Sept. 4, 1945. V. MOORE 2,384,114

REMOTE CONTROL APPARATUS

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FIG. 1

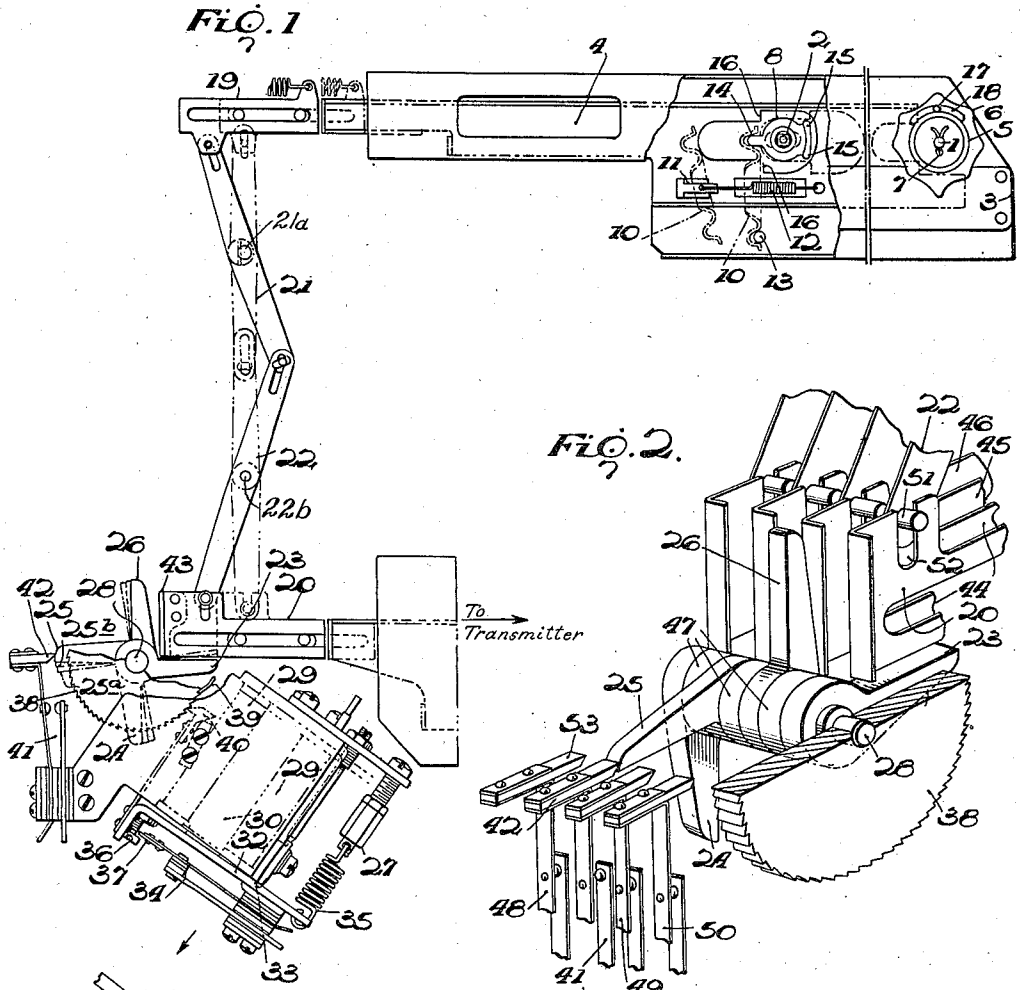


FIG. 2.

FIG. 1a.

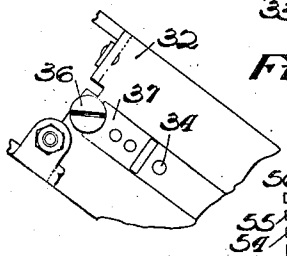
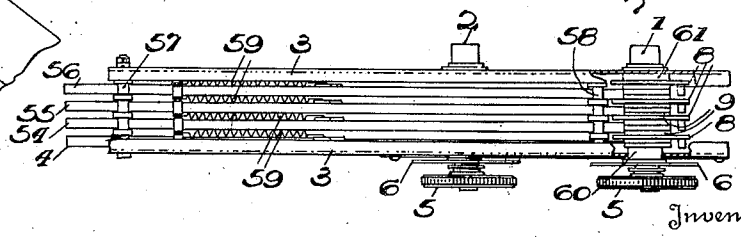


FIG. 3.



