

Aug. 4, 1942.

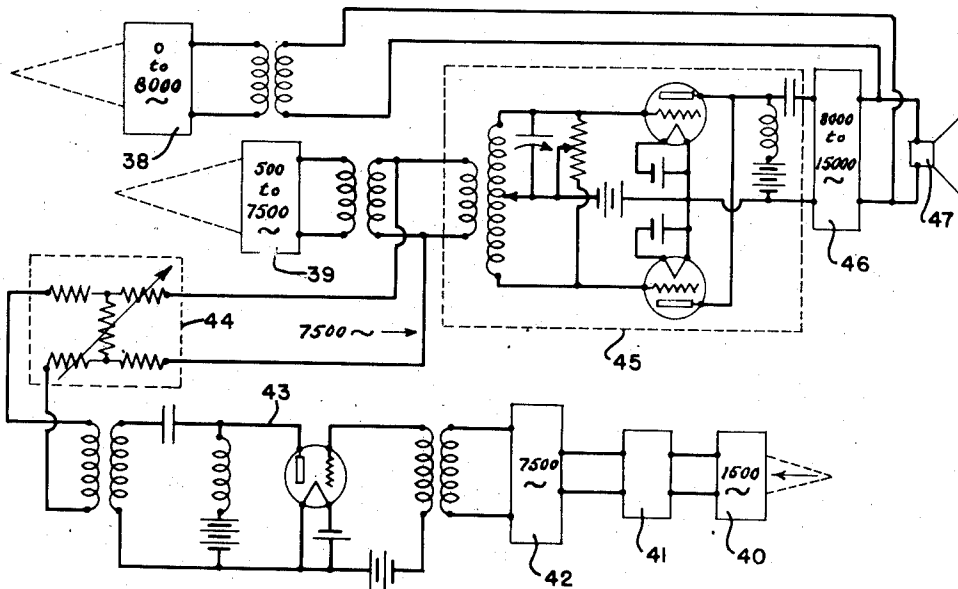
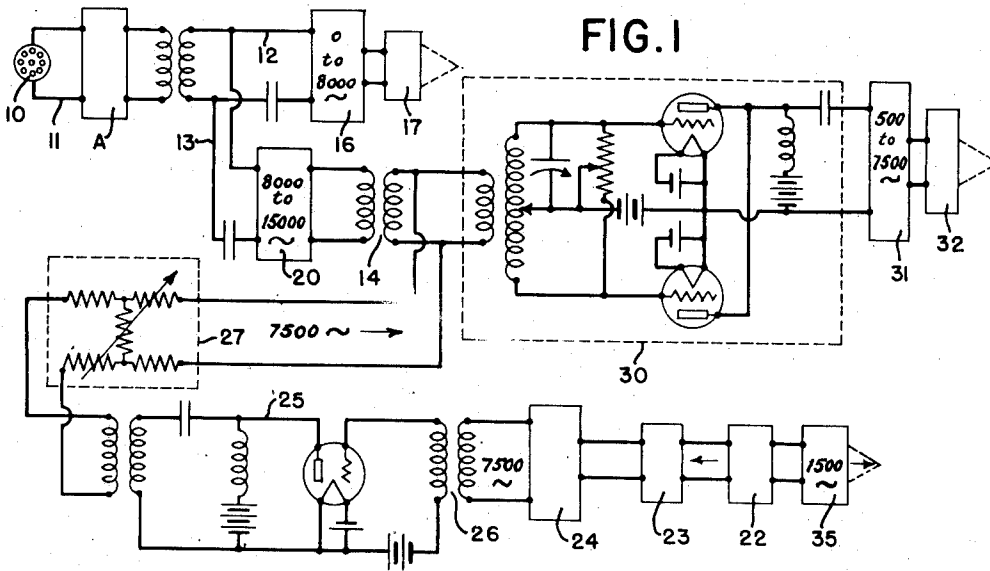
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2,292,014

METHOD AND APPARATUS FOR RECORDING AND REPRODUCING

Filed July 7, 1939

3 Sheets-Sheet 1



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Aug. 4, 1942.

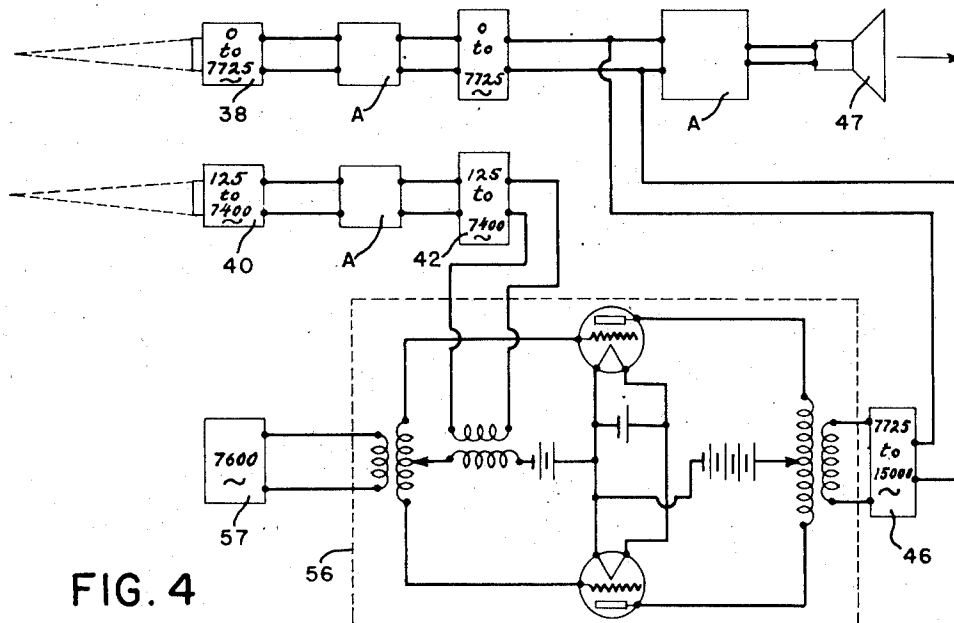
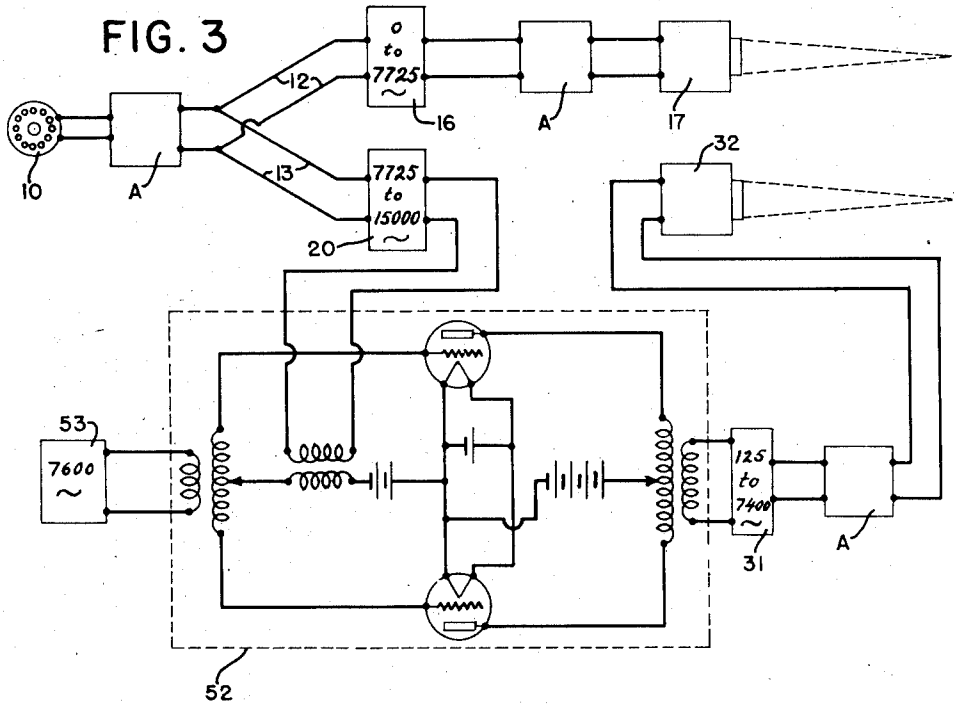
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METHOD AND APPARATUS FOR RECORDING AND REPRODUCING

