July 5, 1927. 1,635,156

E. E. CLEMENT

RADIO BROADCAST DISTRIBUTING SYSTEM

Filed Oct. 21, 1925

Fig. 1.

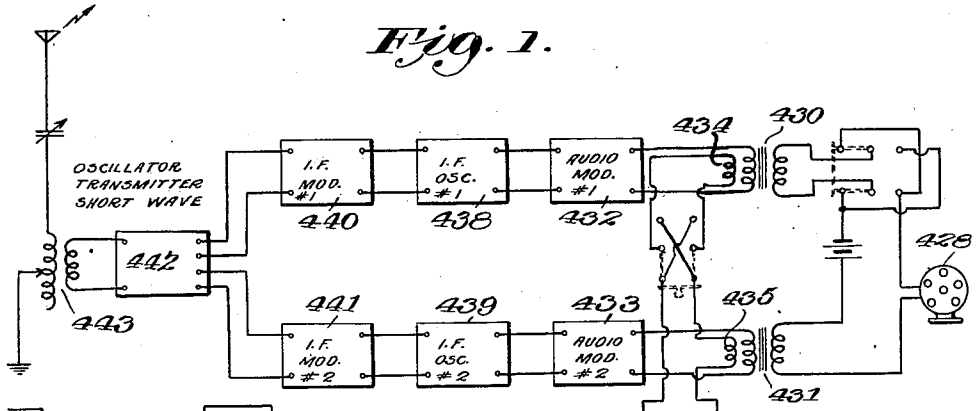


Fig. 1a.

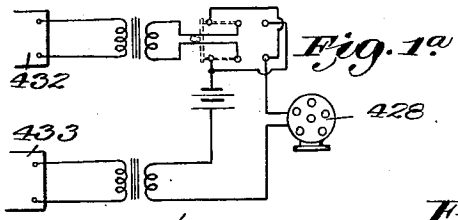


Fig. 2.

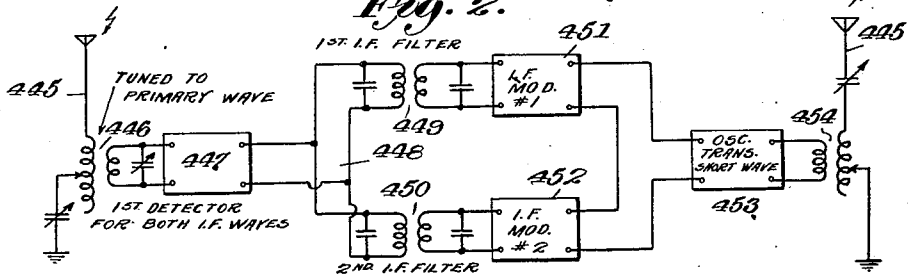


Fig. 3.

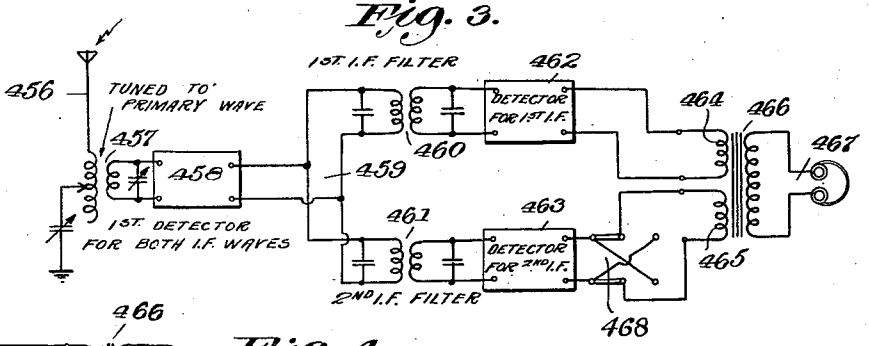
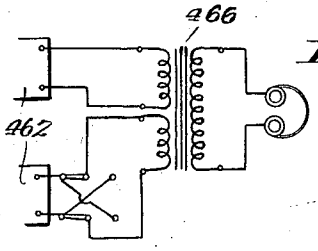


Fig. 4.



Inventor

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UNITED STATES PATENT OFFICE.

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RADIO BROADCAST DISTRIBUTING SYSTEM.

Application filed October 21, 1925. Serial No. 63,977.

