July 9, 1935. E. HOPKINS 2,007,370

PHONODYNES, INCLUDING MECHANISMS, PROCESSES AND MANUFACTURES

Original Filed March 18, 1922 2 Sheets-Sheet 1

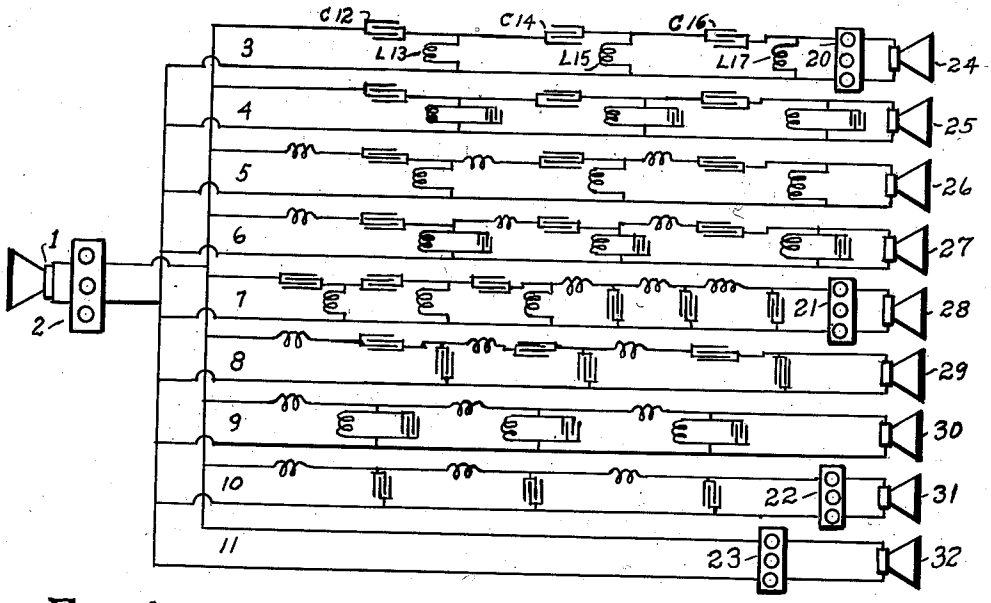


Fig. 1.

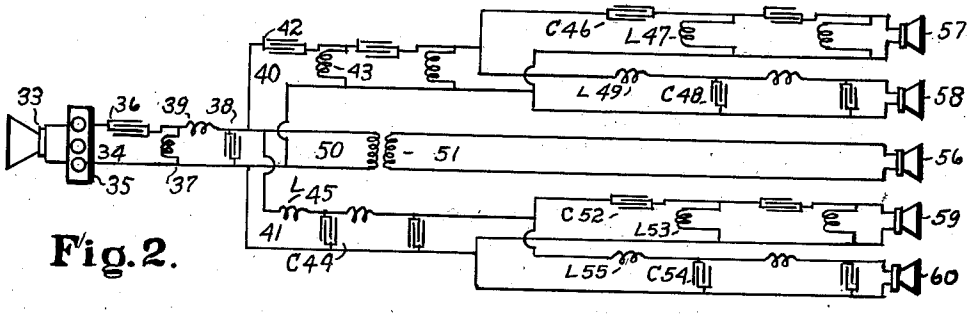


Fig. 2.

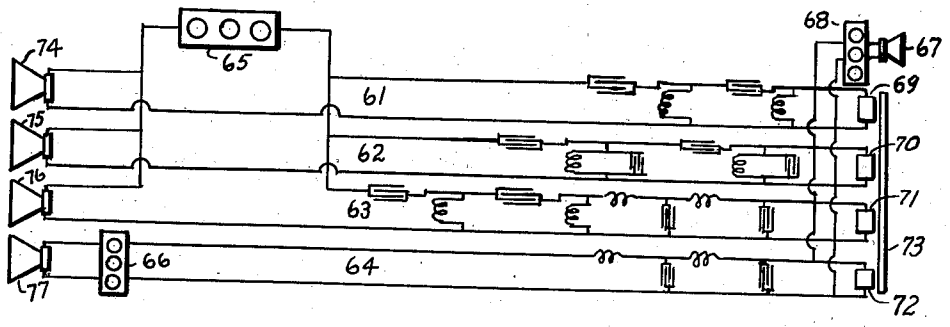


Fig. 3.

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PHONODYNES, INCLUDING MECHANISMS, PROCESSES AND MANUFACTURES

Original Filed March 18, 1922 2 Sheets-Sheet 2

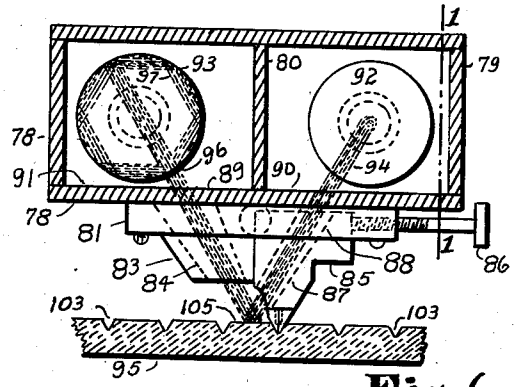


Fig. 6.

