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RADIO TUNING AND SELECTIVITY CONTROL

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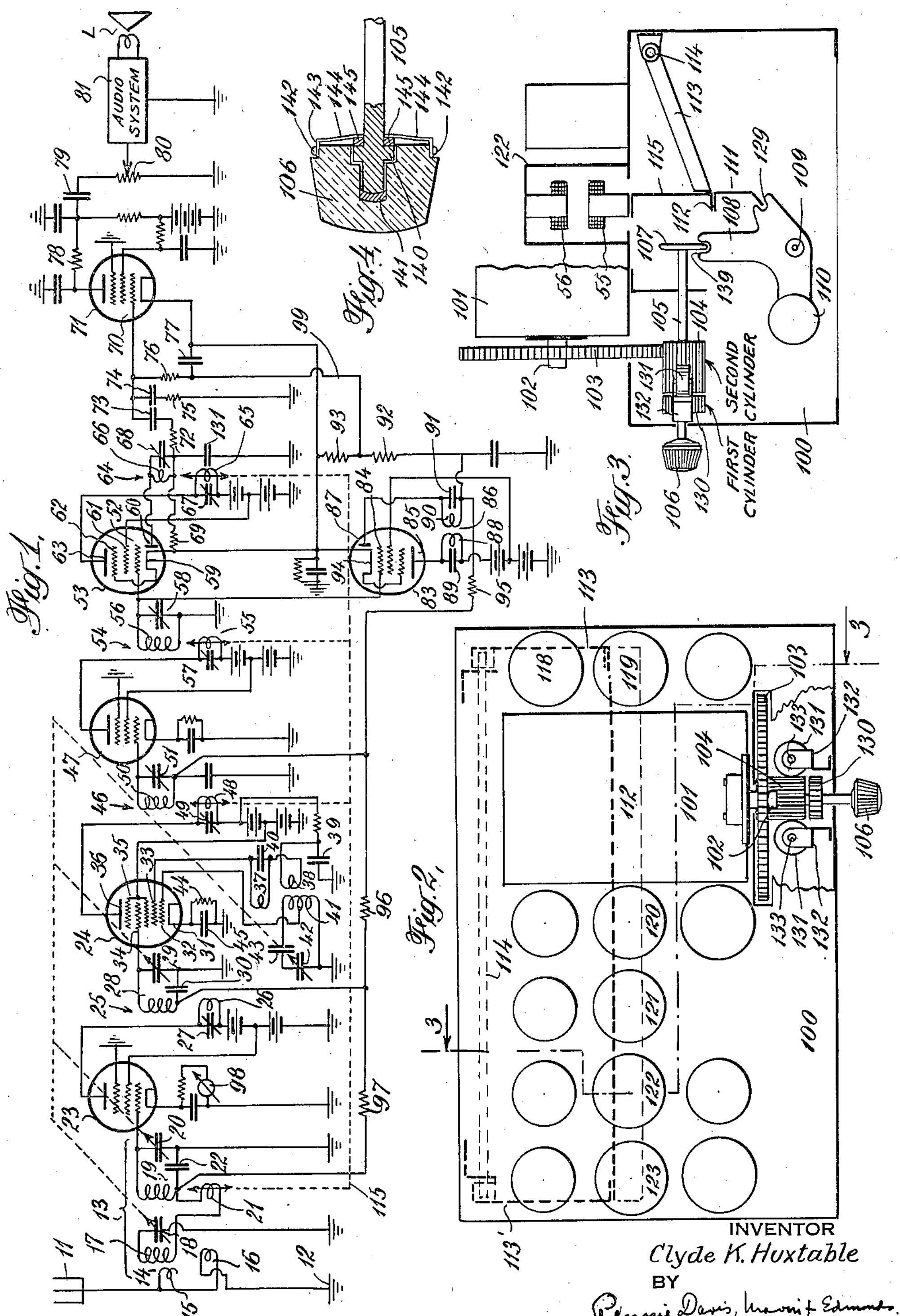

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RADIO TUNING AND SELECTIVITY CONTROL

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12 Claims. (Cl. 250—20)

This invention relates primarily to radio broadcast receiving systems, the tuning and selectivity of which are adjustable by the user for the purpose of receiving a desired station with optimum fidelity consistent with freedom from interference.

