July 4, 1944. K. DE BOER ET AL 2,352,696

DEVICE FOR THE STEREOPHONIC REGISTRATION, TRANSMISSION AND REPRODUCTION OF SOUNDS

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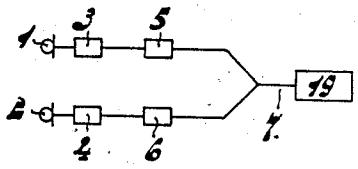


Fig. 2.

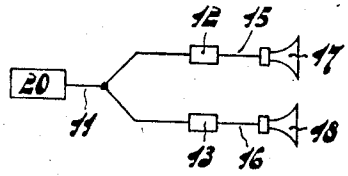


Fig. 3.

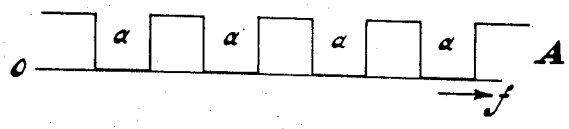


Fig. 4.

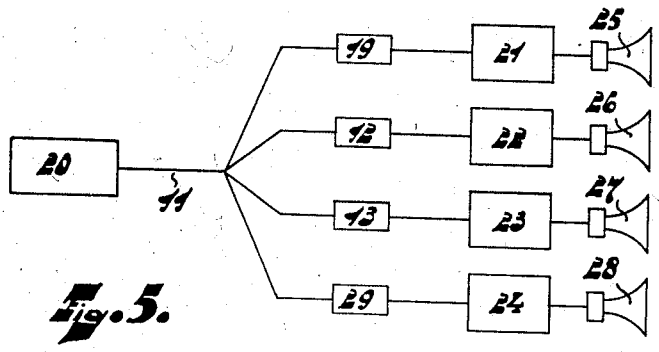


Fig. 5.

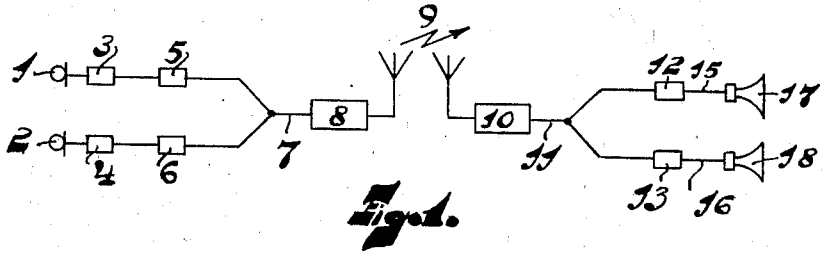


Fig. 1.

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DEVICE FOR THE STEREOPHONIC REGISTRATION, TRANSMISSION, AND REPRODUCTION OF SOUNDS

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Application July 8, 1941, Serial No. 401,528
In the Netherlands July 24, 1940

5 Claims. (Cl. 179—1)

The invention relates to a device for stereophonically recording or transmitting sound waves and to an accompanying device for the stereophonic reproduction of the recorded or transmitted sound waves.

For the stereophonic transmission of sound, use is made, for example, of two microphones which pick up the sound to be transmitted and which are placed at a distance equal to the distance between the ears (about 22 cms.) on either side of a body by which sound waves are screened. Each of the microphones supplies, with the interposition of an amplifier and a transmission line of its own, one of two earphones on the ears of the listener. It is also possible to arrange the above-mentioned microphones at a larger distance (about 2 metres) from one another without utilizing a screening body.

The two microphones take in this case more or less the place of the two auditory organs and since in the reproduction we listen to two sound translating sources to each of which are supplied the oscillations of the corresponding microphone we obtain the illusion of an acoustic perspective.

In the reproduction of sound for a great audience it is a drawback that each listener must be provided with a headphone. By experiments it has proved to be possible to obtain a proper stereophonic effect by utilizing two loudspeakers arranged at a suitable distance from one another. A favourable arrangement of the loudspeakers is described in "Philips Technisch Tijdschrift," of April 1940.

In conducting electrical oscillations from the microphones to the headphone or to the loudspeakers there may be interposed recording and scanning devices by which the sound is first recorded on a sound carrier and is then scanned again.

The oscillations proceeding from each of the microphones, may also be transmitted after modulation on a carrier wave, by wireless.

The method of stereophonic transmission above referred to has the drawback that always two channels are necessary whilst with the interposition of a recording equipment, in addition, either double the number of gramophone records or film bands or a double sound track on the film band is required.

In the case of transmission by wireless the inconvenience of providing a double channel may be partly eliminated by utilizing a particular modulation system, for example, by transmitting the oscillations coming from the one microphone as the lower side-band of the carrier wave and the oscillations coming from the other microphone as the upper side-band of the same carrier wave, in which event, however, receivers of particular construction have to be utilized.

