

PATENT SPECIFICATION

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(54) BROADCAST RECEIVER INCLUDING AN AUTOMATIC FREQUENCY CONTROL CIRCUIT

(71) We PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby
 5 declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

1. The invention relates to a broadcast receiver including an automatic frequency control circuit.

One receiver of this kind is known from United States Patent Specification 3,308,382. In this known receiver a tuning member is coupled to a switch for switching off the automatic frequency control circuit when the receiver tuning is varied.

20 The present invention provides a broadcast receiver including a tuning device the tuning nominally set by which is variable, which device is constructed to produce an electrical level at an output thereof which is representative of the tuning nominally
 25 set thereby, an automatic frequency control circuit for automatically adjusting the receiver tuning towards the frequency of a received broadcast if the tuning nominally set by said device should not coincide with
 30 said frequency, and a level variation detector having an input electrically coupled to said output for detecting any variation in the level at said output, the output of said detector being coupled to an operation signal
 35 input of an automatic frequency control suppression circuit for suppressing the action of the automatic frequency control circuit when any variation in the electrical level at said output of the tuning device is
 40 detected.

The electrical level will normally also vary when the receiver is switched on, and this may be made to actuate the suppression of the action of the automatic frequency control circuit at this time also.

thereby possibly avoiding the receiver becoming tuned to an unwanted frequency.

An embodiment of the invention will be described in greater detail, by way of example, with reference to the accompanying
 50 diagrammatic drawing.

In the drawing:

Figure 1 shows a block schematic diagram of a broadcast receiver, and

Figure 2 shows a possible construction for
 55 a level variation detector for the receiver of Figure 1.

In Figure 1 a broadcast receiver has an RF section 1, a mixer circuit 5 fed from the RF section 1 and from an oscillator 3,
 60 and an IF amplifier 7 coupled to an output of the mixer circuit 5. The circuit 7 feeds a tuning deviation detection circuit 9, for example a frequency or phase deviation
 65 detection circuit.

The receiver may be a radio or a television receiver and may include further signal-processing circuits (which have been omitted for the sake of clarity).

The tuning deviation detection circuit 9
 70 has an output 11, 13 which is connected to an input 15, 17 of an automatic frequency control suppression circuit 19. An output 21 of the latter circuit is connected to a tuning signal input 23 of the oscillator 3.
 75 The circuit 19 has another input 25 which is connected through a resistor 27 to an output 29 of a circuit 31 which produces a voltage representative of the nominal tuning of the receiver (which voltage in fact
 80 itself governs the nominal tuning of the receiver).

The circuit 31 comprises a supply circuit 33 which applies a voltage across a plurality of potentiometers 35, 37 and 39. An adjustable part of this voltage can be applied to the output 29 through the wipers on these potentiometers and a plurality of switches 36, 38 and 40. The potentiometers 35, 37 and 39 may be, for example, of a preset
 90

type so that variation of the nominal tuning is achieved simply by operating the switches 36, 38 and 40, which thus in combination constitute the tuning member of the receiver.

- 5 It is, however, alternatively possible that at least one of these potentiometers is connected to a graduated scale and is provided with a tuning knob for varying the nominal tuning.
- 10 When the nominal tuning of the receiver is varied a voltage variation will occur at the output 29 of the circuit 31. This voltage variation is detected by a level variation detector 43 which has an input 41
- 15 connected to this output 29 and is converted into a signal at an output 45, which signal indicates that a variation is occurring. This signal is applied to an operation signal input 47 of the automatic frequency
- 20 control suppression circuit 19 and thence via two resistors 49, 51 to the bases of two npn transistors 53, 55 which are connected in antiparallel and one of which becomes conducting as a result of this signal. When
- 25 this happens the transistor short-circuits the input 15, 17 thus connecting the input 25 directly to the output 21 of the suppression circuit. The oscillator 3 is thus tuned without being influenced by the automatic frequency
- 30 control signal produced by detection circuit 9. A comparable situation occurs when the receiver is switched on and the voltage produced by the supply 33 varies. The automatic frequency control can then
- 35 only operate when the supply voltage has become constant. When the voltage at the output 29 of the circuit 31 becomes steady, the switch-off signal at the output 45 of the detector 43 disappears and the transistors
- 40 53, 55 are cut off. The voltage applied between the inputs 15, 17 is then added to the voltage applied to the input 25 and the combined voltages appear at the output 21. Thus the tuning voltage required for nominal
- 45 tuning to the desired transmission is applied to the input 23 of the oscillator 3 together with an automatic frequency control voltage originating from the tuning deviation detection circuit 9. The oscillator
- 50 3 is thus locked to the desired transmission. Because the output 11, 13 of the tuning deviation detection circuit 9 is short-circuited when the automatic frequency control is rendered inoperative, any output
- 55 capacitance of the circuit, e.g. a smoothing capacitor 56 shown included in the suppression circuit 19, is discharged so that there is no residual voltage to cause unwanted detuning when the automatic frequency
- 60 control is switched in again. This is a very attractive property especially in receivers, such as remote control receivers, which employ stepwise tuning.

