April 25, 1944.

J. V. FILL

2,347,315

RADIO RECEIVER

Filed Aug. 2, 1940

3 Sheets-Sheet 1

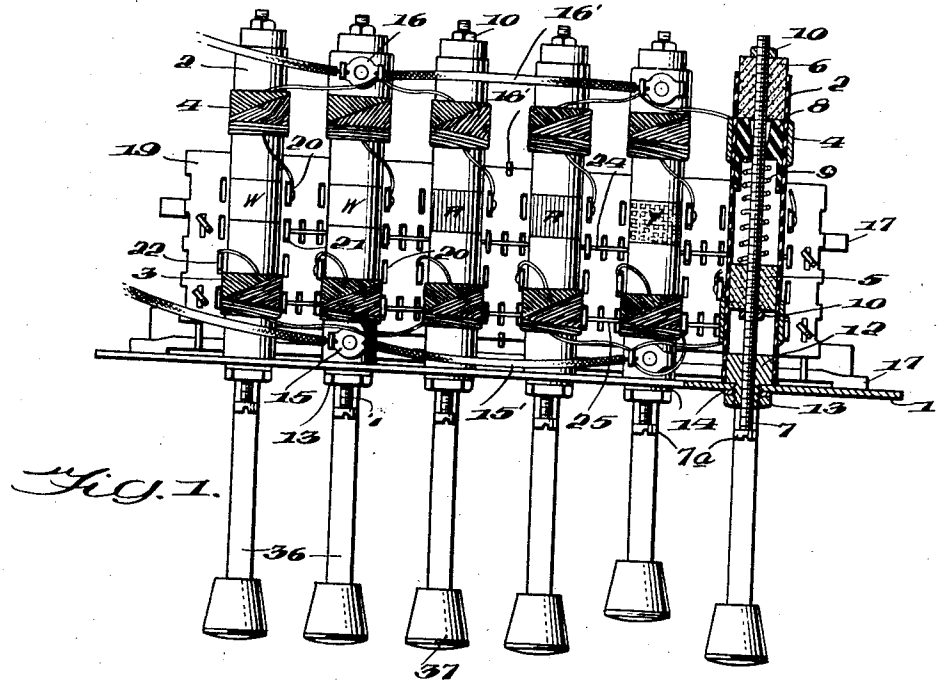


Fig. 1.

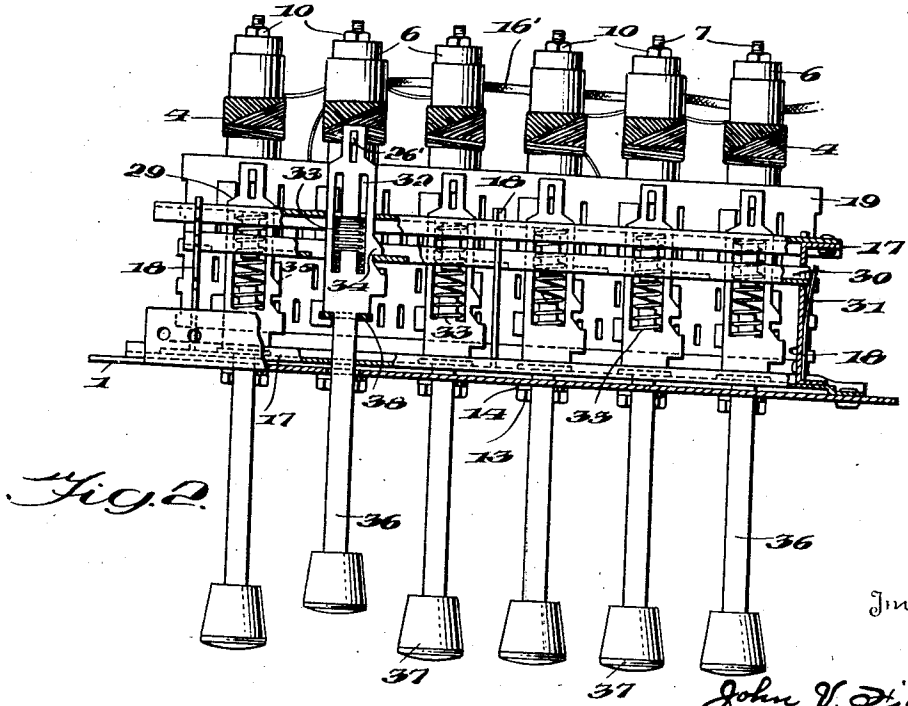


Fig. 2.

