March 20, 1934. G. RAMSEY 1,951,669

METHOD AND APPARATUS FOR PRODUCING SOUND

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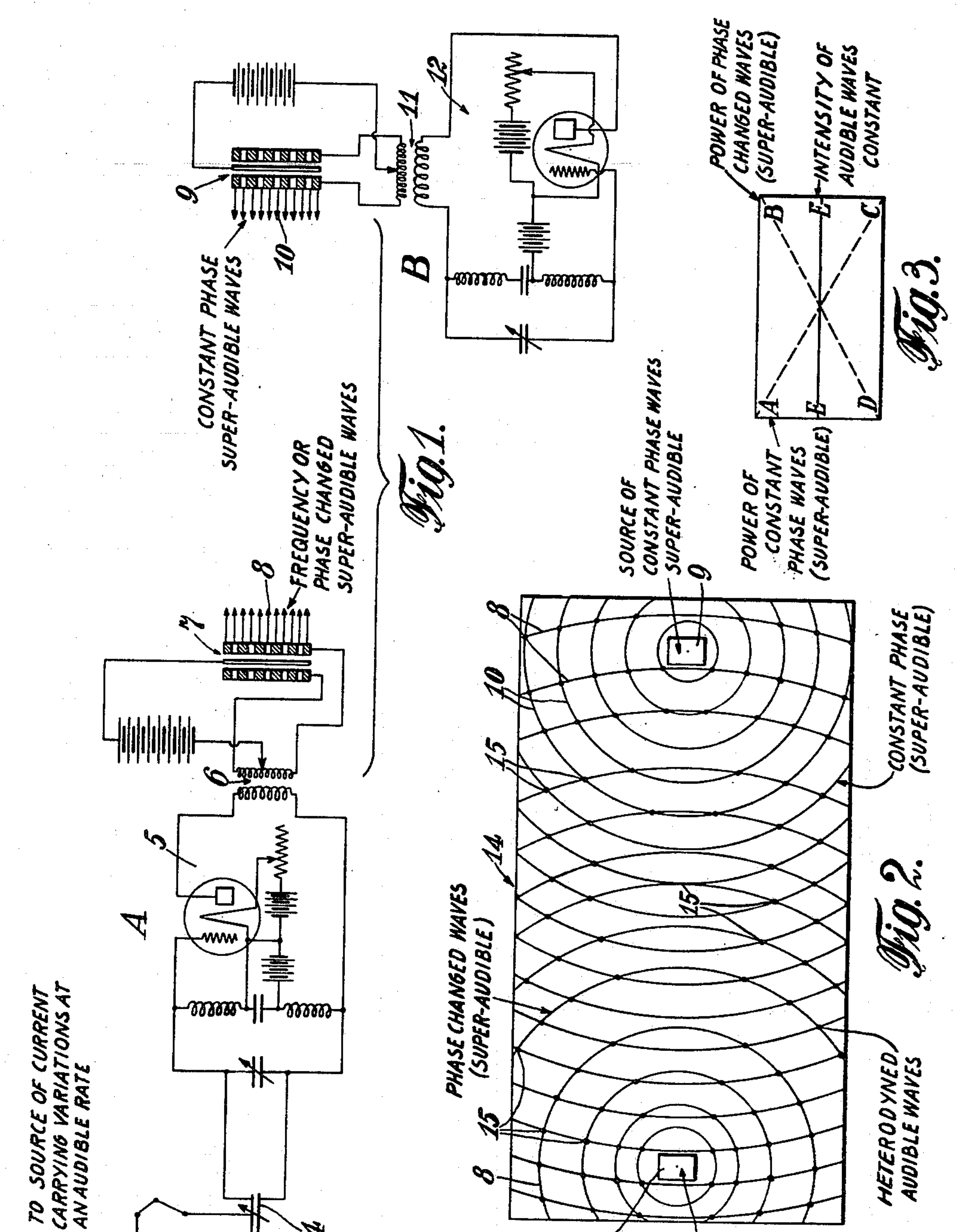

