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[54] **SELECTIVE SIGNAL TUNING DEVICE**

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[51] **Int. Cl.**.....**H04b 1/32**

[58] **Field of Search**.....250/20.41 A, 20.36, 20.52; 325/470, 478, 471, 467, 462, 458, 344

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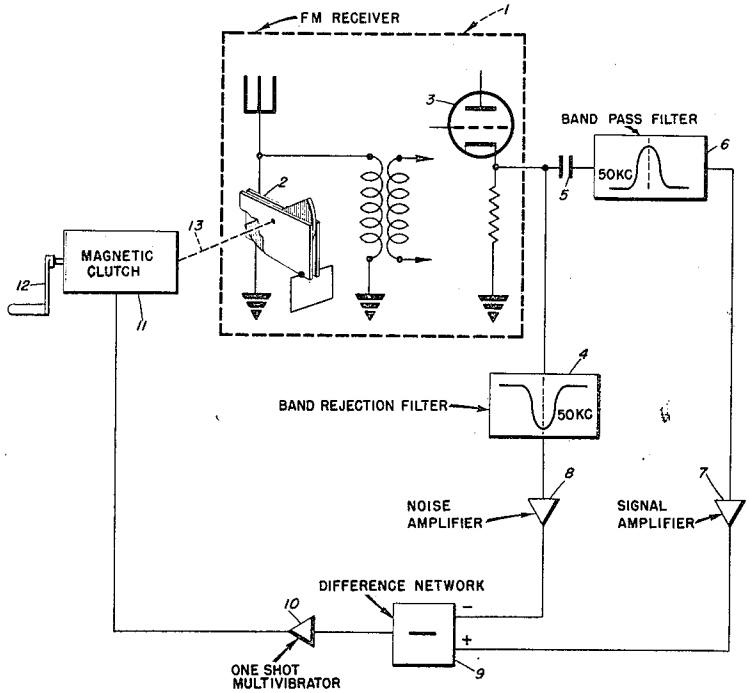
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[57] **ABSTRACT**

A receiver control apparatus is disclosed for locating an emitted signal by utilizing an automatic tuning means with a mechanical clutch mechanism will release the receiver tuning means after the frequency has been found.

