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[54] **APPARATUS AND METHOD OF BROADCASTING AUDIBLE SOUND USING ULTRASONIC SOUND AS A CARRIER**

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[52] **U.S. Cl.** **367/139**; 367/137; 367/134

[58] **Field of Search** 367/137, 139, 367/134; 381/77; 455/46; 607/56

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[57] **ABSTRACT**

An ultrasonic sound source broadcasts an ultrasonic signal which is amplitude and/or frequency modulated with an information input signal originating from an information input source. If the signals are amplitude modulated, a square root function of the information input signal is produced prior to modulation. The modulated signal, which may be amplified, is then broadcast via a projector unit, whereupon an individual or group of individuals located in the broadcast region detect the audible sound.

21 Claims, 4 Drawing Sheets

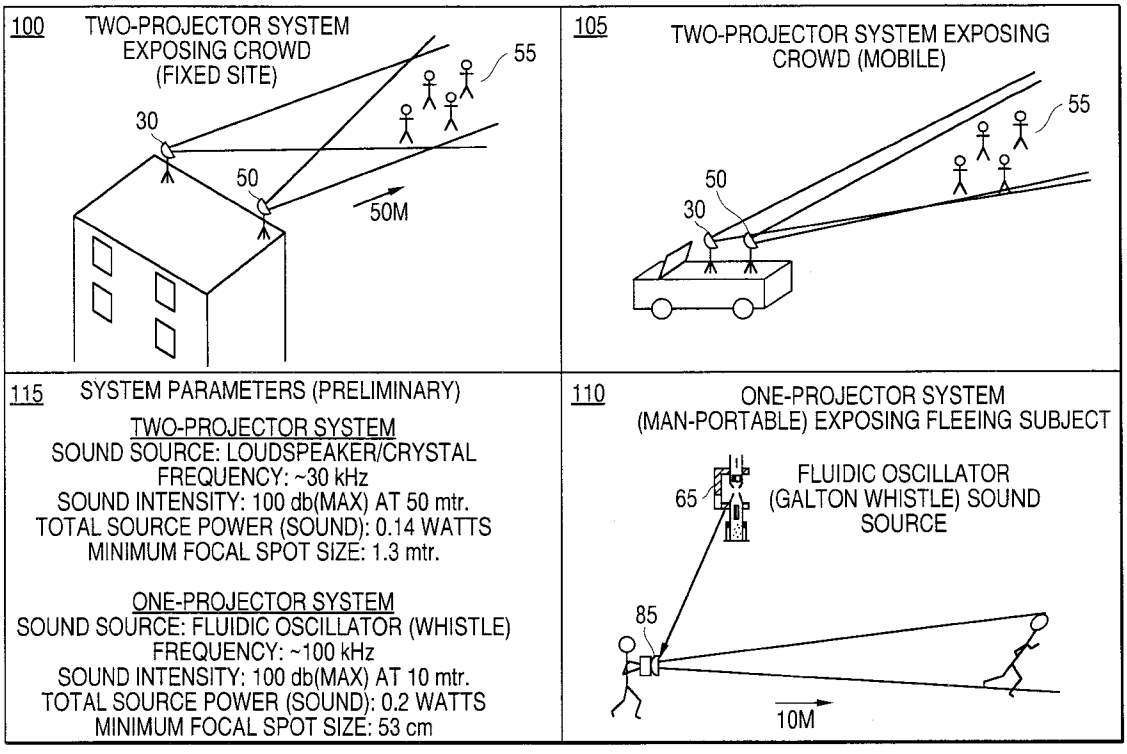


FIG. 1

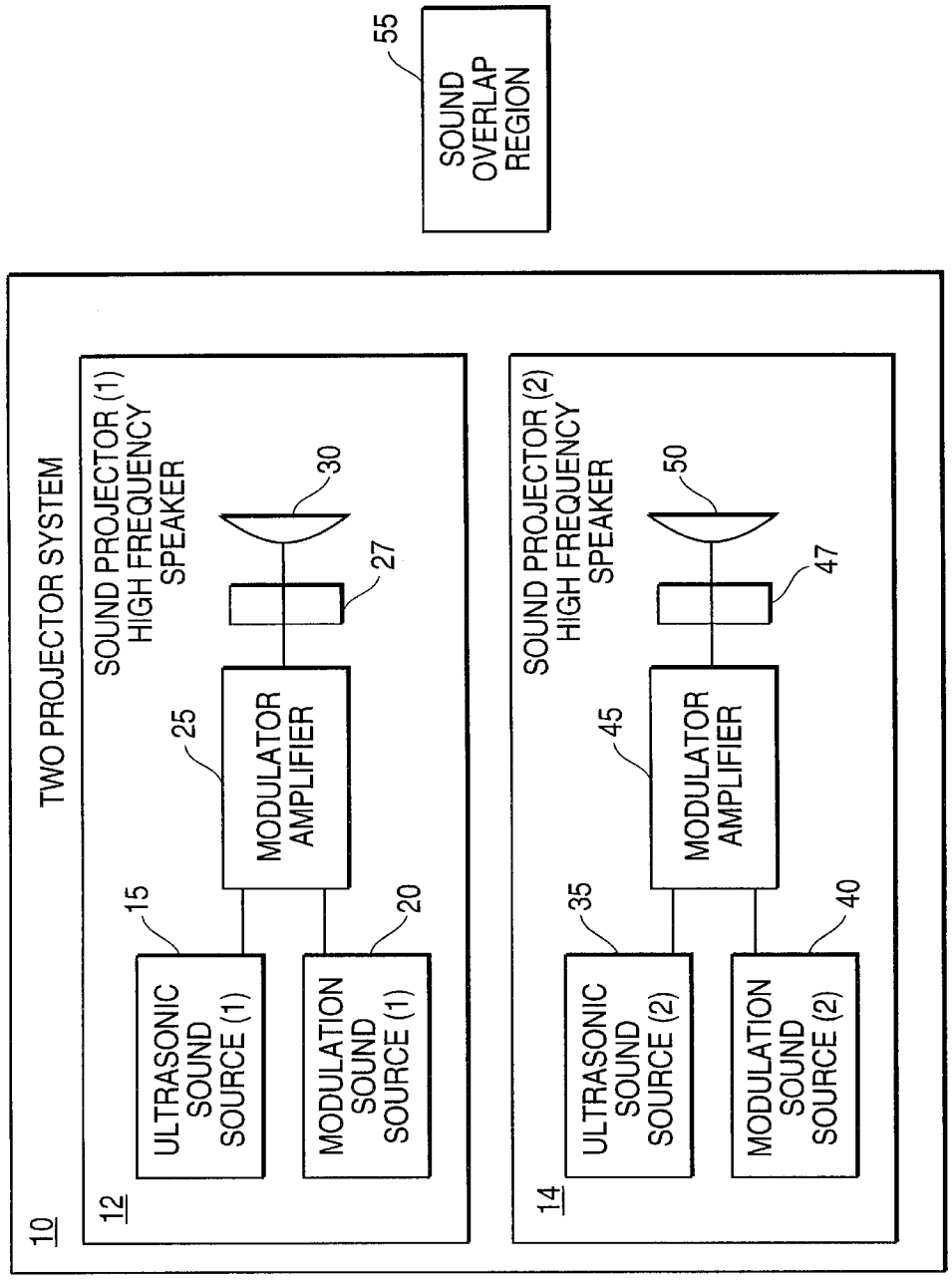

55
SOUND OVERLAP REGION
10
TWO PROJECTOR SYSTEM
12
SOUND PROJECTOR (1) HIGH FREQUENCY SPEAKER
15
ULTRASONIC SOUND SOURCE (1)
25
MODULATOR AMPLIFIER
20
MODULATION SOUND SOURCE (1)
30
27
14
SOUND PROJECTOR (2) HIGH FREQUENCY SPEAKER
35
ULTRASONIC SOUND SOURCE (2)
45
MODULATOR AMPLIFIER
40
MODULATION SOUND SOURCE (2)
50
47

