

[54] **PORTABLE RADIO WITH INTEGRAL ACOUSTICAL HORN**

[75] Inventors: **Todd G. Andersen**, Lombard;
Donald Y. Ing, Chicago, both of Ill.

[73] Assignee: **Motorola, Inc.**, Franklin Park, Ill.

[22] Filed: **Jan. 10, 1972**

[21] Appl. No.: **216,674**

[52] U.S. Cl. **325/353**, 181/27 R, 325/361

[51] Int. Cl. **H04b 1/08**

[58] Field of Search 325/352, 353, 355,
325/356, 361, 16; 179/1 E; 181/27 A, 27 C,
27 D

[56] **References Cited**
UNITED STATES PATENTS

1,532,811	4/1925	Graham	181/27 D
3,693,089	9/1972	Hutchinson et al.	325/355

3,249,873 5/1966 Whittemore et al. 325/361

Primary Examiner—Robert L. Griffin

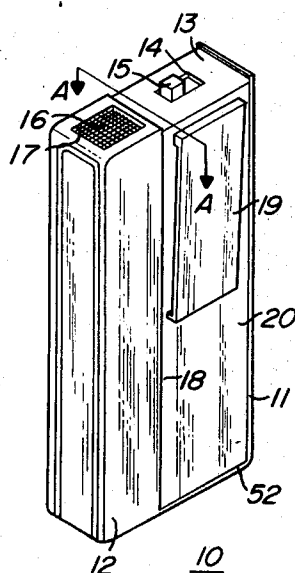
Assistant Examiner—William S. Moore

Attorney—Vincent J. Rauner, Marshall N. Dickler et al.

[57] **ABSTRACT**

A portable radio receiver having a rectangular elongated housing with a first rectangular elongated compartment, and a second rectangular elongated compartment adjacent the first compartment. An interior partition wall separates the two compartments. The second compartment has a passage therein which forms an acoustical horn. A removable radio receiver chassis including a transducer device is seated in the first compartment. An acoustical chamber secured in the first compartment couples the transducer to the acoustical horn which amplifies and emits the sound waves.

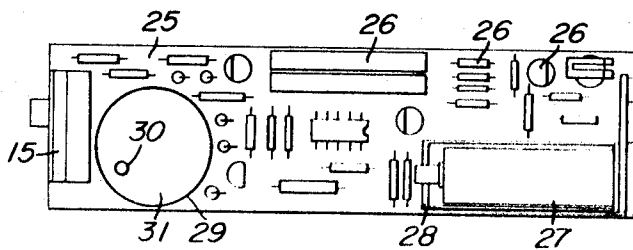
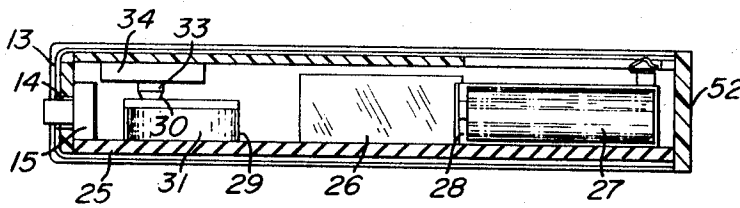
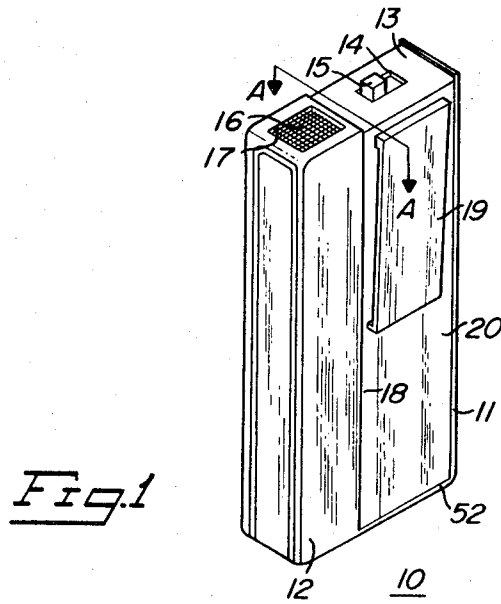
6 Claims, 10 Drawing Figures

