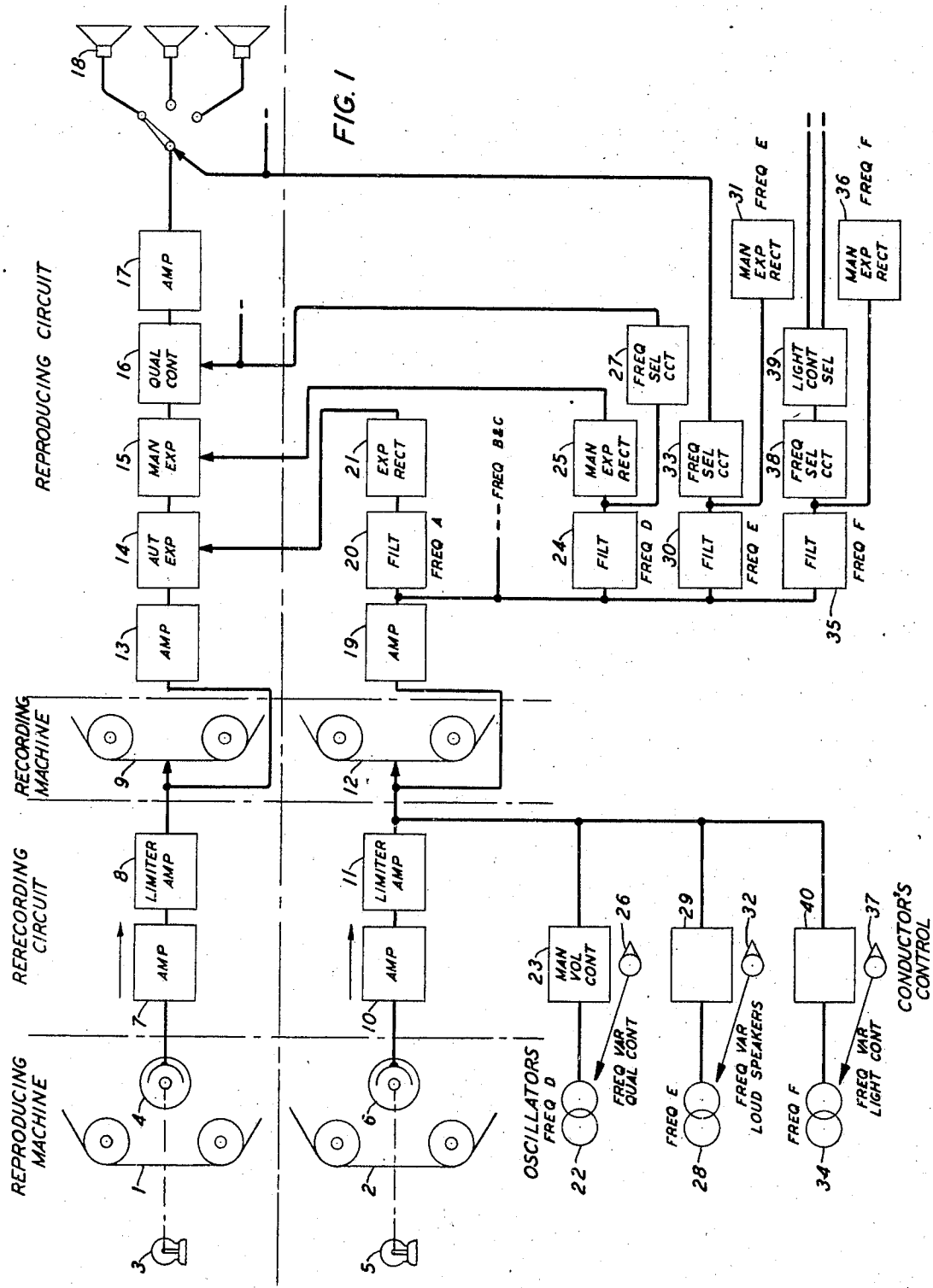
Dec. 15, 1942. W. B. SNOW 2,304,856

ELECTRICAL TRANSMISSION SYSTEM

Filed Oct. 15, 1941 2 Sheets-Sheet 1



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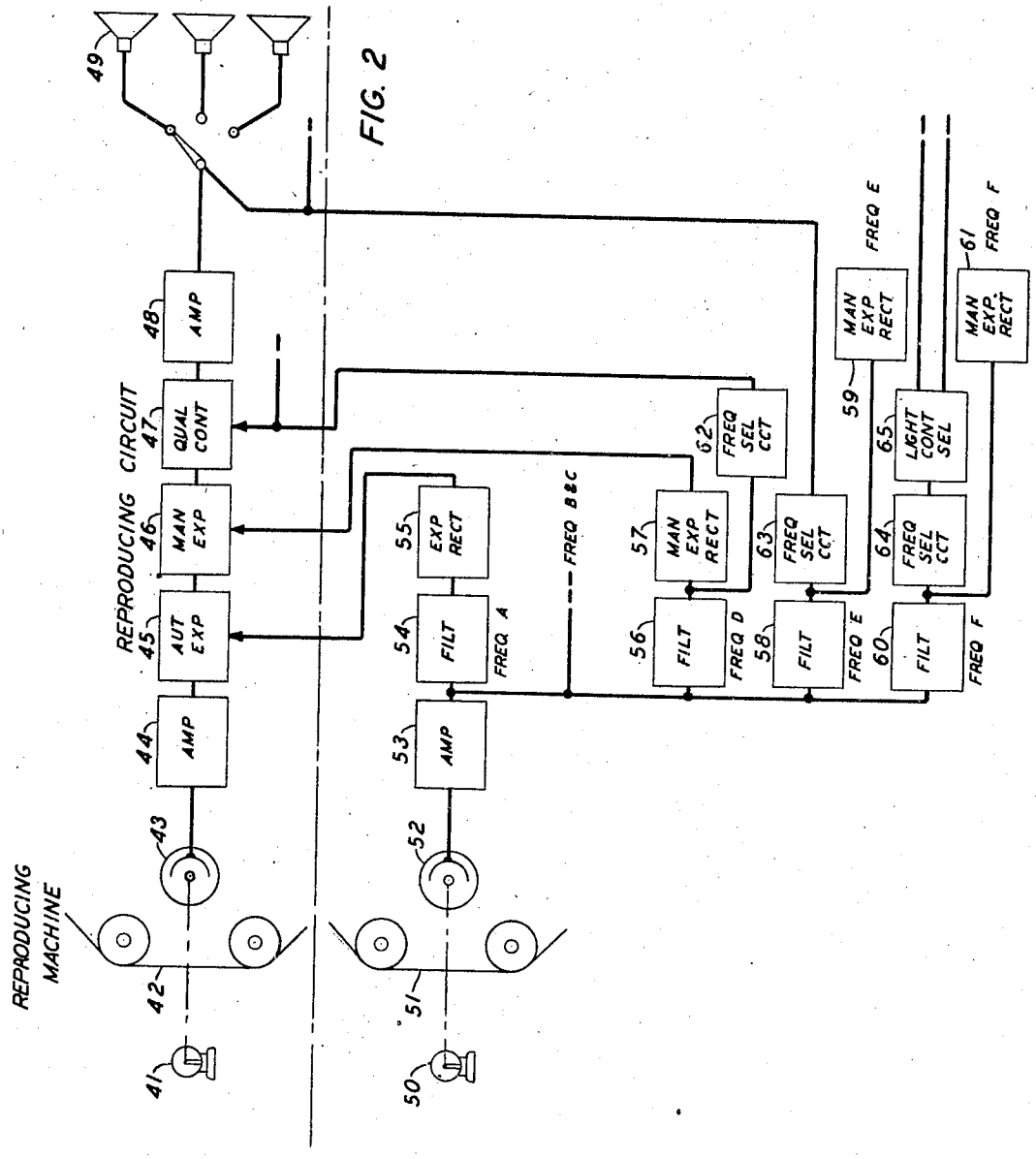

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ELECTRICAL TRANSMISSION SYSTEM

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8 Claims. (Cl. 179—100.3)

This invention relates to electrical transmission systems, and particularly to systems in which the volume range of the signal currents is compressed before transmission and expanded after reception. The invention is applicable to systems using wire, cable or radio channels over which the signal currents are transmitted for immediate reproduction, and also to systems in which the signal currents are recorded for subsequent reproduction.

