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IMAGE-FREQUENCY REJECTION SYSTEM

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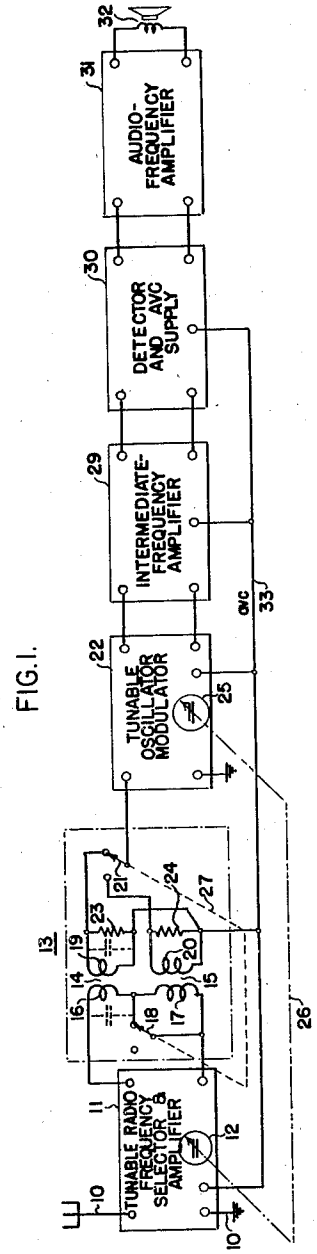



FIG. 1.

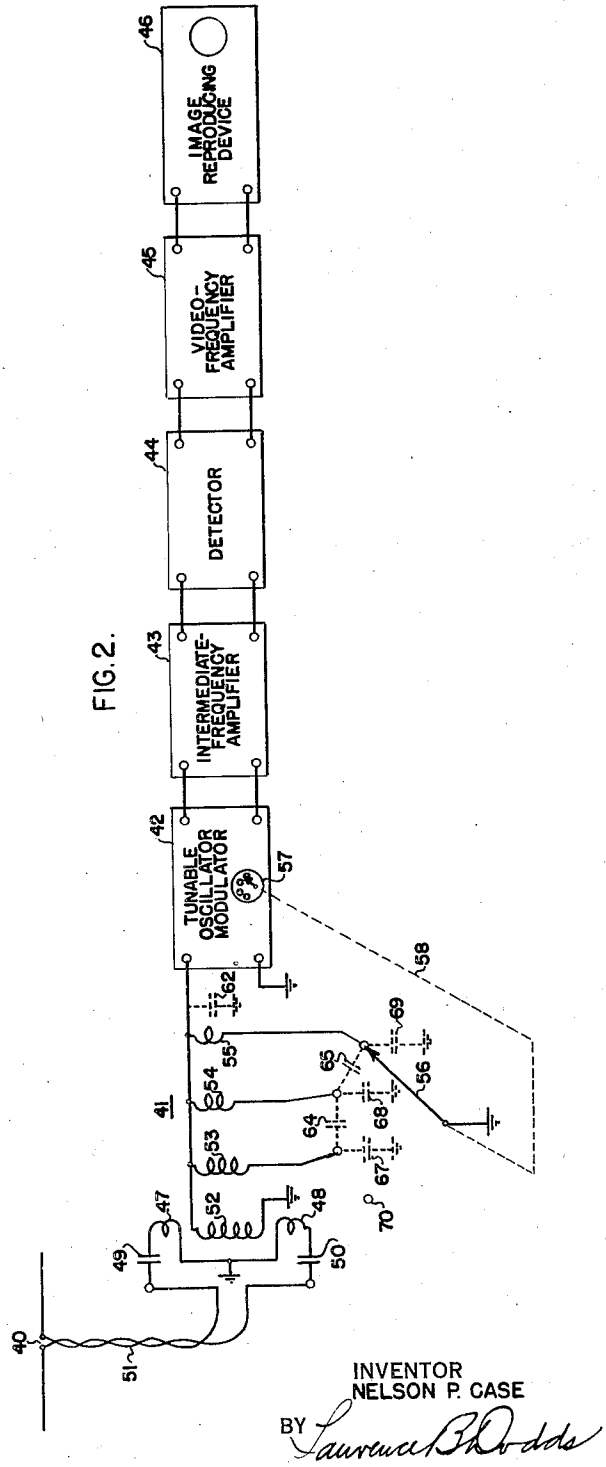



FIG. 2.