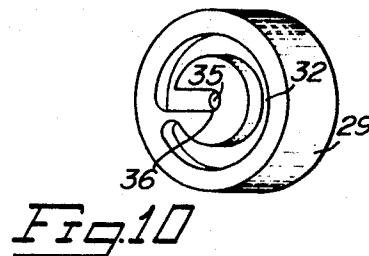
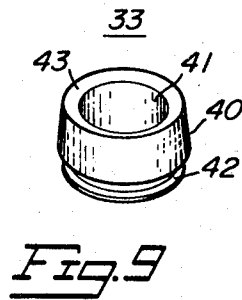
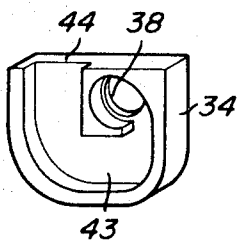
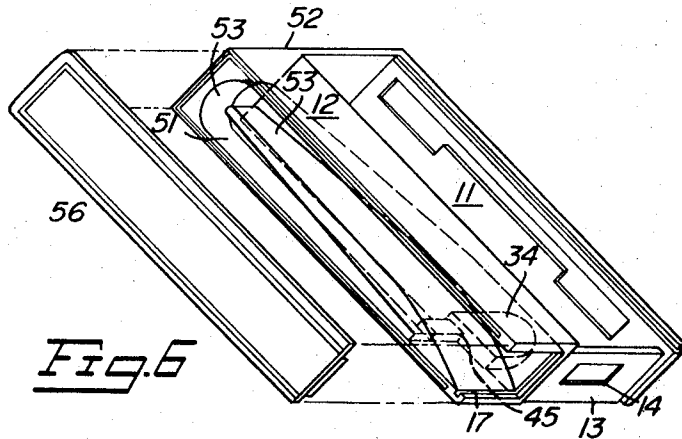
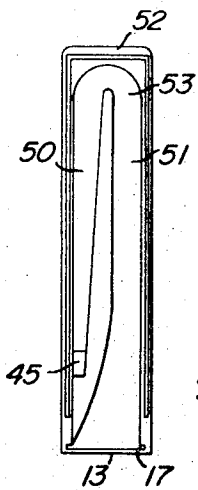
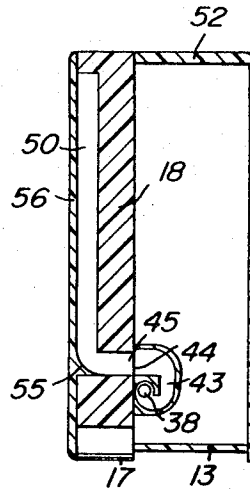
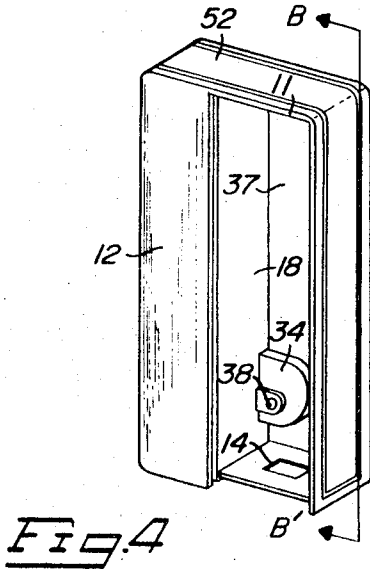


PATENTED JUL 24 1973

3,748,583

SHEET 1 OF 2





PORTABLE RADIO WITH INTEGRAL ACOUSTICAL HORN

BACKGROUND

In a small, portable radio apparatus such as a receiver or pager, to be carried by a user, speakers have been used to convert the received, demodulated signals to audio signals. Although such speakers have been used effectively for a number of years, they suffer from a number of disadvantages. A speaker does not have a flexible physical form factor. It is normally restricted to a circular or oval configuration, for speakers which are designed to reproduce speech. Because of this inflexible form factor, radio receivers must be designed around the speaker, resulting in a bulky package for the apparatus. The speaker in such an apparatus may account for as much as one-third of the total volume.

Speakers are also low efficiency devices. A relatively large battery and substantial circuitry must be used in order to produce a signal having the amplitude to produce a usable sound level from a speaker. This further increases the size of the radio apparatus. Furthermore, the speaker's location in an apparatus worn by a user, causes the sound to be directed away, rather than towards the user's ear making it difficult to hear a received message, and resulting in a less efficient use of the available power.

