

Oct. 1, 1946.

C. M. SINNETT ET AL
RECORD REPRODUCING SYSTEM

2,408,695

Filed Nov. 25, 1942

Fig. 1.

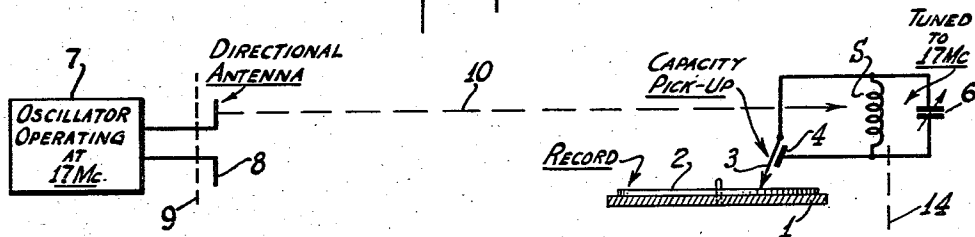


Fig. 2.

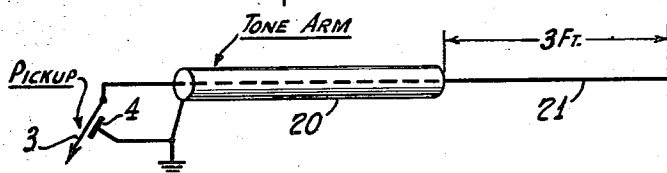


Fig. 3.

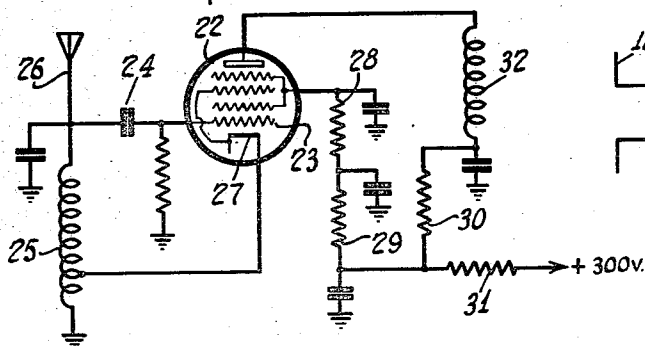


Fig. 4.

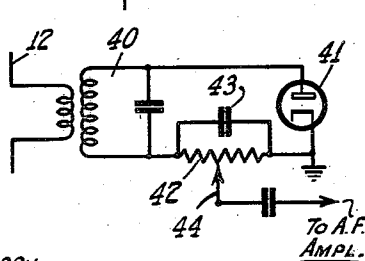
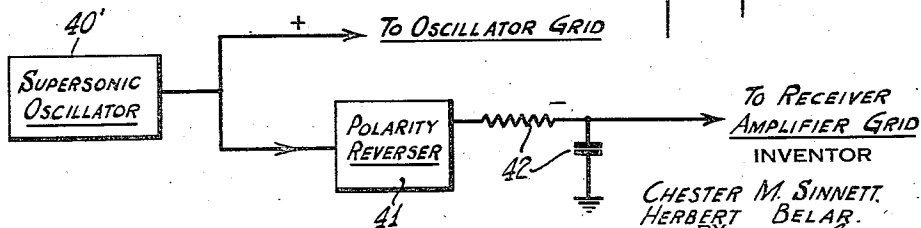


Fig. 5.



INVENTOR
CHESTER M. SINNETT,
HERBERT BELAR.
BY
H. S. Grover
ATTORNEY

UNITED STATES PATENT OFFICE

2,408,695

RECORD REPRODUCING SYSTEM

Chester M. Sinnett, Westmont, and Herbert
Belar, Palmyra, N. J., assignors to Radio Cor-
poration of America, a corporation of Delaware

Application November 25, 1942, Serial No. 466,878

14 Claims. (Cl. 179—100.4)

1

Our present invention relates to sound record reproducing systems, and more particularly to record reproducing systems which function without electrical connections between the various units thereof.

