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METHOD OF RECORDING AND REPRODUCING STEREOPHONIC SOUND VIBRATIONS

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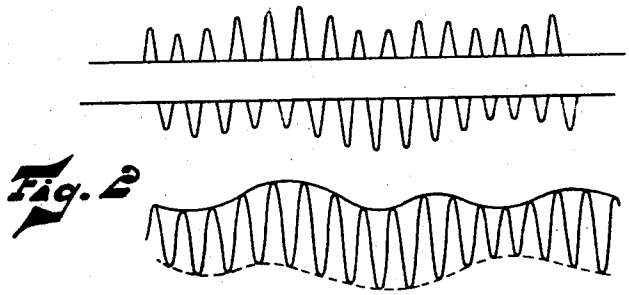


Fig. 2

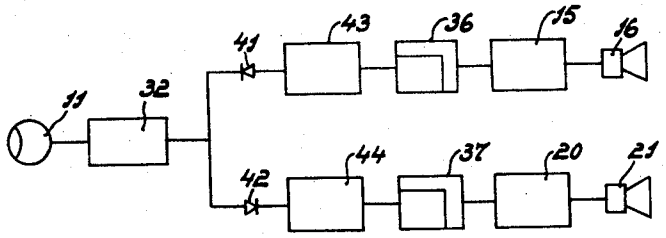


Fig. 3

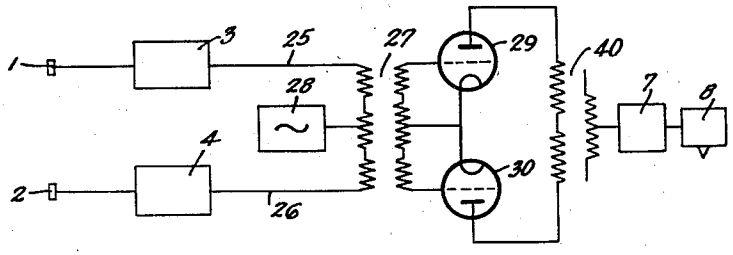


Fig. 1

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METHOD OF RECORDING AND REPRODUCING STEREOPHONIC SOUND VIBRATIONS

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8 Claims. (Cl. 179—100.3)

This invention relates to a method of recording stereophonic sound oscillations. When stereophonically recording sound oscillations use is made of several spatially separated microphones. The electric oscillations produced by the microphones are fed by separate channels to several loud-speakers arranged at adequate relative spacings. Thus a reproduction is obtained which creates the illusion of sound perspective. The electric oscillations derived from the microphones may be individually recorded on separated sound carriers and subsequently reproduced. However, in such arrangements difficulty is encountered in maintaining perfect synchronism between the stereophonically associated sound records during reproduction. The least relative displacement of the sound tracks results in disturbance of the illusion of sound perspective.

In order to maintain synchronism it has been suggested that the sound oscillations received from the various channels should be recorded in a single sound track so that synchronism cannot be lost. One of the known methods consists in modulating several carrier waves by the sound of the various channels and in recording the carrier waves thus modulated jointly in one track. In reproduction these carrier waves have to be separated by filters, the various sound frequencies being then again rendered audible by demodulation.

A further well known method consists in the use of two channels one of which is recorded in an unchanged manner, whereas the other is caused to modulate a carrier wave lying beyond the frequency range of the first channel. The modulated carrier wave is then recorded in the same sound track but since its frequency range lies beyond that of the first channel it can be reproduced separately with the aid of a filter.

All of the above-mentioned known methods, however, have the disadvantage that the reproducing system is rather involved. It is necessary to provide filters having to transmit a given sharply defined frequency band and entirely cut off the frequency lying outside. Such filters are highly involved whilst their operation is not final so that by-sounds are always audible during reproduction.

The invention has for its object to make a stereophonic sound record in two channels in a single sound track, it being possible for this sound record to be reproduced by a comparatively simple equipment.

According to the invention, the sound oscillations of both channels are caused to modulate a carrier wave of at least 7000 cycles/sec. in such manner that the oscillations of one of the channels modulate solely the positive amplitude peaks and those of the other channel modulate solely the negative amplitude peaks of the carrier wave. The carrier wave thus modulated is recorded on a carrier in a single sound track by a single recording device.

The above-mentioned method affords perfect synchronism between the two channels since irrespective of changes in form to which the film material may be subjected the two sides of the sound track are always located opposite to each other.

According to the invention, the sound record thus made is reproduced by scanning the sound track by means of a single photo-electric cell, splitting-up of the positive and negative halves of the carrier wave by means of a device known per se, demodulating each half, filtering-out the carrier wave and reproducing each of the two channels thus obtained by separated reproducing devices.