INVENTOR
NELSON P. CASE
BY Lawrence B. Dodds
ATTORNEY

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## IMAGE-FREQUENCY REJECTION SYSTEM

Nelson P. Case, Great Neck, N. Y., assignor to Hazeltine Corporation, a corporation of Delaware

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8 Claims. (Cl. 250—20)

This invention relates to image-frequency rejection systems and, more particularly, to carrier-frequency selectors including such rejection systems for modulated-carrier signal superheterodyne receivers.

Superheterodyne receivers are subject to an undesirable response which often arises by virtue of the fact that there are signals of two possible frequencies that produce the required intermediate frequency for any given tuning of the receiver. The undesired signal has a carrier frequency differing from the carrier frequency of the desired modulated-carrier signal by twice the intermediate frequency and is termed the image-frequency signal or simply the image signal.

It is known that the image signals can be eliminated by preventing them from reaching the oscillator-modulator stage of the receiver. This requires that the radio-frequency section of the receiver have an adequate number of tuned circuits and that the intermediate frequency be high enough to cause such circuits to suppress the image frequencies. In present day multiband receivers, an intermediate frequency of about 455 kilocycles is generally used, but image-frequency suppression is none too good in the high-frequency bands because the frequency difference between the desired and image signals represents only a small percentage of the desired carrier frequency.

The problem is particularly troublesome in television receivers due to the relatively low intermediate frequencies used therein. This arises because the carrier frequencies are in the ultra-high-frequency portion of the frequency spectrum, seven television bands having been assigned in the spectrum between 44 megacycles and 108 megacycles. For example, in a television receiver the output of a single local oscillator is usually heterodyned with both sound and picture modulated-carrier signals to produce signals of two intermediate-carrier frequencies of 8.25 megacycles and 12.75 megacycles, respectively. Thus, in receiving the first television channel, assuming a picture modulated-carrier frequency of 45.25 megacycles and a local oscillator frequency of 58 megacycles, the intermediate-carrier frequency is 12.75 megacycles. Thus, the receiver is responsive to an undesired image signal having a carrier frequency of 70.75 megacycles, which is in the picture modulated-carrier signal band of the third television channel.

It is an object of the present invention, therefore, to provide means for minimizing spurious responses to image-frequency signals in superheterodyne receivers.

It is another object of the invention to provide an improved carrier-frequency signal selector for modulated-carrier signal superheterodyne receivers which is effective to minimize response to image-frequency signals.

In accordance with the present invention, in a modulated-carrier signal superheterodyne receiver which is responsive to undesired image-frequency signals, there is provided a carrier-frequency signal selector comprising a plurality of fixed-inductance elements each having capacitance associated therewith and having its constants proportioned to form a broadly-resonant fixed-tuned circuit, and means for selecting any one of the fixed-inductance elements to translate a wide band of signal frequencies. Another of the fixed-inductance elements and its associated capacitance have reactive constants proportioned to resonate at frequencies in the vicinity of the image frequency of the wide band of signal frequencies and, upon selection of one of the fixed-inductance elements, the other fixed-inductance element is coupled thereto whereby image-frequency signals are absorbed by the other fixed-inductance element and its associated capacitance and are minimized in the output of the receiver.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Figs. 1 and 2 of the drawing are circuit diagrams, partly schematic, of a complete multiband superheterodyne receiver and a complete television superheterodyne receiver, respectively, embodying the invention.

Referring to Fig. 1 of the drawing, there is shown schematically a superheterodyne receiver including an antenna-ground circuit 10, 10 to which is coupled a tunable radio-frequency selector and amplifier unit 11 having an adjustable tuning control unit represented schematically by the device 12, the output circuit of the unit 11 being coupled to a two-range band-pass selector 13 comprising a pair of fixed-tuned broad band radio-frequency transformers 14 and 15. The primary windings 16 and 17 of the transformers are connected in series in the output circuit of the unit 11, the winding 17 being provided with a short-circuiting switch 18. The transformer secondary windings 19 and 20 are connected for

individual connection by a switch 21 to the input circuit of a tunable oscillator-modulator unit 22 and are provided with damping resistors 23 and 24, respectively. The unit 22 is provided with an adjustable tuning control unit represented schematically by the device 25. Control units 12 and 25 are connected for simultaneous operation by a unicontrol mechanism conventionally represented by broken line 26; similarly, band switches 18 and 21 are connected for simultaneous operation by the unicontrol mechanism 27. Coupled in cascade to the oscillator-modulator 22 are an intermediate-frequency amplifier 29 of any desired number of stages, a detector and automatic amplification control or A. V. C. supply 30, an audio-frequency amplifier 31, and a sound reproducer 32. The A. V. C. supply is connected by way of a lead 33 to the input circuit of oscillator-modulator 22, and to the grids of one or more of the vacuum tubes of radio-frequency amplifier 11 and intermediate-frequency amplifier 29. It will be understood that the several parts of the system illustrated schematically may be conventional in their construction and operation, the details of which are well known in the art, rendering description thereof unnecessary herein.

