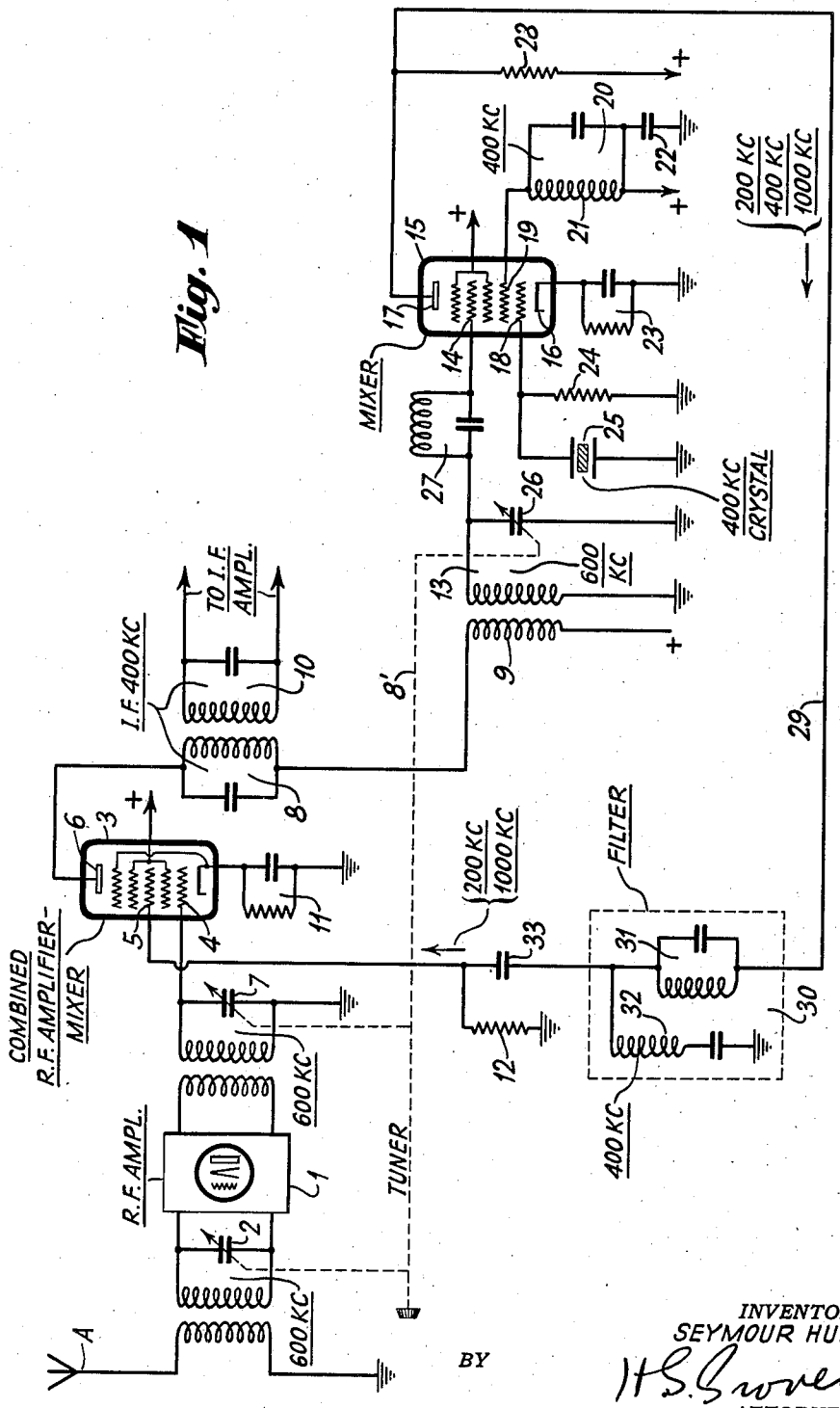
Dec. 13, 1938. S. HUNT 2,140,108

RADIO RECEIVING SYSTEM

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Fig. 1



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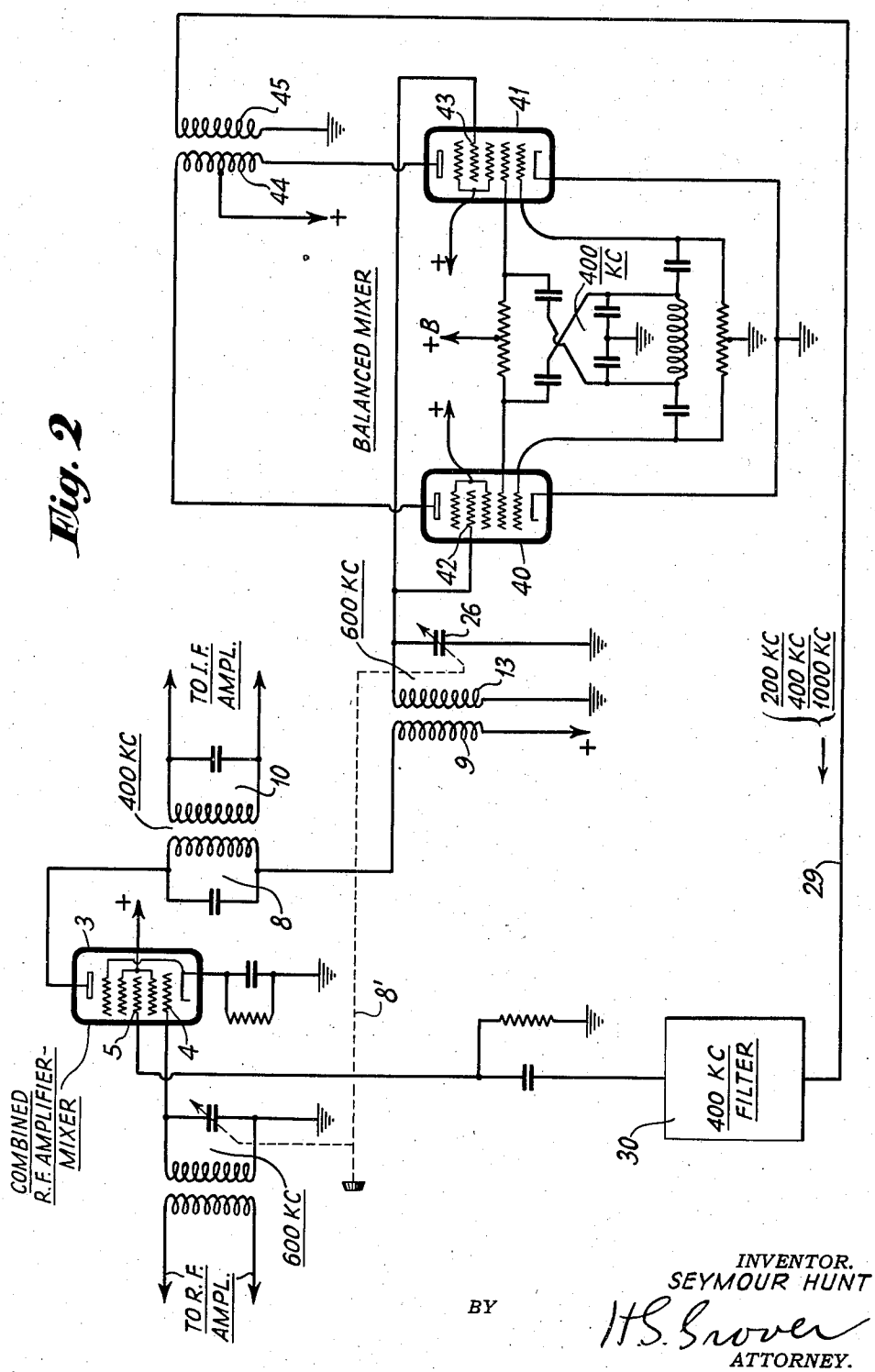


Fig. 2

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RADIO RECEIVING SYSTEM

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8 Claims. (Cl. 250—20)

My present invention relates to radio receiving systems, and more particularly to a receiver of the superheterodyne type employing solely tunable signal circuits for the signal selection process.

One of the main objects of the invention is to provide a method of producing an intermediate frequency (I. F.) from a modulated signal carrier frequency without utilizing tunable circuits tuned to different frequencies.

Another important object of my invention is to provide a signal reception system employing the superheterodyne method; however, the present system employing adjustably tuned selector circuits which are all resonated to a desired carrier frequency, and the local oscillator of the system being fixedly resonated to a frequency which is equal to the desired I. F. value.

