

March 29, 1938.

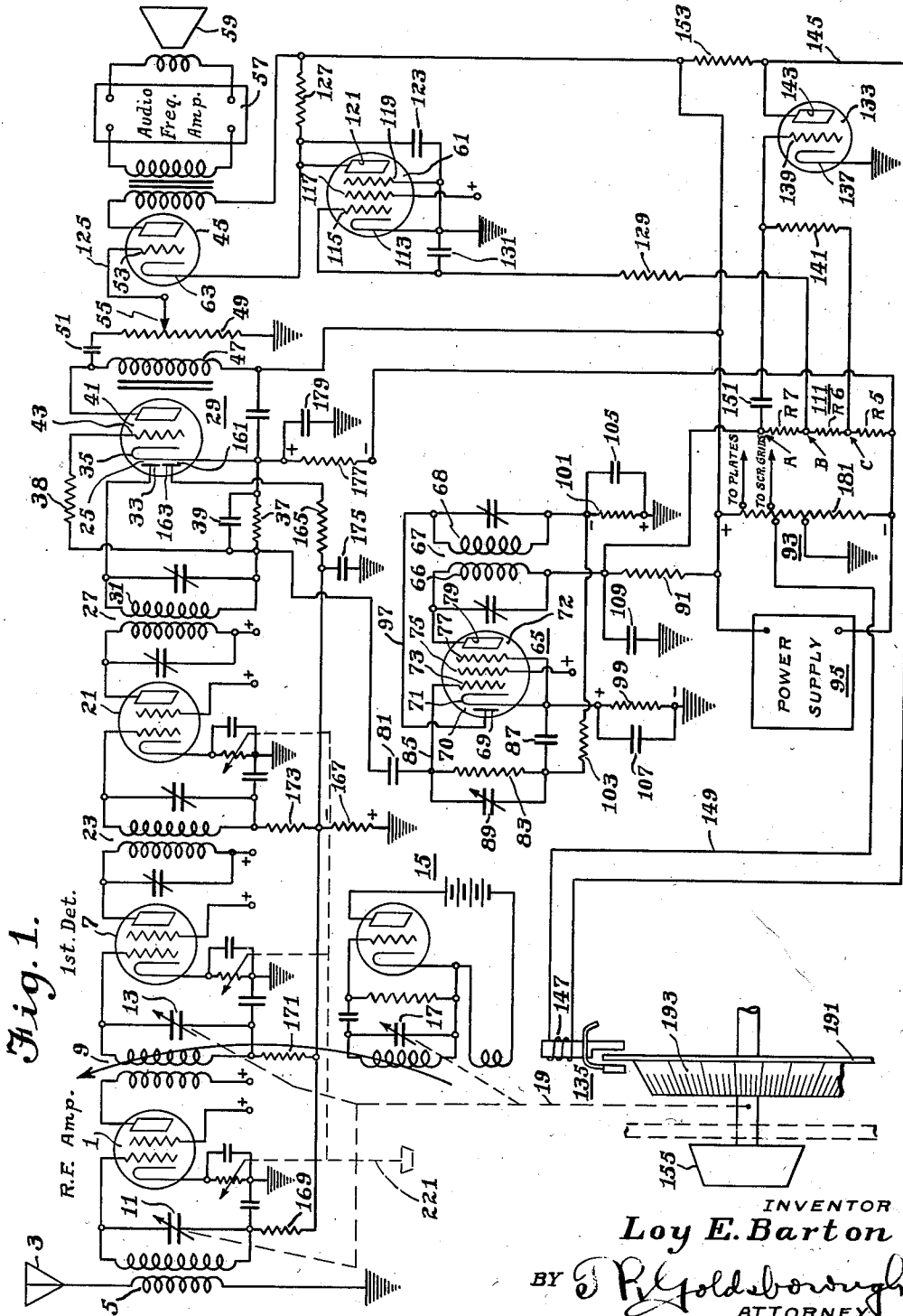
L. E. BARTON

2,112,686

RADIO RECEIVER

Filed Dec. 1, 1933

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Fig. 2.

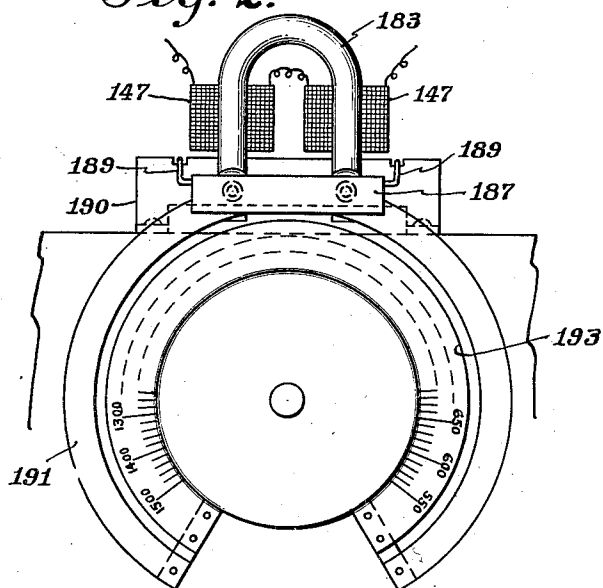


Fig. 3.

