

Feb. 11, 1941.

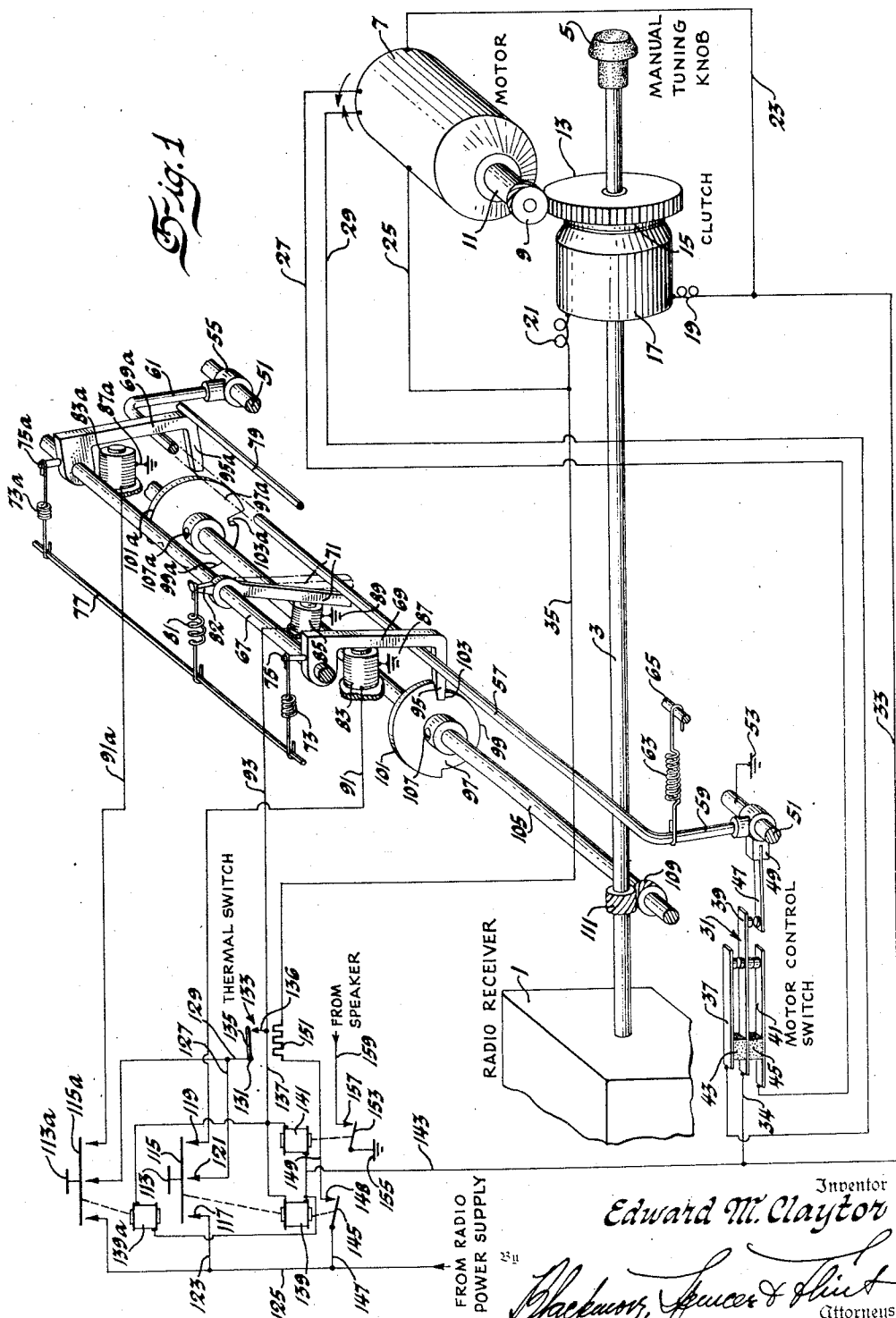
E. M. CLAYTOR

2,231,156

CONTROL CIRCUIT

Filed Aug. 21, 1939

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

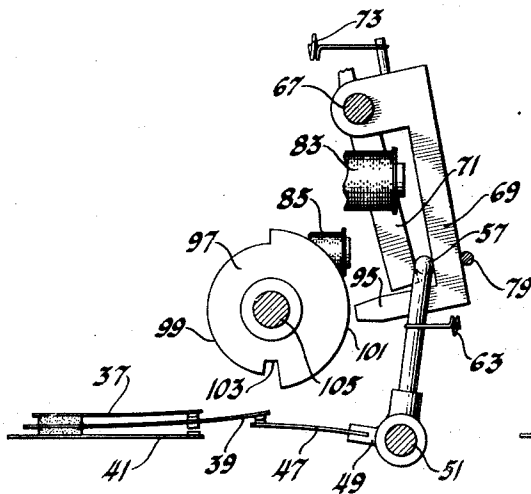


Fig. 2

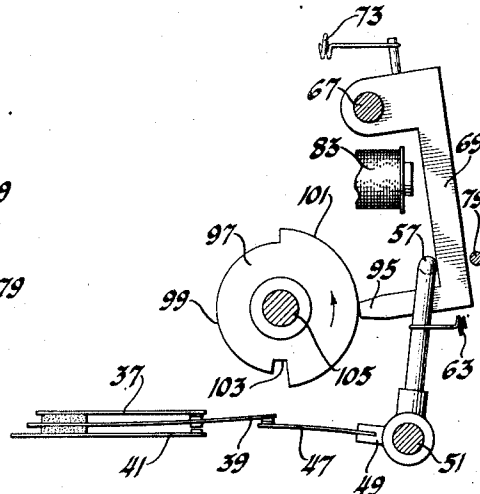


Fig. 3

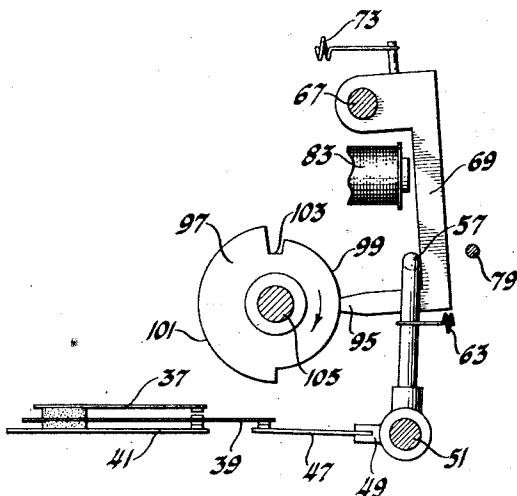


Fig. 4

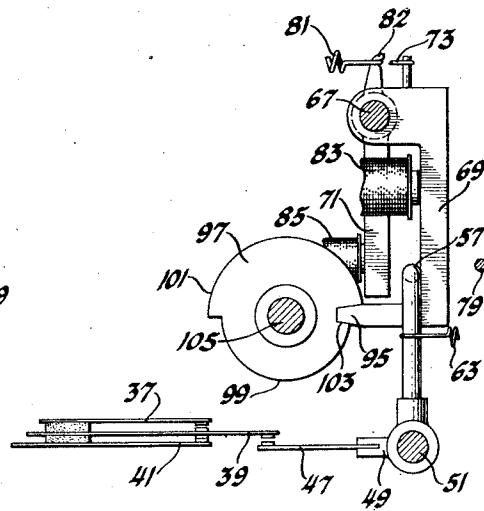


Fig. 5

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UNITED STATES PATENT OFFICE

2,231,156

CONTROL CIRCUIT

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13 Claims. (Cl. 172-239)

This invention relates to remote controlled automatic means for moving an adjustable control element to a plurality of positions. It particularly concerns protective means for remote controlled automatic tuning mechanism associated with radio communication devices.

In many cases it is desirable to locate a radio receiver at some distance from the control station and provide simple push button means by which the tuning mechanism may be controlled accurately with a minimum amount of manual effort and movement. Apparatus of this type is particularly adapted to radio receiving sets installed on vehicles where space requirements make it necessary to locate the receiver in one position and the controls at another. It is also equally desirable in household installations where the control station location is changed frequently with respect to the receiver or where there are a number of control stations.

It has been found that when the control station is located more conveniently and the manual effort required to operate the controls is reduced, people unauthorized to operate them, particularly children, continue to manipulate the controls which overloads the actuating means.

