PATENT SPECIFICATION

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(54) MIXER CIRCUIT

(71) We RCA CORPORATION a corporation, organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, do hereby 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:—

This is an application for a Patent of Addition to our British Patent Specification 1,251,706 based on United States Serial No. 729,747, entitled "Mixer Circuit", and assigned to RCA Corporation.

This prior invention relates to mixer circuits and more particularly to transistor mixer circuits for heterodyne receiver systems, and counters undesirable effects such as parasitic feedback capacity between the output electrode and the input electrode of transistor mixer circuits, without necessity to provide a neutralization capacitor, or such as the interaction of the tuner stage of a receiver with the IF signal processing circuitry of the receiver, without necessity for alignment of the receiver with the tuner connected. Also the prior invention, the subject of the main patent (application), enables an approach wherein modules are separately fabricated and separately prepared for use with any other modular component.

According to the prior invention, in its broadest aspect, there is provided a mixer circuit for a heterodyne radio receiver, comprising the combination of a first transistor connected in common emitter configuration having its output electrode interconnected with the input electrode of a second transistor in common base configuration, and a tuned circuit for deriving intermediate frequency signals from the output electrode of the common base configuration when radio signals and a locally generated signal are applied contemporaneously to the input electrode of the common emitter configuration, wherein the two configurations are included in separate modules and are interconnected by a signal conducting cable, having a characteristic impedance and extending between the two modules.

According to the present invention there is provided a mixer circuit according to any claim of the main British patent specification 1,251,706 in which the module which includes the second transistor is screened in an electrically conductive enclosure, the output of the transistor being connected through a shielded cable extending from the enclosure to a unit on which an IF signal processing circuit is mounted.

Where the mixer of the prior invention has the common base stage mounted on the television chassis near the IF signal processing circuits, oscillation at the IF frequency may occur. This is due to high IF signal gain as well as various regenerative feedback signal current paths. Specifically, the common base stage not only mixes RF and local oscillator signals applied to its input electrode but also amplifies IF signals from the common emitter stage. Although redesign of the television chassis IF circuits to accommodate the additional IF signal gain is well within the state of the art, it may be undesirable because of the cost and time involved. Moreover, where the television chassis IF signal processing circuits are redesigned, it commits the chassis to utilization of television tuners of the particular configuration described, whereas the parent invention was aimed at independence of design and setting up of modules.

To obviate such problems, by this invention a coupling arrangement is provided for the output of mixers of the prior invention. In a preferred arrangement a television cabinet includes a television chassis and a television tuner mounted

[*Price 25p*]

within the cabinet. The tuner houses an RF amplifier stage, a local oscillator stage and a first mixer unit. One end of a coaxial cable is coupled to the input of the television chassis IF signal processing circuits and the other end of the cable is connected to the second mixer unit which is housed within an electrically conductive enclosure. The enclosure may be detachably electrically and mechanically connected to the tuner to provide a circuit path between the first mixer unit housed within the tuner and the second mixer unit housed within the enclosure.

The second mixer unit housed within the conductive enclosure may derive DC operating potential from the television chassis through the coupling cable. To avoid accidental shorting and shock hazard, a capacitor may be connected in series between the second mixer unit and the detachable connector to prevent a DC potential from being applied to the connector.

Principal features of the invention, both as to its organization and manner of operation, may best be understood by reference to the following description, when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a side view of a television receiver partially broken away to show a television tuner and chassis coupling arrangement suitable for television tuner mixer circuits of the type that permit separate alignment of the tuner and the chassis;

FIGURE 2 is an enlarged side view of the conductive enclosure shown in FIGURE 1 partially broken away to show the circuit components mounted within the enclosure;

FIGURE 3 is a schematic circuit diagram of the television tuner and chassis coupling arrangement shown in FIGURE 1; and

FIGURE 4 is a schematic circuit diagram of the interconnection between the television chassis IF circuits and the coaxial cable coupled to the components within the conductive enclosure.

