

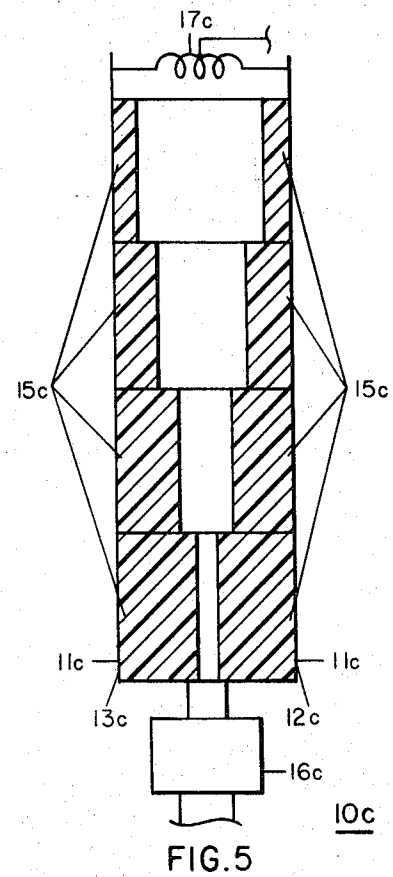
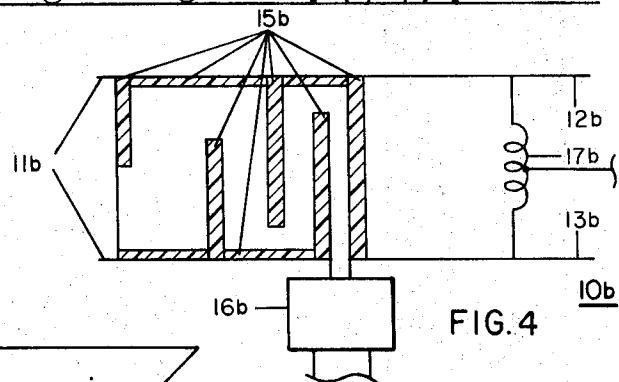
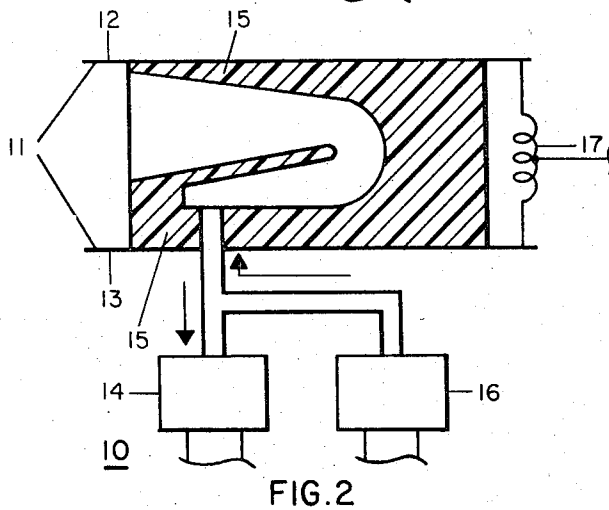
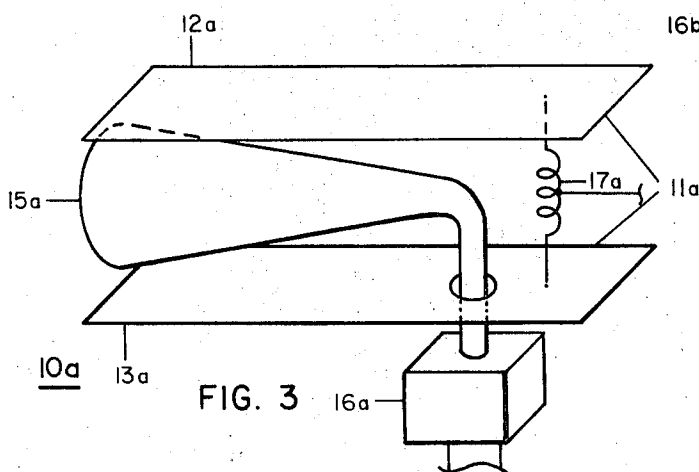
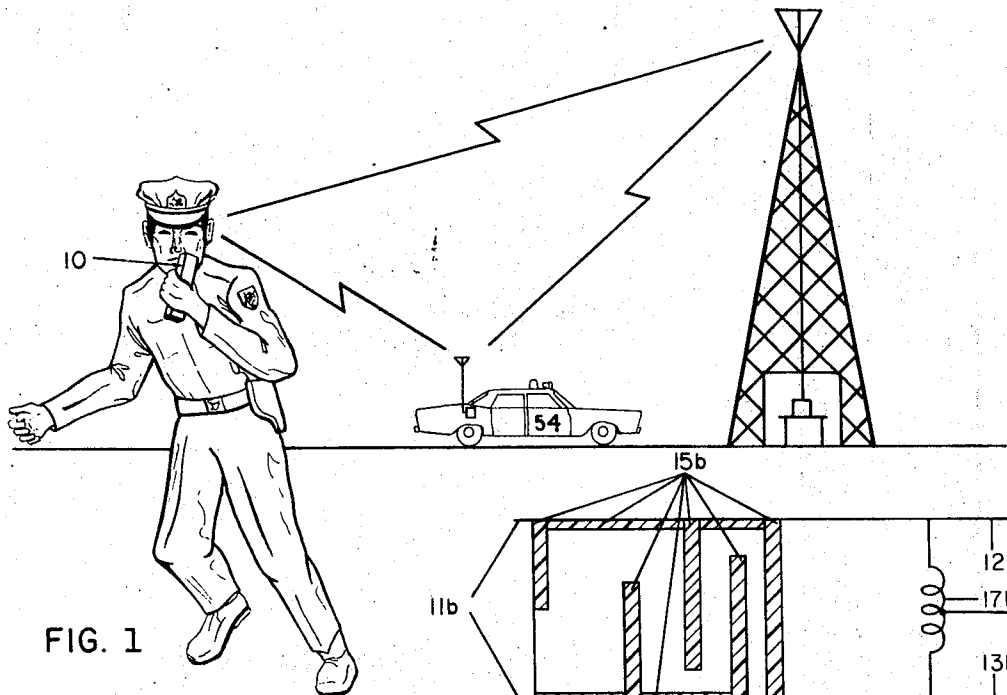
Jan. 12, 1971