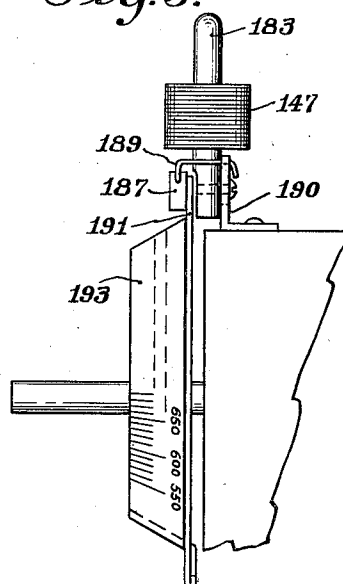
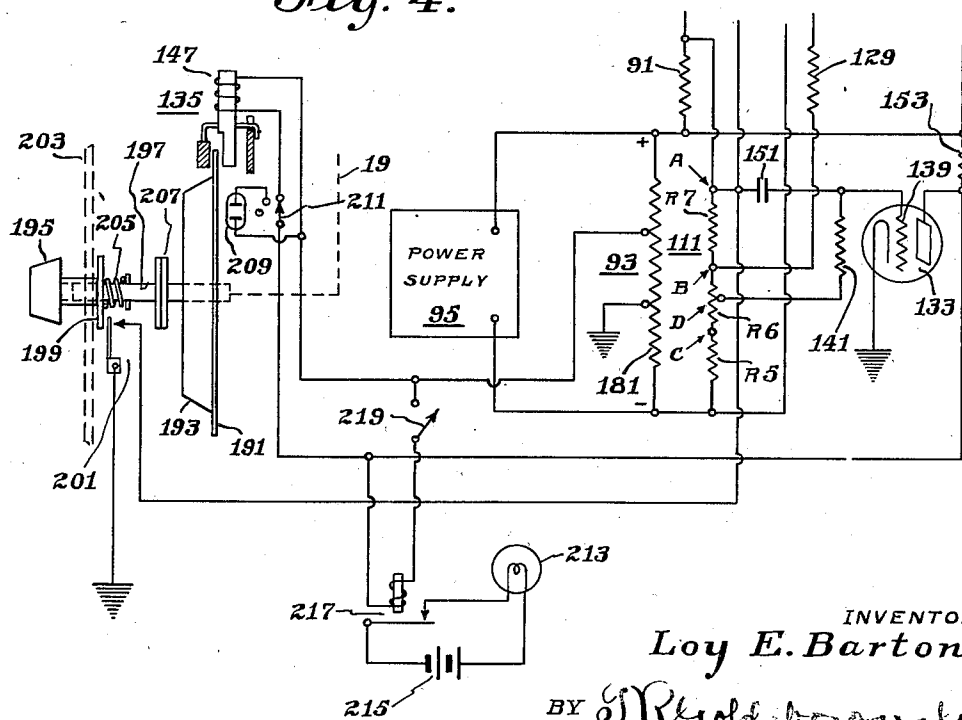


Fig. 4.



INVENTOR
Loy E. Barton

BY *W. R. Goldborough*
ATTORNEY

UNITED STATES PATENT OFFICE

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RADIO RECEIVER

Loy E. Barton, Collingswood, N. J., assignor to
Radio Corporation of America, a corporation of
Delaware

Application December 1, 1933, Serial No. 700,471

16 Claims. (Cl. 250—20)

The present invention relates to radio receivers and particularly to tuning control devices and circuits therefor.

5 An objectionable feature of present high quality radio receivers is that they are so selective that they are somewhat difficult to tune. Furthermore, it is a recognized fact that it is desirable to make the tuning of radio receivers still more exact, preferably by means of a very sharp
10 noise suppressor circuit, the noise suppressor circuit serving both for eliminating "background" noise when tuning between stations and for insuring the proper tuning of the receiver. The selectivity provided by a noise suppressor may be
15 referred to as the "apparent" selectivity since a noise suppressor increases only the sharpness of tuning and does not increase the selectivity of the signal channel.

20 The advantage which is obtained by increasing the apparent selectivity of the receiver is usually offset, however, by the fact that the tuning becomes very critical, and it becomes difficult for the average person to stop the tuning control at the proper tuning point, the proper tuning point
25 being both the correct position for tuning in a signal without distortion and the correct position for releasing the noise suppressor so that the signal is heard.

30 It is, accordingly, an object of my invention to provide a tuning device for radio receivers which will make them less difficult to tune than when they are equipped with a conventional tuning control device.

35 It is a further object of my invention to provide improved tuning means for preventing a radio receiver from being tuned inaccurately during the reception of a signal.

40 More specifically it is an object of my invention to provide automatic tuning control means which permits a sharply tuned radio receiver to be tuned easily to the exact station position.

45 It is a still further object of my invention to provide a radio receiver which may be tuned exactly to an incoming signal without the aid of either sight or hearing, and without preselecting the stations.

50 A still further object of my invention is to provide a radio receiver having an improved indicating device which will indicate when the receiver is tuned exactly to the carrier frequency of an incoming radio signal whereby distortion of the signal due to inaccurate tuning is avoided.

55 In practicing my invention, in one embodiment thereof I provide a superheterodyne receiver with a very sharp noise suppressor circuit and with an

automatic volume control circuit so connected that it prevents the signal input to the noise suppressor from exceeding a predetermined value. The tuning control device of the receiver is provided with a magnetic brake which is controlled
5 by the noise suppressor circuit. When the receiver is tuned exactly to an incoming signal, the noise suppressor circuit functions to permit the signal to pass through the receiver and to energize the magnetic brake, whereby the tuning control device is instantly locked in the correct tuning position.
10

Before the receiver is tuned to another station position, the magnetic brake must be released. This may be accomplished by means of a release
15 circuit which may be closed by some predetermined movement of the tuning knob, such as an axial movement toward the panel of the receiver, or the brake may be released by means of a circuit which automatically de-energizes the brake
20 after it has been energized a predetermined length of time.

Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying
25 drawings in which

Figure 1 is a circuit and schematic diagram of one embodiment of my invention;

Fig. 2 is a front view of the tuning dial and magnetic brake shown in Fig. 1;

Fig. 3 is a side view of the structure shown in Fig. 2; and

Fig. 4 is a view illustrating a modified form of my invention.

Referring to Fig. 1, an embodiment of my invention is shown applied to a superheterodyne receiver which comprises a radio frequency amplifier 1 having an input circuit coupled to an antenna 3 through a radio frequency transformer 5. The output circuit of the amplifier 1 is coupled
40 to a first detector 7 through a radio frequency transformer 9.