Referring now to the drawings, a television picture tube 114 is mounted within a television cabinet 112. The tube is positioned within the cabinet so that the face 116 of the picture tube is viewable through an opening in the cabinet front wall 118. Mounted to the cabinet front wall are a UHF television tuner 120 and a VHF television tuner 122. The television receiver chassis 124 is mounted on the bottom portion of the television cabinet 112. The chassis includes the IF signal processing circuits and other circuitry commonly associated with television chassis to process intermediate frquency signals to obtain video and deflection signals to be applied to the television picture tube 114 and its associated deflection and convergence windings.

While a television tuner is generally considered to include an RF amplifying or preselector stage, a local oscillator stage, and a mixer stage, for the purpose of the discussion relating to FIGURES 1—4, the term tuner is used to indicate the presence of tunable resonant circuits utilized to select a given band of frequencies (television channel) within a larger band of frequencies (54—216 MHz for VHF television signals and 470—890 MHz for UHF television signals). The tuner may or may not contain the entire mixer stage.

The VHF television tuner 122 includes an RF amplifier stage 126 and a local oscillator stage 128 shown in block form in FIGURE 3. Signals from the RF amplifier stage 126 are applied via a coupling cpacitor 130 to the base electrode of a first mixer transistor 132. In a like manner, the local oscillator signal is coupled via a coupling capacitor 134 to the base electrode of the transistor 132. The transistor 132 forms a portion of the television mixer stage and is connected in a common emitter configuration. Operating potential for the transistor is derived from a terminal 136 which is bypassed for signal frequencies by a feedthrough capacitor 137. The potential at the terminal 136 is applied via the voltage divider resistors 138 and 140 to the base electrode of the transistor 132. The potential at the terminal 136 is also applied to the collector electrode of the transistor 132 via a resistor 142. A resistor 144 which is bypassed for signal frequencies by a feedthrough capacitor 146 connects the emitter electrode of the transistor 132 to a fixed reference potential, shown as ground. A feedthrough capacitor 148 is connected to the base electrode of the transistor 132 and, in association with other components, not shown, serves as a peaking network for the signals appearing at the base electrode of the transistor 132.

Output signals from the VHF tuner 122 are derived from the collector electrode of the transistor 132 and coupled via a jack 152 and a plug 154 to signal processing circuits mounted within a conductive enclosure 156. The specific signal processing circuits within the conductive enclosure 156 form the remaining portion of the mixer stage and includes a second mixer transistor 158 and its associated circuitry. As is most clearly shown in FIGURE 1, the conductive enclosure 156 is mounted within the television cabinet 112 in close proximity to the VHF television tuner and at a distance from the television chassis 124.

Signals applied to the plug 154 are coupled via capacitor 160 to the emitter electrode of the second mixer transistor 158.

The capacitor lead coupled to the plug 154 is insulated to prevent accidental shorting (FIGURE 2). The base electrode of the transistor 158 is connected to ground for signal frequencies by a feedthrough capacitor 162. A ferrite bead 164 is applied to the base electrode lead to suppress high frequency oscillation.

The collector electrode of the transistor 158 is connected to a coaxial cable 168 by the parallel combination of an adjustable inductor 166 and a resistor 167. The coaxial cable includes an inner conductor 170 and an outer conductor 172. The adjustable inductor 166 in association with the feedthrough capacitors 173—174 and capacitor 176 from an IF tuned circuit coupled between the collector electrode of the transistor 158 and the coaxial cable 168. Resistor 167 modifies the figure of merit or Q of the tuned circuit to provide the desired frequency bandwidth.

