

SPECIFICATION

Self-oscillating mixer stage

- 5 The invention relates to a self-oscillating mixer stage, for example for an FM radio receiver comprising a transistor connected as an oscillator, an input radio-frequency signal path coupled to the base-emitter circuit of said
- 10 transistor, an output intermediate-frequency signal path to which the collector circuit of said transistor is coupled, and an absorption circuit for the intermediate-frequency signal, said absorption circuit comprising an inductance and a capacitance and being included in the emitter circuit of said transistor.

- Known self-oscillating mixer stages of this type are usually operated in the grounded-base circuit mode both to produce the oscillator signal and also to process the radio-frequency and intermediate-frequency signals. An important requirement such self-oscillating mixing stages must satisfy is that the intermediate-frequency part of the circuit should be
- 25 properly isolated from the oscillator part or the circuit to ensure that the stage performs its function as both oscillator and intermediate-frequency stage in a satisfactory manner over the entire tuning range and that no instabilities occur.

It is an object of the invention to provide a simple way in which this can be achieved.

- The invention provides a self-oscillating mixer stage comprising a transistor connected in the grounded-collector configuration as an oscillator, an input radio-frequency signal path coupled to the emitter-base circuit of said transistor, an output intermediate-frequency signal path to which the collector circuit of said transistor is coupled, and an absorption circuit for the intermediate frequency signal, said absorption circuit comprising an inductance and a capacitance and being included in the emitter circuit of said transistor.

- 45 Because the collector circuit from which the intermediate-frequency signal is derived substantially constitutes a short-circuit for the oscillator signal, the possibility that the intermediate-frequency part of the circuit is influenced by the oscillator part of the circuit and, conversely, that the oscillator part of the circuit is influenced by the intermediate-frequency part of the circuit can be made small over the entire tuning range. This in turn enables the mounting and the choice of the values of the individual circuit elements of the self-oscillating mixer stage to be done in an optimal manner, both as regards the function of the stage as an oscillator and the function
- 60 of the stage as an intermediate-frequency stage, without the need for making compromises as regards the wiring of the entire stage in view of the requirement for a separation of the two functions from one another.

- 65 An embodiment of the invention will now

be described by way of example, with reference to the accompanying drawing, which is a circuit diagram of an FM radio receiver front-end including a self-oscillating mixing stage.

- 70 The circuit diagram is that of an FM radio receiver front-end comprising a radio-frequency stage 1, which is followed by a self-oscillating mixing stage 2. The radio-frequency stage 1 consists of a transistor 3, which is operated in the grounded-base circuit mode for processing the radio-frequency signal, for which purpose its base is a.c.-connected to a reference potential via a capacitor 4. The radio-frequency signal received from an aerial 5 is applied to the emitter of the transistor 3 via a radio-frequency input circuit 6 and a coupling capacitor 7. The collector circuit of this transistor includes a resonant circuit 8, which can be tuned to the radio-frequency signal, and the amplified radio-frequency signal is coupled out from the collector of the transistor 3 via a capacitor 9.

- The self-oscillating mixing stage 2 consists of a transistor 10, which is operated in a customary manner in the grounded-base circuit mode to process both the radio-frequency and the intermediate-frequency signals. The radio-frequency signal coupled out from the radio-frequency stage 1 via the capacitor 9 is applied to the emitter of the transistor 10, mixing the radio-frequency signal with an oscillator signal to give an intermediate-frequency signal being effected at the base-emitter junction of this transistor. The intermediate-frequency signal occurs in the collector circuit of the transistor at a resonant circuit 11 which is tuned to the intermediate frequency. The intermediate-frequency signal is coupled out by means of, for example, a winding 12 coupled to the resonant circuit 11 and is then available at the output 13 of the FM receiver front-end for further processing in the remainder of the receiver. As is customary, the emitter of the transistor 10 is connected to the reference potential via an absorption circuit 16 for the intermediate-frequency signal, this absorption circuit being formed by a coil 14 and a capacitor 15 and being tuned to the intermediate frequency, so that the base-emitter junction of this transistor is terminated in a low-impedance manner for the intermediate-frequency signal, as is required for satisfactory operation of the self-oscillating mixing stage. The oscillator signal (which is produced in the mixing stage itself) and also the radio-frequency signal are passed through to the base-emitter junction of the transistor 10, where mixing of the high-frequency signal and the oscillator signal is effected.

