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FREQUENCY CONTROL SYSTEM

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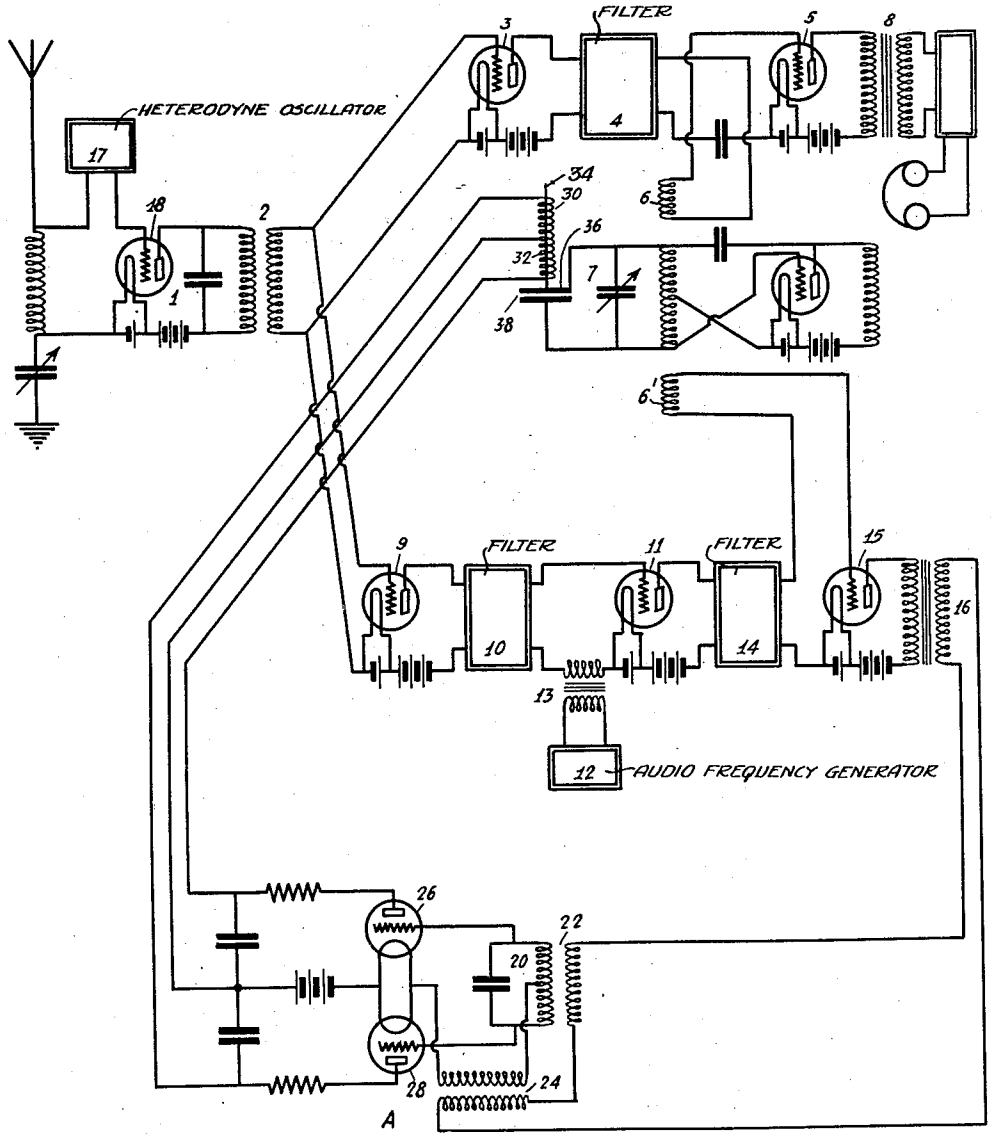

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FREQUENCY CONTROL SYSTEM

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3 Claims. (Cl. 250—20)

In wireless telephone reception it is often of advantage to filter out the received carrier in the receiver and to add a new locally generated carrier. With this arrangement it is possible, among other things, to eliminate the variations in intensity of the received carrier, caused by selective fadings and resulting normally in sound variations.

