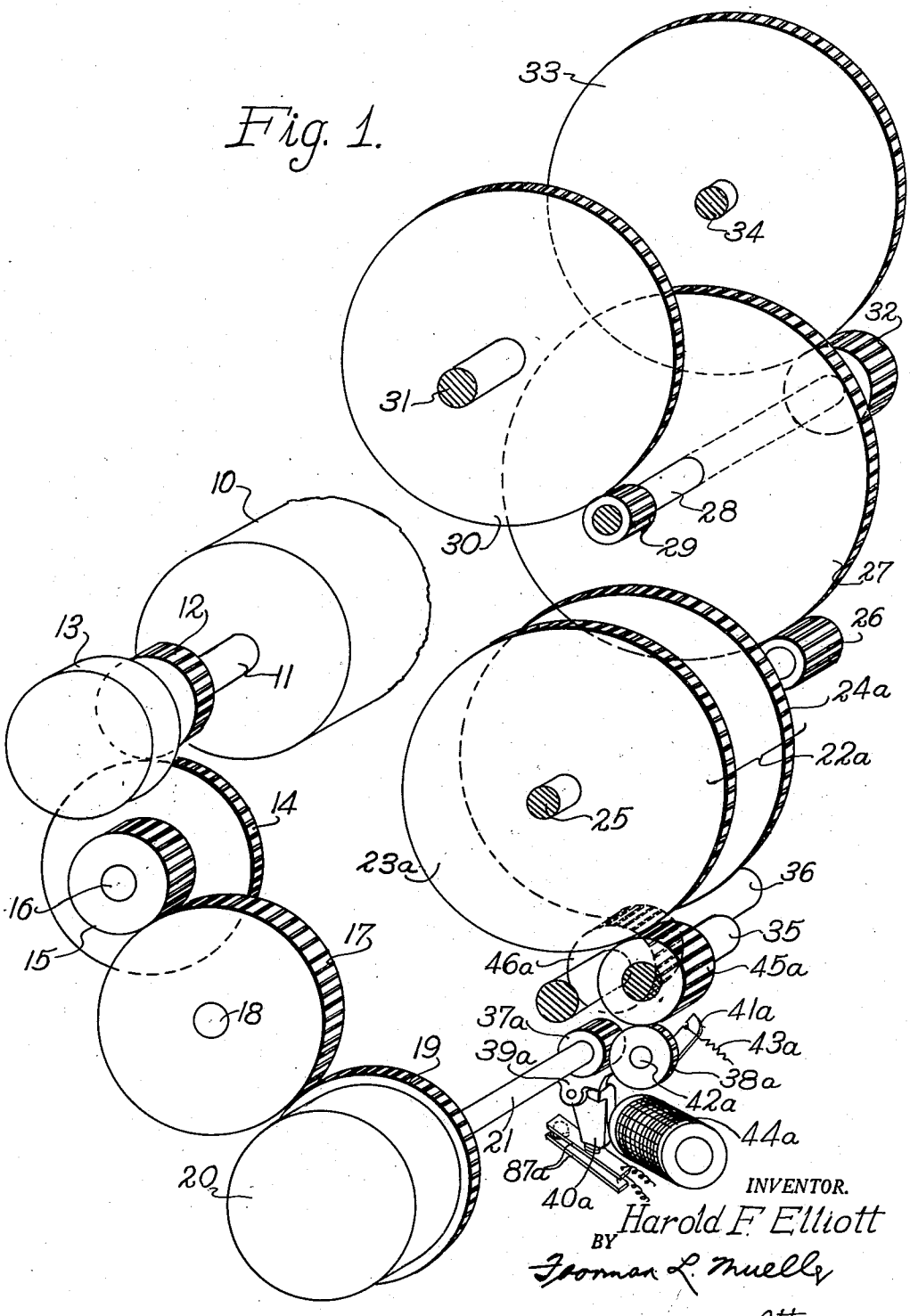
July 8, 1947. H. F. ELLIOTT 2,423,588

RADIO CONTROL APPARATUS

Filed April 17, 1944 5 Sheets-Sheet 1

Fig. 1.



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RADIO CONTROL APPARATUS

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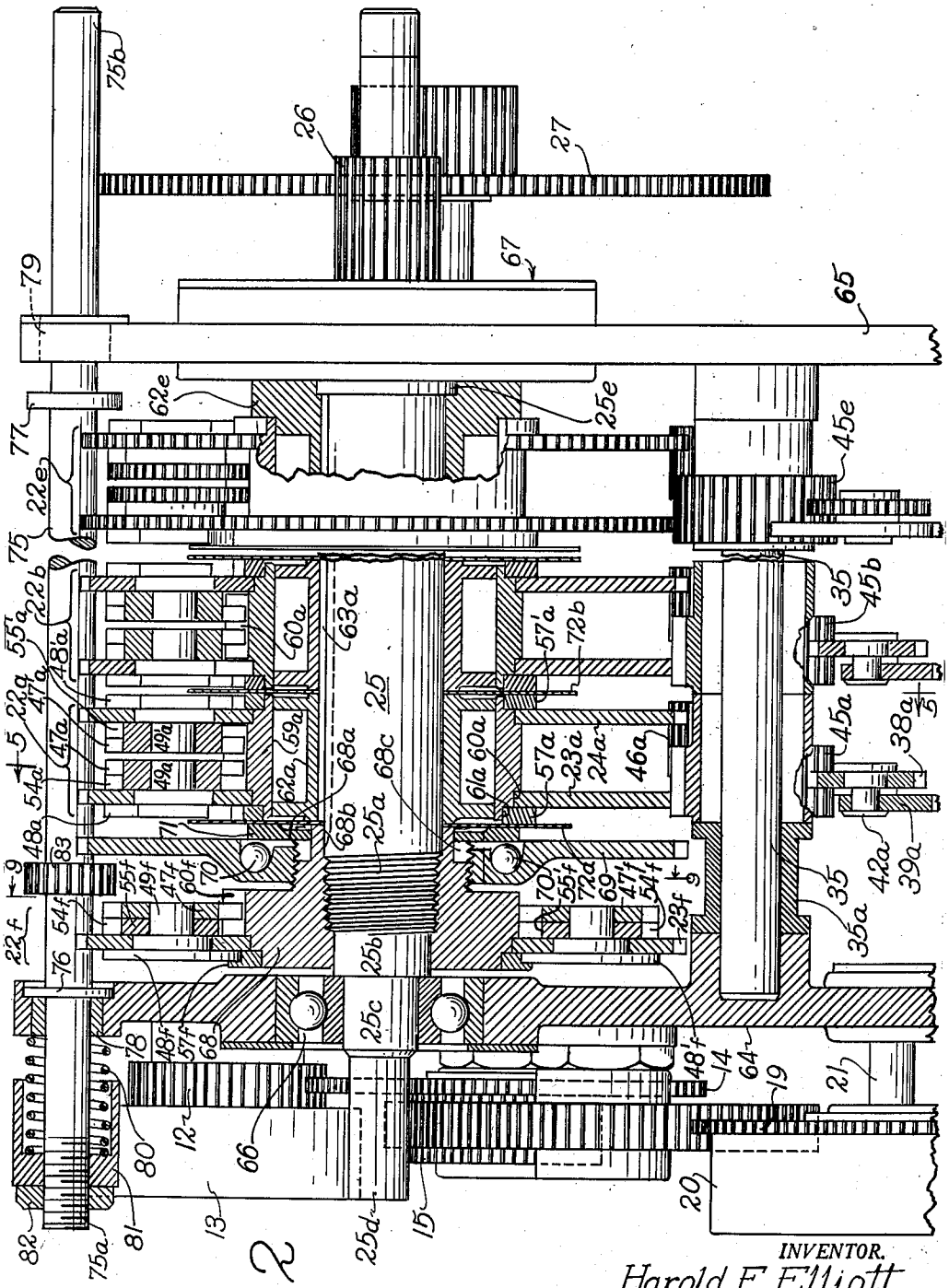


Fig. 2

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RADIO CONTROL APPARATUS

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Fig. 3.

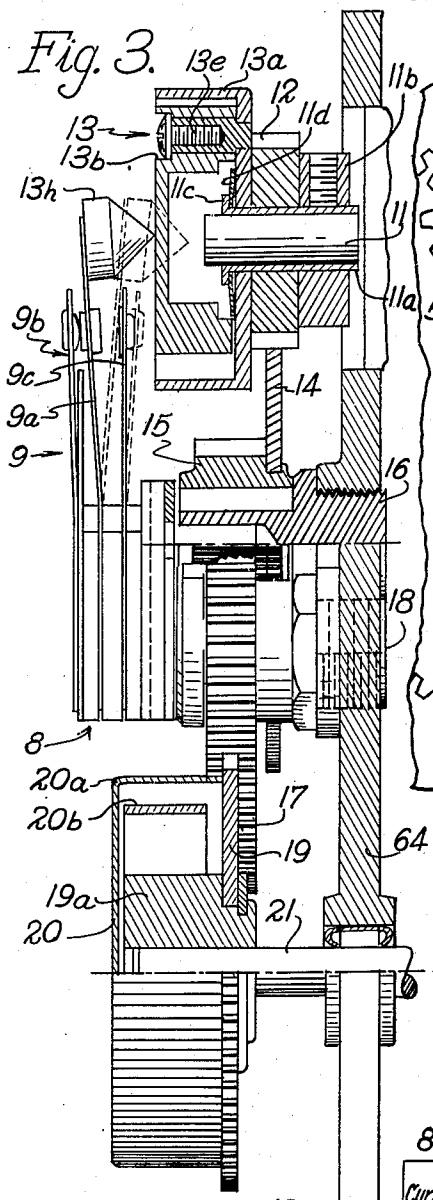


Fig. 9

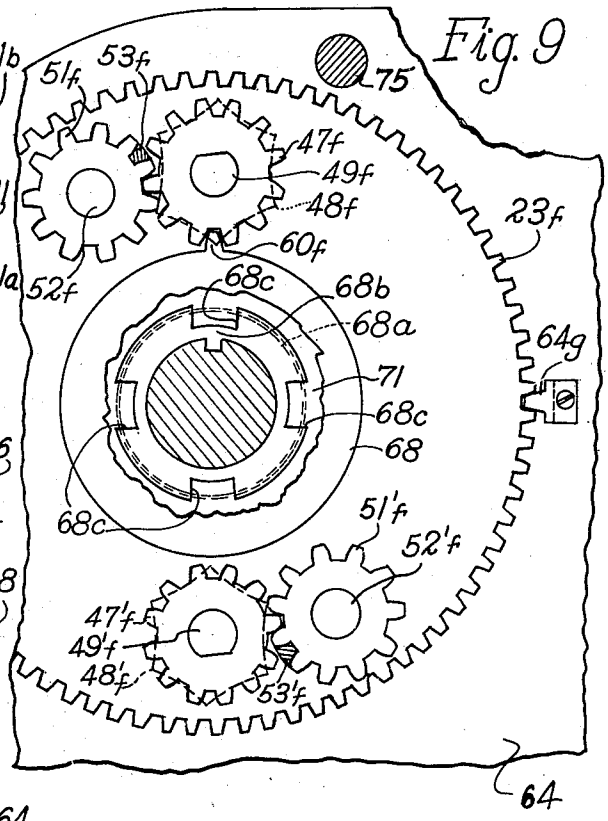


Fig. 8

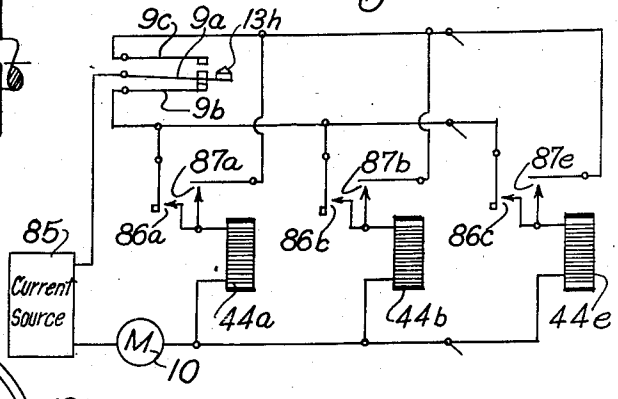
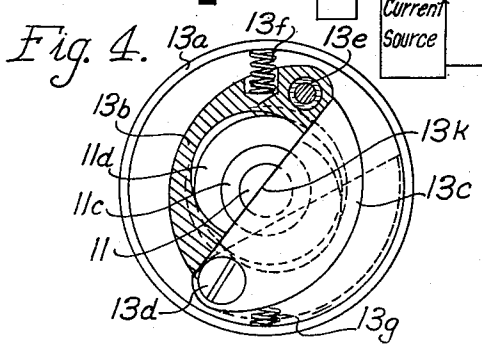


Fig. 4.