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April 25, 1944. J. V. FILL 2,347,315

RADIO RECEIVER

Filed Aug. 2, 1940 3 Sheets-Sheet 2

Fig. 3.

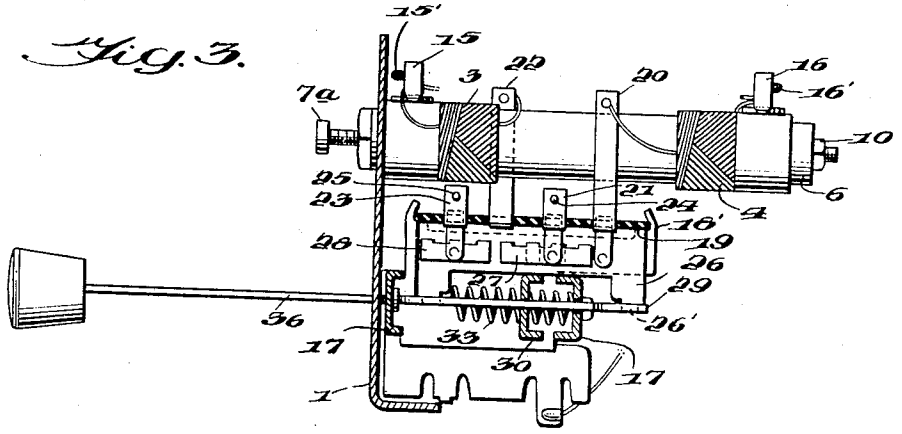
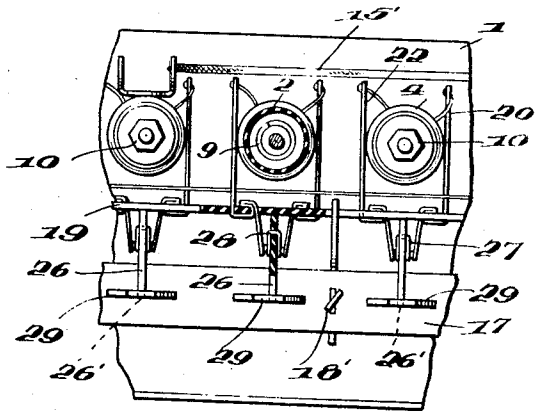


Fig. 4.



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Filed Aug. 2, 1940 3 Sheets-Sheet 3

Fig. 5.