The added, artificially generated carrier must coincide substantially exactly in frequency with the received and suppressed carrier in order to avoid intolerable speech distortions. Such coincidence is, at the present time possible of realization, with an independent synchronism of transmitter and receiver, only on medium and long waves. With frequencies used in short-wave telephony, the oscillation generators known to-day, however, are not steady enough to permit the generation of a distortion-free supplementary carrier without the employment of additional means.

One well known method heretofore practiced for automatically regulating the frequency of a local generator adapted to restore a carrier wave is as follows: The transmitter is supplementarily modulated by a low-frequency tone of a frequency as nearly constant as possible and lying outside of the frequency of the speech band to be transmitted. At the receiver one side band and the carrier are eliminated. The other receiver side band, including the side frequency obtained by the modulation with one tone, is supplemented by an artificial carrier. Subsequent to signal demodulation the speech frequencies and the auxiliary tone frequency are separated by low frequency devices.

The difference in frequency, in cycles, between the pitch of this auxiliary tone and the auxiliary tone used for the modulation of the transmitter is equal to the difference between the supplementary carrier and the received carrier. By known methods the deviation of the auxiliary tone from its calculated value is made to automatically adjust the artificial carrier to its required value. Such an arrangement is described in my Patent No. 1,917,395 granted July 11, 1933.

The objectionable feature of this method is the impossibility of applying it to any but such transmitters which have been modulated with an auxiliary tone of suitable pitch and the necessity for the transmitter to supply the energy required to emit the side bands created by the modulation.

According to the present invention the transmitter is modulated not by an auxiliary tone but by the message signals to be transmitted. At the receiver a side band is at first separated, demodulated together with an artificial carrier frequency and conducted to the output end of the receiver. The distant carrier frequency is singled out of the remainder and modulated by means of an arbitrary audio frequency produced by a constant audio frequency generator. Of the hereby generated side frequencies one is filtered out by further selection and demodulated together with the supplementary carrier frequency. The deviation of the demodulated tone from the frequency of the audio frequency generator is equal, in cycles, to that of the artificial carrier from the supplementary carrier frequency. By certain known means, which are described later in this application, a correction is derived by comparison of the demodulated tone with its calculated value, this correction changing automatically the tuning of the generator producing the supplementary carrier until the demodulated tone has reached its required value and the supplementary carrier frequency equals the received carrier frequency.

A better understanding of the present invention may be had by referring to the following detailed description taken in conjunction with the accompanying single drawing.

An intermediate frequency is generated in the rectifier 18 by means of the heterodyne 17 and the received radio frequency energy and is applied to the grid of the rectifier 18. The intermediate carrier frequency with both side frequencies is fed into the circuit 1 from the rectifier 18. It is immaterial whether the transmitter has been modulated in a normal way with the full carrier frequency or if the latter has been attenuated, for the sake of economy, to a fractional yet discernible value at the transmitter. Received energy now reaches tube 3 by way of the transformer 2. Beyond tube 3 one side band is passed by the filter 4 whereas the carrier frequency and the other side band are by-passed. Filter 4 may also be combined with an amplifying arrangement or may be a tuned amplifier to effect a further amplification of the passed side band. The rectifier 5 is fed from the output of filter 4 as well as from the generator 7 of the supplementary carrier, by way of the coupling coil 6. The audio frequency outlet 8 lies beyond the rectifier 5 which demodulates the message signals.

From the transformer 2 energy is supplied not only to tube 3, but also to tube 9 connected in parallel with tube 3. The entire received signal energy including carrier and side bands are passed by tube 9 to filter circuit 10. This filter

passes the carrier only, eliminating both side bands. Filter 10 may also be combined with an arrangement for amplifying the carrier wave, if so desired. The input circuit of rectifier tube 11 is supplied with energy not only by the carrier currents passing through filter 10, but also by the currents from the audio frequency generator 12 over the transformer 13. The output of rectifier 11 is thus caused to provide an oscillation which is modulated by the tone of generator 12. Of this modulated oscillation, one side frequency is passed by the filter 14 associated with the output of rectifier 11, while the carrier and the other side frequency are surpressed. Of course, if desired, filter 14 may be combined with an arrangement for amplifying the frequency passed therethrough.