The secondary windings of the transformers 5 and 9 have variable tuning condensers 11 and 13, respectively, connected thereacross in the usual
45 manner, for tuning the input circuits of the amplifier 1 and first detector 7 to the desired incoming signal.

50 An oscillator 15 is coupled to the first detector 7 for the purpose of heterodyning an incoming signal to a lower intermediate frequency signal. The frequency of the oscillator output may be varied by means of a variable tuning condenser 17.

55 The tuning condensers 11, 13, and 17 are pref-

erably units of a gang condenser, and may be varied simultaneously through a common tuning control indicated by a dotted line 19.

The intermediate frequency output of the first detector is impressed upon the input circuit of an intermediate frequency amplifier 21 through an intermediate frequency transformer 23, the primary and secondary of which are tuned to make the transformer function as a band-pass filter having a pass range of sufficient width to pass the intermediate frequency carrier and at least one signal side band.

It will be understood, of course, that the tuned radio frequency circuits of the amplifier 1 and detector 7 are also tuned broadly enough to pass the carrier of the incoming radio signal and at least one of its side bands.

The output of the intermediate frequency amplifier 21 is fed to the second detector 25 through an intermediate frequency transformer 27 tuned in the same manner as the preceding transformer 23.

In the particular embodiment illustrated, the second detector 25 is a diode rectifier which is one unit of a double diode-triode vacuum tube 29.

One terminal of the secondary 31 of transformer 27 is connected to the detector diode plate 33, while the other terminal of the secondary 31 is connected to the cathode 35 through a resistor 37, the resistor being shunted by means of an intermediate frequency bypass condenser 39.

The triode section 41 of the vacuum tube 29 functions as the first audio frequency amplifier. Its control grid 43 is connected to the plate end of the resistor 37, whereby any audio signal appearing across the resistor 37 is impressed across the input of the triode section and an amplified audio signal appears in the plate circuit thereof. A resistor 38 reduces the intermediate frequency voltage that may otherwise get to the grid 43.

The amplified audio signal is impressed upon the input circuit of another audio frequency amplifier stage comprising an electric discharge device such as a vacuum tube 45. The signal is impressed upon said input circuit through a coupling system which, in the embodiment shown, includes an audio frequency choke coil 47 in the plate circuit of the triode section 41. The upper end of the choke coil 47 is coupled to a volume control resistor 49 through a coupling condenser 51, the lower end of the resistor being connected to ground. The potentiometer 49 may be tapped to obtain the usual compensation of audio frequency signals at various volume levels.

The control grid 53 of the amplifier 45 is connected to the volume control resistor 49 through a variable volume control tap 55.

The output of the amplifier 45 may be further amplified by any suitable audio frequency amplifier, generally indicated at 57, and supplied to a loudspeaker 59.

It will be noted that the input circuit of the audio frequency amplifier 45 includes an electric discharge device 61 which may be a vacuum tube of the pentode type. The cathode-anode circuit of the tube 61 is connected between the cathode 63 of tube 45 and ground to function as a self-biasing resistor which may be given a very high resistance to block the amplifier tube 45 when tuning between stations. In other words, the tube 61 applies noise suppressor control to the audio frequency amplifier tube 45 by functioning as a self-biasing resistor. This feature of my invention is described and claimed in my Patent

2,028,859 assigned to the same assignee as this application.

The noise suppressor control is obtained, in the preferred circuit, through a diode-pentode vacuum tube 65 which is coupled to a transformer 67 sharply tuned to the intermediate frequency. As will be explained hereinafter, the tube 65 also functions to control the automatic tuning circuit.

The tube 65 comprises a diode section 70 consisting of a diode plate 69 and a cathode 71, and a pentode section 72 consisting of the cathode 71, a control grid 73, a screen grid 75, a suppressor grid 77, and an anode 79.

The input circuit of the pentode section 72 is coupled to the resistor 37 in any suitable manner for impressing the low intermediate frequency voltage drop of the resistor across the pentode amplifier input circuit. In the drawings, this coupling device is shown as a small coupling condenser 81, having a comparatively low impedance to signals at the intermediate frequency, but having an impedance to audio frequency signals sufficient to prevent appreciable audio signal being applied to the control grid 73.

A coupling resistor 83 is provided which is connected at one end to the control grid 73 through a conductor 85, and connected at the other end to the cathode 71 through an audio-frequency bypass condenser 87. The coupling resistor 83 is shunted by a variable condenser 89 which may be adjusted for the purpose of controlling the input voltage to the pentode amplifier 72.

The plate circuit of the pentode section 72 includes the primary winding 66 of the transformer 67 and a resistor 91, the primary winding and the resistor being connected in series, and the lower end of the resistor being connected to a positive point on the voltage divider 93 of the power supply 95.

The secondary winding 68 of the transformer 67 is loosely coupled to the primary winding 66, and both the primary and the secondary are tuned so that the transformer is tuned very sharply to the intermediate frequency.

The amplified intermediate frequency output of the pentode section 72 is transferred through the sharply tuned transformer 67 and impressed upon the elements 69 and 71 of the diode rectifier through a conductor 97 which connects the diode plate 69 to one terminal of the secondary winding 68, and through a connection from the cathode 71 to the other terminal of the secondary 68, which may be traced from the cathode 71 through a self biasing resistor 99 to ground, through ground to the lower terminal of a resistor 101, (which may have a resistance of the order of one megohm), and through the resistor 101 to the said other terminal of the secondary 68.

The sole function of the diode rectifier 70 is to increase the negative bias on the control grid 73 of the pentode section upon reception of a radio signal. Since a flow of current through the diode rectifier 70 causes the upper end of the resistor 101 to become negative, the control grid 73 also becomes more negative because of its connection to the negative end of the resistor 101 through a high impedance resistor 103.

Obviously an audio frequency signal will appear in the circuit of rectifier 70 which should not be impressed upon the control grid 73 of the pentode section. This is prevented by the audio frequency bypass condenser 87.