In a copending application of Harold A. Wheeler and Nelson P. Case, Serial No. 696,990, filed November 7, 1933, there is described a radio receiver of the type referred to wherein the tuning and selectivity may be independently and arbitrarily adjusted by means of a unitary control shaft capable of translational and rotational movement. This shaft is axially displaceable to adjust, at any given frequency of tuning, the selectivity between maximum and minimum limits by variation of the separation between inductively coupled tuned transformer coils. The shaft carries a pinion which at the axial displacement corresponding to maximum selectivity or sharpest tuning, meshes a gear mounted on the shaft of a gang condenser, whereby rotation of the control shaft adjusts the tuning.

In the system of the copending application referred to the control shaft is rotatable at all positions of axial displacement, i. e., irrespective of whether or not the pinion mounted thereon is entrained with the gear of the tuning control. In contradistinction, the present invention provides a mechanical arrangement for maintaining the tuning control continuously engaged for all adjustments of the selectivity control but adds a locking feature to prevent operation of the tuning control except when the selectivity control is adjusted for substantially minimum band width or maximum selectivity.

It is a feature of the present arrangement that the transition from an unlocked to a locked tuning condition takes place smoothly with no additional effect regardless of the adjustment of the tuning control.

The preferred mechanical arrangement consists of a pair of contiguous cylinders of equal diameter, one attached to or frictionally driven by the axially displaceable and rotatable control shaft, the other free to rotate about the shaft. A pair of soft rubber rollers with axes in a plane perpendicular to the shaft are mounted on fixed supports so as to be continuously in friction contact with one or the other of the cylinders depending on the axial displacement of the control shaft. The rollers are placed on opposite sides of the shaft to eliminate lateral stress on the shaft. Axial motion is then permitted by the rotation of the rollers about their axes, during which the points of contact move from one cylinder to the other. The rubber rollers effectively prevent any rotation of the fixed or frictionally driven cylinder when in contact therewith, but permit the fixed cylinder to be driven by the shaft to effect tuning adjustment when the rubber rollers contact the free or idling cylinder. It is desirable to knurl the cylindrical surfaces longitudinally or to use pinions for this purpose to decrease the tendency of the rubber rollers to slip.

It is also desirable to provide against forceful stripping of the rubber roller by a careless user in attempting to rotate the control shaft knob in the locked position. This may be done by providing a friction drive between the control knob and shaft or between the shaft and the fixed cylinder, so proportioned that the friction drive will slip before the cylinder turns against the rollers.

In the accompanying drawing:

Fig. 1 is a schematic circuit diagram of a superheterodyne radio receiving system the tuning and selectivity of which are independently adjustable by the mechanism of the present invention.

Fig. 2 shows in plan view the mechanical assembly of a receiver chassis incorporating the circuit of Fig. 1 and the mechanical tuning and selectivity control of the present invention.

Fig. 3 is a sectional elevation along **3—3** of Fig. 2.

Fig. 4 is a detail in longitudinal section of the control shaft as terminated in a knob mechanically coupled to the shaft through a frictional drive as explained.

In the circuit of Fig. 1, the antenna-ground system **11—12** is coupled to a tuned antenna coupling transformer **14** comprising primary coils **15** and **16** and a secondary coil **17**. There is inductive coupling between coils **16** and **17**. There is also inherent capacitive coupling provided between coils **17** and **15** due to their proximity. The transformer **14** is more fully described in United States Patent 1,907,916, of Harold A. Wheeler, granted May 9, 1933.

Transformer **14** is included in a tuned preselector **13** composed of two tunable circuits, the first of which comprises secondary coil **17** and its associated variable tuning condenser **18**, and the second of which comprises a secondary coil **19** and its associated variable tuning condenser **20**. These two tunable preselector circuits are coupled together by a coupling coil **21** which acts as a primary coil with respect to secondary coil **19**, and are also coupled by a condenser **22** connected between ground and the junction of coils

19 and 21. The type of double-tuned preselector coupled in the manner described above is described in United States Patent 1,927,672, of Harold A. Wheeler, granted September 19, 1933.