2 Claims, No Drawings



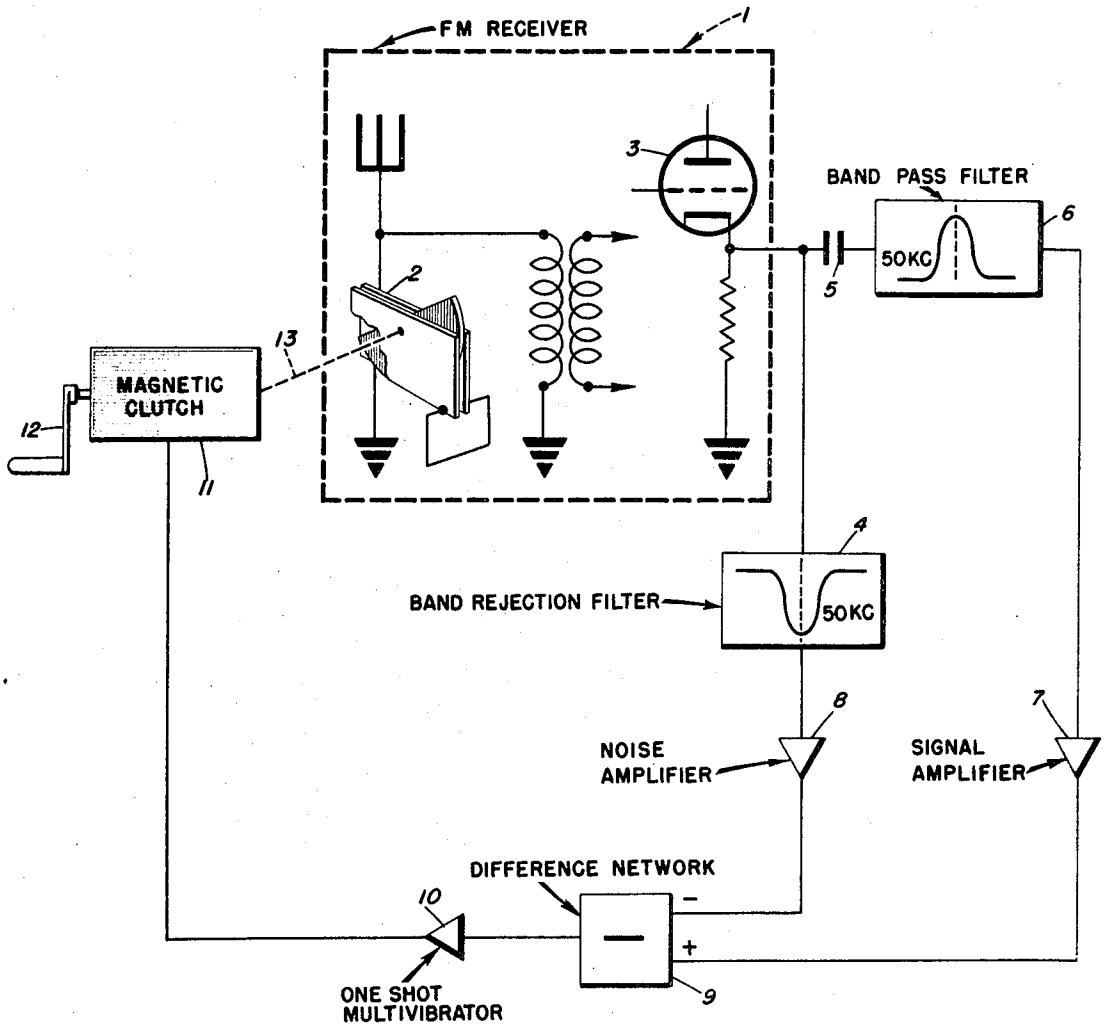
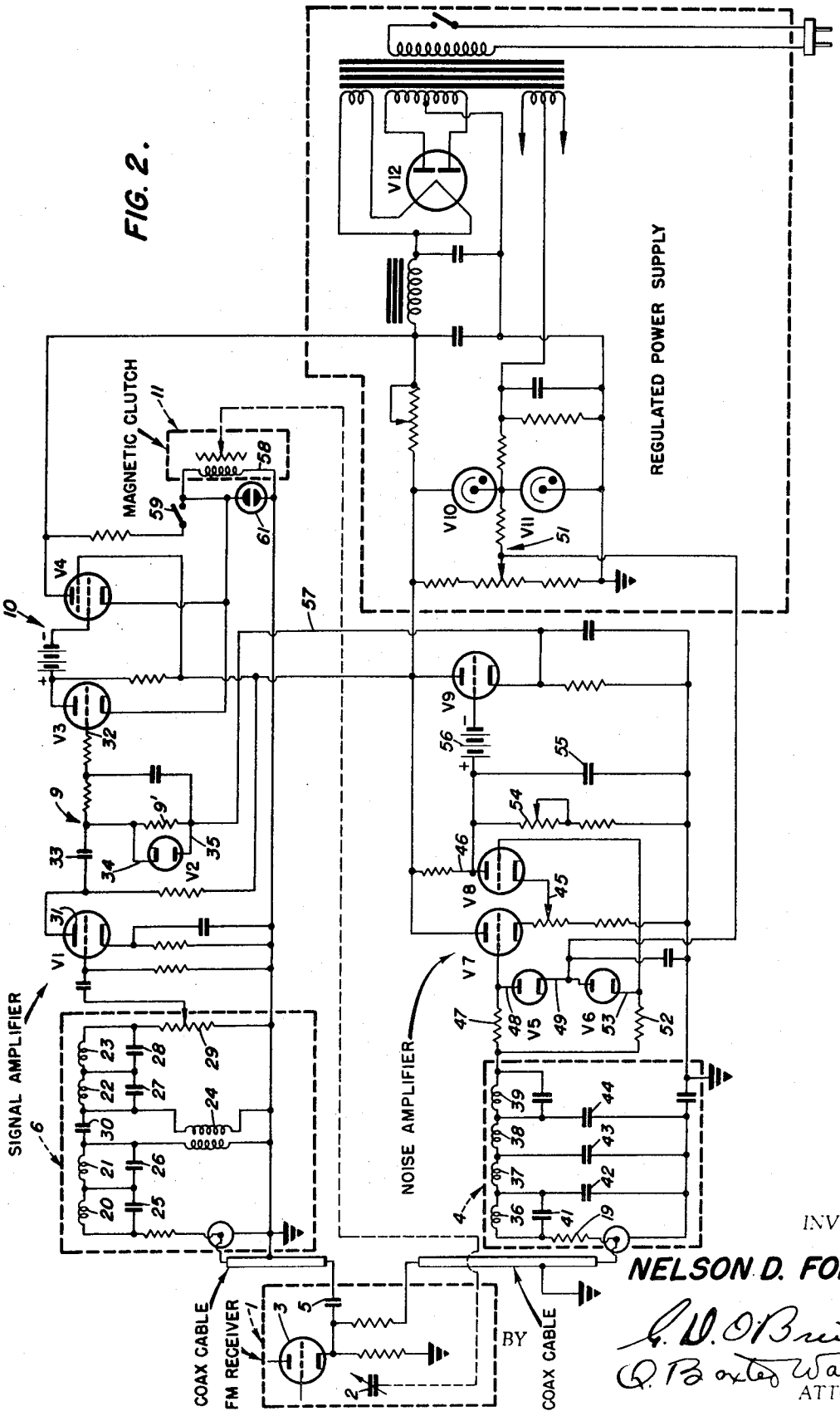