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RADIO CONTROL APPARATUS

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Fig. 5.

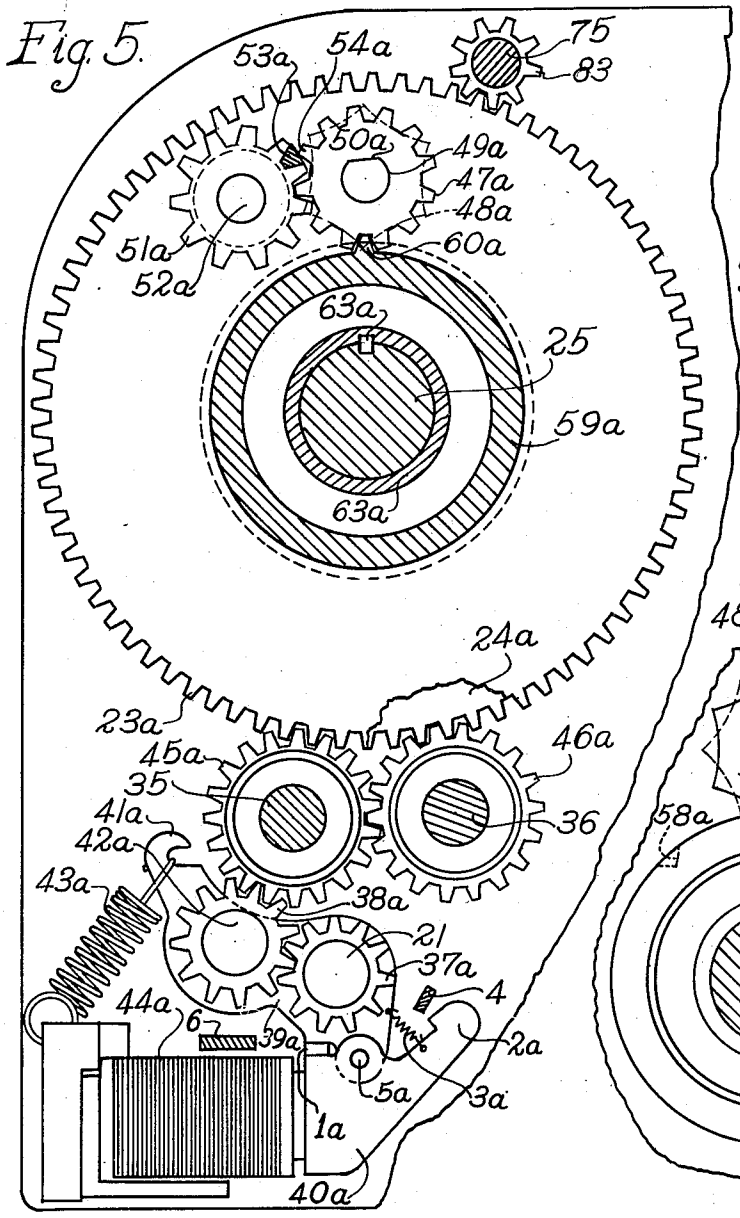


Fig. 7.

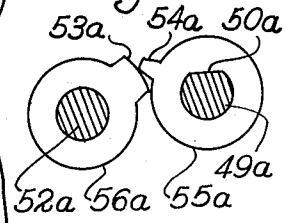
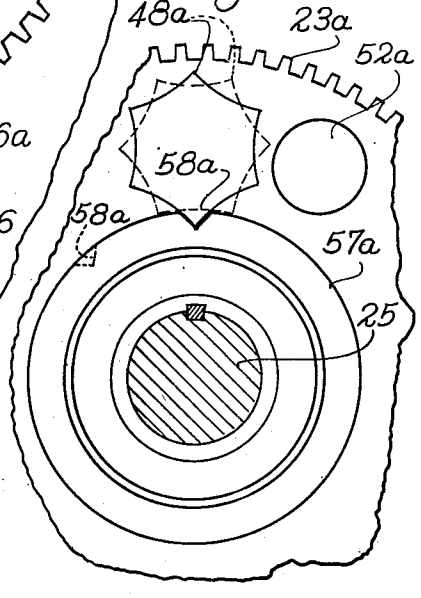


Fig. 6.



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RADIO CONTROL APPARATUS

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Fig. 14

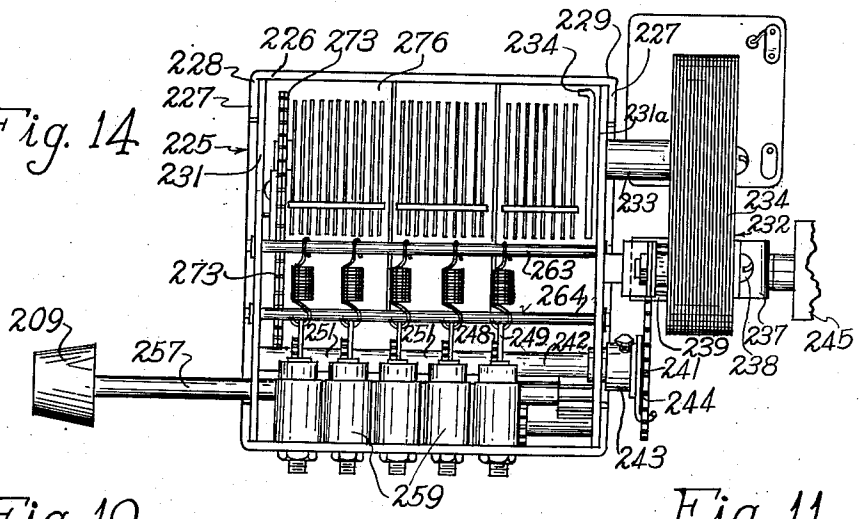


Fig. 10

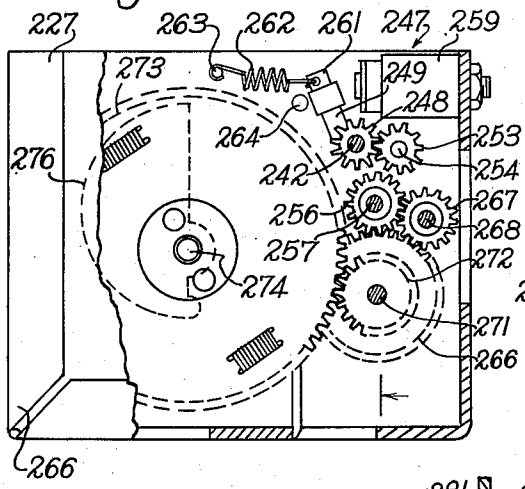


Fig. 11

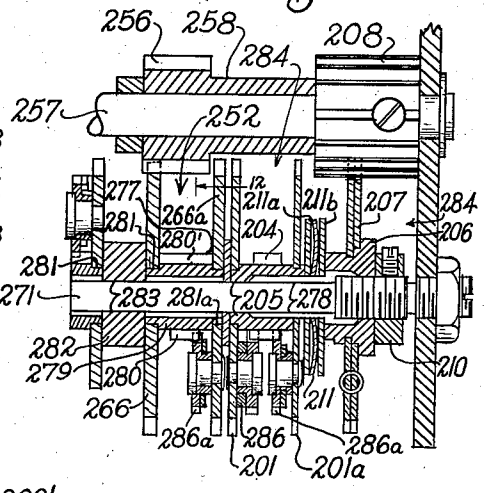
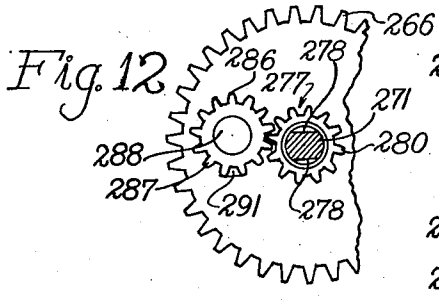


Fig. 12



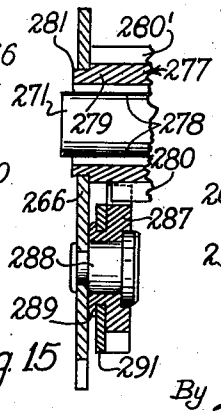
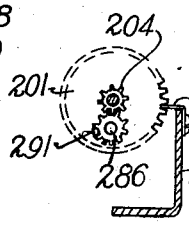


Fig 15

Fig. 13



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Patented July 8, 1947 2,423,588

UNITED STATES PATENT OFFICE

2,423,588

RADIO CONTROL APPARATUS

Harold F. Elliott, Belmont, Mass.

Application April 17, 1944, Serial No. 531,429

20 Claims. (Cl. 74—10)

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The present invention relates to control mechanisms and more particularly to improvements in apparatus for automatically and accurately tuning a radio receiving system to any desired one of a plurality of signal channels. This application is a continuation-in-part of copending application Serial No. 424,234, filed December 24, 1941.

It is an object of the present invention to provide automatic tuning apparatus for a radio receiver, which may be easily controlled on a selective basis to move the frequency changing means of the receiver to any one of a number of different settings corresponding to different desired stations, is simple and compact in arrangement, and yet may be readily adjusted to change the particular settings imparted to the tuning means through the selective control thereof.

It is another object of the invention to provide control apparatus of the character described, wherein an adjustable control unit of improved rugged construction is provided for moving the settable element of the frequency changing means into each predetermined setting and for locking the element in the established setting, while at the same time permitting the settable element to be moved in either direction away from the established setting when actuated through a second control unit corresponding to a different predetermined setting.

According to a further object of the invention, manually operable facilities including a rotatable shaft are also provided for actuating the moving parts of the apparatus, and an improved yielding stop mechanism including a lost motion device of rugged structure is provided for producing a yielding turn resisting indication when the moving parts of the apparatus are moved into predetermined relative positions.

In accordance with still another object of the invention, the construction of the apparatus is simplified by utilizing the manually rotatable shaft as a support for at least a portion of the driving parts through which the control units are normally selectively operated.

It is a still further object of the invention to provide an improved and exceedingly rugged stop and lock mechanism for limiting rotary movement of the rotary control shaft to a predetermined rotational range and for releasably locking the control units in different adjusted settings to provide for operation of the rotary control shaft to the particular predetermined settings which may be desired.

According to yet another and more specific object of the present invention, two lost motion devices of rugged construction and both including parts carried by a common supporting member are provided in the stop and lock mechanism

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for determining the rotational range of the rotary control shaft.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

Fig. 1 is a partially diagrammatic view illustrating the general arrangement of improved control apparatus characterized by the features of the present invention;

Fig. 2 is a fragmentary view, partially in section, illustrating the structural arrangement of those portions of the apparatus shown in Fig. 1 which are essential to an understanding of the invention;

Fig. 3 is a side sectional view further illustrating the left end portion of the apparatus shown in Fig. 2;

Fig. 4 is an end view, partially in section, illustrating the construction of the centrifugal switch provided in the apparatus;

Fig. 5 is a fragmentary end sectional view of the apparatus shown in Fig. 2, illustrating the construction of one of the control units provided in this apparatus;

Fig. 6 is a fragmentary end view of the control unit shown in Fig. 5, as viewed from the reverse side thereof;

Fig. 7 is a detail view illustrating the mode of coaction of two of the stop parts embodied in the control unit shown in Figs. 5 and 6;

Fig. 8 is a diagrammatic view illustrating the arrangement of the circuit provided to control the apparatus shown in Figs. 1 and 2;

Fig. 9 is a sectional view taken transversely through the apparatus shown in Fig. 2 to illustrate the details of the stop assembly provided in the mechanism;

Fig. 10 is an end view, partially in section, of a modified form of control apparatus shown in Fig. 14;

Fig. 11 is an enlarged side sectional view of the apparatus shown in Fig. 14, illustrating a complete control unit and the stop and clamping mechanism;

Fig. 12 is a fragmentary sectional view taken along the lines 12—12 in Fig. 11 showing the lost motion means for a control unit,

Fig. 13 is a fragmentary sectional view of the modified apparatus showing a portion of the means for clamping the control units in their axially stacked relation;

Fig. 14 is a top plan view, illustrating a modified arrangement of the control apparatus; and

Fig. 15 is a fragmentary sectional view further illustrating certain of the parts of the apparatus.