It will be noted that the self biasing resistor 99, the resistor 101, and the plate resistor 91 are

shunted by the usual intermediate frequency bypass condensers 107, 105, and 109, respectively.

It will be apparent from the foregoing description that as soon as an intermediate frequency signal is impressed upon the input circuit of the pentode amplifier 72, the control grid 73 of that amplifier will become more negative because of the current flow through the circuit of the diode 70.

It may be noted that the change in bias on the control grid 73 depends, to a certain extent, upon the voltage drop produced in the self-biasing resistor 99, since this voltage drop is in series with the voltage drop along the resistor of the diode circuit. That these voltage drops are in series will be made evident by tracing the direct current path of the pentode section input circuit. It may be traced from the control grid 73 through the resistor 83, the high impedance resistor 103, through the diode circuit resistor 101 to ground, through ground to the self-biasing resistor 99, and through the self-biasing resistor 99 to cathode 71.

When there is no incoming signal, the plate current of the pentode amplifier portion 72 is large, since the only negative bias on the control grid 73 is that due to the self-biasing resistor 99, and this negative bias is comparatively small. Consequently there is a large voltage drop in the plate resistor 91, whereby the upper end of the resistor 91 is at a fairly high negative potential with respect to the upper end of the voltage divider 93. Also, the gain of amplifier 72 is low because of the low voltage on its anode 79.

As soon as the receiver is tuned to an incoming carrier wave, amplifier 72 supplies signal energy to the diode 70, the voltage drop in the diode circuit resistor 101 increases the negative bias on the control grid 73, whereby the plate current of amplifier 72 decreases and the upper end of the plate resistor 91 becomes less negative and the voltage applied to anode 79 is increased. It is the potential at this end of the plate resistor 91 which is utilized for actuating both the noise suppressor and the automatic tuning control, this point in the circuit being identified as point A on the drawings.

It should be noted that although the decrease in plate current tends to cause a reduction in the biasing voltage in the self-biasing resistor 99, the increased negative bias provided by the current flow through the diode circuit is much greater than any decrease in bias due to reduction in plate current.

The above described action of the diode-pentode circuit whereby the upper end of plate resistor 91 becomes less negative in response to reception of a radio signal is preferably made a "trigger" action by giving plate resistor 91 a proper resistance value. This "trigger" action depends upon the fact that the increase in gain caused by the increase in the plate voltage is greater than the decrease in gain caused by the increase in negative bias on the grid until a more or less definite bias is reached. In practice, a tube of the type known as RCA 2B7 has been found satisfactory for use as the tube 65.

A trigger amplifier employing a resistor in the plate circuit of a pentode tube is described and claimed in my co-pending application Serial No. 704,510, filed December 29, 1933, and assigned to the same assignee as this application.

In order to provide the proper control voltage for the noise suppressor biasing tube 61

and for the magnetic brake control circuit, which is described hereinafter, a potentiometer 111 is connected between the upper end of the plate resistor 91 and the negative end of the voltage divider 93. This potentiometer consists of three resistor sections, R5, R6, and R7, the sections R5 and R7 having a high resistance value which may be of the order of one megohm, while the resistor section R6 preferably has a lower value of the order of 100,000 ohms.

Referring now more specifically to the biasing tube 61, it has a cathode 113, a control grid 115, a screen grid 117, a suppressor grid 119, and an anode 121.

The anode 121 is connected to the cathode 63 of the audio frequency amplifier 45, while the cathode 113 is connected to ground, and through ground to the lower end of the volume control resistor 49. An audio frequency bypass condenser 123 (preferably having a capacity of from 4 to 8 microfarads) is connected between the cathode 113 and anode 121 for bypassing the audio frequency signal around the plate impedance of the tube 61. Thus it will be seen that the plate impedance of the tube 61 is connected in the cathode circuit of the audio frequency amplifier 45 to act as a self-biasing resistor, while the audio frequency signal appearing across the volume control resistor 49 is impressed upon the input circuit of the audio frequency amplifier 45 through the conductor 125 and through ground and the bypass condenser 123.

The anode 121 of the tube 61 preferably is connected to a positive point on the voltage divider 93 through a resistor 127 which may have a value of from one-fourth to one megohm. This resistor serves to maintain a high anode to cathode voltage when the tube 45 is blocked because of any leakage current taken by tube 61. The effect of the use of resistor 127 in the circuit is to make the noise suppressor more rapid and positive in operation.

When there is no incoming signal, the plate impedance of the biasing tube 61 is maintained at a very high value by means of the control grid 115 which has a high negative potential sufficient to block the tube. This high negative grid potential is obtained by connecting the control grid 115 to the lower end of the resistor R7, preferably through a resistor 129, this end of resistor R7 being identified as point B. Resistor 129 may be given a value of approximately one-half megohm.

The negative voltage applied to the control grid 115 from the point B is not critical in value, approximately 20 volts on the grid, with no incoming signal, having been found satisfactory when employing an RCA 57 tube as the tube 61.

Point B is given the desired negative voltage with respect to ground, the above-mentioned 20 volts, for example, by the proper selection of the resistor values of the potentiometer 111. In order to understand the operation of the circuit more clearly, specific voltage values for the voltage divider 93, the plate resistor 91, and the potentiometer 111 will be given.

In one specific embodiment, the voltage divider 93 is connected to ground at such a point intermediate its ends that the lower end of the voltage divider is 150 volts negative with respect to ground, while the upper end of the voltage divider is 250 volts positive with respect to ground. With no incoming signal, and a plate resistor 91 having a value of from 50,000 to 100,000 ohms, the plate current of the pentode produces a

voltage drop in the plate resistor 91 of sufficient magnitude to make the upper end of the resistor 91 and potentiometer 111 (identified as point A) 25 to 50 volts positive with respect to ground. The point B is then approximately 20 volts negative with respect to ground, and the upper end of resistor R5 (identified as point C) is still more negative with respect to ground.

Thus, with no incoming signal, a constant biasing voltage is applied from the point B to the control grid 115 of the biasing tube 61, a bypass condenser 131 being connected between the control grid 115 and the cathode 113 for preventing audio frequency voltages or other ripple voltages from being applied to the grid.