- 125 The known self-oscillating mixing stages of this type are also operated in the grounded-base circuit mode as an oscillator to produce the oscillator signal. In these known stages the tunable oscillator resonant circuit is fed from the collector of the transistor and the
- 130

oscillator signal is fed back to the emitter of the transistor, for example via a capacitive voltage divider, to obtain self-oscillation. However, when this is done it is necessary to provide a separation of the signal paths with respect to the oscillator resonant circuit and the intermediate-frequency resonant circuit, particularly in the collector circuit of the transistor, in order to avoid interaction. To this end it is customary to arrange a choke between the collector of the transistor and the intermediate-frequency resonant circuit, this choke operating, insofar as is possible, as a blocking impedance for the oscillator signal, but it is not possible to avoid some interaction occurring. As the frequency of the oscillator signal is tunable over a wide frequency range to provide the required tuning range of the FM receiver, it is, for this reason, not easy to isolate the oscillator circuit from the intermediate-frequency circuit, so that certain compromises as regards the values of the circuit elements of the self-oscillating mixing stage with respect to its functions as oscillator and as intermediate-frequency stage are necessary. This may result in instabilities in the operation of such a self-oscillating mixing stage.

To render such instabilities less likely to occur, the transistor 10 of the self-oscillating mixing stage 2 is operated in the grounded-collector circuit mode as an oscillator to produce the oscillator signal. As can be seen from the circuit diagram, the tunable oscillator resonant circuit 17 is coupled for this purpose to the base of the transistor 10 via a capacitor 18, and the oscillator signal is fed back to the emitter of the transistor via a capacitive voltage divider formed by capacitors 19 and 20 and leading from the base of the transistor 10 to its emitter and thence to the reference potential. In the collector circuit of the transistor 10, the oscillator signal 1 is short-circuited by the capacitor 21 of the intermediate-frequency resonant circuit 11. A very good isolation of the intermediate-frequency resonant circuit 11 from the oscillator resonant circuit 17 can be achieved in this manner, as it can be arranged that substantially no oscillator signal is found in the collector circuit. This enables such a self-oscillating mixing stage to have very good stability over the entire tuning range. Because the oscillator circuit can be properly isolated from the intermediate-frequency circuit, the values of the circuit elements of the self-oscillating mixing stage can be chosen in an optimum manner for the stage to function both as an oscillator and as an intermediate-frequency stage. The only requirement is that the ratio of the inductance of the coil 22 to the capacitance of the capacitor 21 in the intermediate-frequency resonant circuit 11 is chosen so that the capacitor 31 forms an effective short-circuit for the oscillator signal, which it is not difficult to achieve over the entire tuning range of the

frequency of the oscillator signal.

To obtain a satisfactory mixing action, the base emitter junction of the transistor 10 must be terminated in a low-impedance manner for the intermediate-frequency signal, as mentioned above. In the emitter circuit this is realized by the absorption circuit 16, formed by the coil 14 and the capacitor 15. In order to connect also the base of the transistor 10 in a low-impedance manner to the reference potential as far as the intermediate frequency signal is concerned, the capacitor 18 is connected to a tap 23 on the resonant circuit coil 24 of the oscillator resonant circuit 17, so that the capacitor 18 can have a relatively high capacitance and, consequently, form in practice a short circuit for the intermediate-frequency signal. The part of the inductance of the resonant circuit coil 24 which exists between the tap 23 and the reference potential also constitutes a low impedance for the intermediate-frequency signal, so that the requirement that the base of the transistor 10 be connected to the reference potential in a low-impedance manner as far as the intermediate frequency signal is concerned is also satisfied.

It will be obvious that the oscillator resonant circuit 17 can alternatively be coupled in another prior art manner to the base of the transistor 10, provided that there is a low-impedance connection for the intermediate-frequency signal from the base of the transistor to the reference potential. This connection can, for example, be achieved by providing a further absorption circuit which is tuned to the intermediate frequency.

It should be noted that, if so required, the two transistors 3 and 10 can be connected in series as far as d.c. is concerned. If this is done transistors of mutually opposite conductivity types should be chosen and, in addition to the coupling from the collector of transistor 3 to the emitter of transistor 10, their emitters should also be interconnected via the coil 14 of the absorption circuit 16 and an isolating resistor in such manner that the emitter of transistor 3 is connected to the common point of the coil 14 and the capacitor 15 via the isolating resistor. The capacitor 15 of the absorption circuit 16, which is connected to the reference potential, will then function to decouple the radio-frequency signal, in conjunction with the isolating resistor. The d.c. operating point setting of the two transistors 3 and 10 can be realized in a particularly simple manner in this way.

CLAIMS

1. A self-oscillating mixer stage comprising a transistor connected in the grounded-collector configuration as an oscillator, an input radio-frequency signal path coupled to the emitter-base circuit of said transistor, an output intermediate-frequency signal path to



oscillator signal is fed back to the emitter of the transistor, for example via a capacitive voltage divider, to obtain self-oscillation. However, when this is done it is necessary to provide a separation of the signal paths with respect to the oscillator resonant circuit and the intermediate-frequency resonant circuit, particularly in the collector circuit of the transistor, in order to avoid interaction. To this end it is customary to arrange a choke between the collector of the transistor and the intermediate-frequency resonant circuit, this choke operating, insofar as is possible, as a blocking impedance for the oscillator signal, but it is not possible to avoid some interaction occurring. As the frequency of the oscillator signal is tunable over a wide frequency range to provide the required tuning range of the FM receiver, it is, for this reason, not easy to isolate the oscillator circuit from the intermediate-frequency circuit, so that certain compromises as regards the values of the circuit elements of the self-oscillating mixing stage with respect to its functions as oscillator and as intermediate-frequency stage are necessary. This may result in instabilities in the operation of such a self-oscillating mixing stage.