FIG. 1.

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FIG. 2.



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SELECTIVE SIGNAL TUNING DEVICE

The present invention relates generally to automatic tuning means for radio receivers, and more particularly to an improved signal actuated receiver control apparatus.

In connection with the firing of sondes or proximity fuzes from ordnance projectiles it is often desirable to obtain data indicative of the behavior of said sondes or fuzes in flight. Often a wealth of information can be derived from a radio signal emitted from such sondes or fuzes and received at a remote point, usually a ground station. While at first sight it would not appear difficult to tune a receiver to a preset sonde or fuze transmission frequency, this course is not practicable for the reason that while theoretically a sonde or fuze may be designed to emit a signal at a known frequency, generally, in operation, radiated frequency differs from the design frequency due to variations in impedances of certain of the components, as for example, the battery.

As will be obvious, great haste is necessary in adjusting the receiver to the frequency of the radiated signal. Thus, in the past, attempts to tune the receiver to a sonde or fuze signal have resulted in the lost of data concerning the "early history" of the projectile flight, because of the time lag occasioned in correctly tuning the receiver.

One of the principal objects of the present invention, therefore, is to provide a receiver control apparatus embodying a quick-acting automatic tuning means, actuated mechanically through a clutch, which will function to release the receiver tuning control immediately after the frequency of the emitted signal has been found.

Another object of the invention resides in the provision of a receiver control apparatus which will respond to a signal having a subcarrier modulation, but which will be unaffected by other common types of modulation.

A further object is to provide automatic tuning means which will be simple in arrangement and positive in operation.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 is a functional block diagram of the present invention; and

FIG. 2 is a circuit schematic, only that portion of the receiver which is necessary to having understanding of the invention being shown.

In FIG. 1, portions of a convention FM receiver are illustrated together with blocks representing in functional form the present invention. The receiver, shown generally at 1, includes a conventional variable capacitor 2 for tuning the receiver and an output cathode follower 3. The signal output of the receiver 1 is constituted by a 50 KC subcarrier signal when tuned to the sonde frequency or by a random noise signal characterized in part by a spectrum extending from direct current to 300 KC when detuned. The receiver output is applied simultaneously to a band rejection filter 4, and, after passage through a blocking capacitor 5 to remove direct currents from said signal, to a band pass filter 6. The filter 6 is tuned to pass frequencies near the 50 KC subcarrier frequency. The filter 4 is tuned to pass all

