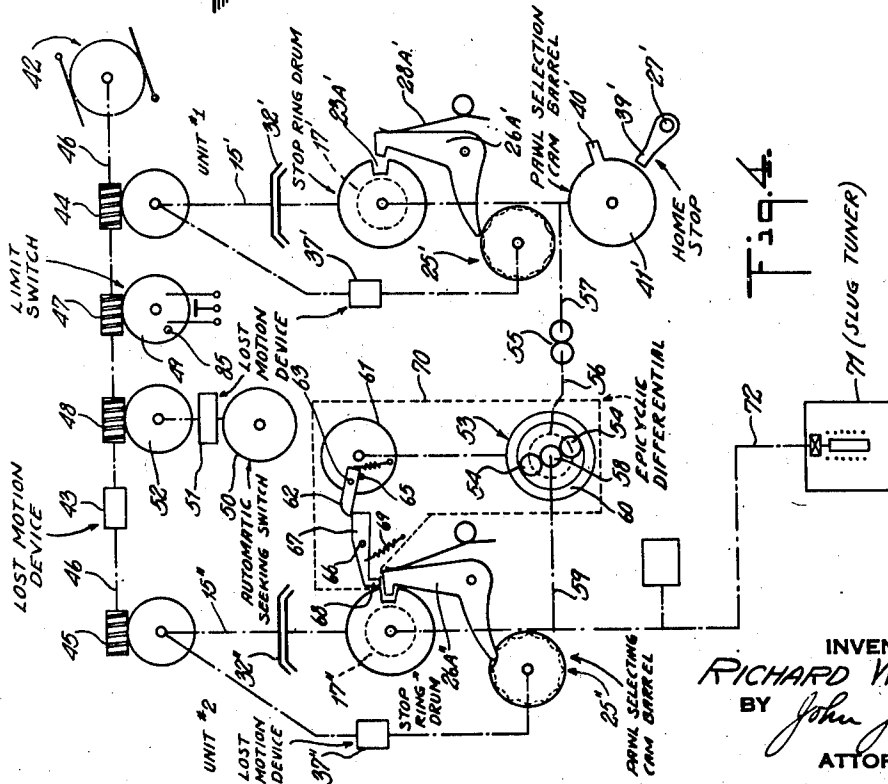
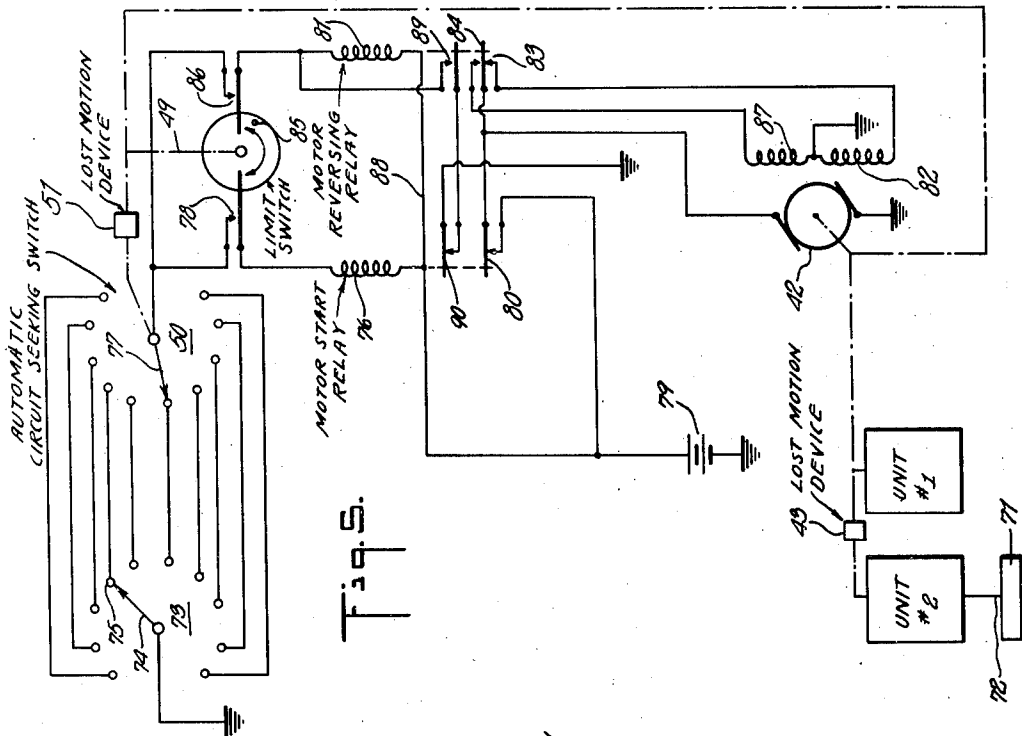
May 17, 1949.