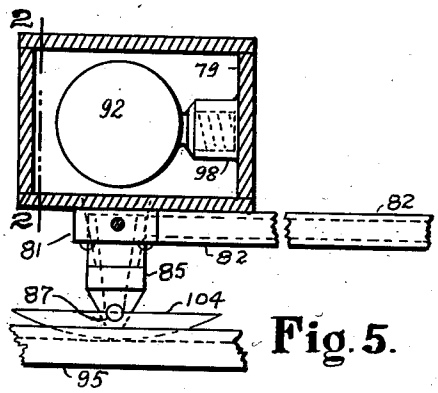


Fig. 5.

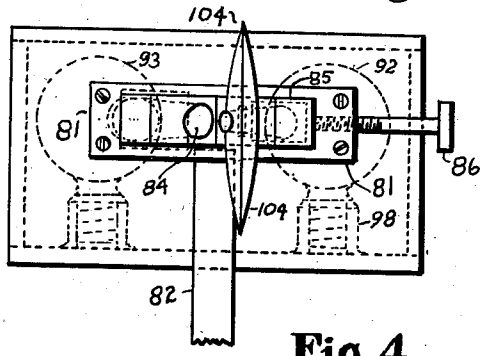


Fig. 4.

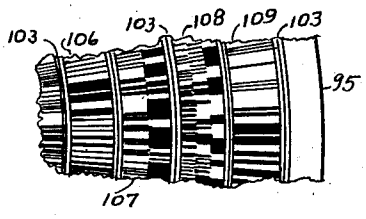


Fig. 7.

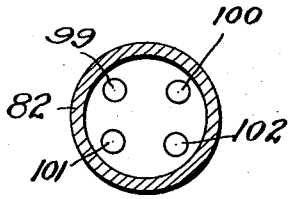


Fig. 8.

Inventor:

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UNITED STATES PATENT OFFICE

2,007,370

PHONODYNES, INCLUDING MECHANISMS, PROCESSES, AND MANUFACTURES

Edwin Hopkins, New York, N. Y.

Original application March 18, 1922, Serial No. 544,928. Patent No. 1,684,129, dated September 11, 1928. Divided and this application August 20, 1928, Serial No. 299,576

58 Claims. (Cl. 179—100.1)

The main object of my invention is to produce sound from sound records in approximately the volume and purity of the original, particularly for use in talking motion pictures.

Heretofore sound recording has been effected in the form of a single track record from a single diaphragm, but as sounds to be recorded are of a great variety of volume, pitch and timbre the records have proven defective.

The basic principle of my invention is to divide the sound into a plurality of frequencies and to record each frequency on a separate track, or to merge a number of such frequencies into a confluent band and record such band on its own track. Each record is thus a component part of the whole band of frequencies. This method is distinct from that of recording each note of a composition on a separate track, since each note contains not only its own frequency but also its partials or overtones. By my method such overtones may occur on a track separate from the track on which the fundamental is recorded.

The speech and musical frequencies usually recorded range from 100 to 3500 vibrations per second. Musical tones are not pure but have numerous overtones or partials and voice effects are less pure. The characteristic timbre of a note depends on the relative force of the fundamental and partials and their relative attenuation of density in the wave. A pure note without partials, A for example, has 435 vibrations per second, that is to say 435 nodal strata occur per second. The density of the wave between the densest part of the nodal strata and the thinnest part of the ventral strata attenuates uniformly but when partials and discords are introduced the uniform attenuation is varied and a tone characteristic of a certain instrument may maintain its density for a considerable time and then pass rapidly into the strata of rarefication, while another instrument may produce a tone that rarefies rapidly. In one case at ⅛ of a wave length from the nodal stratum the density may be 90% of that at the nodal stratum, while in the other the density may have dropped to 20%. Such variations in what may be termed the modulus of density determine the characteristic timbre of the sound and identify the person or instrument singing.

A method of carrying out my invention is to receive sound waves in a microphone which translates them into electrical waves of a suitable range of frequencies, and then to split the range or band of electrical waves by means of electrical filter networks into scion bands or stages of frequencies and to record each band in a separate channel of a multiple channel phonograph record or to record each band in a single channel phonograph record independently. Each channel will thus contain a component part of the whole range of sounds and when reproduced simultaneously the sounds will be reproduced.

The sound channels may be reproduced by means of electrical waves derived therefrom and caused to actuate one or more loud speakers or other sound out-putting devices. In the case of one loud speaker the electrical waves are merged in a single circuit thereto. Multiple loud speakers may be provided, one to each sound record channel.