Referring now to the drawings, and more par-

ticularly to Fig. 1 thereof, the control apparatus there illustrated is particularly adapted to be embodied in a radio receiving system for the purpose of selectively and automatically operating the frequency changing means of the system to different predetermined settings respectively corresponding to different predetermined signal channels. More specifically, the rotor plates of the tuning condensers provided in a radio receiving system may be mounted upon the rotor shaft 31 for rotation between predetermined limits defining the tuning range of the system. The identified shaft is adapted to be actuated to any one of a plurality of different settings, respectively corresponding to different signal channels or stations, by a single driving motor 10. This motor is arranged to rotate the rotor shaft 31 through any one of a plurality of driving connections which commonly include the gears 12, 14, 15, 17, 19, 26, 27, 29 and 30, and also commonly include the three shafts 11, 21 and 28. Individually, the driving connections include different ones of a plurality of control units 22*a*, 22*b*, etc. One of these control units, i. e. the unit 22*a*, is illustrated in Fig. 1 of the drawings as comprising two enlarged driving gears or actuating members 23*a* and 24*a*, two pinions 46*a* and 45*a* which mesh with each other and respectively mesh with the gears 24*a* and 23*a*, and a clutching mechanism which includes the two meshing pinions 38*a* and 37*a*, the first of which is adapted to be moved into meshing engagement with the pinion 45*a* and the second of which is mounted for rotation with the shaft 21. Each control unit further comprises a pair of lost-motion mechanisms of the character shown in Figs. 2, 5, 6 and 7 of the drawings, through which driving and locking connections may be provided between the gears 23*a* and 24*a* and the shaft 25. For the purpose of visually indicating the different settings to which the rotor shaft 31 may be actuated, an indicating gear 33 is provided which meshes with a gear 32 carried by the shaft 28 so that it will be rotated concurrently with rotation of the shaft 31. At the front side thereof, the gear 33 may be provided with suitable scale markings which when indexed with a viewing window or line, identify the different predetermined settings of the rotor shaft 31.

More specifically considered and as best shown in Fig. 2 of the drawings, all parts of the control apparatus illustrated in Fig. 1 are supported between or upon two spaced-apart parallel extending frame members 64 and 65. These members have suitable tie rods extending therebetween for the purpose of providing an entirely rigid and rugged supporting structure. The motor 10 is mounted upon the frame member 64 at the rear side thereof and is provided with a rotor shaft 11 which extends through an opening in this frame member and carries the driving gear 12.

As clearly shown in Fig. 3 of the drawings, the drive gear 12 is slip clutch connected to the projecting end of the motor shaft 11 by means of a slip clutch assembly which comprises a friction collar 11*b*, a sleeve 11*a* and a dish-shaped spring washer 11*d*. At its extreme left end, the shaft 11 also supports the movable parts of a centrifugal switch indicated generally at 13. More in detail, the parts 11*b* and 11*d* of the slip clutch assembly, together with the housing cup 13*a* of the centrifugal switch 13, are

supported upon the sleeve 11*a* which is keyed or otherwise rigidly secured to the end of the shaft 11 for rotation therewith. The friction collar 11*b* is in turn set screw mounted upon the sleeve 11*a* so that the gear 12 and the bottom of the cup 13*a* are confined between this collar and the flange 11*c* of the sleeve 11*a* by means of the spring washer 11*d*. With this arrangement, the two parts 13*a* and 12 are mounted for rotation relative to the shaft 11 but are normally restrained against such relative movement by means of the spring washer 11*d* which is held under tension between the sleeve flange 11*c* and the adjacent inner surface of the bottom of the cup 13*a*. Within the rim of the cup 13*a* there are provided two centrifugally actuated parts 13*b* and 13*c* which, as shown in Fig. 4 of the drawings, are pivotally supported upon the bottom wall of the cup 13*a* at the opposed ends thereof by means of pivot assemblies 13*d* and 13*e*. These parts are hollowed out, as shown in Fig. 3, to provide a recess within which the end of the shaft 11, the flange 11*c* and the friction washer 11*d* are received, and are provided with faces which meet on a line and are held in engagement by means of two small biasing springs 13*f* and 13*g*. The line of meeting engagement between the faces of the two centrifugal parts 13*b* and 13*c* is intersected by the axis of rotation of the shaft 11 and at this point of intersection, a prick punch recess 13*k* is provided to seat the point of a conical contact actuating element 13*h*. This element is carried by the free end of a movable contact spring 9*a* which is included in a contact spring assembly 9, and is utilized to govern the operation of the motor 10 and the various control units 22 in the manner more fully pointed out below. This assembly includes three contact springs 9*a*, 9*b* and 9*c* which are insulated from each other and are mounted upon the supporting member 64 by means of a supporting assembly 8 of conventional arrangement. The center spring 9*a* is, through engagement of the actuating element 13*h* with the two centrifugal parts 13*b* and 13*c*, normally held under tension in a position such that the contact carried thereby engages the contact provided at the free end of the outer contact spring 9*b*. During rotation of the shaft, however, when the parts 13*b* and 13*c* of the centrifugal switch are pivoted radially outward from the axis of rotation of the shaft 11 against the biasing forces of the two spring 13*f* and 13*g*, the conical end of the element 13*h* enters the gap between the two parts permitting the contact carried by the spring 9*a* to engage the inner contact spring 9*c* and then move away from the engaged contact of the outer spring 9*b*.

The two gears 14 and 15 are rigidly connected for rotation together and are supported upon a bearing shaft 16 which is threaded into an opening provided in the supporting member 64. Similarly, the gear 17 which meshes with the two gears 15 and 19 is rotatably supported by a stub shaft 18 which is threaded into the supporting member 64. A yielding connection indicated generally at 20 is utilized to transmit rotary movement from the gear 19 to the shaft 21, this connection comprising a spring member 20*b* which partially surrounds the hub 19*a* upon which the gear 19 is rotatably mounted, is anchored to this hub at one end and at the opposite end is anchored to a pin, not shown, extending outwardly from the face of the gear 19.

The hub 19a is keyed or otherwise rigidly mounted for rotation with the shaft 21 and a housing cup 20a is utilized to enclose this hub and the spring member 20b which partially surrounds the same.

The six shafts 21, 35, 36, 25, 28 and 31 are also supported by the two frame members 64 and 65. Thus, and as shown in Fig. 3 of the drawings, ball bearings respectively carried by the two supporting members 64 and 65 are utilized as bearing supports for the shaft 21. The two idler pinion shafts 35 and 36 are each supported at the ends thereof within opposed openings provided with hubs formed integrally with the two supporting members and extending toward each other from the inner faces of these two members. Ball bearings 66 and 67 are utilized to support the rotary control shaft 25 at points inwardly of the opposed ends of this shaft. Similar bearing structures are utilized for the purpose of rotatably supporting the two shafts 28 and 31 upon the two supporting members 64 and 65. The bearing supports for these shafts are not shown in the interests of limiting the disclosure to those parts which are essential to an understanding of the present invention.

As shown in Fig. 2 of the drawings, the several control units are axially disposed along the rotary control shaft 25 and are of identical construction and arrangement. Accordingly, the arrangement of these units will be readily understood from a consideration of the control unit 22a, the parts of which are detailed in Figs. 2, 5, 6 and 7 of the drawings. This control unit is divided into two halves which are operative to rotate the shaft 25 to a predetermined setting from either direction and to provide a connection for locking this shaft against further rotation when the predetermined setting is reached. All parts of the unit are commonly supported upon a hub 59a which is spaced from the shaft 25 by means of a bushing 62a. The first half of the unit comprises an actuating member in the form of a gear 23a which is rotatably supported upon the stepped portion 60a of the hub 59a and meshes with the idler pinion 45a. At the outer side of the actuating member 23a, a detent collar 57a is provided which is seated upon the stepped portion 61a of the hub 59a and at its inner edge is rigidly secured to this hub. At the inner side of the actuating member 23a and spaced radially from the axis of the shaft 25, a pinion set is provided which comprises two meshing pinions 51a and 47a having different numbers of teeth. The first of these pinions is rotatably supported upon an axis pin 52a and the second pinion is mounted for rotation with an axis pin 49a journaled in an opening through the actuating member 23a. Upon the opposite or outer side of the actuating member 23a the pin 49a carries a star wheel 48a having six points which are connected by edge surfaces of concave arcuate configuration. Each of these surfaces has a radius which slightly exceeds the outer radius of the detent ring 57a, so that when any one thereof is riding over the periphery of the ring the angular position of the star wheel 48a relative to the actuating member 23a cannot be altered. At a predetermined point around the periphery thereof, the ring 57a is provided with a recess 58a into which the points of the star wheel may be successively rotated during succeeding revolutions of the actuating member 23a about the hub 59a.

For the purpose of rotating the meshing pinions 47a and 51a through a predetermined angle in response to rotation of the actuating member through one revolution about the hub 59a, this hub is provided at a predetermined point around its periphery with an axially extending rib or single gear tooth 60a which extends normal to the face of the actuating member 23a. This single gear tooth is arranged to mesh with different ones of the teeth of the pinion 47a during succeeding revolutions of the actuating member 23a about the hub 59a, whereby the meshing pinions 51a and 47a, the shaft 49a and the star wheel 48a are rotated through a predetermined angle relative to the actuating member 23a during each revolution of this member. In this regard it is noted that the angular settings of the star wheel 48a and the pinion 47a are so related to each other and to the relative angular positions of the detent 58a and the single tooth 60a that one of the points of the star wheel is brought into registry with the center of the detent 58a each time the tooth 60a engages one of the teeth of the pinion 47a. Assembly of the parts to provide this desired predetermined angular relationship therebetween is facilitated by making the star wheel 48a and the pin 49a of one-piece construction and by flatting the end of this pin as indicated at 50a to coact with a flatted portion of the opening in the pinion 47a through which the pin 49a extends. The two pinions 47a and 51a are provided with unlike numbers of teeth, the pinion 47a having a greater number of teeth than the pinion 51a such that the latter is rotated through more than one revolution for each revolution of the pinion 47a. Between these pinions and the inner side of the actuating member 23a there are provided two coacting stop parts 55a and 56a which are respectively carried by the pin 49a and the axis pin 52a. The part 55a is in the form of an annular ring having a single tooth 54a at the outer periphery thereof, and may be formed integrally with the pinion 47a. Alternatively, this part may be pinned or otherwise rigidly connected to the pinion 47a. The coacting part 56a is likewise in the form of an annular ring having a blank double tooth 53a provided at a predetermined point around the peripheral surface thereof, and may either be formed integral with the pinion 51a or may be fixedly connected to this pinion.

With this arrangement, the single tooth 54a may be operated to engage the blanked out portion of the double tooth 53a when the two pinions 47a and 51a occupy predetermined relative positions. When these two parts are thus lockingly engaged, relative rotation between the two pinions 47a and 51a in one direction is prevented, whereby upon rotation of the actuating member 23a to bring one of the teeth of the pinion 47a into engagement with the single tooth 60a of the hub 59a, a direct mechanical connection is provided between the actuating member 23a and the hub 59a. Relative rotation of the pinions 47a and 51a in the reverse direction, i. e. in a direction to move the engaged teeth 54a and 53a out of engagement, is permitted however. Because of the different numbers of teeth with which the two pinions 51a and 47a are respectively provided, no further engagement between the two locking teeth 54a and 53a can occur until after the pinion 47a has been reversely rotated a predetermined num- of revolutions relative to the actuating member 23a. After a predetermined number of revo-

lutions of the pinion 47a in the reverse direction, the two locking teeth 53a and 54a are of course moved back into engagement to establish a new locking connection between the actuating member 23a and the hub 59a.

From the above explanation it will be apparent that since the pinion 47a is rotated through only a fraction of a revolution in response to each revolution of the actuating member 23a about the hub 59a, a large number of revolutions of the actuating member are required in order to rotate the two stop parts 55a and 56a from one position in which the locking teeth 53a and 54a are engaged to a new position of engagement between these teeth. Thus, if the pinion 47a is provided with twelve teeth and the smaller pinion 51a is provided with eleven teeth, and the pinion 47a is rotated through a sixty degree angle defining two complete tooth points during each revolution of the actuating member 23a about the hub 59a, sixty-five revolutions of the actuating member 23a about the hub 59a are required in order to rotate the parts 56a and 55a from one point at which the teeth thereof are lockingly engaged to a second point at which these teeth are again moved into engagement. This lost motion between the two parts 59a and 23a of the control unit constitutes the range of free travel within which may be embraced all of the several predetermined settings which may be imparted to the rotor shaft 31 by the respective control units. As indicated above, the star wheel 48a, through its coaction with the detent ring 57a, functions to limit rotation of the two pinions 47a and 51a precisely to predetermined fractions of a revolution during each revolution of the actuating member 23a about the hub 59a. The arrangement is such that when the single tooth 60a of the hub is out of engagement with the teeth of the pinion 47a, one of the six concave peripheral surfaces of the star wheel rides over the periphery of the ring 57a to lock the shaft 50a and the two meshing pinions 47a and 51a against rotation relative to the actuating member 23a. When, however, the member 23a is rotated to engage one of the teeth of the pinion 47a with the tooth 60a, a point of the star wheel 48a is simultaneously brought into coincidence with the depression 58a permitting the connected parts 47a, 49a, 55a and 48a to be rotated relative to the member 23a. The extent of this rotation is of course limited to that required to bring the next succeeding concave surface of the star wheel back into sliding enagement with the periphery of the ring 57a. With a six point star wheel, the extent of rotation of the identified parts relative to the actuating member 23a is of course limited to an angle of sixty degrees, representing a tooth displacement of two teeth on the twelve tooth pinion 47a.