R. W. MAY
SELECTIVE CONTROL APPARATUS FOR
RADIO SYSTEMS AND THE LIKE

2,470,567

Filed April 26, 1946

4 Sheets-Sheet 3



INVENTOR
RICHARD W. MAY
BY *John J. Rogan*
ATTORNEY

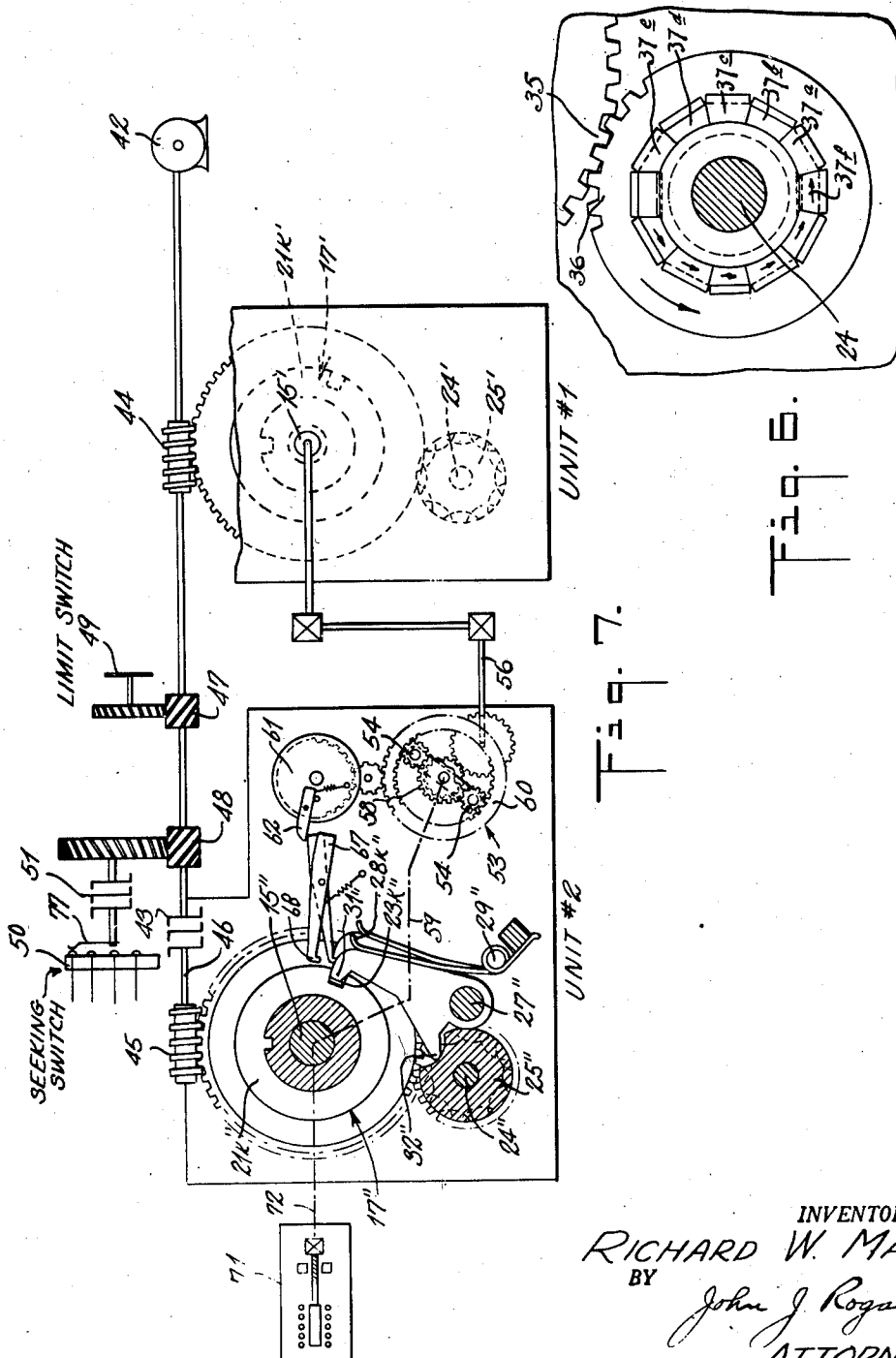
May 17, 1949.

R. W. MAY
SELECTIVE CONTROL APPARATUS FOR
RADIO SYSTEMS AND THE LIKE

2,470,567

Filed April 26, 1946

4 Sheets-Sheet 4



INVENTOR.
RICHARD W. MAY
BY
John J. Rogan
ATTORNEY

UNITED STATES PATENT OFFICE

2,470,567

SELECTIVE CONTROL APPARATUS FOR
RADIO SYSTEMS AND THE LIKE

Richard W. May, Cedar Rapids, Iowa, assignor to
Collins Radio Company, Cedar Rapids, Iowa, a
corporation of Iowa

Application April 26, 1946, Serial No. 665,107

22 Claims. (Cl. 192—142)

1

This invention relates to selective shaft rotation apparatus, and more particularly to arrangements for selectively controlling the angular orientation of a rotatable shaft which is designed to undergo more than one complete rotation before arriving at a final selected orientation.

While devices according to the invention have been found particularly useful in the selective positioning of tuning elements or circuit control elements of radio apparatus, such for example as radio transmitters and receivers, it will be clear from the following disclosure that the principles of the invention can be embodied in any apparatus which is required to determine with utmost accuracy the angular orientation of a control shaft.

The invention is in the nature of an improvement upon the type of tuning control mechanism disclosed and claimed in application Serial No. 515,250, filed December 22, 1943, and in various prior issued patents of Arthur A. Collins of which Patent #2,285,414, granted June 9, 1942, is typical.

In certain kinds of radio equipment employing a control shaft, such for example as a tuning condenser shaft, the complete tuning range can be effected by a single complete rotation of the shaft. In other kinds of radio equipment of which the well-known permeability or slug tuner is typical, the tuning motion is rectilinear and usually requires a control shaft which must be capable of undergoing more than one complete rotation in order to cause the tuning element to move over its complete positional tuning range. For simplicity of reference, the first type of device will be referred to herein as a single turn selecting control, and the second will be referred to as a multi-turn selecting control.

Accordingly, it is a principal object of this invention to provide an arrangement for automatically and selectively controlling the angular positioning of a control shaft regardless of whether the shaft is required to make more than one complete rotation or only a fractional rotation.

It is also an object of the invention to provide composite electrical and mechanical controls for selectively operating a multi-turn control shaft employing a single selector switch having a series of bank contacts each corresponding to a desired angular position of the said shaft.

Another object of the invention is to provide an improved composite electrical and mechanical control device for selectively setting a multi-turn control shaft.

It is a further object of this invention to pro-

2

vide two similar automatic shaft positioner control units at least one of which is of the single-turn control type, the units being interrelated so that the shaft to be controlled can be selectively rotated through more than one complete rotation before being selectively stopped in its final selected position.

A feature of the invention relates to a selective shaft positioning arrangement comprising two selectively operable units each of the type having a series of stop elements which can be preset to any desired angular settings, and a series of selective cam-controlled pawls which cooperate with said elements to determine the selective stopping thereof. The arrangement is such that the two units can be selectively stopped in timed succession, the first unit determining the number of complete rotations desired for the control shaft, and the second unit determining the particular rotational increment required to reach the final selected shaft position.

Another feature relates to a selective shaft positioning arrangement employing a plurality of shaft stopping units which can be selectively stopped in any desired angular orientation, the units being interrelated by a differential drive whereby one unit determines the number of complete rotations of the control shaft and the other unit determines the incremental angular rotations to which the shaft must be moved to its final selected position.