In recording, or in reproducing, from said channels the relative amplification of the output of the bands in the case of recording, or of the channels in the case of reproducing may be altered with respect to each other, in order to affect the tone output of one or more channels.

The original sounds may be received in a plurality of microphones which may be fitted either with similar or with dissimilar diaphragms, dissimilar diaphragms being used to affect the electrical waves of the microphone's filter dissimilarly. The bands may then be subjected to filtering before the waves are recorded on separate channels in order to confine each channel to selected frequencies.

Certain of the bands of frequencies may be integrated after filtration in order to provide a record with a fewer number of channels than the number of microphones, or the bands may be further divided into scion bands in filtration to provide a greater number of channels than the number of microphones.

In carrying out my invention I find it desirable to employ the following apparatus, processes and manufactures, but it is to be understood that less than all of the different means, mechanisms, processes and manufactures herein described may be employed, or parts only may be employed, or other means, mechanisms, processes and manufactures similar may be substituted, or many of the structural arrangements may be varied and changes in details resorted to, without departing from the scope and spirit of my invention, nor do I limit myself to the particular devices, processes and manufactures shown although I believe them especially suited to the ends to be attained by my invention.

In the accompanying drawings illustrating forms of the invention, and in which the same reference letters and numerals indicate the same or corresponding parts:

Sheet 1:

Figs. 1 to 3 illustrate electrical systems for selecting scion band frequencies by filtration networks:

Fig. 1 shows means for deriving the various frequencies from a single sound transmitter with the band filters in parallel:

Fig. 2 shows a method of deriving the scion bands from an original band leading from the transmitter, by progressive divisions:

Fig. 3 shows means for deriving the scion bands from a plurality of sound transmitters.

It also shows means for integrating the filtered circuits to produce a single channel record.

Sheet 2:

Figs. 4, 5, 6 and 7 show a form of radiant energy phonograph suitable for use in conjunction with the filtered records produced by the filtration means:

Fig. 4 is a plan of a radiant energy phonograph pick-up or sound box taken from below:

Fig. 5 is a sectional side elevation of the same taken on section line 1—1 of Fig. 6:

Fig. 6 is a sectional front elevation of the same taken on line 2—2 of Fig. 5:

Fig. 7 is a plan of a portion of a scion band phonograph sound record therefor:

Fig. 8 is a cross-section view of element 82 of Fig. 5.

Among the forms of phonograph recording that may be utilized are those of physically engraving indentations in channels and of photographically recording variations by means of light cast on photographic films either by varying density in accordance with sound or by varying opaque area in accordance with sound.

I provide, in addition, a novel form of phonograph record and reproducer especially suited for use with this invention, as shown in Figs. 4, 5, 6 and 7.

In this the pick up or sound box consists of a double compartment 79 divided by partition 80, and affixed to block 81 which in turn is affixed to arm 82, adapted to function mechanically in guiding the sound box as does the tone arm of the ordinary phonograph.

Block 81 has lug 83 with aperture 84. Block 81 has a cavity in which needle 85 is seated, the needle being held in position by thumb screw 86. The needle has an aperture extending diagonally from its base 87 to one side 88. Apertures 89, 90 in the bottom 91 of the case are in line with the lug and needle apertures.

Any form of radiant energy such as light, heat, X-rays or the like may be used in this apparatus. Assuming the form of radiant energy to be light, a light producing electric bulb 92 is placed in compartment 79 and a photo-electric cell is placed in compartment 78. Light rays 94 from the lamp 92 pass through the apertures 90, 88, 87 and strike the record 95 at 105. The rays are then reflected and pass up through aperture 252 and enter the photo-electric cell at 96, where they are reflected about the inside walls as 97 and increase the conductivity of the cell.

The bulb is affixed at socket 98 and the cell is similarly affixed. Arm 82 is hollow and carries lead-in wires 99, 100, 101, 102, a pair each for the lamp and the cell. The current from the cell is utilized in any convenient form of electric sound reproducer such as a telephone receiver or loud speaker.

The record has a spiral groove 103 in which the point of the needle rests. The needle in this instance is tipped with a canoe like piece 104 to reduce friction. The groove having no accoustical function serves merely as a guide to hold the needle in position so that the light rays fall on the acoustical part of the record, which lies on spiral tableland 105 between the groove tracks, and consists in variations or striations of color proportionate to the sounds recorded.

A portion of a record of this kind is shown in Fig. 7 in plan. Groove 266 lies between portions 106, 107, 108, 109 of the spiral tableland. Portion 107 and portion 109 contain striations extending entirely across the tableland, but portion 107 contains two separate series of striations and portion 108 three series. Such series may represent different voices or different instruments, or may be scion band frequencies, in which case, when the light falls on all three bands the photo-electric cell acts as an integrator, but it is within the invention to provide a plurality of cells and divide the light rays by slots or otherwise so that there may be produced a variable electric current for each series of striations for sound reproduction. Such striations or modifications may, of course, be placed on a ribbon record, in which event they may be made wider and the physical difficulties of transmitting light to and from them separately correspondingly less.