In recording on gramophone records great difficulties are encountered in the isochronous scanning of the two sound tracks because the slightest displacement therein is liable to destroy the illusion of acoustic perspective. The recording and the production of a double sound track on one and the same gramophone record entails difficulties from a practical aspect; besides, a double scanning and amplifying installation is necessary. In recording on a film band there is generally no room for a second sound track whilst also the necessity of a double scanning and amplifying installation remains.

The invention has for its object to effect the stereophonic recording, transmission and reproduction in such manner that only a single recording installation is required or that substantially the whole of the transmission channel may be formed as a single channel so that the above-mentioned drawbacks are eliminated.

According to the invention, mutually complementary bands of frequencies are taken from the electrical oscillations furnished by the microphones or groups of microphones arranged at some distance from one another, whereupon these frequency bands are jointly supplied either to a recording apparatus common to them for the purpose of being registered on a single sound carrier or to a channel common to them for the purpose of transmission.

Furthermore, in the stereophonic reproduction of sound the oscillations obtained by scanning the common carrier or the electrical oscillations transmitted via the common channel are separated, according to the invention, into the initial bands and supplied respectively to the two earphones or loudspeakers.

The sound carriers produced according to the invention have a sound track which is an image of the mutually complementary frequency bands of the oscillations of the stereomicrophones and are suitable for use in a device for stereophonically reproducing sound oscillations.

In carrying the invention into effect use may be made of the usual equipments for pick up, recording and reproduction without the need of radical changes. In addition, the stereophonic sound carrier or channel may be reproduced with apparatus which are not designed for stereophonic reproduction whereby a normal non-stereophonic reproduction is obtained.

The invention will be explained more fully with reference to the diagrammatic figures shown in the drawing wherein

Fig. 1 is a diagrammatic view showing complete transmitting and receiving station systems embodying one form of our invention.

Fig. 2 is a diagrammatic view of a sound recording system.

Fig. 3 is a diagrammatic view of a system for the reproduction of the recorded sound.

Fig. 4 is an illustrative diagram of partial sound spectra passed by two filters shown in Figs. 1 and 2 and

Fig. 5 is a view similar to Fig. 3 but showing a modification.

In this figure 1 and 2 denote two microphones each provided with a preamplifier 3 and 4 respectively. By a filter 5 a number of bands are suppressed from the frequency spectrum of the oscillations coming from the microphone 1; those bands of the oscillations coming from the microphone 2, which are complementary to the first-mentioned bands are suppressed by a filter 6.

The output circuits of the filters 5 and 6 are connected in parallel and in a channel 7, which is connected to a modulated transmitter 8 of usual construction there consequently occurs again the complete frequency spectrum. The wireless connection between the transmitter and the receiver is denoted by 9. The oscillations emitted are received and demodulated in a radio-receiver 10 and the demodulated oscillations are supplied to a channel 11 in which consequently occur the same oscillations as in the channel 7. The channel 11 is connected to filters 12 and 13 which cut out the same bands as did the filters 5 and 6 respectively so that there is supplied to the conductors 15 and 16 respectively a frequency spectrum which corresponds to the frequency spectrum in the output circuit of the filter 5 or 6 respectively. To the conductors 15 and 16 are connected loudspeakers 17 and 18 which convert the mutually complementary frequency bands passed by the filters 12 and 13 into sound waves.

One practical example according to the invention for the direct stereophonic transmission of sound oscillations is also shown in Fig. 1; in this case, for example, 8 and 10 are line amplifiers which are connected to one another by a transmission line 9.

One practical example according to the invention for the stereophonic recording of sound oscillations is represented in Fig. 2 wherein the same numerals denote similar components as in Fig. 1. The recording apparatus is diagrammatically denoted by 19.

One practical example according to the invention for the stereophonic scanning of sound oscillations which have been recorded with the aid of a device as is diagrammatically shown in Fig. 2, is represented in Fig. 3. Here again the same numerals denote similar components as in Fig. 1. The scanning device itself is diagrammatically represented by 20.

Under certain conditions the microphone amplifiers 3 and 4 of Figs. 1 and 2 may be dispensed with. Besides, the equipment for reproduction may be realised in such manner that power amplifiers are connected behind the filters 12 and 13 respectively. The latter may be useful, for example, in those cases wherein a large final energy is desired. In this case the filters 12 and 13 are arranged between a common pre-amplifier and the power amplifiers, owing to which the construction of the filters may be made smaller and therefore cheaper.

In order to explain the operation of the above-described devices Fig. 4 shows at A the frequency spectrum passed by the filter 5; *a* denotes the suppressed frequency bands. B represents the frequency spectrum passed by the filter 6, wherein *b* denotes the suppressed frequency bands. It will be clear that the passed frequency bands in A and B are complementary so that if these bands are added again the complete initial spectrum is obtained.

If in the reproduction, the oscillations are separated again by the filters 12 and 13 according to the frequency bands shown in Fig. 4 A and B are then supplied to the loudspeakers 17 and 18, the loudspeaker 17 substantially reproduces only sound oscillations coming from microphone 1 and the loundspeaker 18 only sound oscillations coming from microphone 2.