signals extending from zero to 300 KC, with the exception of those frequencies near 50 KC. The amplifier receiving the output of the filter 6 is designated as the signal amplifier 7. Similarly, the amplifier receiving the output of the filter 4 is designated the noise amplifier 8. The outputs of the amplifiers 7 and 8 are unidirectional voltages of positive polarity. The difference between the output of amplifier 7 and the output of amplifier 8 is obtained by means of a suitable network 9. A one-shot multivibrator 10 receives the output of the network 9 and is rendered operative, or conductive, by the appearance at the input thereof of a negative voltage. Whenever the multivibrator 10 is in a conductive state, current flow is established through the magnetic clutch 11, rendering the clutch rigid and hence capable of transmitting torque from the tuning control 12 to the shaft 13 of tuning condenser 2. That is, the magnetic clutch contains fine particles of iron suspended in a suitable liquid such as oil, the whole being surrounded by a magnetizing coil. When current flows through this coil, the magnetic particles form a rigid mass which causes the driving element of the clutch to carry along the driven element. However, when the magnetism is destroyed by stoppage of the current, the mass again becomes semi-liquid and no longer can serve as a mechanical connection between the clutch members.

Briefly, the operation of the tuning apparatus of the present invention involves a coarse tuning adjustment of the receiver to the frequency expected to be radiated from the sonde. Whenever the receiver is tuned off channel, the output thereof will be characterized by the appearance of noise. In this condition, the output of amplifier 8 exceeds the output of amplifier 7 thereby resulting in the application of negative voltage to the multivibrator 10, rendering the clutch rigid and the receiver tunable. However, if the receiver is tuned to a channel occupied by a signal having an output characterized by a 50 KC modulation, the output of amplifier 7 exceeds the output of amplifier 8 and results in the application of positive voltage to the multivibrator 10, cutting off any current flowing through the clutch magnetizing coil, and hence disengaging control 12 from shaft 13. Therefore, if the receiver is initially tuned off channel, and is subsequently tuned on channel, the tuning control 12 automatically will disengage from the shaft 13. The loss of signals resulting from tuning the receiver through the channel and beyond is thereby prevented.

In FIG. 2 there appears a more detailed presentation of the apparatus described with reference to FIG. 1. The signal amplifier is shown in the upper portion of the circuit, the noise amplifier being shown below it. The power supply is shown at the right. The receiver output is coupled to the filter 6 through blocking capacitor 5 and to filter 4 through resistor 19. Capacitor 5 prevents the application of any direct currents to the signal amplifier through the filter 6, while both alternating and direct voltages are applied to the filter 4. The filter 6 comprises a conventional band pass filter constituted by inductors 20, 21, 22, 23, and 24, and capacitors 25, 26, 27, 28, and 30.

The output of filter 6 produces a voltage drop across a potentiometer 29 which provides a convenient means of adjusting the voltage applied to the grid of V_1. The output of V_1 is fed from its anode 31 to the grid 32 of

V_3 through a coupling network **9** comprising a capacitor **33** and a resistor **9'**. The resistor **9** is shunted by a diode V_2 having its cathode **34** connected at the junction of capacitor **33** and resistor **9'**, the anode **35** of said diode being connected to the opposite end of said resistor. Therefore, while the resistor **9'** is chosen to present a considerable impedance to the flow of positive current therethrough, the flow of negative current is effectively short circuited by the parallel diode V_2. The result is that only positive currents conducted through the capacitor **33** are effective in controlling the succeeding tube V_3.

The band rejection filter **4** comprises, conventionally, a chain of inductors **36**, **37**, **38**, and **39**, suitably shunted and by-passed by capacitors **41**, **42**, **43**, and **44**. The noise amplifier including its rectifying means is constituted by tubes V_5, V_6, V_7, and V_8. By virtue of the common cathode connection **45** of tubes V_7 and V_8, the output appearing at the anode **46** of V_8 constitutes, in part, the difference between the voltages applied to the grids of V_7 and V_8. The rectifying means comprises a resistor **47** connected to the output of the filter **4** and to the anode **48** of diode V_5, the cathode **49** of which is returned to a low impedance source of bias voltage **51**.