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3 Sheets-Sheet 2



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2,292,014

METHOD AND APPARATUS FOR RECORDING AND REPRODUCING

Filed July 7, 1939

3 Sheets-Sheet 3

FIG. 5

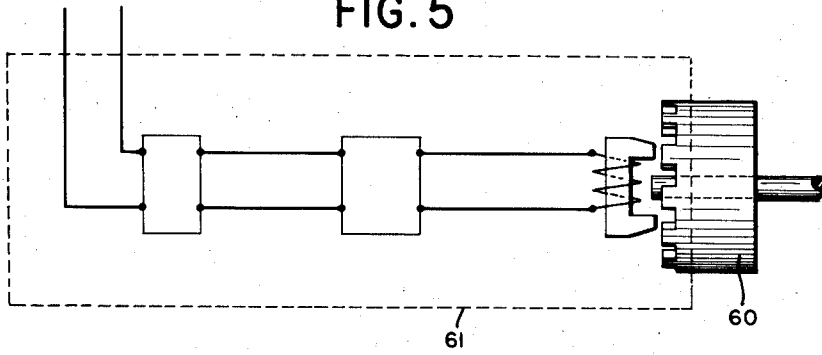


FIG. 6

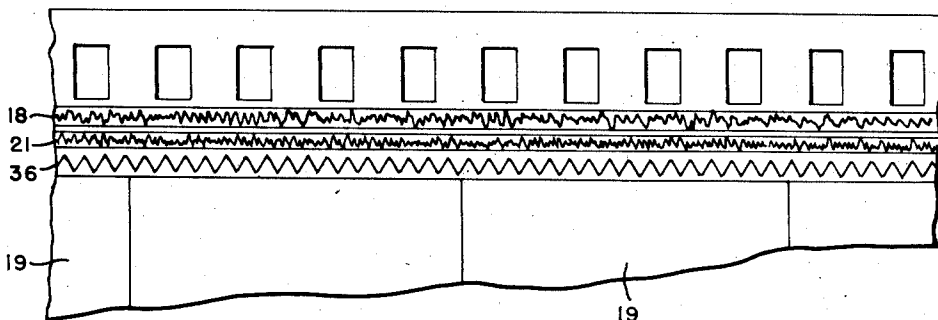
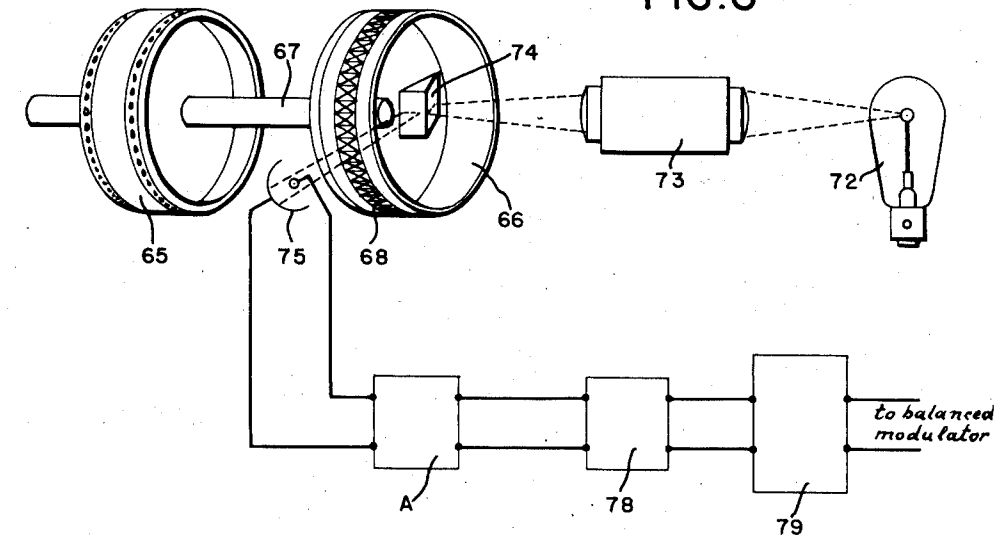


FIG. 7

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UNITED STATES PATENT OFFICE

2,292,014

METHOD AND APPARATUS FOR RECORDING AND REPRODUCING

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44 Claims. (Cl. 179—100.3)

The invention relates to both a method and apparatus or combination of devices particularly designed to record and reproduce, with high fidelity, a substantially greater range of frequencies than could heretofore be recorded and reproduced. The invention has particular applicability to the recording and reproduction of sound frequencies and, by the method and combination of devices to be described, is capable of recording and reproducing, with high fidelity, the entire audible frequency range. The invention necessarily also includes a method and apparatus for recording, with high fidelity, an increased range of frequencies or the complete audible range, and also a method and apparatus for reproducing, with high fidelity, the recordings referred to above.

It is an object of the invention to devise a new and novel method of recording and reproducing, with high fidelity, a wide range of frequencies, such as sound waves and electrical oscillations.

Another object of the invention is to construct a new and novel combination of devices for recording and reproducing, with high fidelity, the audible sound range.

A still further object of the invention is to devise a new and novel method for recording a wide range of frequencies, such as electrical oscillations and the audible sound range, so that the range of frequencies may be reproduced with high fidelity.

Another object is to construct a new and novel combination of devices which are able to record a wide range of frequencies, such as the entire audible sound range, in such a fashion that the reproduction thereof has high fidelity.

Another object is to devise a method of reproducing a recording of a wide range of frequencies, such as sound, which recording has been made in accordance with the recording invention herein.

A further object is to construct a new and novel combination of devices for reproducing, with high fidelity, the recordings made in accordance with the invention herein.

Another object of the invention is to devise a method and combination of devices for transforming the entire audible range of frequencies into corresponding electrical waves and dividing or separating this audible range of electrical frequencies into a plurality of separate frequency bands. The high frequency band or bands is then converted into low frequencies, and each frequency band is recorded upon a separate sound track.

Another object is to devise a method and combination of devices for reproducing the plurality of frequency bands which have been recorded, as set forth above, by transforming the recording or sound track of each high frequency band into electrical oscillations, and each frequency band which has been converted into low frequencies is then reconverted to its initial frequency band. Thereafter, all frequency bands are mixed or combined to reproduce the original range of electrical frequencies which is reproduced as sound waves.

Another object is to devise a method and combination of devices for the recording and reproducing of the entire audible range of sound as set forth in the two next preceding paragraphs. A still further object is to devise a new and novel sound track such as for moving picture film.

