April 2, 1929. C. H. FETTER 1,707,260

RECORDING AND REPRODUCING OF SOUND WAVES

Filed Nov. 10, 1927

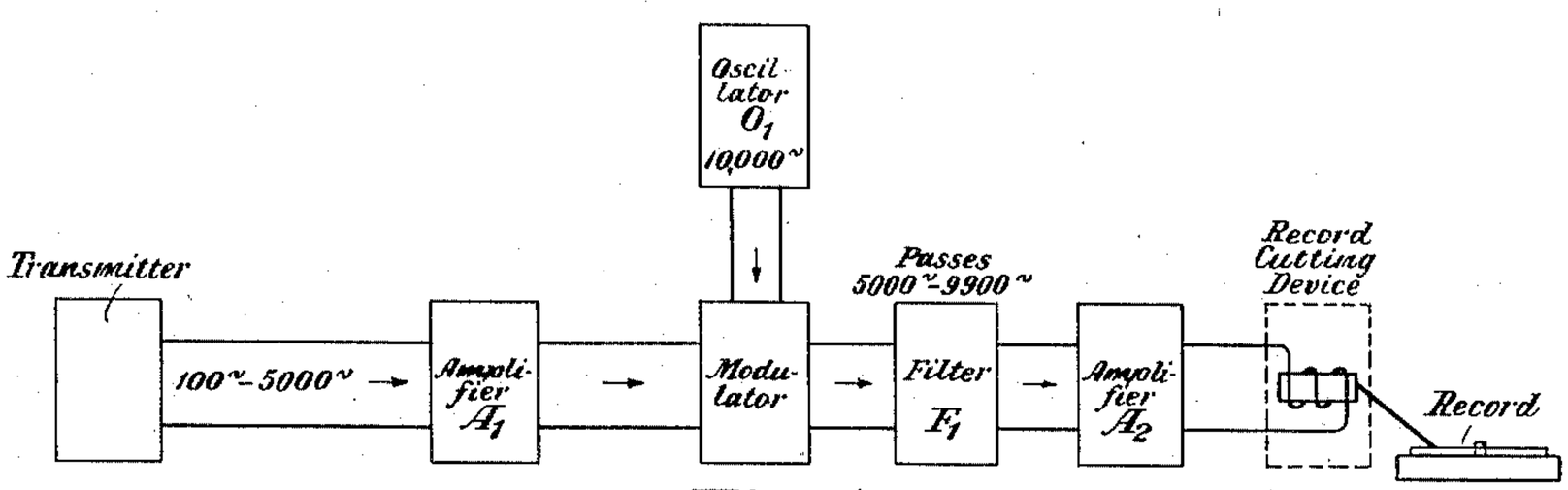

Fig. 1

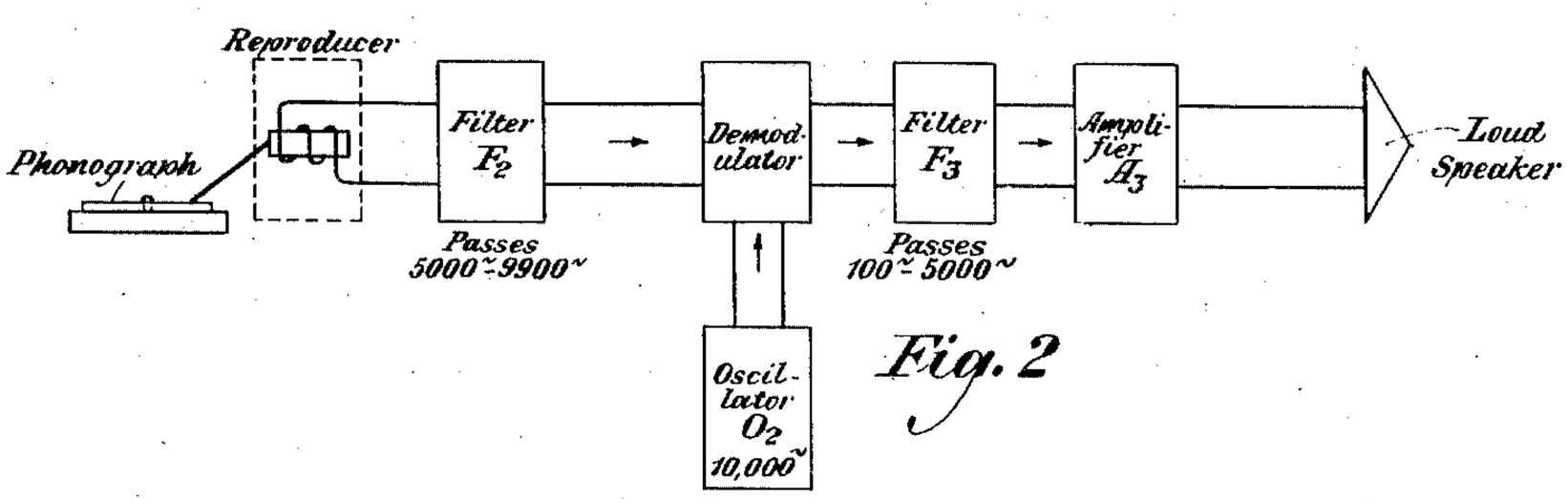

Fig. 2

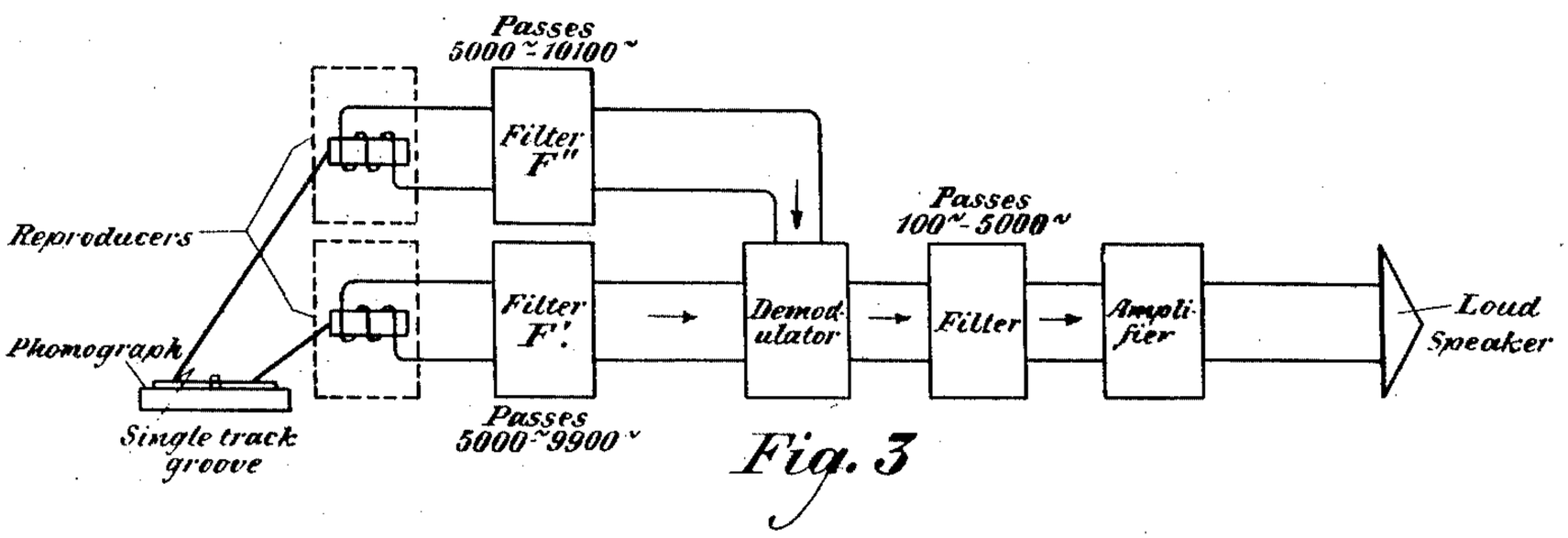

Fig. 3

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UNITED STATES PATENT OFFICE.

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RECORDING AND REPRODUCING OF SOUND WAVES.

Application filed November 10, 1927. Serial No. 232,450.

This invention relates to the recording and reproducing of sound waves, and more particularly to methods and means for recording sound waves electrically on a record and electrically reproducing the waves with a phonograph.

In recording speech and music involving a frequency band of 100 to 5,000 cycles on a phonograph record and reproducing the speech and music from the record, a difficulty in obtaining reproduction of satisfactory quality is encountered at the reproduction end of the system, where noise is introduced because of the physical contact between the needle and the record. The principal object of this invention is to eliminate this noise or "needle scratch".

The advantage found in the attainment of this object, and various other advantages of the invention, will appear in the following description.

It has been found experimentally that most of the noise known as "needle scratch" occurs below a frequency of approximately 5,000 cycles. In general, the method employed by the applicant for avoiding such noise consists of cutting the record with a side-band signal rather than with the original voice signal and then demodulating the output at the reproduction end of the system to restore the original voice waves.

The invention will be more clearly understood when the following detailed description of two desirable embodiments thereof, and the recording and reproduction methods involved, is read with reference to the accompanying drawing. The drawing shows schematically the apparatus and circuit arrangements by which the applicant's object is accomplished. Figure 1 of the drawing shows the recording end of the system; Fig. 2 shows the reproduction end; and Fig. 3 shows an alternative arrangement for the reproduction end.