The biasing voltage applied to the control grid 115 when there is no signal input is sufficient to block the tube 61, thereby making its plate resistance so high that the audio frequency amplifier tube 45 is likewise blocked. The blocking potential applied to tube 45 may become as high as 80 volts, this being much higher than necessary to block a tube such as an RCA56 which has been found satisfactory for use with the RCA57.

When the receiver is tuned exactly to an incoming signal, an intermediate frequency voltage is impressed upon the input circuit of the pentode section 72, whereby the voltage drop in the plate resistor 91 is decreased in value, causing the point B to assume a value sufficiently less negative to unblock the biasing tube 61 and greatly lower its plate impedance. This causes a normal biasing voltage to be applied to the grid 53 and the audio frequency amplifier 45 is immediately changed to its normal condition for an amplifier.

It should be noted that in case the point B becomes positive with respect to ground, it will cause grid current to flow through the resistor 129 so that the grid 115 will be maintained at substantially zero bias.

As fully explained in my above-mentioned patent, the characteristics of the pentode 61 are such that the plate impedance of the tube remains substantially constant within the range of voltage applied to the control grid during the time the amplifier 45 is effective. This range of voltages is determined by the adjustment of the "trigger" amplifier 65. In a preferred adjustment the potential of point B is changed instantly from approximately 20 volts negative to about 3 volts negative upon reception of a signal.

Further slight voltage changes may be caused by variations in the strength of an incoming signal but they will not cause changes in the impedance of tube 61. For example, if the tube 61 is an RCA57, its plate impedance will remain substantially constant for control grid voltages ranging from about 4 volts negative to zero and, since the variation in plate voltage of tube 65 is much greater than is necessary for the control of grid 115, considerable variation in signal may take place without affecting the bias on tube 45.

The above-described circuit may be made so selective that it is an impractical circuit to employ if the receiver is to be tuned in the ordinary way. To overcome this difficulty and also to increase the ease of tuning, even when the receiver is not unusually selective, I provide a tuning control circuit which includes a control tube 133 and a magnetic brake 135.

The control tube 133 includes a cathode 137 which is connected to ground, a control grid 139

which is connected to the upper end of the resistor R5 through a grid leak resistor 141 (which may have a resistance of the order of one megohm), and an anode 143 which is connected through a conductor 145, the magnet coil 147 of the brake 135, and a conductor 149 to a positive point on the voltage divider 93. The control grid 139 is also connected to the point A through a condenser 151 which may have a value of approximately 0.1 microfarad.

So long as no signal is being received, as when the receiver is tuned between stations, the point C applies a negative potential to the control grid 139 which is sufficient to block the tube 133 so that there is no plate current flow through the brake winding 147, and the brake 135 is de-energized.

There is, however, a small flow of current through the magnet winding 147, which flows in a direction opposite to the flow of plate current, for the purpose of removing residual magnetism from the brake after it is de-energized. This flow of current may be traced from the positive end of the voltage divider 93, through a resistor 153 (which may have a resistance of the order of 100,000 ohms) to the conductor 145, and through the magnet winding 147 and the conductor 149 to the positive point on the voltage divider 93.

The instant the receiver is tuned to the carrier wave of an incoming signal, the voltage applied to the control grid 139 of the brake control tube 133 is changed. If it is changed sufficiently, plate current flows through the magnet coil 147 of the brake 135 and the brake is instantly energized, thereby clamping the rotors of the tuning condenser 11, 13, and 17, and the tuning knob 155, in the exact position at which the signal is properly tuned in.

In the apparatus illustrated in Fig. 1 the control grid of the brake control tube 133 is so connected to the potentiometer 111 that the brake 135 is automatically released a predetermined length of time after it has been energized. When employing this automatic release circuit the receiver is tuned by rotating the tuning knob 155 rather slowly in case it is desired to tune in the next incoming signal.

As soon as the receiver is tuned in this manner to the carrier of the next incoming signal, the potential of the point A becomes more positive, and this more positive potential is transferred through the condenser 151 to the control grid 139 of the tube 133. The comparatively slow rotation of the tuning knob 155 gives sufficient time for the control grid 139 to assume a potential such that plate current flows through the magnet coil 147 and the brake is energized. This locks the tuning condensers 11, 13, and 17 securely in position, and the operator's fingers may slip on the tuning knob if further rotation is attempted. After an instant (one half to two seconds), the grid 139 again assumes the potential of the point C which is sufficiently negative to block the tube 133 even when there is an incoming signal. This releases the brake 135, and the receiver may be tuned to the next station in the same manner.

If it is desired to tune through one or more stations without having the brake operate, the tuning knob is rotated more rapidly so that the potential at A cannot increase appreciably because of the condenser 109 and the control grid 139 does not acquire the necessary more positive

potential for operating the brake each time the receiver is tuned to a carrier wave.

It will be understood that, in general, the band pass filters 23 and 27 will be designed to pass the intermediate frequency carrier and the upper and lower side bands, the pass range of each filter being made so narrow for selectivity purposes that the intermediate frequency carrier must fall at the mid-point of the pass range in order to avoid the cutting off of a side band. It is essential, therefore, that the receiver be tuned accurately to an incoming signal so that the intermediate frequency carrier falls at the proper point in the pass range of the filters, as otherwise the quality of the received signal will be impaired. If the transformer 67 in the output circuit of tube 65 is tuned sharply enough to the intermediate frequency, the magnetic brake 135 will be operated only when the receiver is tuned in accordance with the above requirements for high quality reception.

In practice, it is found both difficult and expensive to provide a control circuit for the magnetic brake which is so sharp that the selectivity of the circuit is itself sufficient to prevent the magnetic brake from being operated too soon if strong signals are impressed upon the control circuit. This will readily be understood since the brake is operated when the plate current of tube 65 reaches a predetermined value. If signals of varying strength are impressed upon the input circuit of tube 65, a very strong signal at a frequency on one side of the resonant curve for the transformer 67 might produce the same plate current flow as a weaker signal at the intermediate frequency which is located at the middle or peak of the resonant curve.