It is true that neither the loudspeaker 17 nor the loudspeaker 18 separately reproduce all the frequencies but together they do so and in practice it has been found that if the bands of A and B are chosen with some deliberation a very satisfactory stereophonic reproduction is obtained. This applies both to direct transmission via line or wireless and for the case wherein recording equipment such as a talking film or a gramophone record is interposed.

In one embodiment, which yields satisfactory results in practice and which will be explained with reference to Fig. 5, the sound spectrum was divided into octaves and each octave again into three bands which were divided over the two channels. Since the lowest tones up to 250 cycles per second contribute only slightly to the stereophonic effect, as do the highest tones, they may each be supplied without any objection to one particular loudspeaker for low and high tones respectively so that now four loudspeakers are utilized, viz., a loudspeaker 25 for the lowest frequencies up to 250 cycles per second, two loudspeakers 26 and 27 respectively for the mutually complementary bands in the range of from 250 to 4000 cycles per second and a loudspeaker 28 for frequencies exceeding 4000 cycles per second. The division of the frequency bands in the range of from 250 to 4000 c. p. s. was as follows:

Bands with loudspeaker 26	Bands with loudspeaker 27
C. p. s.	*C. p. s.*
250– 315	315– 397
397– 500	500– 630
630– 794	794–1,000
1,000–1,260	1,260–1,588
1,588–2,000	2,000–2,520
2,520–3,175	3,175–4,000

Fig. 5 represents furthermore at 20, for example, a scanning device with a pre-amplifier, 11 is a channel leading to filters 19, 12, 13 and 29, of which the filter 19 passes only the frequencies up to 250 c. p. s. and is connected to the loudspeaker 25 for low tones; the filter 12 passes frequency bands according to A in Fig. 4 and is connected to the loudspeaker 26; the filter 13 passes bands of frequencies according to B in Fig. 4 and is connected to the loudspeaker 27 whilst the filter 29 passes only frequencies exceeding 4000 c. p. s. and is connected to the loudspeaker 28.

A favourable attendant circumstance of sound

transmissions or sound records realized with the aid of devices according to the invention is that the reproduction thereof with the aid of equipment not designed for stereophonic reproduction is directly possible. It is true that in this case there occurs no stereophonic effect but for the rest the sound reproduced is completely normal so that it is not absolutely necessary to listen to stereophonic transmissions with a stereophonic reproducing installation.

By adding appropriate filters and an additional loudspeaker an existing reproducing installation may be directly made suitable for stereophonic reproduction according to the invention.

What we claim is:

1. A stereophonic sound system comprising a plurality of sound-receiving elements spaced apart and adapted to convert into electrical oscillations sound waves received from a source of a band of sound frequencies, a plurality of filtering means one associated with each of said elements, each of said means transmitting the oscillations of a plurality of spaced sub-bands of said band of frequencies and suppressing the oscillations of the intervening sub-bands, the transmission characteristics of one of said filtering means being complementary to the transmission characteristics of the other filtering means, means to combine the oscillations of the complementary sub-bands transmitted through said filters into a single channel, means to separate said combined oscillations of the complementary sub-bands into individual channels, and a plurality of spaced means one associated with each of said channels for converting the separated oscillations into sound waves.

2. In a stereophonic sound system, a plurality of sound-receiving elements spaced apart and adapted to convert into electrical oscillations sound waves received from a source of a band of sound frequencies, a plurality of filtering means one associated with each of said elements, each of said means transmitting the oscillations of a plurality of spaced sub-bands of said band of frequencies and suppressing the oscillations of the intervening sub-bands, the transmission characteristics of one of said filtering means being complementary to the transmission frequencies of the other filtering means, and means to combine the oscillations of the complementary sub-bands transmitted through said filters into a single channel.

3. A stereophonic sound system comprising a single channel source of electrical oscillations having a band of sound frequencies comprising individual groups of a plurality of complementary sub-bands, filtering means to separate the oscillations of each group of sub-bands and to transmit the same into individual channels, and means one associated with each of said individual channels for converting the separated oscillations into sound waves.

4. A stereophonic sound record comprising a carrier provided with a recorded sound track of a band of sound frequencies comprising individual groups of a plurality of complementary spaced sub-bands stereophonically derived from a source of said band of sound frequencies.

5. A stereophonic sound system comprising a single channel source of electrical oscillations having a band of sound frequencies comprising individual groups of a plurality of complementary sub-bands, filtering means to separate the oscillations having a frequency less than about 250 cycles and to transmit the same into one channel, filtering means to separate the oscillations having a frequency greater than about 4000 cycles and to transmit the same into another channel, filtering means to separate the oscillations of each group of sub-bands within the frequency range of about 250 cycles to about 4000 cycles and to transmit the said sub-bands into individual channels, and means one associated with each of said channels for converting the separated oscillations into sound waves.

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