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H. A. AFFEL

SYSTEM FOR BINAURAL TRANSMISSION OF SIGNALS

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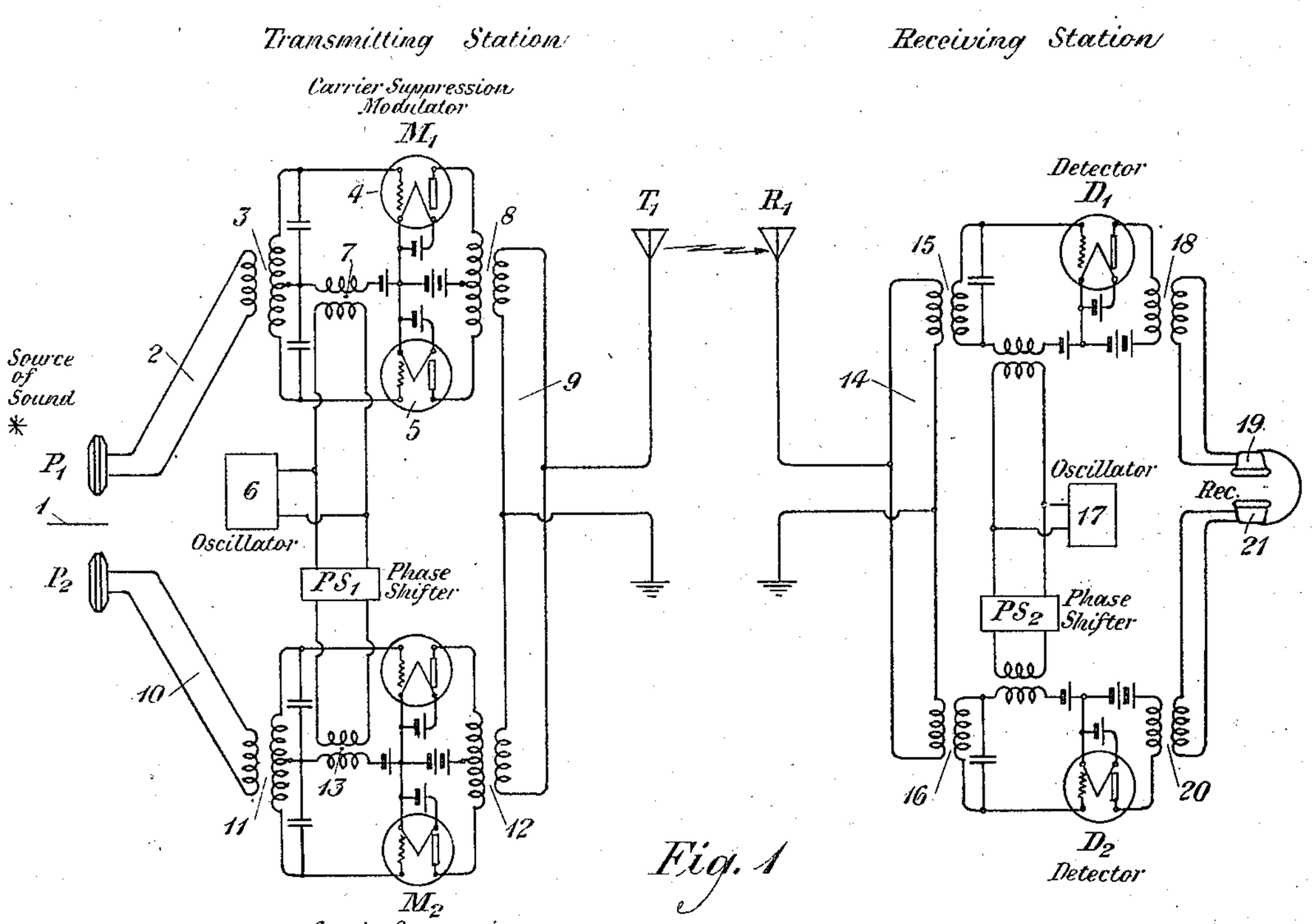

Fig. 1

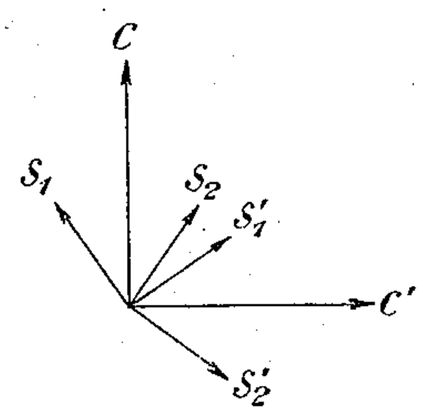

Fig. 2

INVENTOR
H. A. Affel

BY

ATTORNEY

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HERMAN A. AFFEL, OF MAPLEWOOD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SYSTEM FOR BINAURAL TRANSMISSION OF SIGNALS.