The structural arrangement of the second half of the control unit 22a exactly duplicates that just described. Thus, it will be noted that the actuating member 24a is rotatably supported upon a stepped portion of the hub 59a at the right end of this hub, and at a point radially disposed from the axis of the shaft 25, carries the four connected parts 47'a, 48'a, 49'a and 55'a which are arranged to be rotated relative to the actuating member 24a by the single tooth 60a of the hub 59a. The star wheel 48'a is arranged to coact with a detent ring 57'a rigidly mounted upon a second stepped portion of the hub 59a to limit rotation of the pinion 47'a and the parts fixedly and pivotally connected therewith to a predetermined fraction of a revolution during each revolution of the actuating member 24a about the hub 59a.

As indicated above, the two actuating members 23a and 24a of the control unit 22a respectively mesh with idler pinions 45a and 46a which mesh with each other and are rotatably supported upon the shafts 35 and 36, respectively. The pinions 45 individual to the various control units are spaced along the shaft 35 and each thereof is provided with a toothed portion and a spacing portion. A sleeve 35a carried by the shaft 35 adjacent the left end thereof is utilized to prevent movement of the idler pinions 45 axially of the shaft and to thus maintain these pinions in meshing engagement with their respective associated actuating members 23. In an entirely similar manner, the pinions 46 carried by the shaft 36 are self-spacing and are rotatably supported by the shaft 36, a sleeve being provided at the left end of this shaft 36 to prevent axial movement of the pinions 46 along the shaft. The sleeve 62e, which supports the parts of the last control unit 22e upon the rotary control shaft 25, is provided with an extended flanged portion against which the hub of this control unit is adapted to be clamped. This portion of the sleeve 62e is also provided with an annular seat at the inner periphery thereof which is adapted to receive a flanged or ring portion 25e of the rotary control shaft. Thus, this shaft portion acts as a stop against which the hubs 59 of the various control units may be clamped to lock the same against rotary movement relative to the shaft 25. The bushings 62 are clamped against the ring portion 25e of the shaft by means of a clamping member 68 which is threaded onto a threaded portion 25a of the control shaft and is provided with an annular portion 68b, the rim of which is adapted to be clamped against the adjacent surface of the bushing 62a through a spring washer 72a. Similar spring washers are interposed between the sleeves and hubs of the respective control units along the shaft 25. These washers, together with the bushings 62, are keyed to the shaft 25 by means of a key 63a which lies within aligned keyways cut at the inner sides of the bushings and a keyway cut axially of the shaft 25. With this arrangement, the bushings 62 and the spring washers 72 may be clamped against the ring portion 25e of the shaft 25 by threading the clamping member 68 upon the threaded portion 25a of this shaft. The clamping pressure thus produced serves to prevent movement of the bushings axially of the shaft, and the key 63a serves to prevent relative rotary movement between the bushings and the shaft. The hubs 59 individual to the various control units are normally clamped to the shaft ring portion 25e for rotation with the bushings 62, but may be released for rotation to new settings relative to the shaft 25 by means of an improved releasable locking assembly.

This assembly comprises a locking washer or ring 71 having fingers received within slots 68c extending axially of the annular portion 68b of the clamping member 68 to prevent relative rotary movement between the two named parts. The assembly further comprises a traveling nut 69 which is threaded on the threaded portion 68a of the clamping member 68 and is provided with gear teeth around the outer periphery thereof adapted for meshing engagement with a small gear 83 carried by a locking shaft 75. Balls 70 disposed within a ball race formed in the front

side of the traveling nut 69 are interposed between this nut and the locking washer 71 to reduce the frictional engagement between these two parts. The shaft 75 is journaled within sleeve bearings 78 and 79 respectively supported by the two supporting members 64 and 65. It is slidable within these bearings between limits defined by engagement of the shaft rings 76 and 77 with the supporting members 64 and 65. Normally this shaft 75 is biased to a position such that the ring 76 engages the supporting member 64 and the gear 83 is out of meshing engagement with the traveling nut 69. This bias is provided by a coil spring 80 which surrounds the shaft and is tensioned between the supporting member 64 and a cup-shaped nut 81 threaded onto the left end of the shaft. A locking nut 82 also threaded onto the left end of the shaft 75 is utilized to lock the cup-shaped nut 81 against rotation once the position of this nut upon the shaft has been established to properly tension the spring 80.

For the purpose of limiting rotation of the shaft 25 to a predetermined range which embraces all of the desired predetermined settings of the rotor shaft 31, a lost-motion, shaft locking assembly 22*f* is provided which is substantially similar to each of the two lost-motion mechanisms provided in each of the control units 22. In brief, this locking assembly comprises a stationary member 23*f* within which a stepped portion of the clamping member 68 is journaled so that relative rotary movement may occur between the two parts, and a detent ring 57*f* which is rigidly mounted upon a second stepped portion of the clamping member 68 to retain the member 23*f* upon the clamping member. The member 23*f* rotatably supports two sets of lost-motion pinions which are exact duplicates of that shown in Figs. 5 and 7 of the drawings. As shown in Figs. 2 and 9, the first set of lost-motion pinions comprises a pinion 47*f*, a stop part 55*f* having a locking tooth 54*f* at the periphery thereof, an axis pin 49*f* and a star wheel 48*f* arranged to coact with the detent ring 57*f*. These four connected parts are arranged to be rotated relative to the member 23*f* as a unit and are actuated through engagement of the teeth of the pinion 47*f* with a single tooth 60*f* provided at the periphery of the clamping member 68. The pinion 47*f* meshes with a pinion 51*f* having a lesser number of teeth which is pivotally supported by an axis pin 52*f*. This pin also rotatably supports a stop part which is rotatable with the pinion 51*f* and carries a blank double tooth 53*f* arranged for engagement with the tooth 54*f*. The second set of lost-motion pinions, i. e. that comprising the seven parts 47'*f*, 48'*f*, 49'*f*, 51'*f*, 52'*f*, and 55'*f* is of identical arrangement, and is also actuated by the tooth 60*f* of the clamping member 68. With the above-described arrangement of the locking assembly 22*f*, the shaft 25 can only be rotated in one direction until a locking connection is established between this shaft and the stationary member 23*f* through the parts of the pinion set which comprises the pinion 47*f*, for example. In an entirely similar manner, the shaft 25 can only be rotated in the reverse direction until a locking connection is established between this shaft and the stationary member 23*f* through the parts of the other lost-motion pinion set, i. e. that comprising the pinion 47'*f*. In this regard, it is noted that the stationary member 23*f* is provided with gear teeth around the periphery thereof, any one of which may be engaged with a bracket 64*g* extending outwardly from the supporting member 64*f* to prevent rotation of this member. It is noted further, that the two lost-motion pinion sets are provided to limit the rotation of the shaft 25 to a range which is substantially less than the free travel range of either pinion set considered alone. As a result, standard parts may not only be used in the manufacture of the several control units 22*a* to 22*e* inclusive, but these same parts may be used in making up the locking assembly 22*f*. Thus, all parts of this assembly, including the detent ring 57*f*, are exact duplicates of the corresponding parts making up the control unit 22*a*, for example, with the exception that the member 23*f* is provided with two openings instead of one in order to make provisions for supporting the two sets of lost-motion pinions.

For the purpose of selectively connecting the shaft 21 in driving relationship with the actuating members 23 and 24 of any one of the control units 22*a* to 22*e* inclusive, these units are respectively provided with individual clutch assemblies. Thus the control unit 22*a* is provided with a clutch assembly which comprises a pinion 37*a* mounted for rotation with the shaft 21 and meshing with an idler pinion 38*a*. This idler pinion is rotatably supported by means of a pivot pin 42*a*, but the arm 39*a* is normally restrained by a biasing spring 43*a* to a position in engagement with a stop bar 6, such that the two identified pinions are disengaged. More specifically, the spring 43*a* is tensioned between one end 41*a* of the arm 39*a* and a tie bar which extends transversely between the two supporting members 64 and 65. At its opposite end, the rocker arm 39*a* is provided with an armature piece 40*a* which is adapted to be attracted into engagement with the projecting core and of an electromagnet 44*a*, thereby to move the idler pinion 38*a* into meshing engagement with the pinion 45*a*. The electromagnets 44, individual to the various control units, are all bolted or otherwise rigidly secured to a crossbar which extends transversely between and is anchored at its end to the two supporting members 64 and 65.

More specifically, the armature piece 40*a* is pivotally supported by means of an axis pin 5*a* upon the lower end of the arm 39*a*. It includes a catch portion 2*a* which is normally biased to engage a catch bar 4 by means of a coil spring 3*a* connected between the two parts 39*a* and 40*a*. Coacting stop means 1*a* are also provided to furnish a force transmitting connection between the two parts 39*a* and 40*a* when the magnet 44*a* is energized. The two stop bars 4 and 6 are common to the several clutch assemblies and extend transversely between the two supporting members 64 and 65.

With the above-described clutch arrangement, the catch portion 2*a* of the armature piece 40*a* normally engages the catch bar 4 to lock the arm 39*a* in a position such that the gear 38*a* is prevented from engaging the gear 45*a*. Thus during rotation of the shaft 21, the two gears 38*a* and 45*a* are positively locked against engagement when the magnet 44*a* is deenergized. This locking connection is important since the shaft 21 is rotated in a direction to pivot the arm 39*a* toward the gear 45*a* and hence if the friction between the identified shaft and arm should become sufficiently great, through an accumulation of dirt between the engaging surfaces thereof, inadvertent engagement of the two gears 38*a* and 45*a* could be produced in the absence of the locking connection.

When the magnet 44a is energized, the armature piece 40a is first pivoted about its axis pin 5a to disengage the catch portion 2a thereof from the catch bar 4. During continued rotation of the armature piece, the stops 1a are engaged, following which the arm 39a is pivoted against the bias of the spring 43 to bring the gear 38a into engagement with the gear 45a, thereby to establish a connection for driving the parts of the control unit 22a.

The motor 10 is of the unidirectional type and is arranged so that its rotor is rotated to drive the shaft 21 in a clockwise direction as viewed in Fig. 5 of the drawings. With the shaft 21 rotating in this direction, the idler pinions 38 are rotated in a counterclockwise direction. Accordingly, when any selected idler pinion 38 is actuated into meshing engagement with its associated pinion 45, the meshing engagement between the two named parts produces a force which tends to pull the idler pinion 38 into meshing engagement with the associated pinion 45. Thus the two pinions are locked in mesh during the tuning operation. The mechanical pressure urging the armature piece 40 of the rocker arm in the selected unit toward the magnet core of the magnet in this unit occurs concurrently with the electrical attraction of the armature piece by the core, whereby the magnet is aided in operating the movable parts of the clutch assembly. The magnets 44, therefore, need only be large enough to attract their associated armature pieces into engagement with the cores provided therein. This utilization of the mechanical reaction between any one of the pinions 38 and its associated pinion 45 provides for the use of relatively small magnets 44, since each magnet merely functions to initially engage the two associated pinions 38 and 45; the pull of the pinion 38 into meshing engagement with the associated pinion 45 being sufficient to maintain the geared or interlocked engagement between the two elements so long as the shaft 21 is rotating. The spring member 20b through which the shaft 21 is driven by the motor 10 insures positive disengagement of the idler pinion 38 in any actuated clutch assembly when the electromagnet 44 of the assembly is deenergized upon completion of a tuning operation. As best shown in Fig. 1 of the drawings, each magnet structure 44 also includes a pair of contact springs 87a which are normally disengaged, are insulated from each other, and are adapted to be moved into engagement when the associated armature piece 40a is attracted to the core of the associated magnet 44.

For the purpose of energizing the motor 10 and selectively controlling the energization of the clutch magnets 44 individual to the several control units 22a to 22e inclusive, the control circuit illustrated in Fig. 8 of the drawings may be employed. Briefly considered, this circuit comprises a suitable source of current 85 from which current is derived for energizing the motor 10 and for selectively energizing the magnets 44. In order selectively to control the energization of the motor 10 and the magnets 44, switching equipment is provided which includes the three contact springs of the centrifugally actuated spring assembly 9, push button switches 86 individual to the various control units, and the locking contact springs 87 individually controlled by the magnets 44.