The object of the invention is to automatically compress and expand the volume range of the transmitted signal currents under the control of an alternating current varying in amplitude in accordance with some function of the variations im amplitude of the signal currents, to arbitrarily further expand the volume range of the received currents under the control of the same, or a second, alternating current varying in amplitude, and to control the frequency characteristics, spatial distribution or scenic surroundings of the reproduced currents under the control of a change in frequency of one of the alternating currents.

A feature of the invention is the use of alternating currents, varying in amplitude without appreciable change in frequency, to exercise one type of control of the transmitted signal currents, and also varying in frequency without appreciable change in amplitude, to exercise another type of control over the reproduced signal currents, or the conditions under which the currents are reproduced.

Another feature of the invention is the use, in a multichannel system, such as a stereophonic system, of alternating currents of readily distinguishable frequencies, individual to each channel, for controlling the automatic compression and expansion of the volume range of the signal currents; of other alternating currents of frequencies readily distinguishable from each other and from the first currents, individual to each channel, for arbitrarily varying the expansion of the volume range of the signal currents; the latter currents being individually variable in frequency within ranges readily distinguishable from all the other currents; all of said currents being transmitted over a single channel separate from the channels transmitting the signal currents.

For convenience of description, the invention has been disclosed as embodied in a three-channel film sound recording and a film sound reproducing system, but the invention is not thereby limited to these specific systems, as any type of recording and reproducing system may be used, or the recorders and reproducers may be replaced by wire, cable or radio channels.

In the drawings:

Fig. 1 diagrammatically shows the invention embodied in a film sound rerecording system, with a monitoring reproducer; and

Fig. 2 diagrammatically shows the invention embodied in a theater reproducing system.

In my copending application Serial No. 328,078, filed April 5, 1940, a multichannel transmission system is disclosed, in which the volume range of the signal currents in each channel is automatically compressed under the control of an alternating current having a frequency individual to the channel. The compressed output of each channel is individually transmitted or recorded, while all of the control currents are transmitted or recorded in a common channel.

In Fig. 1 of the present drawings, the film 1 symbolically represents the recorded output of one of the channels disclosed in my copending application Serial No. 328,078, while the film 2 symbolically represents the common record of all of the control channels. In a multichannel system there will, of course, be a record and channel, as shown associated with the record 1, for each of the two or more channels concerned. The record 1 of the compressed signal currents from a single channel, and the record 2 of all of the control currents have, for convenience, been shown as on separate films but it will be understood that all, or any number of these records may be combined upon a common film. The records 1 and 2 are driven in synchronism at constant speed in the usual manner by known drive mechanisms, not shown.

Light from a suitable source 3 is projected in the usual manner through the record 1 to excite a photosensitive device 4 to produce an electrical current varying in accordance with the original compressed signal currents. Similarly, light from a suitable source 5 is projected through the record 2 to excite a photosensitive device 6 to produce currents varying in accordance with the control currents used to produce the compression. When some other type of record is used, the appropriate pick-up device will be substituted for the light sources and photosensitive devices disclosed. If a wire, cable or radio link be substituted for the recording and reproducing link, the outputs of these channels will replace the outputs of the photosensitive devices 4 and 6.

The output of the photosensitive device 4 suitably amplified in the amplifiers 7 and 8, is rerecorded on the record 9, driven at constant speed

in synchronism with the record 1, in the usual manner. Similarly, the output of the photosensitive device 6, suitably amplified in the amplifiers 10 and 11, is rerecorded on the record 12, driven in synchronism with the record 2 by known means.

Though, for convenience, the records 9 and 12 have been shown as separate records, it is evident that these records may be combined upon a common medium.

The amplifiers 8 and 11 may, if desired, include means for limiting the output, so that the recorder is not overloaded.

A portion of the output of the amplifier 8 is also supplied to the amplifier 13 thence through the automatic expander 14, the devices 15 and 16 to be explained hereinbelow, and, if desired, a further amplifier 17 to the reproducer 18, or other utilization device.