The record shown in Fig. 7 may be produced by photographic or other printing. The record may be opaque and reflect light as shown in Fig. 6, or it may be transparent and be utilized to transmit light variably in correspondence to its striations. It may be placed at the edge of a motion picture film, preferably bearing analogous subject matter, to produce sound or talking pictures.

The tone arm or guide arm of the radiant energy sound box may be placed on the ordinary phonograph supplementary to the usual acoustical tone arm, and the electrical batteries and sound reproducing apparatus may be mounted in the same cabinet or separately.

My invention splits the voice frequencies into a plurality of stages, or narrow scion bands, and for phonographic purposes records each scion band in a separate track on a sound record, or collects groups of scion bands and integrates them into confluent bands. The scion bands when recorded separately are reproduced in separate sound reproducers for some uses, and the various frequencies coalesce as sound waves in the air reproducing the original sound.

The splitting of the voice frequencies themselves is a novel idea, as set forth in my Patent 1,684,129 of September 11, 1928 of which this is a division and the splitting of them by electrical means as set forth herein is also novel and especially useful as the adjoining bands may more or less overlap as they are attenuated. This avoids gaps in the frequency, although gaps may exist if not too wide without preventing the operation of the invention. The electrical means shown make it feasible to divide the voice frequencies into any desired number of tracks from two upwards, without previously dividing the frequencies and then integrating groups of them. Scion bands are subject to amplification to any desired degree and thus sounds may be projected to a greater distance than has heretofore been possible. This makes the invention especially useful in the synchronization of motion pictures and sound, as a large out-of-doors audience may be entertained. The method is also applicable to telephone or wireless transmission where vis-

ual effects are also sent by electrical transmission at the time of their original production.

Fig. 1 shows a diagram of connections in which all the scion bands are derived in parallel from the sound receiver 1. An amplifier of the audion or other type, as conventionally illustrated at 2, may be inserted. Eight scion bands are indicated, 3, 4, 5, 6, 7, 8, 9, 10, and one normal circuit 11 which acts as a pilot transmitting all frequencies for purposes of comparison in operation. This is not essential but is a matter of convenience.

Scion band 3 comprises all frequencies above the limits for which the apparatus is designed. A capacity C412 and an inductance L413 effect this. The capacity in series permits the passage of high frequency currents while it impedes the low frequencies, while the inductance in shunt affords what is in effect a short circuit for the low frequencies while impeding the high frequencies, the capacity and inductance together forming a lumped impedance. These impedance units or wave filters are repeated at C414, L415 and C416, L417, to produce a more complete effect and further units of the same character may be inserted if desired.

Scion band apparatus 10 has capacity C418 in shunt across the line and inductance L419 in series with the line, thus filtering out all frequencies above the adjusted point and permitting the passage of all frequencies below it. Scion band selectors 3 and 10 may be so adjusted as to divide the total frequency band into two parts, and the remaining apparatus be omitted; or the adjustment may be such that a wide band of frequencies exists between 3 and 10 to be taken care of by the filter systems 4 to 9 inclusive. Further, scion filters 3 and 10 may divide the frequencies into two bands, and the intervening frequency filters may continue to operate, thus overlying the bands of 3, 10.

Scion band circuit 407 is a combination of the forms used in 3 and 10 in series. It thus selects a definite band and excludes all frequencies above and all below that band, Scion band circuit 6 contains capacity and inductance in series and also in parallel in shunt across the line, and thus also selects a definite band of frequencies. Scion band circuits 4, 5, 8, 9 are modifications of the other forms shown and select certain bands. Various other arrangements may be made.

Circuits 3, 7 and 10 contain amplifying units 20, 21, 22, while circuit 411 has amplifying unit 23. These are not essential in principle but desirable in practice. Filter circuits 3 to 10 inclusive are connected to sound reproducers 24 to 31 inclusive which are adapted to obtain the best acoustical results for the various frequencies which they are called upon to transmit into sound.