It is well known that when the inductive coupling between two tuned circuits, such as the two tunable circuits of the preselector, is increased, the admission band width of the coupling system is increased without shifting the center frequency of the band. Such a coupling system is a band-pass selective network, or band selector. When the inductive coupling is increased beyond a certain amount, the characteristic curve of the band-pass selector develops a double peak. The maximum value of coupling which develops only a single peak is known as the optimum value. Reducing the coupling below optimum reduces the band width of the single-peak characteristic until a limiting minimum value is reached. Increasing the coupling above optimum increases the frequency separation of the two peaks of the characteristic, and therefore the band width, but it also makes the individual peaks sharper. This type of band-pass selector is most useful when the inductive coupling is between half and double the optimum value. The selectivity of band-pass selectors is inversely proportional to the band width. This effect is utilized by making the coupling coil 21 movable axially with respect to its associated secondary coil 19, as indicated by the double-ended arrow drawn through coil 21. Consequently, the selectivity, or band-width, of the preselector may be adjusted at will by moving the coupling coil 21 with respect to coil 19.

The output of the preselector is impressed upon a radio-frequency amplifier tube 23 of the pentode type. The output of amplifier 23 is impressed on an oscillator-modulator tube 24 through a tunable coupling system comprising a radio-frequency transformer 25. The primary coil 26 of the transformer 25 is resonated by its associated condenser 27 to a frequency somewhat below the tuning range, and the secondary 28 is tunable by its associated variable tuning condenser 29. A fixed condenser 30 is connected in the tuned circuit to improve the alignment of this tunable circuit with those of the preselector, as described in the said Patent No. 1,927,672.

The oscillator-modulator tube 24 is of the so-called 2A7 type, similar to that described in the copending application of Harold A. Wheeler, Serial No. 654,327, filed Jan. 30, 1933; and the circuit thereof is of a type described in the copending application of Harold A. Wheeler, Serial No. 654,326, filed Jan. 30, 1933. The tube 24 comprises a cathode 31, an inner grid 32, an inner anode 33, an outer grid 34, a double screen 35 and an outer anode 36 The oscillator portion comprises a circuit connection between the inner anode 33 and ground, this circuit including a coil 37 and a coil 38 in series with a radio-frequency by-pass condenser 39 Coil 37 is shunted by an adjustable condenser 40 for aligning the oscillator at lower frequencies, this condenser remaining fixed after it is finally adjusted, and serving to resonate the coil 37 at a frequency below the tuning range of the oscillator.

The coils 37 and 38 of this anode circuit are coupled to the inner-grid circuit, 31, 32, 33, by an inductive coupling to coil 41, part of which is connected between the inner grid 32 and ground. Coil 41 is shunted by an oscillator tuning condenser 42 and a fixed condenser 43 in series therewith, the latter serving to limit the oscillator frequency range. The cathode circuit is completed to ground by a resistor 44 and a by-pass condenser 45. Oscillations are produced by the feedback coupling between the inner-anode circuit and inner-grid circuit. The oscillation voltage across coil 41 is held nearly uniform over the tuning range by proportioning the feedback couplings to coils 37 and 38, the former having more effect at lower frequencies and the latter at higher frequencies.

The radio-frequency signal applied to the outer signal grid 34 from the amplifier 23 is modulated in tube 24 by the oscillations, and the resulting intermediate-frequency product of the modulation appears in the outer-anode circuit of tube 24.

The output of tube 24 is coupled by a double-tuned transformer 46 to an intermediate-frequency amplifier 47 of the pentode type. The primary coil 48 of transformer 46 is tuned by a condenser 49 to the intermediate frequency, and the secondary coil 50 is tuned to the intermediate frequency by a condenser 51. Condensers 49 and 51 are each adjustable, but when finally adjusted remain fixed. The primary coil 48 is movable toward and away from the secondary coil 50. Such movement of coil 48 with respect to coil 50 permits adjustment of the band width of the fixed-tuned intermediate-frequency selecting system, in the manner described above in connection with the radio-frequency preselector. Condensers 49 and 51 permanently tune transformer 46 to the intermediate frequency under the condition of minimum coupling between the coils 48 and 50, in order to avoid errors due to the double-peak characteristic produced when the coupling exceeds optimum.