To render such instabilities less likely to occur, the transistor 10 of the self-oscillating mixing stage 2 is operated in the grounded-collector circuit mode as an oscillator to produce the oscillator signal. As can be seen from the circuit diagram, the tunable oscillator resonant circuit 17 is coupled for this purpose to the base of the transistor 10 via a capacitor 18, and the oscillator signal is fed back to the emitter of the transistor via a capacitive voltage divider formed by capacitors 19 and 20 and leading from the base of the transistor 10 to its emitter and thence to the reference potential. In the collector circuit of the transistor 10, the oscillator signal is short-circuited by the capacitor 21 of the intermediate-frequency resonant circuit 11. A very good isolation of the intermediate-frequency resonant circuit 11 from the oscillator resonant circuit 17 can be achieved in this manner, as it can be arranged that substantially no oscillator signal is found in the collector circuit. This enables such a self-oscillating mixing stage to have very good stability over the entire tuning range. Because the oscillator circuit can be properly isolated from the intermediate-frequency circuit, the values of the circuit elements of the self-oscillating mixing stage can be chosen in an optimum manner for the stage to function both as an oscillator and as an intermediate-frequency stage. The only requirement is that the ratio of the inductance of the coil 22 to the capacitance of the capacitor 21 in the intermediate-frequency resonant circuit 11 is chosen so that the capacitor 31 forms an effective short-circuit for the oscillator signal, which it is not difficult to achieve over the entire tuning range of the

frequency of the oscillator signal.

To obtain a satisfactory mixing action, the base emitter junction of the transistor 10 must be terminated in a low-impedance manner for the intermediate-frequency signal, as mentioned above. In the emitter circuit this is realized by the absorption circuit 16, formed by the coil 14 and the capacitor 15. In order to connect also the base of the transistor 10 in a low-impedance manner to the reference potential as far as the intermediate frequency signal is concerned, the capacitor 18 is connected to a tap 23 on the resonant circuit coil 24 of the oscillator resonant circuit 17, so that the capacitor 18 can have a relatively high capacitance and, consequently, form in practice a short circuit for the intermediate-frequency signal. The part of the inductance of the resonant circuit coil 24 which exists between the tap 23 and the reference potential also constitutes a low impedance for the intermediate-frequency signal, so that the requirement that the base of the transistor 10 be connected to the reference potential in a low-impedance manner as far as the intermediate frequency signal is concerned is also satisfied.

It will be obvious that the oscillator resonant circuit 17 can alternatively be coupled in another prior art manner to the base of the transistor 10, provided that there is a low-impedance connection for the intermediate-frequency signal from the base of the transistor to the reference potential. This connection can, for example, be achieved by providing a further absorption circuit which is tuned to the intermediate frequency.

It should be noted that, if so required, the two transistors 3 and 10 can be connected in series as far as d.c. is concerned. If this is done transistors of mutually opposite conductivity types should be chosen and, in addition to the coupling from the collector of transistor 3 to the emitter of transistor 10, their emitters should also be interconnected via the coil 14 of the absorption circuit 16 and an isolating resistor in such manner that the emitter of transistor 3 is connected to the common point of the coil 14 and the capacitor 15 via the isolating resistor. The capacitor 15 of the absorption circuit 16, which is connected to the reference potential, will then function to decouple the radio-frequency signal, in conjunction with the isolating resistor. The d.c. operating point setting of the two transistors 3 and 10 can be realized in a particularly simple manner in this way.

CLAIMS

1. A self-oscillating mixer stage comprising a transistor connected in the grounded-collector configuration as an oscillator, an input radio-frequency signal path coupled to the emitter-base circuit of said transistor, an output intermediate-frequency signal path to



which the collector circuit of said transistor is coupled, and an absorption circuit for the intermediate frequency signal, said absorption circuit comprising an inductance and a capacitance and being included in the emitter circuit of said transistor.

- 5 2. A self-oscillating mixer stage substantially as described herein with reference to the drawing.
- 10 3. An FM receiver front-end circuit arrangement substantially as described herein with reference to the drawing.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1983.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

ERRATUM

SPECIFICATION NO 2038580B

Front page, heading (73) Proprietor
for N V Philips Gloeilampenfabriken Emmasingdl 29
read N. V. Philips' Gloeilampenfabrieken Emmasingel 29,

THE PATENT OFFICE
8 February 1983