Still other objects of my invention are to improve generally the operation and efficiency of superheterodyne receivers, and more especially to provide a superheterodyne receiver which is constructed to be "self-tracking" and is economically manufactured and assembled.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reefrence to the following description taken in connection with the drawings in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawings:

Fig. 1 shows the circuit diagram of a receiver employing my invention,

Fig. 2 illustrates a modification.

Referring now to the accompanying drawings, wherein like reference characters in the two figures designate similar circuit elements, there is shown in Fig. 1 a superheterodyne receiver which comprises any desired type of signal collector A; the latter can be, for example, a grounded antenna circuit. The collected signals are impressed upon the resonant input circuit of the first radio frequency amplifier 1, and the input circuit includes the usual variable condenser 2. The amplified signal modulated carrier energy is impressed upon the succeeding resonant input circuit of a tube 3. The tube 3 can be of the 6L7 type, and is provided with a cathode, signal grid 4, oscillation grid 5 and an output plate 6. The tube may also include screen grid electrodes for shielding the grid 5, and a suppressor grid is utilized between the plate 6 and the fourth grid of the tube. The signal input circuit of tube 3 includes a variable condenser 7 which is of the same construction as the condenser 2. The dotted lines 8' denote the mechanical coupling between the rotors of the variable condensers 2 and 7, and it will be understood that the designation "Tuner" signifies the usual tuning device employed for varying the rotors of the condensers 2 and 7 so as to select different carrier frequencies which are to be received. For example if the receiver is of a broadcast type, then the signal frequency range will cover 500 to 1500 kc. Of course, the receiver may be of the multi-range type.

The plate 6 of tube 3 is connected to a source of positive potential through a path which includes the resonant network 8 and the coil 9. While the sources of direct current voltage for the various tubes are not shown, it will be understood that the customary common voltage supply source may be employed. The network 8 is fixedly tuned to the operating I. F., and the latter may be chosen from a range of 75 to 450 kc. In the present case it is assumed that the circuit 8 is fixedly tuned to an I. F. of 400 kc. The succeeding resonant circuit 10 is similarly fixedly tuned to the operating I. F., and the coupling between the circuits 8 and 10 may be such as to provide a band pass characteristic so that the I. F. carrier and its modulation side bands can be passed to the following I. F. amplifier. It is not believed necessary to show the I. F. amplifier, but it is to be understood that the latter may comprise one or more amplifier tubes. The amplifier 1, as well as the I. F. amplifier tubes, may be of the 6K7 type if desired. The I. F. amplifier, as is well known to those skilled in the art, may be followed by a second detector, and the detected audio energy may be amplified at audio frequency, and then reproduced by a loudspeaker. Of course, the usual AVC circuit may be employed, as by utilizing the direct current voltage component of the rectified I. F. energy, to vary the gain of the R. F. amplifier 1, and the succeeding tubes if desired, in a sense to maintain the carrier amplitude at the second detector input circuit substantially uniform.

The cathode of tube 3 is connected to ground through the usual biasing network 11, and the low potential side of the input circuit of tube 3 is grounded. The oscillation grid 5 of tube 3 is established at a desired negative potential with respect to the cathode by connecting the grid 5

to ground through a grid leak impedance 12. The carrier component, in amplified condition, flowing in the plate circuit of tube 3 is impressed upon the coil 13 by virtue of the magnetic coupling between coils 9 and 13. One end of the coil 13 is connected to the fourth grid 14 of a tube 15; the latter may be of the 6A8 type, and comprises a cathode 16, and output plate 17 and five grids arranged in the electron stream between cathode 16 and plate 17. The first two grids 18 and 19 cooperate with the cathode 16 to provide an oscillator to generate local oscillation energy of the I. F. value. The local oscillator network comprises a resonant circuit 20 which is fixedly tuned to the I. F. of 400 kc. The grid 19 may be connected to a source of positive potential through the coil 21 of resonant circuit 20, an I. F. by-pass condenser 22 connecting the circuit 20 to ground.