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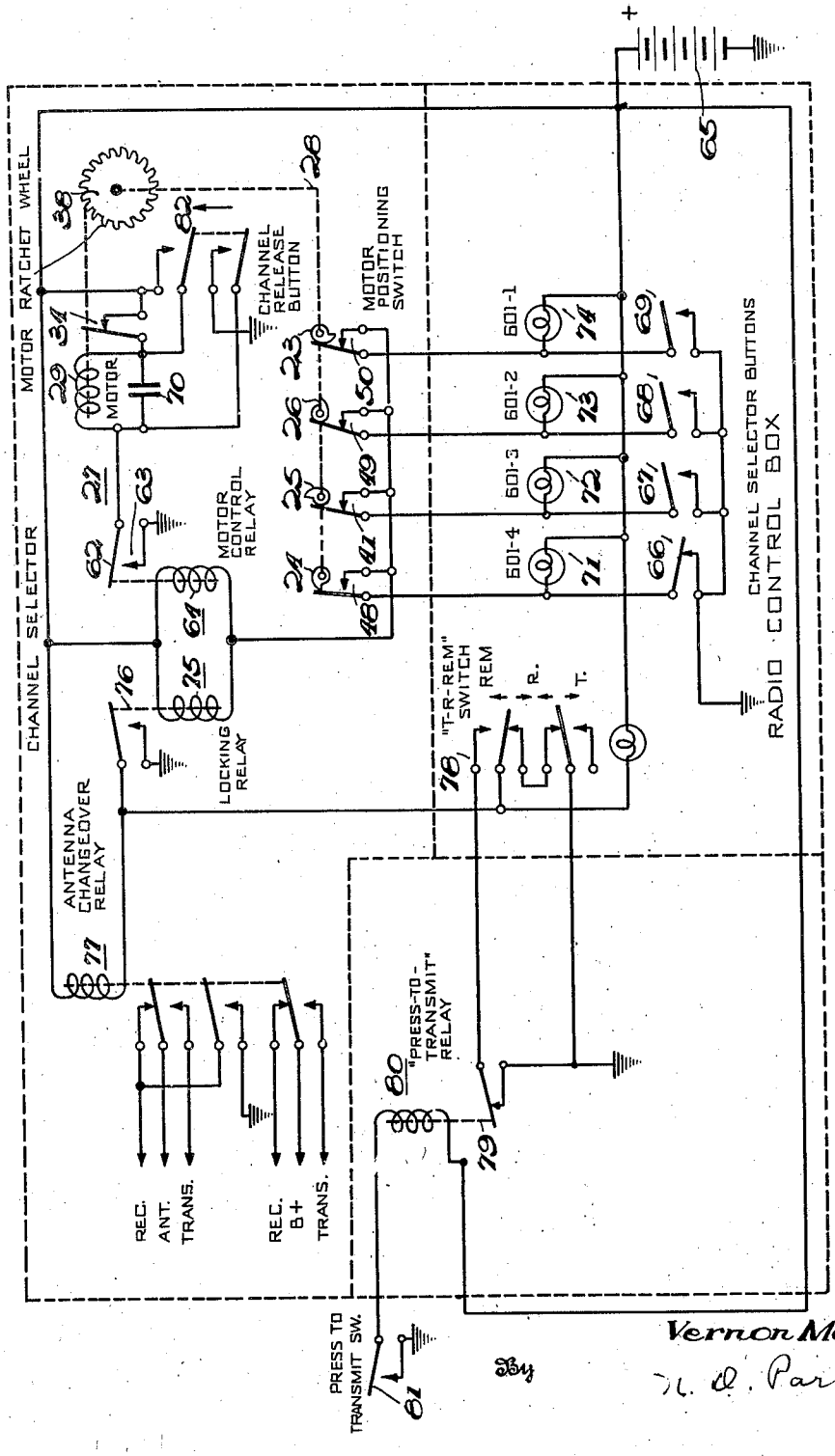


FIG. 4.

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REMOTE CONTROL APPARATUS

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Fig. 5

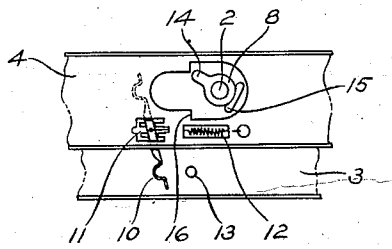


Fig. 5a

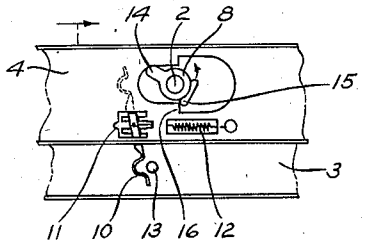
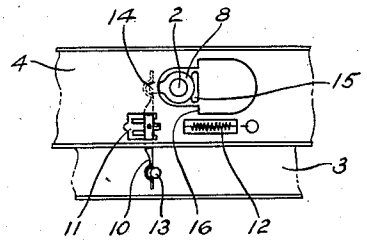


Fig. 5b



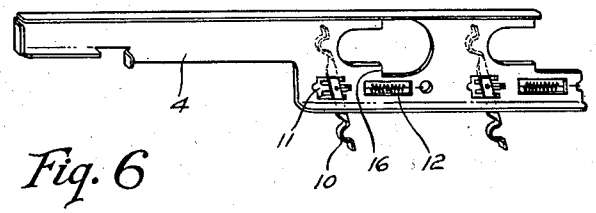


Fig. 6

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UNITED STATES PATENT OFFICE

2,384,114

REMOTE CONTROL APPARATUS

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Application February 19, 1943, Serial No. 476,448

9 Claims. (Cl. 172—239)

This invention relates to radio tuning apparatus and more particularly to radio tuning apparatus controlling several shafts and adapted for remote control.

Simultaneous adjustment of the tuned circuits in a radio receiver from a single dial is well known. In the initial development of the single dial receiver, it was found that the loading on each of the tuned circuits must be very nearly alike for the circuits to track properly with each other over the tuning range, and this condition was readily fulfilled for all circuits save the input circuit, for this might be connected to a wide variety of antennas, with consequent wide variation in the loading and poor tracking of this circuit. At first, an antenna coupling tube was employed to isolate this first circuit from the effects of various antennas, but with the advent of higher powered transmitting stations, the effects of cross modulation became so obnoxious that the antenna coupling tube was finally discarded and the required isolation secured by reducing the coupling between the antenna and the first tuned circuit to the point where the variable loading effects of different antennas no longer caused mistracking. Unfortunately, this expedient also diminished the energy transfer from the antenna circuit to the first tuned circuit, so that the voltage on the first amplifier grid dropped materially. The attendant loss in overall performance in receivers was avoided by adding another amplifier stage, which also contributed increased selectivity. When the need was felt for a push button tuned radio receiver, the demand was relatively easily fulfilled, for it was only necessary to provide a method of adjusting a single shaft to several selected angular positions.