Fig. 2 shows a form of scion band selector in which the frequencies are divided and sub-divided from an original source in an ancestral manner. Sound receiver 33 transmits electrical variations to circuit 434, amplifier 35 being included. Capacity C436 and inductance L437 and capacity C438 and inductance L439 define the upper and lower limits to be transmitted, which include a range sufficient for the voice frequencies and exclude stray frequencies not relevant to the speech or sounds being transmitted. Filter circuits 40 and 41 are in parallel. Circuit 40 by means of capacity C442 and inductance L443 repeated takes all frequencies above a certain limit, and circuit 41 by means of capacity C444 and inductance L445 repeated takes all below that limit. The upper band is then split into two parts or scions in the next generation by capacity C446 and accompanying inductance L447, repeated, and inductance L449 and accompanying capacity C448. The lower scion band is similar split into two further scions in the corresponding generation by capacity C452 and accompanying inductance L453 and inductance L455 and accompanying capacity C454. Further generations of scion bands may be split up in the same manner if desired. Circuit 50 is a pilot circuit for all frequencies being connected in parallel with the first generation and taken off by induction coil at 51. Any or all of the circuits may be connected by induction coils if desired. Reproducers 57, 58, 59, and 60 accompany the four final circuits while reproducer 456 is for the pilot circuit:

Fig. 3 illustrates a form of the invention in which multiple sound receivers transmit their sound variations to separate electrical circuits. Each of such transmitters receives all sound frequencies but the circuit arrangements are such that the transmission of only selected frequencies occurs. The transmitter diaphragms may accordingly have special characteristics for each of the bands of frequencies which are finally to get through.

Transmitters 74, 75, 76, 77 are connected to scion band circuits 61, 62, 63, 64 respectively. Amplifying unit 65 is in parallel with circuits 61, 62 and 63, but separate amplifier 66 is provided for circuit 465. This merely illustrates optional forms of carrying out the invention. Scion band filter 61 transmits all frequencies above a certain limit, 64 all below a certain limit and 62 and 63 divide the intervening frequencies into two scion bands. The bands may, of course, be more numerous if desired, two or more then being taken from one transmitter or a separate transmitter provided for each one. Pilot reproducer 67 with amplifier 68 is in parallel with the terminals of the several bands, as a matter chiefly of convenience. However, such a method may be employed to integrate scion bands into confluent bands, where a large number of transmitters are employed.

The scion band circuits shown terminate in separate telegraphone recorders, adapted to record separate tracks on a common telegraphone record. These telegraphone units are indicated at 69, 70, 71, 72, each recording a separate track on record 73. Such telegraphone may be provided for the circuit system of Fig. 3. Other forms of phonograph recording may be used instead of the telegraphone method.

In the spiral radiant record employing two scion bands, the guide groove may be between the scion paths and the light from a single source directed onto both paths by suitable apertures and reflected upon separate photo-electric cells, one being provided for each path. Between the grooves there will be two paths of striations, but of matter one rotation apart on the record.

The radiant record in any form may be made of a transparent substance such as glass or celluloid, and the light shine through it from the source of light to the photo-electric cell, or in case selenium is used a path of selenium may be provided beneath the record table, which should also be transparent, and the light source is carried over it by the tone arm. The selenium path then need not move.

In producing a tape record of scion bend fre-

quencies it is desirable to make the first matrix record on a large drum or cylinder, say six feet in diameter and twenty feet long. It may be covered with an emulsion and the record paths photographed on it, or the surface may be wax like and numerous styli engrave the suitable tracks, or other suitable means as indicated, may be employed. The record may then be derived from such cylinder in any of the ways described or known in the art. Celluloid may be floated on the cylinder and then cut off in strips by an advancing knife so that the helical windings are followed for the whole length of the cylinder, some 18 feet of ribbon being produced for each rotation. If an inch wide a twenty foot cylinder would thus produce a ribbon 4320 feet long without a break. Repeated celluloid coatings could be made to produce duplicate records. A substance such as rubber and celluloid mixed by a solution of hexalin forms a suitable base.

In place of using photo-electric cells, selenium or other substances, or substances capable of changing their electric conductivity in the presence of variations of light or heat may be employed, such as the thalofide cell.

What I claim is:

1. In apparatus for recording and reproducing waves corresponding to sound, means for transmitting waves corresponding to sound within a given frequency range and for separately transmitting waves corresponding to sound within another frequency range, means for recording the transmitted waves, and means for reproducing from the resulting record waves corresponding to the original sound.

2. In apparatus for recording and reproducing waves, a source of waves corresponding to sound, means for transmitting from said source waves corresponding to sound above a given frequency, separate means for transmitting from said source waves corresponding to sound below said frequency, means for recording said transmitted waves, and means for reproducing from the resulting record waves corresponding to the original sound.

3. In apparatus for recording and reproducing waves corresponding to sound having components remote from each other in the frequency scale, record receiving means, means for producing thereon a record of waves corresponding to said components, said record producing means including means for controlling the recording of waves corresponding to said components of high frequency separately from waves corresponding to said components of low frequency, and means for reproducing from the resulting record waves corresponding to said components.

4. The method of recording and reproducing waves corresponding to sound, which comprises transmitting waves corresponding to components of sound having a frequency above a given value, separately transmitting waves corresponding to sound components having a frequency below said value, recording said transmitted waves, and reproducing said waves from the resulting record.

5. The method of recording and reproducing waves corresponding to speech, which comprises controlling the transmission of said waves corresponding to speech frequencies of the order of one thousand cycles per second or higher, separately controlling the transmission of said waves corresponding to lower speech frequencies, recording the waves thus transmitted, and reproducing from the resulting record waves corresponding to said speech.

