July 16, 1940. A. W. PLENSLER 2,208,549

AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

Filed Nov. 17, 1937 4 Sheets-Sheet 1

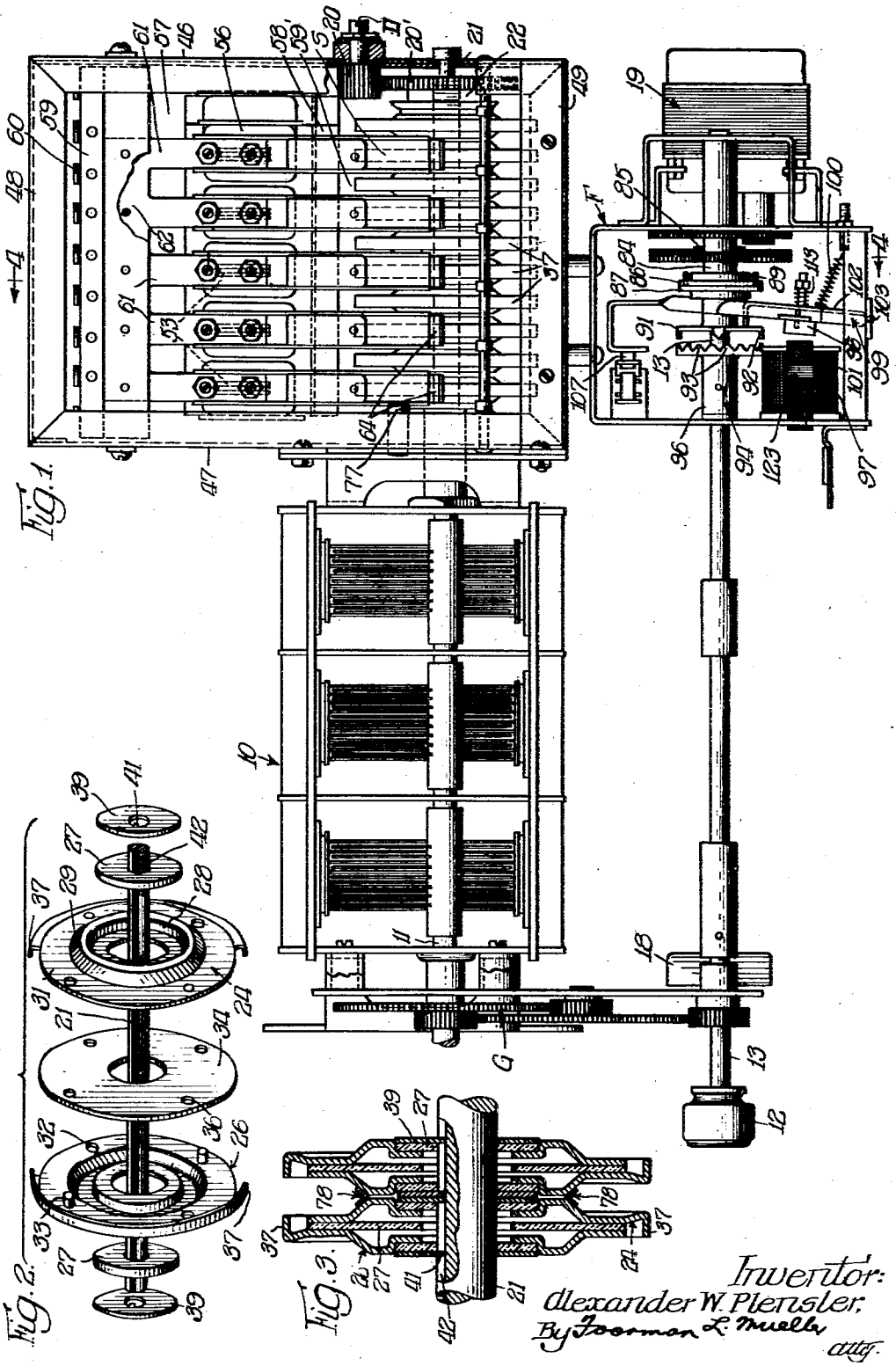

Fig. 1.

Fig. 2.

Fig. 3.

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Filed Nov. 17, 1937 4 Sheets-Sheet 2