It will be evident that, if variable capacitors or inductors are used for coarse

tuning the oscillator 3, the connection between the output 29 of the circuit 31 and the input 25 of the suppression circuit will have to be removed, the input 25 then being connected to a fixed potential. The circuit 31 may then comprise a single potentiometer the wiper of which is mechanically coupled to means for varying the capacitors or inductors.

Figure 2 shows a possible construction for the level variation detector 43 of Figure 1.

In Figure 2 the input 41 of the detector is connected through a capacitor 57 to the base of an npn transistor 59. This base is also connected via a resistor 61 to the tap on an adjustable potential divider 63, 65. These resistors and the capacitor 57 together constitute a differentiating network which applies a signal to the base of the transistor 59 only when a voltage variation occurs at the input 41.

The emitter of transistor 59 is coupled to the emitter of an npn transistor 67 and these transistors together constitute a phase splitter amplifier. The amplifier 59, 67 has two antiphase outputs which are constituted by the collectors of the two transistors, these being provided with load resistors 69 and 71, respectively. The emitters of the two transistors 59, 67 are connected to earth through a resistor 73. The base of the transistor 67 is connected to earth through a capacitor 80 and also via a resistor 81 to the tap on potential divider 63, 65. The bases of the transistors 59 and 67 thus both have the same bias.

The collectors of the transistors 59 and 67 are connected to the bases of two npn transistors 83 and 85, respectively, whose emitters are inter-connected and whose collectors are connected to the positive supply rail. These transistors 83, 85, which are just cut off in the quiescent state, constitute a rectifier circuit which converts voltage variations of different polarities initially fed to the input 41 into corresponding signals having one polarity only. These corresponding signals appear at the common emitters of transistors 83 and 85.

The emitters of the transistors 83, 85 are connected to the base of a npn transistor 87 which, together with another npn transistor 89, constitutes a differential amplifier. The emitters of transistors 87 and 89 are inter-connected and are connected to earth through a resistor 91. The base of the transistor 89 is connected through an emitter follower 99 to an averaging circuit in the form of a potential divider comprising two resistors 101, 103 connected between the collectors of the transistors 59, 67. The collectors of the transistors 87 and 89 are connected to the positive supply rail through a resistor 105 and directly, respectively.

The base of a pnp transistor 107 is connected to the collector of the transistor 87, its emitter is connected to the positive supply rail through a diode 109, and its collector is connected to earth through a resistor 111. This transistor 107, together with the diode 109, constitutes a threshold circuit and its collector is connected to the base of an npn transistor 113 connected as an emitter follower which feeds the output 45 and a storage capacitor 115.

The operation of the circuit of Figure 2 is as follows:—

Voltage variations at the input 41 produce signals of opposite polarity at the collectors of the transistors 59, 67. These signals do not influence the potential at the tap on the potential divider 101, 103 of the averaging circuit. The action of the rectifier circuit 83, 85 results in a positive-going signal being applied to the differential amplifier 87, 89 both when the voltage at the input 41 increases and when it decreases. This positive-going signal gives rise to a negative-going signal at the base of the transistor 107. The transistor 107 is normally cut off and only becomes conducting when the voltage drop across the resistor 105 becomes sufficiently large. The rest condition of this voltage drop is determined by the position of the tap on the potentiometer 65 which is coupled to the resistor 105 via the transistors 59, 67; 83, 85; 87, 89 and 99.

A sufficiently large negative-going signal at the base of the transistor 107 causes its collector voltage to increase from earth potential to the supply voltage as reduced by the voltage across the diode 109, resulting in the voltage across the capacitor 115 changing from zero to substantially the supply voltage. This occurs whenever the voltage at the input 41 varies.

The capacitor 115 together with the circuit connected to the output 45 has a time constant which is sufficiently long to ensure that the automatic frequency control remains inactive for a suitable period immediately after the occurrence of a voltage variation at the input 41 so as to prevent control from being applied unexpectedly when the nominal tuning of a receiver having a continuously adjustable tuning facility is changed unevenly. A suitable value for said time constant may be several, for example two, seconds.