No such simple solution has made its advent in the field of transmission, because the output tube must be operated into a definite value of load, and this load, to secure good over-all efficiency, must be obtained by varying the antenna coupling to the output tank circuit. Therefore, this coupling is almost never such as to prevent the electrical characteristics of various antennas from affecting the tuning of the output tank circuit. Poor energy transfer to the antenna circuits in transmitters cannot be tolerated because of the great cost of supplying the additional power to make up for such inefficiency. Thus, this circuit tunes differently than the tuned radio frequency amplifier circuits and tunes still differently when various antennas are connected to the output terminals. As a result, single dial control is not found in transmitters having continuously variable output frequency, although it is found in transmitters having a number of selected, pretuned channels. In such transmitters, separate tuning elements are generally employed in each stage for each channel and the appropriate tuning elements are switched into the circuits by manipulation of the single control.

Another example of a type of transmitter in which continuous tracking of a number of tuned circuits is very difficult if not impossible, is a transmitter in which there are several frequency multiplier stages, such as triplers or doublers.

Because of the difficulties in tracking all of the tuned circuits of a transmitter having continuously variable output frequency, some prior designs have provided separate means for tuning each stage, and the remote control arrangements provided to operate this type of equipment have been complex and slow in operating, and difficult to adjust for new channels.

A prior art system has been developed for maintaining continuous tracking of circuits which is a forebear of the invention to be disclosed. A number of specially shaped positioning plates are mounted on each of the shafts to be controlled and are spaced along the axis of the shaft on which they are mounted. A driving slide moves linearly into engagement with one set of the positioning plates, rotating the shafts to which these plates are fixed into their desired angular positions and holding them there. One slide is provided for each set of positioning plates, so that as many combinations of position may be derived as there are driving slides and positioning plates attached to any one shaft. For maximum flexibility, the positioning plates are mounted on the shafts in such a manner that their angular position may be easily adjusted and then maintained in that position after adjustment. Two ratchet motors cooperate in operating the driving slides, one selecting the slide to be operated and the other performing the actual operation. Each of these motors drives two cam assemblies, one actuating switches to interrupt the power supply to the ratchet motor when it reaches the selected angular position, and the other forcing the selected driving slide into the desired position. Means are also provided for disengaging all the driving slides simultaneously from the positioning plates on all the shafts, in order that the equipment to which the shafts are connected may be freely removed. This means comprises a switch which energizes the second, or operating ratchet motor, until it has rotated out of the position in which it maintains the driving slide in the

indexing position, so that the slide now returns to the normal position under the influence of the restoring spring attached to it, and all the controlled shafts are freed of restraint by any of the driving slides. As the selecting and operating motors operate in sequence, an objectionably long time interval is consumed in transferring the equipment from one operating channel to another.

One of the principal objects of this invention is to provide new and novel apparatus for the indexing of a plurality of shafts to a number of selected independent positions from a remote point with a single motor performing all the operations pursuant to the indexing of said shafts.

Another object of the invention is to provide new and novel apparatus for the control of a plurality of shafts from a remote point utilizing a single motor and having means for disengaging said shafts from control by the application of power to said motor.

Still another object of the invention is to provide new and novel apparatus for the control of a plurality of shafts to a number of selected independent positions from a remote point in which the time required for selection is shortened with respect to previous systems of this nature.

The above objects and advantages of the invention are accomplished by mounting on each of the shafts to be controlled a number of separately adjustable cam plates spaced along the axis of said shafts, and providing a number of parallel driving slides, each of which engages a cam plate on each of the shafts to be controlled, indexing the shaft to a position determined by the setting of the cam plate. The motive means for actuating the driving slides is provided by a stepping or ratchet motor driving a cam arm assembly which selectively engages one or another of the driving slides. The selected slide is forced into engagement with corresponding cam plates on each of the controlled shafts. Located adjacent the cam arm assembly is an assembly of switches whose blades are actuated mechanically by the passage of the cam arms thereby, and these switches are connected to the operating winding of the stepping motor in such a manner that the power supply is interrupted and the motor stopped upon the engagement of the energized switch element by a cam arm. The cam arms and the follower actuating the switch are so designed that the switch is maintained in the opened position during rotation of the cam arms assembly corresponding to a number of steps of motor operation and the relation between the cam arms and the driving slides is such that the contacts are maintained in the open position when the cam arm has rotated so as to disengage all the driving slides. In practice, the driving slides are released by actuating a push-button switch which connects the magnetizing winding of the stepping motor to the source of electric power independently of the cam operated switches and steps the motor forward one step each time the switch is closed. The operator cyclically operates this release switch until all driving slides snap back to the disengaged position to disengage the cam plates located on each of the controlled shafts so that they may be adjusted during the installation of the equipment.

Other objects and advantages will in part be disclosed and in part be obvious when the following specification is read in conjunction with the drawings in which:

Figure 1 is a side view of a section of the improved channel selector assembly showing the details thereof.

Figure 1*a* is an auxiliary view taken normal to the motor armature.

Figure 2 is an end view showing the engagement of the drive slides and positioning switch operation by the cam arms.

Figure 3 is a top view of a shifter assembly.

Figure 4 is a circuit diagram of the electrical connections in the circuits of the channel selector.

Figures 5, 5*a*, and 5*b* represent successive steps in the operation of the indexing mechanism.

Figure 6 is a view in perspective of a shifter slide.