Neglecting for the moment the particular operation of the band-pass selector 13 embodying the present invention, the above-described system includes the features of a conventional two-range superheterodyne receiver; the operation of such receiver being well known in the art, a detailed explanation thereof is unnecessary. In brief, however, a desired modulated-carrier signal intercepted by the antenna-ground circuit 10 is selected and amplified in the radio-frequency selector and amplifier unit 11, translated by band-pass selector 13 and converted by oscillator-modulator 22 to an intermediate-frequency signal. The intermediate-frequency signal is amplified by intermediate-frequency amplifier 29 and translated therefrom to the detector and A. V. C. supply 30 wherein the audio frequencies of modulation and automatic amplification control potentials are derived. The audio frequencies of modulation are further amplified in amplifier 31 and delivered to sound reproducer 32 for reproduction in the usual manner. Biasing potentials, developed by the A. V. C. supply 30 in a well-understood manner, are applied to the several tubes in the preceding portions of the receiver by way of conductor 33 and are effective to control the amplification in such tubes, thereby to maintain the amplitude of the signal input to the detector within a relatively narrow range or substantially constant for a wide range of received signal amplitudes.

Referring now more particularly to the parts of the system comprising the present invention, the pass-band of the fixed-tuned transformer 15 may be, for example, the broadcast band which extends from about 540 kilocycles to 1720 kilocycles of the carrier-frequency spectrum and that of the fixed-tuned transformer 14 may be, for example, the short-wave band which extends from about 2.2 megacycles to 6.7 megacycles of the carrier-frequency spectrum, the responses of the transformers being broadened by the damping resistors 23 and 24. Thus, the transformers 14 and 15 comprise a plurality of fixed-inductance elements each having capacitance associated therewith and having its constants proportioned to form a broadly-resonant fixed-tuned circuit. The reactive constants of the transformer 14, that is, its inductances and inherent capacitances, are proportioned to resonate at frequencies in the vicinity of the image frequencies of the wide band of signal frequencies translated by the transformer 15, particularly at signal frequencies in the high-frequency portion of the pass-band of the transformer 15 where image signals are most troublesome. The switches 18 and 21 comprise means for selecting any one of the fixed-inductance elements to translate a wide band of signal frequencies. Thus, the transformer 15 is selected to translate to oscillator-modulator 22 modulated-carrier signals in the broadcast frequency band by operating the switch 18 to open the short circuit across the primary winding 17 of the transformer 15 and operating switch 21 to connect oscillator-modulator 22 to the high potential terminal of secondary winding 20. By virtue of this connection, the windings of transformer 14 are coupled, inductively through proximity of the coil forms, or capacitively through the switch and wiring capacitances, or by a combination of both, to the corresponding windings of transformer 15 and are tuned by their inherent capacitances to act as traps for, or absorb, image-frequency signals of desired signals, especially those of the higher-frequency signals in the broadcast band. As a result, image signals in the output of the receiver are minimized.

In operation, the unicontrol mechanism 27 is first moved to select a desired band of frequencies and the uni-control mechanism 26 is then moved to tune the radio-frequency selector 11 and the oscillator-modulator 22 to the carrier frequency of any desired modulated-carrier signal within the selected frequency band. The band-pass selector 13 automatically minimizes response of the receiver to image-frequency signals when operating in the low-frequency band, particularly the higher-frequency portion thereof.

Referring to Fig. 2 of the drawing, there is shown a signal selector in accordance with the invention utilized as the input selector in a modulated-carrier television superheterodyne receiver. The receiver includes a doublet antenna 40 coupled by a selector 41, constructed in accordance with the invention, to the tunable oscillator-modulator 42 of the receiver. Neglecting for the moment the parts of the selector circuit 41 constituting the present invention, the receiver comprises the following additional elements coupled in cascade, in the order named: an intermediate-frequency amplifier 43, a detector 44, a video-frequency amplifier 45, and an image-reproducing device 46, which may be a cathode-ray signal-reproducing tube. It will be understood that suitable scanning apparatus for the image-reproducing device 46 and synchronizing apparatus therefor are included in the unit 45. The portions of the receiver described above, except selector 41, may all be of conventional well-known construction so that detailed illustrations and descriptions thereof are deemed to be unnecessary.