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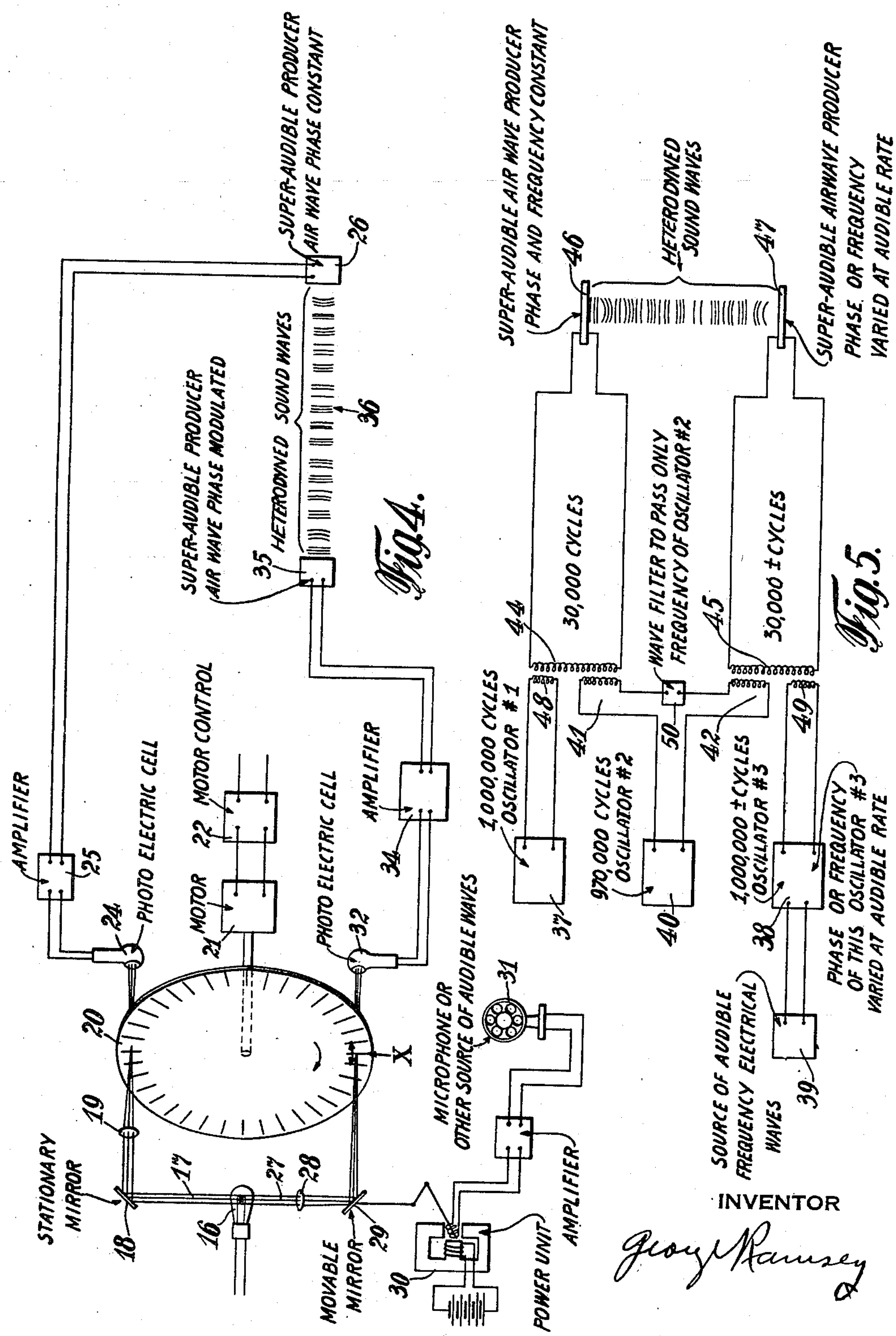