Referring to Figure 1, there is illustrated the application of the improved channel selector switch assembly to radio transmitting and receiving apparatus. The controlled tuning condenser shafts of the receiver are arranged in one bank whose details are shown, while the transmitter tuning condenser shafts are located in another bank whose presence is merely indicated. For the sake of clarity, the details shown in this figure are confined to those involved in the operation of a single channel, as these details are merely duplicated in the remaining three channels. The tuning condenser shafts **1** and **2** project through openings in the shifter frame **3** and through openings in the driving slide **4**. The position and form of these openings is most easily seen in Figure 6, which is a perspective view of the driving slide **4**, with its associated elements. The shaft **1** is provided with a locking knob **5** and indicator assembly **6**, and is fitted with a cotter key **7** to prevent the loss of the locking knob **5** by unscrewing it from the threaded projection of the shaft **1**. Knob **5** is operated to clutch and declutch a number of cam plates from the shaft **1** to permit adjustment of the apparatus in a manner which will be explained later, and the indicator assembly **6** is provided to aid in the adjustment or orientation of the condenser actuated by the shaft **1**, by rotation over a graduated scale. The indicator **6** is keyed to the shaft and may be used for shaft position control when the knob **5** has been loosened or the driving slides are in the disengaged position. The knob and indicator assembly have been omitted in the showing of shaft **2** and the shifter frame **3** has been cut away from this region to enable the clear showing of the operation of the mechanism. The shaft **2** assumes a number of forms over its entire length, as it has the form of a cylindrical threaded screw at the upper end, then becomes square in cross section for the larger portion of the extension length, and finally terminates in a smooth cylindrical member at the end of the square shank, the diameter of the cylinder being somewhat greater than the diagonal of the square. The square portion of the cross section of the shaft **2** is seen in this cut away view, and the cam plate **8** with an internal circular aperture equal in diameter to the diagonal of the square is shown in position on this portion of the shaft. The cam plate **8** is located intermediate a plurality of spacers **9**, each having a square inner aperture and a circular periphery, and is locked in position with respect to the shaft **2** when axial pressure is applied to the group by tightening the locking knob **5**. (See Figure 3.) Upon loosening the locking knob **5**, the friction between the spacers **9** and the cam plate **8** is reduced and the cam plate **8** may be freely ro-

tated upon the shaft to determine the position to which it will be driven by the driving slide 4. In Figure 1 driving slide 4 is shown in two positions, the full outline indicating the disengaged position, while the dashed outline illustrates the engaged position. To secure maximum accuracy in the positioning of the shaft 2, a positioning clip 10 is mounted on the slide 4 in the slot 11 and connected to the clip spring 12. In the engaged position of the slide 4, the clip 10 swings about the pivot pin 13 on the shifter frame 3 and engages the nose 14 of the cam 8 under the pressure applied by the clip spring 12, accurately indexing the shaft to the desired position. The sequence of operations by which the cam plate 8 and shaft 2 are indexed to the desired position by the motion of the shifter slide 4 may be seen most clearly from the Figures 5, 5*a* and 5*b* illustrating the process at its various stages.

Initially assuming (Figure 5) that the shaft 2 does not have the desired position with the shifter slide 4 in the disengaged position, as the slide 4 moves into the engaged position, a heel 15 of the cam plate 8 is engaged by the abutment 16 of the opening in the driving slide 4 (Figure 5*a*), approximately indexing the shaft to the desired position by motion in the indicated direction, and upon the continuation of the movement of the driving slide 4, the nose 14 of the cam plate 8 is engaged by the positioning clip 10 (Figure 5*b*) and accurately indexed to the desired position. An indexing accuracy of three minutes of arc is regularly achieved with this system. The drive slide 4 is maintained in engagement with the cam plates on the shafts 1 and 2 so long as it is desired to continue operation on the same channel, thereby maintaining the shafts in the desired position. Since the cam plates on the shafts 1 and 2 are each independently adjustable on their individual shafts, it is readily seen that the shafts may have any desired mutual angular relation when the driving slide 4 is in the actuated position. The number of cam plates on each of the shafts is determined by the number of channels desired, there being one for each channel, and each of the cam plates 8 on a given shaft may be independently adjusted without disturbing the position of adjacent plates because of the washers or spacers 9 intermediate them which are effectively keyed to the shaft. In the system described herein, provisions are made for four channels, consequently each condenser shaft is provided with four cam plates spaced along the axis of rotation of the shaft and separated by three spacers keyed to the controlled shaft by the cooperating form of their central aperture and the square shaft. Tightening the locking knob 5, effectively secures all the cam plates to the shaft, while loosening this knob frees them for independent adjustment. Because of the form of the cam plates employed, the free rotation of the controlled shafts, in the absence of restraint by the driving slide on one or the other of the attached cam plates, is restricted to approximately 90 degrees by the stop 17 projecting into the slot 18 in the indicator assembly 6. If the free rotation of the shaft were as much as 180 degrees, the mechanism might jam because of the unfavorable angles between the driving and the driven surfaces. For convenience in reference in the later portions of the specification, the cam plates engaged by a single driving slide will be referred to as a set of cam plates, and in the receiver control mechanism described, there are two shafts each carrying four cam plates, thus forming two parallel columns of plates. Correspondingly, there are four driving or shifter slides in the receiver control system, each slide simultaneously actuating the corresponding plates in each of the columns, and which constitute a set. The transmitter control system may be similar to the above.