Other objects of the invention will be more apparent from the following description taken in connection with the accompanying drawings, illustrating preferred embodiments of the invention, in which:

Figure 1 is a view, partially diagrammatic, showing a combination of devices, or the electrical circuit by which a wide range of frequencies, such as the entire or a substantial part of the audible range of sound waves, is recorded in accordance with the invention.

Figure 2 is a view, partially diagrammatic, showing the combination of devices or the electrical circuit by which a recording of a wide range of frequencies, obtained by the circuit shown in Figure 1, may be reproduced.

Figure 3 is a view, partially diagrammatic, of another electrical circuit or combination of devices for recording a wide range of frequencies, such as the entire or substantially the entire audible range of sound frequencies, utilizing the same method used by the circuit of Figure 1 to accomplish this result.

Figure 4 is a diagrammatic view of another electrical circuit or combination of devices by which a recording made in accordance with the invention herein can be reproduced with high fidelity.

Figure 5 shows means for producing a carrier frequency for modulating the high frequency band or bands in the recording of a wide range of frequencies, such as the entire or a substantial part of the audible range of sound frequencies, and also for demodulating the high frequency band or bands in reproducing a recording in accordance with the invention.

Figure 6 illustrates another means for recording and reproducing a carrier frequency for both modulating and demodulating the band or bands of frequencies and particularly the high frequency band or bands.

Figure 7 shows a portion of a moving picture film on which a recording of a plurality of tracks is made in accordance with the invention herein.

Present-day apparatus and methods of recording and reproducing sound, such for example as is commonly used with talking moving pictures, are incapable of accurately recording and reproducing frequencies in excess of 7500 to 8000 cycles per second. At higher frequencies numerous factors are introduced with present methods which tend to reduce high frequency response, some of which factors are inter-electrode capacitance, capacitance shunting of connecting circuits between photocell and amplifier, and the inherent inertia of gas cells at higher frequencies. Also when the light scanning slit is reduced to very small proportions, as is necessary in order to reproduce the very high frequencies, the amount of light which reaches the photocell is unbelievably small, so that the output of the photocell is well below the threshold of ground noise of the amplifiers. Amplification of these high frequencies therefore becomes impossible because the tube noise of the amplifier stage or stages is also amplified and drowns out the high frequency sound waves or renders their reproduction unsatisfactory.

Again, at the higher audible frequencies and particularly the frequencies in the neighborhood of 15,000 cycles per second, and higher, the recording of each wave upon the recording track approaches in dimension the size of the grain structure of the film which also tends to distort the wave shape. Also the wave forms of the recording at these high frequencies in the audible range are invariably so fine or close that they are lost through printing and developing processes. If the recording of higher frequencies were attempted on recording disks, the above difficulties would be multiplied because of the larger grain structure of disk material, as compared with the grain structure of a film. The inability of present systems to reproduce or reproduce accurately the upper harmonics of musical instruments is the one factor, more than any other, that makes present motion picture sound systems unpleasant to listen to particularly at higher volumes. The inaccurate reproduction of upper harmonics produces a metallic or a tinny overtone in music and other sounds. Both the loss of upper harmonics and their inaccurate reproduction is caused by electrical and optical deficiencies in the present-day systems.

It is to be understood that the invention to be described herein, although particularly applicable to the recording and reproduction of sound frequencies, is applicable to any frequencies and to practically any range of frequencies, because by selecting the proper modulating or carrier frequency, the high frequencies can be converted to low frequencies in the range from 0 to 8000 cycles which present-day equipment can record and reproduce with high fidelity. Also the invention can be practiced in a range of frequencies not exceeding 8000 cycles, although within this range the usefulness of the invention is not as apparent since present-day equipment works satisfactorily in this range.

In the form of construction illustrated in Figures 1 and 2, the audible range of the sound

waves, or a desired part thereof, is transformed into electrical oscillations by any known means, such as a microphone 10, and amplified in any known manner, such as by the means A. diagrammatically illustrated. For the purpose of an example, a range of frequencies selected for recording and reproduction by the method of the invention will be from 0 to 15,000 cycles per second, which range is about twice that now satisfactorily recorded and reproduced and is substantially the full audible range. It is understood that the invention is applicable to a lesser or greater frequency range.

The circuit 11 from the microphone is divided into a plurality of branch circuits, such as the circuits 12 and 13. One of these branch circuits, namely the circuit 12, has a wave filter or filtering means 16 which passes or selects a low band of frequencies, which in moving picture recording work may range from 0 to 8000 cycles, and suppresses all other frequencies. This band of low frequencies may then be recorded by any suitable means 17 such as upon a sound track 18 of a moving picture film 19 of Fig. 7. This manner of recording is known to the art. The second branch circuit 13 has a filtering means 20 which passes a band of frequencies, for example, from 8000 to 15,000 cycles, and suppresses the low frequencies.

It is evident that the range of sound waves or frequencies from 0 to 15,000 cycles has been transformed into corresponding electrical oscillations which have been divided or separated into a plurality of frequency bands, two being particularly described. The filters or filtering means 16 and 20, which are used to divide or separate the entire frequency range into branches or separate frequency bands, may be of any suitable kind which have a sharp cut-off frequency curve. The high frequency band is transmitted through a matching transformer 14 to means which converts the frequencies of this band into low frequencies capable of being recorded by known systems upon a sound track, such as the sound track of a moving picture film.

The high frequency band is converted to a low frequency by modulating the same with a carrier frequency of, say, 7500 cycles to produce a low frequency side band and a high frequency side band in a known manner. This low frequency side band, in the illustrated range of 8000 to 15,000 cycles for the high frequency band, includes frequencies from 500 to 7500 cycles. The high frequency side band and the carrier frequency are suppressed and the low frequency side band is recorded to form a recording or track, such as the sound track 21 upon the film 19 of Figure 7. This low frequency side band can be recorded in the same manner and with the same kind of equipment which was used to record the low frequency band since its range of frequencies is well within the range capable of being recorded by present-day systems.

The modulation or conversion of the high frequency band is accomplished by providing an oscillator 22 which preferably develops a fundamental frequency of, say, 1500 cycles. The 1500 cycles pass through a harmonic producer 23, and the filter 24 selects, for example, the fifth harmonic of 7500 cycles which is the carrier frequency and is impressed upon the amplifier circuit 25 through the transformer 26. The carrier frequency may be directly produced if desired, however there are certain advantages in the method described such as greater ease and

accuracy in recording a lower carrier frequency.

The amplified carrier frequency preferably passes through a balanced H pad 27 which is connected with the input of the modulating means 30. The modulating means particularly illustrated is a Hartley balanced type of modulator, such as that described in Patent 1,419,562, which produces a low frequency side band and a high frequency side band and suppresses or balances out the carrier frequency and the modulating frequency. A filter means 31 passes the low frequency side band and suppresses the high frequency side band, and the low side band is recorded by recording means 32 in any suitable fashion to provide a second sound track, such as the second sound track 21 upon the moving picture film 19. The balanced modulator 30 and filter means 31 provide means for passing the low frequency side band and suppressing the modulating frequency, the carrier frequency and the high frequency side band. Other means may be used to accomplish this result.

The 1500 cycle fundamental or basic frequency may be recorded by any suitable means 35 upon a third sound track 36 carried by the moving picture film 19. It is not essential to have this fundamental or basic frequency recorded, although it is beneficial to do so because any shift or drift in the frequency has its effect upon the modulation of the higher frequency band or bands, and upon demodulation of these higher frequency bands, it is desirable that the same frequency shift occur and at the same time for more accurate reproduction of the sound frequencies. It is to be understood, however, that satisfactory high fidelity reproduction is obtained even though the carrier frequency or a fundamental frequency is independently produced. In other words, it is not essential that the carrier frequency or a fundamental frequency be recorded and that a reproduction of this recording be used to demodulate the reproduction of the sound track of the low frequency side band which is a conversion of the high frequency band.

