Oct. 10, 1939. P. M. G. TOULON 2,175,367

SHORT WAVE BROADCAST SYSTEM

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Fig. 1

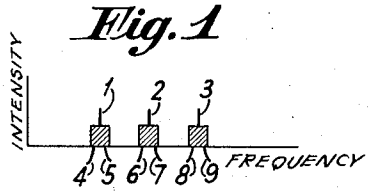


Fig. 2

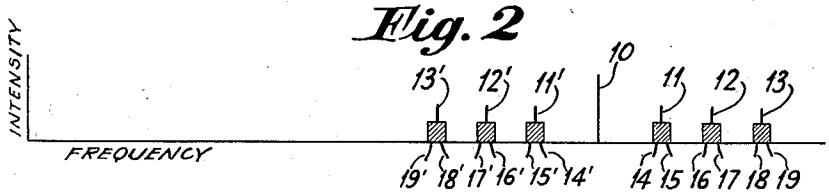


Fig. 3

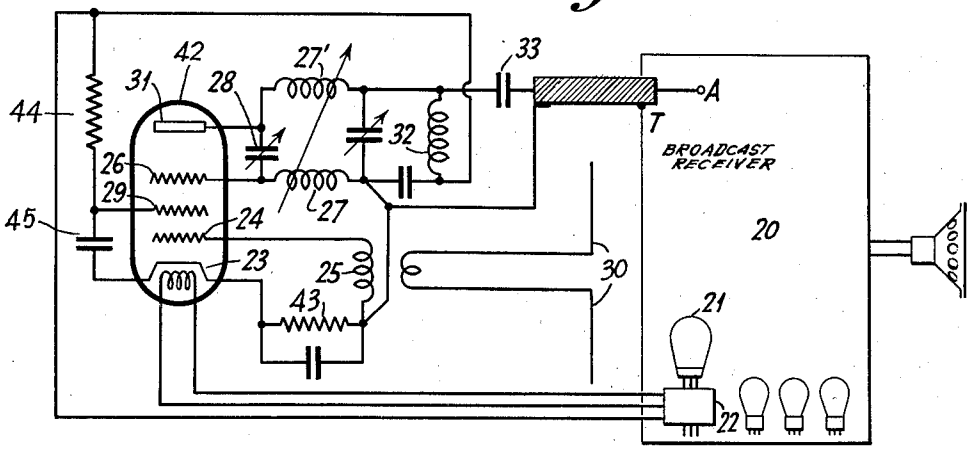
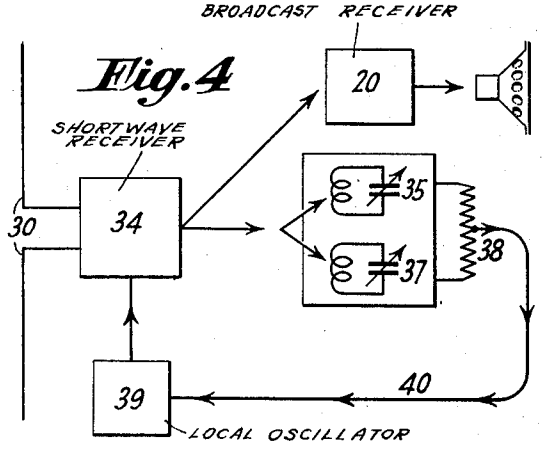


Fig. 4



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SHORT WAVE BROADCAST SYSTEM

Pierre Marie Gabriel Toulon, Paris, France

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In France November 26, 1935

1 Claim. (Cl. 250—9)

This invention relates to improvements in multiple radio broadcasting systems involving short waves.

It is known that it is possible to modulate a transmitting station that utilizes very short waves—100×10^6 cycles per second—at very high frequencies up to 10^6 cycles per second. It has already been proposed to obtain multiple communications through a single transmitting station, by modulating the carrier wave by means of a certain number of auxiliary frequencies which, in turn, are modulated at a low frequency.