W. E. BUEHRLE, JR., ET AL

3,555,422

ANTENNA AND ACOUSTIC HORN APPARATUS

Filed Feb. 20, 1969



1

2

3,555,422

ANTENNA AND ACOUSTIC HORN APPARATUS
 William E. Buehrle, Jr., Huntington Station, and Gerald
 F. Woodard, Centerport, N.Y., assignors, by mesne as-
 signments, to Hazeltine Corporation
 Filed Feb. 20, 1969, Ser. No. 800,980
 Int. Cl. H04b 1/38; H01q 1/00
 U.S. Cl. 325—16 12 Claims

ABSTRACT OF THE DISCLOSURE

Disclosed are antenna and acoustic horn apparatus usable in portable communications units, such as transceivers. One such apparatus includes a dielectric acoustic horn positioned within the volume of space between two parallel plates of an antenna. The acoustic horn, which together with the air in the volume comprises dielectric between the antenna plates, provides a path of varying acoustic impedance for matching the acoustic impedance of free space to the acoustic impedance of a transducer, also included in the apparatus, for more efficiently coupling an acoustic signal therebetween. An inductive tuning device is connected between the antenna plates to compensate for the capacitive effects of antenna dielectric. Other embodiments are also covered.

SUMMARY OF THE INVENTION

This invention relates to communications systems and more particularly to transmitting, receiving and transceiver units usable in such systems.

It is often desirable, especially with regard to portable communication units, that these units contain as little unused space as possible. However, even relatively compact units often contain antennas in which the antenna plates are separated from each other by a volume of space which is not utilized other than in providing the prescribed plate-spacing itself.

Objects of this invention are, therefore, to better utilize the volume of space between antenna elements; to utilize this volume in the efficient coupling of acoustic signals; and, further, to provide such coupling without appreciable degradation of the performance of the antenna.