In the past there have been proposed various reproducing systems for phonograph records. In certain of these systems the sound record has been employed to actuate an electrical pickup for producing frequency modulation signals, and the latter have then been subjected to a discriminator-rectifier for production of audio voltage corresponding to the recorded sound waves. Another type of reproducing system has utilized a high frequency oscillator which was modulated in amplitude in response to the output of an electrical pickup, and a subsequent detector was used to demodulate the amplitude modulated high frequency oscillations. In these various systems the various units between the electrical pickup and the ultimate audio voltage reproducer are electrically inter-connected.

It can be stated that it is one of the main objects of our present invention to provide a phonograph record reproducing system wherein interconnection between a pickup device, an oscillator and a receiver are dispensed with, and wherein the pickup device itself is free of any electron discharge devices.

Another important object of our invention is to provide a system for reproducing sound records wherein a high frequency wave is radiated from a conveniently located oscillator; an electrical pickup, connected across a tuned circuit or a resonant line, is located in the field of the aforementioned oscillator; and a conventional type of receiver picks up a signal corresponding to the changes in the pickup tuned circuit thereby to produce from its loud speaker the sound waves recorded on the phonograph record.

Still another object of our invention is to provide a method wherein an electric pickup device of the capacity type is associated with a resonant network tuned to a predetermined high frequency thereby permitting the motion of the pickup element to vary the frequency of the resonant network, radiating to the resonant network high frequency oscillations of the predetermined frequency whereby changes in the frequency of the resonant network result in the production of high frequency oscillation energy which is amplitude modulated in accordance with the sound waves recorded on the phonograph record, and re-radiating the modulated high frequency oscillation energy to a demodulator located at a point spaced from the pickup device.

Still other objects of our invention are to im-

2

prove record reproduction systems by providing a high frequency oscillator and a radio receiver spaced apart from a record pickup device capable of receiving radiations from the oscillator, re-radiating modulated high frequency oscillations to the receiver, and preventing response of the receiver to oscillations radiated directly from the oscillator.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims; the invention itself however, as to both its organization and method of operation will best be understood by reference to the following description, taken in connection with the drawing, in which we have indicated diagrammatically several circuit organizations whereby our invention may be carried into effect.

In the drawing:

Fig. 1 schematically shows a system embodying the invention.

Fig. 2 illustrates a modified form of electrical pickup device.

Fig. 3 shows a form of oscillator circuit which can be employed.

Fig. 4 illustrates a simple form of demodulator that can be used in the system of Fig. 1.

Fig. 5 illustrates schematically an arrangement for improving the operation of the system of Fig. 1.

In Fig. 1 we have shown a system which employs the invention, and which system employs networks which are utilized in accordance with our concept. The numeral 1 designates the turntable upon which is placed the record 2. These are conventional devices, and need not be described in any further detail. The electrical pickup device is shown as of the capacity type. The pickup is schematically represented as embodying a needle element 3 and a fixed plate 4. Elements 3 and 4 provide a small condenser. The motion of the needle 3 results in variation of the magnitude of the capacitance of condenser 3—4. The pickup device may be constructed in accordance with the teachings of C. M. Sinnett in application Serial No. 414,305 filed October 9, 1941.

Of course, the pickup device need not be of the capacity type, but may be of the type wherein an inductive magnitude is varied. The capacitor elements 3 and 4 are connected to opposite sides of the resonant circuit 5—6. The coil 5 and condenser 6 are connected in shunt, and together provide a circuit tuned to a predetermined high frequency. By way of example, let it be assumed that circuit 5—6 is resonant to 17 megacycles (mc.). Of course, a higher frequency can be

3

utilized. Indeed, the resonant frequency of circuit 5-6 may be as high as 2,000 mc., if desired. It will now be seen that as the element 3 runs along the sound grooves of the record 2 the capacity of condenser 3-4 will vary. As a result the frequency of circuit 5-6 will vary.