It has also been found that mechanical detents associated with the controls and automatic indexing mechanism associated with the tuning shaft driving and stopping means stick at times due to the slight clearance between the parts which is necessary for accurate positioning and sharp tuning of the receiving set. When sticking occurs overloading of the driving means likewise occurs and further operation cannot be obtained until repairs are made.

One of the objects of the present invention is to provide positive means for preventing sticking of the indexing means.

Another object is to provide a positive cutout means associated with the driving means to prevent overloading of the driving means.

With these and other objects in view, together with a description of the means by which these objects are accomplished, this invention will be better understood by reference to the following specification and claims and illustrated in the accompanying drawings, in which:

Figure 1 shows in diagrammatic form the complete assembly of the automatic tuning mechanism, the controls associated therewith and electrical connections between these various elements;

Figures 2 to 5 are diagrammatic views showing

certain of the control elements in various positions, which are as follows:

Figure 2 shows these control elements in their normal or non-controlling position;

Figure 3 shows these elements in a position to establish circuit connections whereby the tuning shaft is rotated in one direction;

Figure 4 shows these elements in a position whereby the circuit connections are changed so that the tuning shaft will be rotated in the reverse direction to that shown in Figure 3; and,

Figure 5 shows these elements in a position to stop rotation of the tuning shaft in a definite angular position and to open all the circuit connections.

A radio receiving set indicated at 1 has a conventional tuning shaft 3 extending therefrom and a control knob 5 fixed to its extremity for manual rotation thereby. An electric motor 7 having a worm 9 fixed to an armature shaft 11 meshes with a worm wheel 13 rotatably mounted on the shaft 3. The worm wheel has a hub 15 acting as a clutch driving element. A clutch driven element 17 rotatable with the shaft 3 is suitably biased for axial movement away from the driving gear hub 15. The driven element encloses a magnet winding having end leads 19 and 21 extending therethrough which are connected respectively to motor armature leads 23 and 25. The magnet winding is thus connected in parallel with the motor armature and is accordingly energized therewith to cause engagement of the clutch elements 15 and 17 by electromagnetic attraction between them. The motor has two field windings either of which may be energized by means of conductors 27 or 29 extending therefrom to a control switch indicated at 31 to cause rotation of the motor in either direction. The clutch lead 19 and armature lead 23 are also connected to the switch 31 by a conductor 33 and the clutch lead 21 and armature lead 25 are connected to a source of energy by control means which will be described later.

The control switch 31 comprises three flexible parallel blades 37, 39 and 41 having their adjacent ends clamped between fixed insulating blocks 43 and 45 and all three blades are provided with electrical contacts on their free ends. The motor field leads 27 and 29 are respectively connected to the switch blades 41 and 37 and the armature lead 23 and clutch lead 19 are both connected to the central blade 39 by conductors 33 and 34. In addition to the fixed blades the switch has a flexible blade 47 adjacent to and movable into or out of contact with the central blade 39. The

movable blade 47 has a contact on its free end and its opposite end is fixed to a fitting 49 rotatably supported on a stationary shaft 51 which is grounded at 53. Another rotatable fitting 55 is spaced axially along the shaft 51 and is connected by a switch actuating rod 57 having bent end portions 59 and 61 fixed respectively to the fittings 49 and 55. A tension spring 63 located between the rod end 59 and a fixed member 65 normally tends to rotate the rod 57 and free end of the switch blade 47 clockwise about the shaft 51 and into contact with the central switch blade 39 bending it upward into contact with the upper blade 37 as shown in Figure 2. Movement of the switch blade counterclockwise is accomplished by the following actuating mechanism.