Transducers and acoustical horns have been used with portable radio apparatus such as pagers or receivers. The acoustical horn in such units is an exponential horn, and is made large in order to develop the necessary sound levels. The horn and transducer constitute a single assembly with the transducer coupled directly to the horn. Because of the integral transducer, and the size and configuration of the exponential horn, the assembly is quite large. The assembly because of its size must be added as a separate unit to the sidewall of the radio apparatus. This makes the entire radio apparatus package large and bulky, and difficult to carry in a user's pocket or on his belt. The size of the horn and its resulting form factor also prevent the sound from being directed towards the user's ear when worn in the pocket or on the belt.

With the transducer and horn mounted external to the radio apparatus the entire radio chassis, including the transducer, cannot be easily removed and tested as a complete radio package. It is desirable for the entire radio chassis, including the transducer, to be easily removable and independently operable so as to facilitate testing and assembly of the unit, and to allow the radio to be used in a number of housings having various configurations. If the transducer is to be included as a part of the radio chassis rather than as a part of the housing or horn assembly, means must be provided for releasably coupling the transducer to the acoustical horn without reducing the efficiency of the horn or affecting the characteristics of the reproduced audio signals.

SUMMARY

It is an object of this invention to provide an improved portable radio apparatus including a housing having an integral acoustical horn.

Another object of this invention is to provide an improved portable radio apparatus including a transducer device, which is easily detachable from the housing and acoustical horn.

Yet another object of this invention is to provide an improved portable radio apparatus having a self-contained radio receiver chassis which is operable when removed from the housing.

Still another object of this invention is to provide a portable radio apparatus having a miniaturized high efficiency acoustical horn.

A still further object of this invention is to provide a portable radio apparatus having a housing including means for coupling a removable transducer to an integral acoustical horn.

In practicing this invention, a portable radio receiver is provided having an elongated rectangular housing with a first rectangular elongated compartment and a second rectangular elongated compartment adjacent the first compartment. An interior partition wall having an aperture therethrough separates the two compartments. The second compartment has a passage therein which forms a hyperbolic acoustical horn, with the mouth of the horn at the top of the unit so as to direct sound towards the user. A removable radio receiver chassis, including a transducer device, is seated in the first compartment. An acoustical chamber secured in the first compartment has a first aperture for allowing entry of the sound waves from the transducer, and a second aperture coupled to the aperture in the interior partition wall for allowing exit of the sound waves into the acoustical horn. A coupling device mounted to the walls of the first aperture in the acoustical chamber, releasably couples the transducer to the chamber. The hyperbolic acoustical horn has a primary resonant frequency at approximately 2,000 cycles, and an acoustical reflection resonant frequency at approximately 700 cycles. These two resonances enhance the audio reproduction capabilities of the hyperbolic acoustical horn thus increasing its efficiency and allowing a reduction in size of the acoustical horn.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a portable radio pager in accordance with this invention;

FIG. 2 is a section view of the pager of FIG. 1 along the section lines AA', showing the circuit board and components of the removable radio receiver mounted in the pager housing;

FIG. 3 is a view of the portable radio receiver chassis, including the transducer adapted to be mounted in the pager housing shown in FIG. 1;

FIG. 4 is a perspective view of the housing shown in FIG. 1 with the U-shaped front and rear cover and removable radio receiver chassis removed;

FIG. 5 is a cross-sectional view of the housing in FIG. 4 along the section lines 5-5;

FIG. 6 is a perspective exploded view of the pager housing with the rear cover and the portable radio receiver chassis removed and one side wall exploded to expose the acoustical horn;

FIG. 7 is a side view of the housing of FIG. 6 with the side wall removed to expose the acoustical horn;

FIG. 8 is a perspective view of the acoustical chamber located in the housing of FIG. 4;

FIG. 9 is a perspective view of the coupling device in the housing of FIG. 4; and

FIG. 10 is a perspective view of the transducer device shown in FIG. 3 with its cover removed.