The means for selectively actuating the driving slides and maintaining them in engagement with the desired set of cam plates, and, at the option of the operator for simultaneously disengaging all shifter slides from the indexing cam assemblies will now be described. This service is performed by the actuator slides 19 and 20 connected together by the arms 21 and 22 pivoted to the frame of the apparatus at 21*a* and 22*a*, and driven by the cam arms 23, 24, 25, 26 on the shaft 28 of the ratchet or stepping motor 27. The motor 27 is of the electromagnetic type and has a tubular shaped operating winding 29 located within a magnetic frame and disposed about a fixed core 30. The armature 32 oscillates back and forth about the point 33 as a pivot in response to its intermittent attraction to and release from the core 30 during the operation of the motor. The magnetizing winding 29 of the motor 27 is connected to a source of direct current in series with various selector circuits and the interrupter contacts 34, and upon the application of direct current energy to the motor 27, the armature 32 moves inward against the tension of the armature restoring spring 35 until the interrupter adjusting screw 36 engages the upper end of contact spring 37, separating the contacts 34 and interrupting the current through the winding 29, whereupon the spring 35 restores the armature 32 to its original position, reclosing the circuit through the winding 29 and initiating another cycle of operation. So long as direct current is applied to the motor 27, therefore, the armature 32 continues to vibrate back and forth in response to the energizing and deenergizing of the winding 29. A ratchet wheel 38 is attached to the shaft 28 and is peripherally engaged by the positioning spring 39 and the pawl 40 which is in turn attached to the armature 32 and moves back and forth in unison with the armature. Each time the winding 29 is deenergized and the spring 35 moves the armature 32 outward from the frame of the motor 27, the pawl 40 engages the ratchet wheel 38, moving it one step clockwise. Positioning spring 39 is so located and shaped that it permits this clockwise movement, but prevents movement of the ratchet wheel 38 in the opposite direction during the forward stroke of the armature 32 and therefore the ratchet wheel continues to rotate in a clockwise direction as long as power is supplied to the ratchet motor. A set of contact pairs is mounted on the frame of the ratchet motor in such a position that each of the contact carrying springs is engaged by the cam arm located opposite it once during each rotation of the shaft 28 and switching means are provided so that power can be supplied to the ratchet motor in series with one or another of the contact pairs. The contacts are so arranged that one of the contact pairs is opened by a cam arm whenever another cam arm drives its corresponding actuator slide into engagement with the indexing cam assembly and is maintained in the open position during the next step of motor operation which disengages all driving slides from the indexing cam assemblies. A release switch is provided which connects the winding 29 of the motor 27 to the direct current source independ-

ently of the contacts 34 and all of the other control circuits, moving the armature forward and advancing the pawl 40 one step on the ratchet wheel 38; upon the release of this switch, the winding 29 is deenergized and the armature 32 is restored to its original position by the spring 35, driving the ratchet wheel 38 one step forward in the clockwise direction.

Figure 1 shows the cam arms on the shaft 28 in three successive positions, corresponding to three successive steps in the operation of the ratchet motor 27, and shows the operation of the positioning switch 41 by the cam arm 25. As before, the dashed line portions of this section of the figure indicate the position of the cam arms 23, 24, 25, and 26, the actuator slides 19, 20 and the pivoted arms 21, 22, when the driving slide is in engagement with the cam plate set corresponding to the selected channel, and the solid outlines of these elements indicate their positions after the disengagement of the cam plates by the driving slide. With the arm assembly in position 25*a*, the arm 23 is in contact with the slide head 43 and forces the actuator slides 19 and 20 to the right to engage the driving slides with the desired cam plate sets in the receiver and the transmitter. In this position of the cam arm 25, contacts 41 remain closed and the ratchet motor 27 continues to operate. Upon completion of the next step of operation, to the position 25*b*, contacts 41 are forced open as the finger 42 mounted at the end of the contact spring of the positioning switch 41 is actuated by the arm 25, interrupting the power supply to the motor 27 and halting the apparatus in this position. With cam arm 25 in position 25*b*, the arm 23 continues in engagement with the slide head 43, maintaining the driving slides in engagement with their respective sets of cam plates to keep the equipment tuned to the desired channel. The cam arms 23, 24, 25 and 26 are not only angularly displaced, but are also spaced linearly along the shaft 28 so that only arm 25 operates the positioning switch 41 which is one of a number which are spaced along the shaft 28 in the same relation as the cam arms. As will be explained later, the final step in the procedure for setting up the apparatus to a number of new channels requires that all driving slides be returned to the disengaged position so that the locking knob 5 may be tightened without disturbing the channel adjustments by reaction between the cam plates and the positioning apertures in the driving slides. In the present system, this is accomplished by depressing the release switch earlier mentioned to advance the ratchet motor 27 one more step, bringing the arm 25 to the position labeled 25 and moving the arm 23 to the position shown in solid lines to disengage it from the slide head 43, permitting the actuators 19 and 20 to return to the normal position in response to the action of the restoring springs. The driving slides are thereby disengaged from the indexing cam assemblies permitting the locking knob 5 to be tightened on the threaded portion of the controlled shaft without disturbing the setting of the indexing cams. Since the positioning switch 41 is maintained in the open position by the arm 25, the power supply circuit to the motor is still interrupted and the apparatus remains stably in this position until such time as the release switch is again operated or until the power supply is connected to the motor 27 through another positioning switch in the cam switch assembly. While the apparatus is in the released position, which is shown in Figure 1, the actuator slides 19 and 20 are not in any way connected with the associated shifter slides, thereby permitting the removal of the receiver or transmitter with its attached shifter slide assembly without interference of the parts.