With reference to the details of Figs. 1 and 2 of the drawing, there is transmitted from a transmitter or other signal source signals covering a frequency range of 100 to 5,000 cycles, for instance. These signals are passed through an amplifier A_1 and into a modulator, where they are caused to modulate a carrier of 10,000 cycles from an oscillator O_1. The carrier modulated with the signal is then passed into a filter F_1 which passes only the side-band of frequencies from 5,000 cycles to 9,900 cycles. This side-band may then be amplified in an amplifier A_2, and by means of any suitable record-cutting device the record is cut at these side-band frequencies.

At the reproduction end of the system an electrical phonograph and reproducer sets up in the circuit the side-band frequencies of 5,000 to 9,900 cycles, at which the record was cut. In the reproduction, however, there may be introduced the "needle scratch" frequencies which, as stated above, lie, for the most part, below 5,000 cycles. In order to eliminate these noise frequencies, a filter F_2 is introduced in the circuit, this filter passing only the frequencies from 5,000 to 9,900 cycles. These side-band frequencies are then beaten by a 10,000 cycle frequency from an oscillator O_2 in the demodulator to restore the original signal. A filter F_3 may be introduced which passes only the frequencies from 100 to 5,000 cycles, thus eliminating the carrier and any other undesirable frequencies which may be present. The resultant waves may then be passed through an amplifier A_3 and on to a loud speaking receiver.

Instead of being supplied by the oscillator O_2 of Fig. 2, the carrier may be supplied at the reproducing end as indicated in Fig. 3. A single trial groove may be cut in the record of the phonograph and a second reproducer (upper) caused to run in this groove to give the proper demodulating frequency. At the output of the lower reproducer, which gives the side-band, a filter F′ passes the frequencies from 5,000 to 9,900 cycles. The filter F″ in the output of the upper reproducer passes frequencies from 5,000 to 10,100 cycles, for instance, thus passing the "carrier". These two filters serve to eliminate the "needle scratch" frequencies. The portions of the reproducer outputs which pass these filters are then passed into a demodulator, the balance of the circuit corresponding to that shown in Fig. 2.

While the invention has been specifically described for the purpose of illustration, it is to be understood that its scope is not limited by such description but is defined in the appended claims.

What is claimed is:

1. The method of recording and reproducing sound waves which consists in modulating a carrier wave with the original waves to

produce a side-band, recording the side-band, reproducing the side-band, eliminating after reproduction all frequencies outside the range of the side-band, and beating the side-band with a high frequency equal to the carrier to restore the original waves.

2. The method of recording and reproducing sound waves which consists in modulating a carrier wave with the original waves to produce a side-band having a lower limit of approximately 5,000 cycles per second, recording the side-band, reproducing the side-band, and beating the side-band with a high frequency equal to the carrier to restore the original waves.

3. The method of recording and reproducing sound waves varying in frequency over a band of approximately 100 to 5,000 cycles per second which consists in modulating a carrier wave with the original waves to produce a side-band having a lower limit of approximately 5,000 cycles per second, separating said side-band from the carrier, recording said side-band, reproducing said side-band, eliminating after reproduction all frequencies outside the range of said side-band, and beating said side-band with a high frequency equal to the carrier to restore the original waves.

4. In a system for recording and reproducing sound waves, means for combining the original waves with a carrier wave to produce a side-band, means for recording the side-band frequencies, means for reproducing the side-band frequencies, means for separating the side-band frequencies from any other frequencies produced in said reproducing means, and demodulating means for restoring the original frequencies.

5. In a system for recording and reproducing sound waves, means for combining the original waves with a carrier wave to produce a side-band having a lower limit of approximately 5,000 cycles per second, means for separating the side-band from the carrier, means for recording the side-band frequencies, means for reproducing the side-band frequencies, means for separating the side-band frequencies from any other frequencies produced in said reproducing means, and demodulating means for restoring the original frequencies.

6. In a system for recording and reproducing sound waves varying in frequency over a band of approximately 100 to 5,000 cycles per second, means for converting the original sound waves into electrical waves, means for combining said electrical waves with a carrier wave to produce a side-band having a lower limit of approximately 5,000 cycles per second, means for separating the side-band from the carrier, means for recording the side-band frequencies, means for reproducing the side-band frequencies, means for separating the side-band frequencies from any other frequencies produced in said reproducing means, demodulating means for restoring the original frequencies, and means for reconverting the resultant waves into sound.

In testimony whereof, I have signed my name to this specification this 9th day of November, 1927.

CHARLES H. FETTER.