The present invention deals with a new method of radio broadcasting, as well as with a new method and physical embodiment for stabilizing the receiving set so as to make it possible to separate easily the various programs that are transmitted simultaneously on the carrier wave and to bring about at will in the loudspeaker the reception of one or the other of the different emissions that are transmitted simultaneously.

The invention is characterized by the use of a heterodyne tube which is constrained to operate at the frequency of the extra short carrier wave that demodulates the emission and permits obtaining directly an intermediate frequency which can be then directly selected by an ordinary radio broadcast receiving set.

The advantage of being able to transmit simultaneously a large number of transmissions on the same high frequency carrier wave is evident: The different modulations may be received with equivalent strength; fading and static will affect the transmission as little as possible, and the latter may be chosen on a particularly favorable wave that is transmitted by a station in the center of the city; finally, the same station may, with comparatively little power, transmit simultaneously a large number of independent concerts. The apportioning of the different stations within the spectrum, that is to say the gap between the frequencies may be selected as judiciously as possible, a feature which is not possible in the case of the relatively long waves that are now being used (100 to 1000 kilocycles per second).

Several figures attached to the text give an idea of the characteristics of the new modulation of the synchronized receiver and of the selecting systems which insure the selection between the different stations.

Fig. 1 represents the spectrum of emission of the actual radio broadcasting systems.

Fig. 2 shows the aspect of the spectrum of emission of a modulated station having a multiplicity of frequencies which permits, by means of one single transmitting station, obtaining the same number of transmitted radio programs as in the case of Fig. 1.

In the two figures, I have shown as abscissas in logarithmic coordinates, the frequencies in cycles per second and in ordinates, the intensities of the radio transmissions.

Fig. 3 represents a wiring diagram of a heterodyne tube which can fall into step with the carrier wave.

Fig. 4 represents the diagram of connection of a group of two oscillating circuits which permit the automatic tuning of the homodyne which is constrained to operate on the carrier wave, so as to obtain the demodulation.

All these figures are only given by way of example, and it is evident that my invention may be realized in many other ways, all of which would come within the scope thereof which consists in utilizing, at the receiving end, a heterodyne, the frequency of which varies so as to fall in step with that of the transmitting station and so as to permit a demodulation of the wave originating from the transmitting station, which demodulation is perfectly stable and capable of being selected by conventional receiving sets.

As Fig. 1 shows, the present radio broadcasting stations transmit their signals on wave lengths ranging from 150 to 1500 kilocycles per second. We have shown at **1**, **2** and **3** the carrier wave corresponding to these different stations. The modulation has the purpose of creating, on both sides of the carrier wave, sidebands, such as **4—5** for the station **1**, **6—7** for the station **2**, **8—9** for the station **3**, etc. In order to permit an easy selection of the various stations, a certain distance must be maintained between the different modulation bands. However, the overcrowding of the ether and the excessive closeness of the frequencies allotted to the different stations cause the pass bands to overlap, so that the selection becomes impossible and musical interference becomes audible. Moreover, the considerable variation in the distance on the one hand and in the power on the other hand, and finally the fading of the transmitted carrier waves make the selection of the different stations rather difficult from a practical standpoint. The automatic variation of the power (anti-fading) and the oscillating circuits with abrupt pass band (stations with variable selectivity) will not suffice to permit a good selection of the various emis-

sions and an easy and even audition, free from heterodyne between the various stations.

In conformity with the invention, the ultra short-wave transmitting station (100,000 kilocycles per second) is located in the center of the city which is to be served, so that the different receiving antennas are in the line of direct visibility from the transmitting station. Moreover, the transmitting station is connected to the various studios, either by wires, or by means of an appropriate number of highly-perfected receiving sets. In this manner, the modulation of the different concerts to be transmitted simultaneously is perfect and suitably leveled as regards power.