The output of amplifier tube 47 is coupled to amplifier tube 53 through a double-tuned intermediate-frequency transformer 54. The latter, which is similar in every essential respect to tuned transformer 46, includes primary and secondary coils 55 and 56, respectively, and tuning condensers 57 and 58 therefor, respectively.

The tube 53 is a composite tube of type 2B7 comprising a pentode intermediate-frequency amplifier and a diode rectifier. The diode rectifier elements are the cathode 59 and the diode anode 60. The cathode 59, the control grid 52, the screen 61, the suppressor 62 and the anode 63 are the electrodes of the pentode amplifier. The intermediate-frequency signal is amplified in the amplifier portion of tube 53, and conducted to a double-tuned intermediate-frequency transformer 64 generally similar to transformers 46 and 54. Transformer 64 comprises primary and secondary coils 65 and 66, tuned by condensers 67 and 68, respectively.

The output of transformer 64, across inductance 66, is impressed between the diode anode 60 and cathode 59 through a condenser 131. The diode operates as a rectifier and develops across resistor 69 both direct and audio-frequency voltages, which latter are impressed on the control grid 70 of an audio-frequency amplifier 71 through a resistor 72 and a coupling condenser 73.

There is connected in a path between the control grid 70 and ground, condenser 74 and resistance 75 in series. The function of this path is to attenuate to a certain extent the higher audio frequencies, thus compensating for the accentuation of the sidebands corresponding to such higher audio frequencies in the intermediate-frequency double-tuned transformers, when the resultant band selection characteristic of the latter is adjusted to develop a double peak. Resistor 76 and condenser 77 function as a grid leak and an audio-frequency by-pass condenser, respectively.

The output of tube 71 includes in series, a resistor 78, an audio-frequency coupling condenser 79 and a variable attenuator 80. Attenuator 80 is variably tapped to the input of an audio-frequency amplifier indicated diagrammatically by rectangle 81, the attenuator serving thus as a volume control. The audio system 81 includes any desired conventional apparatus such as a power amplifier terminating in a loudspeaker L.

There is associated with the receiver a system of automatic volume control which functions to maintain the response of the receiver substantially constant over a wide range of received signal intensities. This automatic volume control comprises a tube 83 of type 2B7, which is a combined pentode amplifier and diode rectifier like tube 53. The intermediate-frequency output voltage of the coupling transformer 54 is impressed on the amplifier control grid 84. The amplified signals appearing in the circuit of anode 85 are coupled by a double-tuned intermediate frequency transformer 86 to the diode anode 87. The coupling transformer 86 comprises primary coil 88 tuned by condenser 89, and secondary coil 90 tuned by condenser 91. This transformer possesses a band-pass characteristic which is much wider than that of transformers 46 and 54. A rectified uni-directional voltage responsive to the intermediate-frequency carrier is developed across resistors 92 and 93 connected in series between the cathode 94 and the secondary coil 90.

The uni-directional voltage across resistors 92 and 93 is impressed on the control grids of tubes 23, 24, 47, by means of the connections including resistors 95, 96 and 97.

For the purpose of facilitating and obtaining the proper tuning adjustment, which would otherwise be somewhat difficult owing to the typical action of the automatic volume control arrangement, a visual tuning meter 98, or other visual tuning indicator, is connected in the cathode lead of the first radio-frequency amplifier 23. Since the anode current of the tube flows through the tuning meter, an indication of minimum direct current is that of accurate tuning. The system of automatic volume control and visual indication of tuning described above, is that of United States Patent No. 1,879,863, of Harold A. Wheeler, issued September 27, 1932, and of his application Serial No. 203,879, filed July 7, 1927.

There is also provided a connection 99 from a point between resistors 92 and 93 to the grid circuit of audio amplifier 71 to control or vary the gain thereof. This improvement in automatic volume control is disclosed in the copending application of Harold A. Wheeler, Serial No. 603,500, filed April 6, 1932.

The tubes 23, 24, 47 and 71, have control grids of the gradual cutoff type. Such a control grid characteristic improves the automatic volume control operation.

There are provided throughout the receiver, resistors and by-pass condensers, as shown, to improve the general operation. Although batteries are used to designate direct voltage sources throughout the receiver, it should be understood that these are only symbols, and may represent, for example, a single source of rectified alternating-current source with the usual ripple filter, by-pass condensers and voltage-dividing resistors.