Referring briefly, however, to the operation of the system described above, television signals intercepted by antenna 40 are selected by selector 41 and supplied to oscillator-modulator 42 wherein they are converted to intermediate-frequency signals which, in turn, are selectively amplified in intermediate-frequency amplifier 43 and delivered to detector 44. The modulation components of the signal are derived by the detector

44 and supplied to the video-frequency amplifier 45 wherein they are amplified and from which they are supplied in the usual manner to a brilliancy-control element of the image-reproducing device 46. The intensity of the scanning beam of device 46 is thus modulated or controlled in accordance with the light-modulation voltages impressed on the control element of the device 46 in the usual manner. Synchronized scanning fields are generated and applied to the device 46, thereby to deflect the scanning ray in directions normal to each other so as to trace a rectilinear scanning pattern on the screen of the tube and reconstruct the transmitted image.

Referring now more particularly to the selector system 41 of Fig. 2 embodying the present invention, there is shown a fixed-inductance transformer comprising primary windings 47, 48, coupled by condensers 49, 50 and a transmission line 51 to antenna 40, and a secondary winding 52. Inductance elements 53, 54, and 55 of progressively decreasing inductance are adapted to be selectively coupled in parallel with winding 52 in the input circuit of the oscillator-modulator 42 by a station-selector switch 56 which is operated with a station-selector switch 57 of the oscillator-modulator unit 42 by a unicontrol mechanism 58, shown conventionally by broken lines. The winding 52 and each of the inductances 53—55, inclusive, is effective to tune the input circuit of unit 42 to predetermined modulated-carrier signals of progressively increasing carrier frequencies. Furthermore, each of the inductance elements 53—55, inclusive, has its reactive constants, including its distributed capacitance and the distributed capacitance of its associated circuit and switch contact, proportioned to resonate at a frequency in the vicinity of the image frequency of the modulated-carrier signals designed to be translated by the circuit including the adjacent inductance element of next higher inductance. The lumped capacitances to ground of the inductances 53—55, inclusive, respectively, are represented by condenser 62 shown in dotted lines. The capacitances 64, 65 between the switch contacts and leads are also represented by dotted lines, as are the capacitances 67, 68, 69 between the switch contacts and ground.

In considering the operation of the signal selector 41, the unicontrol mechanism 58, preferably a push-button system, is adjusted to select desired modulated-carrier signals on a particular carrier frequency, for example, the lowest carrier frequency for which the selector 41 is designed. Thus, the switch 56 is moved to position 70 to couple the transformer winding 52 alone in the input circuit of the oscillator-modulator 42, which is simultaneously adjusted by the switch 57 to the proper oscillator frequency. The winding 52 thereupon supplies modulated-carrier signals of the desired frequency to the unit 42. At the same time the adjacent fixed-tuned circuit, including inductance 53, resonates at a frequency in the vicinity of the image frequency of the desired modulated-carrier signals and, being coupled thereto by capacitance 67, acts to trap or absorb image-frequency signals and thus suppress them from the succeeding portions of the receiver.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a carrier-frequency signal selector comprising, a plurality of fixed-inductance elements each having capacitance associated therewith and having its constants proportioned to form a broadly-resonant fixed-tuned circuit, and means for selecting any one of said fixed-inductance elements to translate a wide band of signal frequencies, another of said fixed-inductance elements and its associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image frequencies of said wide band of signal frequencies, said other fixed-inductance element, upon selection of said one fixed-inductance element, being coupled thereto, whereby image-frequency signals are absorbed by said other fixed-inductance element and its associated capacitance.

2. In a modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a carrier-frequency signal selector comprising, a plurality of fixed-inductance elements each having capacitance associated therewith and having its constants proportioned to form a broadly-resonant fixed-tuned circuit to translate a respective one of a plurality of wide bands of frequencies, and means for selecting any one of said fixed-inductance elements to translate a predetermined wide band of signal frequencies, another of said fixed-inductance elements and its associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image frequency of said predetermined wide band of signal frequencies, said other fixed-inductance element, upon selection of said one fixed-inductance element, being coupled thereto, whereby image-frequency signals are absorbed by said other fixed-inductance element and its associated capacitance.