My invention relates to systems of radio broadcast distribution, and the present application is a continuation in part of my prior copending application, filed May 21, 1925, Serial No. 31,928. This invention has for its object to provide an organization for the broadcasting of intelligence in which orderly distribution, selective receiving, and secrecy may be secured, with maximum efficiency.

Very briefly stated, this system includes subdivision of the ultimate units or subscribers' stations into local groups in local areas, each group related to a local or regional distributing station; the grouping of these regional stations according to districts and relating each district group of regional stations to a district master station; the grouping of districts into divisions, which may conveniently coincide with the geographical standard time divisions of the country; and finally the relation of the district master stations to a central master station.

The first characteristic feature of the system is that of sending from each center to the class or order of centers next above or below it, on a fixed carrier wave frequency or frequencies allotted permanently to said next higher or lower order of stations. If we call the central master station of the entire system A, and call the district master stations B, the local or regional distributing stations C; and the subscribers' instruments in general D, then we may say that A transmits to B on B frequency, B transmits to C on C frequency, and C transmits to D on D frequency, of the respective carrier waves. For information that goes through from A to D, or that goes through from B to D, as well as information originating with C, original modulations are actually reproduced in the instruments at D, by means which will be described. The simplest way to do this is by double modulation, which also enables easy change of carrier wave frequency at the intermediate or relaying stations.

The second characteristic feature of this system which I shall claim therein, is the provision of means for secrecy i. e. confining the reception of intelligible signals to those who are authorized to receive them. By the use of double modulation I am enabled to produce and transmit either directly from transmitter to receiver, or through a relay station, what I call a "silent wave." As a modification of this method I may employ a disabling or obscuring modulation superposed on the signal modulations on the long wave carrier. In either case provision is made at both transmitting and receiving stations for adjustment of phase relations of the modulations on two different intermediate frequency or long wave carriers, so they will neutralize or reinforce each other according to the character and adjustment of the receiving instrument, i. e. unauthorized or authorized.

My invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a circuit diagram of a form of secrecy system

Fig. 1[a] is a modification thereof.

Fig. 2 is a circuit diagram of a relay to be used at the B and C stations for relaying from the system of Fig. 1.

Fig. 3 is a circuit diagram of a subscriber's receiving set for use in the system of Figs. 1 and 2.

Fig. 4 is a modification of part of Fig. 3 showing means for reversing the phase of combined modulations.

Referring to the drawings, Fig. 1 shows an embodiment of the invention which uses double modulation with two secondary or intermediate frequencies, the desired audio modulations being imposed on both intermediate frequencies and an obscuring hum also placed on both, the phase relations being such, that reception by unauthorized parties will result in reproduction of both the desired modulation and the obscuring hum thus rendering the reception unintelligible. Referring in detail to the elements of this system as indicated in Fig. 1 the reference numeral 428 indicates a microphone connected in series with a suitable source of power such as the battery 429 and the primary windings of a pair of induction coils 430 and 431 whose secondary windings are separately connected to audio modulator No. 1 indicated by reference numeral 432 and audio modulator No. 2 indicated by reference numeral 433 respectively. The connection to coil 430 from the microphone 428 includes a pole changing switch for a purpose to be explained. Each of the coils 430—431 is provided with a third winding 434—435 which third windings are connected through a transformer 436 to a suitable source of

alternating current 437 of audible frequency. One winding of the pair 434—435 is reversible with respect to the other as shown. By this means the coils may be brought into the same or opposite phase relation. The modulators 432—433 are each operatively connected with intermediate frequency oscillators 438—439 labeled on the drawings as intermediate frequency oscillator No. 1 and intermediate frequency oscillator No. 2 respectively, which oscillators are connected individually through intermediate modulators 440—441 to a common short wave oscillator transmitter 442 having its output circuit coupled through the coupling 443 with the transmitting antenna 444. In operation, sound waves acting on the microphone 428 will be electrically transferred to the No. 1 and No. 2 audio modulators in synchronism and from thence modulated onto the two different intermediate frequency waves generated by the oscillators 438 and 439 which intermediate frequency waves are in turn modulated through their respective No. 1 and No. 2 modulators onto the short wave generated by the oscillator 442. This short wave carrying both the intermediate frequency waves with their modulations is radiated out from the transmitting antenna 444 as a double modulated wave.