In considering the operation of the above-described control apparatus, it may be assumed that this apparatus is to be utilized to rotate the rotor shaft 31 to the particular setting corresponding to the control unit 22a, thereby to tune the receiver for the reception of a signal or signals radiated at the particular carrier frequency to which the control unit 22a corresponds. In order to initiate the operation of this control unit, the push button switch 86a is actuated to its closed circuit position, thereby to complete a circuit for energizing the clutch magnet 44a individual to the control unit 22a in series with the driving motor 10. When energized in this circuit, the magnet 44a attracts its associated armature piece 40a, whereby the rocker arm 39a is pivoted about the shaft 21 against the bias of the retracting spring 43a to move the idler pinion 38a into meshing engagement with the pinion 45a. In attracting its armature piece 40a, the magnet 44a also closes the contacts 87a to prepare a circuit for holding the magnet 44a and the motor 10 energized after the nonlocking push button 86a is released. When the two pinions 38a and 45a are engaged, a driving connection is established between the motor 10 and the actuating members 23a and 24a of the control unit 22a. This connection comprises the shaft 11, the slip clutch between this shaft and the gear 12, the gears 12, 14, 15, 17 and 19, and the yielding spring member 20b which connects the gear 19 and the shaft 21 through the hub 19a. Assuming that the shaft 21, as viewed in Fig. 5 of the drawings, is rotated in a clockwise direction through this driving connection, the two pinions 45a and 46a are respectively rotated in clockwise and counterclockwise directions. Accordingly, the actuating member 23a is rotated in a counterclockwise direction, as viewed in Fig. 5 of the drawings. The actuating member 24a on the other hand, is driven in the reverse direction by the pinion 46a, i. e., a clockwise direction, as viewed in Fig. 5 of the drawings. During each revolution of the actuating member 23a about the hub 59a, the two pinions 47a and 51a are pivoted through fractions of a revolution relative to the actuating member. Thus each time the actuating member 23a is rotated to a position wherein one of the teeth thereof engages a single tooth 60a of the hub 59a a driving connection is established for rotating the pinion 47a, the shaft 49a and the star wheel 48a relative to the actuating member 23a. As previously indicated, such engagement occurs when one of the points of the star wheel 48a coincides with the depression 58a in the ring 57a. Accordingly, the star wheel 48a is prevented from locking the pinion 47a and hence the actuating member 23a against rotation. As the three connected parts, 47a, 49a and 48a are rotated relative to the actuating member 23a, the tooth 60a passes out of engagement with the engaged tooth of the pinion 47a and the star wheel 48a is rotated to a position wherein the concave surface thereof which next follows the star point engaged with the depression 58a is slidably engaged with the periphery of the ring 57a. Incident to the described part revolution of the pinion 47a relative to the actuating member 23a, the pinion 51a is likewise rotated through a corresponding fraction of a revolution relative to this member.

Rotation of the actuating member 23a about the hub 59a continues until such time as the parts 47a, 51a, 55a, and 56a occupy angular positions wherein the tooth 54a engages the blanked double tooth 53a. As will be evident from the above explanation, depending upon the initial setting of the lost-motion mechanism associated with the actuating member 23a, a variable number of revolutions of this member about the hub 59a will

be required before the locking teeth 54*a* and 53*a* are moved into engagement. When such engagement occurs, a direct mechanical connection, which may be utilized either for locking or driving the shaft 25 in the manner explained below, is provided between the actuating member 23*a* and the rotary control shaft 25. This connection comprises the engaged locking teeth 54*a* and 53*a*, the two stop parts 55*a* and 56*a*, the meshing teeth of the two pinions 47*a* and 51*a*, the single hub tooth 60*a* and the tooth of the pinion 47*a* engaged thereby, the hub 59*a*, the clamping connection between this hub and the bushing 62*a*, and the key connection comprising the key 53*a* between the bushing 62*a* and the shaft 25.

In a manner entirely similar to that just described, rotation of the actuating member 24*a* in the reverse direction about the hub 59*a* is utilized to actuate the lost-motion parts associated with this actuating member until the locking teeth 54'*a* and 53'*a* of the two stop parts provided therein are moved into engagement. The engagement between the identified teeth of these two stop parts likewise provides a direct drive mechanical connection between the actuating member 24 and the shaft 25.

From the above explanation it will be apparent that depending upon the initial setting of the control unit 22*a*, the rotary control shaft 25 will be rotated in one direction or the other by one of the two actuating members 23*a* or 24*a*. Thus, if the tooth 54*a* of the stop part 55 is rotated to engage the blanked double tooth 53*a* of the stop part 56*a* before the corresponding locking teeth of the two stop parts 55'*a* and 56'*a* are engaged, the rotary control shaft will be rotated in a counterclockwise direction, as viewed in Fig. 5 of the drawings, to the predetermined setting to which the control unit 22*a* corresponds. Conversely, if the locking teeth of the two stop parts 55'*a* and 56'*a* are moved into engagement before the locking teeth of the two stop parts 55*a* and 56*a* are engaged, the rotary control shaft 25 will be rotated in a clockwise direction as seen in Fig. 5 of the drawings, to the predetermined setting corresponding to the control unit 22*a*. In either case, the rotary control shaft will be rotated at the speed of the actuating member 23*a* or 24*a* with which it is mechanically connected until the nonengaged locking teeth are brought into engagement. Also, when the shaft 25 is rotated in one direction or the other, the rotor shaft 31 is rotated in a corresponding direction through the driving connection afforded by the gears 26 and 27, the shaft 28, and the gears 29 and 30. The display gear 33 is likewise rotated by the control shaft 25 through the driving connection provided by the gears 26 and 27, the shaft 28 and the gear 32.

When both of the teeth 54*a* andd 54'*a* are moved into engagement with their respective associated teeth 53*a* and 53'*a*, a locking connection is obviously established which prevents continued rotation of the actuating members 23*a* and 24*a*, the lost-motion parts associated with these two actuating members, the pinions 45*a*, 46*a*, 38*a* and 37*a*, and the shaft 21. Thus the entire gear train extending back to the motor drive shaft 11 is locked up when the rotary control shaft 25 is rotated to the predetermined setting corresponding to the actuated control unit 22*a*. After this train has been locked up, continued rotation of the motor shaft 11 is permitted through the described slip clutch connection between this shaft and the motor drive gear 12. Rotation of

the rotor shaft 31 and the display gear 33 is also obviously arrested when rotation of the control shaft 25 is stopped. The shaft 25 is stopped in the particular angular setting to which the control unit 22*a* corresponds and this setting is identified by the indication displayed by the gear 33.

As indicated above, energization of the electromagnet 44*a* and the driving motor 10 is initially produced in response to actuation of the push button switch 86*a*, this circuit being completed through the engaged contact springs 9*a* and 9*b* of the assembly 9. It is also explained above that when the magnet 44*a* attracts its armature piece 40*a* to initiate operation of the control unit 22*a*, the contact springs 87*a* are engaged to prepare a locking circuit for the magnet 44*a* and the motor 10. As the shaft 11, the gear 12 and the parts of the centrifugal switch 13 are brought up to speed following energization of the motor 10, the centrifugally actuated elements 13*b* and 13*c* of the switch 13 are pivoted away from the axis of rotation of the shaft 11 to provide a gap between the normally engaged faces thereof. As the width of this gap increases with increasing speed of rotation of the shaft 11, the conical point of the element 13*h* enters this gap with the result that the center contact spring 9*a* is moved to the right to the dash line position illustrated in Fig. 3 of the drawings. During such movement of the contact spring 9*a*, one of the contacts carried thereby is moved into engagement with the contact carried by the spring 9*c*. Thereafter the engaged contacts carried by the contact springs 9*a* and 9*b* are moved out of engagement. When the contact springs 9*a* and 9*c* are thus electrically engaged, a locking circuit is completed through the engaged contacts 87*a* for sustaining the energization of the magnet 44*a* and the motor 10, independently of the position of the push button switch 86*a*. Thereafter and when the element 13*h* is moved to a position such that the contact springs 9*a* and 9*b* are electrically disengaged, the initial operating circuit for the magnet 44*a* and the motor 10 is opened.

After the shafts 25 and 31 have been operated to the predetermined settings to which the control unit 22*a* corresponds, such that the entire gear train extending back to the motor shaft 11 is locked up, rotation of the centrifugal switch 13 is arrested. When this occurs, the centrifugally actuated parts 13*b* and 13*c* are pivoted back into engagement under the influence of the springs 13*f* and 13*g*. As these parts are moved back to normal, the conical point of the element 13*h* is squeezed from between the two parts 13*b* and 13*c* with the result that it is moved back to its normal position. Incident to this movement of the element 13*h*, the contact springs 9*a* and 9*c* are electrically disengaged to interrupt the locking circuit for the magnet 44*a* and the motor 10. Thus, these two circuit elements are deenergized. Also incident to the return movement of the contact actuating element 13*h*, the contact springs 9*a* and 9*b* are again electrically engaged, thereby to reprepare the parallel circuits for energizing any selected one of the magnets 44 in series with the motor 10. From the above explanation it will be understood that only momentary operation of the nonlocking push button switch 86*a* is required in order to initiate operation of the control unit 22*a* and to insure that this unit will continue to operate until the rotary control shaft 25 and the rotor shaft 31 are rotated to the respective predetermined settings corresponding to the control unit 22*a*. It will also be understood

that when these settings are established, the circuit elements 44a and 10 are automatically deenergized.

The manner in which the remaining control units 22b to 22e inclusive, may, through selective actuation of the push button switches 86b, 86e, etc., be actuated for the purpose of driving the rotor shaft 31 to its other predetermined settings, will be clearly apparent from the above explanation with reference to the operation of the control unit 22a. During the above-described rotation of the shaft 25 to drive the rotor shaft 31 to the particular setting corresponding to the control unit 22a, certain of the movable parts of the nonactive control units are also moved to produce unlocking relative movement between the locking teeth of the stop parts of one of the lost-motion mechanisms provided in each unit. In this regard it will be understood that as the shaft 25 is rotated, all of the hubs 59 individual to the various control units are rotated therewith. The action which occurs in the nonactive units will be more fully apparent from the following explanation relating to the movement of the parts provided in the control unit 22a when the shaft 25 is driven to another predetermined setting by another of the control units. Thus, it may be assumed that after the shaft 25 is operated to the setting corresponding to the control unit 22a, such that the locking teeth 54a and 54'a respectively engage the locking teeth 53a and 53'a, the shaft 25 is rotated in a counterclockwise direction, as viewed in Fig. 5 of the drawings, by a second control unit to a new setting. During such rotation of the shaft 25, the locking teeth 54'a and 53'a remain in engagement to prevent relative movement between the hub 59a, the actuating member 24a and the parts of the lost-motion mechanism carried by this actuating member. Thus, the actuating member 24a is rotated in a counterclockwise direction, and is rendered operative to drive the actuating member 23a in a clockwise direction through the driving connection afforded by the meshing pinions 46a and 45a. The relative movement thus produced between the actuating member 23a and the hub 59a by rotating these two elements in opposite directions causes the pinions 47a and 51a and the stop parts 55a and 56a to be rotated in directions such that the locking teeth 54a and 53a are disengaged. Thus, during each revolution of relative movement between the two parts 59a and 23a, the pinion 47a is rotated through an angle of 60 degrees in a clockwise direction relative to the actuating member 23a and the pinion 51a is rotated through a corresponding angle in the reverse direction. The teeth 53a and 54a are progressively disengaged as the two pinions are intermittently rotated relative to the actuating member 23a in the directions indicated.

Assuming now that the shaft 25 is rotated in a clockwise direction away from the predetermined setting corresponding to the control unit 22a, the actuating member 23a of this unit is rotated in the same direction due to the engagement of the locking teeth 53a and 54a. Through the driving connection afforded by the pinions 46a and 45a, this actuating member rotates the actuating member 24a in a counterclockwise direction relative to the shaft 25. With the two elements 59a and 24a thus rotating in opposite directions, the pinions 47'a and 51'a are intermittently rotated relative to the actuating member 24a to produce progressive disengagement of the locking teeth carried by the stop parts 55'a and 56'a. The extent to which these two stop parts are moved along the free travel range between the locking limits therebetween is of course determined by the amount of movement required to actuate the shaft 25 to its new setting.