An oscillator 7 is provided at a point spaced from the resonant circuit 5-6. This oscillator is constructed to produce high frequency oscillations of 17 mc. These oscillations are of constant amplitude and constant frequency, and the oscillator may be constructed in any well known manner. The antenna 8 thereof is of the directional type. It is desired that the antenna be arranged in such a manner that the waves radiated thereby are projected upon the resonant circuit 5-6. The vertical dotted line 9 schematically represents any desired type of reflector which may be used in conjunction with the antenna 8, and thereby aid in focussing the radiated oscillatory energy upon the resonant circuit 5-6. The numeral 10 denotes the beam of the energy radiated by the ultra-high frequency oscillator 7. Since the resonant circuit 5-6 is in the field of the radiated oscillatory energy 10, changes in frequency of circuit 5-6 due to the sound record varying the capacitance of condenser 3-4 causes the high frequency energy existing in circuit 5-6 to be modulated in accordance with the recorded sound waves.

Since a tuned circuit located in the field of an oscillator will absorb energy from the oscillator, if we change the characteristics of this tuned circuit at an audio rate we in effect change the absorption at the same rate. At the same time if the absorbing circuit has relatively high "Q" some re-radiation will take place. As a result of this the standing wave pattern near the absorbing circuit, and also near the receiver, is upset and may be received and demodulated.

Accordingly, we provide a radio receiver 11 at a point spaced from circuit 5-6. The receiver 11 is provided with a directional antenna 12, which may be of the same type as antenna 8. The numeral 13 denotes a reflection member, similar to that designated by numeral 9, which may be used at the receiver antenna to insure the pickup of energy by antenna 12 solely from circuit 5-6. In other words, the directional antenna 12 of receiver 11 is located in the field of the re-radiated modulated ultra-high frequency energy. The receiver itself may be very simple in construction, and the numeral 14 denotes by dotted lines the path of the re-radiated modulated oscillatory energy. The receiver 11 should be composed of one or more stages of ultra-high frequency amplification followed by a simple detector of amplitude modulated carrier energy. The receiver is tuned to the 17 mc. frequency of circuit 5-6. The detector could feed one or more audio frequency amplifiers feeding into a loud speaker.

As stated heretofore, it is desired to have the resonant circuit 5-6 in the field of oscillator antenna 8, and it is desirable to have the receiver antenna 12 in the field solely of the re-radiated energy from circuit 5-6. The antenna 12 should not pick up any power from the directional antenna 8 directly. In some cases the oscillator 7 could be located at the receiver 11. In this case, the direct output of the oscillator could be neutralized in the receiver circuits by any conventional and well known methods.

In Fig. 2 there is shown a modification of the resonant network associated with the capacity

4

pickup device. In this modification the numeral 20 designates a tone arm. The electrode 3 is connected to an axially located conductor 21 which may project from the tone arm a distance of some three feet. This projection distance is purely illustrative. The electrode 4 would in that case be connected to the outer grounded sheath of the tone arm. In other words, Fig. 2 shows a resonant line which could be used in place of the simple tuned circuit 5-6.

In Fig. 3 we have shown an oscillator circuit which can be employed at 7 of Fig. 1. The oscillator comprises a tube 22 which has its control grid 23 connected by condenser 24 to the upper end of the oscillation tank coil 25. The lower end of the coil is grounded, while the upper end thereof is connected to an antenna 26. As stated before, this antenna is preferably of the directional type. The cathode 27 of tube 22 is connected to a tap on coil 25 which may be a small number of turns above ground. The plate and screen grids of the tube 22 are connected to a source of positive potential, say +300 volts, through proper voltage reducing resistors 28, 29, 30 and 31. The plate of tube 22 is connected in series with resistor 30 through a radio frequency choke coil 32 which has a larger number of coils than coil 25. Appropriate high frequency bypass condensers are connected as shown in Fig. 3.