When the system is used for the immediate reproduction of the signal current, with a wire, cable or radio channel attached to the input of the amplifier 7, the rerecording machine 9 may be eliminated, the output of the amplifier 8 being supplied directly to the amplifier 13.

A portion of the output of the amplifier 11 is supplied to the amplifier 19, thence to a filter 20, which selects the control current individual to the particular channel shown, and supplies this control current to the expander rectifier 21, the output of which controls the automatic expander 14, to expand the volume range of the reproduced signal current to the range of the original signal currents, as described in my copending application Serial No. 328,078.

The output of the amplifier 19 is also supplied to other filters which select the appropriate control frequencies, designated frequencies B and C, which control the automatic expansion in the other channels.

An oscillator 22 generates an alternating current of reasonably constant amplitude and frequency D, which is supplied through the manually variable attenuator 23, to the recorder cooperating with the record 12. A portion of this current is also supplied through the amplifier 19 and the filter 24 to the rectifier 25 which controls the manual expander 15 in the reproducing circuit to produce an arbitrary enhancement of the amplitude of the current reproduced by the reproducer 18, as described in United States Patent 2,254,034, August 26, 1941, H. Fletcher.

A manually operable device 26 controls a switch, relay or other device, associated with the oscillator 22 to change the frequency generated by the oscillator, without changing the amplitude of the current generated by the oscillator. This relay, or other switching device, may change the frequency of the oscillator 22 in known manner by changing the inductance, resistance or capacitance in the oscillating circuit, and may, if necessary, also control an attenuator connected to the output of the oscillator so as to maintain the amplitude of the currents constant.

This current of changed frequency is recorded on the record 12 and is also supplied through the amplifier 19 to the filter 24. The filter 24 is a conventional band-pass filter, which will pass all of the currents of the frequencies generated by the oscillator 22, but will reject all of the other control currents.

The frequency selective circuit 27 may be of the nature of a conventional band-pass filter which will reject currents of the frequency originally generated by the oscillator 22, but will pass currents of the frequency generated by the oscillator 22 under the control of the device 26, or it may be a device of the nature of the discriminator in a frequency modulation receiver, in which the output amplitude is dependent upon the frequency of the currents supplied to the input, thus giving fine gradations to the control of the quality of the transmitted sound currents. The currents passed by the frequency selective circuit 27, or a rectified component thereof, are supplied to relays, or other suitable devices, associated with the quality control network 16 in the present channels, and also to other relays, or controlling devices, associated with similar quality control networks in the other channels. The quality control network 16 is of the nature of a tone control network, or other equalizer, which modifies in any desired manner, the response frequency characteristic of the channel. The currents from the network 27 operate relays, or other control devices, to modify the value of the components in the quality control network 16, or to switch components into or out of the circuit of the quality control network.

The oscillator 28 generates a current of reasonably constant amplitude and frequency which is supplied through the manually variable attenuator 29 and recorded on the record 12. A portion of this current is supplied through the amplifier 19 to the filter 30 and the rectifier 31 which controls a manual expander, similar to the expander 15, in one of the other channels of the system.

A manually operable device 32 controls devices associated with the oscillator 28 to change the frequency of the oscillator 28 in a manner similar to the change in the frequency of the oscillator 22 caused by operation of the device 26.

The current of changed frequency from the oscillator 28 is recorded on the record 12, and is also supplied through the amplifier 19 and passed by the filter 30 to the rectifier 31 and also through the frequency selective circuit 33 to stepping switches, relay groups or variable gain devices, arranged to switch the reproducers associated with each of the channels.

The filter 30, like the filter 24, will pass currents having all of the frequencies generated by the oscillator 28, but will not pass any of the other control currents. The frequency selective circuit 33, like the frequency selective circuit 27, will not pass current of the original frequency generated by the oscillator 28, but will pass current of the frequency generated by the oscillator 28 under the control of the manually operable device 32, or may function as a discriminator in the manner discussed in connection with circuit 27.