The recorded sound waves are reproduced in a manner and with a combination of devices now to be described. The recording 18 of the low frequency band is picked up and transformed into electrical oscillations by any suitable reproducing means 38 which is diagrammatically illustrated. The recording 21 of the low frequency side band, that is of the converted high frequency band, is picked up and transformed into electrical oscillations by any suitable reproducing means and amplified, all of which is accomplished by means indicated generally at 39.

The recorded 1500 cycle frequency is picked up and transformed into electrical oscillations by the reproducing means 40, which oscillations may be amplified and then pass to the harmonic producer 41. The harmonic producer creates or derives the harmonics of the 1500 cycle, and the filter 42 passes the fifth harmonic or a frequency of 7500 cycles, and suppresses all other harmonics. This fifth harmonic is the carrier or demodulating frequency and has any drift or variation which occurred in the original modulating frequency. Any suitable harmonic producer is contemplated. If the reproducing circuit or means is near or adjacent the recording circuit or means, the carrier producing circuit 22, 23, 24, 25, 26 and 27 for the latter circuit may be used, but if these two circuits are widely separated, as would be the case in the

moving picture field, then a separate means, as described, must be provided for producing another carrier frequency for demodulation.

The 7500 cycle carrier frequency is amplified by the circuit 43 and then passes through a balanced H pad 44, after which this carrier frequency is applied to the circuit carrying the 500 to 7500 cycles of the low frequency side band, or the converted high frequency band. In other words, the carrier frequency is applied to the input of a demodulator means 45 which again may be of the Hartley balanced type, as previously mentioned, whereby the carrier frequency and the modulating oscillations are suppressed or balanced out. The demodulated oscillations produce a high and a low frequency side band, the latter being the initial frequency band of 8000 to 15,000 cycles. The output of the demodulator means is connected with a filter 46 which suppresses the low frequency side band and passes the high frequency side band which is the initial or original band of frequencies in the high frequency band. The balanced demodulator and filtering means 46 comprise means for creating a high frequency side band and suppressing the carrier frequency, the modulating oscillations and the low frequency side band.

The reconverted band of frequencies is combined or mixed with the frequencies of the low frequency or unmodulated band, whereby the complete initial range of electrical oscillations from 0 to 15,000 is reproduced. If these electrical oscillations are transformed sound waves, then they may be connected to a loud speaker or other sound reproducer 47 to reproduce the original range of sound waves.

Another apparatus or combination of devices is illustrated in Figures 3 and 4 for recording and reproducing a wide range of frequencies, such as sound waves, by the same method described in connection with the combination illustrated in Figures 1 and 2, but instead of using a balanced modulator and demodulator of the Hartley type, these views illustrate a combination of devices utilizing a Carson type of balanced modulator and balanced demodulator described in his Patent 1,343,306 which suppresses or balances out the modulating oscillations but not the carrier frequency. The Carson balanced modulator and balanced demodulator differs from the Hartley circuit in this respect.

The recording system shown in Figure 3 is substantially the same as that shown in Figure 1 with the substitution referred to above. The parts or devices which are the same have been given the same reference numerals, and hence need not be described in detail. Briefly, the microphone 10 transforms the sound waves into electrical oscillations which are then divided or separated by a plurality of branch circuits, two being particularly shown. Filter 16 passes a low frequency band and suppresses all other frequencies. The low frequency band is recorded by a recording means 17, such as upon a sound-track 18 of a moving picture film.

The filter 20 passes a high frequency band and suppresses all other frequencies, which high frequency band passes to the Carson type of balanced modulator 52. The Carson type of modulator functions in the manner described in his patent referred to above. In other words, by modulating with a carrier frequency of, say, 7600 cycles, there is produced a low frequency side band of 125 to 7400 cycles, and a high frequency side band with the modulating oscillations suppressed or bal-

anced out, but not the carrier frequency, in much the same fashion as the Hartley modulator produces a low frequency and high frequency side band but with the carrier frequency and the modulating oscillation suppressed or balanced out. A filter or filter means 31 passes the low frequency side band which is recorded upon a second sound track, such as the track 21 upon the moving picture film 19. The high frequency side band and carrier is suppressed by the filter means.

It is to be understood that amplifiers A may be supplied any place where desired or needed in the circuit with respect to the circuit or combination shown in Figures 3 and 4, as well as that shown in Figures 1 and 2. The circuit illustrated in Figures 3 and 4 does not show an H pad in the carrier frequency circuit, such as the pad 27 and 44 shown in Figures 1 and 2. Such pads or equivalent means may be used if desired.

In the form of circuit illustrated in Figure 3, the carrier or demodulating frequency is shown as being 7600 cycles which may be produced in any known manner. The production of this frequency is illustrated in a general way by the oscillator means 53 which may produce the carrier frequency of 7600 cycles directly, or it may be produced by creating a basic or fundamental frequency, passing the same through an harmonic producer, and then with suitable filter means pass the desired harmonic of 7600 cycles and suppress all other harmonics. This method was described in connection with the circuit of Figure 1. The carrier frequency, or a fundamental frequency from which a harmonic frequency of 7600 cycles may be derived, may be recorded such as upon a sound track 36 of the moving picture film 19 and the demodulating carrier frequency obtained therefrom.

The reproducing circuit, illustrated in Figure 4, and its method of operation are also much like the combination of devices shown in Figure 2, excepting that it uses a Carson type balanced demodulator, instead of a Hartley type, and the identical parts have been assigned the same numerical designation.

In reproducing the plurality of frequency bands into which the original frequency range has been divided, the recorded low frequency band is transformed into electrical oscillations in the same manner as described in connection with the construction and method of Figure 2. The recording 21 of the converted high frequency band is transformed into electrical oscillations which are demodulated by the Carson type of demodulator 56 utilizing a carrier frequency of 7600 cycles which corresponds with the carrier frequency used to modulate the original high frequency band. The carrier frequency is produced in any suitable way, such as from the recorded frequency 36 or by a device diagrammatically illustrated as an oscillator means 57. The demodulation produces a high and low frequency side band, and the filter 46 suppresses the low frequency side band and carrier frequency and passes the high frequency side band which produces the initial high frequency band of 7725 to 15,000 cycles. The modulating oscillations are balanced out by the demodulator. The two branch circuits are connected so that the electrical frequencies are then mixed or combined to reproduce the original range of frequencies which may be amplified if desired. If the original range of frequencies were sound waves, then the reproduced electrical oscillations may be fed to a loud speaker 47

where the full range of from 0 to 15,000 cycles of audible sound is reproduced with accuracy or high fidelity.

It has been previously mentioned that the carrier frequency may be produced in any suitable manner. It has also been mentioned that for the maximum of accuracy or high fidelity the carrier frequency, or some fundamental frequency from which the carrier frequency is derived by a harmonic producer, is recorded. When the carrier is recorded, any drift in the carrier frequency is also recorded and this drift is subsequently reproduced so that any inaccuracy created in the modulation of the frequency band by this drift is corrected for; in other words, the reproduction of the original modulating or carrier frequency automatically compensates for this drift in the original carrier wave.