The relationship between the cam arm assembly, the cam arm positioning switches and the shifter actuating slides is most clearly seen in Figure 2. Here, the ratchet wheel 38 mounted on the shaft 28 is cut away to show the cam arms 23, 24, 25, and 26, mounted on the shaft 28 and separated by the spacers 47. The position of the assembly corresponds to the solid line view of Figure 1, so that cam arm 23 has just moved to a position releasing the actuator slide 20, arm 26 is moving up to engage the actuator slide 44, but has not yet done so, arm 24 is free, and arm 25 is maintaining the positioning switch 41 in the open position by its action on the finger 42. The other actuator slides 45 and 46 visible in this view are located so that they are operated by the cam arms 25 and 24 respectively upon the rotation of the shaft 28, and the positioning switches 48, 49, and 50 are actuated by the cam arms 24, 26, and 23 respectively. The pivoted arm 22 is linked to the actuator slide 20 by the pin 51 engaging the slot 52 in this slide and the remainder of the pivoted arms seen in this view are similarly linked to their respective shifter actuating slides and driving slides which are made independent to simplify the assembly and disassembly of the apparatus.

Assuming now that power be applied to the stepping motor through the positioning switch 48, the entire cam arm assembly will be rotated, forcing actuator slide 44 and the driving slide in register with it into the engaged position, until the cam arm 24 engages the finger 53 of positioning switch 48, opening the power supply circuit and stopping the motor in this position so that the indexing cams engaged by the selected driving slides force the condenser shafts to the desired position and hold them there. Selection of other operating channels is accomplished by connecting the power supply to the motor 27 through the other positioning switches. The relation of the positioning switches to the shifter actuating slide and hence to the channels controlled by these slides is as follows: switch 41—slide 20; swich 48—slide 44; switch 49—slide 46; switch 50—slide 45.

A shifter assembly viewed from the top is shown in Figure 3 with the driving slides 4, 54, 55, and 56 mounted within the shifter frame 3 on the roller guides 57 and 58. Return of the driving slides to the disengaged position is insured by the restoring springs 59 connected between the slides and a cross number on the shifter frame. The shafts 1 and 2 extending transversely of the driving slides are also clearly seen in this view. Each of these shafts is provided with a locking knob 5 for clutching and declutching the cam plates from the controlled shaft and an indicator scale 6 which is maintained in a fixed position on the shaft at all times in order to indicate the angular position of the condensers being controlled. The complete indexing cam assembly located on the shaft 1 is visible in this drawing. The locking knob 5 is mounted on a threaded extension of the shaft 1 and is in contact with a sleeve 60 axially movable on the square shank portion of the shaft 1. Also located on the square shank in the manner shown are the cam plates 8 and the cam plate spacers 9 there being three

spacers between adjacent cam plates. The internal aperture of the spacers 9 is square in form, matching that of the shaft so that, while they are free to move axially, they are not free to rotate, and the internal aperture of the cam plates 8 is circular in form so that they are not only free to move axially, but may also be rotated on the shaft when not too tightly secured between adjacent spacers 9. The cam plate most remote from the locking knob 5 is located next to a shoulder 61 on the shaft 1 and consequently tightening locking knob 5 squeezes the entire group of cam plates and spacers between the movable sleeve 60 and the shoulder 61, holding the cam plates firmly in position with respect to the shaft. Loosening the locking knob releases this pressure and permits the rotational adjustment of the cam plates on the shaft.

Terming the channels A, B, C and D corresponding to the driving slides 4, 54, 55, and 56 respectively, the mode of adjustment of the various channels is as follows: First the locking knob 5 is loosened on each of the shafts under control and the channel selector switch is then actuated to engage channel A. Each of the controlled shafts is now rotated to the desired position by manual rotation of the indicator 6. This positions each of the cam plates in set A on their respective shafts so that when secured to the shafts by retightening the locking knob 5, the shafts will be returned to the set position when the driving slide is forced into engagement with the cam plates comprising set A. Next channel B is engaged by operating the channel selector switch and the same procedure repeated and the channels C and D are similarly adjusted. Up to this time, no cam plate has been engaged a second time by its corresponding driving slide so that although these plates are relatively loose on the shafts, the desired angular position has been maintained. Before the locking knob 5 is tightened, the cam plates must be disengaged by all the driving slides, as, otherwise, the reaction of the shaft would displace the engaged cam plate from the desired position. This is accomplished by depressing the release button, advancing the motor 27 one step and freeing all driving slides. The locking knob 5 may now be tightened by simply turning it clockwise, whereupon the indicator 6 attached to the shaft rotates until the stop 17 contacts the end of the slot 18, fixing the shaft in position and permitting the completion of the tightening operation.

In the foregoing, only the mechanical details of the structure have been shown, the electrical details being supplied by descriptive material. The electrical circuits operating in conjunction with this apparatus appear in detail in Figure 4 which includes means for disabling the transmitter during the channel shifting periods. The operating winding 29 of the motor 27 is connected at one end to the movable contact 62 of the motor control relay 64 and at the other end through the contacts 34 to the positive terminal of the battery 65 whose negative terminal is grounded. When the operating winding of the relay 64 is energized, contact 62 moves into engagement with the grounded fixed contact 63 and connects the ratchet motor 27 to the direct current source 65. As explained earlier, the resultant vibration of the armature 32 of the motor 27 with the attached pawl 40 causes the ratchet wheel 38 to rotate clockwise, driving the shaft 28 and the cam arms 23, 24, 25 and 26 in this direction. The cam arms mentioned successively engage and open the switches 50, 49, 41 and 48, each of which has one terminal connected to one end of the operating winding of the motor control relay 64. The other end of the operating winding of the motor control relay 64 is connected to the positive terminal of the source 65, and the other terminals of the switches 41, 48, 49 and 50 are optionally connected to ground through the channel selector switches 67, 66, 68 and 69 respectively, which are located in the remote control box at the operator's position. Closing switch 66 as shown grounds the movable contact of the positioning switch 48, connecting the operating winding of relay 64 across the source 65 if the switch 48 is not engaged by the cam arm 24. This operates the relay 64, closing the contacts 62, 63, placing the motor 27 across source 65 and causing it to operate until the arm 24 forces the switch 48 into the open position, at which time the power supply circuit to the motor is broken and operation ceases. The apparatus in Figure 4 is depicted in this position. Sparking of the contacts 34 during the operation of the motor 27 is minimized by the arc-suppressing condenser 70 connected across the winding 29. A number of channel indicating lamps 71, 72, 73 and 74 are connected between the positive terminal of source 65 and the movable contacts of the channel selector switches 66, 67, 68, and 69, respectively; the closing of a given channel selector switch illuminates the indicator lamps during the selection operation. At the conclusion of the selection operation, only the lamp associated with the operated channel selector switch remains lighted.