In accordance with the present invention, there is provided an integral antenna and acoustic horn apparatus usable in a portable communications unit, comprising an antenna including two plates having a prescribed separation therebetween, the separation between the plates defining a volume of space and transducer means responsive to a supplied signal for converting the supplied signal into another predetermined type of signal. The apparatus further includes dielectric acoustic horn means positioned within the volume between the antenna plates and coupled to the transducer means for matching the acoustic impedance of free space to the acoustic impedance of the transducer means for more efficiently coupling an acoustic signal therebetween, the acoustic horn together with air in the volume comprising dielectric between the antenna plates so that the impedance matching is provided without any appreciable degradation of the antenna performance.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawings:

FIG. 1 is an overall perspective view of a communications system in which one form of antenna and acoustic horn apparatus, in accordance with the invention, is shown contained in a portable, hand-held transceiver unit usable for communicating with various fixed and mobile stations.

FIG. 2 depicts a partly sectionalized view of one form of antenna and acoustic horn apparatus also in accordance with the invention;

FIG. 3 depicts an isometric or perspective view of another form of antenna and acoustic horn apparatus in accordance with the invention;

FIG. 4 is a sectionalized top view of still another form of antenna and acoustic horn apparatus in accordance with the invention; and

FIG. 5 depicts yet another form of antenna and acoustic horn apparatus, also in accordance with the invention.

DESCRIPTION OF THE INVENTION

There is depicted in FIG. 1 a perspective view of an audio communications system having one type of antenna and acoustic horn apparatus 10 in accordance with the invention. In this particular embodiment apparatus 10 is shown contained in a portable, hand-held transceiver unit used for communicating with various fixed and mobile remote stations.

One form of apparatus 10 is shown in some detail in FIG. 2. Here, apparatus 10 includes antenna 11 of conventional construction and having substantially parallel first and second antenna plates 12 and 13, the separation between these plates defining a volume of space. Also included in apparatus 10 is transducer means, microphone 14, responsive to a supplied substantially acoustic signal such as one supplied from an acoustic horn means, acoustic horn 15, for converting the signal into a substantially nonacoustic signal such as an electrical signal which may then be coupled to circuitry (not shown) in the transceiver unit for transmission to the remote stations via antenna 11. Further included in the embodiment of FIG. 2 is a second transducer means, acoustic generator 16, responsive to a second supplied signal—this one being substantially nonacoustic such as an electrical signal coupled from circuitry (not shown) in the transceiver unit—for converting the second supplied signal to a substantially acoustic signal to be coupled to the acoustic horn 15.

Additionally included in apparatus 10 is dielectric acoustic horn means, depicted as previously mentioned acoustic horn 15, which may be of plastic or any other suitable dielectric material. Acoustic horn 15, which approximates an exponential acoustic horn although other types of horns such as logarithmic, and the like may be used where appropriate, is positioned and conventionally mounted within the volume of space between antenna plates 12 and 13. Acoustic horn 15 can be mounted to the walls of plates 12, 13 or in any other appropriate manner depending upon the desired size and configuration. The larger end of exponential acoustic horn 15 is shown open to the air, i.e., free space, and the other end is shown connected via tubing or any other convenient connecting means to both the input of microphone 14 and the output of acoustic generator 16. Acoustic horn 15 thus is for coupling an acoustic signal from free space to microphone 14, and for additionally coupling a second acoustic signal from acoustic generator 16 to free space.

Acoustic horn 15 thus provides a path of varying acoustic impedance for matching the acoustic impedance of free space to the acoustic impedance of microphone 14 and acoustic generator 16, respectively, for more efficiently coupling acoustic signals therebetween. This is desirable since the acoustic impedance of air is relatively low compared to the respective acoustic impedances provided by microphone 14 and acoustic generator 16 which ordinarily would provide a relatively inefficient coupling of signals therebetween.