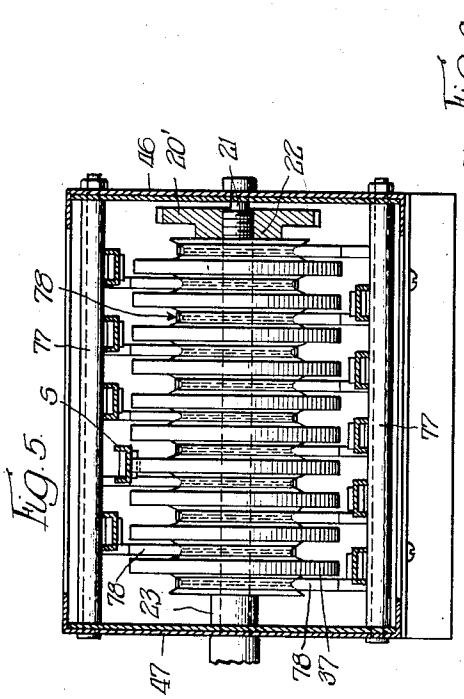

Fig. 5

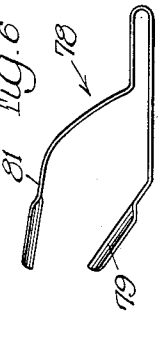

Fig. 6

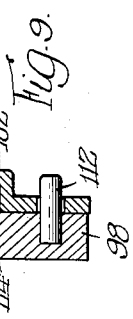

Fig. 9

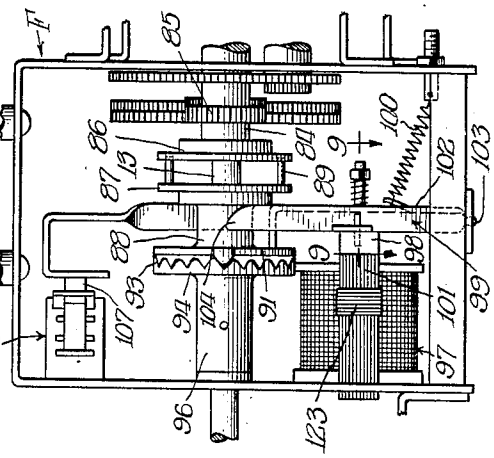

Fig. 8

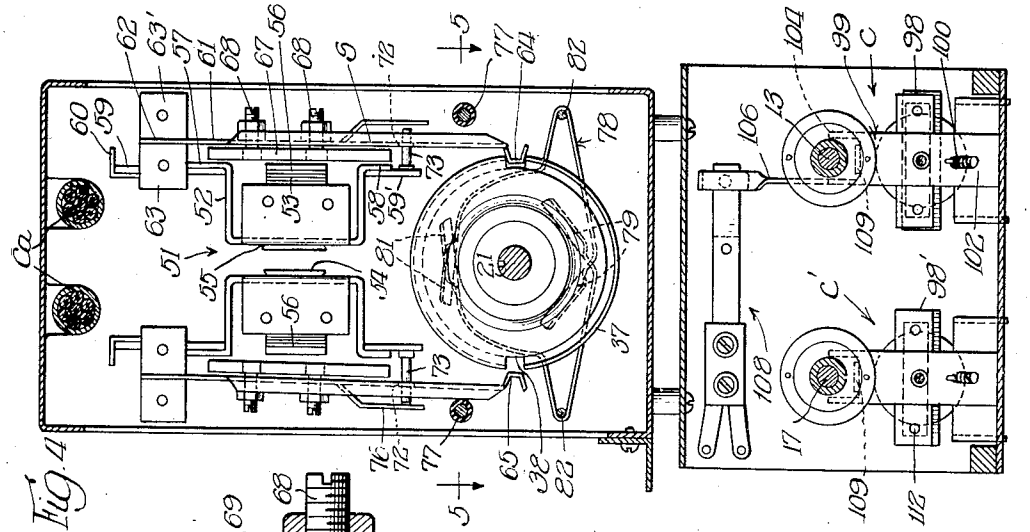

Fig. 4

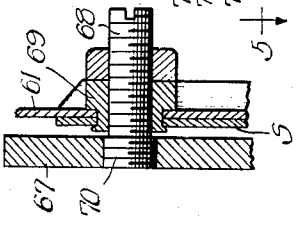

Fig. 7

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AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

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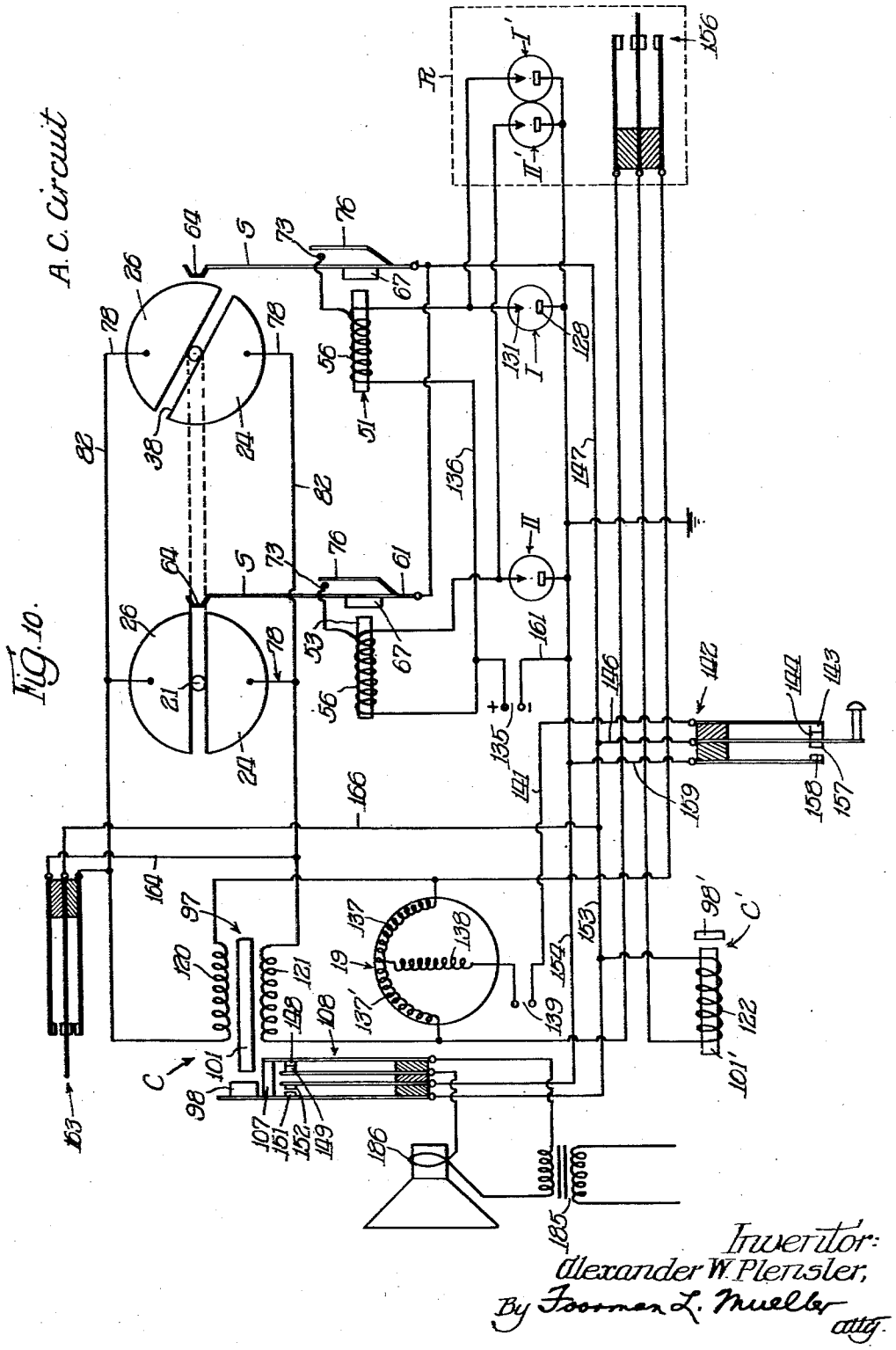

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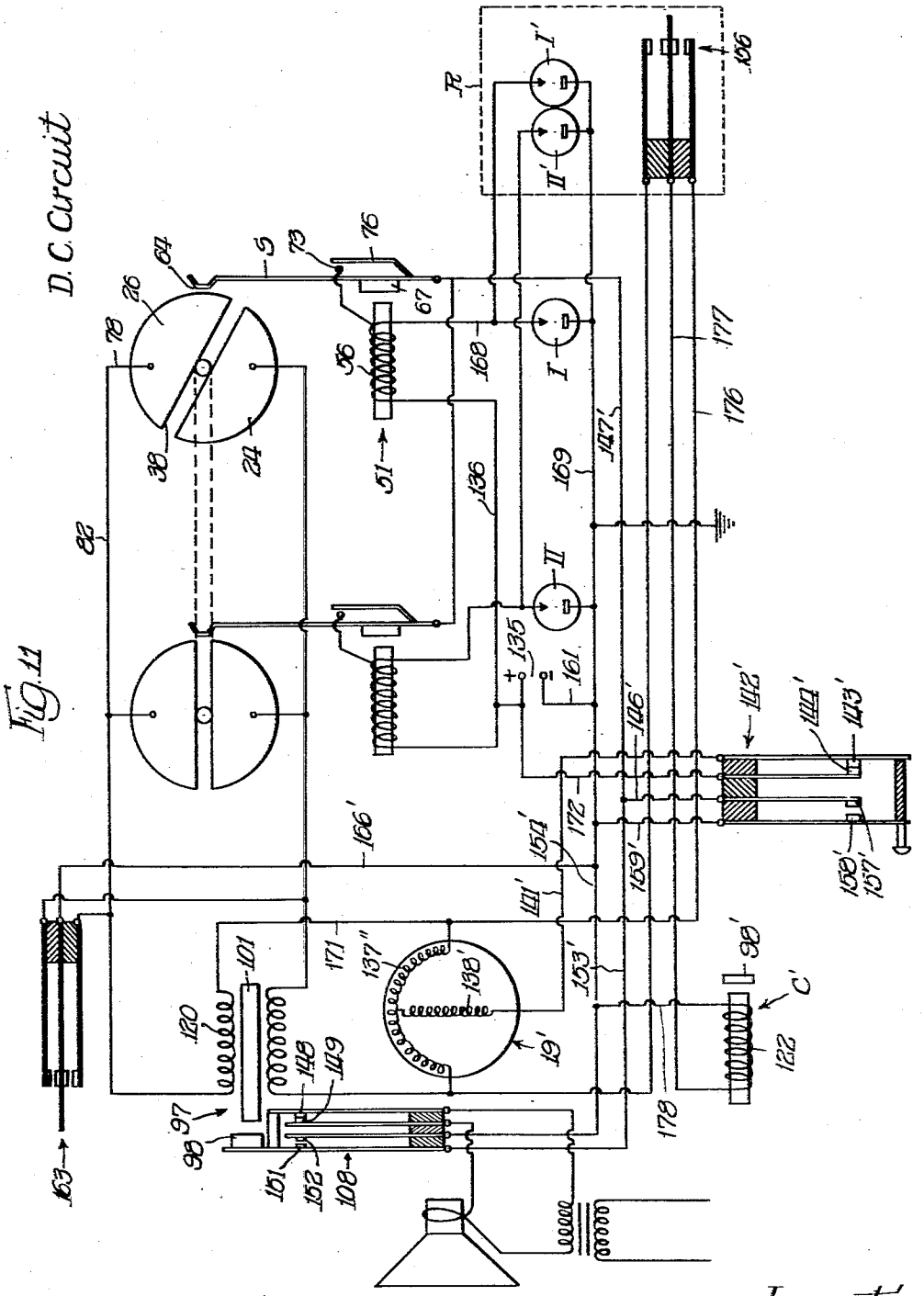
AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