A still further feature relates to the novel organization, arrangement and inter-connection of parts which cooperate to produce an improved positional control system for a multi-turn control shaft.

Other objects, features and advantages not particularly enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing,

Fig. 1 is a top-plan view of an embodiment of one of the positioning units according to the invention.

Fig. 2 is a cross-sectional view along line 2—2 viewed in the direction of the arrows.

Fig. 3 is a bottom view of the device of Fig. 1.

Fig. 4 is a developed schematic diagram showing more clearly the mechanical arrangement of the shaft control system.

Fig. 5 is a schematic electric circuit diagram of a suitable electric control circuit, with the mechanical arrangement shown in block diagrammatic form.

Fig. 6 is a sectional view of Fig. 1 taken along

the line 6—6 thereof and viewed in the direction of the arrows.

Fig. 7 is an assembly view of the two units and their respective interconnections as schematically illustrated in Fig. 4.

This invention makes use of two single turn control devices modified and interrelated to obtain multi-turn control and thereby effecting a simplification over devices normally used to obtain such multi-turn control. A single turn control device which readily lends itself to multi-turn operation in accordance with this invention, is described in detail in application Serial No. 515,250, filed December 22, 1943, to which reference is hereby made.

According to the present invention, two single-turn control devices are employed and modified and arranged for synchronized operation by the addition of suitable mechanical synchronizing means. The stop means disclosed in said application for limiting the shaft to one rotation is removed from one device, and the other device is identical with that disclosed in said application Serial No. 515,250.

Referring more particularly to Figs. 1, 2 and 3, the tuning control device is arranged as a self-contained unit mounted between end plates 10 and 11 held in appropriate relationship by tie rods 12, 13, 14. Shaft 15 represents the tuning control shaft whose rotation is to be selectively controlled, and it is provided with suitable ball bearings 16 in the plates 10, 11. A drum 17 is mounted on shaft 15 and has a clamping ring 18 which is capable of axial sliding movement along the shaft by being suitably keyed thereto. The clamping pressure on ring 18 is controlled by a rotatable bar 19 associated with a stud (not shown) coaxial with shaft 15 and threaded therein so as to cooperate with member 18. Dial knob 20 is fixedly mounted on shaft 15 externally of the end plate 11. Drum 17 rotatably supports on its periphery the desired number of stop rings 21A—21L, which are appropriately spaced along the drum by spacer washers 22A—22K. The stop rings and spacers are axially movable along the periphery of the drum and are arranged to be clamped together by clockwise rotation of bar 19 which causes the rim of member 18 to be displaced to the right as viewed in Fig. 1. The clamping pressure at the opposite end of the series, being against a flange (not shown) on drum 17.

Each of the stop rings 21A—21L has a peripheral notch 23A—23L, and the peripheral orientation of each notch relative to shaft 15 determines a corresponding angular stopping position of that shaft when the stop ring containing that particular notch is stopped by a previously selected pawl. Bar 19 provides means for loosening the stop rings on drum 15 so as to allow them to be independently and manually preset to the desired angular orientation around shaft 15 and to be locked in that position. Obviously, these rings can be manually set in any desired combinations depending upon the particular channels to be selected.

Shaft 24 carries the selector cam barrel 25 comprising cams 25A—25L aligned with and each cooperating respectively with one of the stop rings 21A—21L. These cams are fixedly mounted on shaft 24 and each has a recess in its periphery, the recesses being arranged so that they form a helical path around the periphery of barrel 25. As a result of this helical arrangement of the recesses, only one of the previously mentioned

stop rings can be selectively stopped at any given time, these recesses serving to preselect a particular one of a series of cooperating pawls 26A—26L. Pawls 26A—26L are mounted in appropriately spaced relation on, and for independent oscillation around, shaft 27 (Fig. 2) arranged parallel to shaft 24. Each of the pawls is planarly aligned with a corresponding stop ring and with a corresponding cam. For example, the particular pawl 26A which will be used subsequently for purposes of description in connection with Fig. 4, is aligned with coacting cam 25A and cooperating stop ring 21A. Each pawl is provided with one of a series of wire springs 28A—28L, each spring being looped around the fixed rod 29 and having its lower end (Fig. 2) in engagement with the rectangular bar 30 extending between the plates 10 and 11. The upper end of each spring engages the edge of the corresponding pawl thus tending to rotate the pawl counterclockwise as seen in Fig. 2. Each pawl has a toe 31 and a heel 32. The toes are adapted to coast with the notches in the stop rings, while the heels are adapted to cooperate with the slots in the peripheries of the respective cams. It is clear therefore, that the toe of any pawl cannot completely enter a notch in the corresponding stop ring until the heel of that pawl is riding on the lowest portion on the slot of an associated cam. Fig. 2 shows the mechanism wherein the pawl 26K is in selected position so that its heel 32 rests on the low portion of the slot in the associated cam, while the toe 31 is in full registry with the corresponding notch 23K. In this position each remaining pawl, for example pawl 26L, has its heel resting on the non-slotted periphery of the associated cam, thus preventing the toe of the pawl from registering with a notch in the corresponding stop wheel. When any pawl has its toe 31 in complete registry with a notch such as 23K, it effectively locks that particular stop ring against any further rotation. Consequently, the stop ring drum 17 is positively and accurately stopped in the selected position corresponding to that to which the tuning element is to be adjusted. While the tuning shaft is thus positively stopped, the driving motor may continue to rotate because it is coupled to the shaft 15 through a slip friction clutch 32.

A suitable motor 42 schematically illustrated in Figs. 4 and 5, drives gear 33 which in turn drives shaft 15 through the intermediary of slip clutch 32. Gear 35 is rigidly connected to gear 33 and meshes with gear 36 which drives a lost motion device 37 interposed between the cam barrel shaft 24 and the gear 36. Device 37 drives the element 38 which also drives the selector cam barrel 25. The device 37 may take any form well-known in the art and may consist, for example, of a series of washers 37a—37f (Fig. 6), each washer having a pair of diametrically opposite lugs which are off-set in opposite directions from the plane of the washer. The first washer of the series can be connected to the gear 36, and the remaining washers except the last of the series, are free to rotate around the shaft 24. The last washer of the series is connected to shaft 24. By this arrangement, a series of complete revolutions of gear 36 are necessary before the shaft 24 begins to rotate, it being understood that the gear 36 is not keyed or otherwise fastened to shaft 24. For a detailed description of the construction of a preferred form of lost motion device 37, reference may be had to said application Serial No. 515,250, it being understood that the device 37 is

5

designed with sufficient time delay so as to coordinate the various controls as will be described hereinafter. Terminal stop pawl 39 is mounted on fixed shaft 27, so as to confine the rotation of the corresponding terminal stop ring 41 to an angular orientation of approximately 360 degrees. Terminal stop ring 41 is keyed to shaft of drum 17 and cooperates with pawl 39.