In a similar manner, the oscillator 34 generates a current, which is recorded on the record 12, of a frequency which will pass through the filter 35 to the rectifier 36 controlling the manual expander in the third channel. When the frequency of the oscillator 34 is changed by the manually operable device 37, the currents of changed frequency are passed by the frequency selective circuit 38, which is similar to the circuit 27 and 33, to operate a selector 39 which may control the lights or scenery associated with the reproducers 18.

The record 12 will have in a single track the records of the currents of the frequencies A, B and C, respectively varying in amplitude in accordance with the automatic compression of the volume range of the signal currents in the respec-

tive channels, and will also have records of the currents generated by the oscillators 22, 28 and 34, normally having the frequencies D, E and F, or the corresponding frequencies as modified by the manually operable devices 26, 32 and 37, varying in amplitude in accordance with the enhancement applied by the attenuators 23, 29 and 40.

Fig. 2 discloses a reproducing system, such as a theater system, using the records produced by the rerecording machine in Fig. 1, or a print or duplicate thereof. For convenience, the records of the signal currents from the various channels have been shown on a film separate from the film carrying the records of the various control currents, but, these records may be separate tracks upon the same film.

Light from a suitable source 41 is projected in the usual manner through the record on the film 42 and excites the photosensitive device 43. The signal currents in the output of the photosensitive device 43 are amplified in the amplifier 44, automatically expanded in volume range in the expander 45, arbitrarily expanded in volume range in the expander 46, modified in wave form in the quality control circuit 47, further amplified in the power amplifier 48, and reproduced by the selected reproducer 49.

Light from a suitable source 50 is projected in the usual manner through the record of the control currents on the film 51 to excite a photosensitive device 52.

The filter 54 selects from the output of the amplifier 53 the current having a frequency A corresponding to the automatic compression applied to this channel, and supplies this current to a rectifier 55 which controls the automatic expander 45.

Filters, corresponding to the filter 54, respectively select currents having frequencies of the automatic compression currents corresponding to channels B and C and supply these currents to circuits controlling the automatic expanders in these channels.

Filters 56, 58 and 60 respectively select currents having the frequencies D, E and F and supply these currents to the control circuits 57, 59 and 61, respectively controlling the manual expander, such as the expander 46, corresponding to each of the channels.

When the frequency D, selected by the filter 56, changes from its normal value, current of the changed frequency is supplied through the frequency selective circuit 62 to control the quality control network, such as network 47, in each of the channels.

When the frequency E of the current selected by the network 58 changes from its normal value, this current of changed frequency is selected by the frequency selective circuit 63 and transmitted to the switching devices in the various channels controlling the selection of the reproducers, such as reproducer 49.

When the frequency F of the current selected by the filter 60 changes from its normal value, current is transmitted by the frequency selective circuit 64 to the control selector 65, which is activated to select the desired lighting or scenic conditions surrounding the reproducers.

Though the carrier currents of the frequencies D, E, F have been shown associated with the carrier currents of the frequencies A, B, C, it is evident that these latter currents and their function may be omitted if desired. In other words, the automatic compression and expansion may be omitted, and the system operated only with the manual enhancement, and the control of the conditions surrounding the reproduction.

What is claimed is:

1. In a transmission system, a source of signal waves, a load circuit, a transmission channel from said source to said load circuit, means in said channel for expanding the amplitude range of the transmitted waves, a source of alternating currents, a manually operable attenuator connected to said source, a frequency selective circuit for supplying current from said source to said expanding means under the control of said attenuator, means for changing the frequency of said alternating currents, a second frequency selective circuit arranged to reject the currents from said source of the original frequency and to pass the currents from said source of the changed frequency, and means associated with said channel actuated by the currents passed by said second frequency selective circuit.

2. In a transmission system, a source of signal waves modified in amplitude, a load circuit, a transmission channel from said source to said load circuit, a source of alternating currents of constant frequency varying in amplitude in accordance with the modifications made in the signal waves, means in said transmission channel under the control of said latter currents for restoring said signal waves to their original amplitude, a second source of alternating currents, a manually operable attenuator connected to said source, means in said transmission channel for expanding the amplitude range of the transmitted waves, a filter and rectifier for supplying current from said second source to said latter expanding means under the control of said attenuator, means for changing the frequency of said alternating current, a second filter arranged to reject the current from said source of the original frequency and to pass the current from said source of the changed frequency, and means associated with said channel actuated by the currents passed by said second filter.