It is noted that the double-ended arrows associated with the transformer primary coils 21, 48, 55 and 65, denote movable or adjustably coupled coils. It is also noted that condensers having diagonal arrows are uni-controlled variable tuning condensers, while condensers having diagonal lines without arrow heads are adjustable condensers which remain fixed after the required adjustment has been made.

Referring to Figs. 2 and 3, which illustrate a preferred mechanical arrangement of the receiver of Fig. 1, the apparatus is mounted upon a chassis pan 100 which is of a conventional form having the sides and ends thereof bent downward at a right angle to form a raised horizontal base. Upon the upper side of the chassis is a metal frame 101 which supports the variable tuning condensers 18, 20, 29, and 42 of Fig. 1. These condensers are not shown in detail in Fig. 2, since they are of a conventional form mounted in line upon a shaft 102 for uni-control operation. The end of the shaft has fastened thereto a gear 103 adapted to be driven by a pinion 104 which is mounted upon a control shaft 105. A knob 106 is fastened to the end of control shaft 105 outside the chassis pan. This knob controls different properties of the selective network, as will be described hereinafter.

Situated in line along the center of the chassis pan is a row of shielding cans 119, 120, 121, 122 and 123, mounted above the pan. Each of these shielding cans encloses one of the selective coupling systems of the receiver. Can 119 encloses coupling coil 21 and secondary coil 19 of the preselector; can 120 encloses elements 26, 27, and 28 of transformer 25; can 121 encloses elements 48, 49, 50 and 51, of transformer 46; can 122 encloses elements 55, 56, 57 and 58, of transformer 54; and can 123 encloses elements 65, 66, 67 and 68 of transformer 64.

In the embodiment illustrated, the immovable secondary coil of each of the selective coupling systems is mounted in the shielding can enclosing it, while the movable primary coil is mounted coaxially below it and is adapted to be moved in an axial direction on a mounting lug and core extending through an opening in the chassis pan. Fig. 3 shows how this adjustment of each of the movable primaries is obtained. This figure shows the position of shaft 105 under the chassis pan and also shows in section the shielding can 122 containing the fixed secondary coil 56 and the movable primary coil 55 of intermediate-frequency coupling transformer 54. The construction and mechanical arrangement of the selective coupling systems, as described herein, have proved successful in practice, but other equivalent mechanical arrangements and specific relative modes of motion of the coils may be employed.

For simplicity of illustration, the only shielding can shown in section in Fig. 3, is can 122, although it will be understood that the remaining cans enclosing movable coils are similarly mounted. In can 122 the secondary coil 56 is mounted on a core supported from within the top of the can. Primary coil 55 is supported, coaxially with respect to coil 56, on a core carrier by mounting lug 115. The opposite end of the mounting lug is supported on a rigid cross member 112 along the underside of the chassis pan directly beneath all of the cans 119, 120, 121, 122 and 123. The cross member 112 is supported at its ends by two crank supports 113 and 113'. These crank supports are mounted on a shaft 114 along the rear of the chassis pan, parallel to the cross member 112. The vertical position of cross member 112 is determined by a rigid projecting lug 111 attached at one end to member 112, and engaging at the other end a notch 129 in a bell crank 108, the latter being mounted on a shaft 109. To counterbalance the weight due to projecting arm 111 acting on one side of the bell crank, the opposite side of the bell crank is attached to a counterweight 110.

There is fastened to the inner end of the control shaft 105 a disc 107 which engages a slot 139 in bell crank 108. The shaft 105 is movable by knob 106 in an axial direction which is a degree of freedom termed "translation", so that the position of the bell crank and the resulting elevation of coil 55 (and of all other coils movable therewith) is determined by the axial position of the shaft 105. Movable coils 21, 48, 55 and 65, are supported on mounting lugs, similar to lug 115, which are, in turn, mechanically secured to the cross member 112 so that the coils move in unison to like extents by translation of shaft 105. Axial movement of the knob thus simultaneously varies the coupling between coils 21 and 19, 48 and 50, 55 and 56, and 65 and 66, and thereby adjusts the band width of the selector and hence the selectivity of the receiver.