Another method of producing the carrier frequency is illustrated in Figure 5. The sound sprocket 60 of a moving picture camera and also of a moving picture projector runs at a speed which is substantially constant and its percentage of variation is very low. In other words, its uniformity of rotation is very high. An oscillation generator 61 is illustrated in Figure 5 as being connected to or carried upon the sound sprocket 60. This generator may produce the carrier frequency directly, or may produce a fundamental or basic frequency which passes through a harmonic producer and the carrier frequency is derived therefrom, as previously described. The type of oscillation generator particularly illustrated in Figure 5 is described in the Horton Patent 1,799,795. It is to be understood that this oscillation generator connected to the sound sprocket of the moving picture camera generates the carrier frequency for modulating the high frequency sound band.

The same type of oscillation generator, or an oscillation generator of any suitable kind, may be connected to the sound sprocket of the moving picture projector for developing the carrier frequency either directly or by generating a basic or fundamental frequency which passes through a harmonic producer, as previously described, from which the carrier frequency is derived. The carrier frequency is used in connection with the moving picture reproduction to demodulate the converted high frequency band whereby its original range of frequencies is restored or reproduced.

Figure 6 illustrates another method of generating the carrier frequency, which generator is again connected or coupled with the sound sprocket 65 of the moving picture camera and the same kind of carrier wave producer, or any other kind, may be connected with the sound sprocket of the moving picture projector. In this construction, a transparent sleeve 66 may be directly carried upon the shaft 67 upon which the sound sprocket 65 is mounted. Upon this transparent sleeve a piece of sound film is mounted which carries a sound track 68 of either the carrier frequency or a basic or fundamental frequency from which the carrier frequency may be derived, as heretofore described.

A light source 72 passes through a lens tube 73 of known construction which produces a slit of light which is reflected by the prism 74 through the sound track 68. A photocell 75 converts the variations in light intensity, caused by the sound track 68, into electrical oscillations of the frequency carried by the sound track. Since the

sound sprocket 65 rotates at a very uniform speed, a very uniform carrier oscillation, or a basic or fundamental frequency from which the carrier is derived, is obtained. It should be noted, too, that any variations in the speed of the sound sprocket of the projector will create a slight drift in the frequency of the carrier wave and thereby tend to compensate for the variations in speed of the sound sprocket in the sound reproduced from the sound track on the moving picture film.

Preferably, the sound track 68 is a basic or fundamental frequency which passes through a harmonic producer 78 and a filter 79 selects the harmonic which is the desired carrier frequency. In this construction also amplifiers A may be provided wherever needed.

It has been described hereinbefore that the carrier frequency may be recorded or a fundamental frequency can be recorded from which the carrier frequency is produced. This fundamental frequency may be used to produce the carrier frequency for both the modulation or conversion of the high frequency band or bands into a low frequency side band, and the demodulation of the low frequency side band or bands by which the latter is reconverted into its initial high frequency band. It is to be understood, therefore, that a recording of a frequency from which the carrier frequency can be derived constitutes a definition of a recording, whether it be a recording of the carrier frequency, or a recording of a fundamental frequency from which the carrier frequency may be produced.

Although the method and apparatus described herein have particular applicability to the recording and reproduction of sound waves, the method and apparatus are applicable to record, with high fidelity, a range of electrical oscillations carrying intelligence of any nature. The range of frequencies which can be recorded and reproduced, with high fidelity, by the method and combination of devices of the invention is considerably greater than the range which can be recorded and reproduced by practicing known methods and using known combinations of apparatus. The wide range of oscillations to be recorded and reproduced may be such oscillations like sound waves which must be transformed into electrical oscillations and then reproduced as sound, or may be electrical oscillations which need not be transformed into some other kind of waves or oscillations.

It will be observed that by the method of recording and reproducing sound as described, the recorded frequencies are not in excess of 8000 cycles which present-day apparatus is well capable of recording and reproducing with accuracy or high fidelity. The ultimate reproduction, however, in the example illustrated, is throughout a range of from 0 to 15,000 cycles and a flat or substantially flat frequency response is obtained throughout this entire range.

It is clear that there may be many variations in the details of recording and reproducing a wide range of frequencies as described herein. For example, the recording range can be raised to 16,000 cycles by properly designing the filters and utilizing, say, an 8000 cycle carrier frequency or wave. The modulation of the 8000 to 16,000 frequency would result in a low frequency side band ranging from 0 to 8000 cycles which would be recorded. A basic or fundamental frequency of 2000 cycles may be produced by an oscillator which is recorded, rather than the 1500 cycles

previously described, which 2000 cycles pass to a harmonic producer and a properly designed filter selects the fourth harmonic, or 8000 cycles, both for modulating or converting the high frequency band of the two bands of sound frequencies into low frequencies and for demodulating the converted high frequency band to reproduce the original high frequency band.

It is also clear that by following the principles outlined above, it will be readily apparent that the invention is not limited to dividing the range of electrical frequencies, or the sound frequency range, into two branches or two bands of frequencies, but that it may be divided into a greater number of branches or frequency bands, thereby lowering the frequency range in each branch or frequency band for the full range of frequencies. In other words, if it is desired to record and reproduce a range from 0 to 18,000 cycles, this initial range can be divided into three frequency bands of 6000 cycles each in three branch circuits. The low frequency band is recorded. Each high frequency band is modulated or converted to produce two low frequency side bands, and each low frequency side band is recorded in the manner described hereinbefore. For reproduction of the original frequency range, the recordings are converted into electrical oscillations. Each low frequency side band is then demodulated with a carrier frequency to produce a low frequency and a high frequency side band, the former being suppressed and the latter being combined with the other demodulated side band and the unmodulated frequency band to reproduce the initial frequency range. The electrical oscillations, if originally transformed from sound waves, may be reproduced as sound waves with a loud speaker. The carrier frequency or frequencies is selected so that the plurality of bands into which the full range of frequencies has been divided can be converted into a band of low frequencies which is well within the range of frequencies which present-day equipment is capable of recording and reproducing with accuracy or high fidelity.

The filters or filter means used should be fairly sharp and particularly the filters used to separate or divide the entire range of frequencies into separate frequency bands. The filters used after the modulators and demodulators need not be particularly sharp, although this may depend upon the spread between the low frequency and high frequency side bands.

This invention is presented to fill a need for improvements in a method and apparatus for recording and reproducing. It is understood that various modifications in structure, as well as changes in mode of operation, assembly, and manner of use, may and often do occur to those skilled in the art, especially after benefiting from the teachings of an invention. Hence, it will be understood that this disclosure is illustrative of preferred means of embodying the invention in useful form by explaining the construction, operation and advantages thereof.

What is claimed is:

1. A method of recording and reproducing a wide range of electrical frequencies or oscillations comprising separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, converting at least one of said frequency bands into a band of low frequencies by modulating the same with a carrier frequency, recording each converted frequency band and any unconverted frequency

band, transforming the recording of each frequency band into electrical oscillations, reconverting each converted frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency for that frequency band, and mixing the reconverted frequency band or bands with each other and with any unconverted frequency band or bands to restore the initial frequency range.

2. A method of recording and reproducing a wide range of electrical frequencies or oscillations comprising separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, converting at least one of said frequency bands into a band of low frequencies by modulating the same with a carrier of a desired frequency, recording each converted frequency band and any unconverted frequency band, recording a frequency from which each carrier frequency can be derived, transforming the recording of each frequency band into electrical oscillations, transforming each frequency recording into the carrier frequency, reconverting each converted frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency with which each converted frequency band was modulated, and mixing each reconverted frequency band with any other and any unconverted frequency band to restore the initial frequency range.