3. In a modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a carrier-frequency signal selector comprising, a plurality of progressively decreasing fixed-inductance elements each having capacitance associated therewith and having its constants proportioned to form a broadly-resonant fixed-tuned circuit to translate a respective one of a plurality of wide bands of signal frequencies, and means for selecting any one of said fixed-inductance elements to translate a predetermined wide band of signal frequencies, an adjacent fixed-inductance element of lower inductance and its associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image frequency of said predetermined wide band of signal frequencies, said adjacent fixed-inductance element, upon selection of said one fixed-inductance element, being coupled thereto, whereby image-frequency signals are absorbed by said adjacent fixed-inductance element and its associated capacitance.

4. In a modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a carrier-frequency signal selector comprising, a plurality of fixed-inductance elements each having capacitance associated therewith and having its constants proportioned

to form a broadly-resonant fixed-tuned circuit of progressively increasing inductance and distributed capacitance and each tuned to a different predetermined signal-frequency band, means for selecting any one of said fixed-inductance elements to translate a predetermined wide band of signal frequencies, the fixed-inductance element of lower inductance and its associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image frequency of said predetermined wide band of signal frequencies, said fixed-inductance element of lower inductance, upon selection of said one fixed-inductance element, being coupled thereto, whereby image-frequency signals are absorbed by said fixed-inductance element of lower inductance and its associated capacitance.

5. In a multiband modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a multiband-pass selector comprising, a plurality of fixed-tuned inductance elements each having capacitance associated therewith and having its constants proportioned to form a broadly-resonant fixed-tuned circuit tuned to pass modulated-carrier signals in a predetermined broad frequency band, means for selecting any one of said fixed-inductance elements to translate desired modulated-carrier signals in a broad frequency band, another of said fixed-inductance elements and its associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image frequency of the desired modulated-carrier signals, said other fixed-inductance element, upon selection of said one fixed-inductance element, being coupled thereto, whereby image-frequency signals are absorbed by said other fixed-inductance element and its associated capacitance.

6. In a multiband modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a multiband-pass selector comprising, a plurality of fixed-tuned pairs of inductively-coupled fixed-inductance elements each pair having capacitance associated therewith and having its constants proportioned to form broadly-resonant fixed-tuned circuits tuned to pass modulated-carrier signals in a predetermined frequency band, means for selecting one pair of said inductively-coupled fixed-inductance elements to translate desired modulated-carrier signals in a broad frequency band, another pair of said inductively-coupled fixed-inductance elements and their associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image-frequency of the desired modulated-carrier signals, said other pair of inductively-coupled fixed-inductance elements, upon selection of said one pair of inductively-coupled fixed-inductance elements, being coupled thereto, whereby image-frequency signals are absorbed by said other pair of inductively coupled fixed-inductance elements and their associated capacitance.

7. In a multiband modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals, a multiband-pass selector comprising, a plurality of broad band radio-frequency transformers of fixed-inductance having capacitance each associated therewith and having its constants proportioned to form broadly-resonant fixed-tuned circuits tuned to pass modulated-carrier signals in a predetermined separate frequency band, means for selecting one of said transformers to translate desired modulated-carrier signals in a broad frequency band, another of said transformers and its associated capacitance having reactive constants proportioned to resonate at frequencies in the vicinity of the image frequency of the desired modulated-carrier signals, said other transformer, upon selection of said one transformer, being coupled thereto, whereby image-frequency signals are absorbed by said other transformer and its associated capacitance.

8. In a multiband modulated-carrier signal superheterodyne receiver responsive to undesired image-frequency signals and including a radio-frequency vacuum-tube amplifier and a tunable oscillator-modulator stage, a two-band band-pass selector comprising, a first broad band radio-frequency transformer of fixed-inductance having capacitance associated therewith and adapted to form a fixed-tuned circuit tuned to pass modulated-carrier signals in the shortwave frequency band, a second broad band radio-frequency transformer of fixed-inductance having capacitance associated therewith and adapted to form a fixed-tuned circuit tuned to pass modulated-carrier signals in the broadcast frequency band, the primary windings of said transformers being connected in series in the output circuit of said vacuum-tube amplifier, means for selectively coupling the secondary windings of said transformers to the input circuit of said oscillator-modulator stage to translate modulated-carrier signals in a desired frequency band, and means for simultaneously short-circuiting the primary winding of said second transformer upon the coupling of the secondary winding of said first transformer winding to the input circuit of said oscillator-modulator stage, the reactive constants of said first transformer being proportioned to resonate at frequencies in the image-frequency band of the broadcast frequency band, said first transformer, upon selection of said second transformer, being coupled thereto, whereby image-frequency signals are absorbed by said other transformer and its associated capacitance.

NELSON P. CASE.