6. In sound recording apparatus, means for producing electric waves varying in accordance with the sound, a plurality of transmission circuits connected thereto, means in one of said circuits for selectively transmissing waves within a given frequency range, means in another of said circuits for selectively transmitting waves within another frequency range, unitary means for receiving a record of said waves, and means for recording thereon the waves transmitted by said circuits.

7. In apparatus for recording waves corresponding to sound, means for receiving a record of said waves, and means for separately recording thereon said waves corresponding respectively to sound components within a given frequency range and to components outside said range.

8. In apparatus for recording waves corresponding to sound, means for transmitting a wave corresponding to a sound of high frequency and for separately transmitting a wave corresponding to a sound of low frequency, means for receiving a record of said waves, and means for separately recording thereon the transmitted waves corresponding respectively to the high frequency sound and the low frequency sound.

9. In sound recording apparatus, means for producing electric waves varying in accordance with the sound, a plurality of transmission circuits connected thereto, means in one of said circuits for selectively transmitting waves within a given frequency range, means in another of said circuits for selectively transmitting waves within another frequency range, unitary means for receiving a record of said waves, and means for separately recording thereon the waves transmitted respectively by said separate circuits.

10. In wave transmitting apparatus, a source of waves of different frequencies, and means connected to said source for variably transmitting light in accordance with said waves, said light transmitting means including means for separately controlling the light variations corresponding respectively to the high frequency waves and the low frequency waves.

11. In apparatus for recording waves corresponding to sound, means for transmitting said waves, means connected to said transmitting means for variably transmitting light in accordance with said waves, said light transmitting means including means for separately controlling the light variations corresponding respectively to the high frequency sounds and the low frequency sounds, and means for receiving a record of said light variations.

12. In apparatus for recording waves corresponding to sound, means for transmitting said waves, means connected to said transmitting means for variably transmitting light in accordance with said waves, said light transmitting means including means for separately controlling the light variations corresponding respectively to the high frequency sounds and the low frequency sounds, and a photographic film having a portion exposed to said light variations and arranged for longitudinal movement transversely to the incident light rays.

13. The method of recording waves corresponding to sound, which comprises variably transmitting light in accordance with said waves, separately controlling said light variations corresponding respectively to sounds of high frequency and to sounds of low frequency, and photographically recording said light variations.

14. The method of recording on a strip of

photographic film light variations corresponding to sound waves, which comprises progressively recording along a path on the strip variations of light corresponding to sounds of low frequency, and progressively recording along one side of the path variations of light corresponding to sounds of high frequency.

15. An electrically recorded sound record of the whole range of frequencies of the sound recorded comprising a plurality of independent tracks, each of which tracks is a record of a component part or band of said whole range of frequencies of the original sound, the orders of amplitude variations of the recording in the several tracks being in the same proportionate relationship, track for track to each other, that their frequency bands bear to the corresponding frequency bands of the whole range of the original sound.

16. The matter of claim 15 when the order of amplitude variations on one of the tracks is disproportionate, as related to the orders of the amplitude variations of the other tracks, to its corresponding frequency band of the original sound.

17. The matter of claim 15 when the order of amplitude variations of the track of highest frequency is disproportionately greater, as related to the orders of the amplitude variations of the other track or tracks, than its corresponding frequency band of the original sound.

18. The matter of claim 15 when the order of amplitude variations of the track of the lowest frequency is disproportionately less, as related to the orders of the other track or tracks, than its corresponding frequency band of the original sound.

19. In combination, a sound receiving device adapted to translate vocal and musical frequencies into electrical variations, a plurality of electric wave filters adapted to divide such frequencies into two or more scion bands of frequencies; a sound record adapted to have a plurality of tracks, and means for causing such scion bands to be recorded each in a separate track of such record.

20. In combination, a sound receiving device adapted to translate or transform a normal range of voice and musical frequencies into electric variations disposed in a single channel, a plurality of electric wave filters adapted to divide said range into two or more scion bands of frequencies; a sound record with a plurality of individual tracks and means adapted to record each of said scion bands in a separate, individual track of said record, and means adapted to produce terminal electric waves corresponding to the several track recorded bands, and means adapted to transform said waves each into corresponding sound waves in the air, adapted to merge in the air into a reproduction of the original range of sounds.

21. The matter of claim 20 including means adapted to merge said produced bands of terminal electric waves into a single channel of post-terminal electric waves, and means adapted to transform said channel of waves into sounds in the air corresponding to the original range of sounds.