From the above explanation it will be clearly apparent that the shaft 25 and the rotor shaft 31 actuated thereby may be moved to any desired setting through operation of a particular control unit, without any interference whatever from the nonactive control units. This is due to the fact that during operation of any one of the control units to establish the desired setting for the shaft 31, the parts of the nonactive units are so moved relative to each other as to prevent a locking connection from being established through any one of these units. Thus, the two lost-motion mechanisms as provided in each control unit, permit the shaft 25 to be freely, accurately and positively driven in either direction to any one of the predetermined settings respectively corresponding to the several control units.

As indicated above, the locking assembly 22f is provided to define the rotational range of the rotary control shaft 25 and hence the range of rotation of the rotor shaft 31. Thus, as the shaft 25 is continuously rotated in one direction, the pinions 47f and 51f supported by the stationary member 23f are intermittently rotated to actuate the stop parts 55f and 56f until they occupy relative positions such that the locking teeth 54f and 53f are engaged. When this occurs, the shaft 25 is obviously locked against further rotation in the direction of rotation utilized to effect engagement of the two identified locking teeth. Also during the described rotation of the shaft 25, the parts 47'f, 51'f, 55'f and 56'f are likewise intermittently rotated relative to the stationary member 23f through engagement of the single tooth 60f with different ones of the teeth carried by the pinion 47'f. Before the locking teeth 54'f and 53'f can be moved into engagement, however, the locking teeth carried by the stop parts 55f and 56f are engaged to stop rotation of the shaft. In a similar manner, when the shaft 25 is rotated in the reverse direction, the stop parts as actuated in response to alternate engagement of the pinions 47f and 47'f by the tooth 60f, are concurrently actuated toward locking positions. In this case, the locking teeth 54'f and 53'f are engaged to arrest the rotation of the shaft 25 before the locking teeth of the two other stop parts are engaged. Thus it will be apparent that the two pinion sets as provided in the control unit 22f, function to limit rotation of the shaft 25 to a predetermined rotational range. Obviously, this range may be shifted at will by unlocking the member 23f, rotating this member, the clamping member 68 and the shaft 25 in unison, and then reestablishing the locking connection between the member 23f and the supporting member 64.

In order to adjust the various control units relative to the rotary control shaft 25, thereby to provide for operation of this shaft and the shaft 31 to the desired predetermined settings by these units, the shaft 75b is pulled out against the force exerted by the spring 80 until the pinion 83 carried thereby engages the toothed periphery of the traveling nut 69. The shaft 75b is now rotated to drive the traveling nut in a direction which would back this nut away from the clamping washer 71 but for the freedom of movement of the shaft 25 and the clamping

member 68. Rotation of the identified parts is continued until one limit of the rotational range of the shaft 25 as defined through the action of the locking assembly 22f is reached in the manner just explained. When this occurs, the clamping member 68 and the shaft 25 are locked against further rotation. Accordingly, if rotation of the shaft 75 is continued in the same direction, the traveling nut 69 is backed away from the locking washer 71 to remove the clamping pressure applied axially of the shaft 25 against the hubs 59 of the several control units. Rotation of the traveling nut 69 relative to the clamping member 68 is continued until the left side surface thereof is brought into tight clamping engagement with the opposed surface of the clamping member, thereby to provide a friction drive between these two parts which may be utilized in rotating the parts 69, 68 and 25 in the reverse direction. At this point it is noted that the amount of movement of the traveling nut 69 required to effect the described clamping engagement between this nut and the clamping member 68 is insufficient to permit the antifriction balls 70 from dropping out of the ball race in which they are disposed. Also, the spring washers 72 engage the stepped hubs 59 with sufficient pressure to prevent the hubs from being rotated relative to their supporting bushings 62 during rotation of the shaft 75 to drive the rotary control shaft 25.

After the shaft 75 has been rotated to release the hubs 59 for movement relative to their respective supporting bushings 62 and to produce clamping engagement between the two parts 68 and 69, this shaft may be reversely rotated for the purpose of driving the rotary control shaft 25 and the connected rotor shaft 31 of the tuning means to the particular settings at which the desired station or signal channel is tuned in by the associated receiver. While the shafts 31 and 25 are held in these settings by manually restraining the shaft 75 against rotation, the switch 86 associated with the particular control unit which is to be utilized in operating the rotary control shaft to the manually established setting, is operated to energize the driving motor 10 and the electromagnet 44 of the selected control unit. The motor 10 is thus rendered operative to drive the movable parts of the selected control unit until these parts are lockingly engaged in the manner explained above. During the final portion of the operation of the selected control unit and, more particularly, after the locking fingers 54 and 53 of one of the two lost-motion mechanisms provided in the unit are engaged, the hub 50 is rotated relative to the shaft 25 and the bushing 62 upon which the control unit is supported. Thus the selected control unit is actuated to a position relative to the rotary control shaft 25, such that when the shaft and the hub 59 of the unit are subsequently locked together, the control unit can thereafter only rotate the rotary control shaft to the particular setting which it occupies when the locking operation is completed. The above-described procedure, i. e. that of utilizing the shaft 75 manually to rotate the rotary control shaft 25 and the rotor shaft 31 to different desired settings, may be repeated for each of the other control units 22 in order to establish the other desired predetermined settings for the two named shafts. During each setting operation, the control units which are not being adjusted are maintained in adjustment because of the fact that the frictional engagement of their hubs 59 with the spring washers 72 is sufficient to maintain the established positions of these hubs relative to the shaft 25. When all of the control units 22 have been adjusted, the shaft 75 is rotated to drive the traveling nut 69 in a direction which would bring the balls 70 back into clamping engagement with the clamping washer 71 but for the frictional engagement between this nut and the clamping member 68, and the consequent rotation of the shaft 25 and the clamping member 68 with the traveling nut. Rotation of the three identified parts continues until arrested through the action of the stop assembly 22f in the manner explained above. When the shaft 25 and the clamping member 68 are thus locked against further rotation, continued rotation of the shaft 75 serves to rotate the traveling nut 69 relative to the clamping member 68 in a direction such that the threaded engagement between the parts causes the traveling nut and the clamping washer 71 to be moved axially of the shaft 25 until a clamping pressure is again exerted against the stacked hubs 59. When this clamping pressure is restored, the hubs 59 are positively locked to the shaft 25 to prevent relative rotation therebetween. Thus, the adjusting operations are completed.

From the foregoing explanation, it will be apparent that the frictionally engaged parts 68, 69 and 70 coact to provide a yielding stop connection between the shafts 25 and 75. Thus when the shaft 75 is rotated in a direction to back the traveling nut 69 away from the clamping washer 71, the resistance to turning movement of the shaft 75 is increased when one limit of the rotational range of the shaft 25 as defined by the control unit 22f is reached. Again, with the traveling nut 69 frictionally clamped against the part 68, a yielding stop connection is provided such that the resistance to turning movement of the shaft 75 is increased when this shaft is operated to reversely rotate the shaft 25 to the other limit of its rotational range. Further, the control unit 22f, and more particularly the two lost-motion mechanisms embodied therein, control the turn resisting touch indications in that these mechanisms block rotation of the shaft 25 to define the points in the rotational range of the shaft 25 at which the parts 68 and 69 or 69 and 71 may be disengaged by the application of additional turning force to the shaft 75.

In the modified embodiment of the invention illustrated in Figs. 10, 11, 12, 13 and 14 of the drawings, the control mechanism is applied to a radio preselector or tuning unit including a frame means 225 comprising a channel or U-shaped member 226 having inwardly bent flange portions 227 at each end 228 and 229 thereof. The ends 228 and 229 are closed by end plate members 231 and 231a, respectively, extended transversely of the frame member 226 and positioned inwardly of the corresponding flange portions 227 at the ends 228 and 229. The plate members 231 and 231a are rigidly secured to their corresponding flange portions 227 by welding or like means, so that the assembly of the members 231 and 231a with the frame member 226 is of a substantially integral construction.

A uni-directional driving motor 232 is mounted on the outside of the end plate 231a by supporting studs 233 extended through the laminated motor field structure 234. The motor shaft is rotatably supported in strap or bearing members 237 secured to the field structure 234 by screws or the like 238. A pinion 239 is secured to the

motor shaft and is held in frictional engagement with the motor armature by a spring washer and a collar. The pinion 239 is in meshing engagement with a gear 241 mounted on a rotary driving shaft 242 which is rotatably supported in the end plates 231 and 231a. The gear 241 is in driving connection with the shaft 242 through flexible connecting means designated generally as 243 and including a driving spring 244. A centrifugal switch mechanism designated generally as 245 may be mounted on the outer end of the motor shaft for circuit control purposes.

The driving shaft 242 is formed with an axially extending spline or groove for receiving in mating engagement corresponding key portions on each of a plurality of driving gears 248. A crank clutch arm 249 is rotatably supported on the shaft 242 and positioned adjacent each gear 248 with each paired gear 248 and clutch arm 249 being spaced axially of the driving shaft 242 by spacer members or collars 251. Thus the shaft 242 is rotatable relative to the arms 249. Each associated gear and crank arm unit is operatively associated with a particular control unit 252.

Each gear 248 is in continuous meshing engagement with a clutch gear 253 which is rotatably supported at the end 254 of the clutch arm 249, the gear 253 in turn being adapted for meshing engagement with a pinion 256 rotatably supported on a shaft 257. There is a gear 256 corresponding to each control unit 252, the gears 256 being spaced axially of the shaft 257 by spacer portions 258 integral therewith. A gear 253 is moved into meshing engagement with a corresponding gear 256, to operatively connect a control unit selected for operation with the driving shaft 242, by pivotal movement of the clutch arm 249 by means including an actuating magnet 259. From a consideration of Fig. 10 it will be seen that the magnets 259 are extended transversely of the driving shaft 242 and are so positioned as to attract thereto the end 261 of a corresponding clutch or crank arm 249. On attraction of the crank arm 261 in closing position with a corresponding magnet, as will be later described, the arm end 254 is pivotally moved an amount sufficient to provide for the complete meshing engagement of the gears 253 with a corresponding pinion 256. When the magnet 259 is deenergized, the clutch arm 249 is pivotally moved to a rest position against a stop member 264 by a coil spring 262 connected at one end to a tie rod 263 and its opposite end to the clutch arm end 261. The driving spring 244 of the flexible connecting means 243 provides a small reverse rotation to the motor shaft after the magnet 259 is deenergized to assure a positive disengagement of the gears 253—256.

Each pinion 256 is in continuous meshing engagement with a rotary gear member 266 and a pinion 267. There is a pinion 267 associated with each control unit 252, the pinions 267 being rotatably supported on a shaft 268 in spaced axial alignment by spacer or collar members. Each control unit 252 includes a pair of similar gear members 266 and 266a, with each gear 266a being in continuous meshing engagement with a corresponding pinion 267. Since each control unit 252 is of a similar construction only one thereof will be referred to in the following description.

The control units 252 are aligned axially of a rotary control shaft 271 having a gear 272 mounted at one end thereof, in continuous meshing engagement with a split spring tensioned gear 273 mounted on a shaft 274 for tuning means 276 illustrated as of gang condenser type. It is to be understood, however, that the improved control units 252 of this invention are also applicable for use with other types of tuning means. The rotary control shaft 271 and the condenser shaft 274 are suitably mounted in the end plates 231 and 231a preferably on ball bearings having no lost motion. It is thus evident that the condenser tuning means 276 is in driven connection with the control shaft 271 for rotation in either direction by means including tensioned bearings and gears, so that rotation of the shaft 271 to a predetermined control position in turn accurately rotates the condenser 276 to a corresponding predetermined tuning position. From the above description it will also be evident that all of the axis means 242, 257, 268, 271 and 274 supporting the control mechanism are extended in parallel alignment longitudinally of the frame means 225 and are operatively carried by the end plates 231 and 231a, with the elements carried on corresponding ones of the above defined axis means being confined entirely within the frame means 225.

As previously indicated, each control unit 252 includes a pair of rotary gears 266 and 266a which are spaced axially of the control shaft 271 and are operatively assembled with a corresponding adjustable gear member 277. The adjustable member 277 is freely rotatable and slidable on the control shaft 271 which as shown in Fig. 12 is formed with a pair of oppositely positioned flat sides 278. The hub 279 for the adjustable member 277 is provided with end portions 281 and 281a of a reduced diameter for rotatably supporting at each end a corresponding one of the gear members 266 and 266a. The periphery of the hub 279 intermediate the end portions 281 and 281a is formed with gear teeth 280 with a tooth indicated as 280' being extended axially in both directions beyond the remaining teeth 280.

