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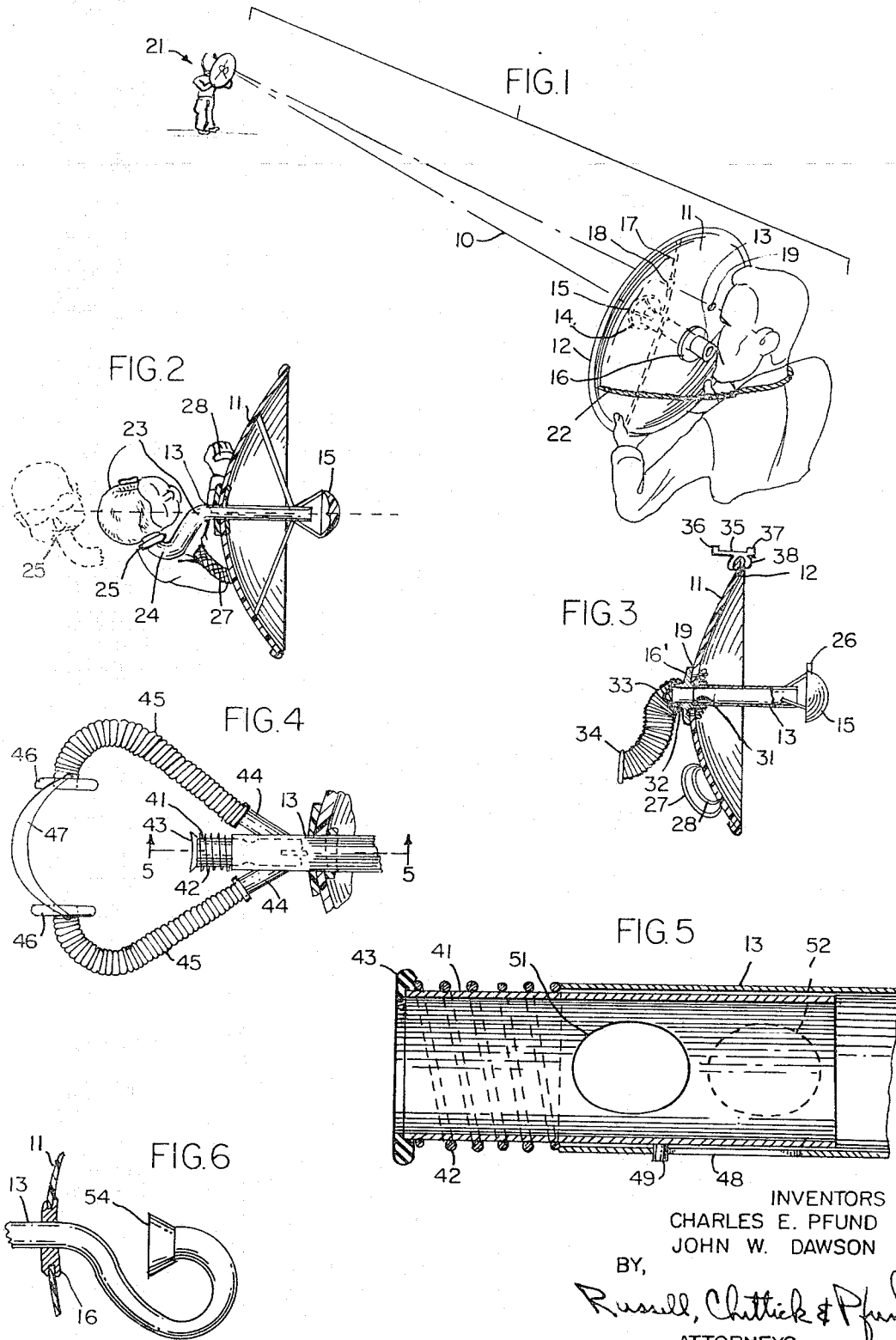
C. E. PFUND ETAL