More particularly, acoustic horn 15, responsive to an acoustic signal propagating in free space, provides a path of increasing impedance for coupling this acoustic signal to microphone 14 so that the impedance path provided by

acoustic horn 15 causes the acoustic signal so coupled to appear amplified. Microphone 14 then converts the acoustic signal supplied thereto by horn 15 to a substantially nonacoustic or electrical signal for use by circuitry in the transceiver. In the reverse direction, acoustic horn 15 also provides a path of decreasing impedance for coupling the second acoustic signal from acoustic generator 16 to free space with increased audibility. It is, of course assumed that both acoustic signals will not be coupled through acoustic horn 15 at the same time if any adverse interaction may thereby occur. Moreover, more than one such acoustic horn 15 may be included in an apparatus 10 where feasible.

FIG. 2 additionally depicts tuning means, inductance 17, connected between antenna plates 12 and 13 for tuning the antenna 11 to compensate for the capacitive effects of dielectric between antenna plates 12 and 13; acoustic horn 15 together with air in the volume of space between the plates comprising at least a portion of this dielectric. The magnitude of inductance 17 is usually selected as is known to those skilled in the art of antenna design, to provide together with the capacitive effect of the antenna dielectric, a resonant circuit at the frequency at which antenna 11 is to be utilized, thereby substantially canceling the capacitive effect of the dielectric between plates 12 and 13.

For convenience, apparatus 10 in this embodiment has been shown to include two types of transducer means, units 14 and 16, and acoustic horn 15 has been described as having two modes of operation. In one mode, as previously noted, acoustic horn 15 provides a path of increasing impedance and, in the other, a path of decreasing impedance. However, it should be realized and as will be shown by way of example in later described embodiments also in accordance with the invention, acoustic horn 15 may in some instances provide only one mode of operation and, likewise, apparatus 10 may include only one transducer means. Also, where appropriate, a single transducer may be utilized to perform both microphone 14 and acoustic generator 16 functions. It should be further noted that, if desired, the acoustic path for microphone 14 need not necessarily include the length of acoustic horn 15, but could be ported or coupled from microphone 14 directly into or near the horn 15 opening, thereby essentially providing a more direct path from microphone 14 to free space.

OPERATION OF THE APPARATUS OF FIG. 2

In order to facilitate describing the operation and since only one mode of operation is provided in some embodiments, each of the two modes of operation previously referred to will be described separately.

In what may conveniently be referred to as a first mode of operation, acoustic generator 16, responsive to a supplied electrical signal, converts the electrical signal to an acoustic signal. This acoustic signal is then supplied to the narrower end of acoustic horn 15 in any convenient manner such as via a short tube or like connecting device. The particular size and material of the connecting device being of course, dependant upon the precise location of acoustic generator 16 relative to the location of acoustic horn 15. The acoustic signal propagates through acoustic horn 15 and out the wider end of horn 15 to free space. Acoustic horn 15 thereby provides a path of decreasing impedance for more efficiently coupling this acoustic signal from acoustic generator 16, which has a relatively high acoustic impedance, to free space or air, which has a relatively low acoustic impedance. Thus, the acoustic signal is coupled to free space with increased audibility.

In the second mode of operation, the wider open end of acoustic horn 15 is responsive to an acoustic signal propagating in free space. This acoustic signal propagates through acoustic horn 15 and is coupled to microphone 14 through a connecting device such as previously de-

scribed with reference to acoustic generator 16. Acoustic horn 15 in this instance provides a path of increasing impedance for the acoustic signal so that the signal appears amplified upon reception at microphone 14. This latter mode of operation may be of particular value, for example, where the transceiver containing acoustic horn 15 is physically positioned at a location somewhat distant from where various conversations are likely to occur or when a person wishes to transmit via the transceiver but is required to whisper. The acoustic signal is converted to an electrical signal which may subsequently be coupled to appropriate transceiver circuitry (not shown) for transmission via antenna 11 to receiving units at other locations.