It will be noted that a locking relay 75 has its operating winding connected in parallel with that of the motor control relay 64 so that whenever the motor 27 is operating in response to a circuit completed through the channel selectors, this relay is actuated. The locking relay contacts 76 are connected between the winding of the antenna changeover relay 77 and ground. The other terminal of the antenna changeover relay winding is connected to the positive terminal of the source 65, and when the contacts 76 are closed, this relay is actuated to connect the anode supply and the antenna to the receiver circuits and disable the transmitting equipment. Therefore, the transmitter cannot be operated during the channel selection operation. As soon as the channel selecting operation has been completed, power is removed from the motor control relay 64 and the locking relay 75 to enable the operation of the transmitting equipment when the "Transmit—Receive—Remote" switch 78 is in the "Transmit" position. Switch 78 is so connected that when in the "T" position, the low potential terminal of relay 77 winding is ungrounded and the relay 77 moves to the release position, energizing the transmitter circuits, connecting the transmitter output to the antenna, and grounding the receiver antenna terminal. In the "R" position of switch 78, the low potential terminal of the winding of the relay 77 is connected to ground actuating the relay contacts to remove the ground from the receiver antenna input terminal and connect this terminal to the antenna while at the same time connecting the anode or "B" supply to the receiver circuits. The third position of switch 78 is designated "Remote" and connects the low potential terminal of the winding of the antenna changeover relay 77 to ground through the contacts 79 of the "Press to transmit" relay 80. With switch 78 in this position, selection of the reception or transmission function is effected

by operation of the switch 81 connected between one terminal of the operating winding of relay 80 and ground. The other terminal of this operating winding is connected to the positive terminal of the source 65 and the closing of the switch 81 energizes the winding to open the contacts 79, in turn deenergizing the relay 77 and completing the circuit arrangements necessary for transmission. Release of the switch 81 reestablishes the conditions necessary for reception.

The channel release switch 82 is a double-pole-single-throw switch having the movable contacts connected to the field winding 29 of the stepping motor 27 and the fixed contacts connected to ground and to the positive terminal of the source 65 respectively. The switch 82 is normally maintained in the open position by a spring action, but may be manually closed by the operator when desired. Closure of the switch 82 connects the winding 29 to the source 65, pulling the armature 32 over to the operated position and advancing the pawl 40 of Figure 1 one step on the circumference of the ratchet wheel 38. Upon release, the armature returns to the normal position and the attached pawl moves the ratchet wheel one step clockwise.

Switch 82 is connected to operate independently of the contacts 34 and contacts 62, 63 of the motor control relay 64. Therefore, while a cam arm maintains the corresponding energized cam switch in the open position, the shaft 28 may be advanced one step to disengage all the driving slides from the cam arm assembly by depressing and releasing the switch 82. It has been earlier specified that the cam arms retain the cam switches in the open position during a shaft rotation corresponding to one step of motor operation subsequent to the disengagement of the driving slides by the cam arms, so that power is not reapplied to the motor circuits at the completion of the above release operation. From the release position, the equipment may be set on any desired channel except the one immediately preceding the release position by operating the selected channel control button in the usual manner, and once another channel has been selected, any channel, including the one immediately preceding the release position, may be selected in the normal manner.

Although a structure has been described in which the power supply to a stepping motor or ratchet motor is interrupted for one step before and one step after the disengagement of the shaft indexing means from the controlled shaft, it is clear that these figures have been chosen only for the purpose of specific illustration and that they merely constitute an irreducible minimum. If desired, the power supply connection may be interrupted for a greater period before and/or after the disengagement of the shaft indexing means. Further, the incorporation of suitable anti-overshoot provisions will enable the use of a continuously rotatable motor means rather than the intermittently rotating motor of the type shown.

It will be obvious that many changes and modifications may be made in the invention without departing from the spirit thereof as expressed in the foregoing description and in the appended claims.

I claim:

1. In remote control apparatus, a controlled shaft, a plurality of cam plates adjustably secured to said shaft, drive means intermittently engaging each of said cam plates, motor means selectively forcing said drive means into engagement with said cam plates, a source of power, a plurality of power interrupting means connected to and actuated by said motor means and disconnecting said power supply from said motor means during the engagement of a cam plate by its cooperating drive means and during a predetermined movement of said motor means after the disengagement of said drive means and said cam plate, means for selectively connecting said power source to said power interrupting means, and means for energizing said motor means to disengage said drive means from said cam plates while maintaining said power interrupting means in the open position.