The receiver 11 can be of a very simple type. For example, the directional antenna 12 need only be coupled to the tuned input circuit 40 of a rectifier 41 of the diode type. The low potential side of the input circuit 40 is connected to the grounded cathode of diode 41 through a load resistor 42, the latter being properly bypassed by condenser 43 for high frequency currents. The potentiometer 44 will then be capable of taking off any magnitude of audio voltage from the load resistor 42. It need only be pointed out that since the antenna 12 will pick up from the resonant circuit 5-6 amplitude modulated ultra-high frequency energy, then the circuit 40 need not be tuned to the normal frequency of circuit 5-6.

To minimize other reflections of ultra-high frequency energy that may not be due to the changes in the tuned circuit associated with the pickup device, it is possible to key the oscillator 7 and receiver 11 in such a manner that the receiver is only active during silent periods of the transmitter oscillator. Preferably, the keying should be at a supersonic frequency. A delay in bringing the receiver up to sensitivity can be introduced so that normal reflections occurring for a short time only are not received, whereas the modulated oscillations radiated from the tuned circuit of the pickup are received because of their longer duration. Considering Fig. 5, therefore, we have shown a supersonic oscillator 40' capable of generating constant amplitude wave energy of supersonic frequency.

The energy is applied to the grid of the oscillator directly. For example, the energy from the oscillator 40' would be applied directly to grid 23 to control the gain of the oscillator tube. Simultaneously, the supersonic oscillatory energy is applied to a polarity reversing network 41 so as to produce negative voltage at the same time that positive voltage is applied to the oscillator grid. This negative voltage is preferably passed through a time constant network 42 which has its resistance and capacity so chosen that there is a delay in bringing the receiver up to sensitivity. The delayed voltage may be applied to the control grid of an amplifier tube of receiver 11.

5

It will now be seen that the receiver will only be active whenever the oscillator is inactive. Of course, the negative voltage applied to the receiver should be sufficient to bias the receiver amplifier to cut-off. The same will be true on the other half of the supersonic oscillation cycle when negative voltage is applied to the oscillator grid. In this latter case the negative voltage biases oscillator 7 to cut-off, while the cut-off bias is removed from the receiver. Due to the delay network 42 the receiver will not be sensitive enough to respond to the relatively short period direct radiation from oscillator 7. However, when the receiver has attained full sensitivity it will still be capable of responding to the re-radiated energy from S due to the longer duration of the oscillations thereof. Accordingly, we have provided a means for preventing the pickup of energy by receiver 11 from any source, except from the tuned network 5-6.

In connection with the "keying" system, the record pickup device may be replaced by a capacity microphone. In this case there could be used a dipole antenna in place of the tuned circuit 5-6. Voice waves on the microphone would vary the capacity thereof, and thereby change the resonant frequency of the dipole antenna. The "beam" from the keyed oscillator would be directed at the microphone and antenna, and there would then be re-radiated to the receiver amplitude modulated signals. Hence, for public address and portable uses no transmitter equipment or connecting wires would be needed at the microphone. Other uses for such a keyed system would comprise remote listening posts to be swept by the transmitted beam so as to listen in to conversations; dictographs for secret service; airplane identification.

While we have indicated and described several systems for carrying our invention into effect, it will be apparent to one skilled in the art that our invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of our invention as set forth in the appended claims.

What we claim is:

1. In combination, a sound wave record, an electrical pickup device associated therewith to translate the recorded sound waves into variations in reactance, a resonant network electrically connected with said pickup device and adapted to have its frequency varied by said reactance variations, means for producing high frequency wave energy, said means being spaced from said resonant network, said resonant network being normally tuned to the frequency of said high frequency wave energy, said high frequency wave energy being radiated to said resonant network in the form of a beam whereby the high frequency energy at said network is modulated in accordance with the recorded sound waves, said resonant network having a sufficiently high "Q" to provide re-radiation therefrom, and a receiver spaced from said resonant network and being free of normal coupling thereto and being adapted to receive therefrom reradiated modulated high frequency wave energy.