22. In combination, a sound receiving device adapted to translate or transform a normal range of voice and musical frequencies into electrical variations disposed in a single channel, a plurality of electric wave filters adapted to divide said range into two or more scion bands of frequencies; a sound record with a plurality of individual tracks and means adapted to record each of said scion bands in a separate, individual track of said record, and means adapted to produce terminal electric waves corresponding to the several track recorded bands, and means adapted to merge said produced bands of terminal electric waves into a single channel of post-terminal electric waves, and means adapted to transform said channel of waves into sounds in the air corresponding to the original range of sounds, said means of transforming said channel of waves into sounds in the air including thermionic valve electric amplifying and sound reproducing system.

23. The method of recording a wave band within which waves in a given frequency range have relatively small energy as compared with waves outside said range, which comprises transmitting and amplifying the waves within said range, separately transmitting the waves outside said range, and recording the amplified waves and the waves outside said range.

24. The method of recording waves corresponding to speech, which comprises transmitting said waves corresponding to the components of speech having a frequency above a given value, separately transmitting said waves corresponding to components of speech having a frequency below said value, amplifying said waves corresponding to said higher frequency components, and recording the amplified waves and the transmitted waves corresponding to said low frequency components.

25. An electric wave filter structure comprising a device adapted to translate sound into electrical variations and comprising a primary or ancestral electrical wave filter adapted to exclude all frequencies above and below predetermined limits; in parallel therewith two secondary wave filters, one being a superior filter adapted to transmit scion band frequencies above a predetermined median point and the other an inferior wave filter adapted to transmit scion band frequencies below said median point; in parallel with said superior filter two tertiary filters, one adapted to transmit frequencies above a median point of the superior filter's band, and the other adapted to transmit frequencies below said median point; in parallel with said secondary inferior filter two tertiary filters, one adapted to transmit frequencies above a predetermined median point of the frequency band of said secondary inferior filter and the other to transmit frequencies below said median point, and means for translating said tertiary scion band frequencies into sound.

26. The matter of claim 25 when the primary or ancestral electrical wave filter is not included.

27. The matter of claim 25 including a sound record adapted to have a plurality of tracks, and means adapted to record on said tracks the several tertiary scion band frequencies of the said tertiary filters each in a separate track.

28. The matter of claim 25 when including means adapted to record on a sound record the electrical variations after said variations pass said tertiary filters.

29. A plurality of electric wave filters connected in parallel with a source of sound-produced electrical variations comprising a band of vocal or instrumental frequencies, said wave filters adapted to divide said band of frequencies into a plurality of scion bands of frequencies, components of the whole band or range of frequencies and a plurality of sound recording devices and a

record having a plurality of tracks, said recording devices adapted to record in separate tracks upon said sound record the several scion bands divided off by the said wave filters.

30. A plurality of electric wave filters adapted to divide a band or range of vocal or instrumental musical sound frequencies impressed upon an electric current into aliquoit parts or bands, and to subdivide each of said scion bands into further aliquoit parts or scion bands progressively, stage after stage.

31. The matter of claim 30 when including means adapted to reproduce from said terminal scion bands sounds corresponding to the original.

32. The matter of claim 30 when including means whereby the variations of each of said scion bands may be recorded on a sound record having a plurality of tracks, one for each band.

33. In combination a plurality of independent electric wave filters, a plurality of devices adapted to translate sounds into electrical variations, one for each of said wave filters and a plurality of sound recording devices, one for each wave filter; said wave filters being in such relation to each other as to be adapted to select from said sound translating devices each a predetermined or scion band of electrical wave frequencies, each of said scion bands being a component part of the whole range of frequencies of the original sound as heard by the ear, and said sound recording devices adapted to record each, one of the said scion band frequencies on a separate track of a multiple track scion band sound record.

34. The matter of claim 33 in which are included triode valve or thermionic valve amplifying units adapted to amplify the electric variations of the filters, one for each sound recording device and its scion band filter, whereby to effect said recording.

35. The matter of claim 33 in which is included means of amplification of the said scion band currents prior to recording by said sound recording devices comprising a triode valve or thermionic valve amplifying system in parallel electrically with all the said scion band circuits.

36. In combination with a plurality of devices adapted to translate sounds into electrical wave variations a plurality of electric wave filters, one independently connected to each of said sound translating devices; each of said filters adapted to select a predetermined scion band range of frequencies of the whole stage of frequencies and all of said filters adapted to include the whole of said stage, and means connected with each of said filters adapted to record variations of electrical waves therefrom each on a track of a multiple track record, all of the said track whereby contain the summation of the whole range of frequencies.

37. In a system as set forth in claim 33 adjustable means whereby the width of a scion band may be increased or decreased during operation.

38. In a system as set forth in claim 33 triode valve or thermionic valve amplifying means adapted to amplify the scion band frequencies, and adjustable means whereby the amplification of the electric wave vibrations delivered at the terminus of any one or more than one of the filters may be increased or decreased without altering the amplification of the others.

39. A sound record having a plurality of tracks each the record of a component scion band frequency of a plurality of scion band frequencies derived from a system of electric wave filters supplied from a single original source of all frequencies of electric wave variations derived from sound.