3,305,043

ACOUSTIC COMMUNICATION DEVICE AND TOY

Filed March 8, 1965

2 Sheets-Sheet 1



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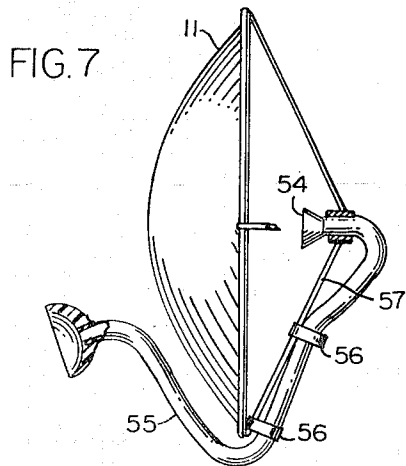
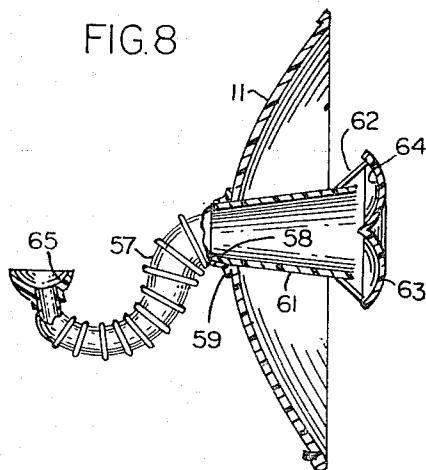
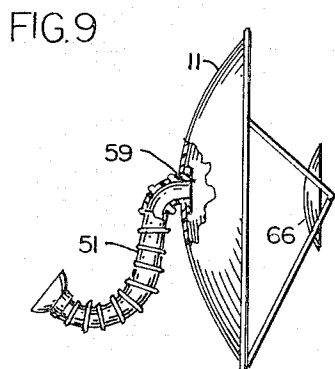
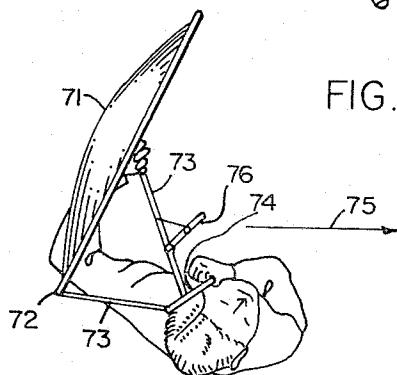
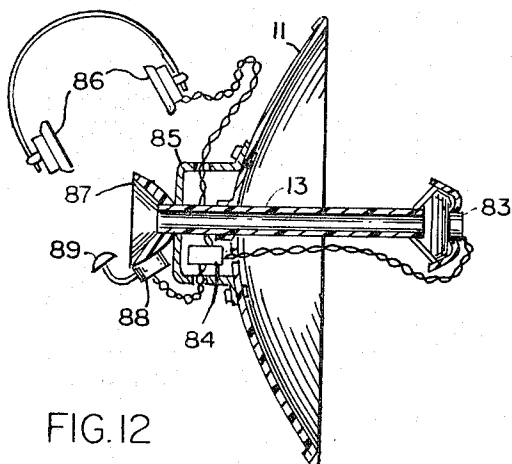
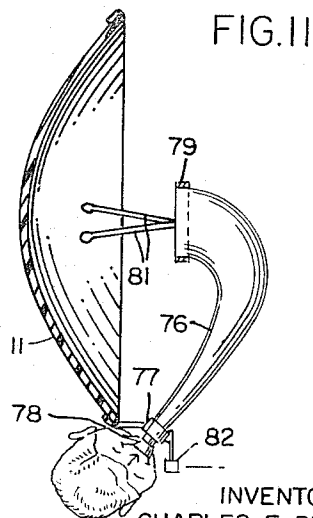
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ACOUSTIC COMMUNICATION DEVICE AND TOY