FIG. 2

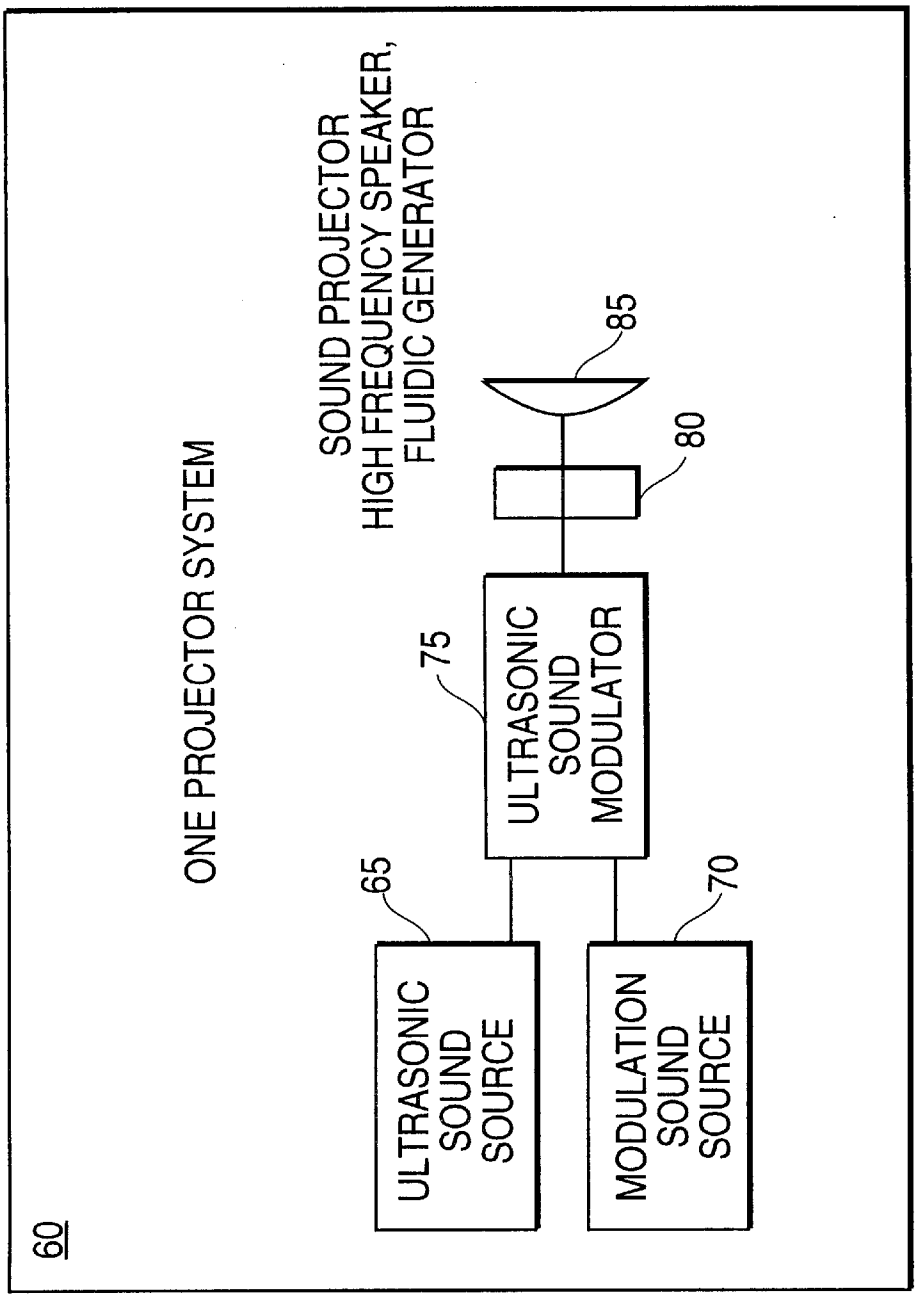

60
ONE PROJECTOR SYSTEM
SOUND PROJECTOR
HIGH FREQUENCY SPEAKER,
FLUIDIC GENERATOR
85
80
75
ULTRASONIC
SOUND
MODULATOR
65
ULTRASONIC