It will be evident that a suppression circuit similar to that described may be used with digital tuning circuits.

If the receiver is of the kind having an automatic station finder in which a tuning voltage varies until a station is found, the automatic frequency control will be switched off by the suppression circuit until the desired station is found. When this happens the tuning voltage will become steady and

the automatic frequency control will come into operation. If the automatic station finder uses an output signal from the tuning deviation detection circuit to stop the finding action, this detection circuit will have to have a further output for this purpose, which output is not influenced by the suppression circuit and which therefore will continue to supply the desired output signal even when the automatic frequency control is switched off.

It will be evident that the detection circuit 43 may be made responsive to current variation instead of voltage variation if the circuit 31 produces a control current for the input of the oscillator instead of a control voltage.

Of course other methods of suppressing the output signal from the tuning deviation detection circuit may alternatively be used. For example, the output of the level variation detection circuit may be used to suppress an input signal to the tuning deviation detection circuit.

An automatic frequency control suppression circuit similar to that described may also be used in receivers in which a tuning voltage or tuning current is combined with an automatic frequency control voltage or current in a way other than by connecting them in series in the way described.

1. A broadcast receiver including a tuning device the tuning nominally set by which is variable, which device is constructed to produce an electrical level at an output thereof which is representative of the tuning nominally set thereby, an automatic frequency control circuit for automatically adjusting the receiver tuning towards the frequency of a received broadcast if the tuning nominally set by said device should not coincide with said frequency, and a level variation detector having an input electrically coupled to said output for detecting any variation in the level at said output, the output of said detector being coupled to an operation signal input of an automatic frequency control suppression circuit for suppressing the action of the automatic frequency control circuit when any variation in the electrical level at said output of the tuning device is detected.

2. A receiver as claimed in Claim 1, constructed so that the electrical level at said output of the tuning device will itself govern the nominal tuning of the receiver.

3. A receiver as claimed in Claim 1 or 2, wherein said electrical level is a voltage and the level variation detector includes a phase splitter antiphase outputs of which are coupled to the suppression circuit via a rectifier circuit.

4. A receiver as claimed in Claim 3, wherein an output of the rectifier circuit is coupled to an input of a differential ampli-

← CLAIM.



The base of a pnp transistor 107 is connected to the collector of the transistor 87, its emitter is connected to the positive supply rail through a diode 109, and its collector is connected to earth through a resistor 111. This transistor 107, together with the diode 109, constitutes a threshold circuit and its collector is connected to the base of an npn transistor 113 connected as an emitter follower which feeds the output 45 and a storage capacitor 115.

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A sufficiently large negative-going signal at the base of the transistor 107 causes its collector voltage to increase from earth potential to the supply voltage as reduced by the voltage across the diode 109, resulting in the voltage across the capacitor 115 changing from zero to substantially the supply voltage. This occurs whenever the voltage at the input 41 varies.

The capacitor 115 together with the circuit connected to the output 45 has a time constant which is sufficiently long to ensure that the automatic frequency control remains inactive for a suitable period immediately after the occurrence of a voltage variation at the input 41 so as to prevent control from being applied unexpectedly when the nominal tuning of a receiver having a continuously adjustable tuning facility is changed unevenly. A suitable value for said time constant may be several, for example two, seconds.

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2. A receiver as claimed in Claim 1, constructed so that the electrical level at said output of the tuning device will itself govern the nominal tuning of the receiver.

3. A receiver as claimed in Claim 1 or 2, wherein said electrical level is a voltage and the level variation detector includes a phase splitter antiphase outputs of which are coupled to the suppression circuit via a rectifier circuit.

4. A receiver as claimed in Claim 3, wherein an output of the rectifier circuit is coupled to an input of a differential ampli-



fier the other input of which is coupled to an output of an averaging circuit connected between the outputs of the phase splitter circuit.

5 5. A receiver as claimed in Claim 4, wherein an output of the differential amplifier is coupled to an input of a threshold circuit.

10 6. A receiver as claimed in any preceding Claim, including a capacitor connected in parallel with the output of the level variation detector, said capacitor, together with the circuit connected to said output,

having a time constant of at least two seconds.

7. A broadcast receiver substantially as described herein with reference to Figure 1 of the accompanying drawing, or to said Figure 1 as modified by Figure 2 of said drawing.

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C. A. CLARK,
Chartered Patent Agent,
Century House,
Shaftesbury Avenue,
London, W.C.2.
Agent for the Applicants

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