Filed Nov. 17, 1937 4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,208,549

AUTOMATIC TUNING DEVICE FOR RADIO RECEIVERS

Alexander W. Plensler, Chicago, Ill., assignor to Belmont Radio Corporation, a corporation of Illinois

Application November 17, 1937, Serial No. 175,001

12 Claims. (Cl. 192—142)

My invention relates in general to a device for electrically operating control and indicating apparatus, and more in particular to an automatic tuning device for a radio receiver, and in this respect is directed to an improvement over the invention of my copending application Serial No. 390,064, filed September 3, 1929, now issued as Patent No. 2,114,068.

It is an object of the present invention to provide an improved electrically operated automatic control device for controllable apparatus such as a radio receiver.

A still further object of my invention is to provide a very compact device capable of tuning the radio receiver to a relatively large number of predetermined stations, yet one which may be mounted in the radio receiver cabinet itself immediately adjacent the tuning and control apparatus therefor, so as to provide as direct mechanical and electrical connections with such apparatus as possible.

One of the features of my automatic tuning device is the provision of a staggered assembly for the electrical selector contact elements so that there will be a minimum of lost space in the device and consequently make it as compact as possible.

A further feature of my present invention is the provision of rotary electrical contact elements which may be preassembled as a unit and relatively stationary electrical contacts therefor which may also be preassembled as a unit, the two units being of such construction as to be readily assembled together, the preassembly of each unit simplifying the testing and inspection thereof and facilitating the complete assembly of the device. Another feature is the provision of two electro-magnetic clutches for connecting different receiver control elements to the driving motor for the complete apparatus, which clutches are positive in this operation yet provide for a simple disengagement of the motor even when operating, in the event the apparatus is not stopped at the end of the normal operating arc for the tuning condenser.

The present invention also provides for remote control not only for broadcast station tuning, but also for the speaker volume, and accomplishes both operations by motor drive.

A still further feature of my invention is the provision of control apparatus and a circuit for quickly moving the condenser through all or part of the complete 180° arc through which it normally travels.

Other objects, features, and advantages will be apparent from the following description taken with the drawings, in which:

Fig. 1 is a side elevation of the complete assembly of the tuning condenser, and automatic tuning device and driving mechanism therefor for mounting on a radio receiver chassis.

Fig. 2 is an explosion view of one cam unit.

Fig. 3 is a fragmentary sectional view of two cam units on their mounting shaft.

Fig. 4 is a sectional view along the line 4—4 of Fig. 1 showing particularly the internal structure of the tuning unit as well as the clutch assemblies for connecting and disconnecting the driving motor from the automatic tuning structure.

Fig. 5 is a fragmentary view, partly in section, along the line 5—5 of Fig. 4 and looking in the direction of the arrows indicated thereon.

Fig. 6 is a detailed view of a stationary brush for a cam unit in its non-expanded position before mounting on the cam assembly.

Fig. 7 is an enlarged fragmentary sectional view of the adjusting means for an armature on a movable selector finger.

Fig. 8 is an enlarged detail view partly in section of the clutch shifting mechanism for the electro-magnet.

Fig. 9 is an enlarged fragmentary view, partly in section, of the movable armature for the clutch magnet.

Fig. 10 is a diagrammatic illustration of the circuit and part of the control structure for an A. C. circuit for the complete tuning device.

Fig. 11 is a diagrammatic illustration of the comparable circuit for the tuner operated by a D. C. motor.

In the illustration of Fig. 1, the ordinary variable condenser 10 for a radio receiver is connected through suitable reduction gears G on its shaft 11 to a tuning knob 12 carried on a shaft 13 for manual movement and positioning of the tuning condenser 10 as shown by the indicator on the dial 14 visible at the front of the radio receiver cabinet. The speaker sound output for the receiver is controlled by the knob 16 on a shaft 17 extending from the front of the cabinet through an "on" and "off" switch 18 (Fig. 1) for the radio receiver, to the automatic tuning device as will be hereinafter described. A motor 19 mounted beneath the control elements of the tuning device will selectively drive shaft 13, or shaft 17, through magnetic clutches in connection therewith.

To control the operation of the motor, whether it be an A. C. motor or a D. C. motor, which in

turn drives the tuning mechanism for the receiver in response to such control, a plurality of cam units are assembled on a shaft 21 integral with, or coupled to the shaft 11 of the condenser. The cam units are retained in set position on the shaft by means of frictional engagement between adjacent cam units with the frictional pressure being varied by the axial position of a nut 22 threaded onto one end of the shaft 21 to press the cam units against a bushing and shaft coupling assembly 23 at the opposite end of the shaft. A pinion 20 is secured to a stub shaft journalled in the frame wall and having a screw driver slot D in the outer or right hand end as viewed in Fig. 1, for insertion of a screw driver to rotate the shaft and pinion, to in turn rotate the gear 20' secured to the nut 22 to cause axial movement of the nut on the threads of the shaft and thereby vary the frictional pressure on the cams. This frictional pressure is such that it will retain the cams in an angular position on shaft corresponding to the desired station setting, yet such that it will permit the manual rotation of the shaft while retaining a cam stationary so as to change the angular position. It is understood that there will be no necessity to operate the friction varying means unless the friction decreases through wear, or is too great to permit resetting. Resetting of a cam unit is ordinarily accomplished with normal frictional pressure on the cam units. It is further understood however that the simple mechanism for accomplishing variation of the frictional pressure permits of a complete clamping of the cam units on the shaft, so that resetting may be effected only after the pressure has been reduced by the simple means described above. The cam units may then be tightened up again. Each cam unit is identical and any desired number may be assembled on the shaft 21 depending upon the desires of the manufacturer. In the embodiment illustrated herein, a total of ten (10) cam units are shown, making it possible to set the tuning device for the radio receiver to ten (10) predetermined broadcast stations. Two complete units are shown in Fig. 3, while a single cam unit is illustrated in detail in Fig. 2. This general structure is described and illustrated in my copending application noted above.