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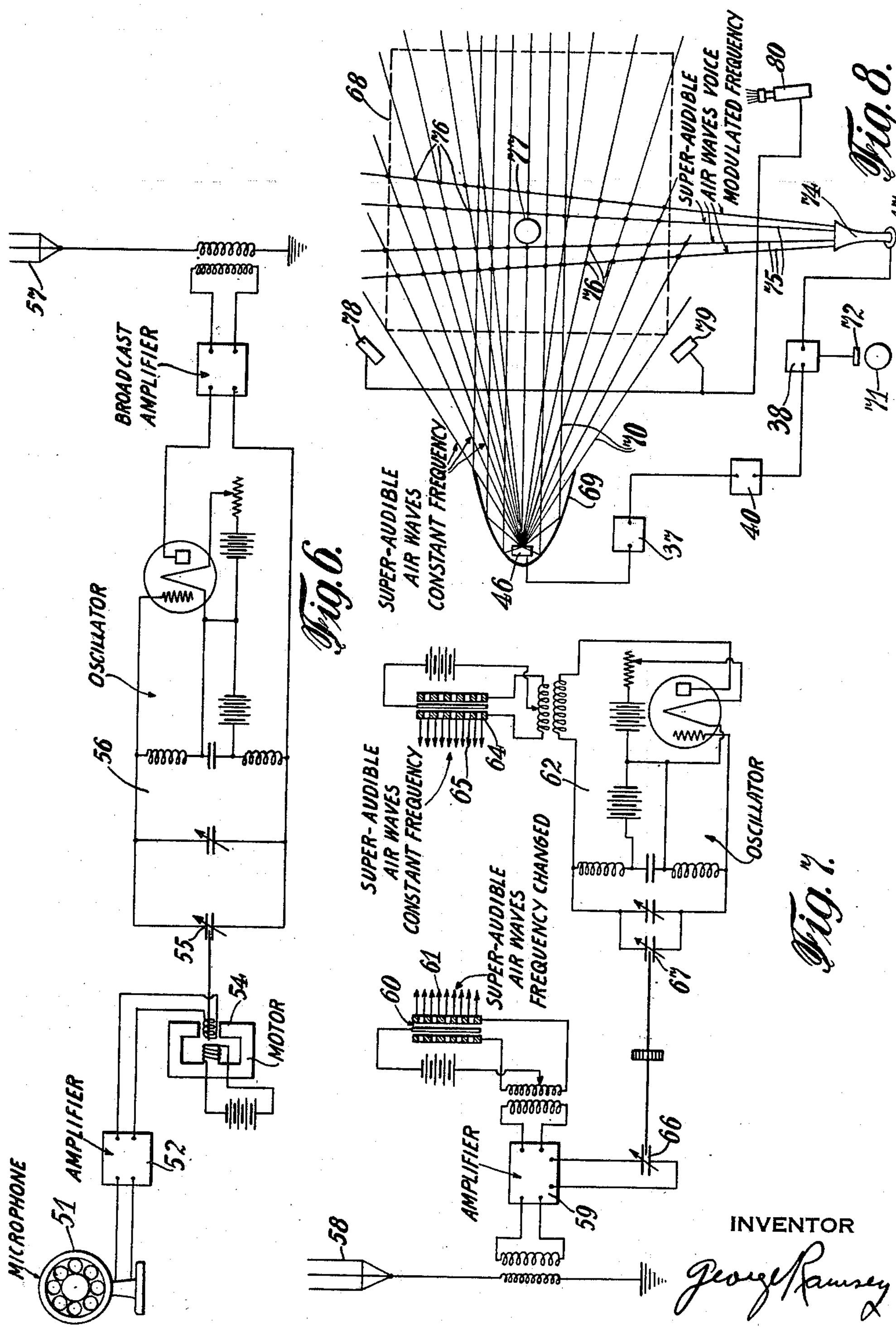

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR PRODUCING SOUND

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11 Claims. (Cl. 181—0.5)

The present invention relates broadly to acoustics, and more especially to a method and apparatus for producing sound.