As is represented in Fig. 2, a carrier wave 10, modulated at different frequencies 11, 12 and 13 is used. The modulation of the carrier wave has the effect of creating an image spectrum at 11', 12' and 13'. The auxiliary carrier waves are, in turn, modulated at low frequency with the result that there is created, on both sides of each auxiliary modulation, a pass band 14—15 for the wave represented at 11, another pass band 16—17 for the wave represented at 12 and a third pass band 18—19 for the wave represented at 13. These modulation bands have their image 14'—15', 16'—17', 18'—19'. Fig. 2 represents thus the whole of the emission spectrum of the new station in conformity with the invention. If a local oscillator is mounted in the receiving set which has exactly the same frequency as that of the carrier wave 10, it will be possible to separate the lateral carrier waves 11, 12 and 13, and to transmit them, after demodulation, into a conventional radio broadcast receiving set. The great advantage of the device is that the auxiliary carrier waves 11, 12 and 13 have the same amplitude, so that the selection will cause no difficulties; moreover, static has disappeared as well as whistling noises, and the reception of all radio programs is improved.

The problem of using such transmission is thus solved by introducing, in the radio receiving station, a local oscillator, the frequency of which remains in concordance with that of the transmitting station.

According to the preferred variant of the invention, a tube is used which falls into step with the received short waves, and which acts at the same time as detector so as to supply to the normal radio broadcasting receiver, the modulated wave which falls within its sensitivity range. One selects preferably a tube provided with several groups of independent grids, for instance a three-grid tube. As is shown in Fig. 3, this tube is mounted toward the receiving end of the conventional receiving set 20 which is represented schematically and which may be of any conventional type. One of the tubes 21 of the set is removed so as to be able to place an adapter 22, making it possible to obtain the heating and plate voltages that are necessary for supplying the auxiliary tube 42. This tube comprises a heating filament, a cathode 23, a grid 24 connected to a coil 25 and negatively polarized by virtue of its connection to the end of resistance 43 remote from the cathode 23. Grid 24 receives the carrier wave, picked up by the ultra short-wave dipole 30 that is shown schematically. Auxiliary tube 42 comprises also a second grid 29 which receives a positive polarization through a resistance 44 and the potential of which is stabilized by a condenser 45 connected to the cathode. The third grid 26 of the auxiliary tube is coupled to a coil 27, constituting a part of an oscillating circuit which comprises that coil and a capacitance 28. This coil is connected besides to a coil 27' which is tied to the anode 31 and which forms also a part of that oscillating circuit. The anode circuit of that tube is coupled, through a capacitance 33 and a choke coil 32, to the antenna connection of a conventional radio receiving set 20. In this figure, T indicates the ground terminal. It will be easily understood that the tube which is thus connected will be capable of automatic synchronization on the frequency of the carrier wave and of remaining in step, in phase with it. The oscillating system 27—27'—28 is so designed that its natural wave length comes very close to that of the carrier wave to be received. Because of the fact that the grid 26 is negatively polarized and grid 29 receives a positive polarization, the phenomenon of a virtual cathode between the two is produced. Under these conditions, the grid 24 has the effect of producing a periodical variation in the amplitude of the electron flux emitted by the virtual cathode. Thus, if a slight lead in the current phase tends to manifest itself in the oscillating circuit 27—28 with respect to the current received from the transmitting station, this lead tends to disappear automatically. Vice versa, if the phase of the oscillating circuit 27—28 tends to lag, the system operates so as to cause an automatic leading of the phase of oscillation of grid 26. In this manner, the oscillating potentials of grids 24 and 26 tend automatically to fall back into phase. The coincidence of the vectors of the oscillating potentials has the effect that the real frequency of oscillation of circuit 27—28 remains always strictly equal to the signal frequency impressed on the grid 24, even if the characteristics of the oscillating circuit 27—28 would define a different inherent frequency. This phenomenon of falling into step may be easily understood if it is compared to that of a single phase alternator (oscillating circuit 27—28) which rotates at a certain speed and furnishes a current, the phase and frequency of which are slightly different from that of the network (dipole 30). It suffices to connect it to the network (the junction taking place through the virtual cathode) to cause the falling into step of the alternator, which means that its phase and frequency become equal to that of the network. The condenser 33 leads the beat frequencies, comprised between 100 and 1000 kilocycles per second, to the input circuit A of station 20. These beat frequencies, which are themselves modulated by a low frequency, act on the receiving set 20, which then permits their selection with considerable ease. Thus, the invention permits adapting a normal station and without modifying it to the reception of the new system of radio broadcasting which is one of the objects of my invention.