SOUND
SOURCE
70
MODULATION
SOUND
SOURCE

FIG. 3

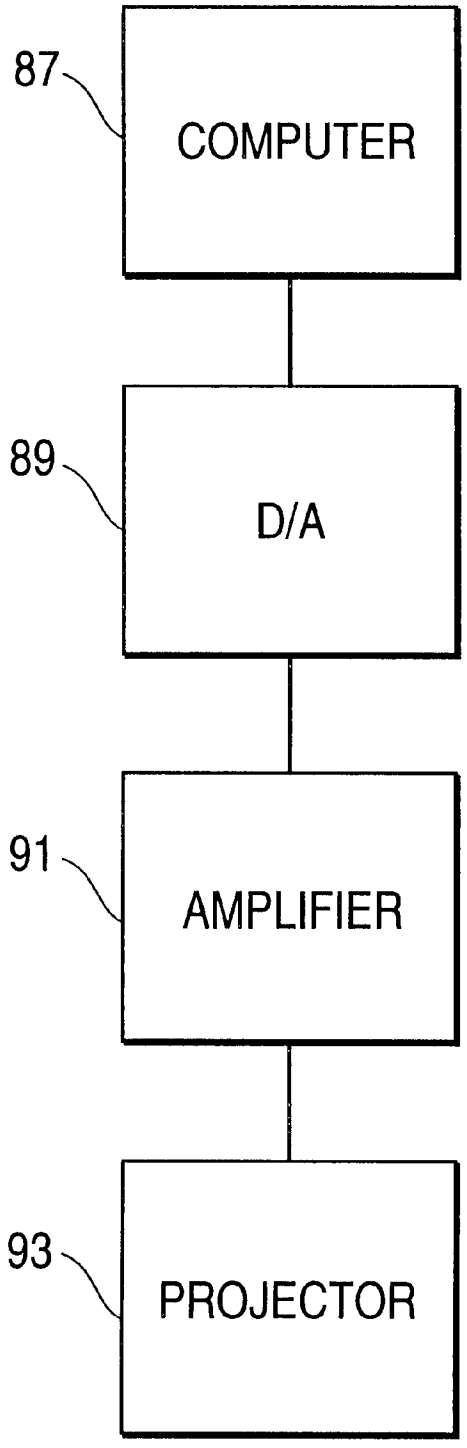
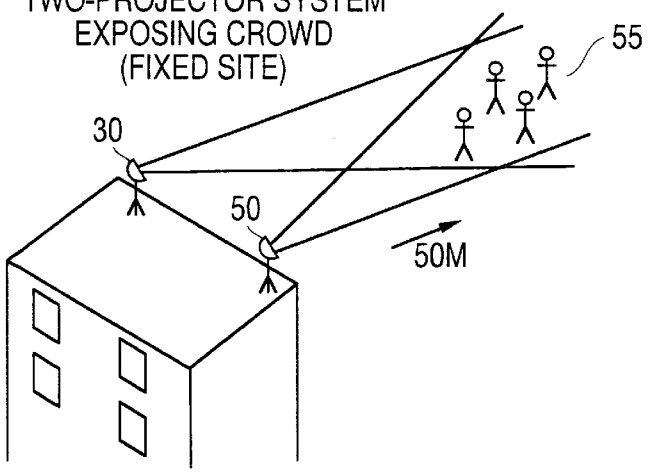
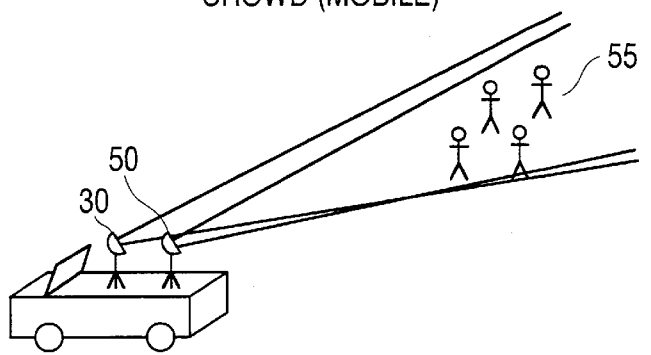