For convenience I will merely describe one unit, in this improved structure, and it is understood that the other units are identical. A unit normally comprises a pair of identical cam segments or sections 24 and 26 mounted on the shaft 21 and insulated therefrom by means of fibre positioning washers 27. These washers fit rather snugly on the shaft 21 and are positioned in cavities 28 formed in the one-piece stamped out cam segments 24 and 26. Each cam segment comprises an embossed ring 29 forming the wall of the cavity 28, and an integral plate portion 31 is provided with alternate apertures 32 and projections 33. A fibre spacer disc 34 with apertures 36 therein corresponding to the projections on the two cam segments insulates one segment from the other over the complete body portions thereof. The disc 34 also acts to retain the cam segments in fixed position with respect to one another. The apertures 36 are of such a size as to fit very snugly over corresponding projections 33 of each cam segment. As is noted in Fig. 2, these projections are so positioned that they occupy the four (4) apertures in the disc. The apertures 32 in the segments are quite a bit larger in diameter than are the projections 33, so that when the latter extend through the disc 34 they will still be spaced away from the metal of the oppositely disposed cam segment, and thus be insulated therefrom. An inwardly turned flange 37 on each of the cam segments extends over slightly less than one-half (½) of the periphery of each segment so that when the segments are brought together on the shaft 21, the flanges extend in opposite directions and yet are spaced from one another by contact and mechanical locking gaps 38 formed on each side by virtue of the length of the two flanges 37. With each flange 37 extending almost 180° over the periphery of the cam segment, this corresponds with the 180° arc through which the rotors of the tuning condenser 10 rotate. In this manner flange 37 of segment 24 for instance, may travel in a clockwise direction through all or a part of the condenser arc of 180°, depending upon the particular cam setting while the flange 37 of the segment 26 may similarly travel through the same arc in a counter-clockwise direction.

With the cam units mounted on the shaft 21 as shown in Fig. 4, they are spaced apart from one another by means of steel locking washers 39 having a key or lug 41 thereon for engagement with the key way 42 on the shaft 21 to spline each washer on the shaft and prevent its rotation thereon. The steel washers are slightly smaller than the fibre discs 27 so that there is no possibility of engagement with the embossed ring 29 on each cam segment to make electrical connection with the shaft 21. Each cam unit excepting the washers 39 may be rotated on the shaft 21 for setting to a predetermined tuning position as will be hereinafter explained, and with the washers 39 desirably stamped from spring stock and bowed slightly, the frictional engagement between the fibre washer 27 and its adjacent washer 39 as well as the cavity 28 may be varied by adjustment of the nut 22 to provide any desired pressure on the rotatable cam unit and prevent its movement on the shaft except when resetting for station tuning as has previously been described. If the dimensions of the shaft and cam assembly are such that the units described will not occupy the desired axial space, one or more ordinary metal washers may be inserted over the shaft to lie between adjacent keyed washers 39.

The members of a cam unit as illustrated in Fig. 2 may be quickly slipped over the shaft 21 and the cam segments then brought together in proper alignment by means of the corresponding apertures 32 and projections 33. These portions as well as the apertures 36 in the disc 34 are of such dimensions that a tight fit to maintain the members of the cam unit in a rigid position results from the assembly.

The cam shaft 21 is suitably journalled in plates 46 and 47 of a mounting frame for the automatic tuning device, which frame includes top and bottom plates 48 and 49, respectively. The cam units on the shaft 21 may be preassembled on plate 47. A second sub-assembly comprising primarily the electrical structure for the cam units, may be preassembled on the other frame plate 46 and insulated therefrom as well as from the plate 47. This latter subassembly as shown in Fig. 4 comprises electro-magnets 51 with the frame therefor comprising a one-piece channelled bracket 52 extending between the frame plates and supported therefrom, and electrically common to all of the laminated cores 53 having a rear portion 54 extending through

a corresponding aperture in the base of the channelled frame to be peened over as at 55, to rigidly retain the laminations in the frame without other securing means. It is understood that there are two such one-piece channelled brackets 52 in the tuning device. An insulated wire winding 56 is provided for each core. Integral flanges—57 extending upwardly and 58 extending downwardly—are provided on the member 52 serving with the core 53 as pole pieces for each magnet. A terminal strip 59 is mounted on the flange 57, and a strip 59' is mounted at the rear of the flange 58. Connections to the windings for the electro-magnets 51 extend from the current supply cables C, to the terminal lugs 60 on the strip 59.

The circuit for energizing the split-phase reversible motor 19 to effect operation of the tuner and thereby automatically tune the radio receiver, extends through a selector finger S to a corresponding single cam unit as shown in Fig. 2. There, of course, is a selector finger for each cam unit and half of the fingers are mounted on one side of the cam-finger assembly, while the other half are staggered with respect thereto on the other side of the assembly as shown in Fig. 5. The electro-magnets 51, with one for each selector finger, are similarly positioned, and with this construction it is possible to mount the cam units closer together. The over-all length of the tuner device is substantially reduced over the structure shown in my copending application identified above.

Each selector finger S on each side of the tuner is mounted upon a downwardly extending resilient finger 61 in a one-piece comb having an integral connecting bar 62 (Fig. 1) rigidly secured between a pair of mounting brackets 63 and 63' (Fig. 4) for securing the comb to the tuner frame itself. The lower end of the finger S is formed to provide a projection 64 with tapering sidewalls 65 adapted to seat firmly with a wedge-like action in the gap 38 formed at the ends of adjacent flanges 37 on the cam segments 24 and 26. With this configuration when the selector finger is drawn into the gap 38 by the electromagnet 51, a positive and immediate electrical contact is completed with the two segments 24 and 26, originally insulated from one another, to cause the motor 19 to become disconnected from the shaft 21. Likewise, the configuration of the projection 64 provides for a mechanical stopping of the rotation of the cam unit at the exact predetermined tuned position of the tuning device.

The selector finger S is attracted to the core 53 and faces of the flanges 57 and 58, by an armature 67 adjustably secured on one side of the finger S by securing means which also secure the selector finger S to the spring finger 61 on the comb. It is desirable that the armature 67 make a full-face contact at all such three points on the magnet to prevent magnetic losses and permit the operation of the magnet on the smallest possible amount of power. It is desirable to maintain the maximum operating efficiency for the magnet and finger structure so that a firm and positive electrical and mechanical engagement of the projection 64 in the cam gap 38 is obtained. A pivotal action on the finger S is obtained by virtue of its mounting on the spring finger 61, with the latter normally holding the finger S out of engagement with a cam unit. To assure the proper alignment between the armature and magnet pole pieces, and obtain full-face contact thereof, adjusting and mounting means are provided which comprise two adjusting screws 68 threadably secured in corresponding bushing and mounting members 69 engaging the spring finger 61 and extending through this finger and the selector finger S, as shown in Fig. 7 to hold the two together. Each screw 68 extends in a threaded aperture 70 in the armature 67. The portion of the screw 68 in the bushing 69 is provided with threads pitched in one direction while the portion in the aperture 70 has threads pitched in the other direction, and, of course, the threads in the bushing and armature are either left hand or right hand to correspond therewith. With the screw turned in one direction, for instance, one end of the armature will be moved away from the face of the selector finger S while turning the screw in the opposite direction will draw the armature toward the selector finger and thus properly align the armature 67 to provide a full-faced contact on the electro-magnet 51 when the magnet is energized.

