Nov. 15, 1927. 1,649,538

M. MAURER ET AL

MEANS FOR RECEIVING AND SENDING DIRECTIONAL SOUND RAYS

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Fig. 1

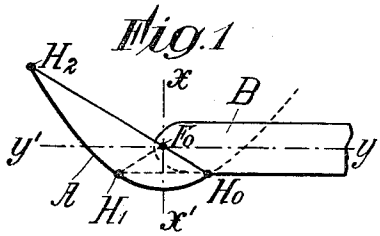


Fig. 2

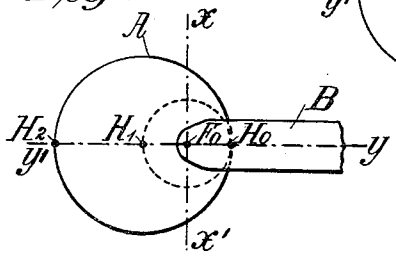


Fig. 4

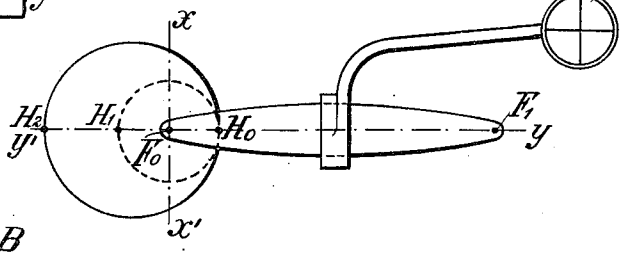


Fig. 3

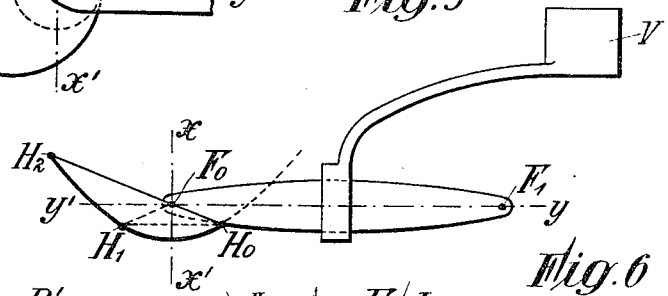


Fig. 6

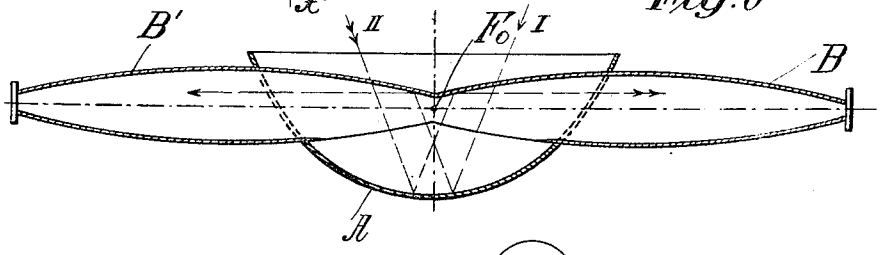
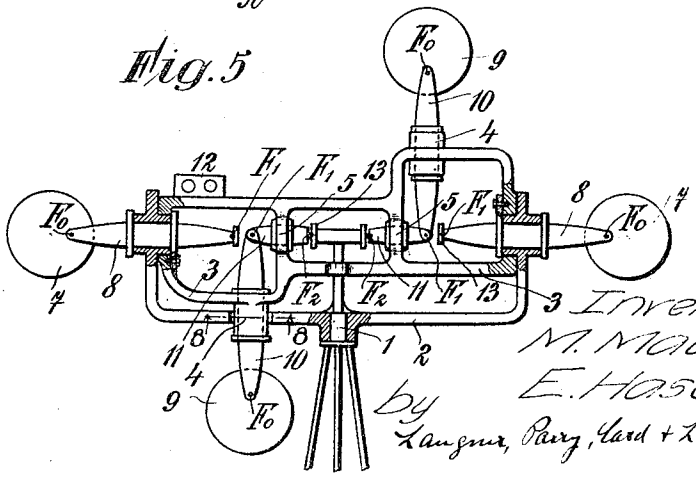