Sound according to the present invention is produced by the interference or heterodyning of super-audible air waves. Preferably certain of these super-audible waves are constant in frequency and phase while others of these super-audible waves are varied at an audible frequency. The interference or heterodyning caused by the variation in one set of super-audible waves produces beat air waves at the audible frequency.

Where this invention is utilized to reproduce voice waves or music, preferably two super-audible waves of the same basic frequency are used. One of these waves is varied as to phase or frequency according to the voice or music to be reproduced. The beat note resulting from the heterodyning of the constant super-audible air wave with the varied super-audible air wave, is a reproduction of the voice or music. This beat note is made wherever the heterodyning of the super-audible air waves occurs. Therefore, if the two sources of super-audible waves be separated, for example, one at each end of a room, the whole room is filled with the beat note. Since the beat note is formed in the air adjacent the auditor's ear, the directional character or location of the origin of the sound is substantially absent. This is of a distinct advantage where this invention is used with talking moving pictures. The only indication of the origin of the sound is the visual movement observed on the screen and the auditor, therefore, associates the sound and movement without the distraction now caused by the sound coming from some fixed point not coincident with the movement on the screen.

There is also another advantage to the use of the present invention in that since the audible air wave is a beat note resulting from two or more basic waves, the loudness or intensity of the beat note is dependent on the sum of the amplitude of the basic waves. Where two basic waves of equal intensity are produced at each end of a hall, the beat note will be of the same intensity throughout the hall. If an auditor walked from one end of the hall to the other, the sound would be of the same intensity at all times for the reason that the amplitude of one set of super-audible waves diminishes at the same rate as the amplitude of the other set of super-audible waves increases, and since the amplitude of the audible beat note is the sum of the heterodyning waves, the amplitude of the audible wave is constant. Of course, the intensity of the audible notes vary as the music is loud or soft, but the level of the intensity is constant throughout the hall.

Where the present invention is utilized to produce sound as in the electric organ or in other electrical sources of sound, either or both the sources of super-audible waves may be varied, or a plurality of super-audible waves of different frequencies may be used simultaneously and varied as desired to produce overtones and harmonics to control and change the timber of the notes.

The disclosure herewith is more or less diagrammatic and is intended to be illustrative of the invention but is not to be understood in the limiting sense because it is realized the invention may be embodied in structures and apparatus other than that disclosed.

Fig. 1 illustrates one apparatus for carrying out the present invention.

Fig. 2 is a diagrammatic view showing how the audible waves are formed in a room.

Fig. 3 is a diagram illustrating the uniform intensity of the audible waves in a room.

Fig. 4 illustrates diagrammatically an apparatus for producing two super-audible waves of the same basic frequency.

Fig. 5 illustrates diagrammatically an electrical device for producing waves of the same basic frequency.

Fig. 6 illustrates a broadcasting apparatus according to the present invention.

Fig. 7 illustrates a receiving apparatus according to the present invention.

Fig. 8 illustrates the invention as applied to directional, and selective uses.

Referring to Fig. 1, the leads 1 from a source of electrical current varied at an audible rate (may be from a microphone, a film, an antenna, or other source) lead to a motor 2, which operates a variable condenser 4 in an oscillator 5. This oscillator 5 is set to oscillate at a super-audible rate. The operation of the variable condenser 4 varies this super-audible rate at an audible rate, the variation being in phase or frequency change as may be selected. This varied super-audible rate wave is transmitted through a transformer 6 to a loud speaker 7. This loud speaker may be of any suitable form but preferably is a condenser type of loud speaker of the form in the United States patent to Lee 1,622,039, March 22, 1927. The result is that this loud speaker 7 produces super-audible air waves 8 modulated at an audible rate.