Each rotary gear member 266 and 266a has rotatably supported thereon a corresponding rotary gear or idler means 286 and 286a positioned inwardly of the gear members. As is clearly shown in Fig. 12, each rotary means 286 is radially spaced from the adjustable member 277, with a rotary gear portion 287 thereof in continuous meshing engagement with the teeth 280 on the adjustable member for maintaining a predetermined operating relationship in a lost-motion means to be later explained. It is to be understood, of course, that the rotary gear means 286a is similarly operatively connected with the adjustable member 277. Since this operative connection with the adjustable member 277 is the same for each of the rotary means 286 and 286a, only the rotary means 286 will be referred to in the detailed description of these parts.

Referring to Figs. 11 and 12 the rotary gear portion 287 is seen to be rotatably supported on a rivet or axis means 288 extended through and secured to the gear 266. The rotary gear portion 287 is operatively connected with a locking portion 289 comprising a disc rotatable with the gear portion 287 and having a stop 291 extending radially between a pair of adjacent teeth on the gear portion 287. The locking portion 289 is positioned between the gear portion 287 and the rotary gear 266 so as to be radially spaced out of an engaging position with the teeth 280 on the adjustable member 277. However, since the long tooth 280' extends substantially between the gears 266 and 266a, each end thereof is in a radially spaced relation with a corresponding locking portion 289 and 289a. Relative rotation

or lost motion between the rotary gear portion **287** and the adjustable member **277** thus takes place only so long as the stop **291** does not engage the stop or long tooth **280'** on the adjustable member. When the stop **291** engages the stop **280'**, the gear **266** is locked in a fixed position relative to the adjustable member **277** so that the two may rotate together.

The lost motion occurring in the control unit **252** prior to a locking of the gears **266** and **266*a*** with the adjustable member **277** may be established at any desired amout by merely changing the gear ratio between the idler gear **286** and the adjustable member **277**. As illustrated in Fig. 12, the idler gear **286** is shown with 13 teeth, while the adjustable member **277** is shown with 12 teeth. With the stop portion **291** in an engaged position with one side the stop portion **280'** on the adjustable member **277**, the adjustable member **277** can be rotated twelve and a fraction complete revolutions in a direction out of such locking position before the stop **291** will again engage the stop **280'** on the opposite side thereof.

In the stacking of the control units **252** axially of the control shaft **271**, each control unit **252** is separated from a next adjacent control unit by a washer or separating collar **282** having flat sides **283** for mating engagement with the flat sides **278** on the rotary control shaft **271** so as to be held against rotation relative to the shaft. As noted, each of the reduced hub portions **281** and **281*a*** is of an axial length greater than the thickness of a corresponding rotary gear **266** or **266*a***. Thus with the control units **252** axially stacked on the rotary control shaft **271**, and in a spaced relation by virtue of the spacing washers **282**, on their being clamped together as by clamping means designated generally as **284**, the adjustable members **277** are frictionally locked between adjacent ones of the spacing washers **282** so as to be rotatable with the washers **282** and the shaft **271** as an integral unit. However, since the axial length of a reduced hub portion at each end of the adjustable member **277** is greater than the thickness of a corresponding rotary gear **266** and **266*a***, such gears are freely rotatable on the adjustable member for rotation relative thereto and to each other.

In considering the operation of a control unit **252** let it be assumed that the adjustable member **277** is in an adjusted position corresponding to a predetermined control position of the shaft **271** and in turn to a corresponding predetermined tuning position of the tuning means **276**. As previously mentioned, the motor **232** is of the uni-directional type and for purposes of explanation it may be assumed that its direction of rotation is such that the driving pinions **248** are rotated in a clockwise direction as viewed in Fig. 10, through the driving connection afforded by the shaft **242** and the meshing gears **244** and **239**.

On pivotal movement of the clutch arm as effected by energization of the magnet **259**, the gear **253** is moved from its full line position to a position in engagement with the pinion **256**. This engagement rotates the pinion **256** in a clockwise direction to in turn drive the pinion **267** and gear **266**, which are in continuous engagement with the pinion **256**, in counterclockwise directions. Since the pinion **267** is in continuous meshing engagement with the gear **266*a***, this gear is rotated in a clockwise direction or oppositely to the direction of rotation of the gear **266** in a corresponding control unit **252**. By virtue of this reversed rotation of the gear members **266** and **266*a***, their corresponding idler gears **286** and **286*a***, respectively, are reversely rotated in opposite directions about the adjustable member **277**. It is apparent that with the shaft **271**, and hence the adjustable member **277** in a stationary position, that rotation of the idler gears is accomplished by their being rotated about the adjustable member by the gears **266** and **266*a***.

Because of the rotating lost-motion action of the idler members **286** and **286*a*** relative to the adjustable member **277**, the control shaft **271**, and hence the tuning means **276**, remain stationary until one of the gears **266** and **266*a*** is locked with the adjustable member **277**. Thus let it be assumed that the gear member **266** is initially locked with the adjustable member **277**. When this locking occurs, lost-motion between the idler gear **286** and member **277** is discontinued, and the adjustable member and hence the control shaft **271** are rotated in a counterclockwise direction corresponding to the direction of rotation of the gear member **266**. Because of the reversed rotation of the gears **266** and **266*a***, this rotation of the adjustable member **277** by the gear **266** accelerates the relative movement between the idler **286*a*** and the adjustable member **277** to in turn accelerate the occurrence of the locking action between the adjustable member **277** and the wear **266*a***. Since the idler gears **286** and **286*a*** are rotated in opposite directions relative to each other, and reversely about the adjustable member **277**, the corresponding stop portions **291** and **291*a*** thereof engage opposite ends and sides of the stop portion or long tooth **280'** on the adjustable member. Since the driving force of the gears **266** and **266*a*** act on the tooth **280'** in opposite directions, and since these opposed forces are equal, the coupled engagement of both gears with the member **277** locks such gears against further relative rotation to define the predetermined control position of the shaft **271**. It is obvious, of course, that if the gear **266*a*** is initially locked with the adjustable member **277** that rotation of the control shaft **271** will be in a direction corresponding to the direction of rotation of the gear **266*a***, which rotation will continue until the gear **266** is also locked with the adjustable member **277**. Because of the continuous meshing engagement of the adjustable member **277** with each of the idler gears **286** and **286*a***, a predetermined operating relationship is continuously retained between these three elements. Although the rotation of the motor **232** is uni-directional, the opposite rotation of the gears **266** and **266*a*** provides for a rotation of the control shaft and hence of the condenser **276** in either direction of rotation to a predetermined tuning position.

It is obvious, of course, that with a control unit in a locked condition resulting from one direction of rotation of the shaft **271**, rotation of the shaft may take place in an opposite direction to a degree corresponding to the lost-motion in the control unit, until locking of the control unit is again accomplished. This establishing of a known lost-motion may be used where it is desired to rotate the apparatus to be controlled through a predetermined angular distance prior to locking it in a stop position. A plurality of control units may thus be attached on a single shaft without mutual interference, while permitting manual rotation of the shaft without requiring any disengagement of the control units.

As indicated above, the adjustable members **277** for the control units **252** are held in their ad-

justed positions by clamping means 284. The clamping means 284 (Fig. 11) are mounted on the control shaft 271 together with means for limiting the rotation of the control shaft and includes a pair of axially spaced gear members 201 and 201a rotatably supported on the shaft 271 but retained against rotation relative to the frame 226 by the locked engagement of the teeth thereon with stop clips 202 removably attached to the frame member 226 by screws 203. The member 204 intermediate the gears 201 and 201a is provided with flat key portions 205 for mating engagement with the flat shaft sides 278 so as to be slidably but non-rotatably supported on the shaft 271. Rotary means 286 and 286a identical in all respects to the like means used in the control units 252 are rotatably carried on corresponding gear members 201 and 201a in continuous meshing engagement with the member 204. A locking nut 206 axially threadable on the shaft 271 is provided with a gear portion 207 for meshing engagement with a driving gear 208 fixed on the shaft 257 for the pinions 256. It is seen, therefore, that the pinion 208 is rotated with the shaft 257, as by the control knob 209, independently of any rotation of the pinions 256. Thus the shaft 257 not only functions as a support for the motor driven elements 256 through which the control units are selectively actuated, but also functions as one link in the mechanism for manually actuating the rotary control shaft 271.

In considering the operation of the clamping means 284 it may be assumed that all of the control units 252 are clamped against movement relative to the shaft 271. To release the adjustable members 277 for adjustment to new positions, the shaft 257 is rotated in a direction to accomplish such release through finger manipulation of the knob 209. Incident to this shaft rotation, the control shaft 271 and hence the member 204 are driven through the gears 208 and 207. Since the gear members 201 and 201a are retained against rotation, rotation of the member 204 continues until it is locked with one of the idler means such as 286 to limit any further rotation of the shaft 271. At this point and due to the frictional engagement of the nut 206 with the washer 211b, a turn resisting indication is provided indicating that the shaft 271 has been rotated to one limit of its rotational range. In other words, a yielding stop connection is provided between the two shafts 257 and 271 when the latter shaft is rotated to the end of its rotational range, which connection can only be overcome by the application of additional torsional force to the shaft 257. Upon continued rotation of the shaft 257 through this point, the clamping nut 206 is axially threaded away from the control units 252, or to the right as viewed in Fig. 11, until it engages the stop nut 210, so as to release the adjustable members 277. Some pressure is continued on the adjustable members 277 and nut 206 by a tension washer 211 to retain them against free rotation, the washer being supported on the shaft 271 between washers 211a and 211b, with the three-washer assembly in turn being intermediate the gear member 201a and the clamping nut 206. Since the locked position of the member 204 with each of the rotary means 286 defines the extent of rotation of the shaft 271 in reversed directions, it is contemplated that this rotation be such as to permit rotation of the condenser 276 throughout a complete tuning range. Thus with the control units 252 in a released position, manipulation of the knob 209 rotates the condenser to any desired tuning position. In this regard it is noted that the traveling nut 206 is tightly clamped in frictional engagement with the stop nut 210 to permit the shaft 271 to be manually rotated by the shaft 257 in either direction without clamping the adjustable members 277 against adjustment. With the knob 209 held manually to retain a selected tuning position, the control unit corresponding to the selected tuning position is actuated by energizing the corresponding magnet 259 and the driving motor 232. This rotates the rotary elements of the control unit to a locked position defining the adjusted position of the adjustable member 277 corresponding to the selected tuning position. Each of the control units is tuned in a like manner, with the adjusted position of each adjustable member 277 being retained by virtue of the frictional pressure retained between the control units 252 by the spring washer 211.

When all of the control units 252 have thus been set, the shaft 257 is rotated in a direction for clamping the control units. This rotation of the shaft 257 in turn rotates the control shaft 271 until locking is accomplished between the member 204 and the other one of the idler means 286 to stop the rotation of the shaft 271. During such manual rotation of the moving parts, the traveling nut 206 remains frictionally clamped to the stop nut 210. Accordingly, when the shaft 271 is locked against rotation at the other end of its rotational range through the action of the locking means 284, added torsional force must be manually applied to the shaft 257 in order to free the traveling nut from frictional engagement with the stop nut 210. Thus the locking means 284 and the various parts of the clamping mechanism coact to provide a turn resisting indication that the shaft 271 has been rotated to a predetermined setting, i. e. one limit of its rotational range. After rotation of the shaft 271 has been stopped in the manner just explained, continued rotation of the shaft 257 moves the clamping nut 206 axially of the shaft 271 until clamping pressure is again restored to the adjustable members 277 of the control units, with these members in their adjusted positions. In this regard it is pointed out that a suitable stop portion (not shown) is provided at the shaft end opposite the nut 206 against which the adjustable members 277 are clamped. Thus the tuning unit is reprepared for selective tuning.

From the foregoing explanation it will be understood that the mechanism consisting of the shaft 257, the clamping means 284 and the lost-motion locking means 252, while of compact and rugged construction, yet accurately and reliably performs the functions of permitting manual adjustment of the tuning means 276 to a desired setting, limiting the tuning of the tuning means to a definite range without interfering with the action of the control units 252, and releasably locking the adjustable elements 277 in set positions to permit easy adjustment of each control unit to define different settings of the tuning means. The same is true of the equivalent mechanism embodied in the apparatus disclosed in Figs. 1 through 8 of the drawings. In each embodiment, moreover, the lost-motion stop mechanism coacts with the stack clamping mechanism to provide a yielding stop or turn resisting indication of two predetermined settings of the rotary control shaft.

While different embodiments of the invention

have been disclosed, it will be understood that various modifications may be made therein which are within the true spirit and scope of the invention.