DETAILED DESCRIPTION

The radio apparatus of the invention is shown in FIG. 1 and is illustrated as a radio pager, it being understood that other devices, such as transceivers may employ the features of this invention. A rectangular elongated housing 10 includes a first rectangular elongated compartment 11 and a second rectangular elongated compartment 12 adjacent the first compartment 11. Compartment 11 contains a self-contained removable radio receiver chassis, and compartment 12 contains a hyperbolic acoustical horn. Compartments 11 and 12 are separated by an interior partition wall 18, shown in FIG. 4. Top wall 13 has an aperture 14 therein through which extends switch 15 on the radio receiver. A second aperture 17 in top wall 13 is the output opening for the hyperbolic acoustical horn. A grill cloth 16 covers aperture 17, preventing dirt or foreign matter from entering the acoustical horn. Clip 19, secured to back wall 20 of compartment 11 in housing 10, allows the radio pager to be secured in a user's shirt pocket or on the user's belt.

Referring to FIGS. 2 and 3 the portable radio receiver chassis for the pager is shown. Printed circuit board 25 seats in the first compartment 11 of housing 10. Switch 15 is mounted thereon and extends through aperture 15 in top wall 13. A number of components 26 representative of the entire radio circuitry for the radio receiver chassis are shown on printed circuit board 25. A battery 27 is secured in battery holder 28 on printed circuit board 25, and provides the power necessary for operating the radio receiver. Transducer device 29 is also secured to printed circuit board 25, and converts the received demodulated signals to audio signals, thus providing an entirely self-contained portable radio receiver.

Referring to FIG. 10 there is shown transducer device 29 with housing cover 31 removed. The transducer 35 is located beneath the structure shown and directly below aperture 36. Sound waves developed by transducer 35 are coupled through the spiral passage shown at 32 and emitted at aperture 30. The audio signals are emitted from output aperture 30 in transducer housing cover 31 as sound waves. These sound waves are coupled via a coupling device 33, (shown in position in FIGS. 2 and 9) to an acoustical chamber 34 secured to an inner wall of housing 10.

Referring to FIG. 4, the acoustical chamber 34 is more clearly shown. Chamber 34 is secured, adjacent top wall 13, to rear wall 37 in compartment 11 and to interior partition wall 18, which separates compartments 11 and 12. The acoustical chamber 34 has a first aperture 38 in the top surface thereof. Coupling device 33 is seated in aperture 38, and held in place by the aperture side walls. Coupling device 33 is a resilient cylindrical member, which has an outer wall 40, and an aperture 41, axially extending through the cylinder. Circumferential groove 42 is cut in outer wall 40 of coupling device 33, adjacent end 43. The side walls of aperture 38 on acoustical chamber 34 are inserted into groove 42 for securing coupling device 33 to chamber 34. Coupling device 33 may be manufactured from rubber or a synthetic equivalent of rubber.

Referring again to FIG. 2, output aperture 30 of transducer device 29 is positioned adjacent aperture 41 in coupling device 33. When circuit board 25 is inserted into compartment 11, coupling device 33 is

compressed, with end 43 bearing against transducer housing cover 31 and surrounding output aperture 30. Coupling device 33 acts to couple the sound waves from output aperture 30 of transducer device 29 to acoustical chamber 34. Because coupling device 33 only resiliently bears against transducer housing 31, the portable radio receiver may be removed and reinserted in housing 10, and when reinserted will make a good acoustical connection with acoustical chamber 34. This allows printed circuit board 25, and the entire self-contained radio receiver mounted thereon, to be removed, tested and easily reinserted; or to be inserted in a number of housings having different types of acoustical horns.

Referring to FIG. 8, sound waves developed by transducer device 29 are coupled through coupling device 33 to aperture 38 in acoustical horn 34. A spiral conduit 43 conducts the sound waves to a second or output aperture 44 of transducer device 29. Referring to FIGS. 6 and 7 the sound waves are coupled from output aperture 44 in acoustical chamber 34 through aperture 45 in inner partition wall 18, to the hyperbolic acoustical horn located in compartment 12. Acoustical chamber 34 acts to match the output characteristics of transducer device 29 to the acoustical horn and couple the sound waves from transducer device 29 to the acoustical horn, while providing an isolation between the compartments.