Another loud speaker 9 preferably of the same type is located so that the air waves 10 from this speaker 9 heterodyne with the air waves 8 from the loud speaker 7. The loud speaker 9 is energized through a transformer 11 from an oscillator 12, set to oscillate on the same basic frequency as the oscillator 5.

The result is a heterodyning of the air waves 8 with the air waves 10 to produce an audible beat wave which corresponds to the audible rate wave that came over the leads 1.

Fig. 2 illustrates the loud speaker 7 at one end of a room 14 and the loud speaker 9 at the other end of the room. The waves 8 from the speaker 7 are varied super-audible waves, while the waves 10 from the speaker 9 are constant super-audible waves. These waves meet and heterodyne throughout the room 14 as indicated at the points 15.

Fig. 3 illustrates that the intensity of any given wave is equal throughout the room 14. The line A—C indicates amplitude of the waves from the speaker 9 showing a decrease from A toward C. The line B—D indicates the amplitude of the waves from speaker 7 showing a decrease for B toward D. The middle line E—E indicates adding the amplitude represented by line A—C to the amplitude represented by line B—D and the result is the constant level line E—E.

It is desirable for some purposes that both super-audible air waves shall be of the same basic frequency. Fig. 4 illustrates one apparatus for producing this effect. A source of light 16 throws a beam of light 17 on a stationary mirror 18 and through a lens 19 which focuses the beam 17 on a slotted disc 20. A motor 21 under a control 22 rotates the disc 20 at a high speed so that the light beam 17 is interrupted or chopped at a high rate of speed before it reaches the photoelectric cell 24, thus producing a super-audible constant wave through the amplifier 25 and the loud speaker 26.

A beam 27 of light from the same source 16 passes a lens 28, also focused on the disc 20 and falls on a movable mirror 29. This mirror 29 is operated by a motor 30 which is actuated by waves at an audible rate from a source 31. The light beam 27 focused on the disc 20 is oscillated back and forth in the direction of the double arrow X which is either in the direction or against the direction of the rotation of the disc 20, depending on the swing of the mirror. The chopped beam 27 falls on a photoelectric cell 32, which through the amplifier 34 and loud speaker 35 produces a super-audible air wave modulated at an audible rate. Since the speed of the disc 20 and the number of slots therein determine the frequency of light chopping for both beams 17 and 27, it is obvious that both super-audible air waves have the same basic frequency. The air wave from speaker 26 is constant, while the super-audible air wave from the speaker 35 is varied at an audible rate as to its phase. The result is the production of beat or heterodyned sound waves 36 which correspond to the sounds from the source 31.

Fig. 5 illustrates another way of producing two super-audible waves of the same basic frequency, with one set of super-audible rate waves constant and the other set varied at an audible rate. The oscillator 37 is set for a predetermined number of oscillations per second, for example, one million cycles. The oscillator 38 is set for the same basic number, for example, one million cycles, but this oscillator 38 may be varied at an audible rate from the source 39 of audible waves. A control oscillator 40 is provided between the oscillators 37 and 38, and has its output connected to primaries 41 and 42 of the transformers having secondaries 44 and 45 connected with loud speakers 46 and 47. The oscillator 37 has its output connected with a primary 48 adjacent secondary 44, while oscillator 38 has its output connected with a primary 49 adjacent secondary 45. A wave filter 50 is connected between the primaries 41 and 42 to pass only nine hundred and seventy kilocycles, for example, the cycles to which the control oscillator 40 is set to oscillate. The result of the example of cycles chosen for illustration, is that loud speaker 46 produces thirty thousand cycle air waves per second, while loud speaker 47 produces thirty thousand plus or minus air waves per second. These air waves beat to produce the desired audible air waves.