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2 Sheets-Sheet 2



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3,305,043

ACOUSTIC COMMUNICATION DEVICE AND TOY
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7 Claims. (Cl. 181-27)

This invention relates generally to short-range communication devices and, more particularly, to an acoustic hand-held portable device for two-way communication. The device of this invention is particularly adapted to be carried by an individual and used both for transmission and reception while orienting the directive axis of the device toward a remote person who is equipped with a similar device thereby utilizing the directive gain of both devices for communication over substantial distances. By virtue of the simplicity and reliability of the device, it can be employed in a variety of applications and, in view of its economical construction, makes a novel toy for outdoor use.

Portable acoustic megaphones have been provided in the past for communication such as shown in the patent to Cunningham, 2,496,988, but such devices are limited in their gain and directivity and suffer from the unusually long aspect ratio of the device and difficulty in sighting for any given aperture of the exponential radiating horn. Parabolic acoustic signaling devices have also been provided in the prior art, such as shown in the patent to Maurer et al., No. 1,649,538, and while the paraboloids there employed are capable of significant gain, they do not provide a hand-held device which is capable of being optically oriented on a remote like-equipped station while being used for both transmission and reception.

It is, accordingly, the principal object of the present invention to provide a simple, compact, sturdy and light weight paraboloid acoustic communication device which is capable of being used for both transmitting and receiving and oriented by the user accurately toward a remote station during either the transmission or reception operation. These objects are achieved by a variety of constructions which utilize the acoustic gain of a parabolic reflector with the additional structure necessary for both acoustic transmission and reception being provided in a simple construction which is rugged and readily assembled from simple parts. The device in accordance with the invention provides a completely portable station which can be used for transmission and reception while aligning the acoustic directional axis of the paraboloid toward a remote station.

The features and objects of the invention will be understood from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a view in perspective of a local and remote station each consisting of an individual equipped with a device in accordance with the invention;

FIG. 2 is a top plan view partly in section showing one form of device suitable for both transmission and reception while sighting along the axis of the directivity pattern of the paraboloid;

FIG. 3 is a modified form of the invention employing a flexible acoustic conduit and an alternate form of optical sighting device;

FIG. 4 is a fragmentary view of a further alternate embodiment employing separate mouthpiece and earpiece devices with a novel switching element for changing from transmission mode to reception mode;

FIG. 5 is a sectional view taken along the line 5-5 of FIG. 4;

FIG. 6 is a fragmentary view of an alternate feed horn arrangement for paraboloid;

FIG. 7 is a plan view of a paraboloid with an acoustic tube terminating in a flared horn for energizing the paraboloid;

FIG. 8 is a similar view partly in section of another alternative employing an exponentially tapered acoustic conduit terminated in a folded horn structure for energizing the paraboloid;

FIG. 9 is a view of another alternative employing an acoustic conduit and a convex reflector for illuminating the paraboloid;

FIG. 10 is a top plan view of a modification employing a segment of a paraboloid having the paraboloidal surface offset with respect to the vertex of the paraboloid and requiring no acoustic feed conduit;

FIG. 11 is a top plan view of a paraboloid with a curved exponential horn feed adapted for transmission and reception with the operator standing at the edge of the dish instead of on the convex side thereof; and

FIG. 12 shows a modification employing electronic amplification for the reception mode.