Each magnet and selector finger unit is provided with a contact pin 73 carried on the terminal strip 59' secured to the flange 58 on the magnet frame. The pin 73 is connected to the winding 56 on its corresponding magnet 51 as shown in the circuit diagram of Fig. 13 and is positioned to extend through a corresponding enlarged aperture 72 (Fig. 4) in the finger S, and is of a length to engage a holding contact 76 integral with the spring finger 61 on the selector comb. The pin 73 engages the contact 76 when the selector finger is drawn in to engage the rim or flange 37 of a cam segment, and is included in a holding circuit for that finger as will be described. A rubber covered bumper rod 77 extends between the frame plates 46 and 47 on each side thereof, to limit the outward movement of the selector finger as is shown on the left hand side of Fig. 4, for instance.

All of the cam segments to control clockwise movement of the motor are connected electrically in parallel, and similarly with all segments for counter-clockwise movement, as can be seen from the circuit diagram of Fig. 13. To conserve parts and space and simplify the assembly of the tuning device the cam units are assembled back to back, so to speak. Adjacent cam segments have the same angular displacement, while the flange 37 on each of the other segments of two cam units are angularly displaced 180° with respect to those first mentioned. This is shown in Fig. 3. As a result, a single stationary brush 78 may be used to engage two adjacent cam segments because they are both connected to provide the same direction of rotation for the motor. As shown in Fig. 6 each brush 78 has a pair of resilient fingers 79 and 81 extending from one side of the U-shaped body portion which is soldered or otherwise permanently secured in electrical and physical engagement with a metal rod 82 mounted between the two frame plates 46 and 47 and insulated therefrom. The ends of the fingers 79 and 81 are turned outwardly to permit the brush as a whole to be slid over the rim 29 of the embossed portion of each cam segment. The spring pressure on the fingers causes them to remain in positive electrical contact with each corresponding segment and providing two fingers instead of one gives greater assurance of continued electrical contact. These cam brushes 78 are staggered as described for the selector finger and electro-magnet units, and as shown in Fig. 5 a total of eleven

(11) brushes are required for the ten (10) cam units.

All the parts of the selector finger and magnet assemblies as well as all of the parts of each cam unit, including the stationary brushes, are of such a configuration that the same part can be used either on the left or on the right hand side of any of the assemblies. This, of course, reduces the cost of manufacture materially and facilitates the assembly of the complete device.

The motor is thrown in and out of connection with the tuning shaft 13 and volume control shaft 17, having the receiver switch 18 thereon, by means of electro-magnetic clutch structures C and C' respectively. The clutches are identical as employed in the illustrated embodiment of my invention so far as the principal part of their assembly is concerned, and for convenience, simply the clutch C for the tuning shaft 13 will be described. As is shown in Fig. 1, the shaft 13 or a coupled continuation thereof, extends entirely through the clutch frame F and has a gear collar 84 slidably secured thereon, with suitable gearing 85 thereon for connection to the motor gears. The collar 84 also carries an apertured disc 86 rigidly secured thereto, and axially aligned with a corresponding disc 87 integral with or secured to a sliding collar 88 on the shaft 13. Pins 89 on the disc 87 extend through corresponding apertures in the disc 86 to ride therein and cause disc 86 to drive disc 87 and consequently the collar 88 having the clutch plate 91 on the opposite end thereof. The clutch plate 91 is provided with spaced apart pointed prongs 92 (Fig. 1) for engaging the serrated rim 93 of the driven clutch plate 94 integral, or rigid with the sleeve 96 secured to the shaft 13.

When the clutch electro-magnet 97 is energized the armature 98 on the shifting lever 99 is attracted to the face of the laminations or core 101 of the magnet to shift the clutch plate 91 into engagement with the corresponding clutch plate 94 having the serrated rim 93 thereon (Fig. 8). This, of course, causes the motor 19 to drive the tuning shaft 13. The clutch plates are normally out of engagement as a result of the tension of the spring 100 pulling the lever 99 away from the magnet when it is deenergized.

The shifting lever 99 comprises a stamped out bar 102 pivoted on the clutch frame at 103 and extending upwardly to a U-shaped portion 104 straddling the collar 88 and being confined thereon axially by the discs 87 and 91. In clutch C, as shown in Fig. 4, an extension 106, integral with one leg of the U-shaped portion, is provided with a hooked top for engagement with the button 107 on the muting switch 108 shown more clearly in the diagrammatic illustration of Fig. 10. A lip 109 on the body portion of the lever 102 extends forwardly to engage the back of the disc 91 to prevent the lever member from floating or rattling on the collar 88.

The armature 98 is carried in a floating connection with a cross bar 111 integral with or secured to the lever 102, and is positioned and supported by pins 112 (Fig. 9) from the armature extending through apertures in said cross bar, and normally retained against the cross bar by the tension on the spring 113 carried on the threaded pin 114. This floating connection acts, in effect, as a safety valve when the "sweep switch" is being operated, as will be explained, so that in the event the motor is maintained energized to ordinarily rotate the rotors for the condenser 10 beyond their limit of rotation, at such limits, due to the stopping of such rotors in the normal manner, the rounded ends of the prongs 92 ride over the rounded surface of the serrations on the rim 93, meanwhile forcing the lever 102 rearwardly even though the armature 98 is retained against the magnet. This condition causes a rasping noise at the clutch plates to warn the operator of the position of the tuning condenser. With this structure no harm results either to the motor due to stopping it while energized, nor to the condenser which might have an undue driving force exerted on it at its limit of movement if the clutch remained in engagement.

As mentioned above, the clutch structures C and C', including the electro-magnets therefor, are identical in their principal mechanical parts. However, as is shown in the circuit diagram of Fig. 10, the electro-magnet 97 of clutch C has a pair of windings 120 and 121 thereon, while the clutch structure C' with core 101' has only a single winding 122 thereon. The differences in the operation of these two magnets will be explained in detail hereinafter. Shading rings 123 are provided on the laminations of each of the electro-magnets to increase and smooth out the coercive force exerted by the magnet on the armature when excited by A. C. to prevent chattering of the armatures 98 and 98' thereon, as will be explained in connection with the circuit diagram of Fig. 10. When using an A. C. motor, the D. C. supply to the tuner is used only for operating the electro-magnets 51. When using a D. C. supply to the electro-magnets for the clutches, this, of course, eliminates the necessity for the shading rings.