The motor control switch actuating mechanism comprises a fixed supporting shaft 67 located above and parallel to the shaft 51. On the shaft 51 are pivoted any number of axially spaced armatures, two of which, 69 and 69a, are shown, and a single knockout armature 71. The armatures 69 and 69a extend downwardly on the right of the switch actuating rod 57 and have helical tension springs 73 and 73a fixed between pins 75 and 75a on their upper ends and a fixed rod 77 which tend to normally rotate these armatures counterclockwise about the shaft 67 into contact with a fixed stop rod 79. The actuating rod 57 is normally held by its spring 63 in contact with the left side of the downward extending armatures 69 and 69a when the right sides of these armatures are against the stop rod 79. The knockout armature 71 extends downwardly on the opposite or left side of the actuating rod 57 and is normally held in contact therewith by a tension spring 81 connected between a hooked portion 82 and the fixed rod 77. The normal position of the knockout armature is best shown in Figure 2. The armatures 69 and 69a, together with the knockout armature 71, are movable clockwise about the shaft 67 from their normal position by fixed electromagnets, each of which is located adjacent the respective armatures and indicated at 83, 83a and 85. One end of each of these electromagnetic windings is grounded at points 87, 87a and 89 and the other ends thereof, 91, 91a and 93, extend to control apparatus to be referred to subsequently. The armatures 69 and 69a each have end portions 95 and 95a bent at right angles thereto which act as cam followers to contact cams 97 and 97a located adjacent thereto when these armatures are moved toward the cams by the respective electromagnets 83 and 83a.

The cams 97 and 97a have arcuate portions 99 and 99a of small radius and arcuate portions 101 and 101a of larger radius and radial slots 103 and 103a. The cams are fixed to a camshaft 105 by set screws 107 and 107a and may be adjusted to different angular positions thereon. The camshaft 105 is mounted for rotation about its axis, which extends parallel to the switch actuating rod 57, by means of the gears 109 and 111 of equal pitch diameters running in constant mesh and fixed respectively to the camshaft 105 and the tuning shaft 3. The ends 95 and 95a of these armatures are movable into sliding contact with either of the arcuate portions of the cams and are capable of entering the slots between to stop rotation of the camshaft and tuning shaft in a definite angular position, depending upon the angular position the cams are set with respect to the camshaft and which armature is moved toward its respective cam by its

respective electromagnet. The end 95 of the armature 69 is shown in the radial slot 103 of the cam 97 to stop rotation of the cam and tuning shafts and the switch actuating rod has been moved counterclockwise thereby to its maximum angular position so that the movable switch blade 47 which is grounded at 53 is moved out of contact with the fixed blade 39 of the switch 31. This is the open circuit position of the switch 31, as shown in Figures 1 and 5, which deenergizes the clutch winding and driving motor. When the end 95 of the armature is moved into contact with the arcuate surface 99 of the cam, as shown in Figure 4, the movable switch blade 47 is moved into contact with the fixed blades 39 and 41 to connect the field lead 27 to conductors 33 and 34 which are connected to the armature lead 23 to cause rotation of the motor in a direction so that the tuning shaft will be rotated in one direction and the cam 97 will be moved clockwise as shown by the arrow. When the end 95 of the armature is moved into contact with the arcuate surface 101 of the cam, as shown in Figure 3, the movable switch blade 47 moves the fixed blade 39 out of contact with the blade 41 and into contact with the blade 37 which connects the other field lead 29 to the armature to cause rotation of the motor in the opposite direction which rotates the cam 97 counterclockwise as indicated by the arrow. The switch blades 37, 39 and 47 are also in contact when the actuating rod 57 and the armatures 69 and 69a are returned to their normal non-controlling position as indicated in Figure 2.

As mentioned above, any number of cams and armatures may be used so that the tuning shaft may be moved to any one of a plurality of angular positions, each of which may be adjusted by rotating any particular cam angularly with respect to the camshaft. Each of the electromagnets operating the armatures may be selectively energized as they are included in separate circuits, each of which also includes a manually operable selector switch. Any one of these switches in addition to energizing any one of the armatures simultaneously energizes the electromagnet 85 of the knockout armature and holding coils, one of which energizes the motor and clutch windings and another of which grounds the radio speaker circuit in the following manner.