Although on the reproducing side filters are required for filtering-out the carrier wave, these filters need only to filter out a single given frequency. Such filters are of very simply construction and their operation may be fairly complete.

The highest sound frequency that can be transmitted by the method according to the invention is equal to half the carrier-wave frequency used and hence when using a carrier frequency of 7000 cycles/sec. the maximum sound frequency is 3500 cycles/sec. The invention is also based on recognition of the fact that such vivification of the sound reproduced occurs that the above-mentioned limitation of the frequency band to be reproduced has no disturbing effect.

In one embodiment of the invention a further improvement in sound transmission is enabled by the use of a recording method known per se according to which the sound track exhibits width and depth variations cut through an opaque covering layer of a carrier by means of a V-shaped cutter having an apical angle of about 174°. This recording method even permits of faithfully recording frequencies above 7000 cycles/sec. It is thus possible to obtain a record up to 9000 cycles/sec. and this permits of the range of the sound frequencies to be recorded being increased to 4500 cycles/sec.

In order that the invention may be clearly understood and readily carried into effect it will

now be described more fully with reference to the accompanying drawing, in which

Fig. 1 shows a circuit arrangement for sound recording,

Fig. 2 shows a carrier wave modulated by means of the circuit shown in Fig. 1,

Fig. 3 shows a reproducing device for the sound record thus obtained.

Referring to Fig. 1, 1 and 2 designate two recording microphones which jointly with the associated microphone amplifiers 3 and 4 constitute two channels 25 and 26 by which the sound oscillations are transmitted while conserving the stereophonic effect. Before the recording device are connected two electric discharge tubes 29 and 30 which are coupled to both recording channels by means of a suitable transformer 27. This transformer 27 has fed to it a carrier wave by means of an oscillator device 28 which generates a frequency of 7000 cycles/sec. or higher. The value of the amplitude of this carrier wave and the characteristics of the tubes 29 and 30 are such that these tubes operate in the curved parts of their anode-grid characteristic curve so that the sound oscillations supplied by the channels 25 and 26 are caused to modulate this carrier wave. This modulation occurs in such a manner that the amplitude peaks of a given direction, for example the positive direction, are modulated by the sound frequencies from the channel 25 and the amplitude peaks of the opposite direction, for example the negative direction, by the sound oscillations of the channel 26. The carrier wave is thus given a nature as shown in Fig. 2, that is to say the side bands are different.

The carrier wave thus obtained is fed, with the interposition of a transformer 40 and a recording amplifier 7, to a recording device 8 which records a sound track on a carrier. This recording device may be of any known construction, i. e. it may be a photographic recorder or a mechanical recorder, so long as at least a frequency of 7000 cycles/sec. can be recorded thereby.

Fig. 3 shows a device by means of which a sound record recorded in the manner shown in Fig. 1 can be reproduced. The sound track is scanned by means of a single photo-electric cell 11. The electric oscillations thereby generated are amplified in a photo-electric cell amplifier 32 and are fed to two oppositely connected valves 41 and 42. A separation of the carrier wave into two opposite parts is brought about by these valves, one of which solely transmits the positive amplitudes, whereas the other valve solely transmits the negative amplitudes. In these valves, which are constructed as rectifiers, also demodulation occurs by rectification. Each of the halves of the carrier wave which is modulated by the sound oscillations received from one of the two channels is amplified in the intermediary amplifier 43, 44. The sound frequency still present which is received from a carrier wave is filtered out by filters 36, 37, the sound being then fed by one of the final amplifiers 15 and 20 to two spatially separated reproducing devices 16 and 21.

The above-described reproducing device can be readily arranged in an existing system in replacement of a non-stereophonic reproducing device. For this purpose it is necessary to provide two separated reproducing devices. Generally, two amplifiers are already provided so that the interconnection of the valves 41 and 42 and of the filters 36 and 37 suffices. If desired, this aggregate may be assembled in an appliance, thus permitting the system to be rebuilt for stereophonic reproduction by the addition of the said appliance and a second loudspeaker.

Since, as is well-known, the stereophonic effect is practically imperceptible in the reproduction of sound oscillations below 300 cycles/sec. it is sufficient to feed these low tones in only one of the two reproducing channels to the loudspeaker for the reproduction of the low-frequencies. This may be effected by supplying a third loudspeaker, which is arranged between the loudspeakers 16 and 21 with the interposition of a filter that cuts off the frequencies above 300 cycles/sec. In such an arrangement the supply conductors to the loudspeakers 16 and 21 include filters which suppress the oscillations below 300 cycles/sec.