Fig. 6 illustrates a broadcasting station according to the present invention. The audible rate waves are established by the microphone 51 and are amplified by the amplifier 52, the output of which connects with the motor 54 which operates the variable condenser 55 of the oscillator 56 which is tuned to produce a basic frequency that is at a super-audible rate. The modulation due to the operation of the variable condenser, however, is, at an audible rate so that the output of the oscillator 56 through the broadcast amplifier and the antenna 57 is a super-audible wave modulated at an audible rate as to phase or frequency.

Fig. 7 illustrates a receiver adapted to receive the waves from a broadcast station such as illustrated in Fig. 6 and produce audible sound by heterodyning the received super-audible air waves. The phase or frequency modified wave is picked up by the antenna 58 and fed into the tuning amplifier 59, the output of which supplies the super-audible modified wave to the loud speaker 60 which transforms the electrical waves into super-audible air waves 61. An oscillator 62 is tuned to the same basic frequency as the received modified wave. The output of this oscillator 62 is connected with the loud speaker 64 which produces the super-audible air wave 65 that heterodynes with the air waves 61 to produce the audible sounds. The amplifier 59 is tuned by a variable condenser 66 to the basic frequency of the incoming wave. The movable element of the condenser 66 is connected with the movable element of a variable condenser 67 of the oscillator 62 so that when the receiving amplifier 59 is tuned, the oscillator 62 is simultaneously tuned to the same basic frequency.

From the foregoing, it will appear that it requires at least two super-audible air waves to produce sound according to the present invention. The mere modulation of a set of super-audible waves by frequency or phase change does not produce a sound wave. It is necessary that the relationship of two or more sets of super-audible waves must be such as to cause interference or heterodyning before sound is produced.

Super-audible air waves have decided directional characteristics and these waves may be readily directed in the form of beams. Fig. 8 illustrates an embodiment of the invention in which the directional characteristic of these waves is employed. One of the difficulties of making talking moving pictures is that under the present methods, the director of the picture cannot talk with the actors while the scenes are being photographed and recorded, therefore retakes are frequently necessary. The present invention solves this problem by enabling the director to talk to the actors while the film is being made without the director's voice being picked up by the microphones that transmit the actors' voices. In Fig. 8, the stage area in which the action occurs is indicated by the dotted line 68. The sound wave apparatus chosen for illustration in Fig. 8 is the form of device shown in Fig. 5. The loud speaker 46 is located in the focus of a sound reflector 69 so that super-audible constant frequency air waves 70 cover the stage area 68. The director, indicated at 71, speaks softly into the telephone or microphone 72, which is connected with the oscillator 38 to impose his voice frequency on the super-audible waves delivered to the speaker 47 that is located in a directional device, for example, the movable horn amplifier 74. The control oscillator 40 is suitably connected with the oscillators 37 and 38 as previously explained relative to Fig. 5. The modified super-audible air waves 75 from the directional horn 74 are projected as a beam and strike the super-audible constant frequency waves 70 from the speaker 46. Where these beams of waves 70 and 75 intersect, the waves heretodyne at 76, and audible sound is produced. Thus, if the directional horn 74 be directed toward an actor located as at 77, the actor will hear the director's voice. The recording microphones 78 and 79 which are connected to the sound recording camera 80 are outside the zone 76 of heterodyning, and, therefore, the voice of the director does not reach these microphones 78 and 79. It is desirable to use precaution to prevent the direct voice of the director from reaching the recording microphones 78 and 79, and this may be accomplished by providing a sound proof observation booth for the director with the directional horn outside the booth, or the mouthpiece of the telephone transmitter 72 may be constructed to prevent the escape of the speaker's voice as is well known in the art. In this use of the invention, the heterodyned air waves should not be of such amplitude as to establish travelling air waves of such magnitude as to reach the recording microphones 78 and 79.

The invention may be used for other uses where it is desired to produce sound locally without audible waves covering the intermediate space. This is accomplished as illustrated in Fig. 8 by focusing a pair of beams of super-audible heterodynable air waves so that these beams intersect at the location of the auditor. The sound will be formed only in the area of the intersection of the beams.