2. In combination, a sound wave record, an electrical pickup device associated therewith to translate the recorded sound waves into variations in reactance, a resonant network electrically connected with said pickup device and adapted to have its frequency varied by said reactance variations, means for producing high fre-

6

quency wave energy, said means being spaced from said resonant network, said resonant network being normally tuned to the frequency of said high frequency wave energy, said high frequency wave energy being radiated to said resonant network in the form of a beam whereby the high frequency energy at said network is modulated in accordance with the recorded sound waves, said resonant network having a sufficiently high "Q" to provide re-radiation therefrom, a receiver normally free of coupling to said resonant network spaced from said resonant network and being adapted to receive therefrom re-radiated modulated high frequency wave energy, and means for preventing reception at said radio receiver of high frequency wave energy radiated directly to it from said wave energy producing means.

3. A method of reproducing sound records which includes producing ultra-high frequency energy at one point in space, radiating said energy in the form of a beam to a second point in space, locating a resonant network tuned to the frequency of said ultra-high frequency energy at said second point, maintaining the resonant network at a sufficiently high "Q" to provide re-radiation therefrom, translating the recorded sound waves into frequency changes of said resonant network thereby to produce at said second point modulated ultra-high frequency energy whose modulation corresponds to the recorded sound waves, re-radiating the modulated ultra-high frequency energy in the form of a beam to a third point in space, and demodulating the re-radiated energy at the third point thereby to produce sound waves corresponding to the recorded sound waves.

4. A method of reproducing sound records which includes producing ultra-high frequency energy at one point in space, radiating said energy in the form of a beam to a second point in space, locating a resonant network at said second point, translating the recorded sound waves into frequency changes of said resonant network thereby to produce at said second point modulated ultra-high frequency energy whose modulation corresponds to the recorded sound waves, re-radiating the modulated ultra-high frequency energy in the form of a beam to a third point in space, demodulating the re-radiated energy thereby to produce sound waves corresponding to the recorded sound waves, and automatically preventing the aforementioned demodulation during said radiation from said first point.

5. A method of reproducing sound records which includes producing ultra-high frequency energy at one point in space, radiating said energy in the form of a beam to a second point in space, locating a resonant network at said second point, translating the recorded sound waves into frequency changes of said resonant network thereby to produce at said second point modulated ultra-high frequency energy whose modulation corresponds to the recorded sound waves, re-radiating the modulated ultra-high frequency energy in the form of a beam to a third point in space, demodulating the re-radiated energy thereby to produce sound waves corresponding to the recorded sound waves, and alternately rendering said radiation and demodulation ineffective at a supersonic rate thereby to minimize demodulation of ultra-high frequency energy radiated directly from the first point to the third point.

6. In a sound wave record reproducing system,

the combination of an ultra-high frequency energy transmitter for radiating unmodulated carrier waves of a predetermined frequency, a demodulator network, a resonant sound wave record pickup circuit of the capacity type tuned to said predetermined frequency for modulating the waves transmitted from said transmitter in accordance with the pickup output, said transmitter, demodulator and pickup circuit being normally free of coupling therebetween, and said pickup circuit having sufficiently high "Q" to provide re-radiation of said modulated wave energy to said demodulator.

7. In combination, means for generating wave energy at a high radio frequency, means for radiating said energy in the form of a beam, a sound wave record pickup device normally free of coupling to said radiating means located in the path of said beam, said device including a resonant network tuned to said high frequency, a receiver device placed in line with said resonant network and at such an angle with respect to the said beam that the amount of energy reaching the receiver from the generating means is small, said resonant network producing modulation of the beam in accordance with the output of the said pickup device, said resonant network having a relatively high "Q" thereby to provide re-radiation of the modulated beam to said receiver device.