Referring now to FIG. 1, the device of the invention in accordance with its simplest embodiment is seen to comprise a paraboloid 11 constructed of any suitable material, such as metal or plastic, and preferably reinforced by a curved rim 12 and provided with an axial speaking tube 13 which extends from the convex side of the paraboloid to a point on the concave side of the paraboloid just short of the mathematical focus thereof. The distal end of the tube 13 has affixed thereto by means of struts 14 an annular inverting bend in the form of a bowl 15 which acts to invert the direction of sound passing to and from the tube 13 thereby energizing the entire concave surface of the paraboloid 11. The effective acoustic continuity of the voice channel even where physical discontinuity is necessary in order to reverse the direction of the sound propagation is important in devices such as herein disclosed where the physical size of the elements is generally not large in comparison to the wavelengths involved. In particular, the optical analogy is not precise for defining the effect of secondary reflectors at the focus of the paraboloid. This is illustrated by the fact that in the acoustic device useful (although diminished) gain is achieved even with the bowl 15 not present whereas the presence of a secondary reflector in an optical device is essential.

The tube 13 is preferably of substantial inner diameter, of the order of one inch or more, and is mounted at the vertex of the paraboloid 11 by means of a reinforcing collar 16 of any suitable construction. On the concave side three radial supporting struts 17 may be employed to give the tube 13 structural rigidity in alignment with the acoustic directive axis 10 of the paraboloid 11. On one of the struts 17 a bead 18 may be secured positioned for alignment with a small hole 19 in the surface of the paraboloid 11 thereby providing an optical sight which is parallel with the direction of the axis of the paraboloid 11.

The entire structure as thus described may be readily held and used as indicated for both transmission by speaking into the open end of the tube 13 or by turning the head to position the ear at the open end of the tube 13 for listening. In the listening mode the directivity can be maintained at the aligned position established during transmission and the detection of incoming sound can be maximized due to the directive pattern of the paraboloid to maintain the alignment by means of the sensitivity of the ear in hearing the decrease in sound amplitude that occurs when the device is off alignment as little as five (5°) degrees from a remote station 21 which is transmitting to the local receiver. If desired, a neck strap

22 may be secured to opposite points on the rim 12 for partially supporting the weight of the device.

The modified form shown in FIG. 2 is adapted for more convenient sighting while both talking and listening by extending the axial tube 13 through a forty-five (45°) degree bend 23 and a ninety (90°) degree bend 24 to terminate in an open end 25 offset with respect to the projected axis of paraboloid 11. As indicated in FIG. 2, the device can be used for listening while sighting with the right eye of the operator through an aperture such as the hole 19 and a blade sight 26 located on the reflector bowl 15 at the end of the tube 13 (FIG. 3). The alternate speaking position is indicated in FIG. 2 with the head of the operator rotated through ninety (90°) degrees to engage the open end 25 in front of his mouth while using his left eye to sight through the optical sighting arrangement as described for listening. An alternate form for supporting the device is shown in FIG. 2 comprising an arm strap 27 and a hand strap 28 secured to the lower convex portion of the paraboloid 11 and engaging the forearm and hand of the operator respectively.

In the modification shown in FIG. 3 the tube 13 is mounted in a specially constructed hub member 16' which has an internal shoulder 31 and a diameter forwardly of the shoulder 31 which provides a snug fit for the outer diameter of the tube 13 thereby making the tube 13 self-supporting in the bore of the hub 16'. The hub 16' has an extension 32 on the convex side of the paraboloid 11 which provides a snug fit for a flexible hose 33, the free end of which may be fitted with a plastic or rubber ring 34, if desired. The flexible hose 33 is preferably a large diameter (greater than one inch inside diameter) tubing formed by a metal or stiff plastic wire wound in the form of a helix and coated on the outside with a flexible skin and preferably of a construction having a relatively smooth inner bore. Flexible tubing of the type ordinarily employed in the hoses for vacuum cleaners and hair dryers has been found to be suitable for this purpose. The device of FIG. 3 is fitted with arm and hand straps 27 and 28 as shown in FIG. 2 and employs a clamp-on type of optical sighting device 35. The optical sight 35 comprises a notch 36 at the rear and a blade 37 at the fore-end and is used like a conventional open sight. The sight 35 is mounted on the rim 12 by means of a spring clamp 37 of any suitable construction.