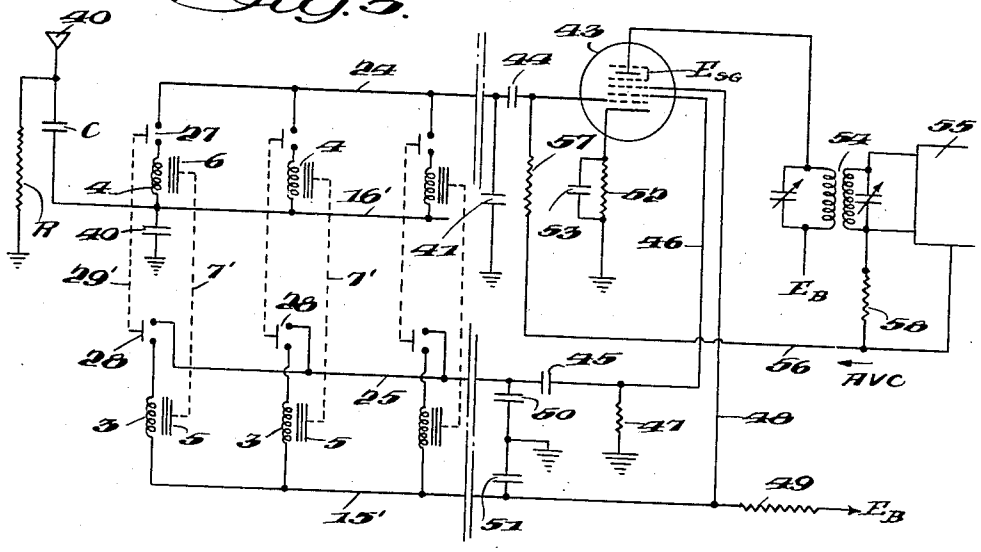
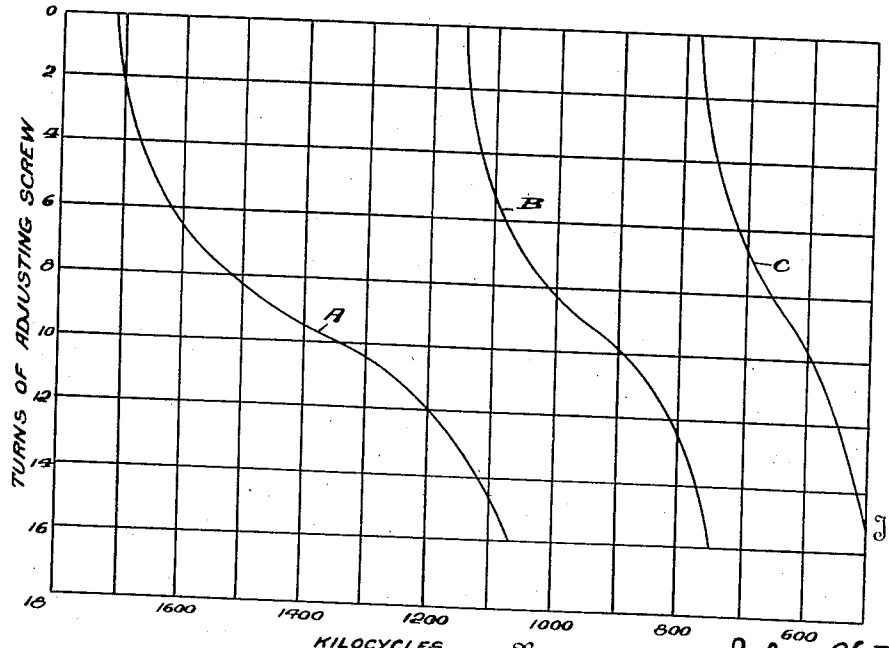


Fig. 6.



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UNITED STATES PATENT OFFICE

2,347,315

RADIO RECEIVER

John V. Fill, Dobbs Ferry, N. Y., assignor to Ferrocart Corporation of America, Hastings on Hudson, N. Y., a corporation of Delaware

Application August 2, 1940, Serial No. 349,568

1 Claim. (Cl. 250—40)

This invention relates to radio receivers of the automatic tuning type and to permeability tuned oscillator tracking circuits for use in such receivers.

One of the so-called "push button" types of radio receivers is provided with a plurality of receiving circuits that are individually tuned to different signal frequencies, and a bank of switches for selecting the desired signal frequency when the push-button corresponding to that frequency or transmitting station is depressed. Each of the receiving circuits includes both an oscillator coil and an antenna or detector coil in the case of a superheterodyne receiver, and it is obviously desirable to connect the tuning elements of the coils together to permit a single tuning adjustment for each station.

Inductances of the iron-cored type are of small size and therefore well adapted to use in an automatic radio tuner, but, prior to this invention, it was not practical to employ permeability tuning as satisfactory tracking was not obtained when both circuits were adjusted simultaneously. In accordance with this invention, satisfactory tracking for the pre-tuning to a plurality of frequencies in a relatively wide frequency band is accomplished through the use of a number of permeability tuned units that each track with substantial accuracy over a portion of the frequency band.