According to the variant of the invention, the first changing of frequency by means of an oscillator which "has fallen into step", can be realized by a tube which is connected as an autodyne. In this circuit, the oscillating circuit, instead of being coupled through the virtual cathode (as was the case in the former embodiment) is directly connected through capacitive, inductive coupling, or through direct insertion in the circuit, to the antenna circuit. This system is of less value than the preceding system because the autodyne will radiate. In order to avoid this radiation, one can insert, ahead of the autodyne, a separating tube. However, the embodiment

shown in Fig. 3 has the same advantage without the necessity of adding an extra tube.

Instead of a system which falls into step with the carrier wave, one can also use, although in a less practical manner, all the systems which permit automatic tuning. By way of example, I have shown in Fig. 4 a well-known circuit of automatic tuning which makes it possible, by means of two oscillating circuits that are tuned, respectively, to frequencies above and below the carrier wave to be received, to insure automatically the synchronization of the oscillator. In my description, I have limited myself to those elements that are strictly indispensable to the understanding of the system. In this figure, the rectangle **34** represents schematically the receiver which is associated with the collecting dipole **30**; items **35** and **37** denote the two oscillating circuits which receive the frequency amplified by the amplifier **34** and which permit obtaining on a potentiometer **38** a voltage, the amplitude of which varies as function of the variation of the frequency of the transmitting station. At **39**, I have represented the local oscillator which reacts on the amplifier **34**, while at **40**, I have shown the connection which modifies the frequency of the oscillator **39** under the influence of the potential differences engendered in potentiometer **38**. The operation of this portion of the device is described more fully in a patent to H. J. Round, #1,642,173, patented September 13, 1927. The main feature of the known hook-up of a device with automatic tuning lies essentially in the fact that the frequency of the oscillator **39** tends automatically to come closer to that of the carrier wave of the station to be received by an amount which is constant.

The demodulated waves are transmitted to a receiving set **20** of conventional design which insures the selection, through the normal ways, of the various programs transmitted simultaneously.

In certain cases where one is ready to sacrifice selectivity, one can, instead of utilizing an oscillator, detect simply the extra high-frequency wave, preferably by means of a crystal which requires no supply voltage.

Although I have described here only the general features of the new method, it is evident that the invention covers not only the constructive arrangements which were given by way of non-limiting examples, but that it covers also any device which has the same purpose, that is to say the separation of the different carrier waves that are transmitted simultaneously.

What is claimed is:

A signalling system comprising a transmitting station having a source of ultra-high frequency carrier waves, means for multiplex-modulating the energy from said source by different waves of relatively lower frequency, means for modulating each of said lower frequency waves by a different message signal, means for radiating the carrier waves thus doubly modulated, thereby to transmit a plurality of messages simultaneously, a receiving system having an antenna and a multiple-grid electron discharge tube, an input circuit connected between the cathode and one grid of said tube and coupled to said antenna, a homodyning oscillator constituted by a resonant network connected to the anode, the cathode and a second grid of said tube, means connected to said tube for deriving from said doubly modulated carrier wave a signal-modulated wave of one of said relatively lower frequencies, means for detecting the selected signals, and means operable by the receiving wave energy for controlling the frequency of said oscillator.

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