The control shaft 105 carries a wide faced cylinder or pinion gear 104 which, within the limits of axial displacement of shaft 105, continuously engages a cylinder or gear 103 keyed to shaft 102 supporting the rotor elements of all of the tuning condensers. A second cylinder or pinion 130 of equal diameter to 104 is rotatably supported on shaft 105 in juxtaposition to 104. A pair of soft rubber rollers 131 frictionally engaging cylinders 104 or 130, depending on the axial displacement of shaft 105, are rotatably mounted by means of brackets 132 affixed to the chassis 100, on opposite sides of shaft 105 with their axes 133 in a plane perpendicular to shaft 105.

Either pinion 104 or the control knob 106 preferably engages shaft 105 with a frictional drive so proportioned in relation to the frictional contact with which the rubber rollers 131 engage cylinder 104, that the frictional drive will slip before pinion 104 turns against rollers 131. Thus so long as rollers 131 are in contact with cylinder 104 the tuning control shaft 102 is locked against adjustment by the control knob 106.

Axial motion of shaft 105 to vary the selectivity in the manner explained and without affecting the tuning, is permitted by rotation of rollers 131 about their axes. The length of cylinder 104 is such in relation to the limits of axial displacement of shaft 105 that rollers 131 will frictionally engage and thus prevent rotation of cylinder 104 for all selectivity adjustments less than substantially the maximum obtainable with knob 106 pushed in to its limiting position.

As knob 106 approaches this limiting position the contact points of rollers 131 pass from cylinder 104 to the idling cylinder 130. Thereupon rotation of knob 106 will produce corresponding rotation of cylinder 104 through the mentioned frictional drive. Cylinder 104 will in turn rotate cylinder 103 either through a frictional drive or gear entrainment depending on the surfacing of these cylinders. In this way tuning adjustment is effected by operation of the tuning control shaft 102 keyed to cylinder 103.

Fig. 4 illustrates a type of frictional drive that may be employed to couple either cylinder 104 or control knob 106 to shaft 105. The drawing shows the frictional drive as applied to the control knob.

The shaft is provided with a peripheral flange 140 near its end and the knob provided with bores conforming to the contour of the shaft terminus. The inner bore of the knob houses an end bearing plate 141 for the shaft. Affixed to an inner edge of knob 106 by means of screws 142 is a ring 143 provided with radially projecting spokes 144 resiliently engaging flange 140 of shaft 105 through the intermediary of frictionally engaging pads 145 of rubber or the like. The tension provided by spokes 144 is such that knob 106 will slip on shaft 105 before cylinder 104 will move against the friction of rollers 131.

I claim:

1. In a modulated-carrier receiver, a band-pass selector, tuning control means for tuning the receiver over a range of frequencies, selectivity control means for independently varying the band width of the selector, and means for mechanically locking the tuning control to prevent its adjustment when the selectivity control is adjusted for substantially greater than minimum band width.

2. In a modulated-carrier receiver, a band-pass selective network, a single knob for controlling different properties of the network, tuning control means for varying the center frequency of the band by rotation of the knob, selectivity control means for independently varying the band width of the network by motion of the knob in the axial direction, and interlocking means for preventing rotation of the knob when the knob is adjusted for substantially greater than minimum band width.

3. The arrangement for permitting the axial displacement of a shaft while preventing its rotation for a portion of said displacement, comprising a first cylinder rotatable about the shaft as an axis, a second cylinder attached to the shaft, said second cylinder being of equal diameter to said first cylinder and in juxtaposition thereto, and a roller rotatable about a fixed axis in a plane perpendicular to the shaft and so disposed relative thereto that axial displacement of said shaft automatically effects friction contact between said roller and the surface of said second cylinder for said portion of the displacement to hold said shaft against rotation while permitting free axial movements thereof at all angular positions, and that of said first cylinder for the remainder of the displacement.

4. The combination of an arrangement according to claim 3, a knob, and a friction drive between knob and shaft for manual control of the motions of the shaft, said friction drive being proportioned to cause the torque produced on the shaft by rotation of the knob to be greater than that required to rotate the shaft within said first cylinder and less than that required to rotate said second cylinder against said roller.