Since at the center frequency the discriminator output of the FM receiver **1** is biased about **150** volts above ground potential, due to the cathode follower **3** it is necessary to return the junction of the diodes V_5 and V_6 to a low impedance point of equal DC voltage. The required voltage can be conveniently obtained from a voltage divider **51** in the regulated power supply. The power supply need not be described further, as it may be of conventional nature, using a full wave rectifier V_{12} and two voltage regulating tubes V_{10} and V_{11}.

The diode V_5 and resistor **47** constitute a voltage divider so that whenever a positive voltage appears at the output of filter **4** the diode V_5 readily conducts and thereby presents a very low impedance with the result that very little voltage is applied to the grid of V_7. On the other hand, whenever a negative voltage appears at the output of filter **4**, the diode V_5 is nonconductive and hence presents a high impedance thereby resulting in the application of a relatively great voltage to the grid of V_7.

Similarly, resistor **52** is connected to the output of the filter **4** with its opposite end returned to the bias voltage source through diode V_6. The connection of V_6, however, is opposite that of V_5. That is, the cathode **53** is connected to the bias voltage source. Therefore, the operation of the voltage divider comprising resistor **52** and diode V_6 will be opposite that of the above described voltage divider. Namely, that the appearance of positive voltages in the output of filter **4** results in the application of a voltage to the grid of v_8 whereas negative voltages are effectively short circuited.

The noise amplifier constituted by triodes V_7 and V_8 produces at the anode **46** of triode V_8, a voltage which is proportional to the difference between the voltages applied to the grids of said triodes. Therefore, since a positive voltage is applied to one grid (V_8) and a negative voltage is applied to the other grid (V_7) the output appearing at anode **46** is equivalent to the output of a full wave rectifier which has been amplified many times. An adjustable resistor **54** and a capacitor **55** are connected from the anode **46** to ground to provide an adjustable filter for smoothing the output of V_8.

The output of the noise amplifier, V_7 and V_8, is coupled to a cathode follower V_9 through a biasing arrangement comprising a battery **56**. The bias applied to V_9 is sufficient to maintain V_9 nonconductive until a substantial output appears from the noise amplifier. The output of cathode follower V_9 is directly coupled to the lower end of resistor **9** by a conductor **57**. It will be understood that so long as cathode follower V_9 remains nonconductive, the potential at the lower end of resistor **9'** will be very nearly equal to ground potential. Therefore, by virtue of diode V_2, positive voltages alone are applied to the grid of V_3. However, whenever V_9 conducts, the potential at the lower end of resistor **9'** rises considerably above ground potential and therefore results in a reversal of current flow through the resistor to produce negative control voltages at the grid of V_3.

A multivibrator **10** of the "single-shot" type is shown as including tubes V_3 and V_4 which have their cathodes commonly connected through the magnetizing coil **58** of the magnetic clutch **11**. The multivibrator is arranged so that the application of negative voltages to the grid of V_3 renders V_4 conductive and hence the magnetic clutch **11** rigid or operative. The application, however, of a positive voltage to the grid of V_3 rapidly drives V_4 to cut off, the speed of operation being accentuated by virtue of the common cathode connection of V_3 and V_4.

A switch **59** is provided to supply magnetizing current to the clutch **11** in the event it is desired to adjust the receiver during periods when the multivibrator **10** is nonconductive. A neon lamp **61** connected across the magnetizing coil **58** glows as long as the coil is energized, thereby providing a visual indication of the clutch condition.

