March 25, 1947. C. T. SCULLY ET AL 2,417,844

RADIO RECEIVER

Filed May 8, 1943

FIG. 1.

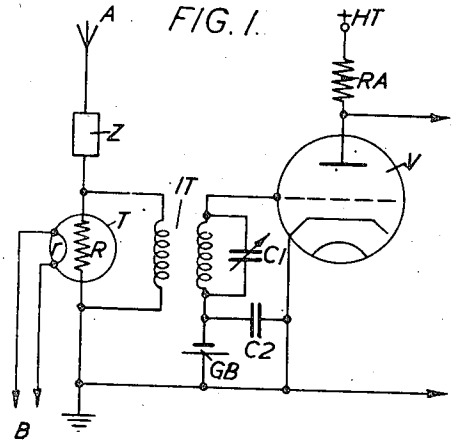


FIG 2.

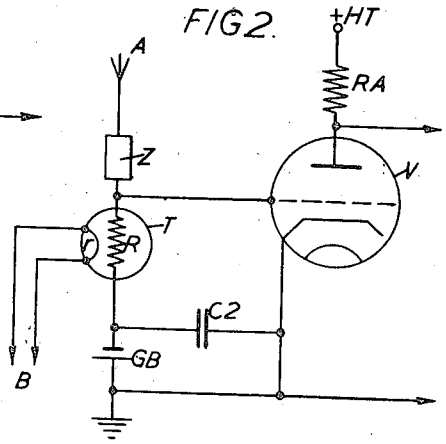


FIG. 3.

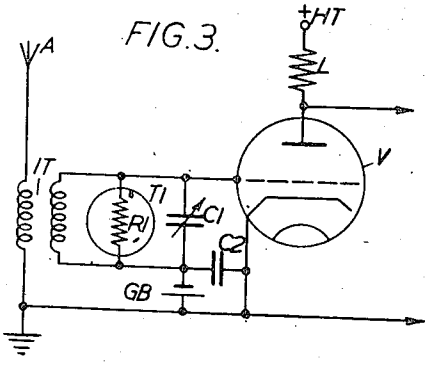


FIG. 4.

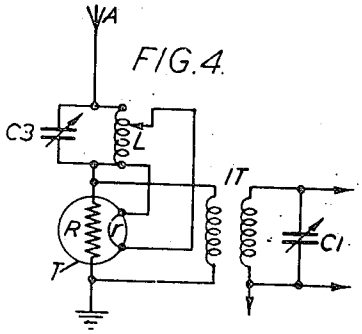
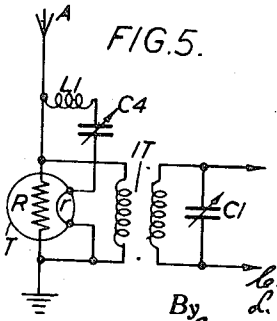


FIG. 5.



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RADIO RECEIVER

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5 Claims. (Cl. 250—20)

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The present invention relates to volume control arrangements for radio receivers and employs for this purpose thermally sensitive resistance elements known as thermistors.

Thermistors have been in use for some years and are characterised by a temperature coefficient of resistance which may be either positive or negative and which is moreover many times the corresponding coefficient for a pure metal such as copper. This property renders thermistors particularly suitable for a variety of special applications in electric circuits.

Various different materials are available for the resistance element of a thermistor, these various materials having different properties in other respects; as one example, a resistance material having a high negative temperature coefficient of resistance comprises a mixture of manganese oxide and nickel oxide, with or without the addition of certain other metallic oxides, the mixture being suitably heat treated.

Thermistors have been employed in two different forms: (*a*) known as a directly heated thermistor and comprising a resistance element of the thermally sensitive resistance material provided with suitable lead-out conductors or terminals, and (*b*) known as an indirectly heated thermistor comprising the element (*a*) provided in addition with a heating coil electrically insulated from the element. A directly heated thermistor is primarily intended to be controlled by the current which flows through it and which varies the temperature and also the resistance accordingly. Such a thermostor will also be affected by the temperature of its surroundings and may therefore be used for thermostatic control and like purposes with or without direct heating by the current flowing through it. An indirectly heated thermistor is chiefly designed to be heated by a controlling current which flows through the heating coil and which will usually, but not necessarily, be different from the current which flows through the resistance element, but this type of thermistor may also be subjected to either or both of the types of control applicable to a directly heated thermistor.

More detailed information on the properties of thermistors will be found in an article by G. L. Pearson in the Bell Laboratories' Record December 1940, page 106.