Referring to FIGS. 5, 6 and 7, the hyperbolic acoustical horn located in compartment 12 consists of a first portion 50 extending downwardly from a position adjacent top wall 13, a second portion 51 extending upwardly from bottom wall 52 to top wall 13, and a curved portion 53 connecting the first portion 50 and the second portion 51. As can be seen by reference to FIGS. 5, 6 and 7 the area of the cross-section of the horn expands hyperbolically along its axis starting at aperture 45. Sound waves entering aperture 45 strike a curved section 55 of side wall 56 and curve around into first portion 50. The sound waves are amplified in portions 50, 51 and 53 and are emitted at aperture 17 in top wall 13. The hyperbolic horn in compartment 12 of the preferred embodiment is approximately nine inches long. A nine inch long hyperbolic horn has an acoustical primary resonance at approximately 2,000 cycles and an acoustical reflection resonant frequency response at approximately 700 cycles. These resonances produce an enhancement of the sound waves in the audio, and particularly in the speech frequency range so that the sound level emitted from aperture 17 is substantially greater than normally associated with horns having such small physical dimensions. Because aperture 17 of the horn is located in top wall 13, the audio signals are directed towards, rather than away from the user.

As can be seen, an improved portable radio apparatus has been provided including a housing having an integral acoustical horn. The portable radio receiver chassis is self-contained and operable when removed from the housing. Removal from and insertion into the housing can be easily accomplished without the necessity for special mechanical interconnecting devices between the acoustical horn and receiver because of the use of a resilient acoustical coupling device. The acoustical horn because of its length, its hyperbolic characteristic and resonance produces a greater sound level than normally associated with such small physical di-

mensions. An acoustical chamber is used to match the transducer device output to the acoustical horn while providing isolation between the compartments.

We claim:

1. In a portable radio receiver adapted to be carried 5
by a user, the combination including; a rectangular elongated housing having a first rectangular elongated compartment formed therein, a second rectangular elongated compartment formed therein adjacent said first compartment, and an interior partition wall 10
formed between and separating said first and second compartments, said second compartment having a passage therein forming an acoustical horn, an acoustical chamber formed in said first compartment having a first aperture for allowing entry of sound waves, an expanding spiral conduit formed therein for allowing 15
transmission of said sound waves, and the second aperture for allowing exit of said sound waves, said interior partition wall having an aperture therethrough for coupling said sound waves from said acoustical chamber second aperture to said second compartment acoustical horn, compressible coupling means mounted to the walls of said second aperture in said acoustical chamber, removable radio receiving means forming a complete self-contained operable radio and including transducer means for converting electrical waves to said 20
sound waves and having an output opening for said sound waves, said radio receiving means being seated in said first compartment, said coupling means being compressed by said transducer means between said transducer means output opening and said acoustical chamber for coupling said sound waves to said acoustical chamber, said radio receiving means and transducer means being completely physically separable from said coupling means for allowing removal and independent 25
operation of said radio receiving means.

2. The portable radio receiver of claim 1 wherein said housing further includes top, bottom and side walls, said interior partition wall extending from said top wall to said bottom wall, said transducer means being positioned adjacent said top wall and said interior partition wall, said passage in said second compartment having 30
a first portion extending in a direction away from said top wall towards said bottom wall for coupling said sound waves in said direction, a second portion extending in a direction away from said bottom wall to said top wall for coupling said sound waves in said direction, a third curved portion coupling said first and second portions for coupling said sound waves from said first portion to said second portion, and an aperture in said top wall for allowing emission of said sound waves from said second portion, said first, second and third portions being so designed that their cross sectional area expands approximately hyperbolically and terminates at said aperture in said top wall.

3. The portable radio receiver of claim 2 wherein said acoustical horn has a primary resonant frequency response at approximately 2,000 cycles, and an acoustical reflection resonant frequency response at approximately 700 cycles.

4. The portable radio receiver of claim 3 wherein said transducer means includes an electroacoustic transducer for converting electrical waves to sound waves, and a housing for mounting said transducer therein, said housing having a spiral passage therein coupling said transducer to said transducer means output opening and being operative to drive said acoustical chamber.

5. The portable radio receiver of claim 4 wherein said coupling means includes, a resilient cylindrical member having an outer wall, an aperture axially extending therethrough, and a circumferential groove cut in the outer wall adjacent one end of said cylinder, said walls of said first aperture in said acoustical chamber being inserted in said groove for securing said coupling means thereto, and said transducer means output opening being adjacent the other end of said cylinder, said transducer sound waves being coupled from said transducer means output opening through said coupling means aperture to said acoustical chamber.

6. The portable radio receiver of claim 5 wherein said coupling means is made of rubber.

* * * * *

45

50

55

60

65