An object of the present invention is to provide a radio receiver, or automatic station selector for a radio receiver, that includes one or more permeability tuned units that may be adjusted by a single control, each unit including an antenna coil and an oscillator coil. An object is to provide a superheterodyne radio receiver of the automatic tuning type in which only a single antenna trimming condenser and a single set of oscillator trimming condensers are required for a plurality of permeability tuned antenna and oscillator coils. An object is to provide a superheterodyne radio receiver including a plurality of tuning units and a switch system for selecting the desired tuning unit; each tuning unit comprising an antenna coil and an oscillator coil on an insulating tube, a ferromagnetic core for each coil, and a common adjustable support for the cores, the permeability of the cores being different to maintain the desired intermediate frequency difference between the tuning of the coils when the cores are adjusted simultaneously. Other specific objects relate to the provision of simple mechanical constructions that contribute to the stability of a push-button station selector having permeability tuned oscillator tracking circuits

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a plan view, with parts in section, of a station selector assembly embodying the invention;

Fig. 2 is a bottom view of the same;

Fig. 3 is an enlarged vertical section through the selector;

Fig. 4 is an enlarged fragmentary section through one of the switches;

Fig. 5 is a fragmentary circuit diagram of a radio receiver employing the station selector of Figs. 1 and 2; and

Fig. 6 is a curve sheet showing the relation between the adjustment of the core-adjusting bolt and the tuning for different tuning units of the station selector.

In the drawings, the reference numeral 1 identifies the front plate of a station selector assembly that may be mounted on the chassis of a radio receiver. Each tuning unit comprises an insulating tube 2 on which an oscillator coil 3 and antenna coil 4 are wound or mounted in such spaced relation as to have negligible magnetic coupling. The coils are of the usual universal wound type for tuning by ferro-magnetic cores 5, 6, respectively, over the frequency range or a substantial part of the frequency range of the receiver. The particular section of the receiver range over which a tuning unit will track properly is indicated by a band of color, W, R, Y, etc. at the center portion of the tube 2. The method of determining the tracking range of a unit will be described later. A threaded adjusting rod 7 extends loosely through both cores, and an insulating bushing 8 and compression spring 9 are arranged between the cores to hold them against stop nuts 10 that are threaded upon the rod 7. A threaded metal bushing 12 is cemented into the forward end of each tube 2 and has an externally threaded outer end of reduced diameter that extends through an opening in the mounting plate 1 to receive a clamp nut 13 and lock washer 14. The outer end 7a of each adjusting rod is preferably enlarged and slotted to receive a screw driver or other tool.

Any desired number of tuning units may be provided in a station selector and, as a typical construction, an assembly of six units is shown in Figs. 1 and 2. Insulating rings carrying terminals 15, 16 are fitted upon the opposite ends of certain tubes to serve as terminals for the inner ends of

the oscillator coils 3 and antenna coils 4, and jumpers 15', 16' connect the terminals of each set to simplify the wiring of the selector into a receiver. The opposite ends of the several coils are connected to contacts of a bank of switches that is secured to the mounting plate 1.

The frame of the switch bank includes front and rear channel members 17, and transverse plates 18, 18' that connect the channels to each other and support a plate or strip 19 of insulating material. The plate 19 is provided with a large number of slots alined in four rows that extend parallel to the mounting plate 1 to receive the thin metal strips that form the fixed contacts of the switch bank. As shown in Fig. 4, each strip is folded upon itself at a central portion and the folded section is inserted through a hole of plate 19 from the bottom and one end is passed upwardly through an adjacent hole in the plate 19, the overlapping parts of the strip being then pressed tightly against the plate 19 to lock the strip in place.

The contacts 20 to 23, respectively, of the several rows, as viewed from the rear of the plate 19, are connected to the antenna coils 4, a common bus or lead 24, the oscillator coils 3 and to a common lead 25, respectively. The movable switch member for the contacts associated with each tuning unit is a plate 26 of insulating material having holes through which contact members 27, 28 are inserted and pressed in locking engagement with the plate. Extensions 26' at the front and rear edges of each plate 26 pass through slots in a switch operating plate 29 that extends through slots in the channels 17 and in a locking plate 30. The plate 30 is of channel form and slides laterally in slots in the transverse plates 18, 18' of the switch frame, the plate being urged toward the left, as seen in Fig. 2, by a leaf spring 31 that is riveted to a transverse plate 18. The rear end of each switch plate is punched out to provide a slot 32 for receiving a compression spring 33 that seats between the forward end of the switch plate and the rear channel 17, thus urging the switch plate outwardly. The right hand edge of each switch plate, Fig. 2, is provided with a locking lug 34 that is trapped behind the locking plate 30 when the plate is forced toward the rear channel 17. The edge of the locking plate in front of the lug 34 is curved or inclined to form a cam surface 35 that engages the locking plate 30 to force it toward the right. Each switch plate has an outer portion 36 of reduced width that extends through the forward channel 17 and the mounting plate 1 to receive a push button knob 37, and soft washers 38 are provided on the extensions 36 at the inner side of the channel 17 to serve as buffers when the switch plates are forced outwardly by their springs 33.