In the present invention thermistors are employed for volume control purposes in radio receivers and the like and are associated with the aerial circuit to provide means for varying the signal voltage which is applied to the first amplifying stage. They can thus be employed for automatic or manual volume control and also for protective purposes to prevent the receiving set from damage due to abnormally strong signals from a transmitting station nearby, for example.

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According to the invention there is provided an arrangement for coupling a receiving aerial to the first amplifying stage of a radio receiving set, comprising a thermistor which is adapted to vary the level of the signals applied from the aerial to the first amplifying stage in accordance with the variations of temperature of the thermistor.

The invention will be more clearly understood from the detailed description which follows and which refers to the accompanying drawing, in which Figures 1 to 5 show schematic circuit diagrams of embodiments of the invention.

Referring to Figure 1 there is shown the first amplifying stage of a radio receiver comprising a thermionic valve V shown conventional as a triode, but it will be understood that any convenient type of valve may be used. The valve V is coupled to the aerial A through a transformer IT, the secondary winding of which is tuned to the wavelength of the incoming signal by a variable condenser C_1, and the primary winding is connected in series with the aerial; and in accordance with common practice, it should preferably be only lightly coupled to the secondary winding. Connected in shunt to the primary winding is the resistance element R of an indirectly heated thermistor T of which the heating coil is *r*. A battery GB is conventionally shown for biassing the control grid of the valve V and a by-pass condenser C_2 is provided. The plate of the valve is supplied with high tension through a load resistance RA and the output is taken to the next stage (not shown) from the plate in any known manner.

Assuming that the thermistor T has a negative temperature coefficient of resistance, it will be evident that the voltage applied to the control grid of the valve V will be a maximum when the thermistor is cold, and when the thermistor is heated in any suitable way the signal voltage received from the aerial and applied to the grid will decrease. The heating coil *r* may for example be connected at B to a local circuit (not shown) containing a source of electromotive force through an adjustable resistance which may be manually controlled so that the thermistor temperature may be varied between any desired limits thereby adjusting the signal voltage applied to the control grid of the valve. Alternatively, it may be

arranged for the heating coil to be controlled by the automatic volume control voltage derived in any of the well known ways from some part of the circuit (not shown), so that the output level of the radio receiver may be made independent of the incoming signal level.

It is clear that the thermistor could, if desired also have a positive temperature coefficient of resistance, and the only difference in the operation would be that the direction of control would be reversed. When the thermistor is used for automatic volume control in the manner described above the temperature coefficient should be chosen in accordance with the manner in which the volume control voltage varies with the signal level. Thus, if the control voltage increases with increase in signal level the thermistor should have a negative temperature coefficient, but if the control voltage decreases the thermistor should clearly have a positive temperature coefficient.

A suitable impedance Z may be connected in series with the aerial A as shown if the characteristic of the aerial is such that the thermistor shunt would not act over a sufficiently large range with the aerial alone.

In Figure 2 there is shown a similar arrangement applied to the case where it is desired to use a buffer valve immediately following the aerial having an untuned input circuit. The thermistor is connected in series with the aerial as before and takes the place of the grid resistance of the buffer valve V, the grid bias battery GB or other equivalent arrangement being connected in series therewith. It will be evident that the thermistor will operate to vary the signal level applied to the control grid of the valve V in a similar manner to that shown in Figure 1, and its heating coil may be controlled in any of the ways which have been described. As before, a suitable impedance Z may be connected in series with the aerial. The plate of the buffer valve V will be connected to the next stage (not shown) which will have a tuned input for selecting the desired wavelength.

If it is desired to use a thermistor with a positive temperature coefficient of resistance, a similar result will be obtained if R and Z are interchanged.

When a receiving set is in close proximity to a transmitting station there is some risk of damage to the set should it be left connected to the aerial or accidentally tuned to the station, owing to the extremely high power of the signals that will be picked up. A directly heated thermistor may conveniently be used to remove this danger as shown in Figure 3. The valve V is coupled to the aerial A as in Figure 1, through a transformer IT, the secondary winding of which is tuned by means of the condenser C_1. A directly heated thermistor T_1 has its resistance element R_1 connected in shunt with the secondary winding of the transformer. This thermistor should have a negative temperature coefficient of resistance. If signals at a very high level are received and if the transformer is tuned to the incoming wavelength a high voltage will tend to be developed across the thermistor. This will become hot and its resistance will fall to a low value, thus reducing very considerably the voltage which can reach the control grid of the valve V, so that the risk of damage to the receiving set will be removed. The thermistor may be so chosen that when incoming signals having a reasonable level are received its temperature is low and the value of R_1 is sufficiently high that it does not produce much reduction in the voltage applied to the control grid of the valve V.