FIG. 4

100 TWO-PROJECTOR SYSTEM EXPOSING CROWD (FIXED SITE)



105 TWO-PROJECTOR SYSTEM EXPOSING CROWD (MOBILE)

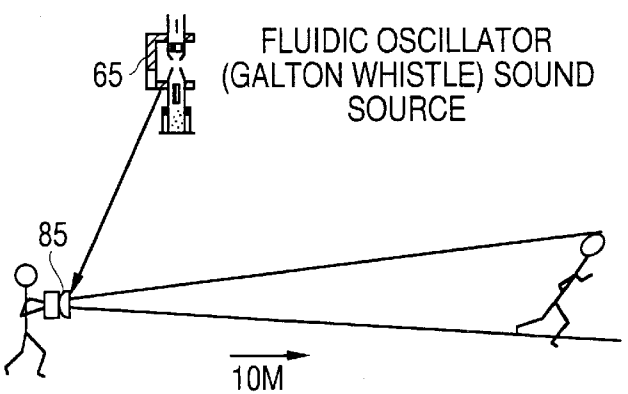


115 SYSTEM PARAMETERS (PRELIMINARY)

TWO-PROJECTOR SYSTEM
SOUND SOURCE: LOUDSPEAKER/CRYSTAL
FREQUENCY: ~30 kHz
SOUND INTENSITY: 100 db(MAX) AT 50 mtr.
TOTAL SOURCE POWER (SOUND): 0.14 WATTS
MINIMUM FOCAL SPOT SIZE: 1.3 mtr.

ONE-PROJECTOR SYSTEM
SOUND SOURCE: FLUIDIC OSCILLATOR (WHISTLE)
FREQUENCY: ~100 kHz
SOUND INTENSITY: 100 db(MAX) AT 10 mtr.
TOTAL SOURCE POWER (SOUND): 0.2 WATTS
MINIMUM FOCAL SPOT SIZE: 53 cm

110 ONE-PROJECTOR SYSTEM (MAN-PORTABLE) EXPOSING FLEEING SUBJECT



APPARATUS AND METHOD OF BROADCASTING AUDIBLE SOUND USING ULTRASONIC SOUND AS A CARRIER

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. provisional application Ser. No. 60/046,803, filed May 2, 1997, entitled A METHOD FOR TRANSMITTING AUDIBLE SOUNDS THROUGH THE AIR USING ULTRASONIC SOUND AS A CARRIER by Austin Lowrey, III and incorporated by reference herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to an apparatus and method of broadcasting an audible sound, and in particular, to an apparatus and method of broadcasting an audible sound using an ultrasonic sound as a carrier modulated by the audible sound as an input signal.

2. Description of the Related Art

Over the past few years, several situations have arisen in military and civil areas where crowds, with or without leaders, have posed a serious problem to Government forces.

For example, in Somalia, leader General Aideed would almost never remain outside unless surrounded by a crowd of sympathizers. Troops attempting to seize or capture the leader would have to engage the crowd, probably killing or injuring some, in order to get close enough to capture him. Hence, forces were not likely to attempt to capture the leader.

Another example is the U.S. invasion of Haiti, where a ship with troops was sent to perform various actions that would have been helpful to the population living there. The landing of these troops was, however, opposed by a crowd on the dock. Hence, in order to land, the crowd on the dock must first be disposed of. Again, crowd members would likely be hurt, resulting in the troops deciding not to act.

Still another example is any situation where an angry crowd gathers. In this situation, the crowd frequently turns to looting and destruction of property. It is a constant challenge for, for example, police to disperse such a crowd without causing casualties, perhaps fatal ones.

All of these examples have a common theme, namely a crowd or leader that one would like to influence such that they leave or stop their hostile activities.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a nonlethal individual or crowd control device which uses an audible sound broadcasted using an ultrasonic sound as a carrier.

It is another object of the present invention to provide a device that will allow the hearing impaired to hear speech.

It is still another object of the present invention to provide a device that will emit audible sound to listeners located in a defined area.

It is yet another object of the present invention to provide a low frequency sound, either audible or sub-audible frequency, in the heads of listeners.

In one embodiment of the present invention, there is provided an apparatus including a unit amplitude modulating an ultrasonic signal with a square root of an information signal to produce a modulated signal, and a projector coupled to the unit and projecting the modulated signal to a listener.