In operation, assuming that the receiver **1** is initially off channel and being tuned toward a signal channel, high frequency noise signals will be applied to both the signal amplifier and the noise amplifier. In addition, the noise amplifier receives the direct current and very low frequencies present in the output of the receiver. The noise signals are highly attenuated by the filter **6**, but readily passed without undue attenuation by the filter **4**. Consequently, the voltage appearing at the anode of V_8 will be relatively high, causing V_9 and hence V_3 and V_4 to conduct. The clutch **44** is therefore rigid and receiver **1** tunable. As the receiver **1** is tuned into the signal channel, characterized by the appearance of a 50 KC signal in the output of the receiver, said output is highly attenuated by filter **4**, and readily passed by filter **6**. As will be understood, the application of an off-channel frequency modulated signal to a discriminator will result in the production of an output possessing a d.c. component. The amplitude of the d.c. component decreases as the signal center frequency and the discriminator center frequency approach coincidence. Since the noise amplifier is responsive to d.c. signals, the noise amplifier maintains an appreciable output until tuning is very nearly exact. As nearly exact tuning is realized, however, it will occur that the voltage appearing at the anode of V_8 is diminished while the voltage appearing at the anode of V_1 is maintained relative-

ly high, or even increased, depending upon the linearity of the discriminator. The combined effect of diminished V_8 anode voltage and increased V_1 anode voltage is to produce a positive control voltage at the grid of V_3 thereby rendering V_4 nonconductive. The clutch **11** therefore returns to a fluid state and is no longer capable of transmitting motion to further adjust the tuning of receiver **1**.

Thus, the procedure of locating a signal and accurately tuning the receiver to the frequency of the signal is vastly simplified. It is merely necessary to rapidly adjust the tuning shaft throughout the expected range of signal frequencies. Whenever a signal appears within the range of adjustment, and a precise condition of resonance is attained, the tuning shaft is disengaged at once without the attention of the operator or without the requirement of monitoring the receiver output to detect the appearance of a signal therein.

Obviously many modifications and variations of the present invent are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a radio receiver having an input circuit of adjustable reactance and providing an output in the form of a subcarrier characterized by an off-channel direct current component; a selective signal tuning device, comprising, mechanical means for adjusting the reactance of the input circuit of the receiver, a magnetic clutch having an output element and an input element, said output element being connected to said reactance adjusting means, a tuning control connected to said input element for adjusting said input reactance when said clutch is energized, a first filter receiving said receiver output including said direct current component and adapted to reject the band of frequencies therefrom constituting the subcarrier signal, a second filter receiving said receiver output and adapted to pass the band of frequencies constituting the subcarrier thereof and rejecting the direct current component, means for determining the average output of said first filter, means for comparing the magnitude of the average output of said first filter including said direct current component with the output of said second filter, and means controllable by said comparing means for deenergizing said clutch to arrest adjustment of the reactance of said input circuit whenever the output of said second filter exceeds the average output of said first filter, whereby said receiver is tuned to provide an output constituted by the frequencies passed by said second filter.

2. In a tunable frequency modulation radio receiver having an input circuit of adjustable reactance and providing an output in the from a subcarrier characterized by an off-channel direct current component; a selective signal tuning device, comprising, mechanical means for adjusting the reactance of the input circuit of the receiver, a magnetic clutch having an output element and an input element, said output element being connected to said reactance adjusting means, a tuning control connected to said input element for adjusting said input reactance when a magnetizing current is applied to said clutch, a first filter receiving said receiver output and adapted to pass outputs having frequencies extending from direct current to a relatively high frequency except the band of frequencies constituting the subcarrier which are rejected, a second filter receiving said receiver output and adapted to reject all outputs except those within the band of frequencies constituting the subcarrier, a first amplifier including rectifying means for amplifying and rectifying the output of said first filter, a second amplifier including rectifying means for amplifying and rectifying the output of said second filter, a difference network receiving the outputs of said first and second amplifier and providing a signal having a first polarity whenever the output of said first amplifier exceeds the output of said second amplifier and providing an opposite polarity whenever the output of said second amplifier exceeds the output of said first amplifier, and a multivibrator adapted to apply magnetizing current to said clutch in accordance with the polarity and the output of said difference network, said multivibrator being adapted to magnetize said clutch whenever the output of said first amplifier exceeds the output of said second amplifier, whereby the receiver is tuned to provide an output constituted by the frequencies passed by said second filter.

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