8. In combination, an ultra-high frequency energy transmitter for radiating unmodulated carrier waves of a predetermined frequency, a demodulator network, a resonant sound wave pickup circuit of the capacity type tuned to said predetermined frequency for modulating the waves transmitted from said transmitter in accordance with the pickup output, said transmitter, demodulator and pickup circuit being normally free of coupling, and said pickup circuit including a resonant line radiator whose "Q" is sufficiently high to provide re-radiation of said modulated wave energy to said demodulator.

9. In combination, means for generating wave energy at a high radio frequency, means for radiating said energy in the form of a beam, a capacity microphone device normally free of coupling to said radiating means located in the path of said beam, said device including a resonant network tuned to said frequency, a receiver placed in line with said resonant network and at such an angle with respect to the said beam that the amount of energy reaching the receiver from the generating means is small, said resonant network producing modulation of the beam in accordance with the output of the said microphone and said resonant network having a sufficiently high "Q" to provide re-radiation of the modulated beam to the receiver.

10. In combination, means for generating wave energy at a high radio frequency, means for radiating said energy in the form of a beam, a capacity transducer normally free of coupling to said radiating means located in the path of said beam, said transducer being included in a resonant circuit, a receiver device placed in line with said resonant circuit, said resonant circuit producing modulation of the beam in accordance with the output of the said transducer, and means alternately rendering said radiation and reception ineffective to minimize reception of wave energy radiated directly from said first means.

11. A method which includes producing ultra-high frequency energy in the form of a beam at one point in space, radiating said energy to a sec-

ond point in space, translating the recorded sound waves into frequency changes of a resonant circuit at the second point thereby to produce at said second point modulated ultra-high frequency energy, re-radiating the modulated ultra-high frequency energy in the form of a beam to a third point in space, demodulating the re-radiated energy at the third point thereby to produce sound waves corresponding to the recorded sound waves, and automatically preventing at a supersonic rate the aforementioned demodulation at the third point during said radiation from said first point.

12. In combination, a sound wave record, an electrical pickup device of the condenser type associated therewith to translate the recorded sound waves into variations in capacity, a resonant network electrically connected with said pickup device and adapted to have its frequency varied by said capacity variations, means for producing high frequency wave energy, said resonant network being tuned to the frequency of said high frequency wave energy, said means being spaced from said resonant network and being normally free of coupling thereto, said high frequency wave energy being radiated to said resonant network whereby the high frequency energy at said network is modulated in accordance with the recorded sound waves, said resonant network having a relatively high "Q" to provide re-radiation of modulated high frequency energy, and a receiver spaced from said resonant network without electrical connection thereto and being adapted to receive therefrom the aforementioned re-radiated modulated high frequency wave energy.

13. In combination, a sound wave record, an electrical pickup device associated therewith to translate the recorded sound waves into variations in reactance, a resonant network of a predetermined frequency electrically connected with said pickup device and adapted to have its frequency varied by said reactance variations, means for producing high frequency wave energy of said frequency, said means being spaced from said resonant network, said high frequency wave energy being radiated to said resonant network whereby the high frequency energy at said network is modulated in accordance with the recorded sound waves, a receiver, tuned to said predetermined frequency, spaced from said resonant network and being adapted to receive therefrom the aforementioned modulated high frequency wave energy, and means, operating at a supersonic rate, for preventing reception at said radio receiver of high frequency wave energy radiated directly to it from said wave energy producing means.

14. In a high frequency wave system, means for radiating unmodulated waves of a predetermined high frequency in the form of a beam, a tuned modulator circuit in the path of the beam and normally free of coupling to said radiating means, said modulator circuit being adapted to re-radiate said waves in modulated form, a demodulator circuit spaced from said modulator circuit for demodulating the re-radiated modulated waves, and means for alternately rendering said radiation and demodulation ineffective at a predetermined rate thereby to minimize the effect of any direct radiation from said radiating means to said demodulator.

CHESTER M. SINNETT.
HERBERT BELAR.