In one aspect of the embodiment, the apparatus further includes a circuit producing the square root of the information signal, a modulator amplitude modulating the ultrasonic signal with the square root of the information signal, a first sound source outputting the information signal, and a second sound source outputting the ultrasonic signal.

In another aspect of the embodiment, the information signal is a voice signal from, for example, a microphone.

In another embodiment of the invention, there is provided a method of modulating an ultrasonic signal with a square root of an information signal to produce a modulated signal, and projecting the modulated signal to a listener.

In one aspect of the embodiment, the method further includes producing a square root signal from the information signal, modulating the ultrasonic signal with the square root of the information signal to produce the modulated signal, amplifying the modulated signal, and transmitting the amplified modulated signal.

In another aspect of the embodiment, the modulating is an amplitude modulation.

In yet another embodiment of the present invention, there is provided an apparatus including a first modulator frequency modulating a first ultrasonic signal with a first input signal to produce a first modulated signal, an ultrasonic signal source providing a second ultrasonic signal, and a broadcasting system, coupled to the first modulator and the ultrasonic signal source, broadcasting the first modulated signal and the second ultrasonic signal to a listener.

In one aspect of the embodiment, the apparatus further includes a first projector projecting the modulated signal, a second projector projecting the second ultrasonic signal, a first input sound source outputting the first input signal, a second ultrasonic signal source providing the first ultrasonic signal, a second modulator amplitude modulating the second ultrasonic signal with a second input signal to produce a second modulated signal, a second input sound source outputting the second input signal, and an amplifier amplifying the amplitude modulated signal.

In another aspect of the embodiment, the first and second ultrasonic signals produce a difference signal for the listener in an audible range of the listener.

In yet another aspect of the embodiment, the input signal is a square root of an information signal.

In still another aspect of the embodiment, the information signal is a voice from, for example, a microphone.

In still another embodiment of the present invention, there is provided a method of frequency modulating a first ultrasonic signal with a first input signal to produce a first modulated signal, providing a second ultrasonic signal, and broadcasting the first modulated signal and the second ultrasonic signal to a listener.

In one aspect of the embodiment, the method includes amplitude modulating the second ultrasonic signal with a second input signal to produce a second modulated signal, amplifying the amplitude modulated signal, and projecting the first and second modulated signals in the audible range of the listener.

In yet another embodiment of the present invention, there is provided an apparatus including a unit modulating an ultrasonic signal with an information signal to produce a modulated signal in which the information signal is completely intelligible to a listener, and a projector coupled to the unit and projecting the modulated signal to the listener.

These together with other objects and advantages which will be subsequently apparent, reside in the details of

construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an exemplary embodiment of a two projector system for broadcasting an audible sound using an ultrasonic sound as a carrier.

FIG. **2** illustrates an exemplary embodiment of a one projector system for broadcasting an audible sound using an ultrasonic sound as a carrier.

FIG. **3** illustrates an exemplary embodiment of a projector system using computer based signal processing.

FIG. **4** illustrates exemplary embodiments of one and two projector systems employed in a stationary and mobile environment.

DESCRIPTION OF PREFERRED EMBODIMENTS

An apparatus and method of using ultrasonic sound to create audible sounds in the heads of individuals, or of a crowd of individuals, will be described. The sounds could be voices, music or ringing sounds to cause discomfort, disorientation, or low frequency vibrations that have been shown to induce discomfort.

The physical principles involved in such devices will be described together with the way that they would be used to disrupt or affect the actions of an individual or crowd. Additionally, examples will be used to indicate ways in which to handle the situations described above.

QUALITATIVE DESCRIPTION

PRELIMINARY CONSIDERATIONS

The use of sound controlling groups or crowds in both civil and military situations was considered at least as far back as World War II. Psychological studies on sounds that produce an aversive effect, or a pleasant effect, have been reported since the early decades of this century. Work in the nineteenth century by Helmholtz and Lord Rayleigh (detailed below) show an understanding of the effect that combination tones, or beats, with low frequencies (less than about one hundred Hertz) have on the pleasant or unpleasant quality of a sound.

Crowds can largely be divided into two kinds; those with leaders, and those without. A crowd with a leader can be affected either by limiting the communication between the leader and the crowd, or by directly affecting the crowd. A crowd without a leader (such as a looting mob) can only be affected by something that influences everyone in the crowd. Thus, it is necessary to develop physical methods to either impair communication, or to produce a physical or psychological effect in all persons exposed to the system.

Some of the methods suggested for affecting an entire crowd involve very high intensity sound (120 dB or more above the standard level of 2×10^{-5} N/m^2). Sirens or very low frequency vibrations (less than 100 Hertz) are frequently spoken of.

Studies indicate several classes of sound to be of interest in crowd control. One class of sounds includes those which are aversive in themselves. Examples of these are: (1) scraping noises, such as that of chalk on a blackboard, (2) the crying of a baby, and (3) screams of pain. These sounds almost involuntarily cause a person to avert his/her attention from what he/she is doing, at least momentarily. Repeated exposure to this class of sounds, if the occurrence is not predictable, tends to produce jumpiness and sometimes leads to irrational behavior.