A. C. motor circuit and operation

As to the operation of the tuning device with an A. C. motor and a circuit in accordance with the diagram of Fig. 10, the device is set into operation by pushing one of the buttons as I at the receiver or a button as I' at the remote control unit R. As is shown in the diagram, each of these buttons in the remote control position is connected in parallel position with a corresponding button in the receiver itself. A circuit through the particular button operated is then completed, and assuming it is button I, a tuner operating circuit is initiated which extends from the source of current 135, which may be the D. C. supply for the receiver or may be a battery, through lead 136 to the winding 56 on the magnet 51. This energizes such magnet to attract the armature 67 which in turn pulls the selector finger S, secured to the armature 67, against a segment such as 26 on the tuner cam. It is understood that the tuner will be driven clockwise for one segment of the cam, and counter-clockwise when the finger engages the rim 37 on the other segment of the cam. One segment is connected with one side of the split phase motor 19, through clutch winding 120 while the other segment is connected to the other side of the split phase motor 19 through the clutch winding 121. The above circuit is completed substantially instantaneously with the pressing of the button I, which under pressure of the spring tension in the strip 128 then returns to normal position and the circuit through the driving motor is maintained by a holding circuit as will be explained. With the selector finger in engagement with segment 26, the current passes through one of the metal bars 82 carrying a stationary brush 78, to winding 120 on the clutch magnet 97 of clutch C. Winding 120 is in series connection with field winding 137 of the A. C.

driving motor, and the current passes through windings 137 and common winding 138, through the A. C. supply 139, and through lead 141 to the reset switch 142. The circuit continues through contacts 143 and 144 of the reset switch 142 which contacts are normally in engagement, through leads 146 and 147 to the finger S, and more particularly to the contact member 76.

As current passes through the magnet winding 120, the magnet is energized to attract armature 98 which causes the shifting lever 102 to move, and the arm 106 thereon to engage the button 107, and open the contacts 148 and 149 of the switch 108. This opens the speaker circuit including the output transformer secondary 185, and the voice coil 186, so that the noise of tuning will not be reproduced therein. This action simultaneously closes the contacts 151 and 152 on the other side of the switch 108. This closes a "holding circuit" for the selector finger S which extends through lead 153 and 147 to the holding contact 76 on the selector finger S, from which contact 76 the current extends through the pin 73 to the winding 56. On the other side of the switch 108 the circuit extends through the contact 152 of the switch and over the lead 154 to the negative side of the D. C. supply. With the closing of this circuit, the motor remains energized and the selector finger S remains in engagement with the segment 26 by virtue of the attraction of the armature 67 to the magnet 51.

With the motor energized and connected through the clutch to the tuning shaft 21, common to both the rotor and the tuning condenser, this shaft turns until the projection 64 on the finger S engages both segments 26 and 24 at the gap 38. This gap represents the predetermined station setting for the tuning condenser. With such simultaneous engagement, a circuit is completed through segment 24, through the stationary brush 78 in engagement with that segment, through the corresponding bar 82 as shown in the lower position in Fig. 10, and then to winding 121 on the magnet 97. In the meantime the circuit through segment 26 and the other bar 82 and connecting wires to winding 120 is maintained. The current phase in these two circuits is opposite and causes the field of the windings 120 and 121 to collapse, thereby deenergizing the magnet 97 to in turn release the armature 98. As the armature 98 is released, it acts to simultaneously disengage the discs 91 and 93' to break the mechanical connection between the motor and tuning shaft. As a result, the driving mechanism is entirely released from the driven shaft 13 before the electrical circuit holding the projection 64 in the gap 38 is broken and, as a result, there is positive stopping of the cam at the predetermined station setting represented by the gap 38. The cam stops immediately under such mechanical braking although the armature of the motor 19 may coast under its own momentum. Upon release of the armature 98, the contacts 151 and 152 in switch 108 are opened to break the "holding circuit". When the circuit at contacts 151 and 152 is broken, the circuit including D. C. supply 135 is also broken to cut off the D. C. supply to the winding 56, to deenergize the magnet and release the retaining finger 76, thereby releasing the selector finger S from the gap 38.

All of the selector circuits including buttons I, II, etc., paralleled of course by the corresponding buttons I', II', etc., in the remote unit R, and each in series with its respective holding magnet 51, are in parallel, so that the same operation results from pushing in any one of the buttons as is described in connection with the button I above. In this connection it is noted that all of the various manually operated switch circuits are in parallel connection, so that no harm will come to the mechanism even though more than one switch is manually operated at the same time. When the first selector contact shorts the two segments of one of the energized cams under these conditions, all of the holding circuits will be opened.

The remote control device, shown diagrammatically in Fig. 10, contains a toggle switch 156, which, when operated in either one direction or the other as a single-pole double-throw switch, closes a circuit through the winding 122 of the electro-magnet for the clutch C' at the receiver. This energizes the magnet core 101' to attract the armature 98' which in turn actuates the clutch C' (Fig. 4) to connect the motor 19 to the shaft 17 for conventional volume control in the radio receiver. The volume control is rotated one way or the other depending upon which direction the switch handle is moved so as to provide complete control of the volume of reproduction of the radio receiver from a remote position. The "on" and "off" switch 18 for the receiver is mounted on the volume control shaft 17 and operated in the usual manner, so that the receiver may also be turned on and off from the remote position. Either of these operations is accomplished without movement of the tuning cams, or rotors. It will be noted that the circuit through the single winding 122 for the magnet core 101' extends from switch 156 directly through such winding and one or the other of the windings 137 and 137' of the motor itself. This circuit more in detail includes the conductor extending from the single contact on the switch 156 through the winding 122 to the conductor 153, the conductor 146, contacts 143 and 144 which are normally closed, and conductor 141 to the energizing source at 139. Assuming that the movable contact on the switch 156 is moved upwardly, the remainder of the circuit extends from the energizing source 139 through the winding 138, winding 137', and the conductor extending therefrom to the power contact in the switch 156. This circuit does not extend through the tuning control clutch magnet 97 with windings 120 and 121, so that with this direct connection to the motor, such motor may be used for any one of three different operations, viz., for operating the tuning shaft, for operating the shaft 17 to operate the switch 18 for "on" and "off" switching, or for operating the shaft 17 to in turn operate a volume control device for the radio receiver. This circuit for both tuning and switching permits the use of one, or a plurality of remote positions.

A particular cam is angularly adjusted on the shaft 21 so that the angular position of a gap 38 corresponds to a predetermined broadcast station setting of the condenser 10 by means including the reset switch 142. The setting or resetting operation includes the original energization of the tuning circuit described above, by pushing a button as I, to cause the cam to turn until the projection 64 engages the gap 38. It is understood, of course, that each cam or rotor unit, frictionally mounted upon the control shaft, may be operated independently of the others, and similarly, each rotor unit may be reset independently of the others, so that the button depressed is that for the particular cam whose station setting it is desired to change. After the

button I has been depressed to make contact, it is released in the usual manner. After the rotor has rotated in the manner described above until the projection 64 engages the gap 38, the motor-circuit is broken by the collapse of the magnetic field at the magnet 97 and the finger S returns to the normal non-operating position as shown on the left-hand side of the structure in Fig. 4 with the projection 64 opposite the gap 38. Button I is then depressed again to throw projection 64 into gap 38, and in this instance, of course, the clutch will not operate. While button I is maintained depressed the button on the reset switch 142 is depressed. While holding the latter button depressed the button I is released. A circuit is then completed through contacts 157 and 158 to one side of the D. C. supply 135 through leads 159 and 161. The other side of the circuit extends through leads 146 and 147, finger contact 76, pin 73, winding 56, and lead 136 to energize the magnet 51 and maintain the projection 64 in the gap 38 without at the same time energizing the motor windings inasmuch as that circuit is broken at contacts 143 and 144. With the cam retained mechanically against rotation, the knob 12 on end of the tuning shaft 13 is turned to move the condenser to any desired tuning position as shown on the dial 14. When the condenser 10 is properly positioned for the desired station the shaft 21 will, of course, have attained an angular position with respect to the cam, such that stopping the cam at that point subsequently will tune the radio receiver to that predetermined station.