Two selector switches 113 and 113a are shown, both comprising identical parts, and are similarly connected in separate parallel circuits. Identical parts and connections are indicated by the same numerical characters included in both circuits, but may be separately identified as the parts and connections in one circuit carry a subscript "A" after the numerical characters. The switch 113 comprises an armature 115 manually movable to bridge three adjacent contacts 117, 60 119 and 121 but is normally biased to the open position. The contact 117 is connected by conductors 123 and 125 to the radio power supply which may be a battery having one terminal grounded. The contact 119 is connected by a conductor 91 to the electromagnet 83, the other side of which is grounded at 87. Energization of the electromagnet 83 attracts the armature 69 which moves the switch blade 47 from the position shown in Figure 2 to any of the positions shown in Figures 3 to 5. The contact 121 is connected to a fixed terminal support 131 of a thermal switch 133 by conductors 127 and 129. This switch comprises a bimetallic blade 135, one end of which is fixed to the support 131 and the

other is normally in contact with an adjacent contact 136, but when heated it expands and breaks this contact. Conductors 93 and 137 fixed to and extending from the contact 136 are connected respectively to the knockout electro-
 5 magnet 85, the other side of which is grounded at 89 and to holding coils 139, 139a and 141. The opposite ends of these coils are connected to the central fixed blade 39 of the switch 31 by a com-
 10 mon conductor 143 and the conductor 34. The knockout armature 71 is attracted to the electro- magnet 85 when the above circuit is thus ener- gized and the holding coils 139, 139a and 141 are simultaneously energized. The holding coils
 15 139 and 139a are located when the central blade 39 is in contact with the movable blade 49, as shown in Figures 2 and 3, to attract the arma- tures 115 and 115a of the selector switches 113 and 113a respectively, as shown by the dotted
 20 lines in Figure 1, and are designed so that they exert just sufficient attractive effort to hold these respective armatures in their closed circuit position so that whichever armature has been closed manually remains closed.

25 Another armature 145 located adjacent to the holding coil 139 is connected to the source of power by the conductors 125 and 147 and is attracted and moved toward the holding coil 139 as shown by the dotted lines and into contact
 30 with a fixed contact 148 located adjacent thereto. Closure of this armature energizes the motor and clutch circuits through a resistance heating element 151 located adjacent the bimetallic blade 135 of the thermal switch 133. The heater ele-
 35 ment is connected to the contact 148 by a con- ductor 149 and to one side of the electromagnetic clutch winding and armature winding by the conductor 35. The opposite sides of the clutch
 40 winding and armature winding respectively are both connected to the central blade 39 of the switch 31 by the conductors 33 and 34. The holding coil 141 when energized attracts an arma-
 45 ture 153 which is grounded at 155, moving it into contact with a fixed contact 157. A con- ductor 159 attached to this contact 157 extends from the speaker associated with the radio re-
 50 ceiver 1 and is grounded when the armature 153 is closed to ground the speaker circuit and mute it while the tuning shaft is being rotated by the motor.

The operation of the automatic tuning mecha- nism and protective devices associated therewith is as follows: Closure of any selector switch, for
 55 example, 113a, completes a circuit from the source of power through the electromagnet 83a to ground at 87a to attract and move the arma- ture 69a from its normal position, as shown in
 60 Figures 1 and 2, toward the cam 97a. Its move- ment is limited by its end 95a contacting with the arcuate cam surface 101a of large radius which causes it to contact and move the switch
 65 actuating bar 57 and switch blade 47 so that the switch blades 37, 39 and 47 are moved to the position shown in Figure 3. This position of the switch blades makes the proper motor field con-
 70 nection to cause rotation of the tuning shaft in one direction and rotation of the camshaft in a counterclockwise direction. The holding coils 139a, 139 and 141 and the electromagnet 85 are simultaneously energized to hold the armature
 75 115a of the switch closed, to move the armature 145 into contact with the contact 148 energizing the motor and clutch windings, and to move the knockout armature clockwise out of contact with the switch actuating rod 57, the knockout arma-

ture 71 taking a position as shown in Figure 5.

The tuning shaft rotation continues until the end 95a of the armature 69a moves to the bottom of the radial slot 103a of the cam which causes the switch 31 to open and open all of the above
 5 circuits, stopping the tuning shaft in this par- ticular angular position. All the control ele- ments are accordingly returned to their normal position, as shown in Figure 2, by their respective
 10 biasing springs. Should however the armature end 95a bind in the slot 103a in this position, the knockout armature 71 will strike the switch actuating rod 57 upon its return to the normal
 15 position to move the armature 69a toward its normal position to eject its end 95a from the slot 103a. Thus the knockout armature prevents binding between these elements and if not pro-
 20 vided it would be impossible to again energize the motor and clutch windings until these ele- ments were freed to allow the switch blades to assume their normal position for reenergization
 25 of the motor and clutch by any selector switch. This is normal operation for counterclockwise rotation of the cam. Rotation of the tuning shaft in the opposite direction, which causes
 30 clockwise rotation of the cams, is obtained when the armature end contacts the arcuate cam surface 99a which moves the blade 47 so that blades 39, 41 and 47 are in contact, as shown in Figure 4, to connect the other motor field winding in a
 35 similar manner as explained above.