When using one of these control devices for positioning a single turn shaft such as that of a tuning condenser or the like, the shaft which drives gear 33 also drives a suitable limit switch and a suitable multi-point selector switch, both of which are schematically illustrated in Figs. 4 and 5 and designated respectively therein by the numerals 49 and 50. The limit switch 49 is directly driven from the above-mentioned shaft while the selector switch 50 is driven through a lost motion device 51 similar to the device 37, so as to provide the necessary time delay in coordinating the various selective functions to be described. The limit switch 49 comprises a rotatable member having a pin which cooperates with a snap switch arm so that when the pin is at one limit of its movement, it closes one set of contacts and opens the other set, and vice versa, when the said pin is at the opposite limit of its movement.

The selector switch 50 is of the usual "line finder" type having a rotatable brush which is driven by the same motor which drives the shafts 24 and 15. This switch is provided with a series of bank contacts which are multiplied to the corresponding fixed contacts of a manually rotatable selector switch, the brush arm of which is grounded. In accordance with well-known "line finder" principles, the grounding of any contact in the manual switch applies a ground to the corresponding bank contact of the selector switch, and when the cycle of operations is at a predetermined point to be described, the switch motor is set into operation and causes the selector switch to seek the previously grounded bank contact. The stationary bank contacts of the selector switch correspond respectively to the selector cams 25A—25L, the arrangement being such that when the rotary brush of the selector switch finds the particular grounded contact of its bank of contacts, the common motor comes to a stop as does the cam barrel 25 in a predetermined angular orientation which in turn determines the selection of one of the corresponding pawls 26A—26L. The motor then reverses its direction of rotation but without affecting the selected stopped position of barrel 25. For a detailed description of the functioning of the various parts described hereinabove, reference may be had to said application Serial No. 515,250. The foregoing described structure functions as described in said application normally as a single turn selector control device. In accordance with the present invention, a pair of such devices are combined to achieve the effect of a multi-turn selector. In order to achieve this result, it is necessary to provide a special mechanism which cooperates with both single turn selector units whereby one of such units acts to determine the number of rotations of the controlled shaft and the other unit determines the particular angular orientation of the controlled shaft in its selected rotation.

Fig. 4 shows an arrangement of the units according to the invention with the various parts schematically illustrated and arranged to simplify the explanation. Fig. 7 is an assembly view corresponding to the schematic view of Fig. 4. The

6

parts of Fig. 4 which correspond to those of Figs. 1 to 3 bear the same designation numerals primed and double primed respectively. For simplicity of explanation, only one stop ring, one selector cam and one pawl are shown for each of the units, it being understood of course that each unit comprises the requisite number of stop rings, selector cams and associated pawls.

Both unit #1 and unit #2 are powered from the same driving motor 42 (Figs. 4 and 5) which may be of the direct current reversible type. Unit #2 is driven through a lost motion device 43 which may be similar to device 37 (Fig. 1), it being designed to provide the appropriate time delay between the rotation of the stop ring drum 17' of unit #1 and the stop ring drum 17'' of unit #2.

Shaft 46 provides direct drive through slip clutches 32' and 32'' to the stop ring drums 17' and 17'' respectively, and worm gears 47 and 48 drive the limit switch 49 and the multi-point selector switch 50 respectively.

Stop ring shafts 15' and 15'' of units 1 and 2 respectively cooperate, in accordance with the invention, with a device which controls the desired rotational relations between the two stop drums. This means is diagrammatically illustrated in Fig. 4 in the form of a differential link, the extent and direction of rotation of which is determined by the relative movements of the two shafts 15' and 15''. This differential link may comprise for example a planetary gear system 53, the planetary gears 54 of which are coupled to shaft 15' through idler gears 55, the idler gear shafts being indicated schematically by numerals 56 and 57. In the drawing, the various shaft interconnections are represented by dot-dash lines. The sun gear 58 is coupled to shaft 15'' of unit #2 as indicated by numeral 59; ring gear 60 is connected to a rotatable disc 61 which carries a ratchet arm 62 pivotally mounted on the disc 61 at 63 and normally biased by spring 64 in a clockwise direction against the stop 65 carried by the disc. Extending parallel to the axis of the disc 61 is a fixed shaft 66 on which is pivotally mounted an anvil 67. This anvil has at its left-hand end a downwardly depending lip or flange which overlies and extends across all the pawls 26A'—26L'. The anvil 67 is normally biased by means of the tension spring 68 so as to maintain the lip 68 in position between the end of the pawl toes and the associated stop rings when the pawls are in non-selected position. In other words, the pawl toes cannot enter the corresponding notches in the stop rings until the anvil 67 has been rotated clockwise as viewed in Fig. 4 so as to unlatch the lip 68 from the pawls. The unlatching of the pawls by anvil 67 is accomplished at the proper timed instant by means of the ratchet 62 which, during the counter-clockwise rotation of disc 61, engages the right-hand end of anvil 67. The elements 53 to 60 can be housed in a separate unit represented by the dotted outline 70, which can be appropriately attached to unit #2 as indicated in Fig. 2.

In Fig. 4, there is illustrated a device 71 which is to be adjusted to any one of a large number of selected positions. For example, device 71 may be any well-known form of permeability or slug tuner, comprising a tubular inductance winding and a slidable magnetic core whose extent of telescopic adjustment determines the effective inductance. Because of the linear movement of this core, it is usually necessary to employ some kind of lead screw and follower. Likewise, because of the critical nature of tuning, the

lead screw must be capable of a considerable number of rotations. In Fig. 4, line 12 represents the shaft which is connected to the lead screw, and it is therefore necessary to determine with extreme accuracy the total angular orientation of the shaft, which may vary from a very small fraction of one rotation to $2\pi n + a$, where "n" is the total number of complete rotations and "a" is the additional fractional rotation necessary to achieve final selective positioning of device 71.