3. In a sound reproducing system, a source of sound currents modified in amplitude, a sound reproducer, a transmission channel from said source of sound currents to said sound reproducer, a source of currents of constant frequency varying in amplitude in accordance with the modifications made in said sound currents, means in said transmission channel for compensating the modifications in said sound currents under the control of current from said latter source, means in said transmission channel for expanding the amplitude range of the sound currents, a source of alternating current varying in amplitude in accordance with desired changes in the amplitude of said sound currents, a filter and rectifier for supplying current from said latter source to said expanding means, and a second filter connected to said latter source and arranged to reject the current from said source of one frequency and to pass the current from said source of another frequency, and means associated with said channel actuated by the current passed by said second filter to modify the condition under which said sound currents are reproduced.

4. A composite sound record comprising a plurality of records in separate tracks of a plurality of sound currents modified in amplitude, and a plurality of records in a single track including records of carrier currents respectively varying in amplitude with the modifications in the amplitude of said sound currents, and a plurality of records

of carrier currents respectively varying in ampliture with desired additional modifications in the amplitude of said sound currents, and, at times, changing in frequency in accordance with desired changes in the conditions under which said sound currents will be reproduced, all of said carrier currents being of different and distinguishable frequencies.

5. In a sound rerecording system, a record of sound currents modified in amplitude, means for reproducing and rerecording said record, a monitoring sound reproducer, a transmission channel from said recorder to said sound reproducer, an automatic expander, a manual expander, and a quality control circuit in series relationship in said transmission channel, a record of a current of constant frequency varying in amplitude in accordance with the modifications in the amplitudes of said sound currents, means for reproducing said latter record, means for rerecording the currents reproduced from said latter record, a filter connected to said rerecorder transmitting current to said automatic expander to compensate the modifications in the amplitudes of the sound currents, a source of alternating current, a manually operable attenuator connected to said source, means for supplying current from said attenuator to said rerecorder, a filter and rectifier for supplying current from said source to said manual expander in said transmission channel under the control of said attenuator, means for changing the frequency of the alternating currents from said source, a second filter arranged to reject the currents from said source of the original frequency and to pass the currents from said source of the changed frequency, and means connected to the output of said second filter for controlling said quality control network in said transmission channel.

6. In a sound reproducing system, a recording medium having a plurality of records of sounds modified in amplitude and separate records of a plurality of carrier currents, a pick-up device individual to each of said sound records, a sound reproducer individual to each of said sound records, a transmission channel containing two control means in serial relationship respectively connecting each pick-up to the corresponding reproducer, a common pick-up for all said carrier current records, means for selecting from the output of said common pick-up the carrier current corresponding to a given channel and for controlling one of the control means in said channel with said current, means for selecting from the output of said common pick-up a second carrier current corresponding to a given channel and for controlling the second control means in said channel by variations in the amplitude of said current, and means responsive to a change in the frequency of said latter current for controlling the condition surrounding the reproduction of the sound.

7. A composite sound record comprising a plurality of records in separate tracks of a plurality of sound currents, and a plurality of records in a single track of carrier currents respectively varying in amplitude with desired arbitrary modifications to be made in said sound currents, and, at times, changing in frequency without change in amplitude in accordance with desired changes in the conditions under which said sound currents will be reproduced, all of said carrier currents being of different and distinguishable frequencies.

8. In a sound reproducing system, a medium having a plurality of records of sounds and a plurality of records of carrier currents, a pick-up for each of said sound records, a sound reproducer for each of said sound records, transmission channels each containing two control means in serial relationship respectively connecting each pick-up to the corresponding reproducer, a common pick-up for all said carrier current records, means for selecting from the output of said common pick-up a carrier current corresponding to a given channel and for controlling one of the control means in said channel by variations in the amplitude of said current, and means responsive to a change in the frequency of said carrier current for controlling the second control means in said channel.

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