Secondly, there are a class of sounds which will cause a person to be startled and divert his/her attention from the task that he/she is doing because they indicate a possible imminent danger to him/her. Examples are: (1) gunfire, and (2) automobile crash noises.

Both of these classes of sound will likely produce a "startle" reaction in a crowd the first time that they are used. If the crowd, however, identifies the source as, for example, a loudspeaker, they will likely adapt to and ignore the noise. If the crowd mills around for a longer time, the sounds could cause headaches and other symptoms of stress. The crowd may disperse, but this is not at all certain.

If, on the other hand, one is trying to stop a fleeing person, a sudden noise, such as the screech of brakes, would undoubtedly cause the person to be startled and try to see whether the noise indicated impeding danger to him/her. He/She will clearly be disoriented for a few seconds, although the average time will vary from person to person. The sound of a gunshot may, for example, cause the same effect, or it may simply cause the person to run faster or run in a weaving manner.

A third class of sound includes low frequency vibrations either slightly above or below 20 Hertz; the lower audible limit. Vibrations in this frequency range produce several effects on a person's body.

Resonances of several internal organs lie in this frequency range. It has been shown that exposure to vibrations at an organ resonance cause nausea and a general feeling of malaise. Vibrational amplitudes that are too high will cause physical damage to the organs, whereas vibrations at a constant frequency or starting very low an rising through the range appear to cause a feeling of unease and tend to increase the suggestibility of a crowd.

The effects on a person's mood appear to be caused by hitting frequencies close to the alpha frequency of the brain waves. A phenomenon called "entrainment" occurs when the brain is stimulated at frequencies close to 10 Hz. This means that the brain's natural frequency is pulled close to, and sometime equal to, the stimulating frequency. A normal brain displays a prominent "alpha" pattern (8 to 12 Hz) at a time of relaxed alertness. Tense alertness, such as caused by freeway driving, leads to a "beta" pattern with a frequency of 13 Hz or higher. A relaxed, dreamlike state causes a "theta" pattern of frequencies from 4 to 8 Hz.

Other experiments, such as the ones cited by Norbert Wiener in "Nonlinear Problems in Random Theory", found that "a decidedly unpleasant sensation" was produced by stimulating the brain at "about 10 Hz." In fact, Helmholtz argues that beats of frequency less than 40 Hz are not perceivable as tones, but rather create a jarring feeling and are responsible for the unpleasant sensation of dissonant combinations of notes in music. As the low notes of the organ are in the range of 30 Hz, it would seem that tones ranging in frequency from about 12 to 40 Hz will produce an unpleasant feeling, or suggestibility. These tones are probably useful in crowd control used either by themselves, or to induce a mood that could then be triggered by another sound.

In producing low frequency vibrations with a conventional loudspeaker, several problems arise. First, at frequencies as low as this, loudspeakers are not very efficient in producing sound. The speaker will have to be quite large. Second, there is very little directivity possible with frequencies this low. Directive arrays would be huge, making it almost impossible to define an area where the effect occurs

combination tones. If the two tones are ultrasonic, the sum frequency will also be ultrasonic, and hence inaudible. The difference frequency, however, will be audible if it lies in the audible range for the ear. The production of an audible difference from two inaudible ultrasonic tones was reported by Lord Raleigh. This shows that the non-linearity, experimentally verified for audible sounds, is not appreciably different for ultrasonic sounds.

In summary, a non-linearity of the ear exists giving rise to a quadratic term in the ear's response. This effect occurs both when the original sounds are audible, or ultrasonic.

If the two ultrasonic tones of different frequencies were beamed at an individual, or a crowd, the difference frequency would be heard, assuming that it lies in the audible range. The frequency could be changed in any desired pattern, or left at a constant frequency, such as a low frequency to increase apprehensivess.

If one wishes to induce a wave with a complex frequency pattern such as a voice, the wave could be used to amplitude modulate one or both of the ultrasonic waves. The frequency of the two waves would likely be the same, or else there would be a background note consisting of the difference tone. Although, it might be preferable to deliberately induce a low frequency to increase apprehensiveness.

The quadratic terms also imply that the "constant" term exists even with only one tone. Thus, a single high amplitude ultrasonic source, amplitude modulated with a voice (a square root of the voice), would induce the voice in the heads of those exposed to the signal. A one projector system, such as system **60**, would be the system of choice for, for example, man-portable devices.

Beat Tones

In addition to the combination tones described above, which are due to the quadratic response of the ear, a phenomenon called the "Beat Frequency" effect occurs if the two frequencies are very close together. Beat tones are of importance in the use of very low frequencies, since they are caused by a linear response term, which is generally larger in amplitude than the combination tone.

Observing two waves with slightly different frequencies f and f+δf (with δf small), the linear response will be:

$$R(t)=A*\{a*\cos(ft)+b*\cos[f+\delta f)t]\}$$

using trigonometric identities:

$$\cos\{(f+\delta f)t]=\cos(\delta ft)*\cos(ft)-\sin(\delta ft)*\sin(ft),$$

and

$$R(t)=A*\{[a+b*\cos(\delta ft)]*\cos(ft)-b*\sin(\delta ft)\sin(ft)\}$$

Both of these terms include waves with frequency f whose amplitude is modulated at frequency δf. When f is an audible frequency, the pulsing changes in amplitude (beat) are clearly audible.