Should the end 95a bind and stop in the radial cam slot 103a before bottoming, the rotating tun- ing shaft would be stopped but the motor switch
 40 would not be opened and the increased motor current passing through the heating element 151 would cause an increase in heat therefrom to open the thermal switch 133. Opening of this switch also opens all circuits and the knockout
 45 armature again acts to eject the dog end upon its return to the normal position.

If the selector switches are continuously operated to cause the motor to be started and stopped for long periods of time, the current
 50 through the heater 151 will cause the heat there- from to open the thermal switch 133 to prevent damage to the motor.

I claim:

1. In an automatic tuning device for radio communication systems comprising a motor, a
 50 tuning shaft connected to the motor for rotation thereby, a member connected to and rotated by the shaft having a slot in its surface, a second member movable with respect to the first member into contact therewith and adapted to enter
 55 the slot to stop rotation of the shaft in a definite angular position, electromagnetic means for mov- ing the second member, knock out means for ejecting said second member from the slot in said first member, electromagnetic means for moving
 60 said knock out means to allow movement of said second member into the slot in said first member, a source of current and means for connecting the motor and both of said electromagnetic means to the source of current, said means in-
 65 cluding disconnecting means operable upon ab- normal values of current flowing therethrough.

2. In an automatic tuning device for radio communication systems comprising a motor, a tuning shaft connected thereto for rotation
 70 thereby, a member connected to and rotated by the shaft having a slot in its surface, a second member normally held out of contact with the first member but movable into engagement with the slot in the first member to stop rotation of
 75

the shaft, electromagnetic means for moving the second member, knock out means for ejecting said second member from the slot in said first member, electromagnetic means for moving said knock out means to prevent ejection of said second member, a source of current, and means for connecting the motor and both of said electromagnetic means to the source of current, said means including disconnecting means movable by the second member entering the slot in the first member to denergize and stop rotation of the motor.

3. In an automatic tuning device for radio communication systems comprising a motor, a tuning shaft connected thereto for rotation thereby, a member connected to the shaft for rotation thereby having a slot in its surface, a second member normally held out of engagement with the first mentioned member but movable into engagement with a slot therein to stop rotation of the tuning shaft in a definite angular position, electromagnetic means for moving said second member, a third member normally held in contact with the second member and movable therewith, a fourth member normally held in contact with the third member but movable away from both the second and third members, electromagnetic means for moving said fourth member, a source of current, means for connecting both electromagnetic means and the motor to the source of current, and disconnecting means in said last mentioned means operably connected to the third member to disconnect the motor and both electromagnetic means to allow the fourth member to strike the third member to eject the second member from the slot in the first mentioned member.

4. In an automatic tuning device for radio communication systems comprising a tuning shaft, a motor connected thereto to rotate the shaft, a member connected to the shaft for rotation thereby having a slot in its surface, a second member movable into engagement with the slot in the first mentioned member to stop rotation of the shaft, a third member normally held in contact with the second member holding it out of contact with the first member, a fourth member normally held in contact with the third member but movable out of contact therewith, electromagnetic means for moving the second and fourth members, a source of current, means for connecting the electromagnetic means and the motor to the source of current, disconnecting means included in said last mentioned means operably connected to the third member and movable by said second member entering fully into the slot of the first member and additional disconnecting means operable by excessive motor current through the connecting means upon failure of the second member to break these connections, both of said disconnecting means causing the second member to be ejected from the first named member upon return of the fourth member to its normal position.