The selecting of the desired channel, i. e., the channel determined by the desired setting of device 71, is effected by moving switch arm 74 to ground the appropriate channel contact, e. g., contact 75 (Fig. 5). The bank contacts of switch 73 are multiplied to corresponding bank contacts of the automatic switch 50, which operates on the well-known "line finder" principle. It should be observed that the motor start relay 76 remains energized during the entire time that the equipment remains at rest in a selected position. This normal circuit for relay 76 is traceable from the grounded brush 74 through the multiplied bank contacts of switches 73 and 50, brush 77, closed contacts 78 of the end limit control switch 49, winding of relay 76 and thence to the grounded battery 79. As long as relay 76 is thus operated it opens the power circuit of motor 42 at contacts 80. When a new channel selection is desired, the movement of brush 74 to a different contact opens this circuit for relay 76. As soon as relay 76 deenergizes it closes a circuit traceable from ground through the armature of motor 42, contacts 80 of relay 76 and thence to ground through battery 79. The direction of rotation of the motor 42 is determined by the condition of the motor reversing relay 81. In the particular condition as illustrated in Fig. 5, the directional winding 82 of the motor is energized from ground through that winding, thence through the back contact 83 and armature 84 of relay 81 to the grounded battery through contacts 80 of relay 76. This direction of the motor rotation continues until the rotatable element of the end limit switch 49 rotates sufficiently to cause the pin 85 to close the contacts 86, and brush 77 makes contact with the grounded terminal. Under the above described conditions, it will be assumed that the motor 42 begins to rotate the stop drum shaft 15' of unit #1 in a counterclockwise or homing direction. It will be observed however, that the brush 77 of the finder switch does not immediately start to rotate at the same time as shaft 15' because of the lost motion device 51 which is interposed between the gear 52 and the shaft of switch 50. This lost motion device is designed so as to provide sufficient time delay after the initiation of the motor rotation, to enable the shaft 15' to rotate sufficiently to cause the stop tooth 40 to engage the limiting stop pawl 39 representing the home position of unit #1. Likewise, the cam barrel 25' starts rotating a timed interval after the beginning of rotation of the motor by reason of the lost motion device 37'. As soon as the cam barrel 25' starts to rotate counterclockwise, it causes a previously selected pawl e. g. 26A' to be rotated clockwise against the action of its associated spring, thus permitting the stop ring drum 17' to rotate in a counterclockwise direction. This rotation continues until the stop lug 40 on the terminal stop ring 41 engages the limiting stop lug 39, as above described. At the same time that motor 42 begins to rotate, it rotates the control element of the limit switch 49 in a counterclock-

wise direction. Almost immediately after beginning of motor rotation contact 78 is opened. Shortly thereafter contact 86 becomes closed allowing the circuit to be completed through switch 80 and brush 77.

After a timed interval determined by the delay design of the lost motion device 51, the brush 77 starts rotating to seek the grounded terminal in its contact bank, which when found thereby simultaneously determines the selective stopping position of drum 25'. Likewise, there is a predetermined time delay between the starting of the motor rotation and the starting of shaft 15', this delay being introduced by the lost motions device 37' and 43. This lost motion is required because unit #1 must set up its position, thereby determining the position of disc 61 and latch 62 before unit #2 begins its set-up cycle. When lug 40 engages stop 39, stop ring drum 17' stops rotating allowing clutch 32' to slip. While the stop ring drum 17' is thus stopped the lost motion devices 37', 37'' and 51 have now taken up, and the cam barrels 25' and 25'' rotate counterclockwise in synchronism with switch 50. When brush 77 comes to rest on the selected grounded contact of switch 50, it closes a circuit traceable through the contacts 86 of the home limit switch thence through the winding of motor reverse relay 81 to the grounded battery 79. Relay 81 thereupon connects the reversing motor field winding 87 in circuit and the motor stops, as does the drum 25', and then the motor begins to rotate in the opposite direction. During the reverse rotation of the motor the previously selected stopping position of drum 25 is not disturbed because of the action of the lost-motion device 37'.

As the stop ring drum 17' was being turned counterclockwise to home position as above described, the disc 61 was rotated in a clockwise direction through the intermediary of differential 53, thus removing the ratchet 62 away from anvil 67. After a short interval determined by lost motion device 43, the stop ring drum 17'' begins to rotate counterclockwise in its homing direction causing the member 53 to rotate in a clockwise direction. After another short interval determined by device 37'', the cam barrel 25'' rotates in synchronism with barrel 25' and with selector switch 50 as above-mentioned. When the selector switch brush 77 reaches the grounded terminal as above described, the end limit switch 86 having meanwhile closed its contacts, the motor stops and reverses. During this reversal, neither of the cam barrels 25' or 25'' reverses because of the intervening lost motion devices 37' and 37''. However, both stop ring drums 17' and 17'' rotate clockwise until the previously selected pawl 26A' drops into the notch 23A' on the stop ring associated with the selected pawl. This effectively stops further rotation of stop drum barrel 17'. However, barrel 17'' is not stopped by the previously selected pawl 26A'' because all the pawls are held in their latched position by the lip 68 of anvil 67. Since however, the drum 17' is stopped and since the drum 17'' is rotated in a clockwise direction, the net result is that the member 61 rotates in a counterclockwise direction so as to again bring the ratchet 62 into engagement with anvil 67 thereby unlatching the selected pawl 26A''. Consequently, the drum 17'' continues to rotate in a clockwise direction until it is positively stopped by the selected pawl 26A'' entering the corresponding notch in the associated stop ring. It will be

seen therefore, that the extent of counterclockwise rotation of the member 61 which is necessary to unlatch the pawls of unit #2, is a function of the extent of clockwise motion that the drum 17' undergoes before it is selectively stopped by the previously selected pawl 26A'. In other words, until the member 61 causes unlatching of the pawls of unit #2, the shaft 72 continues to rotate the proper number of whole turns $2\pi n$ as determined by the extent of clockwise rotation of drum 17'. Thereafter, the fractional turn which is necessary to set the shaft 72 is determined by the partial rotation which the drum 17' undergoes before it is stopped by the selected pawl 26A'. Thus unit #1 determines the number of complete rotations that shaft 72 is to undergo, and unit #1 determines the additional fractional turn required for final setting of shaft 72.