2. In remote control apparatus, a plurality of controlled shafts, a plurality of cam plates adjustably secured to each of said shafts, drive means intermittently engaging corresponding cam plates on each of said shafts, motor means selectively forcing said drive means into engagement with said cam plates, a source of power, a plurality of power interrupting means connected to and actuated by said motor means and disconnecting said power supply from said motor means during the engagement of a set of cam plates by the cooperating drive means and during a predetermined movement of said motor means after the disengagement of said drive means and said cam plates, means for selectively connecting said power source to said power interrupting means, and means for energizing said motor means to disengage said drive means from said cam plates while maintaining said power interrupting means in the open position.

3. In remote control apparatus, a plurality of controlled shafts, a plurality of independently adjustable indexing members secured to each of said shafts, drive means engageable with corresponding indexing members on each of said shafts, motor means selectively forcing said drive means into engagement with said indexing members, a source of power, a plurality of power interrupting means connected to and actuated by said motor means, said power interrupting means disconnecting said power supply from said motor means during the engagement of a set of indexing members by the cooperating drive means and during a predetermined movement of said motor means after the disengagement of said drive means and said indexing members, means for selectively connecting said power source to said power interrupting means, and means for energizing said motor means to disengage said drive means from said indexing members while maintaining said power interrupting means in the interrupting position.

4. In remote control apparatus, a plurality of controlled shafts, a plurality of independently adjustable indexing members secured to each of said shafts, drive means engageable with corresponding indexing members on each of said shafts, a plurality of rotatably mounted angularly and linearly displaced arms selectively engaging said drive means, unidirectional electrically driven motor means connected to said arms, a plurality of separable electrical contacts actuated by said arms and maintained in separated relationship during the engagement of said indexing means by said drive means and during a predetermined rotational movement of said arms after the disengagement of said indexing members by said drive means, a source of electric power, means for selectively connecting said source to said contacts, means connecting said contacts to said

motor means, and a second switching means connected between said power source and said motor.

5. In remote control apparatus, a plurality of controlled shafts, a plurality of independently adjustable indexing members secured to each of said shafts, drive means engageable with corresponding indexing members on each of said shafts, a plurality of rotatably mounted angularly and linearly displaced arms selectively engaging said drive means, a stepping motor driving said arms and having a magnetizing winding, a plurality of separable electrical contacts actuated by said arms and maintained in separated relationship during the engagement of said indexing means by said drive means and during a predetermined rotational movement of said arms after the disengagement of said indexing means by said drive means, a source of electric power, means for selectively connecting said source to said contacts, means connecting said contacts to said winding, and a second switching means connecting said source and said winding.

6. In remote control apparatus, a plurality of controlled shafts, a plurality of axially spaced independently adjustable indexing members secured to each of said shafts, a plurality of parallel driving slides engageable with corresponding indexing members on each of said shafts, a plurality of rotatably mounted angularly and linearly displaced arms selectively forcing said driving slides into engagement with said indexing members, a stepping motor driving said arms and having a magnetizing winding, a plurality of separable electrical contacts actuated by said arms and maintained in separated relationship during the engagement of a set of corresponding indexing means by a driving slide and during a predetermined rotational movement of said arms after the disengagement of said indexing means by said driving slide, a source of electric power, means for selectively connecting said source to said contacts, means connecting said contacts to said winding, and a second switching means connected between said source and said winding.

7. In remote control apparatus, a plurality of controlled shafts, a plurality of axially spaced independently adjustable indexing members mounted on each of said shafts, means for clutching and declutching said indexing members on said shaft, a plurality of parallel driving slides engageable with corresponding indexing members on each of said shafts, a plurality of arms radially disposed about a common center of rotation and spaced along said center of rotation, said arms selectively forcing said driving slides into engagement with said indexing members upon rotation about said center, a stepping motor rotating said arms about said center and having a magnetizing winding, a plurality of separable electrical contacts actuated by said arms and maintained in separated relationship during the engagement of a set of said indexing means by a driving slide and during a predetermined rotational movement of said arms after the disengagement of said indexing means by said driving slide, a source of electric power, means for selectively connecting said source to said contacts, means connecting said contacts to said winding, and a second switching means connecting said source and said winding.

8. In remote control apparatus, a plurality of controlled shafts, a plurality of axially spaced independently adjustable indexing members mounted on each of said shafts, means for clutching and declutching said indexing members from said shaft, a plurality of parallel driving slides engageable with corresponding indexing members on each of said shafts, a plurality of arms radially disposed about a common center of rotation and spaced along said center of rotation, said arms selectively forcing said driving slides into engagement with said indexing members upon rotation about said center, a stepping motor rotating said arms about said center and having a magnetizing winding, a plurality of separable electrical contacts actuated by said arms and maintained in separated relationship during the engagement of a set of corresponding indexing means by a driving slide and during at least one step of motor operation after the disengagement of said indexing means by said driving slide, a source of electric power, means for selectively connecting said source to said contacts, means for applying power from said source to said motor in accordance with the position of said contacts, and a second switching means connecting said source and said winding.

9. In remote controlled apparatus, a controlled shaft, a plurality of cam plates adjustably secured to said shaft, drive means intermittently engaging each of said cam plates, motor means selectively forcing said drive means into engagement with said cam plates, a source of power, a plurality of power interrupting means connected to and actuated by said motor means and disconnecting said power supply from said motor means during the engagement of a cam plate by its cooperating drive means and during a predetermined movement of said motor means after the disengagement of said drive means and said cam plate, means for selectively connecting said power source to said power interrupting means, and means operative independently of said power interrupting means for driving said motor means in increments smaller than said predetermined movement.

VERNON MOORE.