The device of FIG. 3 is especially suited for being shipped in three pieces comprising the tube 13 with the bowl 15 mounted thereon, the paraboloid 11 with the hub 16' mounted thereon, and the flexible hose 33. These three pieces can be readily assembled by simply inserting the tube 13 in the bore of the hub 16' until the end of the tube seats against the shoulder 31 and then fitting the flexible hose 33 over the projection 32 on hub 16'. The entire assembly, when so constructed, is self-supporting and can be readily assembly and disassembled for use and storage respectively.

In the device shown in FIG. 4 the tube 13 has its open end fitted with a sliding extension 41 which is urged by spring 42 to an extended position. The tube 41 may be fitted at its open end with a rubber or plastic smooth ring 43 to form a mouthpiece. The tube 13 supports opposed projecting tubes 44 which are fitted to flexible hose extensions 45 that terminate in earpieces 46. The earpieces 46 may be connected by a resilient band 47 in the manner of a radio head set. The inner diameter of the tubes 44, the flexible hoses 45, and the earpieces 46 are continuous without discontinuities and of relatively large diameter for transmission of acoustic energy without significant attenuation.

The details of the transmit-receive switching arrangement of FIG. 4 are shown in the sectional view of FIG. 5 wherein the limits of motion for the sliding tube 41 are determined by the arrangement of a slot 48 in the tube 13 and a projection 49 from the tube 41 through the slot 48. As previously stated, the spring 42 urges the tube

41 to an extended position as shown in FIG. 5. In this position an opposed pair of holes 51 in the tube 41 are covered by the wall of the tube 13 and are ineffective to alter the transmission characteristics of the tube 41 and 13 when the spoken voice is applied at the open end of the tube 41. Two opposed holes 52 in the wall of the tube 13 which provide the communication between the extension tubes 44 and the interior of the tube 13 are similarly covered by the wall of the tube 41 in the position shown in FIG. 5. Thus in this position, all of the acoustic energy applied at the open end of the tube 41 travels through the tube 41 and then through the tube 13 to the remote end where the reflecting bowl 15 reverses the sound waves to illuminate the surface of the paraboloid 11 for transmission. During reception the mouth and surrounding lip area of the user are placed against the mouthpiece ring 43 effectively sealing off the open end of the tube 41. Slight pressure is applied by the user to compress the spring 42 and move the tube 41 inwardly to a position where the holes 51 in the tube 41 register with the holes 52 in the tube 13. In this position sound energy received by the paraboloid traveling in the tube 13 is effectively stopped by the seal effected by the mouth of the user on the ring 43 but is free of travel through the registered holes 51 and 52 into the branch conduits 44 and thence through the flexible conduits 45 to the earpiece openings 46 for reception of the sound signal.

FIG. 6 shows another form of feed in which the acoustic conduit 13 is formed through an offset bend on the concave side of the paraboloid 11 and terminates in a flared horn 54 for translating acoustic energy with the paraboloid for both transmission and reception.

A somewhat similar arrangement is shown in FIG. 7 except that instead of an axial rigid tube 13 a flexible tube 55 is employed and supported by lashings 56 to a strut member 57 to maintain flared horn 54 at the effective focus of the paraboloid 11.

FIG. 8 is a schematic representation of a modification in which the flexible tube on the convex side of paraboloid 11 is in the form of an exponentially tapered hose 57. The large end of the hose 57 fits onto a projection 58 from the hub 59. On the concave side of the paraboloid 11 the hub 59 provides a continuation of the exponential flare through a projection 61 the end of which supports by means of struts 62 a folded horn structure 63. By suitably proportioning the spacing of the folded horn 63 from the end of the flared projection 61 and controlling the shape of the interior contour of the folded horn 64, a substantially continuous extension of the exponential taper which starts in the flexible tube 57 can be effected so that the paraboloidal surface is energized without acoustic discontinuity in the transmission and reception path. The open end of the tube 57 can be fitted with a suitable cup shaped ring 65 which is alternately usable as a mouthpiece or earpiece for transmission or reception respectively as shown in FIG. 3. In FIG. 8 the exponential tape for the flexible hose 57 can be constructed by forming the stiff wire helix on a tapered mandrel and applying the plastic flexible skin to the self-supporting tapered helix.