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This invention relates to high frequency signaling systems, and particularly to a system of the binaural type by means of which it is possible to give to a listener an idea of the position of the source of sound producing the transmitted signal.

In a system for the dissemination of speech, music or other sounds such as a radio broadcast or a wire distributing system, it is desirable to create within the listener a sense of the position from which the sound emanates; for example, it is particularly satisfying to be able to follow the movement of participants during the broadcasting of a play or to know the source of individual elements entering into the orchestration of a musical selection.

This invention resides in a high frequency transmission system which may be either of the radio broadcast or the wire distributing type which is adapted to give to the listener at the receiving station a sense of the relative position of the sound that is conveyed electrically over the transmission system.

The conveyance of such sense of position requires the transmission of two signals practically identical when separately considered but containing a small phase and amplitude difference such as is necessary to produce the same position discrimination as is afforded by the direct transmission of sound to the ears. The electrical circuit must therefore be capable of conveying these relations with a perfect balance of phase and amplitude, because if one channel of transmission is distorted in somewhat different manner from the other, the result is somewhat negatived.

This invention will be clearly understood from the following description when read in connection with the attached drawing, of which Figure 1 shows schematically an arrangement embodying the invention, and Fig. 2 shows graphically the relations between the carrier and side band currents of the system.

In Fig. 1 the microphones P_1 and P_2 represent symbolically any means for picking up sounds to be transmitted electrically over a high frequency transmission system to a listener at a distant receiving station. These microphones are separated preferably by a distance equal to the separation between the ears of the average person, and a screen such as is indicated by the line 1 may be inserted between the microphones in order to simulate the barrier between the ears of a human being. The microphone P_1 is connected by means of the circuit 2 with the modulator M_1, the connection being effected by the transformer 3. This modulator is of the well known carrier suppression type, comprising the tubes 4 and 5 symmetrically arranged with respect to the input and the output circuits and having a source of oscillations 6 connected with the common conductor of the tubes 4 and 5 through the transformer 7. This modulator is fully disclosed in the patent to Carson, No. 1,449,382, which issued on March 27, 1923. The output circuit of the modulator is connected by the transformer 8 with the output circuit 9 to which the transmitting antenna T_1 is connected. Band filters may be inserted in circuit 9 between the transformers 8 and 12 and the point of connection of the antenna, or they may be inserted in the antenna. And an amplifier or amplifiers may be connected either with the circuit 9 or the antenna T_1 to raise the level of transmission. The microphone P_2 is connected by the circuit 10 with the modulator M_2 which is preferably similar to M_1. The circuit 10 is coupled by the transformer 11 with the input side of the modulator M_2, which modulator has its output side connected by the transformer 12 with the output circuit 9 to which the antenna T_1 is connected. The oscillator 6 is connected with the common conductor of the modulator M_2 by means of the transformer 13. Inserted between the oscillator 6 and the transformer 13 is a phase shifter PS_1, the function of which is to control the phase of the carrier oscillations applied by the source 6 to the input circuit of the modulator M_2. The receiving station comprises an antenna R_1 which is bridged across the common receiving circuit 14. This circuit is connected with the detector D_1 by the transformer 15 and with the detector D_2 by the transformer 16. A carrier frequency oscillator 17 is connected with the input sides of both detectors. The connection between the oscillator 17 and the detector D_2 includes a phase shifter PS_2, the function of which is to control the phase angle of the carrier oscillations applied to the latter detector. The output circuit of detector D_1 is connected by the transformer 18 with the receiver 19 and similarly the output circuit of detector D_2

is connected by transformer 20 with the receiver 21.

It is recognized that two carriers 90 degrees displaced in time phase may be modulated to produce independent side band systems. This is clearly shown in Fig. 2 in which the carrier C, when modulated, produces the side bands represented by the vectors S_1 and S_2, and similarly, the carrier C′, when modulated, produces the side bands represented by the vectors S_1' and S_2'. A source of sound such as is indicated by the star in Fig. 1 will affect both of the microphones P_1 and P_2, but since the source is not equidistant from both microphones, the effect upon them will occur at different instants of time. The current set up in the circuit 2 by the action of the sound upon the microphone P_1 will impress a voltage across the secondary winding of the transformer 3, which will modulate the carrier designated C impressed by the source 6 upon the secondary winding of the transformer 7 which is connected with the common conductor of the modulator M_1. This will produce two side bands S_1 and S_2, which, as shown in Fig. 2, will have at any instant of time the same phase angle with respect to the carrier C. Since the carrier is suppressed by the modulator M_1 the side bands will be transmitted through the transformer 8 to the circuit 9 and will be radiated by the antenna T_1. The effect of the sound upon the microphone P_2 produces a current in the circuit 10 which induces a potential across the secondary winding of transformer 11, and this in turn serves to modulate oscillations of the carrier frequency impressed upon the secondary winding of the transformer 13 which is connected with the conductor of the modulator M_2. The carrier oscillations pass through the phase shifter PS_1 which is adjusted to render the carrier oscillations applied to modulator M_2 90 degrees out of phase with the carrier oscillations applied to modulator M_1. As shown in Fig. 2, the carrier vector C′ is 90 degrees out of phase with the vector C. Since the modulator M_2 is of the carrier suppression type, only the side bands S_1' and S_2' will be transmitted by the transformer 12 to the output circuit 9 and thence to the antenna T_1.