5. The arrangement for permitting the axial displacement of a cylinder while preventing its rotation for a portion of said displacement, comprising an auxiliary cylinder equal in diameter to the first said cylinder, both said cylinders mounted in juxtaposition upon a shaft as an axis and rotatable with respect thereto, a roller rotatable about a fixed axis in a plane perpendicular to said shaft, said roller being in friction contact with the surface of said first cylinder for said portion of the displacement and said auxiliary cylinder for the remainder of the displacement, the torsional resistance to rotation of said first-

named cylinder about said shaft being greater than that of said auxiliary cylinder about said shaft and less than that of said first-named cylinder with respect to said roller.

6. In a radio receiver having a band-pass selector, a control knob and shaft capable of rotation and axial displacement, a meshed gear and pinion, said gear attached to a tuning device and said pinion attached to said shaft for causing said rotation to adjust the tuning of the receiver, a friction lock for preventing said rotation for a portion of said axial displacement, means for causing said displacement to adjust the band width of said selector, said portion of the displacement corresponding to greater than minimum band width, and the remainder of said displacement corresponding to substantially minimum band width, an auxiliary gear of equal diameter to said pinion and rotatable about said shaft, said friction lock comprising said pinion, said auxiliary gear, and a roller rotatable about a fixed axis in a plane perpendicular to said shaft, said roller being in friction contact with the periphery of said pinion for said portion of the displacement and said auxiliary gear for said remainder of the displacement.

7. In a radio receiver, a band selector adjustable in band width, a rotatable tuning device, a shaft coaxially mounting a pair of contiguous cylinders of equal diameter, one affixed to and the other rotatable about said shaft, said shaft being axially displaceable to vary said band width, said affixed cylinder being rotatable by said shaft to adjust said tuning device, and a roller rotatable about a fixed axis in a plane perpendicular to said shaft, said roller frictionally engaging said affixed cylinder to prevent its rotation for shaft displacements providing in excess of substantially minimum band width, and said roller frictionally engaging said rotatable cylinder for shaft displacement providing substantially minimum band width.

8. In a radio receiver, a band selector adjustable in band width, a rotatable tuning device, a shaft coaxially mounting a pair of contiguous cylinders of equal diameter, one affixed to and the other rotatable about said shaft, said shaft being axially displaceable to vary said band width, said affixed cylinder being rotatable by said shaft to adjust said tuning device, a roller rotatable about a fixed axis in a plane perpendicular to said shaft, said roller frictionally engaging said affixed cylinder to prevent its rotation for shaft displacements providing in excess of substantially minimum band width, said roller frictionally engaging said rotatable cylinder for shaft displacement providing substantially minimum band width, a control knob affixed to said shaft and a frictional drive permitting rotation of said knob without rotating said affixed cylinder when engaged by said roller.

9. In a signal wave receiver including a band-pass selector, means for tuning the receiver over a range of frequencies, selectivity control means for independently varying the band width of the selector, uni-control mechanism continuously in operative engagement with both said tuning means and said selectivity control means, and means for preventing adjustment of said tuning means by said mechanism over a predetermined portion of the range of operation of said selectivity control means.

10. In a signal wave receiver including a band-pass selector, means for tuning the receiver over a range of frequencies, selectivity control means for independently varying the band width of the selector, and means for mechanically locking the tuning means, to prevent its adjustment, over a predetermined portion of the range of operation of said selectivity control means.

11. In a signal wave receiver including a band-pass selector, means for tuning the receiver over a range of frequencies, selectivity control means for independently varying the band width of the selector, a shaft rotatable to operate said tuning means and axially movable to operate said selectivity control means, and means controlled by the axial movement of said shaft for preventing rotation thereof to prevent operation of said tuning means over a predetermined portion of the range of operation of said selectivity control means.

12. The arrangement for permitting the axial displacement of a shaft while preventing its rotation for a portion of said displacement, comprising a cylinder attached to said shaft, and a roller rotatable about a fixed axis in a plane perpendicular to the shaft and so disposed relative thereto that axial displacement of said shaft automatically effects frictional contact between said roller and the surface of said cylinder for said portion of the displacement to hold said shaft against rotation while permitting free axial movements thereof at all angular positions, and automatically effects disengagement between said roller and said surface for the remainder of said displacement.

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