It has been found that the magnetic brake 135 may be made to operate at the proper time when employing a control circuit having reasonably sharp selectivity if the strength of all signals applied to the control circuit is held substantially uniform. A convenient way of accomplishing this is to provide the receiver with an automatic volume control circuit or AVC circuit which is applied to the portion of the receiver preceding the point supplying voltage to the brake control circuit.

While various forms of automatic volume control may be utilized, the circuit illustrated in the drawings is simple and effective in operation. The AVC circuit includes one of the diode rectifiers 161 of the vacuum tube 29, this diode comprising the cathode 35 and a plate 163. The plate 163 is connected through a filter resistor 165 and a volume control resistor 167 to ground. The junction point of the resistors 165 and 167 is connected to the control grids of the tubes 1, 7 and 21 through resistors 169, 171, and 173, respectively. A filter condenser 175 is connected between the grid end of the filter resistor 165 and ground.

The cathode 35 is connected to the negative end of the voltage divider 93 through a cathode resistor 177. This resistor is bypassed by means of an audio frequency bypass condenser 179.

The operation of the AVC circuit is as follows: Assuming that a strong signal is being received, there is then maximum flow of current through the second detector resistor 37 and the control grid 43 is at a rather high negative potential, whereby the plate current of tube 29 is small and there is a small voltage drop in the cathode resistor 177. Therefore, a large part of the voltage across the lower section 181 of the voltage

divider 93 is impressed upon the diode rectifier 161. This will be seen by noting that the grounded point of the voltage divider 93 is connected to the plate 163 of the diode rectifier 161 through ground and through the volume control resistor 167, this grounded point being positive with respect to the cathode 35. The voltage across the voltage divider section 181 is large compared with the voltage drop in the volume control resistor 177 under the conditions assumed, so that although the two voltages are in opposition, the greater part of the voltage across the voltage divider section 181 is applied to the rectifier 161.

This results in a comparatively large flow of current through the resistor 167, with the result that the voltage drop in resistor 167 maintains the control grids of the tubes 1, 7, and 21 highly negative with respect to their cathodes, whereby their gain is held at a low value.

If the strength of the received signal becomes less, the control grid 43 becomes less negative, the plate current and the voltage drop in the resistor 177 increase, and a lower voltage is impressed across the rectifier 161. As a result, the current flow through the volume control resistor 167 decreases and the control grids of the tubes 1, 7, and 21 become less negative, whereby the gain of the receiver is increased to bring up the signal strength.

From the above description it will be apparent that the output of the transformer 27 remains substantially constant in amplitude so that signals of uniform amplitude are applied to the brake control circuit whereby it will function uniformly regardless of the strength of incoming signals. Thus, the tuning condensers will never be stopped by the brake before they have been rotated to the proper position.

The above described automatic volume control circuit is described and claimed in my application Serial No. 640,946, filed November 3, 1932, and assigned to the same assignee as this application.

While various forms of magnetically operated brakes may be employed in my automatic tuning circuit, the brake 135 shown in detail in Figs. 2 and 3, has been found to be especially effective. It comprises a U-shaped core 183 of magnetic material having a pair of magnet windings 147 on the legs of the core. The ends of the core legs are flattened on one side to permit their use as a braking surface.

A flat bar 187 of magnetic material is mounted opposite the flat surfaces of the core legs by means of hinge supporting members 189 which permit the bar or armature 187 to rest against a disc segment 191. The supporting members 189 may be supported from a bar 190 of non-magnetic material secured to the core 183.

The disc segment 191 is fastened to the shaft of the tuning condensers with the edge thereof positioned between the flat surface of the magnet core 183 and the armature 187. In a preferred embodiment, the disc segment 191 is mounted upon the tuning dial 193 at the outer edge of the dial. This disc segment 191 is preferably made of magnetic material in order to increase the effectiveness of the brake.

An inspection of Fig. 3 will show that the air gaps in the brake's magnetic circuit are very short so that the reluctance of the circuit is low, and the brake very efficient.

Referring to Fig. 4, there is shown a manually operable release for the magnetic brake 135, this release being actuated by pushing in on a tuning

knob 195. In Figs. 1 and 4, like parts are indicated by the same reference numerals. In the circuit shown in Fig. 4, the control grid 139 of the tube 133 is connected to a point D on the potentiometer 111 which is sufficiently less negative than the point C to permit the control grid 139 becoming positive, or nearly so, upon the reception of an incoming signal whereby tube 133 is unblocked and the brake is energized.

It will generally be desirable to have the tube 133 and the biasing tube 61 start drawing plate current at the same time. Therefore, the point on the potentiometer 111 to which the control grid 139 should be connected depends upon the relative characteristics of the two vacuum tubes. If the tube 133 were the same type as the tube 61, the control grid 139 preferably would be connected to the same point as the control grid of tube 61, that is, to the point B.

Although the condenser 151 has been shown in connection with the manual brake release, it may be omitted if desired. Its use, however, will cause the magnetic brake to respond somewhat more rapidly to the reception of an incoming signal than it would otherwise since the increasing potential of point A will be applied momentarily to the grid 139.

The tuning knob 195 of the receiver is slidably mounted upon a shaft 197 in non-rotatable relation therewith, and provided with a flange 199 for actuating a switch 201 when the tuning knob is pushed in. The tuning knob is normally held pushed out away from the panel of the receiver, indicated in dotted lines at 203, by means of a spring 205 as indicated in the drawings.

The tuning knob shaft 197 may be connected directly to the tuning dial and tuning condenser shaft, or it may be connected thereto through a friction drive. In the drawings, the two shafts are shown mechanically connected through a friction clutch 207, comprising two friction plates which are held against each other in any suitable manner.