Fig. 5



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Fig. 7

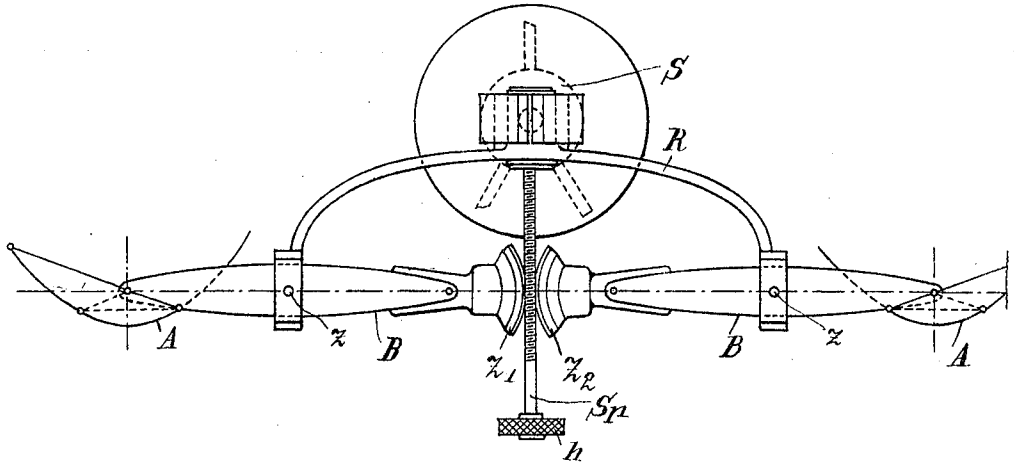


Fig. 5a

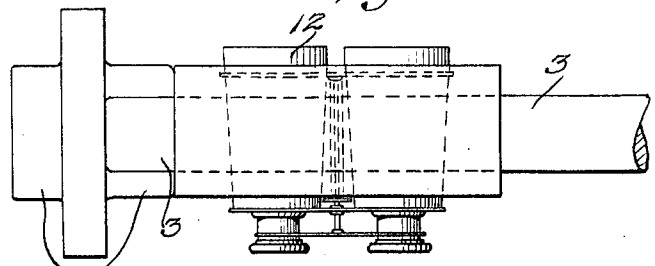
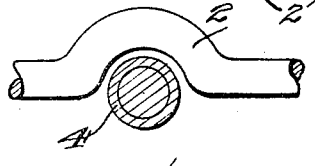


Fig. 8.



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UNITED STATES PATENT OFFICE.

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MEANS FOR RECEIVING AND SENDING DIRECTIONAL SOUND RAYS.

Application filed August 8, 1925, Serial No. 49,156, and in Austria May 29, 1925.

The object of the present invention is to provide means whereby it is possible, on the one hand, to ascertain the direction from which sound-impulses arrive from a remote source of sound, and, on the other hand, to send out into space sound impulses in a definite direction as pencils of parallel rays.

Receivers or megaphones serving these purposes do not give satisfactory results, since they are limited by the employment of arbitrarily shaped funnel or pear-shaped sound receivers or senders, by means of which the sound waves, after repeated reflections and diffractions arrive at their destination in an acoustically impure or distorted condition.

It is true that acoustically correct paraboloids of revolution with microphones or telephones arranged at their focal points have been employed as sound-receivers and senders, especially in cases where the sounds emitted by an invisible aircraft or one flying at night, are utilized to ascertain the position in space of such aircraft. However, even in such a case the intended purpose has not been completely achieved, since by the employment of telephones only very weak current impulses are produced by the incoming sound impulses; moreover when employing microphones the sound reception is impaired by additional disturbing sounds, due to the variation in inclination of the microphone-diaphragm necessary for locating the direction of sound and the unintentional movements of the graphite-grains caused thereby.

These drawbacks are avoided according to the present invention in that the sound waves, coming in a parallel axial direction, are collected at the focal point of the receiving paraboloid, and are transmitted, through a second hollow reflector arranged as far as possible unifocally therewith, as a bundle of parallel or convergent rays, to the ear of the observer or to the diaphragm of a microphone, the latter being adapted to rotate azimuthally only, in which case, to facilitate the location of the direction of the incoming sound rays, the admission-opening therefor is preferably so limited, that a slight angular deviation of the direction of sound from the axis of the receiving reflector relatively to the axis of the auxiliary transmission reflector causes only slight losses in intensity in the one direction, but considerably greater intensity losses in the other direction. While as the most suitable shape for the receiving reflector the paraboloid of revolution only is to be considered, for the auxiliary transmission reflector, there may be employed a narrow paraboloid unifocally arranged on the receiving paraboloid to produce bundles of parallel sound waves of high intensity, or an ellipsoid of revolution unifocally arranged on the receiving paraboloid which is adapted to unite the sound waves in the second focal point.

If, by means of such reflector combination, the sound impulses are transmitted in the opposite direction, devices are produced, which may be employed for sending out directed bundles of parallel sound rays.