For relaying this double modulated wave without passing through the audio stage, the relay apparatus of Fig. 2 is provided. This consists generally of means for receiving the primary wave, demodulating the same to detect the two different intermediate frequency waves and again modulating these two waves onto another short primary wave of a frequency different from and non-interfering with the received wave. Referring more in detail to the elements constituting this system, the reference numeral 445 indicates the receiving antenna coupled through a coupler to a first detector apparatus 447, the input circuit of which is tuned to the primary wave. This detector 447 is arranged to detect out both intermediate frequency waves and put them onto its output circuit 448 which is connected as shown to two filter couplers 449 and 450 tuned, respectively, to the first and second intermediate frequency waves. The filter couplers 449 and 450 are connected to the input terminals of the No. 1 and No. 2 intermediate frequency modulators 451 and 452 the output terminals of which connect to the input side of a short wave oscillator transmitter 453 which has its output circuit coupled through the coupler 454 to the transmitting antenna 455, the oscillator 453 being adjusted to generate a wave of a frequency different from and non-interfering with that of the received wave. Thus, in operation, the two intermediate frequency waves borne by the primary radiated wave are relayed onto a second primary wave transmitted from the transmitting antenna 455 without demodulation. The relay system of Fig. 2 is the same for both the intermediate or relay stations, that is the B and C stations, with the exception that their oscillator transmitters are, of course, adjusted to transmit on different and non-interfering frequencies.

The subscriber's apparatus for receiving the special double modulated wave transmitted from its local C station is indicated diagrammatically in Fig. 3 in which the receiving antenna 456 is shown coupled through a tuned coupling circuit 457 with a first detector apparatus 458, which detects out both the intermediate frequency waves and passes them on through its output circuit 459 to the two filter couplers 460 and 461 tuned to the first intermediate frequency and to the second intermediate frequency respectively. The filter couplers 460—461 are connected to the input circuits of second detectors 462—463 whose output circuits are in turn connected to the primary coils 464 and 465 respectively, of transformer 466 the secondary winding of which includes a telephone receiver set 467 which, it is to be understood, is typical of any suitable form of telephone receiver such as a loud speaker or the like. In operation the double modulated wave received on the antenna 456 is first demodulated by the first detector 458 to detect out the two different intermediate frequency waves the first of which passes through the filter coupler 460 and the second detector 462, while the second intermediate frequency wave passes through filter coupler 461 to the second detector 463. Each of the two second detectors operates to detect out the desired audio modulations together with the obscuring hum and passes the same through its primary windings to the induction coil or transformer 466 the two primary windings being so related by means of pole changing switch 468 as to augment each other as to the desired audio modulations, while the modulations representing the obscuring hum are dephased so that they will neutralize each other in the common magnetic circuit of the transformer and only the desired modulations will be heard in the receiver 467.

It will be noted that by reversing the connections of one of the secondary windings of the transformer 466 as by means of switch 468 the modulations of the two different intermediate frequency waves representing the hum may be thrown in phase while those representing the desired signal modulations may be thrown in opposite phase, with the result that only the modulations representing the hum will be audible while those representing the sound waves picked up by the microphone at the sending station will be cancelled out or neutralized and so will not

be audible. Thus, if at the sending station (Fig. 1) a second microphone is used to vary the current flow in the third windings 434 and 435 of the modulating transformers, in place of source of alternating current 437, matter being picked up by one microphone may be used to obscure or render unintelligible the matter picked up by the other. In practice, this enables both intermediate frequencies to be usefully employed without lessening the secrecy feature. For example, the two sets of modulations may be constituted of two different program numbers in the same program, or in the case of a song or spoken part, the same item rendered in different languages. The advantage attained by this use of the system of Figs. 1, 2 and 3, is that the combination of the two frequencies is made to subserve two functions, at the same time, namely, secrecy and selection.