One end of the coaxial cable 168 is connected to the television chassis 124. The inner conductor 170 is connected to the input terminal 200 of the television chassis IF signal processing circuits 186, only the first stage of which is shown (FIGURE 4). The IF signal processing circuits may be similar to those shown in Television Service Data, File 1969 No. T8. Copies of the Service Data may be obtained from RCA Corporation, 600 North Sherman Drive, Indianapolis, Indiana. The outer conductor 172 is connected to the chassis terminal 198 which is maintained at the chassis fixed reference potential, ground potential. The opposite end of the coaxial cable 168 is connected to the conductive enclosure 156 and signal processing circuits. At this end, the inner conductor 170 is coupled to the signal processing circuits and the outer conductor 172 is connected to the conductive enclosure 156. As a result, the conductive enclosure is connected to the chassis fixed reference potential by the outer conductor 172. The cable is connected to the chassis 124 IF signal processing circuits in a manner such that a DC potential is applied to the cable inner conductor 170. A source of DC potential for the IF signal processing circuits is applied to the chassis terminal 202. The terminal 202 is coupled by a resistor 188 to the terminal 200 to apply the potential to the cable inner conductor. The resistor 188 cooperates with filtering capacitors, not shown, to prevent the IF signal applied to the terminal 200 from affecting the B+ supply.

Operating potential for the second mixer transistor 158 is obtained from the coaxial cable inner conductor 170 and is applied to the collector electrode of the second mixer transistor 158 via the adjustable inductor 166. The emitter electrode of the transistor 158 is returned to the chassis fixed reference potential by resistor 178 which is partially bypassed by a feedthrough capacitor 180. The resistor 178-capacitor 180 combination functions to roll off the transistor's high frequency gain to help prevent spurious oscillations. The operating potential obtained through the coaxial cable inner conductor 170 is also applied to the base electrode of the transistor 158 by the voltage divider resistors 182 and 184.

Although the second mixer transistor 158 heterodynes RF and local oscillator signals applied to plug 154, it also provides amplification of IF signals at the plug. These IF signals result from the heterodyning of RF and local oscillator signals in the first mixer transistor 132. Because the conductive enclosure 156 is mounted at a distance from the television chassis circuits, undesired interaction between the second mixer transistor and its associated circuitry with the television chassis 124 IF circuits is significantly minimized. During manufacture, the cable 168 and conductive enclosure 156 with its circuitry are assembled with the television chassis 124. When the television chassis is aligned, the plug 154 is connected to a suitable source of signals and the various tuned circuits are adjusted. The capacitor 160, connected between the plug 154 and the emitter electrode of the second mixer transistor 158, prevents the DC potential at the emitter electrode of the second mixer transistor 158 from being applied to the plug 154. This reduces the possibility of accidental shorting and shock hazard. The VHF television tuner 122 may be separately manufactured and independently aligned.

WHAT WE CLAIM IS:—

1. A mixer circuit according to any claim of the main British patent specification 1,251,706 in which the module which includes the second transistor is screened in an electrically conductive enclosure, the output of the transistor being connected through a shielded cable extending from the enclosure to a unit on which an IF signal processing circuit is mounted.

2. A mixer circuit according to claim 1 in which the second transistor module is separate from but connects mechanically and electrically by plug and socket means to the module for said first transistor and separate from a preceding RF tuner stage, the plug and socket also effecting signal transfer between the transistors.

3. A mixer circuit according to claim 1 or 2 in which the shielded cable has two conductors, of which one couples the output electrode of said second transistor to the input of said IF circuit, and the other conductor DC-connects the conductive

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enclosure to a fixed reference potential point on the IF processing unit.

4. A mixer circuit according to claim 3 in which said one conductor is a DC connection between said second transistor and said IF input which input is at a point of potential such as to provide DC energisation of the second transistor, in addition to its signal output to the IF input.

5. A mixer circuit according to claim 4 in which said second transistor has its input electrode coupled to receive its input signal through a capacitor.

6. A mixer circuit according to claim 5 in which the module and enclosure for the first and second transistors respectively are mounted in close proximity to each other compared with their distance from said IF unit.

7. A mixer circuit according to claim 6 in which said respective module and enclosure and said unit are mounted within a television receiver cabinet, the module and enclosure being in a different part of the television cabinet from the unit.

8. A mixer circuit according to any of claims 1—7 wherein the shielded cable is a coaxial two conductor cable.

9. A mixer circuit according to claim 1 and substantially as hereinbefore described in conjunction with Figures 1—4.

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