The contacts 27, 28 are secured to the insulating plates 26 of each movable member in such position as to bridge across contacts 20, 21 and 22, 23, respectively, when the switch plate 29 is forced rearwardly by pressure applied to the corresponding push button 37. This rearward movement of a switch plate 29 displaces the locking bar 30 toward the right by the cam surface 35, thus moving the locking bar out of the path of the locking lug 34 of the switch plate 29 that was previously actuated.

One satisfactory circuit arrangement of the station selector in a radio receiver is shown in Fig. 5. The circuit elements are identified by the reference numerals that are applied to the corresponding physical elements of Figs. 1 to 4, inclusive, and the mechanical connections between the cores 5, 6 of each turning unit and between the switch contacts 27, 28 are indicated by the dotted lines 7' and 29', respectively.

The antenna A is connected to ground through a resistance R of the order of 20,000 ohms, and to the jumper 16' of the tuning assembly through an isolation condenser C of the order of .01 microfarad. The resistor R has a relatively high impedance at the broadcast frequencies but it provides a path of relatively low impedance for low frequency currents and thus removes spurious voltages from the antenna. This is advantageous in localities where 60 cycle power lines may induce antenna voltages that cause cross-modulation in the first detector tube. The antenna circuit to ground is completed through the coupling condenser 40 that may have a capacity of the order of 2000 mmf., and a small fixed condenser 41 of the order of 350 mmf. is connected between the lead 24 and ground to complete the tuned circuit of the particular coil 4 that may be connected in circuit by a closure of its switch 27. The condenser 41 provides the tuning capacity for all of the antenna coils, and it is to be noted that the antenna gain will be high as there is no fixed inductance in shunt with the antenna coil of a selected station. The switch lead 24 is connected to the control grid of a multiple element tube 43 through the usual coupling condenser 44.

The switch lead 25 of the oscillator coils is connected, through a condenser 45 and lead 46 to a grid electrode of tube 43, the lead 46 being grounded through a high resistance 47. The jumper 15' or common terminal of all oscillator coils is connected to another grid electrode through a lead 48, and to a plate current source E_B through a resistor 49. A pair of condensers 50, 51 of about 350 and 500 mmf., respectively, are serially connected between the lead 25 and the jumper 15', and the junction of the condensers is grounded. The tube cathode is grounded through a resistor 52 and shunt condenser 53, and the condensers 50, 51 thus cooperate with any coil 3 that may be connected across them to form a Colpitts oscillator circuit.

The plate of tube 43 is connected through a tuned intermediate frequency transformer 54 to an amplifier stage 55 which, as is customary, may be of the type that includes means, not shown, for developing an automatic volume control voltage that is returned to the control grid of the tube 43 and to the control grids of the amplifier 55 through a lead 56 and decoupling resistors 57, 58, respectively. The volume control voltage is applied directly to the control grid of tube 43 and not through the antenna coils, thus avoiding hum modulation.

The receiver may include manually tuned circuits but such circuits form no part of the present invention and, for simplicity, are not illustrated in Fig. 5. The coils of any tuning unit may be connected into the receiver circuit by depressing the push-button 37 of that unit to shift the switch plate 29 to the rear to bridge the contact strips 27, 28 across the contacts 20, 21 and 22, 23, respectively.