These four side bands will be received by the antenna R_1 and impressed upon the input circuit 14 and will in turn be impressed by the transformers 15 and 16 upon both of the detectors D_1 and D_2. Carrier oscillations from the source 17 will also be impressed upon the detectors. These carrier oscillations have the same frequency as those produced by the source 6 at the transmitting station. The oscillations applied to the detector D_2 will be shifted in phase by 90 degrees from the oscillations applied to the detector D_1. The phase relationships of the carriers and the side bands must be as shown in Fig. 2. That is to say, the frequency of the receiving carrier must be exactly the same as that of the sending carrier, and the phase must be adjusted so that the relationship of Fig. 2 obtains. Thus it will be seen that although the four side bands S_1, S_2, S_1', S_2' are present in the input circuits of both detectors, only the side bands S_1 and S_2 will be detected by D_1 and only the side bands S_1' and S_2' will be detected by D_2. The audible signal produced by D_1 will be impressed by the transformer 18 upon the receiver 19, and similarly the double signal produced by D_2 will be impressed by the transformer 20 upon the receiver 21. The effect of the sound produced by these receivers upon the listener conveys to him an idea of the position of the source of sound that created the variations in the separate channels from which they were transmitted to the listener, from a distant point.

The principle upon which this invention rests is that two carriers, 90 degrees displaced in time phase, may be modulated to produce independent side band systems. If one set of side bands is detected by a carrier in phase with the symmetrical mean of the side bands, detection of the signal will result, whereas if the carrier is 90 degrees out of phase with the symmetrical mean of the side bands, the signal will not be detected. While such a system is practically difficult to employ in the transmission of unrelated signals, it is entirely feasible for the conveyance of a single signal for the production of binaural effect. The cross-talk between channels in the latter case will not produce quality deterioration but will simply reduce the effectiveness of the binaural result.

While this invention has been disclosed as embodied in a particular form, it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a system for the binaural transmission of signals, the combination with a transmitting circuit of two similar input circuits connected therewith, each having a microphone and a modulator, a source of carrier current common to both modulators, and a phase shifter interposed between the said source and one of the said modulators.

2. In a system for the binaural transmission of signals, the combination with a transmitting circuit of two similar input circuits connected therewith, each having a microphone and a modulator, a source of carrier current common to both modulators, and a phase shifter interposed between the said source and one of the said modulators adjusted to render the oscillations applied to

the said one of the modulators 90° out of phase with the oscillations applied to the other modulator.

3. In a system for the binaural transmission of signals, the combination with two branch circuits each having a microphone and a modulator, both microphones being in the same plane but separated in space, a source of carrier oscillations connected with both modulators, and a phase shifter interposed between the said source and one of said modulators to render the oscillations 90° out of phase with those applied to the other of the said modulators.

4. In a system for the binaural transmission of signals, the combination with a transmitting station comprising two similar branch circuits connected with a transmitting medium, each branch circuit having a microphone and a modulator, a source of carrier oscillations connected with both modulators, a phase shifter connected between the said source and one of the modulators, and a receiving station comprising two similar branch circuits connected with the transmitting medium, each branch circuit having a detector and a receiver, a source of carrier oscillations connected with both detectors, and a phase shifter interposed between one detector and the said source of oscillations.

5. In a system for the binaural transmission of signals, the method which consists in producing electrical variations in separate circuits by a common source of sound, separately modulating carrier oscillations of the same frequency by the said variations in each circuit, the carrier oscillations employed in one circuit differing in phase by 90° from those in the other circuit, suppressing the carrier oscillations, and transmitting the bands resulting from both modulating processes.

6. In a system for the binaural transmission of signals, the method which consists in transmitting two sets of side bands resulting from modulating by the same signal carrier oscillations of the same frequency but differing in phase by 90°, receiving the said sets of side bands, separately beating the received side bands with carrier oscillations of the same frequency but differeing in phase by 90°, and receiving the audio-frequencies resulting from said beating operations.

In testimony whereof I have signed my name to this specification this 30th day of December, 1925.

HERMAN A. AFFEL.