As the beats increase, the beat frequency becomes harder to distinguish and is gradually perceived as a weaker, independent tone. The beat phenomenon can thus be said to shade the combination tone phenomenon.

Two ultrasonic tones whose combination tone is a very low frequency produce a beat phenomenon, where the beat frequency would equal the combination tone frequency. In this case, the ear would perceive the beat. The amplitude of the beat will be higher than the combination tone since it arises from the linear, rather than the quadratic, response of the ear.

Hence, its likely that low frequency sounds, can be induced with particularly high amplitudes.

Producing Undistorted Sounds Using Two Ultrasonic Sound Sources

Real time computer based signal processing can be used to produce an understandable, non-distorted signal from a pair of ultrasonic projectors in the following way.

Assume a sinusoidal signal of frequency f_1 is fed into one of projectors **30** and **50**, and the signal for broadcasting is Fourier analyzed in real time by a computer and can be written:

$$f(t)=\Sigma a_i*\cos(f_i t).$$

The computer takes each of the frequencies f_i and adds f_1 to it, and then constructs the signal:

$$g(t)=\Sigma a_i*\cos[(f_1+f_i)t].$$

If g(t) is amplified and then fed to the second projector, the signal in the regions where the two beams cross (sound overlap region **55** is:

$$A\cos(f_1 t)+Bg(t).$$

The square of this signal is:

$$A^2\cos^2(f_1 t)+B^2 g^2(t)+2AB\cos(f_1)g(t).$$

We will ignore the first two terms as being both ultrasonic. The third term is:

$$2AB\{\Sigma a_i[\cos(f_1 t)\cos(f_1+f_i t)]\}$$

Using standard trigonometric identities, this is:

$$AB\{\Sigma a_i[\cos[(f_1+f_1+f_i)t]+\cos[(f_1-f_1-f_i)t]\}$$

The first set of these sums will again be ultrasonic, thus not audible. The second set, however, is

$$AB\Sigma a_i\cos(f_i t)$$

(noting that: $\cos(-ft)=\cos(ft)$)

Hence, an amplified form of the signal that we wish to transmit.

Similarly, real time computer based signal processing can be used to produce an understandable, non-distorted signal from a single ultrasonic projector, wherein the square root of an input signal is produced by the computer.

Propagation and Focussing of Ultrasonic Sound

One of the great advantages of using an ultrasonic sound as a carrier for audible sounds is the ease of focussing due to the short wavelength involved. Sounds are a wave phenomenon, just as light, and can be treated mathematically by the same equations that describe light, with appropriate changes in the interpretation of the quantities involved.

Assume a point source of sound placed at or near the focus of sound mirror. Since sound is reflected by a sudden difference in the density of the material of propagation, most materials, such as metals or plastics, will serve as mirrors. As in the case of light, the position of the source at, in front of, or behind the focal point will determine the character of the wave reflected from the mirror. When using the "geometrical optics" approximation, the focal point in front of the mirror is more important. We will be most interested in the case where the sound would be brought to a point focus at some distance in front of the mirror, if we were to use the "geometrical optics" approximation. The sound wave should then be represented by a spherical wave centered on the

geometric focal point of the mirror. The wave would not be a complete sphere, however, since the mirror has a finite size. Sound emitted by the source that passed beyond the mirror boundary will not be reflected and focussed at the focal point. The finite size of the mirror causes the wave to exhibit diffraction and not to focus to a geometrical point.

The most pertinent part of the analysis lies in the fact that there is a diffraction circle surrounding the focal point. The radius of the circle is 00/.610*(1/a)*f. In this formula, 1 is the wavelength (the speed of sound ($3.30–10^4$ cm./sec.) divided by the frequency), a is the radius of the mirror, and f is the distance to the focal point of the mirror. About 80% of the total energy striking the mirror from the source passes through the diffraction circle described above. This is the basis for the calculation of the source power required to produce a given power flux at the focal point.

By moving the source away from the close focal point of the mirror, the energy will be spread over larger areas in the vicinity of the far focal point. This will be the technique used when a crowd, rather than an individual, is to be exposed.

Another important feature of ultrasonic sound is that it is absorbed by the air to a much greater extent than audible sound. At 1 mhz, an attenuation coefficient for air is **15**(1/mtr.), varying as the square of the frequency. This coefficient is for the pressure, so double the calculated value must be used to obtain the attenuation of the intensity, which depends on the square of the pressure.

Absorption is moderate for frequencies around 30 kHz, but becomes severe for 100 kHz waves. This will lead to tradeoffs between the better focussing properties of shorter waves and the lower absorption of longer waves.

The many features and advantages of the invention are apparent from the detailed specification and, thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed is:

1. An apparatus, comprising:

a unit amplitude modulating an ultrasonic signal with a square root of an information signal to produce a modulated signal; and

a projector coupled to said unit and projecting the modulated signal to a listener.

2. The apparatus according to claim **1**, wherein said unit comprises:

a circuit producing the square root of the information signal; and

a modulator amplitude modulating the ultrasonic signal with the square root of the information signal.