If the operator of the radio receiver is manually tuning the same, and wants to tune a station substantially at the opposite end of the wave band to that to which the receiver is tuned when the operation is begun, the condenser may be moved through its 180° of rotation, or any lesser amount, more quickly than can be accomplished by manually tuning itself, by operating the "sweep switch" 163 available at the front of the radio receiver. This switch operates to close the motor circuit and the circuit through the clutch control magnet 97 so as to engage the clutch members 91 and 93 and thereby connect the motor with the tuning shaft 21. The switch 163 is operated as a single-pole double-throw device and the motor is rotated in one direction or the other depending upon whether the switch is moved up or down, as viewed in the circuit diagram of Fig. 10. Assuming the switch is moved upwardly, as shown in Fig. 10, the current passes through the lead 164 to the winding 121 on the clutch magnet 97 thus energizing said magnet and attracting the armature 98 thereto to shift the movable clutch plate 91. The circuit continues through the motor winding 137, winding 138, A. C. supply 139, lead 141, through contacts 143 and 144, lead 146, and lead 166 back to the switch. The rotation of the condenser can be stopped at any desired position by merely moving the sweep switch to a center position as shown in Fig. 10. The receiver may then be tuned manually if desired to obtain a fine adjustment, or, of course, the tuning device may be operated to get the peak tuning for the station desired if a cam has been previously set for the station desired. This eliminates the necessity of tuning the manual knob 12 with a high gear ratio from one point of the dial to the other point of the dial, if manual tuning at that particular time is desired. It is noted, also, that the speaker is muted during this operation.

With reference to the remote control operation, it is, of course, understood that the switch 156 causes energization of the clutch C', and the motor 19 to rotate the shaft 17 having the switch 18 thereon. However, inasmuch as the motor cannot again be energized from the A. C. supply 139 to drive the shaft 17 when the switch 18 has been turned off from the remote position, a separate source of A. C. is provided for the motor for energization from a remote position when the switch 18 is off.

D. C. motor circuit and operation

To operate the tuner with a D. C. motor (Fig. 11), a button I in Fig. 11 is depressed exactly as described in connection with the A. C. motor circuit. Upon depressing the button, the circuit extends from the D. C. supply 135 through lead 136 to the winding 56 of the magnet 51, energizing said magnet and attracting the armature 67, when the circuit is completed through the lead 168 through the button I, and lead 169 back to the current supply at 135. When the armature is attracted to the magnet 51 the "holding circuit" from the winding 56 through the pin 73 and contact finger 76 is completed through the finger S engaging one of the cam segments as 26, lead 82, magnet winding 120, lead 171, motor windings 137'' and 138', lead 141' to reset switch 142'. From switch 142', and particularly contacts 143' and 144' the circuit continues through lead 172 to the positive (+) side of the current supply at 135. Tracing the circuit backwardly from the finger contact 76, the circuit extends through lead 147', 153', contacts 151 and 152 which have been closed by the movement of the armature to the magnet core 101, as heretofore described, through lead 154' and back to the negative (—) side of the current supply at 135. The speaker is muted upon opening of the contacts 148 and 149.

The motor operates when originally energized by engagement of finger S with a cam segment, and acts to drive the cams in the same manner as described with respect to the A. C. motor. Similarly, the clutch magnet is deenergized, and the motor circuit then broken when the projection 64 contacts the two segments at the gap 38 as heretofore described.

To originally set or to reset a cam for the desired broadcast station tuning, the cam to be changed in angular position is rotated by the energizing of the motor circuit as described above. The button, as I, is again depressed to attract the armature 67 to the magnet 51 and pull the projection 64 into engagement with the cam segments at the gap 38 in the same manner as described with respect to the A. C. circuit. While holding the button I depressed as previously described, the button on the reset switch 142' is pressed down to open the contacts 143' and 144' and close the contacts 157' and 158'. This closes a circuit extending from the D. C. supply 135 through lead 136 to winding 56, through pin contact 73, finger contact 76, lead 147', lead 146' through the contacts 157' and 158' and lead 159' back to the negative side of the D. C. supply through lead 161.

The "sweep switch" 163 for the D. C. circuit is identical with the switch designated by the same reference character for the A. C. circuit. Similarly, the operation is the same, viz., the switch is moved up or down as viewed in Fig. 11, to energize either the counter-clockwise or clockwise winding for the D. C. motor 19'. To describe this

circuit for movement of the tuning cams in one direction, the switch may be considered as pulled downwardly as viewed in Fig. 11. The circuit then extends through the winding 120 of the clutch magnet 97 to draw the armature 98 thereto and thereby move the clutch into engagement. The circuit also extends through the winding 137'' of the motor, 138', lead 141', and the contacts 143' and 144' of the reset switch 142'. The lead 172 from these contacts is connected to the D. C. circuit supply at 135. The other side of the circuit extends from the center contact of the "sweep switch" 163 through lead 166' to a connection with lead 169 which in turn is connected to the other side of the D. C. supply at 135.

The remote control switch 156 for the D. C. motor operates to energize the motor and clutch C' with its connected electro-magnet so that the radio receiver may be turned off or on from the remote position, and similarly so that the volume control may be actuated from a remote position. The clutch C', of course, connects the motor only with the shaft 17 carrying the "on" and "off" switch and volume control thereon. When pressing the switch downwardly as viewed in Fig. 11, the circuit is completed from the direct current supply at 135 through the lead 172 and through the contacts 143' and 144' of the reset switch. The circuit then extends through lead 141' to the motor winding 138' and then through the winding 137'' and lead 176 to the switch 156. The center contact of the switch 156 is connected into the other side of the circuit extending through the lead 177, the winding 122 of the electro-magnet for the clutch C' through lead 178 to lead 154' which connects with the lead 161 extending to the minus (—) side of the D. C. supply at 135. Upon energization of the electro-magnet for the clutch C', the armature 98' is attracted thereto and the clutch members brought into engagement for connecting the motor and the drive shaft 17 as heretofore explained.

When the tuning device of my invention is operated either by an A. C. or a D. C. motor, and consequently operating on an A. C. or a D. C. circuit, if one button is pressed in and a cam unit set into motion, pressing of another button merely causes the selector finger corresponding to that button to engage the rim of a segment of its corresponding cam. The tuner will then stop at the predetermined station setting corresponding to the gap 38 which is reached first by a selector finger for the first operated button or the second operated button. In other words, pressing more than one button will cause no injury whatever to the mechanism, but will merely cause the deenergization of the electro-magnet for the clutch C when the first short circuit across two corresponding cam segments is accomplished. Of course, if the operator actually desired to tune the station whose button was first depressed, while the gap 38 corresponding to a subsequently depressed button is reached first in the rotation of the shaft 21, the operator will have to depress the first button a second time. However, there should be no occasion to press more than one button at a time unless the operator is merely experimenting with the tuning device so that no inconvenience will be caused. On the other hand, by operating the tuner in the manner described above, the device becomes substantially fool proof against injury due to such experimentation because regardless of the number of buttons depressed, no harm can befall the mechanism.