I claim:

1. In electrical control apparatus having a rotary control shaft and a plurality of control units axially aligned on said control shaft, with each said control unit including an adjustable member on said control shaft, the combination of means for clamping said adjustable members in adjusted positions including a mounting member rotatably supported on said shaft, means retaining said mounting member against rotation, a locking member axially movable on said shaft adjacent said mounting member and having a toothed portion thereon, rotary means carried on said mounting member having a gear portion operatively connected with said toothed portion so that said gear portion is rotated by said locking member on rotation of said shaft, stop means operatively connected with each of said locking member and rotary means for locking the same in fixed relative positions, means for rotating said shaft including a rotary member having a hub portion axially movable on said shaft and operating on said control units to clamp and release said adjustable means, with the degree of rotation of said shaft intermediate the clamping and releasing positions of said rotary member being determined by the reversed rotation of said locking member into locked positions with said rotary means.

2. In electrical control apparatus having a rotary control shaft, and a plurality of control units axially aligned on said control shaft, with each of said control units including an adjustable member on said control shaft, the combination of means for clamping said adjustable members in adjusted positions including a pair of axially spaced mounting members rotatably supported at one end of said shaft, means retaining said mounting members against rotation, a locking member on said shaft intermediate said mounting members having a tooth portion thereon, rotary means carried by each of said mounting members having a gear portion operatively connected with said tooth portion so that said gear portions are reversely rotated by said locking member on rotation of said shaft, and stop means operatively connected with each of said rotary means and locking member, with the stop means on said two rotary means being selectively engageable with the stop means on said locking member to define the angular rotation of said shaft, means for rotating said shaft including a gear having a hub axially movable on said shaft and acting on said control units to clamp and release said adjustable means, with the degree of rotation of said shaft intermediate the clamping and releasing positions of said gear hub being determined by the rotation of said locking member from a locked position with one of said rotary means into a locked position with the other of said rotary means.

3. In a mechanism for identifying a predetermined setting of a rotatable element, a pair of members mounted upon said element for relative rotary movement therebetween in response to rotation of said element, lost motion means having a predetermined free travel range and including at least one part supported for rotation relative to one of said members, the free travel range of said lost motion means being taken up in response to relative rotary movement between said members, and means controlled by said one part for providing an indication of the setting of said element when one limit of the free travel range of said lost motion means is reached.

4. In a control mechanism for identifying a predetermined setting of a manually rotatable element, a first member carried by said element for relative rotary movement therebetween, means holding said member stationary, a second member mounted for rotation with said element, a gear supported by one of said members for rotation about an axis which is parallel to but spaced radially from the axis of rotation of said element, means for rotating said gear relative to its supporting member in response to rotation of said element, and means controlled by the relative movement between said gear and its supporting member for providing a turn resisting stop indication when said element is manually rotated to said predetermined setting.

5. In a control mechanism for identifying a predetermined setting of a manually rotatable element, a first member carried by said element for relative rotary movement therebetween, means holding said member stationary, a second member mounted for rotation with said element, a gear supported by one of said members for rotation about an axis which is parallel to but spaced radially from the axis of rotation of said element, means for rotating said gear relative to its supporting member in response to rotation of said element, a pair of tooth-like parts radially displaced from said element and rotated relative to each other into engagement in response to a variable amount of relative movement between said gear and its supporting member, and means including said tooth-like parts for providing a yielding turn resisting stop indication of the setting of said element when said tooth-like parts are moved into engagement.

6. In a control mechanism for identifying a predetermined setting of a manually rotatable element, a member carried by said element for relative rotary movement therebetween, means holding said member stationary, a first gear supported for rotation about an axis which is parallel to but spaced radially from the axis of rotation of said element, a second gear carried by said element and meshing with said first gear, means including said second gear for rotating said first gear about its axis of rotation in response to rotation of said element, a pair of tooth-like parts radially displaced from said element and rotated relative to each other into engagement in response to a variable amount of relative movement between said gears, and means including said tooth-like parts for providing a yielding turn resisting stop indication of the setting of said element when said tooth-like parts are moved into engagement.

7. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and wherein each control unit includes a member adjustable relative to said shaft; the means for releasably clamping said members in adjusted positions relative to said shaft which comprises lost motion means for limiting rotation of said shaft to a predetermined plural revolution range and for stopping rotation of said shaft when either limit of said range is reached, a clamping member for releasably clamping said adjustable members against movement relative to said shaft and normally rotatable with said shaft, means responsive to relative rotation between said clamping member and said shaft for moving said clamping member

axially of said shaft between a clamping position and a second position wherein said adjustable members are unclamped, drive means for rotating said shaft to either limit of its rotational range and for producing relative rotation between said clamping member and said shaft after said shaft has been stopped at either limit of its range, whereby said clamping member may be moved axially of said shaft in either direction between said two positions, and means for releasably restraining said clamping member in said second position, whereby said drive means may be operated to rotate said shaft to predetermined settings intermediate the limits of its rotational range when said clamping member occupies its second position.

8. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and wherein each control unit includes a member adjustable relative to said shaft; the means for releasably clamping said members in adjusted positions relative to said shaft which comprises a lost motion mechanism for stopping said shaft after it has been rotated to a predetermined setting in one direction, a second lost motion mechanism for stopping said shaft after it has been rotated from said predetermined setting over a predetermined rotational range to a second predetermined setting, a clamping member for releasably clamping said adjustable members against movement relative to said shaft and normally rotatable with said shaft, means responsive to relative rotation between said clamping member and said shaft for moving said clamping member axially of said shaft between a clamping position and a second position wherein said adjustable members are unclamped, drive means for rotating said shaft to either limit of its rotational range and for producing relative rotation between said clamping member and said shaft after said shaft has been stopped at either limit of its range, whereby said clamping member may be moved axially of said shaft in either direction between said two positions, and means for releasably restraining said clamping member in said second position, whereby said drive means may be operated to rotate said shaft to predetermined settings intermediate the limits of its rotational range when said clamping member occupies its second position.

9. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and wherein each control unit includes a member adjustable relative to said shaft; the means for releasably clamping said member in adjusted position relative to said shaft which comprises lost motion means for limiting rotation of said shaft to a predetermined plural revolution range and for stopping rotation of said shaft when either limit of said range is reached, clamping means normally rotatable with said shaft but movable relative to said shaft between positions wherein said adjustable members are either restrained or non-restrained against movement relative to said shaft, and means coacting with said lost motion means to produce relative movement between said clamping means and said shaft when said shaft is moved to either limit of its rotational range.

10. In control apparatus which comprises a rotary control shaft and a plurality of mutually noninterfering control units which are respectively operative to rotate said shaft to predetermined settings within a predetermined range of rotation; a second rotatable shaft, means including rotatable parts carried by said second shaft for selectively operating said control units, and means controlled by rotation of said second shaft for permitting adjustment of the predetermined shaft settings to which said units correspond.

11. In control apparatus which comprises a rotary control shaft and a plurality of mutually noninterfering control units which are respectively operative to rotate said shaft to different predetermined settings within a plural revolution range of rotation, and wherein said control units include members which are axially aligned on said shaft and are adjustable relative to said shaft to change the predetermined shaft settings to which their respective associated control units correspond; a second rotatable shaft, means including rotatable parts journaled on said second shaft for selectively actuating said control units to operate said rotary control shaft to selected ones of said predetermined settings, and clamping means controlled by rotation of said second shaft to releasably clamp said adjustable members against movement relative to said shaft.

12. In control apparatus which comprises a rotary control shaft, a plurality of mutually noninterfering control units which are respectively operative to rotate said shaft to predetermined settings within a predetermined revolution range of rotation, and lost motion mechanisms actuated by rotation of said shaft and respectively operative to stop the rotation of said shaft when the respective limits of said range are reached.

13. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and each provided with an element which is adjustable relative to said shaft; the means for releasably clamping said elements in adjusted positions relative to said shaft which comprises a supporting member mounted for rotation with said shaft, lost-motion means supported by said supporting member and operative to limit rotation of said shaft to a predetermined plural revolution range and to stop rotation of said shaft when either limit of said range is reached, a clamping member carried by said supporting member and normally rotatable therewith, means responsive to relative rotation between said members for moving said clamping member axially of said shaft between positions wherein said elements are either restrained or non-restrained against rotation relative to said shaft, and means coacting with said lost-motion means to produce relative movement between said members.

14. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and each provided with an element which is adjustable relative to said shaft; the means for releasably clamping said elements in adjusted positions relative to said shaft which comprises a supporting member mounted for rotation with said shaft, a lost-motion mechanism including parts supported by said supporting member and operative to stop said shaft after it has been rotated to a predetermined setting in one direction, a second lost-motion mechanism also including parts supported by said member and operative to stop said shaft after it has been rotated from said predetermined setting through a predetermined number of revolutions to a second predetermined setting, a clamping member carried by said supporting member and normally rotatable therewith, means responsive to relative rotation between said members for moving said clamping member axially of said

shaft between positions wherein said elements are either restrained or non-restrained against rotation relative to said shaft, and means coacting with said lost-motion means to produce relative movement between said members.

15. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and each provided with a supporting hub which is adjustable relative to said shaft and with a bushing spacing the hub from the shaft; the means for releasably clamping said hubs in adjusted positions relative to said shaft which comprises a first clamping member threaded on said shaft to clamp said bushings in set positions along said shaft, lost-motion means supported by said clamping member and operative to limit rotation of said shaft to a predetermined plural revolution range and to stop rotation of said shaft when either limit of said range is reached, a second clamping member threaded on said first clamping member, said second clamping member normally being rotatable with said first clamping member but being rotatable relative thereto between positions wherein said hubs are either restrained or non-restrained against rotation relative to said shaft, and means coacting with said lost-motion means to produce relative movement between said clamping members.

16. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and each provided with an element which is adjustable relative to said shaft; the means for releasably clamping said elements in adjusted positions relative to said shaft which comprises a supporting member mounted for rotation with said shaft, lost-motion means supported by said supporting member and operative to limit rotation of said shaft to a predetermined plural revolution range and to stop rotation of said shaft when either limit of said range is reached, a clamping member carried by said supporting member and normally rotatable therewith, means responsive to relative rotation between said members for moving said clamping member axially of said shaft between positions wherein said elements are either restrained or non-restrained against rotation relative to said shaft, means coacting with said lost-motion means to produce relative movement between said members, a clamping piece interposed between said clamping member and the adjacent one of said elements to transmit the clamping pressure to said elements, and means including slidably engaged parts of said clamping piece and said member for preventing relative rotary movement between said piece and said elements during movement of said clamping member into and out of its clamping position.

17. In control apparatus which comprises a rotary control shaft having a plurality of control units axially aligned thereon and each provided with an element which is adjustable relative to said shaft; the means for releasably clamping said elements in adjusted positions relative to said shaft which comprises a supporting member mounted for rotation with said shaft, lost-motion means supported by said supporting member and operative to limit rotation of said shaft to a predetermined plural revolution range and to stop rotation of said shaft when either limit of said range is reached, a clamping member carried by said supporting member and normally rotatable therewith, means responsive to relative rotation between said members for moving said clamping member axially of said shaft between positions wherein said elements are either restrained or non-restrained against rotation relative to said shaft, means coacting with said lost-motion means to produce relative movement between said members, a clamping piece interposed between said clamping member and the adjacent one of said elements to transmit the clamping pressure to said elements, means including slidably engaged parts of said clamping piece and said member for preventing relative rotary movement between said piece and said elements during movement of said clamping member into and out of its clamping position, and antifriction balls interposed between said clamping piece and said clamping member to facilitate relative rotation between said clamping member and said supporting member.

18. In control apparatus which comprises a rotary control shaft, a plurality of mutually non-interfering units which are respectively operative to rotate said shaft to predetermined settings within a predetermined plural revolution range of rotation, a supporting member mounted for rotation relative to said shaft, a pair of lost-motion mechanisms each including parts rotatably supported by said member, and means including said mechanisms for arresting rotation of said shaft when the respective limits of said rotational range are reached.

19. In control apparatus which comprises a rotary control shaft and a plurality of mutually noninterfering units which are respectively operative to rotate said shaft to predetermined settings within a predetermined plural revolution range of rotation; the means for limiting said shaft to rotation within said range which comprises a stationary member, an element rotatably supported upon said member, means for rotating said element relative to said member in response to each rotation of said shaft, a star wheel rotatable with said element, means carried by said shaft and coacting with said star wheel for positively limiting the relative rotary movement between said element and said member to a fraction of a revolution of said element for each revolution of said shaft, and stop means controlled by said element to establish a stop connection between said shaft and said member when said shaft is rotated to one limit of its rotational range.

20. In control apparatus which comprises a rotary control shaft, a plurality of mutually non-interfering control units which are respectively operative to rotate said shaft to predetermined settings within a predetermined range of rotation of said shaft, and lost-motion means actuated by rotation of said shaft and operative to stop the rotation of said shaft when the respective limits of said range are reached.

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