It should be observed that in the particular condition illustrated in Figs. 4 and 5, the various parts indicate that portion of the operating cycle during which the positioning elements of each of unit #1 are running to some reference position which is referred to as the home position. When the mechanism is at rest as a result of having finally selectively set the shaft 72, the circuit is completed from battery 79 through relay 76 to ground through brushes 77 and 74 which results in opening of the motor power circuit. When it is desired to select a different preset shaft position, brush 74 is moved to the contact corresponding to that position. This causes relay 76 to release and close its contacts 80, thereby closing the motor power circuit. Motor 41 begins rotating and drives units #1 and #2, limit switch 49, and channel seeking switch 50 as described in connection with Fig. 4.

Shortly after rotation of channel seeking switch 50 begins, home limit switch contact 86 closes and lead motor reverse relay 30 is operated. This causes reversal of motor 42. Channel seeking switch arm 50 remains in its selectively stopped position, but limit switch 49 rotates and causes the opening of home limit switch contacts 86.

In order to maintain rotation of motor 42, motor reverse relay 81 is kept energized by a holding circuit traceable from grounded battery 79, conductor 88, winding of relay 81, contacts 89, contacts 90 to ground. This holding circuit keeps motor reverse relay 81 energized until the rotation of limit switch 49 causes the end limit switch contact 78 to close. At this time units #1 and #2 have completed their selective positioning cycle and the tuning shaft is at rest at the desired selected angular position.

To establish a new position of the driven shaft 72 corresponding to another desired channel, brush 74 of switch 73 is rotated to that channel. The dial which may be engraved on the front face of knob 20 of unit #1 indicates the portion of a turn in which the operating cycle of unit #2 will be completed. A detailed description of this dial will be found in Patent No. 2,378,941, granted June 26, 1945.

Bar 19 (Figs. 1 and 3) associated with this dial is rotated to unlock the stop rings of unit #2 and shaft 14'' (Fig. 4) is rotated to the approximate portion of a turn on which set-up is required as indicated by the dial and then re-locked. In a similar way, the stop rings of unit #1 are unlocked and shaft 14'' (Fig. 4) is rotated to the desired position and then re-locked, or alternatively the brush 74 can be momentarily moved off this previously set contact thus starting a tuning cycle. After completion of this tuning

cycle, the shaft 72 (Fig. 4) of the tuning element is at rest within one turn of its final position which eliminates the necessity of manually turning shaft 14' of unit #2 through a number of revolutions. With this last method of setting, the exact position of shaft 72 is selected after completion of the tuning cycle, and in subsequent tuning cycles the shaft 72 will be reset to the same position every time the corresponding channel is selected by selector switch 73. In order to reduce the labor necessary in cranking unit #2 through a plurality of revolutions, unit #1 may be set-up at the desired turn as indicated by its dial. The selector switch may then be momentarily moved from the contact corresponding to the channel on which set-up is desired. This starts a tuning cycle which is completed with unit #2 within one turn of the final position required. The locking bar of unit #2 may then be loosened, releasing the stop rings, and the shaft rotated to its exact position and relocked. The mechanism is then ready to stop the shaft at that position whenever that channel is selected.

In order to prevent damage to the driven element 71, a lost-motion device 91 may be provided between shaft 72 and a suitable rigid member 92 so as to prevent over-travel of unit #2 in the event of a faulty set-up cycle. This lost-motion device also establishes the home or terminal position of the stop ring drum 17'.

In order that the operations may be more clearly followed, the following table illustrates the timing sequence of a complete tuning or selecting cycle.

1. Selector switch 73 is moved to a new position.
2. Ground is removed from brush 77.
3. Relay 76 falls out.
4. Motor 42 begins rotating.
5. Unit #1 is driven counterclockwise toward its home position.
6. Cam drum 25' begins rotation.
7. Unit #2 is driven counterclockwise after lost motion 43 takes up. 51 begins clockwise rotation.
8. Cam drum 25'' begins rotation. Selector switch 50 begins rotation in synchronism with 25' and 25''.
9. Limit switch 49 closes contact 86.
10. Brush 77 of switch 50 contacts the grounded switch position.
11. Reversing relay 81 pulls in.
12. Drive motor 42 reverses.
13. 25', 25'', and 50 stay in position. Stop ring 17' is rotated in a clockwise direction. Limit switch 49 is rotated in a clockwise direction.
14. Stop ring 17' sets up with the pawl falling into the notch.
15. Stop ring 17'' begins rotation in a clockwise direction.
16. Pawl anvil 67 releases selected pawl 26A'.
17. Stop ring 17'' sets up to desired position.
18. Limit switch 49 closes contact 78.
19. Relay 76 pulls in.
20. Motor stops. Completing tuning cycle.

While there has been here described a preferred embodiment of this invention, it is understood that various changes and modifications may be made therein without departing from the scope of the invention.

What is claimed is:

1. An arrangement for selectively positioning a rotatable shaft such as a control shaft for radio apparatus and the like which shaft undergoes more than one complete rotation before arriving at a certain final selective angular orientation,

comprising a first automatic shaft positioning unit arranged to act as a turn controlling device to determine the number of complete rotations for said control shaft, a second similar automatic shaft positioning unit arranged to control the additional fractional rotation of said shaft to bring it to said final selective orientation, and a differential gear system operated under control of both said units to cause said shaft to be selectively stopped by the second unit only after said shaft has executed a number of complete rotations under control of the first unit.

2. An arrangement for selectively positioning a rotatable shaft such as a control shaft for radio apparatus and the like which shaft undergoes more than one complete rotation before arriving at a certain final selective angular position, comprising a first automatic shaft positioning unit arranged to act as a turn controlling device to control the number of complete rotations for said control shaft, a second similar automatic shaft positioning unit arranged to control the additional fractional rotation of said shaft to bring said control shaft to said final selective position, and means interlinking said units so that the first unit controls the number of complete rotations said shaft undergoes before said shaft is selectively stopped by said second unit, the last-mentioned means including a differential device and an element controlled thereby for controlling the said second unit, the extent and direction of movement of said element being determined by the conjoint selective movements of the first and second units.

