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RADIO SIGNALING SYSTEM

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Fig. 1

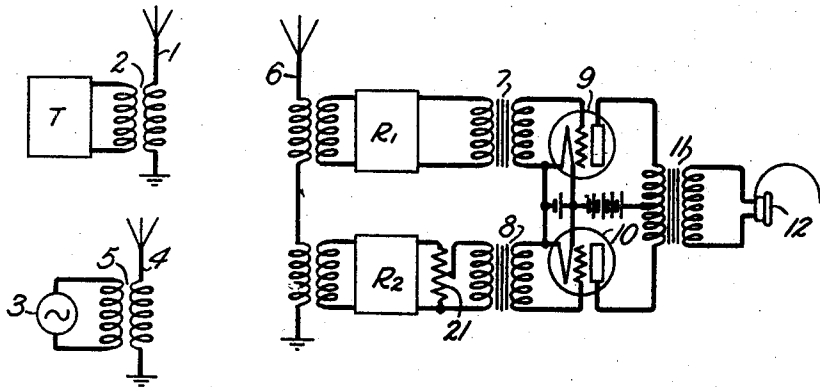


Fig. 2

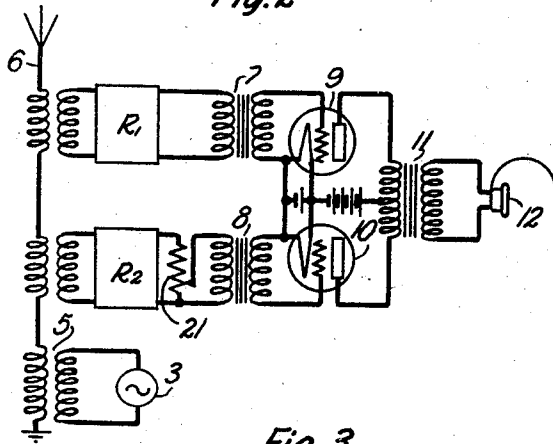
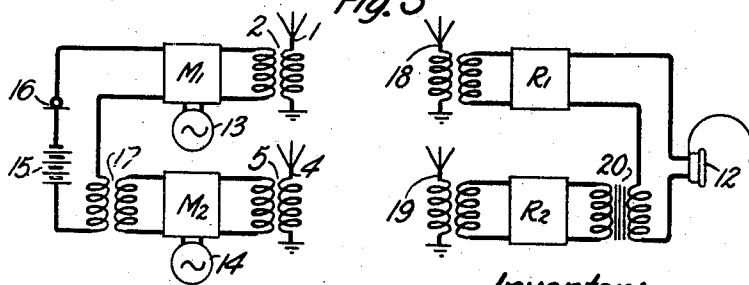


Fig. 3



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## UNITED STATES PATENT OFFICE

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## RADIO SIGNALING SYSTEM

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This invention relates to signaling systems and more particularly to a method and means for eliminating interference due to atmospheric and other disturbances in a radio signaling system.

A signal wave transmitted from a radio sending station is frequently distorted due to undesired disturbances of atmospheric or other origin in the transmission medium. These disturbances affect the signal wave in such manner that upon demodulation at a distant radio receiving station noise currents are produced and converted into sound waves. The ratio of the amplitude of the undesired sound waves to the received signals, frequently called the noise ratio, is at times, sufficiently great to effectively mask the received signal. This is particularly true when the received signal is of comparatively low intensity as the noise ratio in that case may be very large.

It is an object of this invention to minimize the effect of undesired disturbances upon a signal carrying wave.

Another object is to enable signal waves received from a distant station to be demodulated in a radio translating apparatus to reproduce signals which are substantially free from distortion due to extraneous disturbances.

These objects and others which will be apparent as the nature of the invention is disclosed are accomplished by radiating in addition to a signal carrying wave, an auxiliary carrier wave of frequency different from that of the signal wave. The two waves, which will undergo substantially identical distortion or modulation due to atmospheric and other disturbances, are combined in the receiving apparatus in such a manner that the low frequency currents due to the disturbances oppose each other so that they do not affect the signal responsive means, while the desired signal is translated and is used to actuate the signal responsive means.