3. A method of recording and reproducing a wide range of sound frequencies or waves comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, converting at least one of said frequency bands into a band of low frequencies by modulating the same with a carrier frequency, recording each converted frequency band and any unconverted frequency band, transforming the recording of each frequency band into electrical oscillations, reconverting each converted frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency with which that frequency band was modulated, mixing the reconverted band or bands with each other and with any unconverted frequency band or bands to restore the initial frequency range, and reproducing the oscillations of the wide frequency range as sound waves.

4. A method of recording and reproducing a wide range of sound frequencies or waves comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, recording the low frequencies into a band of low frequencies by modulating with a carrier frequency, recording each of said converted frequency bands, transforming the recording of each frequency band into electrical oscillations, reconverting each higher frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency for that respective frequency band, mixing the reconverted high frequency band or bands with each other and with the low frequency band, and reproducing the oscillations of the wide frequency range as sound waves.

5. A method of recording and reproducing a

wide range of sound frequencies or waves comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, recording the low frequency band, producing a carrier frequency, converting each higher band of frequencies into a band of low frequencies by modulating with the carrier frequency, recording each of said converted frequency bands, recording a frequency from which the carrier frequency can be derived, transforming the recording of each frequency band into electrical oscillations, reproducing the carrier frequency from the recorded frequency, reconverting each higher frequency band to its initial frequency range by demodulating with the carrier frequency, mixing the reconverted high frequency bands with each other and with the low frequency band, and reproducing the oscillations of the wide frequency range as sound waves.

6. A method of recording and reproducing a wide range of sound frequencies or waves comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, recording the low frequency band, producing a fundamental frequency from which a carrier frequency may be derived, converting each higher band of frequencies into a band of low frequencies by modulating with the carrier frequency, recording each of said converted frequency bands, recording the aforesaid fundamental frequency, transforming the recording of each frequency band into electrical oscillations, reproducing the carrier frequency from the recording of the fundamental frequency, reconverting each higher frequency band to its initial frequency range by demodulating with the carrier frequency, mixing the reconverted high frequency bands with each other and with the low frequency band, and reproducing the electrical oscillations of the wide frequency range as sound waves.

7. A method of recording a wide range of electrical frequencies or oscillations comprising separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, converting at least one of said frequency bands into a band of low frequencies by modulating the same with a carrier frequency, and recording each converted frequency band and any unconverted frequency band.

8. A method of recording a wide range of electrical frequencies or oscillations comprising separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, converting at least one of said frequency bands into a band of low frequencies by modulating the same with a carrier of a desired frequency, recording each converted frequency band and any unconverted frequency band, and recording a frequency from which each carrier frequency can be derived.

9. A method of recording a wide range of sound frequencies or waves comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, converting at least one of said frequency bands into a band of low frequencies by modulating the same with a carrier frequency, and recording each converted frequency band and any unconverted frequency band.

10. A method of recording a wide range of sound frequencies comprising transforming the

sound waves into electrical waves, separating the range of frequencies of the electrical waves into a plurality of frequency bands, recording the low frequency band, converting each higher band of frequencies into a band of low frequencies by modulating with a carrier frequency, and recording each of said converted frequency bands.

11. A method of recording a wide range of sound frequencies comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, recording the low frequency band, producing a carrier frequency, converting each higher band of frequencies into a band of low frequencies by modulating with the carrier frequency, recording each of said converted frequency bands, and recording a frequency from which a carrier frequency can be reproduced.

12. A method of recording a wide range of sound frequencies comprising transforming the sound waves into electrical oscillations, separating the range of frequencies of the electrical oscillations into a plurality of frequency bands, recording the low frequency band, producing a fundamental frequency from which a carrier frequency may be derived, converting each higher band of frequencies into a band of low frequencies by modulating with a carrier frequency, recording each of said converted frequency bands, and recording the aforesaid fundamental frequency.

13. A method of reproducing a wide range of electrical frequencies or oscillations which have been separated into a plurality of frequency bands, at least one of said frequency bands having been converted into a band of low frequencies by modulating the same with a carrier frequency and each converted frequency band and any unconverted frequency band having been recorded comprising transforming the recording of each frequency band into electrical oscillations, reconvertng each converted frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency for that frequency band, and mixing the reconverted frequency band or bands with each other and with any unconverted frequency band or bands to restore the initial frequency range.

14. A method of reproducing a wide range of electrical frequencies or oscillations which have been separated into a plurality of frequency bands, at least one of said frequency bands having been converted into a band of low frequencies by modulating the same with a carrier of a desired frequency, and each converted frequency band and any unconverted frequency band and a frequency from which each carrier frequency can be derived having been recorded comprising transforming the recording of each frequency band into electrical oscillations, transforming each frequency recording into the carrier frequency, reconvertng each converted frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency with which each converted frequency band was modulated, and mixing the reconverted frequency band or bands with each other and with any unconverted frequency band or bands to restore the initial frequency range.

15. A method of reproducing a wide range of sound frequencies or waves which have been separated into a plurality of frequency bands, at

least one of said frequency bands having been converted into a band of low frequencies by modulating the same with a carrier frequency, and each converted frequency band and any unconverted frequency band having been recorded comprising transforming the recording of each frequency band into electrical oscillations, reconvertng each converted frequency band to its initial frequency range by demodulating with a carrier frequency the same as that of the modulating carrier frequency with which that frequency band was modulated, mixing the reconverted band or bands with each other and with any unconverted frequency band or bands to restore the initial frequency range, and reproducing the oscillations of the wide frequency range as sound waves.

16. A method of reproducing a wide range of sound frequencies or waves which have been separated into a plurality of frequency bands, at least one of said frequency bands having been converted into a band of low frequencies by modulating with a carrier frequency and each of said frequency bands having been recorded comprising transforming the recording of each frequency band into electrical oscillations, reconvertng each higher frequency band to its initial frequency range by demodulating with a frequency the same as that of the modulating carrier frequency for that frequency band, mixing the reconverted high frequency band or bands with each other and with the low frequency band, and reproducing the oscillations of the wide frequency range as sound waves.

17. A method of reproducing a wide range of sound frequencies which have been transformed into electrical oscillations, the electrical oscillations having been separated into a plurality of frequency bands, each higher band of frequencies having been converted into a band of low frequencies by modulating with a carrier frequency, all of which bands having been recorded as well as a frequency from which a carrier frequency can be reproduced comprising transforming the recording of each frequency band into electrical oscillations, reproducing the carrier frequency from the recorded frequency, reconvertng each higher frequency band to its initial frequency range by demodulating with the carrier frequency, mixing the reconverted high frequency bands with each other and with the low frequency band, and reproducing the electrical oscillations of the wide frequency range as sound waves.

18. A method of reproducing a wide range of sound frequencies which have been transformed into electrical oscillations and the range of frequencies of the electrical oscillations have been separated into a plurality of frequency bands with each higher band of frequencies being converted into a band of low frequencies by modulating with a carrier frequency and each of said frequency bands and a fundamental frequency from which a carrier frequency can be derived having been recorded comprising transforming the recording of each frequency band into electrical oscillations, reproducing the carrier frequency from the recording of the fundamental frequency, reconvertng each higher frequency band to its initial frequency range by demodulating with the carrier frequency, mixing the reconverted high frequency bands with each other and with the low frequency band, and reproducing the electrical oscillations of the wide frequency range as sound waves.