3. An arrangement for selectively positioning a rotatable shaft such as a control shaft for radio apparatus and the like which shaft undergoes more than one complete rotation before arriving at a certain final selective angular position, comprising a first automatic shaft positioning unit arranged to act as a turn controlling device to determine the number of complete rotations for said control shaft, a second similar automatic shaft positioning unit arranged to control the additional fractional rotation of said shaft to bring said control shaft to said final selective position, and means interlinking said units so that the first unit controls the number of complete rotations said shaft undergoes before said shaft is selectively stopped by said second unit, the last-mentioned means including a differential gear train and a movable member controlled thereby for controlling the said second unit, the said gear train having one section connected to rotate in timed relation with the said first unit and another section connected to rotate in timed relation with the said second unit, said movable member having its position controlled by the relative rotations of said gear sections.

4. An arrangement for selectively positioning a rotatable shaft such as a control shaft for radio apparatus and the like which shaft undergoes more than one complete rotation before arriving at a certain final selective angular position, comprising a first automatic shaft positioning unit arranged to act as a turn controlling device to control the number of complete rotations for said control shaft, a second similar automatic shaft positioning unit arranged to control the additional fractional rotation of said shaft to bring said shaft to said final selective position, each of said units including a selectively rotatable stop ring assembly, and differential means interlinking said units, said differential means having a selectively positioned element which is responsive to the

relative selective movements of said stop ring assemblies for determining the number of complete rotations of said shaft.

5. An arrangement for selectively positioning a rotatable shaft such as a control shaft for radio apparatus and the like which shaft undergoes more than one complete rotation before arriving at a certain final selective angular orientation, comprising a first automatic shaft positioning unit arranged to act as a turn controlling device to control the number of complete rotations for said control shaft, a second similar automatic shaft positioning unit arranged to control the additional fractional rotation of said shaft to bring it to said final selective orientation, each of said units including a selectively rotatable stop ring assembly, and a cooperating shiftable pawl assembly; a differential gear train coupled to the stop ring assemblies of both units, and a control member for the stop ring assembly of the second unit said control member having its extent of movement and direction of movement controlled by the differential gear of said differential gear train.

6. An arrangement for selectively positioning a rotatable shaft such as a control shaft for radio apparatus and the like, which shaft undergoes more than one complete rotation before arriving at a certain final selective angular position, comprising a first automatic shaft positioning control unit arranged to act as a turn-controlling device to control the number of complete rotations for said control shaft, a second similar automatic shaft positioning control unit arranged to control the additional fractional rotation of said shaft to bring it to said final selective position, each of said units including a selectively rotatable stop ring assembly and a selectively movable pawl assembly, there being one pawl for each stop ring, means to move a selected pawl to a preliminary selected position, means to rotate the associated stop ring assembly to a selected position to enable said pawl to move to its final position where it stops the said associated assembly, and means coupled to the stop ring assemblies of both units whereby the stop ring assembly of the second unit continues rotating until the stop ring assembly of the first unit is selectively stopped and until the stop ring of the second unit is likewise selectively stopped by its associated selected pawl assembly.

7. An arrangement according to claim 6 in which each of said automatic units includes a rotatable cam barrel whose angular orientation determines the selection of an individual one of the associated pawls.

8. An arrangement for selectively positioning a radio control shaft and the like which shaft undergoes more than one complete rotation before arriving at a certain final selective angular position, comprising a first automatic shaft-positioning control unit, a second similar automatic shaft-positioning control unit, each of said units including a selectively rotatable stop ring assembly, means to limit the rotation of the stop ring assembly of the first unit to one complete rotation while allowing the stop ring assembly of the second unit to move a plurality of complete rotations, means to drive the stop ring assemblies of both units from a common shaft but with the initiation of rotation of the stop ring assembly of the second unit delayed a predetermined amount with respect to the initiation of rotation of the stop ring assembly of the first unit, said shaft to be controlled being connected

13

to the stop ring assembly of the second unit, each unit having a series of selectively shiftable pawls for selectively stopping the associated stop ring unit, a member which is differentially controlled by the movement of the stop ring assemblies of the first and second units, said member normally rendering the pawls of the second unit from moving into stopping relation with the associated stop rings, and means responsive to the selective stopping of the first unit for causing said member to unlatch said pawls of the second unit and thereby to allow said pawls of the second unit selectively to stop the associated stop ring assembly.

9. An arrangement for automatically controlling the positioning of a control shaft, comprising a first automatic control unit, a second automatic control unit each of said units having a pair of rotatable selector drums one drum comprising a series of pre-settable stop rings and the other drum comprising a series of selectable pawl actuating cams one for each of said stop rings, a series of oscillatable pawls for each cam drum and cooperating with the associated stop ring drum to stop it in a selected angular position, means to limit the rotation of the stop ring drum of the first unit to one complete rotation, a common reversible electric motor coupled through slip clutch means to the stop ring drums of both said units, means to start said motor to drive the cam drum of the first unit in a homing direction, means selectively to stop the stop ring drum of the first unit when the associated cam drum reaches a selected angular orientation but without simultaneously stopping the stop ring drum of said second unit, a common locking latch for all the pawls of the second unit and normally preventing said pawls from stopping the stop ring drum of said second unit, releasing means for said locking latch, means to move said releasing means away from said latch to an extent determined by the particular pawl which is selected in said first unit, and means effective in response to the selective stopping of the stop ring drum of the first unit to move said releasing means to unlock said latching means and thereby determine the number of complete rotations for the stopping ring drum of said second unit, said control shaft being connected to the stop ring drum of said second unit.

10. An arrangement of the character described, comprising a first automatic control unit, a second automatic control unit, each of said units being of the stop ring drum and selectable stopping pawl type, a selector switch, means for driving both said units and said switch from said motor, means controlled by said switch for selecting a stopping pawl in each of said units, time delay means for delaying the selective action of the second unit with respect to the first unit, a latching device common to all the pawls of the second unit for normally preventing them from stopping the stop ring drum of the second unit, means responsive to the selective stopping of the said first unit for unlatching said latching device after the stop ring drum of the second device has made a number of complete rotations as determined by the extent of selective rotation of the stop ring drum of the first unit, and a master shaft to be controlled and connected to the stop ring drum of said second unit.