Although the novel features which are believed to be characteristic of this invention will be pointed out with particularity in the following claims, the invention itself, its objects and advantages, the mode of its opera-

tion and the manner of its organization will be better understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof in which:

Fig. 1 is a diagrammatic representation of a radio signaling system embodying this invention.

Figs. 2 and 3 show different modifications of the system illustrated in Fig. 1.

Referring more particularly to Fig. 1, the transmitter T, which may consist of any desired form or type of apparatus for transmitting a signal modulated carrier wave, is coupled to antenna circuit 1 by means of transformer 2. As the particular form of transmitting apparatus is not material to this invention, it has been shown in a conventional manner. A source 3 of carrier frequency oscillations differing in frequency from the wave radiated from antenna 1, is coupled by means of transformer 5 to an antenna circuit 4 which is resonant to waves of this particular frequency.

Waves transmitted from antennae 1 and 4 are received by antenna 6 located at a distant receiving station. Waves incident upon the antenna circuit 6 are transferred to a suitable receiving apparatus R<sub>1</sub>, including means selective of the signal frequency. The receiver R<sub>1</sub> may consist of any desired system for demodulating the signal wave received from the distant transmitting station. Currents of the auxiliary carrier frequency radiated from antenna 4 are transferred in the receiving station to a receiver R<sub>2</sub> which is substantially identical with the receiver R<sub>1</sub>, except that it includes means for selecting the auxiliary wave. The gain in receiver R<sub>2</sub> is adjusted by potentiometers 21 to produce noise current of the desired intensity.

Audio frequency currents resulting from detection in receivers R<sub>1</sub> and R<sub>2</sub> after passing through transformers 7 and 8 respectively are impressed upon the respective input circuits of the space discharge amplifiers 9 and 10. The output circuits of amplifiers 9 and 10 are connected by means of transformer 11 to the signal responsive device 12, so that

the effects of noise currents are mutually opposed.

In the operation of this system any modulation which occurs effects waves from antennae 1 and 4 in substantially the same manner. The two receivers  $R_1$  and  $R_2$  at the receiving station will detect these undesired modulations to produce the noise currents which are supplied to the primary of the transformer 11 in such manner that their effects upon the receiver 12 are equal and opposite. The intensity of the noise currents produced by receiver  $R_2$  is adjusted by potentiometer 21 to substantially neutralize that produced by receiver  $R_1$ , and hence there will be no resultant effect produced in signal indicating means 12 due to these currents.

Since no energy due to the signal frequency wave is supplied to the receiver  $R_2$ , the desired signal current will be reproduced in the receiver  $R_1$ , and will produce a response in device 12.

In systems operating in the manner described above, atmospheric disturbances which were of sufficient intensity to effectively mask a received signal, in systems which did not include noise current neutralizing means, were reduced to such an amount that the reception of the desired signal was not interfered with.

It has been found that the auxiliary carrier may be supplied from a transmitting antenna located at a point nearer to the receiving antenna than the signal transmitting apparatus. In this case, the auxiliary carrier and signal modulated carrier are affected equally by undesired disturbances which may then be balanced out and eliminated in accordance with this invention.

In the system shown in Fig. 2 elements corresponding to those shown in Fig. 1 are represented by correspondingly numbered parts. The source of auxiliary oscillations 3 is coupled directly to the receiving antenna circuit 6 instead of being located at the distant point as indicated in Fig. 1. With a system of this type any modulation which is effected in the antenna circuit due to the disturbances acting upon the receiving aerial effect the auxiliary carrier to the same extent as the signal carrying wave is affected in the transmitting medium and the local receiving circuit will operate to produce effects which are balanced out or neutralized in a manner similar to that described in connection with the operation of Fig. 1.

In the transmitter of the system shown in Fig. 3, two modulators  $M_1$  and  $M_2$  are supplied with currents of different carrier frequency from sources 13 and 14 respectively. Signal frequency currents from source 15 controlled by microphones 16 are impressed directly upon modulator  $M_1$  and are impressed upon modulator  $M_2$  through transformer 17. The modulated carrier currents from modu-

lators  $M_1$  and  $M_2$  are transferred to antenna circuits 1 and 4 respectively through transformers 2 and 5 as described in connection with Fig. 1. As the current in the secondary of a transformer is opposite in phase to that in the primary, transformer 17 serves as a phase changing device with the result that signal currents impressed upon modulators  $M_1$  and  $M_2$  are  $180^\circ$  out of phase.