In tuning the receiver, the tuning knob 195 is rotated while it is in the "out" position indicated in Fig. 4. As soon as the receiver is tuned to an incoming signal, the bias on the control grid 139 is so reduced in value that plate current flows through the magnetic brake 135 and the tuning condensers are locked in position. Any further rotation of the tuning knob 195 will cause the friction clutch 207 to slip and the tuning of the receiver will not be changed.

In order to tune the receiver to the next incoming signal, the tuning knob is pushed in to close the switch 201. This places a high negative potential on the control grid 139, thereby blocking the tube 133 and releasing the brake 135. The tuning knob 195 is then rotated far enough to tune the receiver away from the station that was being received, which action will cause the point D to become sufficiently negative to block the tube 133. The tuning knob is then permitted to move back to its original position away from the panel 203, thereby opening the switch 201 and bringing the receiver to its former condition. By further rotation of the tuning knob, the next incoming signal may be tuned in, thus causing the brake to be energized again.

If desired, a lamp may be substituted for the magnetic brake as a device for indicating when the receiver is tuned exactly to the desired radio station. For example, a neon lamp 209 may be supported in the rear of the tuning dial 193, as shown in Fig. 4, and so connected that it may be

included in the plate circuit of tube 133 by moving a switch arm 211 to its middle position.

It will be noted that when the switch arm 211 is in the middle position, the magnetic brake 135 is disconnected so that it cannot operate. Therefore, the release switch 201 has no function where the lamp alone is used. In tuning the receiver, the receiver is tuned until the lamp 209 lights up, thus showing that the receiver is accurately tuned to an incoming signal.

In one form of my invention, the lamp 209 may be used as described above with the noise suppressor omitted. In this form, the signal may be heard before the receiver is tuned to the point where the signal is undistorted but the operator will know that the receiver is not properly tuned unless the lamp has become lighted. The main feature of a receiver designed in this manner is that the circuit which controls the lamp 209 is sharply tuned to the intermediate frequency and, therefore, is much more sharply tuned than the signal channel.

If preferred, a signal lamp may be employed in combination with the magnetic brake. Thus a lamp 213 is positioned behind the tuning dial 193 or in any other suitable location and provided with any suitable source of current, such as a battery 215. A relay 217 may be connected in the plate circuit of tube 133 by closing a switch 219. When the receiver is tuned exactly to an incoming signal, the relay 217 is actuated and the lamp 213 is lighted.

In some cases, and particularly where the release mechanism of Fig. 4 is employed, it may be preferred to have the radio receiver respond to strong incoming signals only, such as those of local stations, whereby the brake will be actuated by a comparatively small number of radio stations. This result can be obtained by providing any suitable form of sensitivity control for the receiver. In the circuit shown in Fig. 1, such a control is provided by making the self-biasing resistors of tubes 1, 7, and 21 variable. The resistance values of these resistors may be varied simultaneously by means of a common control device indicated by the dotted line 221.

The use of the magnetic brake in combination with the noise suppressor has a further advantage, in addition to those mentioned in the foregoing description. Because of an appreciable time lag in the action of the noise suppressor, an operator might easily tune through a desired station before the suppressor released if the brake were omitted. It will be noted that a considerable part of this time lag is introduced by the resistor 129 and condenser 131, the circuit of condenser 131 having a fairly large time constant since condenser 131 must be large enough to bypass audio frequencies, preferably having a capacity of the order of 0.25 microfarad.

The control circuit for the brake may be, and is in the circuit above described, given a time constant less than that of the noise suppressor control circuit. Thus the brake responds to an incoming signal and stops the tuning condensers before the noise suppressor releases.

Various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim as my invention:

1. In a radio receiver, a signal selecting circuit having a variable tuning element therein, a man-

ually operable tuning knob, means for making a movement of said tuning knob effective normally to produce a corresponding movement of said tuning element, and means responsive to the reception of a signal for making said tuning knob ineffective to produce a movement of said tuning element.

2. A radio receiver for the reception of modulated carrier waves, said receiver comprising a demodulating device and converting means for converting the carrier wave of an incoming signal to a predetermined frequency, said means including a tunable oscillator, filter means for transferring said converted carrier wave to said demodulating device, said filter means having a pass range sufficiently wide to pass the converted carrier having said predetermined frequency and at least one side band thereof, a control circuit coupled to receive energy from the output of said converting means and sharply tuned to said converted carrier frequency, means responsive to the energy passed by said control circuit upon the reception of a signal for controlling the tuning of said oscillator, a manually operable tuning knob, means for making a movement of said tuning knob effective normally to produce a corresponding change in the tuning of said oscillator, and said means which is responsive to the energy passed by the control circuit upon the reception of a signal being operative to render the tuning knob movement ineffective to produce a change in the tuning of the oscillator.

3. In a radio receiver tunable over a predetermined frequency range, a variable tuning device, sensitivity control means for adjusting the response of said receiver to signals of predetermined strength, means for rendering a portion of said receiver inoperative until the receiver is tuned to an incoming signal of said predetermined strength, and means responsive to the reception of said incoming signal for automatically preventing undesired movement of said tuning device, said second and last-named means having differing time constants of operation whereby the tuning movement is stopped in advance of the release of the inoperative condition of the receiver.

4. In a radio receiver, a signal selecting circuit, a variable tuning element in said selecting circuit, a manually operable tuning knob coupled to said tuning element, means including a magnetically operated brake for locking said tuning element in position in response to the reception of a signal, and means for releasing said brake by a predetermined movement of said tuning knob.

5. A magnetic brake for a radio tuning device, said brake comprising a disc segment of magnetic material coupled to said tuning device, a U-shape core positioned with its ends opposite one side of said disc segment, a magnet winding on said core, and an armature bar of magnetic material movably supported on the opposite side of said disc segment and opposite the ends of said core.