Several constructional examples of devices according to the invention are illustrated in the accompanying drawings, in which:—

Fig. 1 shows an arrangement with a parabolic auxiliary reflector in side elevation, and

Fig. 2 is a plan view thereof;

Fig. 3 shows an arrangement with an elliptical auxiliary reflector in side elevation, and

Fig. 4 is a plan view thereof;

Fig. 5 is a side elevation, partly in section of a complete sound-direction detector with horizontally and vertically tiltable sound-receiving bases in combination with an optical aiming device for finding the source of sound, or when used as a sound sending device, for adjusting the direction of the sound.

Fig. 5ª is a plan view of the search telescopes shown at 12 in Figure 5.

Fig. 6 shows in cross section an arrangement in which the parabolic receiving reflector is provided with an additional auxiliary elliptical reflector, and

Fig. 7 is a diagrammatical representation, in plan view, of a modification of the arrangement shown in Fig. 3.

Fig. 8 is a transverse section taken along the line 8—8 of Figure 5.

In all figures $Fo—x$ represents the axis of the receiving or sending reflector A, and $Fo—y$ the axis of the auxiliary reflector B for transmitting the rays from, or to, the reflector A, Fo being the focal point common to both reflectors, since all sound-rays coming from the direction x—Fo, or sent out in this direction, intersect in this point. In Figs. 3 and 4 F_1 represents the second focal point of the elliptical auxiliary reflector.

When these reflector combinations are used for finding the direction of incoming sound waves it is advantageous to form the boundary of the receiving reflector A and that of the admission opening of the auxiliary transmitting reflector by a plane, which is at right angles to the plane x; $Fo\,y$ and passes through the common focal point Fo and through the main-meridian intersection point Ho. By this arrangement quite slight deflections of the sound direction from the axis x—Fo result in quite noticeable intensity reductions in the direction y, whilst greater direction-deflections in the opposite direction y^1 result in an unnoticeable reduction in the sound perceptibility.

When the device is used for the sending of directional sound impulses, it is advantageous to determine the boundary of the sending reflector and that of the exit opening of the auxiliary reflector B by a surface of a cone $Ho\ Fo\ H_1$, arranged coaxially to Fo, x and given by the development $Fo\ Ho$. It is then of advantage to adjust the direction $Fo\ x$ of the sound emission by means of a simple diopter or like finding device V having its axis parallel to $Fo\ x$.

In sound receiving devices, it is likewise advantageous for finding the sound-source to employ with the reflector combination a ring or like diopter, having its viewing-axis corresponding with the direction $Fo\ x$.

If the sound source is stationary on the ground the azimuthal oscillability of the axis $Fo\ x$ of the reflector combination, mounted on a tripod, is sufficient for finding the position, in which case it is also advantageous that the reflector combination is rotatably journalled about the axis $Fo\ y$.

If, however, the sound source is invisible, say an aircraft, its acoustic azimuth and angle of height must be ascertained at the same time, for which purpose the reflector combination for two observers, shown in Fig. 5 is preferable. One of the observers would have to ascertain the azimuthal plane of sound and the other the vertical plane of sound.

A forked bracket 2 is azimuthally rotatable about a vertical pivot 1 on the tripod, and forms the journal for the horizontal supporting frame 3. Rigidly mounted upon the latter are the supports 4, 5 for the reflectors. In this case the sound reflectors are arranged in pairs and reversed relatively one to another in order to obtain a high sensitiveness.

The two reflector combinations, forming the azimuthal base, consist, in this arrangement, of two interconnected reflectors 7, 8 while the two reflector combinations, forming the vertical sound base, each consisting of three reflectors 9, 10, 11 are arranged adjacently and unifocally in pairs, with the reflectors 7, 8. Each of the units 9, 10, 11 consists of a paraboloidal receiving reflector 9, an outer elliptical auxiliary reflector 10, unifocally connected thereto and extending at right angles to the axis of the frame 3, and an inner ellipsoidal or paraboloidal auxiliary reflector 11 connected to the reflector 10 the reflector 11 directing the sound waves either to the ear of the observer, or to the vertically arranged diaphragm of one of the microphones 13, which latter, on account of the said arrangement, are not subjected to variations in their inclination and thus no irritating additional sounds are produced by azimuthal or vertical movements of the reflectors. Arranged on the support frame 3 is a telescope 12 to facilitate the finding of the source of sound.

Where sound waves from remote and extended sources of sound, such as from a theatre orchestra and stage, are to be received microphonically, the arrangement according to Fig. 6 is suitable, wherein the receiving paraboloid is provided laterally, not with one, but with two unifocal auxiliary reflectors (ellipsoidal or paraboloidal) which are suitably co-axially arranged, so that each focal point of the two auxiliary hollow reflectors is situated in the focal point of the receiving reflector. (Fig. 6.) The sound waves arriving parallel to the axis of the receiving paraboloids are received uniformly by each of the auxiliary ellipsoids, whereas the sound waves arriving parallel to the direction I (Fig. 6) are all directed by the ellipsoid B, to the microphone and the waves arriving parallel to the direction II are conveyed by the ellipsoid B_2 to its microphone. Obviously, instead of ellipsoidal auxiliary reflectors, parabolic auxiliary reflectors with cylindrical extension tubes (Figs. 1, 2) could also be employed.