In the receiving apparatus, waves of the frequency radiated by antenna 1 are received by antenna 18, resonant thereto, and supplied to the receiving set  $R_1$ , and waves of the frequency radiated by antenna 4 are received by antenna 19, which is resonant to waves of this frequency, and supplied to the receiver  $R_2$ . The two waves after being demodulated in receivers  $R_1$  and  $R_2$  are again reversed in relative phases, i. e.  $180^\circ$ , by transformer 20 and used to operate a signal responsive device 12. The modulating components of the carriers received in apparatus  $R_1$  and  $R_2$ , being  $180^\circ$  out of phase as above described, will be superimposed in signal responsive device 12 in the same phase and mutually aid in producing the desired signal. Any extraneous modulation of the two carriers will occur in the same phase and produce low frequency noise currents in the same phase in receivers  $R_1$  and  $R_2$ . These will be impressed in mutually opposing relationship upon signal responsive device 12 and consequently neutralize each other in the manner described in connection with Figs. 1 and 2.

The system shown in Fig. 3 is especially adapted to long distances point to point signaling systems as the power may be divided between the two carriers, in which case both carriers would aid in transmitting the signal. In a system of this kind, the power necessary to supply the auxiliary carrier is advantageously utilized in transmitting the signal and is not, as is the case of the systems of Figs. 1 and 2, used merely for interference elimination.

The system of Figs. 1 and 2 is advantageous under certain conditions such as for relatively short distance transmission where the expense of duplicating the modulating apparatus is not warranted. A separate oscillator may be cheaply installed either at an already existing transmitting station or in the proximity of the receiving station and good results secured, although the power is not as efficiently utilized as in the system of Fig. 3.

Although this invention has been disclosed as applied to particular systems, it is not to be limited thereto but only in accordance with the scope of the invention as defined by the following claims. Obviously, radio frequency and audio frequency amplification may be used, if desired.

What is claimed is:

1. The method of eliminating undesired disturbances in a carrier telephone trans-

mitting and receiving system having a plurality of paths which comprises, transmitting the signals as modulations of a signal carrier wave, receiving and demodulating the signal carrier wave in one path of the receiving system to produce the signal and disturbing currents, simultaneously supplying to a second path of the receiving system an auxiliary carrier wave which is affected only by the undesired disturbances, demodulating the auxiliary carrier wave whereby the disturbing current alone is produced, and applying the demodulation products in the second path to the first path to neutralize the disturbing current produced therein whereby the signal, free from disturbance, is reproduced.

2. A method of eliminating undesired disturbances in a carrier telephone transmitting and receiving system which comprises, transmitting signals as modulations of a signal carrier wave, simultaneously supplying an auxiliary carrier wave to the receiving apparatus independently of the signal modulated carrier wave and in such a manner that the auxiliary wave is affected only by extraneous interfering disturbances similarly to the signal modulated carrier wave, demodulating said waves independently whereby, in the one case, signal and interfering currents due to extraneous disturbances are produced and, in the other case, only interfering currents are produced, and combining the products of demodulation in such manner that the interfering currents are neutralized and the signal, free from interference, is reproduced.

3. A carrier telephone signaling system comprising means for receiving a signal wave, means for demodulating said wave, means at said receiving station for supplying to said signal wave receiving means, an auxiliary wave unmodulated by signals, a separate means for demodulating said auxiliary wave, and means for combining the separately produced demodulation products to effect neutralization of similar variations present in the two waves.

4. In a carrier telephone signaling system, means for transmitting a signal carrier wave, a receiving station, means at said receiving station for supplying an auxiliary wave, unmodulated by signals, two demodulating paths at said receiving station, one for said signal carrier wave and one for said auxiliary wave, and means for combining the demodulation products of said paths to effect neutralization of certain components which are present in both demodulation products.

In witness whereof, I hereunto subscribe my name this 1st day of July A. D., 1925.

CHARLES L. GOODRUM.