DESCRIPTION AND OPERATION OF THE EMBODIMENTS OF FIGS. 3, 4 and 5

FIGS. 3, 4 and 5 each depict, in accordance with the invention, another form of integral antenna and acoustic horn apparatus 10. These are shown, respectively, as apparatus 10a, apparatus 10b and apparatus 10c. Apparatus 10a, 10b and 10c are constructed and operate in a manner analogous to that described with reference to apparatus 10 of FIG. 2. Apparatus 10a includes elements 11a-14a, 16a and 17a which correspond to like elements 11-14, 16 and 17 of apparatus 10. However by way of example of some of the possible variations of apparatus 10, one transducer means, which would correspond to microphone 14 in FIG. 2, is not included in apparatus 10a. Thus, acoustic horn 15a is utilized in one operating mode for more efficiently coupling the acoustic signal from acoustic generator 16a to free space. Elements which correspond to microphone 14 are likewise not included in apparatus 10b and 10c so that acoustic horns 15b and 15c in these embodiments are likewise utilized in one operating mode, for more efficiently coupling respective acoustic signals from acoustic generators 16b and 16c to free space.

The embodiments of FIGS. 3, 4 and 5 each depict in accordance with the invention, different physical arrangements for acoustic horns 15a, 15b and 15c, respectively. These embodiments are constructed and will be described with regard to the aforementioned first mode of operation. However, this is for convenience only, and other modes such as the aforementioned second mode of operation or a combination thereof, are equally permissible with appropriate modification of the transducer means if necessary.

FIG. 3, for example, depicts acoustic horn 15a constructed of plastic or other dielectric material and in what may be referred to as a hollow conical shape, thereby approximating an exponential horn so that the signal coupled therefrom to free space appears amplified.

Embodied in apparatus 10b of FIG. 4 is a technique for increasing the apparent length of acoustic horn 15b while nevertheless having acoustic horn 15b positioned within a fixed volume of space between antenna plates 12b and 13b. Various other desired techniques for achieving the same result may be employed, as appropriate. In the illustration of FIG. 4, the acoustic signal supplied by acoustic generator 16b is coupled from acoustic generator 16b to free space by being channeled between sheets of dielectric material such as plastic, these sheets comprising the acoustic horn 15b. The acoustic signal is channeled into successive corridors or paths bordered by a pair of dielectric sheets. Each corridor represents an increasing volume of space so that an acoustic horn is approximated via incremental steps, until the acoustic signal reaches free space. The closeness of the approximation to an actual exponential or other desired horn type depends on various factors, of course, such as the number of sections used, the volume of space provided by each section and the like.

Apparatus 10c of FIG. 5 depicts still another arrangement for an acoustic horn, acoustic horn 15c, which em-

employs a different technique for increasing the apparent length of horn 15c. Pairs of solid plastic blocks, each pair being of the same or different length, but of successively decreasing volume, are mounted to the inside surfaces of antenna plates 12c and 13c so as to comprise a channel therebetween which provides successively increasing incremental volumes of space through which the acoustic signal is coupled to free space. Initially, the acoustic signal is coupled from acoustic generator 16c to the open end of the channel having the smallest volume of space. The signal then progresses or is coupled through the successively increasing incremental volumes until it reaches free space.

While there have been described what are at present considered to be the preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An integral antenna and acoustic horn apparatus usable in a portable communications unit, said apparatus comprising:

an antenna including two plates having a prescribed separation therebetween, the separation between said plates defining a volume of space;

transducer means responsive to a supplied signal for converting said supplied signal into another predetermined type of signal;

and dielectric acoustic horn means positioned within the volume between said antenna plates and coupled to said transducer means for matching the acoustic impedance of free space to the acoustic impedance of said transducer means for more efficiently coupling an acoustic signal therebetween, said acoustic horn together with air in said volume comprising dielectric between said antenna plates so that said impedance matching is provided without any appreciable degradation of the antenna performance.

2. An antenna and acoustic horn apparatus as described in claim 1, which further includes tuning means coupled between said antenna plates for use in tuning said antenna to compensate for the effects of dielectric between said plates.

3. An antenna and acoustic horn apparatus as described in claim 1, wherein the two antenna plates are substantially parallel to each other.

4. An antenna and acoustic horn apparatus as described in claim 1, wherein said transducer means converts a supplied substantially nonacoustic signal to a substantially acoustic signal to be supplied to said acoustic horn means and wherein said acoustic horn means provides a path of decreasing impedance for coupling said acoustic signal from said transducer means to free space with increased audibility.