65 5. In an automatic tuning device for radio communication systems comprising an electric motor, a tuning shaft connected to the motor for rotation thereby, a member connected to and rotated by the shaft having a slot in its surface,
70 a second member normally held out of contact with the first member but movable into the slot therein to stop rotation of the tuning shaft in a preselected angular position, an electro-magnet for moving said second member, a source
75 of current, a circuit from said source to the elec-

tromagnet including a normally open selector switch manually movable to its closed position to complete said circuit and a holding coil in said circuit to attract and hold said switch in the closed position, a separate circuit from said 5 source to the motor including an armature switch adjacent said holding coil movable to its closed position by tractive force therefrom to complete said circuit and cause rotation of the tuning shaft and thermal means associated with both of said 10 circuits to open them when the current in said second circuit exceeds a safe value.

6. In an automatic tuning device for radio communication systems comprising an electric motor, a tuning shaft connected to the motor for rotation thereby, a member connected to and rotated by the shaft having a slot in its surface, a second member normally held out of contact with the first member but movable into the slot therein to stop rotation of the tuning shaft in a preselected angular position, an electromagnet for moving said second member, a source of current, a circuit from said source to said motor including a control switch normally closed and operably connected to and movable by the second member to open said circuit, an armature switch normally open but movable to close said circuit, a control circuit connected to said source including a holding coil adjacent said armature switch to attract and move it, and a selector switch normally open but manually movable to close said circuit through said electromagnet and control switch, said selector switch being located adjacent to said holding coil to attract and hold it closed until said tuning shaft is rotated to said preselected position.

7. In an automatic tuning device for radio communication systems comprising an electric motor, a tuning shaft connected to the motor for rotation thereby, a member connected to and rotated by the shaft having a slot in its surface, a second member normally held out of contact with the first member but movable into the slot therein to stop rotation of the tuning shaft in a preselected angular position, an electromagnet for moving said second member, a source of current, a circuit from said source to said motor including an armature switch normally open but movable to close said circuit to cause rotation of the tuning shaft, a control circuit connected between said source and the electromagnet including a holding coil adjacent said armature switch to attract and move it to its closed position and a selector switch adjacent the holding coil manually movable to its closed position at which it is held by the holding coil to complete said control circuit, a disconnecting means through which both of said circuits are normally completed having a movable member operably connected for movement with the second member to open these circuits when said second member enters and bottoms in the slot in the first member and thermal disconnecting means common to both said circuits to open said control circuit upon abnormal current flow in the first circuit due to failure of the first named disconnecting means to open said first circuit when the tuning shaft is stopped thereby.

8. In an automatic tuning device for radio communication systems comprising an electric motor, a tuning shaft connected to the motor for rotation thereby, a member having surfaces of different radii separated by a slot driven by the tuning shaft, a second member movable into contact with either surface and capable of entering

the slot in the first member to stop rotation of the tuning shaft in a preselected angular position, a control switch for establishing forward or reverse driving connections of the motor or breaking these connections at the preselected angular position, said control switch comprising a movable member normally held in contact with the second member tending to hold it out of contact with the first member and movable to a plurality of positions by the second member contacting either surface or entering the slot in the first member, a third member normally held in contact with the movable member of the switch and also tending to move the second member out of contact with the first member but movable in the opposite direction to allow such contact, separate electromagnetic means for moving both the second and third members, a source of current, means for connecting the electromagnetic means to the source of current for moving said second member, said means having a separate connection to said control switch and including the other electromagnetic means, a thermal switch and a holding coil, means connecting the motor to said source including said control switch, a resistance heater adjacent said thermal switch and an armature attracted toward said holding coil to complete said circuit, said heater causing opening of said thermal switch upon excessive current through said motor upon failure of said control switch to open said circuits, either of said switches when open causing ejection of said second member from the slot in the first member upon the return of the third member to its normal position.

9. In an automatic tuning device for radio communication systems comprising a motor, a tuning shaft connected thereto for rotation thereby, means for reversing the motor and simultaneously stopping said tuning shaft in any one of a plurality of angular positions and deenergizing said motor, said means comprising a switch member movable to establish forward or reverse connections of the motor and to break these connections, a plurality of cams driven by said tuning shaft, each having arcuate surfaces of different radii separated by a radial slot, said cams and slots being angularly adjustable with respect to each other, a plurality of members normally held out of contact with said cams but individually movable into contact with the surfaces thereof and into the slot therebetween, means operably connected to said switch normally held in contact with all of said members when they are in their normal position and movable by the individual members, a plurality of electromagnets for attracting and moving said members away from their normal position, a single ejection means for said members comprising a knockout armature normally held in contact with the means held in contact with said members but movable out of contact therewith and an electromagnet for attracting and moving said armature, a source of current, a plurality of circuits from said source to the individual magnets of the first mentioned means, each including a manually operable selector switch to complete the circuit, a holding circuit including the electromagnet of the ejection means, a plurality of holding coils adjacent respective selector switches to hold them closed and the switch of the first mentioned means, said circuit having a plurality of conductors connected to each selector switch for energization thereby, a motor circuit including an armature switch adjacent one of said