19. An apparatus for recording and reproducing a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with at least one branch circuit for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the high frequency side band, the modulating oscillations and the carrier frequency, means for recording each low frequency side band and any unmodulated frequency band, means for each recording for transforming the same into electrical oscillations, the carrier frequency producing means being connected with each of the next aforesaid means which carries a side band frequency for demodulating each side band frequency into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band, the carrier frequency and the modulating frequency whereby the initial frequency band is recreated, the output of each of the next aforesaid means and any transforming means carrying an unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

20. An apparatus for recording and reproducing a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with at least one branch circuit for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated current for passing the low frequency side band and suppressing the high frequency side band, the carrier frequency and the modulating oscillations, means for recording each low frequency side band and any unmodulated frequency band, means for each recording for transforming the same into electrical oscillations, a second means for producing a carrier frequency of the same frequency as the carrier frequency used for modulating the aforesaid frequency band and being connected with each of the next aforesaid means which carries a low frequency side band for demodulating the same into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band, the demodulating oscillations and the carrier frequency whereby the initial frequency band is recreated, the output of each of the aforesaid means being connected and the transforming means carrying an unmodulated frequency band whereby the demodulated frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

21. An apparatus for recording and reproduc-

ing a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with at least one branch circuit for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated current for passing the low frequency side band and suppressing the high frequency side band, the carrier frequency and the modulating oscillations, means for recording each low frequency side band and any unmodulated frequency band, means for recording a frequency from which the carrier frequency can be derived, means for each frequency band recording for transforming the same into electrical oscillations, means for producing the carrier frequency from the frequency recording and connected with the output of each of the next aforesaid means which carries a side band frequency for demodulating each low frequency side band into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band, the demodulated side band and the carrier frequency whereby the initial frequency band is recreated, the output of each of the aforesaid means and any transforming means carrying an unmodulated frequency band being connected whereby the reconverted frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

22. An apparatus for recording and reproducing a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, a balanced modulator connected with at least one of the filter means, means producing a carrier frequency connected with the input side of at least one balanced modulator for modulating the frequency band carried thereby into a low frequency and a high frequency side band, filter means in the output of each balanced modulator for passing the low frequency side band and suppressing the high frequency side band, means for recording each low frequency side band and any unmodulated frequency band, means for each recording for transforming the same into electrical oscillations, a balanced demodulator connected with each of the next aforesaid means which carries a side band frequency, the carrier frequency producing means being connected with the input side of each demodulator for demodulating each side band frequency into a low frequency and a high frequency side band, filter means for passing the high frequency side band and suppressing the low frequency side band whereby the initial frequency band is recreated, and the output of each of the next aforesaid means and the output of all transforming means carrying an unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with any

unmodulated frequency band or bands to restore the initial frequency range.

23. An apparatus for recording and reproducing a wide range of sound frequencies or waves comprising means to transform the waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with the output side of the filter means passing a high frequency band for modulating the same into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the carrier frequency, the modulating oscillations and the high frequency side band, means for recording each low frequency side band and the unmodulated low frequency band in separate sound tracks, means for each recording for transforming the same into electrical oscillations, carrier frequency producing means connected with the output side of the transforming means which carries a side band frequency for demodulating each side band frequency into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the carrier frequency, the demodulating oscillations and low frequency side band whereby the initial frequency band or bands is recreated, the output of each of the next aforesaid means and of the transforming means for the low frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range, and means to reproduce the initial frequency range as sound waves.

24. An apparatus for recording and reproducing a wide range of sound frequencies or waves comprising means to transform the sound waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with the output side of one filtering means for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the carrier frequency, the modulating frequency and the high frequency side band, means for recording each low frequency side band and the unmodulated frequency band in separate sound tracks, means for each recording for transforming the same into electrical oscillations, a second carrier frequency producing means connected with the output side of at least one of the next aforesaid means which carries a side band for demodulating the side band into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band, the demodulating oscillations and the carrier frequency whereby the initial frequency band is recreated, the output of each of the next aforesaid means and of any transforming means carrying an unmodulated frequency band being connected whereby the de-

modulated frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

25. An apparatus for recording and reproducing a wide range of sound frequencies or waves comprising means to transform the waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, a balanced modulator connected with at least one of the filter means carrying a higher frequency band, means producing a carrier frequency and connected with the input side of each balanced modulator for modulating the frequency band carried thereby into a low frequency and a high frequency side band, filter means in the output of each balanced modulator for passing the low frequency side band and suppressing the high frequency side band, means for recording each low frequency side band and the unmodulated low frequency band and a frequency from which the carrier frequency can be derived, means for each recording for transforming the same into electrical oscillations, a balanced demodulator connected with each of the next aforesaid means which carries a side band frequency, means for producing a carrier frequency from the frequency recording and connected with the input side of each demodulator for demodulating each low frequency side band into a low frequency and a high frequency side band, filter means for passing the high frequency side band and suppressing the low frequency side band whereby the initial frequency band is recreated, the output of each of the next aforesaid means and the transforming means for the unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range, and means to reproduce the initial frequency range as sound waves.

26. An apparatus for recording and reproducing a wide range of sound frequencies or waves comprising means to transform the waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, a balanced modulator connected with at least one of the filter means carrying a higher frequency band, means producing a fundamental frequency from which a carrier frequency can be derived and connected with the input side of each balanced modulator for modulating the frequency band carried thereby into a low frequency and a high frequency side band, filter means in the output of each balanced modulator for passing the low frequency side band and suppressing the high frequency side band, means for recording each low frequency side band and the unmodulated low frequency band and the fundamental frequency upon separate sound tracks, means for each recording for transforming the same into electrical oscillations, a balanced demodulator connected with each of the next aforesaid means which carries a side band frequency, means for producing a carrier frequency from the fundamental frequency sound track and connected with the input side of each

demodulator for demodulating each side band frequency into a low frequency and a high frequency side band, filter means for passing the high frequency side band and suppressing the low frequency side band whereby the initial frequency band is recreated, the output of each of the aforesaid means and the transforming means for the unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range, and means to reproduce the initial frequency range as sound waves.

27. An apparatus for recording a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with at least one branch circuit for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in the output of each circuit which carries a modulated frequency band for passing the low frequency side band and suppressing the high frequency side band and the carrier frequency, and means for recording each low frequency side band and any unmodulated frequency band.

28. An apparatus for recording a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with at least one branch circuit for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the high frequency side band and the carrier frequency, and means for recording each low frequency side band and any unmodulated frequency band.

29. An apparatus for recording a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with at least one branch circuit for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the high frequency side band and the carrier frequency, means for recording each low frequency side band and any unmodulated frequency band, and means for recording a frequency from which the carrier frequency can be derived.

30. An apparatus for recording a wide range of electrical frequencies or oscillations carried by a circuit comprising a plurality of branch circuits, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies

whereby the initial range of frequencies is separated into a plurality of frequency bands, a balanced modulator connected with at least one of the filter means, means producing a carrier frequency connected with the input side of at least one balanced modulator for modulating the frequency band carried thereby into a low frequency and a high frequency side band, filter means in the output of each balanced modulator for passing the low frequency side band and suppressing the high frequency side band, and means for recording each low frequency side band and any unmodulated frequency band.

31. An apparatus for recording a wide range of sound frequencies or waves comprising means to transform the waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with the output side of the filter means passing a high frequency band for modulating the same into a low frequency and a high frequency side band, means in the output of each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the carrier frequency and the high frequency side band, and means for recording each low frequency side band and the unmodulated low frequency band in separate sound tracks.