3. The apparatus according to claim **2**, further comprising:

a first sound source, coupled to an input of the modulator, outputting the information signal; and

a second sound source, coupled to the input of the modulator, outputting the ultrasonic signal.

4. The apparatus according to claim **1**, wherein the information signal comprises a voice signal.

5. A method, comprising:

modulating an ultrasonic signal with a square root of an information signal to produce a modulated signal; and

projecting the modulated signal to a listener.

6. The method according to claim **5**, wherein the modulating further comprises producing a square root signal from the information signal.

7. The method according to claim **6**, further comprising:

amplifying the modulated signal; and

transmitting the amplified modulated signal.

8. The method according to claim **5**, wherein the modulating is an amplitude modulation.

9. An apparatus, comprising:

a first modulator frequency modulating a first ultrasonic signal with a first input signal to produce a first modulated ultrasonic signal;

a first ultrasonic signal source providing a second ultrasonic signal; and

a broadcasting system, coupled to the first modulator and the ultrasonic signal source, broadcasting the first modulated ultrasonic signal and the second ultrasonic signal to a listener.

10. The apparatus according to claim **9**, wherein the broadcasting system comprises:

a first projector, coupled to the first modulator, projecting the first modulated signal; and

a second projector, coupled to the ultrasonic signal source, projecting the second ultrasonic signal.

11. The apparatus according to claim **9**, further comprising:

a first input sound source, coupled to the first modulator, outputting the first input signal; and

a second ultrasonic signal source, coupled to the first modulator, providing the first ultrasonic signal.

12. An apparatus, comprising:

a first modulator frequency modulating a first ultrasonic signal with a first input signal to produce a first modulated ultrasonic signal;

a first input sound source, coupled to the first modulator, outputting the first input signal;

a first ultrasonic signal source providing a second ultrasonic signal;

a second ultrasonic signal source, coupled to the first modulator, providing the first ultrasonic signal;

a second modulator amplitude modulating the second ultrasonic signal with a second input signal to produce a second modulated signal;

a second input sound source, coupled to the second modulator, outputting the second input signal;

an amplifier, coupled to an output of the second modulator, amplifying the amplitude modulated signal; and

a broadcasting system, coupled to the first modulator and the ultrasonic signal source, broadcasting the first modulated ultrasonic signal and the second ultrasonic signal to a listener.

13. The apparatus according to claim **12**, wherein the first and second ultrasonic signals produce a difference signal for the listener in an audible range of the listener.

14. The apparatus according to claim **12**, wherein the input signal comprises a square root of an information signal.

15. The apparatus according to claim **14**, wherein the information signal comprises a voice.

16. A method, comprising:

frequency modulating a first ultrasonic signal with a first input signal to produce a first modulated signal;

providing a second ultrasonic signal; and

broadcasting the first modulated signal and the second ultrasonic signal to a listener.

17. A method, comprising:

frequency modulating a first ultrasonic signal with a first input signal to produce a first modulated signal;

providing a second ultrasonic signal;

amplitude modulating the second ultrasonic signal with a second input signal to produce a second modulated signal; and

amplifying the amplitude modulated signal; and

broadcasting the first modulated signal and the second ultrasonic signal to a listener.

18. The method according to claim 17, further comprising:

emitting the first and second modulated signals in the audible range of the listener.

19. An apparatus for broadcasting an audible sound using an ultrasonic sound as a carrier such that at least one person exposed to the ultrasonic sound can hear the audible sound, without detecting the source of the sound, comprising:

an information sound source outputting an information signal;

an ultrasonic sound source outputting the ultrasonic sound;

a square root circuit, coupled to the sound source, producing a square root of the information signal output by the information sound source;

an ultrasonic modulator, coupled to the square root circuit and the ultrasonic sound source, amplitude modulating the ultrasonic sound with the square root of the information signal to produce a modulated signal;

an amplifier, coupled to the ultrasonic modulator, amplifying the modulated signal; and

a projector unit, coupled to the amplifier, projecting the modulated signal such that the audible signal is detected by the at least one person.

20. An apparatus for broadcasting first and second audible sounds using first and second ultrasonic sounds, respectively, as a carrier such that at least one person exposed to the ultrasonic sounds can hear the audible sounds, without detecting the source of the sounds, comprising:

a first information sound source outputting a first information signal;

a second information sound source outputting a second information signal;

a first ultrasonic sound source outputting a first ultrasonic signal;

a second ultrasonic sound source outputting a second ultrasonic signal;

a first modulator, coupled to the first ultrasonic sound source and the first information sound source, frequency modulating the first ultrasonic signal with the first information signal to produce a first modulated signal;

a second modulator, coupled to the second ultrasonic sound source and the square root circuit, frequency modulating the second ultrasonic sound with the second information signal to produce a second modulated signal;

a first projector unit, coupled to the first modulator, projecting the first modulated signal to the at least one person; and

a second projector unit, coupled to the second modulator, projecting the second modulated signal to the at least one person.

21. An apparatus, comprising:

a unit modulating an ultrasonic signal with the square root of an information signal to produce a modulated signal in which the information signal is intelligible to a listener; and

a projector coupled to the unit and projecting the modulated signal to the listener.

* * * * *