Having described my invention, I claim:

1. A sound producing device comprising in combination, means comprising an electrical oscillator to produce super-audible air waves of a predetermined basic frequency, means comprising another electrical oscillator to produce another set of super-audible air waves of substantially the same basic frequency, a common control for said oscillations, and means to modulate one set of said waves at audible frequency, the means for producing the superaudible air waves being so related that said superaudible waves intersect whereby heterodyning of said waves produces sound.

2. A device for receiving super-audible radio waves varied at audible frequency comprising receiving means to receive said waves and transform said waves into super-audible air waves varied at audible frequency, producing means to produce a set of unmodified super-audible air waves on substantially the same basic frequency, the receiving means and the producing means being so related as to cause said super-audible waves to intersect, and means to simultaneously tune said receiving means and said producing means.

3. A device for receiving super-audible radio waves varied at audible frequency comprising receiving means to receive said waves and transform said waves into super-audible air waves varied at audible frequency, producing means to produce a set of unmodified super-audible air waves on substantially the same basic frequency, the receiving means and the producing means being so related as to cause said super-audible waves to intersect, and means to simultaneously tune said receiving means to a predetermined frequency and to cause said producing means to produce super-audible air waves of the same frequency to which the receiving means is tuned.

4. The method of producing sound having predetermined overtones and harmonics comprising producing a series of super-audible air waves on a predetermined basic frequency, and varied as to said overtones and harmonics, producing another series of super-audible air waves in substantially the same space on substantially the same basic frequency varied at an audible rate, and causing said super-audible waves to intersect to produce audible waves.

5. The method of producing sound comprising producing a series of super-audible air waves on a predetermined basic frequency, producing independently of said series another series of super-audible air waves in substantially the same space on substantially the same basic frequency, and varying the frequency of one of said series at an audible rate.

6. The method of reproducing sound within a predetermined space from sources outside of said space, said method comprising producing a beam of super-audible air waves, producing independently of said beam a second beam of super-audible air waves of substantially the same basic frequency as said first mentioned beam, modulating the frequency of said second beam at an audible rate, and causing said beams to intersect and overlap in the space in which the sound is to be reproduced.

7. The method of reproducing speech within a predetermined space from sources outside of said space, said method comprising producing a beam of super-audible air waves, producing independently of said beam a second beam of super-audible air waves of substantially the same basic frequency as the first mentioned beam, modulating the frequency of said second beam in accordance with the speech to be reproduced, and causing said beams to intersect and overlap in the space in which the speech is to be reproduced.

8. The method of producing sound within a predetermined area from sources without said area and with a silent zone surrounding said area, said method comprising producing a beam of super-audible air waves, producing a second beam of super-audible air waves of a frequency adapted to heterodyne with the air waves of the first beam to produce sound, projecting said beams to cause intersection thereof whereby the super-audible air waves heterodyne where the beams intersect to produce audible standing waves in the area of intersection only, and placing a microphone outside of the said area of pick up normal audible sounds.

9. The method of generating sound within a predetermined space, comprising directing a wide beam of super-audible air waves into said space,

intersecting said waves within said space with a narrow beam of super-audible air waves of substantially the same frequency, and modulating one of said beams at an audible rate.

10. The method of producing sound comprising directing into a predetermined space a super-audible air wave modulated with harmonics and under-tones of audible rates, and directing into the same space a second super-audible air wave of substantially the same basic frequency modulated at voice rate frequencies.

11. The method of producing sound comprising utilizing a control to produce an electrical wave at a rate above audibility, transforming said electrical wave into an inaudible air wave, utilizing said control to produce a second electrical wave corresponding in rate to the first mentioned electrical wave, modulating the second electrical wave at an audible rate, transforming the modulated second electrical wave into an inaudible air wave, directing said air waves over a portion of common space wherein said air waves may heterodyne to produce air waves at audible rates.

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