11. An arrangement of the character described, comprising a first automatic control unit, a second automatic control unit, each of said units having a rotatable drum which is adapted to be

14

selectively stopped in any desired angular orientation, a plurality of selectively operable stops for the drums of each unit, a latch common to all the stops for the second drum and normally holding said stops out of stopping engagement with said drum, a shiftable member controlled jointly by the relative rotations of the drums of the first and second units for unlocking said latch means to enable the drum of the second unit to make a plurality of complete rotations, and selector switch means for controlling the selection of a stop member in the first unit and for controlling the selection of a stop member in the second unit.

12. An arrangement according to claim 11 in which said shiftable member is rotatably mounted on a shaft which is connected to the differential gear of a differential gear train, the remaining gears of the differential gear train being coupled respectively to the drums of the said first and second units.

13. An arrangement according to claim 11 in which said first drum is of the homing type and is arranged to undergo a homing rotation for the purpose of selecting one of its associated stops and in a reversed direction for the purpose of being selectively stopped by the said selected stop.

14. An arrangement according to claim 11 in which the first unit is provided with an additional rotatable cam drum which is coupled to the shaft of the stop drum through a lost motion connection and an additional lost motion connection is provided between the motor and the second unit.

15. An arrangement according to claim 11 in which said shiftable member is in the form of a ratchet pivotally mounted on a rotatable disc, said disc being connected to the differentially responsive member of a differential gear train, the remaining gears of said train being connected respectively to the drum shafts of said first and second units.

16. An arrangement of the character described, comprising a main drive shaft, a master shaft to be controlled, a plurality of similar automatic control units for controlling the positioning of said master shaft, a selector switch and a limit switch driven from said main driving shaft, a selective stop drum in each of said automatic control units, a differential gear system operated in response to the relative rotations of the said drums in said units, a lost motion device between the first and second units for delaying the beginning of the selective movement of the second unit a predetermined time interval after the beginning of the selective movement of the first unit, means controlled by said selector switch for selectively determining the extent of rotation of the stop drum in said first unit, and means controlled by the extent of movement of said stop drum in the first unit and the extent of rotation of said shiftable member for determining the number of complete rotations for the stop drum of the second unit.

17. An arrangement of the character described, comprising a master shaft which is to be rotated more than one complete rotation to a final selective position, a first automatic shaft control unit, a second automatic shaft control unit, each of said units comprising a stop ring drum and a selector cam drum and a plurality of stopping pawls for stopping the stop ring drum under control of the setting of the associated cam drum; means to limit the rotational movement of the

15

stop ring drum of the first unit to less than one complete rotation whereby the setting of said stop ring drum of the first unit determines the number of complete rotations of the stop ring drum of the second unit, and selector switch means for selectively stopping the stop ring drums of both units when the said master shaft has arrived at its desired final selective position, said master shaft being connected to the stop ring drum of the said second unit.

18. An arrangement of the character described, comprising a reversible electric motor, a first shaft section driven by said motor, a second shaft section driven from the first shaft section through a lost motion connection, a stop ring drum driven through a slip-friction clutch from the said first shaft section, another stop ring drum driven through a slip-friction clutch from the said second shaft section, a selective cam drum driven through a lost motion connection from the first shaft section, another selective cam drum driven through a lost motion connection from the second shaft section, selectively operable stops controlled by the first cam drum for selectively stopping the first-mentioned stop ring drum, another set of selectively operable stops controlled by the second-mentioned cam drum and arranged to selectively stop the second-mentioned stop ring drum, and differential control means for rendering the last-mentioned set of selective stops ineffective to stop said second stop ring drum until said second stop ring drum has undergone a number of complete rotations determined by the selective setting of the first-mentioned stop ring drum.

19. An arrangement according to claim 18 in which said first-mentioned stop ring drum is connected to a limit control device for limiting its rotation to approximately 360 degrees.

20. An arrangement according to claim 18 in which both of said shaft sections are driven from a common reversible electric motor, said motor having a start circuit which is controlled by said selector switch and a limit control switch which is driven by said first shaft section, a motor reversing circuit also controlled by said selector switch and by said limit control switch, and means for causing said motor to rotate in one direction to restore the stop ring drum of the said first unit to a homing position to set the associated cam drum in selective position and for reversing the direction of rotation of said first stop ring drum until it arrives at selective stopping position.

21. Apparatus for selectively positioning a control shaft which is arranged to undergo more

16

than one complete rotation in arriving at its final selected position, comprising a first shaft control unit arranged to execute less than one complete rotation, a reversible electric motor, a second shaft control unit driven from said motor and provided with a lost motion mechanism for delaying the beginning of its control cycle for a predetermined time interval after the beginning of the control cycle of the first unit, said second unit being arranged to execute more than one complete rotation, each of said units including a plurality of devices providing selectable stop combinations, a differential device jointly controlled by the shafts of both said units, a device for holding and releasing the selective stopping means in said second unit, the last-mentioned device being connected to the differentially movable element of said differential means, an end limit switch responsive to the complete rotation in either direction of said first unit, a multi-point selector switch having a plurality of contacts one allotted to each selective stopping position for said first unit, means to operate said limit switch and said selector switch from said motor, circuit means controlled by said motor for causing the first unit to be rotated in one direction to a select stop combination therein and for causing the second unit to be rotated to select a stop combination therein, other circuit means for thereafter causing the motor to reverse its direction of rotation to reverse the direction of rotation of said first unit until the selected stop combination of the first unit is effective to stop the first unit in its reversed motion, while allowing continuous rotation of the second unit until the stop combination of said second unit is effective to stop said control shaft in its final selected position.

22. Apparatus according to claim 21 in which said differential means includes a planetary gear arrangement in which the sun gear is connected to the shaft of the second unit, planetary gears are connected to the shaft of the first unit, and the ring gear is connected to said stop-holding and releasing means.

RICHARD W. MAY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,246,050	Leishman	June 17, 1941
2,351,185	Boterweg et al.	June 13, 1944
2,391,470	May	Dec. 25, 1945