The rectifier 15 is supplied not only by the side frequency passed through the filter 14 but also by the generator 7 producing the supplementary carrier frequency, by way of the coupling coil 6'. The rectifier 15, therefore, delivers to the audio frequency output 16 a beat note whose frequency is as many cycles above or below the audio frequency generator, as the frequency of the supplementary carrier generated at 7 is above or below the received carrier frequency, passed through filter 10.

The frequency derived at 16 is conducted to a device A which delivers a direct current in one direction, whenever a certain frequency limit is exceeded, and which makes a direct current flow in the other direction whenever the frequency falls short of a certain value. The currents delivered by this device or relay are used to increase or diminish the frequency of the supplementary carrier generator 7 inasmuch as they cause a reduction if the frequency of generator 7 is too high, and an increase in case the frequency of generator 7 is below the required frequency. The correcting arrangement itself may be similar to the one described in my copending patent application referred to.

In the present case, phase shift relay A comprises a pair of tubes having a tuned input circuit 20 tuned to the frequency of the audio frequency generator 12. By virtue of transformers 22, 24 audio frequency currents from rectifier 15 are fed in phase quadrature to the tubes 26, 28, which supply equal plate currents through coils 30, 32 when the supplied frequency corresponds to the tuning of circuit 20.

Should there be a shift in frequency supplied by rectifier 15, currents through coils 30, 32 will become unequal causing movement of plunger 34 and hence movable plate 36 of condenser 38 in one direction or another, thereby correcting the frequency or the local carrier generator.

In the operation of the system let us suppose that the carrier passing through transformer 2 is 175 kilocycles and that local generator 7 is tuned to generate 175 kilocycles plus some correction factor δ; also that audio frequency generator 12 is designed to generate a frequency of 5 kilocycles. The incoming signals are received and amplified by vacuum tube 9 in the output of which is filter 10, the latter permitting only the carrier of 175 kilocycles to pass and suppressing both side bands. The 175 kilocycle carrier, together with the audio frequency of 5 kilocycles will produce in the output circuit of rectifier 11 a 180 kilocycle side frequency which will be passed by filter 14. This side frequency of 180 kilocycles will be added to the 175 plus δ frequency generated by local generator 7 to obtain a current on the grid of rectifier 15 equal to $180+(175+\delta)$. There will, therefore, appear in the output of rectifier 15 a current of a frequency equal to 5 kilocycles minus δ which will be applied to phase shift relay A. Tuned circuit 20 will be tuned to 5 kilocycles. Now depending upon whether the frequencies applied to phase shift relay A are more or less than 5 kilocycles, the output of phase shift relay A will affect solenoid 30 to increase or decrease the capacity of condenser 38. Although it has been stated that the output 16 of rectifier 15 is 5 kilocycles minus δ, it should be remembered that the correction factor may have a reversal of sign and, therefore, the frequency applied to phase shift relay A may be more or less than 5 kilocycles. In this manner any departure of generator 7 from a desired frequency will be compensated for.

I claim:

1. In a receiving system wherein the frequency of a local carrier is controlled to bear a desired relation with respect to the frequency of received carrier energy, a local carrier generator, means for isolating received carrier energy, means for modulating the isolated carrier with locally generated low frequency energy, means for isolating a side frequency of the modulated energy, means for demodulating the side frequency energy together with carrier energy from the local carrier energy generator, and means responsive to the demodulated energy for controlling the frequency of the local carrier generator.

2. The method of controlling the frequency of a local carrier generator which includes collecting modulated carrier energy, filtering out carrier energy from the collected energy, modulating the filtered carrier energy with locally generated energy of low frequency, combining the resultant energy with locally generated carrier energy, demodulating the combined energy and varying the frequency of the locally generated carrier energy in response to the demodulated energy.

3. In a receiving system the method of regulating the frequency of locally generated carrier energy which includes collecting transmitted modulated carrier energy, filtering out carrier energy from the collected energy, locally generating audio frequency energy, combining the filtered carrier with the locally generated audio frequency energy, combining the combined energies with the locally generated carrier energy, demodulating the resultant energy and varying the frequency of the local carrier generated in a desired direction whereby it bears a desired relation in frequency, with the received carrier energy.

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