The receiving paraboloid may also be provided with four auxiliary reflectors (ellipsoidal or paraboloidal) arranged in a unifocal manner, so that the four transmission reflectors form a right angled cross.

The arrangement shown in Fig. 7 represents a duplication of the receiving device as shown in Fig. 3.

On a tripod S a bracket R is rotatably mounted, said bracket carrying at each end, on vertical pivots, with sufficient free play, an auxiliary transmission reflector B. Each of the auxiliary reflectors has rigidly con-

nected thereto a worm-wheel segment Z_1 or Z_2, which are in engagement with a worm-spindle Sp adapted to be operated by a hand wheel h. On turning the hand wheel the auxiliary reflectors B B will be oscillated in opposite directions about their pivots z, thus causing the axes of the two receiving reflectors A to converge one towards the other.

If this arrangement is not provided, there would exist the drawback that in the case of receiving the music of an orchestra, the space between the vertical planes, passing through the axis of the receiving reflectors, would form a dead space. Sound waves, which are directed from said space towards the device would not be received, since they would be reflected in the receiving reflector towards that side where there is no auxiliary reflector.

If sound waves are to be received from such a source it is possible to adjust the above described device in such a manner that the axes of the receiving reflectors intersect in front of the centre of the sound waves. This will ensure that all sound waves which travel from said source towards the device will be received by the latter. Obviously such a device may be employed to determine, from the extent of convergence of the axes of the receiving reflectors and the distance of their focal points, the distance of the source of sound.

What we claim is:

1. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector.

2. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is in the form of an ellipsoid of revolution and is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector.

3. A receiving and transmitting device for sound waves comprising the combination of two hollow sound reflecting surfaces, the edges of the surfaces of these reflectors being constituted by a plane passing through their common focal point and through the inner main meridian intersection point situated in the plane of the two reflector axes and at right angles thereto substantially as set forth.

4. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces one of which is formed as a paraboloid of revolution while the other is arranged substantially unifocally with the first named reflector and has the edge of its surface determined by the surface of a cone arranged co-axially to the reflector and having its apex at the common focal point, its development being expressed by a straight line connecting the focal point with the inner main-meridian intersection point.

5. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector, in combination with a similar reflector arrangement, the two reflector combinations being arranged reversely relative one to the other, and adjustable supports therefor, substantially as set forth.

6. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector, combined with a third reflector arranged unifocally on the second reflector, substantially as set forth.

7. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector, and a third reflector arranged unifocally on the second reflector in combination with a similar three-reflector arrangement, the two reflector combinations being arranged reversely relatively one to the other, and adjustable supports therefor substantially as set forth.

8. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector and an optical finding device arranged parallel to the axis of the paraboloidal reflector for the purpose set forth.

9. A receiving and transmitting device for sound waves comprising, in combination, sound reflecting hollow surfaces, one of which is formed as a paraboloid of revolution while the other is in the form of an ellipsoid of revolution and is arranged substantially unifocally with the first named reflector and transmits the sound waves from or to said reflector and an optical

finding device arranged parallel to the axis of the paraboloidal reflector for the purpose set forth.

10. A receiving and transmitting device for sound waves comprising the combination of two hollow sound reflecting surfaces, the edges of the surfaces of these reflectors being constituted by a plane passing through their common focal point and through the inner main meridian intersection point situated in the plane of the two reflector axes and at right angles thereto, and an optical finding device arranged parallel to the axis of the paraboloidal reflector for the purpose set forth.

11. A receiving and transmitting device for sound waves, for ascertaining the azimuthal plane of the sound and the vertical plane of the sound, comprising two sets of three reflectors, 9, 10, 11 each, and two sets of two reflectors 7, 8, the reflectors 8 being co-axial with the reflectors 11 and at right angles to the reflectors 10 and a frame upon which said reflectors are mounted, substantially as set forth.

12. A receiving and transmitting device for sound waves for ascertaining the azimuthal plane of the sound and the vertical plane of the sound, comprising two sets of three reflectors 9, 10, 11, each and two sets of two reflectors 7, 8, the reflectors 8 being co-axial with the reflectors 11 and at right angles to the reflectors 10, a frame upon which said reflectors are mounted, and an optical finding device arranged parallel to the axis of the reflectors 7 for the purpose set forth.

In testimony whereof we have signed our names to this specification.

MAX MAURER.
PROFR. ED. HASCHEK.