6. In a radio receiver tunable over a predetermined frequency range, a variable tuning device, a noise suppressor circuit comprising means for rendering a portion of said receiver inoperative when the receiver is not tuned to an incoming signal and for rendering said portion operative in response to tuning said receiver to an incoming signal, and a control circuit comprising means responsive to said receiver being tuned to an incoming signal for preventing undesired movement of said tuning device, said control circuit having

a time constant which is shorter than the time constant of said noise suppressor circuit.

7. In a radio receiver having a continuously variable tuning device, a manually operable tuning knob, means for making a movement of said tuning knob effective normally to produce a corresponding movement of said tuning device, means responsive to the reception of a signal for making said tuning knob ineffective to produce a movement of said tuning device, and adjustable means for making said last means effective only when the strength of said incoming signal is above a predetermined amplitude.

8. In a radio receiver having a tuning device, a magnetic brake for said device, said brake comprising a magnetic core having a winding thereon, means for producing a flow of current through said winding in one direction in response to said receiver being tuned to an incoming signal, and means for producing a flow of current through said winding in the opposite direction in response to the receiver being tuned away from said signal.

9. In a radio receiver, a signal selecting circuit, a variable tuning element in said selecting circuit, a tuning knob for said tuning element, a magnetic control device for said tuning element, said control device including a winding, an electric discharge tube having a control grid and having an output circuit which is coupled to said winding, a resistor section, a condenser and a grid resistor connected in series across said section, said grid being conductively connected to the junction point of said condenser and said grid resistor, means normally for maintaining a voltage across said resistor section such that said grid is made sufficiently negative to substantially block said tube, and means for so changing the voltage across said section in response to tuning said receiver to an incoming signal that said tube is unblocked for a period determined by the time constant of the circuit including said condenser and said grid resistor.

10. In a radio receiving system, the combination of a plurality of tuning condensers, a shaft directly connected with and movable to operate said condensers simultaneously thereby to tune said receiver continuously through a predetermined frequency range, a plate directly carried by said shaft, a magnetic brake for locking said plate, shaft and condensers when said brake is energized, means for energizing said brake including a circuit sharply tuned to a predetermined frequency whereby said tuning condensers are locked in position when said receiver is tuned exactly to a predetermined frequency, and means for causing said brake to operate in response to a signal of a predetermined strength only in response to movement of said tuning shaft at a rate below a predetermined value.

11. A radio receiver for the reception of a signal modulated carrier wave, said receiver having a signal channel response of sufficient width to pass said carrier wave and at least one and not more than both side bands, a signal selecting circuit having a movable tuning element therein, and means including a sharply selective signal circuit for abruptly locking said tuning element in response to the reception of a signal, said last circuit being responsive to said carrier wave and more selective than said signal channel, and means for adjusting said response to signals of a predetermined strength.

12. A radio receiver comprising a signal selecting circuit tunable over a predetermined fre-

quency range, an intermediate frequency amplifier coupled to said selecting circuit, automatic volume control means for said amplifier, a tuning control circuit coupled to said amplifier to receive signals therefrom at substantially constant amplitude, said control circuit being more selective than said signal selecting circuit to the same signal, means including a brake responsive to the energy passed by said control circuit for controlling the tuning of said signal selecting circuit, and means for automatically deenergizing said brake after it has been energized for a predetermined length of time.

13. A radio receiver comprising a signal selecting circuit tunable over a predetermined frequency range, an intermediate frequency amplifier coupled to said selecting circuit, automatic volume control means for said amplifier, a tuning control circuit coupled to said amplifier to receive signals therefrom at substantially constant amplitude, said control circuit being more selective than said signal selecting circuit to the same signal, means responsive to the energy passed by said control circuit for controlling the tuning of said signal selecting circuit, said last-named means including a tuning device for said first-named circuit having a movable tuning element, a magnetic brake for said element and a control tube through which said brake is energized, said control tube having a control grid connected with said tuning control circuit, and means in said last-named connection for causing said brake to operate only when said tuning element is moved relatively slowly.

14. In a radio receiving system, the combination of a plurality of tuning condensers, a shaft directly connected with and movable to operate said condensers simultaneously thereby to tune said receiving system continuously through a predetermined frequency range, a plate carried by said shaft, a magnetic brake for locking said plate, shaft and condensers when said brake is energized, means for energizing said brake including a circuit sharply tuned to a predetermined frequency, whereby said tuning condensers are locked in position when said receiver is tuned exactly with said predetermined frequency, said circuit including an amplifier tube, automatic volume control means for applying signals of substantially constant amplitude thereto, means for

deriving a signal-responsive control potential therefrom, a control tube for the brake operative in response to said potential, and means providing a predetermined time constant for the operation of said control tube and brake.

15. In a radio receiving system, the combination of a plurality of tuning condensers, a shaft directly connected with and movable to operate said condensers simultaneously thereby to tune said receiving system continuously through a predetermined frequency range, a plate carried by said shaft, a magnetic brake for locking said plate, shaft and condensers when said brake is energized, and means for energizing said brake including a circuit sharply tuned to a predetermined frequency whereby said tuning condensers are locked in position when said receiver is tuned exactly with said predetermined frequency, said circuit including an amplifier tube, automatic volume control means for deriving a signal-responsive control potential therefrom, and means for causing said brake to operate when said tuning shaft is moved relatively slowly, said last-named means including a signal rectifier, a control tube for the brake connected with said rectifier to receive a controlling potential therefrom, and a filter in said connection for regulating the time constant of the operation of the control tube in response to change in the controlling potential.

16. In a radio signal receiving system, the combination with a variable tuning device therefor having a movable element, of a tuning control circuit including a control tube and an electromagnetic brake, one element of said brake being rigidly connected with said movable tuning element to move therewith, means for energizing said brake to lock said movable tuning element against tuning movement, including an electromagnet winding for the brake in circuit with said control tube to receive anode current therefrom, a grid circuit for said control tube having a time delay filter means therein, means for applying a signal-responsive control potential to said grid circuit through said filter, and automatic volume control means for controlling the amplitude of said potential, whereby said last-named means may be more broadly responsive to a received signal of relatively high amplitude.

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