FIG. 9 shows a modification in which the speaking tube 57 terminates at the hub 59 and thus launches the transmitted sound waves in the direction of the axis of paraboloid 11. A convex reflector 66 (analogous to an optical cassagranian) having a surface contour of a hyperboloid is located nearer the apex of paraboloid 11 than the focus thereof in order to reflect incident sound waves in a manner uniformly to energize the parabolic surface of paraboloid 11. The actual construction of a device of this type is generally analogous to the equivalent optical apparatus and the precise surface 66 and the location thereof with respect to the focus of the paraboloid can be determined in accordance

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with the usual practice in optics. Since, as in all of the devices of the invention, reciprocity exists, the reception of sound waves by the paraboloid 11 effectively concentrates the energy at the open end of the speaking tube 51 located at the aperture of the paraboloid 11 by the action of the reflector 66.

The device shown in FIG. 10 requires no speaking tube since the mouth and the ear of the user are located at the focus of the parabolic section 71. The section 71 is a portion of a paraboloid having a vertex at 72 and is obtained by slicing an ordinary symmetrical paraboloid with a vertical plane that passes through the vertex 72 at an angle other than ninety (90°) degrees to the axis of the paraboloid. The resulting section 71, if viewed along the directive axis thereof, would appear as a circle, but if viewed normal to the plane of intersection with the paraboloid from which it was cut would appear as an ellipsoid. Such elliptical parabolic sections are well known in the radio antenna art.

For the purpose of locating the mouth and ear of the user at the focus of such a parabolic section, a set of struts 73 is mounted at the rim of the section 71 and extends to support a ring member 74. The center of the ring 74 is the focus of the parabolic section 71 and, as indicated, by placing the side of the head against the ring 74 the ear of the user is located substantially at the focus of the section 71. As indicated, the user can, by a right side orientation of his eyes, look in a direction that is substantially parallel to directive axis 75 of the section 71. For transmission the head is turned counterclockwise in the view shown in FIG. 10 to position the mouth inside the ring 74 in which position the normal speech by the user will be transmitted from the focus which is at the center of the ring 74 and thus will be reflected by the parabolic section 71 along the directive axis 75 thereof. As an aid in sighting the device during transmission, a plain mirror 76 may be mounted on the strut 73 in a position and angle to permit the normal eye position of the user in transmitting position to see by reflection in the mirror surface 76 along the directive axis 75. As indicated, the entire device can be supported on the arm of the user and steadied by grasping the ring 74 with the other hand.

An improved version of the device shown in FIG. 7 is shown in FIG. 11 wherein the acoustic conduit has been formed as a rigid hollow exponentially flared tube 76 which has a substantially 45 degree bend therein. The tube 76 has a small end 77 which serves as a mouthpiece and earpiece located and rigidly secured to a rim 78 of the paraboloid 11. The opposite end of the tube 76 has a large opening 79 which is located at the effective focus of the paraboloid 11 and securely supported from the surface or rim of the paraboloid 11 by means of struts 81. The area of the end 79 is approximately an order of magnitude larger than the end 77. As indicated in FIG. 11, the device can be used for transmitting sound waves by speaking into the small end 77 of the tube 76 while sighting the remote station with a right eye viewing either directly or through a suitable sighting loop 82 mounted on tube 76. For reception, the head of the user is rotated clockwise through ninety (90°) degrees to place the ear at the small end 77 and the left eye is then in position for sighting directly or through the loop 82 in a line which generally parallels the directive axis of the paraboloid 11. This particular construction is extremely rugged and provides a minimum of extensions on the convex side of the paraboloid 11 thereby being particularly adaptable for laying the device down on its convex side without interfering with the feed mechanism in any way.