The cathode 16 is connected to ground through the biasing network 23, the grid 18 being grounded through a leak resistor 24 so that the grid 18 is established at a desired negative potential with respect to cathode 16. In order to maintain the oscillator network constantly at the desired I. F. value a crystal control element is provided, and a 400 kc.-resonated crystal 25 may be connected across the leak resistor 24 for this purpose. Since the local oscillator network is operating solely at one frequency, the I. F. value, it may be crystal-controlled by any of the well known methods.

A variable condenser 26 is connected in shunt with the coil 13 for the purpose of tuning the input circuit 13–26 of tube 15 over the same signal frequency range as the input circuits of networks 1 and 3. The dotted line 8' denotes the mechanical coupling between the rotors of variable condenser 26 and the rotors of condensers 2 and 7. Of course, the variable condensers 2, 7 and 26 may be a gang of condensers having their rotors mounted on a common, adjustable shaft. If desired, a 400 kc. filter network 27 may be inserted in the lead between grid 14 and the high potential side of input circuit 13–26. The plate 17 of tube 15 is connected to a source of positive potential through a resistor 28, and the lead 29 connects the plate 17 to a filter section 30. The filter section comprises a parallel-resonant circuit 31, tuned to the I. F., disposed in series in lead 29; a series-resonant path 32, tuned to the I. F. as well, is connected between the grid side of circuit 31 and ground. The numeral 33 designates a coupling condenser which impresses 200 kc. and 1000 kc. components upon the grid 5 of tube 3.

To explain the operation of the receiving system, let it be assumed that the variable condensers 2, 7 and 26 have been adjusted to receive a carrier frequency of 600 kc. In that case the first input circuit of amplifier 1 selects the desired carrier frequency, and the selected carrier energy is amplified and impressed upon the input circuit of tube 3. The tube 3, functioning as a radio frequency amplifier, amplifies the 600 kc. carrier energy and impresses the amplified energy upon the input circuit 13–26 of the mixer tube 15. In this mixer network, which is of the well known electron-coupled type, there is produced in the plate circuit of the tube beat energy of 200 kc. and 1000 kc. energy. The combined energies are transmitted through the filter 30, and the 400 kc. energy is prevented from reaching the grid 5 of tube 3.

The tube 3, now functioning as a mixer tube of the electron-coupled type, develops the I. F. of 400 kc. in the I. F. output circuit 8. It will be observed that both the 1000 kc. beat energy and the 200 kc. beat energy will combine with the signal energy of 600 kc. to produce the desired 400 kc. energy. Any other frequency components, produced by the mixing action in tube 3, will not be transmitted through networks 8, 10. The 600 kc. circuit 13–26 may be sharply tuned, if desired, so that only the signal carrier component will be impressed on the mixer tube 15. The resistor 28, in the plate circuit of tube 15, is the load element; the 1000 kc. and 200 kc. voltages developed across load 28 will reach grid 5 of tube 3. The filter 30 will effectively prevent the 400 kc. voltage from reaching grid 5; and 600 kc. voltage produced across resistor 28, if produced at all, will be of such small intensity as to be incapable of causing oscillation in mixer 3. Further, the common audio modulation on the 200, 600 and 1000 kc. carriers at grids 4 and 5 will be in phase, and not cause distortion. If the radio frequency selectivity at grid 14 of mixer 15 is to be increased beyond that degree obtainable by employing loose coupling between coils 9 and 13, or high "Q" coils; then regeneration, at the 600 kc. carrier, from the plate 17 may be employed.

It is, also, possible completely to suppress the 600 kc. or signal carrier frequency component, appearing in the output circuit of mixer 15. This can be accomplished by using a balanced modulator network in place of tube 15. The circuit shown in Fig. 2 differs from that shown in Fig. 1 only in the replacement of mixer 15 by the balanced mixer network. The general construction and functioning of a balanced modulator for carrier suppression in the output circuit is too well known to require a detailed explanation. It will suffice to point out that tubes 40 and 41, which may each be of the 6A8 type, have the 600 kc. carrier energy applied to the grids 42 and 43 thereof in parallel. The plates of tubes 40 and 41 are connected in push-pull across coil 44. Hence, the voltages across coil 44 produced by the 600 kc. voltage on grids 42–43, are out of phase; they cancel out and leave no 600 kc. voltage across coil 44. However, the 100 kc. and 200 kc. voltages appear across coil 44, and are impressed on grid 5 through coil 45 and lead 29. The oscillator electrode sections of tubes 40 and 41 are provided with a common 400 kc. tank circuit.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. A method of signal reception which includes amplifying desired signal carrier energy, beating the amplified carrier energy with locally produced energy to provide sum and difference beat frequency energies, beating the sum and difference beat energies with said desired carrier energy, and deriving signals from the resultant beat energy which have a carrier frequency equal to the frequency of said locally produced energy.