Another arrangement for minimising the effect of unwanted signals at a high level is shown in Figure 4. This figure is a modification of Figure 1 and shows only the connections between the aerial and the tuned circuit, connections to the valve V being otherwise the same. In Figure 4 a parallel resonant circuit L, C_3 acting as a wave trap is connected in series with the aerial and is tuned to the unwanted wavelength. This, of course, is a well known arrangement. However, if the unwanted signals are of extremely high level there may still be an appreciable residue applied to the input of the radio receiver and according to the present invention an indirectly heated thermistor T has its resistance element R connected in series with the aerial exactly as in Figure 1. The heating coil *r* of the thermistor T is connected across a suitable proportion of the inductance L, so that when the unwanted signals are received a high voltage is developed across the inductance L which heats the thermistor and reduces its resistance R to a low value thereby heavily shunting the input to the valve V as described in connection with Figure 1. It will be seen that the action of the arrangement is similar to that of a potentiometer, the series impedance of which comprises the wave trap and is high at the unwanted wavelength, and the shunt impedance comprises the thermistor T which is low for the unwanted wavelength. In this manner the discrimination produced by the wavetrap is augmented by the thermistor.

Figure 5 shows a modification of Figure 4 in which the parallel resonant circuit connected in series with the aerial A is replaced by a series resonant circuit L_1, C_4 arranged to shunt the transformer IT. In this case the heating coil *r* of the thermistor is connected in series with the resonant circuit. The circuit L_1, C_4 being tuned to the frequency of the unwanted waves, the thermistors will have a maximum temperature and minimum resistance for these waves, and will operate further to exclude them from the transformer.

It will be understood that the operating arrangements of the valve V which have been shown are conventional and may be provided in any other known way as desired. The invention lies in the use of the thermistor as part of the coupling arrangement between the aerial and the first valve in such a way that the level of the signal applied to the first valve is varied in accordance with the temperature of the thermistor which may be controlled in any of the ways which have been described. Since, also, the thermistors will be affected by the ambient temperature, the effect of this may be compensated in any of the known ways.

What is claimed is:

1. A device for automatic volume control of a radio receiver comprising an aerial circuit including an aerial, an indirectly heated thermistor having a heater, means connecting the resistance element of said thermistor in the aerial circuit, means for deriving electrical energy directly from the aerial circuit proportional to the energy reaching said receiver, means connecting said deriving means to said heater whereby increase of energy causes said thermistor to absorb energy from said aerial circuit, and a transformer for making a connection with the radio receiver having a primary winding in which said thermistor

resistance shunts the primary of said transformer.

2. A device for automatic volume control of a radio receiver comprising an aerial circuit including an aerial, an indirectly heated thermistor having a heater, means connecting the resistance element of said thermistor in the aerial circuit, means for deriving directly from said circuit electrical energy proportional to the energy reaching said receiver, means connecting said deriving means to said heater, whereby increase of energy causes said thermistor to absorb energy from said aerial circuit, a parallel resonant circuit which is connected in series with the aerial to serve as a wave trap, the heating coil of the thermistor being connected to the said parallel resonant circuit, whereby undesired signals cause said wave trap to function as said generating means.

3. An aerial circuit for a radio receiver comprising an aerial having a connection with ground, an indirectly heated thermistor in the aerial connection which thermistor includes a heater, means in said aerial connection for deriving electrical energy, and means connecting said deriving means with the heater.

4. An aerial circuit for a radio receiver comprising an aerial having a connection with ground, an indirectly heated thermistor in the aerial connection which thermistor includes a heater, a resonant circuit in said aerial connection for deriving electrical energy, and means connecting said resonant deriving circuit with the heater.

5. An aerial circuit for a radio receiver comprising an aerial having a connection with ground, an indirectly heated thermistor in the aerial connection having a heater, a series resonant circuit in said aerial connection to derive electrical energy, and means connecting said series resonant deriving circuit with the heater.

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LESLIE WILFRED HOUGHTON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,012,433	Meyers	Aug. 27, 1935
2,171,638	Zepler	Sept. 5, 1939
2,084,135	Ford	June 15, 1937
2,182,329	Wheeler	Dec. 5, 1939
2,271,208	Sauer	Jan. 27, 1942
2,298,192	Bollman	Oct. 6, 1942

FOREIGN PATENTS

Number	Country	Date
502,562	British	Mar. 20, 1939