What I claim is:

1. A method of stereophonically reproducing sound oscillations derived from two spatially-separated sound-receiving elements, comprising the steps of generating a carrier wave of at least about 7000 cycles per second, modulating only the positive amplitude peaks of said carrier wave with the oscillations derived from one of said elements, modulating only the negative amplitude peaks of said carrier wave with the oscillations derived from the other of said elements, combining the modulated positive and negative amplitude peaks of the carrier wave, recording the said modulated carrier wave to form a single sound track on a sound carrier, scanning said sound track and reproducing the said carrier wave, separating the negative and positive amplitude peaks thereof into individual channels and converting the oscillations in each of said channels into sound waves by means of separate sound reproducing devices.

2. A method of stereophonically recording on a sound carrier sound oscillations derived from two spatially-separated sound-receiving elements, comprising the steps of generating a carrier wave of at least about 7000 cycles per second, modulating only the positive amplitude peaks of said carrier wave with the oscillations derived from one of said elements, modulating only the negative amplitude peaks of said carrier wave with the oscillations derived from the other of said elements, combining the modulated positive and negative amplitude peaks of the carrier wave to form a single modulated carrier wave, and recording the said modulated carrier wave to form a single sound track on a sound carrier.

3. A method of stereophonically recording on a sound carrier sound oscillations derived from two spatially-separated sound-receiving elements, comprising the steps of generating a carrier wave of at least about 7000 cycles per second, modulating only the positive amplitude peaks of said carrier wave with the oscillations derived from one of said elements, modulating only the negative amplitude peaks of said carrier wave with the oscillations derived from the other of said elements, combining the modulated positive and negative amplitude peaks of the carrier wave, and recording the modulated carrier wave to form a sound track having both width and depth variations.

4. A method of stereophonically reproducing sound oscillations derived from two spatially-separated sound-receiving elements, comprising the steps of generating a carrier wave of at least about 7000 cycles per second, modulating only the

positive amplitude peaks of said carrier wave with the oscillations derived from one of said elements, modulating only the negative amplitude peaks of said carrier wave with the oscillations derived from the other of said elements, combining the modulated positive and negative amplitude peaks of the carrier wave, recording the said modulated carrier wave to form a single sound track on a sound carrier, scanning the sound track by means of a photoelectric cell and reproducing the modulated carrier wave, rectifying the carrier wave and separating the negative and positive peaks thereof into individual channels, suppressing the carrier wave in each channel and separately reproducing the oscillations in each of said channels.

5. A method of stereophonically reproducing sound oscillations derived from two spatially-separated sound-receiving elements, comprising the steps of generating a carrier wave of at least about 7000 cycles per second, modulating only the positive amplitude peaks of said carrier wave with the oscillations derived from one of said elements, modulating only the negative amplitude peaks of said carrier wave with the oscillations derived from the other of said elements, combining the modulated positive and negative amplitude peaks of the carrier wave, recording the said modulated carrier wave to form a single sound track on a sound carrier, scanning said sound track and reproducing the said carrier wave, separating the negative and positive peaks thereof into individual channels, converting the oscillations having frequencies greater than about 300 cycles per second in each of said channels into sound waves by means of separate sound reproducing means and converting the oscillations having frequencies less than about 300 cycles per second into sound waves by means of a single reproducing device actuated by only one-half of the modulated carrier wave.

6. A device for recording stereophonic sound oscillations, comprising a plurality of sound-receiving elements, a plurality of electron discharge tubes having input and output electrodes and each associated with one of said elements by means of its input electrode, means to generate a carrier wave of at least about 7000 cycles per second, means to apply said carrier wave in phase opposition to the input electrodes of said discharge tubes and to render said discharge tubes alternately conductive, means to combine the outputs of said discharge tubes and a single recording device actuated by said combined outputs.

7. A device for reproducing a sound track comprising a recorded carrier wave having positive amplitude peaks modulated in accordance with oscillations derived from one of a plurality of spatially-separated sound-receiving elements and having negative amplitude peaks modulated in accordance with oscillations derived from another of the plurality of spatially separated sound receiving elements, comprising an optical electrical scanning element for converting said recorded wave into electrical oscillations, means comprising two electric discharge valves for separating the positive and negative peaks of said electrical oscillations, individual transmission channels connected to each of said discharge valves, a filter in each of said channels for suppressing the carrier wave component of said electrical oscillations, and means for converting the modulation component of said electrical oscillations in said channels into sound waves.

8. A sound carrier comprising a recorded carrier wave having positive amplitude peak variations conforming to oscillations derived from one of a plurality of spatially-separated sound-receiving elements and having negative amplitude peak variations conforming to oscillations derived from another of the plurality of spatially-separated sound-receiving elements.

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