FIG. 12 shows a device generally similar to that shown in FIG. 1 but adapted for electronic amplification in the receiving mode. For this purpose the bowl 15 is fitted

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with a microphone 83 that is electrically connected to a transistor amplifier 84 contained in a hub enclosure 85. The amplifier 84 may be equipped with the usual on-off switch, not shown, and the output of the amplifier is connected to a set of head phones 86 in conventional manner. The mouthpiece 87 is fitted to the open end of the tube 13 and mounted adjacent the mouthpiece 87 is a spring return switch 88 having an actuating lever 89 extending for operation by pressure from the cheek of the user. The switch 88 operates to interrupt the amplification signal channel either by switching the amplifier 84 off or otherwise opening the signal channel thereby rendering the reception in earphones 86 ineffective. Thus during transmission when the mouth of the user is adjacent the mouthpiece 87 a slight pressure of the cheek against the actuation lever 89 will make the amplifier 84 inoperative so that amplified direct sound waves from the mouth of the user will not be applied to the user's ears through the earpiece 86. During reception by merely releasing the pressure on the lever 89 the switch 88 which is spring loaded to a normally operative position for amplifier 84 will permit the amplifier 84 to function normally for amplifying sound waves concentrated at the microphone 83 located at the focus of the paraboloid 11.

While various modifications and embodiments of the invention have been described, it will be appreciated that the various features are capable of being utilized in a variety of combinations to achieve a simple, rugged and economical hand-held portable two-way acoustic transmission device which is capable of being used either for transmission or reception while at the same time being oriented with the acoustic directivity axis of the paraboloid aimed at a desired point which usually is the location of a user similarly equipped. Good intelligibility for normal voice levels has been achieved over distances of one-quarter mile or more using paraboloids of 18 to 24 inch diameters. Any one of the embodiments may be employed by either user and various obvious changes may be made in the individual embodiments without departing from the scope of the invention which is defined by the appended claims.

We claim:

1. A portable two-way acoustic communication device comprising a hand-held paraboloid, a large diameter voice tube mounted on the axis of said paraboloid and having a bend in operative condition to extend one open end of said tube on the convex side of said paraboloid to be off-set from said axis and the other open end of said tube positioned to transmit and receive acoustic energy from the effective focus of said paraboloid, the off-set said one end facilitating communication with the mouth or ear of the user while sighting along a direction parallel to said axis.

2. Apparatus according to claim 1 in which said voice tube is mounted on the axis of said paraboloid and the portion of said voice tube on said convex side has two bends to off-set said one open end from said axis with a projected angle of intersection of said tube with said axis beyond said one open end of approximately forty-five (45°) degrees.

3. Apparatus according to claim 1 and including sighting means aligned substantially along the axis of said paraboloid.

4. Apparatus according to claim 3 in which said sighting means comprises an aperture in the surface of said paraboloid off-set from the apex and a forward index means mounted spaced in front of the concave side of said paraboloid and aligned with said aperture to provide a sighting axis parallel to the axis of said paraboloid.

5. Apparatus according to claim 1 and including a bowl shaped structure fixed to and spaced from said other end of said tube to form effectively an annular inverting bend for reversing the direction of sound waves passing in and out of said other end.

6. Apparatus according to claim 1 in which a portion

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of said voice tube on the convex side of said paraboloid comprises a flexible hose to facilitate placing said one open end alternately to the mouth and ear of the user.

7. Apparatus according to claim 1 in which said paraboloid supports at its apex a hub having tubular extensions in both axial directions and said voice tube includes a rigid tube mounted on the one of said extensions on the concave side of said paraboloid to extend to the vicinity of said effective focus and a flexible hose mounted on the other of said extensions.

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