From the foregoing description and a consideration of the drawings therefor, it is apparent that I provide a compact, sturdy, and relatively simple electrical automatic tuning device for radio receivers. The commercial embodiment of the invention tunes to a substantially hair-line predetermined station setting and by virtue of the structure for retaining the cams on the shaft 21, and by virtue of the selector finger and electro-magnet structure, this same station can be tuned in time after time with the same accuracy. Resetting of the relative position between the shaft 21 and consequently the variable condenser 10, and the individual cam units, is accomplished quickly and simply so that the tuning device has substantially unlimited flexibility so far as automatically tuning any desired station over a broadcast band. No supplemental tools or devices are required to accomplish this setting as is necessary in many of the prior art devices so that the operator of the radio receiver can likewise completely operate the tuning device by merely utilizing the mechanical and electrical structure all permanently mounted on the radio receiver cabinet or at the remote control unit.

Although this improved electrical automatic tuning structure has been illustrated and described in its preferred embodiments, it is understood that my invention is not limited thereby, but rather is limited only by the scope of the appended claims.

I claim:

1. In a control device for controllable apparatus, power means for actuating said device, and means for controlling the actuating interval for said power means including a pair of adjacent rotary units, and means for extending a circuit through one unit or the other comprising a movable contact with magnet means for each rotary unit for selectively attracting a contact into engagement with its corresponding unit, and a fixed brush common to both units and in continuous engagement therewith comprising a pair of spring fingers adapted to be spring pressed against two radially spaced portions on each of said control units.

2. In a control device for controllable apparatus, power means for actuating said device, and means for controlling the actuating period for said power means including a plurality of coaxially assembled rotary control units, each of said control units comprising a pair of insulatingly separated conducting segments with one segment adapted to control the clockwise rotation of the unit and the other the counterclockwise rotation thereof, with said control units positioned with respect to one another in the coaxial assembly in a manner such that each two adjacent conducting segments of adjacent control units are both adapted for either clockwise or counterclockwise rotation control, means for extending control circuits through said control units including a movable contact for each control unit, and a fixed contact common to each two adjacent conducting segments for adjacent control units.

3. In a control device for controllable apparatus, a rotary shaft, a control unit on said shaft comprising a pair of conducting members, an insulating disc intermediate said members, insulating means on the outside of each member and supporting said members out of contact with the shaft, and a washer keyed to said shaft and posi-

tioned adjacent an insulating means at the outside thereof.

4. In a control device for controllable apparatus, a rotary shaft, a control unit on said shaft including a pair of complementary conducting discs, an insulating plate intermediate said discs to insulate one from the other, and means for maintaining said discs in relatively fixed relation including laterally extending projections on each disc fitting snugly in corresponding apertures in said insulating plate to fix each disc with respect to said plate and thereby fix each disc with respect to one another.

5. In a control device for controllable apparatus, a rotary shaft, a control unit on said shaft comprising a pair of metal discs, each disc having a body portion, a laterally extending flange over substantially 180° of the periphery thereof, with said disc having an aperture in the center thereof fitting over said shaft and an embossed annular rim spaced away from said aperture and defining a cavity in the body portion of said disc, insulating means for separating said discs, and insulating means on said shaft fitting the cavity of each of said discs to insulate the control unit from the shaft.

6. In a control device for controllable apparatus, power means for actuating said device, and means for controlling the actuating interval for said power means, said control means including a rotary member comprising a pair of coaxial conducting discs each having inwardly extending projections, and means for insulating said discs from one another and at the same time retaining the same in relatively fixed relation with respect to one another, said means comprising an insulating plate having apertures positioned to correspond to the projections on each disc and of a size to receive said projections in a snug fit, with the projections of each disc being spaced from the other disc when in mounted position in the insulating plate.

7. A control device for controllable apparatus comprising a rotary shaft, power means for driving the shaft, and clutch means for connecting said power means with said shaft, including an electro-magnet having a pair of energizing windings with each extending in a direction such that the polarity of the field and for one winding neutralizes the field of the other winding, a control unit on said shaft including a pair of separated conducting segments, a contact for engagement with one of said segments to extend an energizing circuit through one of said magnet windings to actuate the clutch to connect the shaft and power means to rotate said shaft to a point at which said contact simultaneously engages both of said segments to extend a circuit through each of the windings of said magnet and cause the collapse of the energizing field for said magnet to deenergize the same and cause disengagement of the clutch means.

8. An electric control device for controllable apparatus including a rotary shaft, a control unit on said shaft comprising a pair of conducting members, an insulating disc intermediate said pair of conducting members, with each of said conducting members being fixedly supported on said insulating disc but out of contact with one another, and insulating means independent of said insulating disc on the outside of each of said conducting members for supporting said unit on said shaft and maintaining said unit out of electrical engagement therewith.

9. A control device for controllable apparatus, power means for actuating said device, and means for controlling the actuating interval of said power means, including a pair of coaxial control units rotatably mounted and positioned adjacent one another, a movable contact member for each control unit with the contact members being supported in oppositely but laterally displaced positions with respect to one another on the device, with a control circuit being completed through one control unit or the other depending upon the contact member selected by engagement of the selected contact member and the control unit and a single stationary brush in continuous engagement with both of said control units.

10. A control device for a radio receiver including a plurality of rotatable control units supported in an assembly in axial alignment with respect to one another, means for completing control circuits through said control units, including two groups of movable contact members, with said groups being spaced apart and mounted on said control device so that the contact portions thereof are approximately 180° in an angular distance from one another, with the contact members in one group adapted to engage alternate control units and the contact members in the other group adapted to engage the remaining control units, electromagnet means on said device between the two groups of contact members for selectively attracting a contact member into engagement with a control unit, and a plurality of stationary brushes with one brush for each two adjacent control units.

11. In an electric tuning device for a radio receiver having rotary control means, a compact electro-magnet having at least two separated pole faces, means for driving said rotary control means, and a circuit for energizing said driving means, the combination of a movable contact in said circuit to be attracted to the electro-magnet and moved into engagement with said rotary control means, said contact having an armature thereon for direct engagement with said pole faces, and means for adjustably mounting said armature on said contact for positioning the same so as to provide a substantially full faced contact between said armature and said pole faces so that said compact electro-magnet will exert a relatively large amount of pull on said armature with a relatively small amount of current in said electro-magnet, said mounting means including a pair of spaced apart apertured portions on said contact, an adjusting screw supported in each aperture with said adjusting screws threadably secured in corresponding apertures in said armature to selectively move the ends of said armatures toward or away from said contact to provide an alignment with said electromagnet such as to obtain substantially full face contact with said pole faces.

12. A radio receiver tuning system, including rotary tuning means, power means for driving the rotary tuning means and clutch means for connecting said power means with said rotary tuning means, said clutch means including an electromagnet having a pair of energizing windings with each winding extending in a direction such that the polarity of the field for one winding neutralizes the field of the other winding, control means in said rotary tuning means including a pair of separated conducting portions fixed with reference to one another and moving with said rotary tuning means, a contact for engagement with one of said conducting portions to extend

an energizing circuit through one of said electromagnet windings to actuate the clutch means to connect the power means and rotary tuning means to rotate the latter to an angular position at which said contact simultaneously engages both of said conducting portions to extend a circuit through each of the windings of said electromagnet and cause the collapse of the operating field for said electromagnet to deenergize said operating field and cause disengagement of the clutch means from the rotary tuning means.

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