5. An antenna and acoustic horn apparatus as described in claim 1, wherein said two antenna plates are substantially parallel to each other, said transducer means converts a supplied substantially nonacoustic signal to a substantially acoustic signal to be supplied to said acoustic horn means, said acoustic horn means provides a path of decreasing impedance for coupling said acoustic signal from said transducer means to free space with increased audibility, and wherein said apparatus further includes tuning means coupled between said antenna plates for use in tuning said antenna to compensate for the effect of dielectric between said plates.

6. An antenna and acoustic horn apparatus as described in claim 1, wherein said acoustic horn means, responsive to a substantially acoustic signal propagating in free space, provides a path of increasing impedance for coupling said acoustic signal to the transducer means so that the impedance path provided by said acoustic horn means causes the acoustic signal so coupled to appear amplified, and

wherein said transducer means converts said acoustic signal supplied from said horn means to a substantially non-acoustic signal.

7. An antenna and acoustic horn apparatus as described in claim 1, wherein said two antenna plates are substantially parallel to each other, said acoustic horn means, responsive to a substantially acoustic signal propagating in free space, provides a path of increasing impedance for coupling said acoustic signal to the transducer means so that the impedance path provided by said acoustic horn means causes the acoustic signal so coupled to appear amplified, said transducer means converts the acoustic signal supplied from said horn means to a substantially nonacoustic signal, and wherein said apparatus further includes tuning means coupled between said antenna plates for use in tuning said antenna to compensate for the effect of dielectric between said plates.

8. An antenna and acoustic horn apparatus as described in claim 7, wherein said apparatus further includes second transducer means responsive to a second supplied signal for converting said second supplied signal into a second acoustic signal which is supplied to said acoustic horn means, and wherein said acoustic horn means additionally provides a path of decreasing impedance for coupling said second acoustic signal from said second transducer means to free space with increased audibility.

9. An integral antenna and acoustic horn apparatus usable in a portable communications unit, said apparatus comprising:

an antenna including two substantially parallel plates having a prescribed separation therebetween, the separation between said plates defining a volume of space;

transducer means responsive to a supplied substantially nonacoustic signal for converting said nonacoustic signal into a substantially acoustic signal to be supplied to an acoustic horn;

dielectric acoustic horn means positioned within the volume between said antenna plates, for providing a path of decreasing impedance to match the acoustic impedance of free space to the impedance of said transducer means for more efficiently coupling the acoustic signal supplied from the transducer means to free space with increased audibility, said acoustic horn together with air in said volume comprising dielectric between said antenna plates so that said impedance matching is provided without any appreciable degradation of the antenna performance;

and tuning means coupled between said antenna plates for use in tuning said antenna to compensate for the effect of dielectric between said plates.

10. An antenna and acoustic horn apparatus as described in claim 9, wherein said tuning means provides inductance for compensating for the capacitive effect of dielectric between said plates.

11. An integral antenna and acoustic horn apparatus usable in a portable communications unit, said apparatus comprising:

an antenna including two substantially parallel plates having a prescribed separation therebetween, the separation between said plates defining a volume of space;

transducer means responsive to a substantially acoustic signal from an acoustic horn for converting said acoustic signal into a substantially nonacoustic signal;

dielectric acoustic horn means positioned within the volume between said antenna plates and coupled to said transducer means, for providing a path of increasing impedance to match the acoustic impedance of free space to the acoustic impedance of said transducer means for more efficiently coupling the acoustic signal from free space to the transducer means so that the acoustic signal thereby coupled appears am-

plified, said acoustic horn together with air in said volume comprising dielectric between said antenna plates so that said impedance matching is provided without any appreciable degradation of the antenna performance;

and tuning means coupled between said antenna plates for use in tuning said antenna to compensate for the effect of dielectric between said plates.

12. An antenna and acoustic horn apparatus as described in claim 11, wherein said tuning means provides inductance for compensating for the capacitive effect of dielectric between said plates.

References Cited

UNITED STATES PATENTS

2,539,477 1/1951 Rines 325—16
5 2,749,436 6/1956 Rines et al. 325—8(UX)

ROBERT L. GRIFFIN, Primary Examiner

JAMES A. BRODSKY, Assistant Examiner

U.S. Cl. X.R.

325—24, 130, 372; 343—720