2. In a receiving system, collecting and amplifying selected signal modulated carrier energy, selecting and amplifying the said carrier energy at least one additional time, mixing the resultant

amplified energy with local energy of a different frequency equal to a desired intermediate frequency, mixing the aforesaid carrier energy, prior to said additional time, with beat frequency energy derived from said previous mixing, and selecting from the beat energy of the second mixing energy of a frequency equal to said intermediate frequency.

3. A method of receiving modulated carrier energy of a predetermined band of carrier frequencies which includes selecting a desired carrier frequency, amplifying the selecting carrier energy, producing local oscillations of a predetermined intermediate frequency, combining the amplified carrier energy and the local oscillations, deriving beat energy from the combined carrier energy and local oscillations, combining the derived beat energy with the amplified selected carrier energy, and deriving from the latter combined energies modulated carrier energy of said intermediate frequency.

4. In combination with a mixer tube having independent signal and oscillator grids, means impressing signals of one carrier frequency on the signal grid, means impressing signals of a different carrier frequency on the oscillator grid, means for selecting signals of said one frequency from the mixer tube output circuit, a local oscillator producing oscillations of a fixed frequency different from the said one frequency, means for mixing the oscillations and the selected signals to produce said different carrier frequency signals, and a net work in the mixer tube output circuit resonant to an intermediate frequency equal to the said oscillator fixed frequency.

5. In combination with a mixer tube having independent signal and oscillator grids, means impressing signals of one carrier frequency on the signal grid, means impressing signals of a different carrier frequency on the oscillator grid, means for selecting signals of said one frequency from the mixer tube output circuit, a local oscillator producing oscillations of a fixed frequency different from the said one frequency, means for mixing the oscillations and the selected signals to produce said different carrier frequency signals, a network in the mixer tube output circuit resonant to an intermediate frequency equal to the said oscillator fixed frequency, and said local oscillator and mixing means being provided by a tube provided with separate signal and oscillator grids.

6. In a receiver having a tube provided with a tunable signal input circuit, at least two spaced electrodes in the tube electron stream, one of the electrodes being connected to the signal circuit, a beat frequency output circuit connected to the tube output electrode, a second tunable circuit, said two tunable circuits being tunable over a common signal frequency range, the said second circuit being connected to said tube output electrode whereby the tube acts as an amplifier for signals, a local oscillator operating at the frequency of said beat frequency, means for mixing the signals in said second tunable circuit and oscillations from the oscillator, and means for impressing the beat energy of the mixed signals and oscillations on the second of said two spaced electrodes.

7. In a receiver having a tube provided with a tunable signal input circuit, at least two spaced electrodes in the tube electron stream, one of the electrodes being connected to the signal circuit, a beat frequency output circuit connected to the tube output electrode, a second tunable circuit, said two tunable circuits being tunable over a common signal frequency range, the said second circuit being connected to said tube output electrode whereby the tube acts as an amplifier for signals, a local oscillator operating at the frequency of said beat frequency, means for mixing the signals in said second tunable circuit and oscillations from the oscillator, and means for impressing the beat energy of the mixed signals and oscillations on the second of said two spaced electrodes, said oscillator including a piezoelectric crystal control unit for maintaining the oscillator accurately fixed at said beat frequency.

8. In a receiver having a tube provided with a tunable signal input circuit, at least two spaced electrodes in the tube electron stream, one of the electrodes being connected to the signal circuit, a beat frequency output circuit connected to the tube output electrode, a second tunable circuit, said two tunable circuits being tunable over a common signal frequency range, the said second circuit being connected to said tube output electrode whereby the tube acts as an amplifier for signals, a local oscillator operating at the frequency of said beat frequency, means for mixing the signals in said second tunable circuit and oscillations from the oscillator, means for impressing the beat energy of the mixed signals and oscillations on the second of said two spaced electrodes, and means for preventing the transmission of energy of said first beat frequency value from being impressed on said second electrode.

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