holding coils movable thereby to complete said circuit through said switch in the first mentioned means, and thermal disconnecting means associated with said holding circuit and motor circuit operable upon abnormal current flow through the motor circuit to deenergize all circuits to cause ejection of any member from any cam.

10. In an automatic tuning device for radio communication systems comprising a manually rotatable tuning shaft, a driving motor for said shaft, a clutch between said tuning shaft and motor engageable to permit rotation of the shaft by the motor, electromagnetic means for engaging said clutch, conductors from the electromagnetic means to said motor for energizing said means with the motor, a plurality of slotted members angularly adjustable with respect to one another driven by the tuning shaft, a plurality of elements individually movable into engagement with each respective slotted member to stop rotation of the tuning shaft in a plurality of angular positions, individual electromagnets for attracting and moving the individual elements, a bar normally held in contact with all of said elements and movable by any one, an armature normally in contact with said bar tending to hold said elements out of contact with said slotted members, an electromagnet for moving said armature out of contact with said bar, a source of current, means connecting the motor, the electromagnet for moving the armature and any one electromagnet for moving a respective element to the current source to cause rotation of the tuning shaft to a selected angular position, and thermal means included in said last mentioned means operable upon abnormal current flow therethrough to open said means to return all of said elements to their normal position.

11. In a device for angularly indexing a rotatable shaft, driving means for said shaft, means for controlling the starting and stopping of said driving means and said shaft, said means comprising a plurality of cams rotatable with said shaft, a plurality of cam followers, each of which is individually movable into engagement with a respective cam, means operable by movement of any cam follower for controlling the duration of energization of said driving means and means operative upon de-energization of said driving means for knocking any cam follower out of engagement with any cam and normally holding all said followers in disengaged relation with said cams.

12. In a device for angularly indexing a rotatable shaft, driving means for said shaft, means for controlling the starting, stopping and reversal of said driving means and said shaft, said means comprising a plurality of cams rotatable with and angularly adjustable with respect to said shaft, a plurality of cam followers, a plurality of power means individually energizable to move and hold any cam follower in engagement with any cam, control means for selectively controlling energization of any one of said power means and a second control means operable by movement of any cam follower to control the duration of energization of any one of said individual power means and said driving means for either forward or reverse drive thereof, and means operable upon de-energization of said driving means and said first named power means for knocking any cam follower out of engagement with any cam, said last named means comprising a member normally biased to engage and hold all of said cam followers disengaged, and a

second power means the energization of which is controlled by said first named control means to move said member to allow engagement with any cam by any cam follower and the de-energization of which is controlled by said second control means to cause any cam follower to be knocked out of contact with any cam.

13. In a device for angularly indexing a rotatable shaft, a motor for driving said shaft, cut out means for said motor operative on overload to de-energize and stop rotation thereof, means for controlling energization, de-energization and reversal of said motor and for stopping rotation of said shaft, said means comprising a plurality of cams rotatable with said shaft, a cam follower for each cam normally biased out of engagement therewith, an individual electromagnet adapted when energized for moving and holding each fol-

lower in contact with a respective cam, a plurality of switches, each of which is operable to control energization of one of said electromagnets, a second switch operable by movement of any cam follower for controlling the duration of energization of any electromagnet and said motor, and knock out means for said cam followers comprising a member biased to engage and hold said cam followers disengaged from said cams, an electromagnet energizable by any one of said first named switches to attract and hold said member out of contact with said followers, de-energization of said last mentioned electromagnet being controlled by said second named switch and said motor cut out means to cause said member to strike said cam followers and return them to their normally disengaged position.

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