32. An apparatus for recording a wide range of sound frequencies or waves comprising means to transform the sound waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, means producing a carrier frequency connected with the output side of one filtering means for modulating the frequency band carried thereby into a low frequency and a high frequency side band, means in each circuit carrying a modulated frequency band for passing the low frequency side band and suppressing the carrier frequency and the high frequency side band, and means for recording each low frequency side band and any unmodulated frequency band and a frequency from which a carrier frequency can be derived in separate sound tracks.

33. An apparatus for recording a wide range of sound frequencies or waves comprising means to transform the waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, a balanced modulator connected with at least one of the filter means carrying a higher frequency band means producing a carrier frequency and connected with the input side of each balanced modulator for modulating the frequency band carried thereby into a low frequency and a high frequency side band, filter means in the output of each balanced modulator for passing the low frequency side band and suppressing the high frequency side band, and means for recording each low frequency side band and the unmodulated low fre-

quency band and a frequency from which the carrier frequency can be derived.

34. An apparatus for recording a wide range of sound frequencies or waves comprising means to transform the waves into electrical oscillations, a plurality of branch circuits leading therefrom, filtering means in each branch circuit for passing a band of frequencies of the electrical oscillations and suppressing other frequencies whereby the initial range of frequencies is separated into a plurality of frequency bands, a balanced modulator connected with at least one of the filter means carrying a higher frequency band, means producing a fundamental frequency from which a carrier frequency can be derived and connected with the input side of each balanced modulator for modulating the frequency band carried thereby into a low frequency and a high frequency side band, filter means in the output of each balanced modulator for passing the low frequency side band and suppressing the high frequency side band, and means for recording each low frequency side band and the unmodulated low frequency band and the fundamental frequency upon separate sound tracks.

35. An apparatus for reproducing a wide range of electrical frequencies or oscillations which have been separated into a plurality of frequency bands and at least one frequency band having been converted into a low frequency side band and each low frequency side band and any unmodulated frequency band being recorded comprising means for each recording for transforming the same into electrical oscillations, carrier frequency producing means connected with each of the aforesaid means which carries a side band frequency for demodulating the same into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band and the carrier frequency whereby the initial frequency band is recreated, the output of each of the next aforesaid means and the transforming means for any unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

36. An apparatus for reproducing a wide range of electrical frequencies or oscillations which have been separated into a plurality of frequency bands and at least one frequency band having been converted by modulating with a carrier frequency into a low frequency side band and each low frequency side band and any unmodulated frequency band being recorded comprising means for each recording for transforming the same into electrical oscillations, means for producing a carrier frequency of the same frequency as the modulating frequency and being connected with each of the aforesaid means which carries a side band frequency for demodulating the same into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band and the carrier frequency whereby the initial frequency band is recreated, the output of each of the next aforesaid means and the transforming means for any unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

37. An apparatus for reproducing a wide range of electrical frequencies or oscillations which have

been separated into a plurality of frequency bands and at least one frequency band being modulated by a carrier frequency into a low frequency side band which has been recorded as well as any unmodulated frequency band and a frequency from which the carrier frequency can be derived comprising means for each recording for transforming the same into electrical oscillations, means for producing the carrier frequency from the frequency recording and connected with the output of each of the next aforesaid means which carries a side band frequency for demodulating each side band frequency into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the low frequency side band and the carrier frequency whereby the initial frequency band is recreated, the output of each of the next aforesaid means and any transforming means carrying an unmodulated frequency band being connected whereby the reconverted frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

38. An apparatus for reproducing a wide range of electrical frequencies or oscillations which have been separated into a plurality of frequency bands and at least one frequency band being modulated into a low frequency side band which has been recorded as well as any unmodulated frequency band comprising means for each recording for transforming the same into electrical oscillations, a balanced demodulator connected with each of the aforesaid means which carries a side band frequency, carrier frequency producing means connected with the input side of each balanced demodulator for demodulating each side band frequency into a low frequency and a high frequency side band, filter means for passing the high frequency side band and suppressing the low frequency side band whereby the initial frequency band is recreated, and the output of each of the next aforesaid means and the output of all transforming means carrying an unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with any unmodulated frequency band or bands to restore the initial frequency range.

39. An apparatus for reproducing a wide range of sound frequencies or waves which have been separated into a plurality of frequency bands and recordings upon separate sound tracks having been made of at least one high frequency band modulated into a low frequency side band and an unmodulated low frequency band comprising means for each sound track for transforming the same into electrical oscillations, carrier frequency producing means connected with the output side of the transforming means which carries a side band frequency for demodulating the same into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the carrier frequency and low frequency side band whereby the initial frequency band or bands is recreated, the output of each of the next aforesaid means and of the transforming means for the unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range, and means to reproduce the initial frequency range as sound waves.

40. An apparatus for reproducing a wide range

of sound frequencies or waves which have been separated into a plurality of frequency bands and recordings upon separate sound tracks having been made of at least one high frequency band modulated by a carrier frequency into a low frequency side band and an unmodulated frequency band and a frequency from which the carrier frequency can be derived comprising means for each sound track for transforming the same into electrical oscillations, means for producing a carrier frequency from the frequency sound track and connected with the output side of at least one of the next aforesaid means which carries a low frequency side band for demodulating the same into a low frequency and a high frequency side band, means for passing the high frequency side band and suppressing the carrier frequency and the low frequency side band whereby the initial frequency band is recreated, the output of each of the next aforesaid means and the transforming means carrying the unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range.

41. An apparatus for reproducing a wide range of sound frequencies or waves which have been separated into a plurality of frequency bands and recordings upon separate sound tracks having been made of at least one of the higher frequency bands modulated with a carrier frequency into a low frequency side band and a frequency from which the carrier frequency can be derived comprising means for each sound track for transforming the same into electrical oscillations, a balanced demodulator connected with each of the next aforesaid means which carries a side band frequency, means for producing a carrier frequency from the frequency recording and connected with the input side of each demodulator for demodulating each side band frequency into a low frequency and a high frequency side band, filter means for passing the high frequency side band and suppressing the low frequency side band whereby the initial frequency band is recreated, the output of each of the next aforesaid means and the transforming means for the unmodulated frequency band be-

ing connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range, and means to reproduce the initial frequency range as sound waves.

42. An apparatus for reproducing a wide range of sound frequencies or waves which have been separated into plurality of frequency bands and recordings upon separate sound tracks having been made of at least one of the higher frequency bands modulated by a carrier frequency into a low frequency side band and an unmodulated low frequency band and the fundamental frequency comprising means for each sound track for transforming the same into electrical oscillations, a balanced demodulator connected with each of the next aforesaid means which carries a side band frequency, means for creating a carrier frequency from the reproduced fundamental frequency and connected with the input side of each demodulator for demodulating each side band frequency into a low frequency and a high frequency side band, filter means for passing the high frequency side band and suppressing the low frequency side band whereby the initial frequency band is recreated, the output of each of the next aforesaid means and the transforming means for the unmodulated frequency band being connected whereby the demodulated frequency band or bands are mixed with each other and with the unmodulated frequency band to restore the initial frequency range, and means to reproduce the initial frequency range as sound waves.

43. A recording for reproducing a wide range of frequencies with high fidelity comprising a track recording a low frequency band of the range of frequencies to be recorded, and at least one other track recording the low frequency side band of a modulated high frequency band.

44. A recording for reproducing a wide range of frequencies with high fidelity comprising a track recording a low frequency side band of the range of frequencies to be recorded, and a track recording a frequency from which a carrier frequency can be derived for demodulating the side band frequency.

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