Each tuning unit is designed, and is adjusted in the factory, for tuning over a portion of the tuning range of the receiver. The final adjustment of a particular unit to a station frequency can then be effected by adjusting the cores 5, 6, simultaneously, by turning the threaded bolt 7. The tracking range of a particular unit, and the number of tracking ranges, will depend upon the frequency range of the receiver. In the case of a

"broadcast" receiver for operation over the range of about 550 to 1700 kilocycles, three tracking ranges are sufficient and, in general, a six station assembly will include two tuning units for each range.

The cores 6 of the antenna coils of all units have the highest permeability that can be obtained in practical commercial manufacture, as the range over which the carrier frequency may be adjusted by displacement of the cores increases with the permeability of the cores. The tracking range of a particular unit depends upon the permeability of the core 5 of the oscillator coil 3 and, in general, the permeability of an oscillator coil core 5 is less than that of the core 6 of the antenna coil and decreases with the width of the frequency band over which the unit is to "track." The tracking range of a unit for use at the higher end of the receiver frequency range has a greater frequency spread than a unit for tracking at the low end of the frequency range, and the oscillator core for the highest tracking range therefore is given a higher permeability than that of cores 5 for lower tracking ranges. The following data is indicative of permeability values that were satisfactory in a broadcast band receiver. The cores 6 of the antenna coils of all units had a permeability, when measured in a particular coil, of about 2.0, while the "yellow" units for tracking at the high end of the frequency band had cores 5 with a permeability of about 1.3, the "red" units for covering the intermediate tracking band had oscillator cores with a permeability of about 1.5, and the "white" units for the lowest frequency tracking range had oscillator cores 5 with a permeability of the order of 1.3.

In the factory adjustment of each tuning unit, the spacing nuts 10 are adjusted to obtain that spacing of cores 5 and 6 which tunes the antenna and oscillator coils accurately to obtain the desired beat frequency at a given signal frequency within the tracking range of that unit. As noted above, the tracking range of each unit is indicated by a color code marking on the insulating tube 2. The station selector is then assembled with the desired number of tuning units of each tracking range.

The final adjustment of the station selector is made by adjusting the threaded rods 7 of the several units to tune to the particular stations that are preferred by the customer. The tracking will not be perfect over the entire range, as it is not possible to maintain a fixed difference between the resonant frequencies of the two coils when the cores are adjusted simultaneously, but the departure from perfect tracking is not objectionable within the tracking range for which each unit is designed.

The curves A, B and C of Fig. 6 show the relation between signal frequency and turns of the adjusting rod 7 for tuning units designed for tracking at the high and, an intermediate section and the low end of the receiver frequency range. These curves show the actual antenna coil or received carrier frequency and the oscillator coil frequency was 456 kilocycles higher within a preselected tolerance range of not more than 7 kilocycles mistracking of the circuits. A tracking accuracy of this order corresponds to a deviation of 6 decibels or a sensitivity ratio of 2 to 1.

The specific physical structure of the coils, cores and supporting structure may of course be varied but it is convenient to employ coils and cores of conventional design and size. The cores may be of ⅜" diameter and ½" long, and the coils may be spaced about 1¼" on a paper tube. The factory adjustment of the units could be effected by sliding one coil upon the tube 2 when the cores are spaced at a fixed distance from each other. An additional radio frequency coil 4 and core 6 could be included in each tuning range when an amplifier stage is to be provided between the antenna and the first detector.

It is to be understood that the invention is not limited to the specific constructions herein shown and described, and that various changes may be made in the design and assembly of the component parts without departing from the spirit of the invention as set forth in the following claim.

I claim:

In a tuning device for a superheterodyne radio receiver, a station selector comprising a mounting plate, a plurality of tuning units carried by said plate; each tuning unit including a tube carrying an antenna coil and an oscillator coil in spaced relation, a ferromagnetic core for each coil, and means connecting said cores to each other for simultaneous adjustment; and a switch assembly including a frame secured to said mounting plate, a plate of insulating material on said frame and extending along said tuning units, sets of switch terminals carried by said plate of insulating material adjacent each tuning unit, a switch plate for each tuning unit, said switch plates extending through said frame and being guided thereby for reciprocating movement, an insulating strip mounted on each switch plate and carrying contacts for engagement with one set of switch terminals, and connections between the coils of each tuning unit and certain terminals of the set of switch terminals adjacent that unit.

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