It is to be understood that the foregoing description and specific illustration accompanying the same are used for purposes of definition and explanation but not of limitation. The different modulations in phase and out of phase may be imposed on intermediate waves modulated in turn on separately generated primary carrier waves, and in general any change necessary or desirable for carrying out the principle of this invention is contemplated as within the scope and purview thereof. Thus, two or more separate secondary or intermediate frequency carrier waves may each be modulated with a different audio signal, and may also carry an obscuring tone or hum, all of these being modulated in turn on a single short wave carrier or on several carriers of the same frequency. This arrangement will obscure the signals completely. However, a separate intermediate frequency carrier to be used as a neutralizer of hum, will also be modulated with the same hum, in phase, and this will then also be modulated on the primary carrier. Any unauthorized receiving station, whether using single detection or double detection, will get only hum; but an authorized receiving station equipped as herein described, and illustrated for example in Fig. 3, will be able to dephase the hum derived from the balancing wave, and by combining this with any selected one of the obscured signal waves, can neutralize the hum thereon and receive the signal. Selective equipment for this purpose is shown in Fig. 4.

It is to be further understood that in the diagrammatic showing herein no attempt has been made to include the details of working circuits; and such necessary pieces of apparatus as amplifiers, filters, filter networks, and phase adjusting means, all of which are well known in the art, are contemplated in the practice of the invention.

I claim—

1. The method of secret radio transmission which consists in imposing the same signal modulations on two different intermediate frequency carrier waves both modulated on one high frequency primary carrier wave, said signal modulations being in opposite phase on the different intermediate waves so as to neutralize each other for detection alone, and at a receiving station separately detecting the opposite audio modulations from the different intermediate waves and bringing them into phase so as to augment each other.

2. The method of relaying matter transmitted by the method described in claim 1 which consists in receiving the primary wave, detecting out both modulated intermediate waves and remodulating the same together on a second primary wave different from and non-interfering with the first primary wave.

3. A secrecy radio transmission system comprising means for transmitting by double modulation the same signal modulations dephased from each other on different intermediate waves in turn modulated on a primary wave, and receiving means for separately detecting and bringing into phase said signal modulations.

4. A secrecy radio transmission system comprising means for generating two sets of electrical oscillations of different relatively low frequency, means for modulating one set of audio signal waves on both said relatively low frequency oscillations in phase, means for modulating a second set of audio signal waves in opposite phase, on the different sets of oscillations, means for generating relatively high or radio frequency oscillations, means for modulating both said relatively low frequency oscillations on said high frequency oscillations, and means for radiating the said high frequency oscillations.

5. A secrecy radio broadcast system comprising means for generating two sets of relatively low frequency oscillations of different frequencies, means for modulating both said relatively low frequency oscillations with two different sets of audio modulations the first in phase on both sets of oscillations and the second in opposite phase on the different sets of oscillations, means for generating and radiating oscillations of relatively high frequency, means for modulating both said relatively low frequency oscillations on said relatively high frequency oscillations and receiving means comprising means for receiving high frequency oscillations, a first detector for demodulating said high frequency waves to detect said low frequency waves, a pair of filter circuits for segregating said low frequency waves, a pair of second detectors, one for each filter cir-

cuit arranged to detect the audio modulations carried by the respective sets of low frequency waves and means for combining the audio modulations thus detected.

6. A secrecy radio broadcast system comprising means for generating two sets of relatively low frequency oscillations of different frequencies, means for modulating both said relatively low frequency oscillations with two different sets of audio modulations the first in phase on both sets of oscillations and the second in opposite phase on the different sets of oscillations, means for generating and radiating oscillations of relatively high frequency, means for modulating both said relatively low frequency oscillations on said relatively high frequency oscillations and receiving means comprising means for receiving high frequency oscillations, a first detector for demodulating said high frequency waves to detect said low frequency waves, a pair of filter circuits for segregating said low frequency waves, a pair of second detectors, one for each filter circuit arranged to detect the audio modulations carried by the respective sets of low frequency waves and means for combining audio modulations thus detected, together with means for translating said audio modulations into sound waves.

7. A secrecy system of radio broadcast distribution comprising a transmitter for transmitting a double modulated primary wave modulated with two different intermediate frequency waves, means for modulating a set of audio waves on both said intermediate waves in phase, means for modulating a second set of audio waves on both said intermediate waves in opposite phase, a relay transmitter arranged to receive said primary wave and retransmit both said intermediate waves on another primary wave different from and non-interfering with the first primary wave, and receiving stations grouped around each said relay station in a local area and arranged to detect and combine both said sets of audio waves.

In testimony whereof I hereunto affix my signature.

EDWARD E. CLEMENT.