40. The matter of claim 39 when the source is a single sound translating device adapted to translate sound waves into electrical wave variations.

41. A sound record having a plurality of tracks each the record of a component scion band frequency of a plurality of scion band frequencies derived from a system of electric wave filters each connected to a device adapted to translate sound into electric wave variations, one such translating device for each component band.

42. A sound record comprising a plurality of tracks each containing a component scion band of the whole band of frequencies recorded, said scion bands derived from individual electrical wave filters of a system of wave filters progressively proceeding from ancestor or total range to scion or component bands.

43. The matter of claim 42 when the record is physically impressed in its several tracks by said scion band frequencies.

44. In combination a plurality of sound receiving devices adapted to translate sound vibrations into electrical wave vibrations, a plurality of electrical wave filters consisting of connecting lines of negligible attenuation containing in each line lumped impedance in series with the line and lumped impedance in shunt across the line, said impedances having precomputed values, those for each line depending upon the upper limiting frequency and lower limiting frequency which it is desired to transmit without attenuation, the values of said series and shunt impedances being so proportioned that the structures transmit with practically negligible attenuation sinusoidal currents of all frequencies lying between the limiting frequencies of the several filters, while attenuating and approximately extinguishing currents of neighboring frequencies outside of said limiting frequencies, said transmitted frequencies being each a component part of a vocal or musical band of frequencies transmitted and means adapted to record wave variations from each filter separately.

45. The matter of claim 44 in which the lumped impedance consists of a plurality of sections, each section including a capacity element and an inductance element, one of said elements of each section being in series with the line and the other in shunt across the line.

46. The matter of claim 44 in which the lumped impedance consists of lumped inductance across the line in shunt and lumped capacity in series with the line and lumped inductance in series with the line and lumped capacity in shunt across the line.

47. The matter of claim 44 in which the impedance consists of a plurality of sections, each containing a condenser and an inductance coil in series with the line and an inductance coil in shunt across the line.

48. The matter of claim 44 in which the impedance consists of a condenser and an induction coil in series with the line and a condenser in shunt across the line.

49. The matter of claim 44 in which the impedance consists of a condenser and induction coil in series with the line and an induction coil and condenser in parallel in shunt across the line.

50. The matter of claim 44 in which the impedance consists of a condenser in series with the

line and a condenser and an induction coil in parallel in shunt across the line.

51. The matter of claim 15 when the order of amplitude variations of the track of the highest frequency is disproportionately greater, as related to the orders of amplitude of the other track or tracks having orders of amplitude proportionate to their original sound band or bands than its corresponding frequency band of the original sound and when the order of amplitude variations of the track of the lowest frequency is disproportionately less, as related to the orders of amplitude of the other track or tracks having orders of amplitude proportionate to their original sound band or bands, than its corresponding frequency band of the original sound.

52. The matter of claim 15 when the order of amplitude variations of the track of the highest frequency is disproportionately greater, as related to the orders of amplitude of the other track or tracks having orders of amplitude proportionate to their original sound band or bands, than its corresponding frequency band of the original sound and when the order of amplitude variations of the track of the lowest frequency is disproportionately less, as related to the orders of amplitude of the other track or tracks having orders of amplitude proportionate to their original sound band or bands, than its corresponding frequency band of the original sound and when the order of amplitude variations of one or more of the tracks other than the highest frequency track and the lowest frequency track is disproportionate, as related to the orders of amplitude of the track or tracks having orders of amplitude proportionate to their original sound band or bands, to its corresponding frequency band of the original sound.

53. The matter of claim 20 when said means adapted to transform said waves each into corresponding sound waves in the air comprises a system or systems of thermionic valve electric amplifying and sound reproducing means.

54. Means for recording and reproducing sound including sound receiving means adapted to translate sound waves into electrical waves, means adapted to split into selected frequencies or divide into scion bands or stages said electrical waves by electrical filter networks; a multiple channel phonograph record and means adapted to record said bands each in a separate channel of said record and a radiant energy phonograph adapted to reproduce sound from said record.

55. The matter of claim 54 when the radiant energy phonograph is adapted to reproduce sound from each channel of said record separately and simultaneously.

56. The matter of claim 54 when the radiant energy phonograph is adapted to reproduce sound from a plurality of said channels of said record by the absorption of radiant energy therefrom in a single radiant energy absorption member when said energy is reflected thereto from a source of energy in the phonograph, and the transformation of said absorbed radiant energy into sound.

57. A radiant energy phonograph sound record comprising a plurality of separate sound channels each corresponding to one of a similar plurality of scion band frequencies of a whole range of frequencies corresponding to original sounds, said frequencies separated into scion bands by means of electrical networks adapted to filter electrical waves produced by the original sounds into said scion band frequencies.

58. The matter of claim 57 when the several channels of said record are derived from photographic impressions of the said filtered electric waves.

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