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SUBMARINE SIGNALING.

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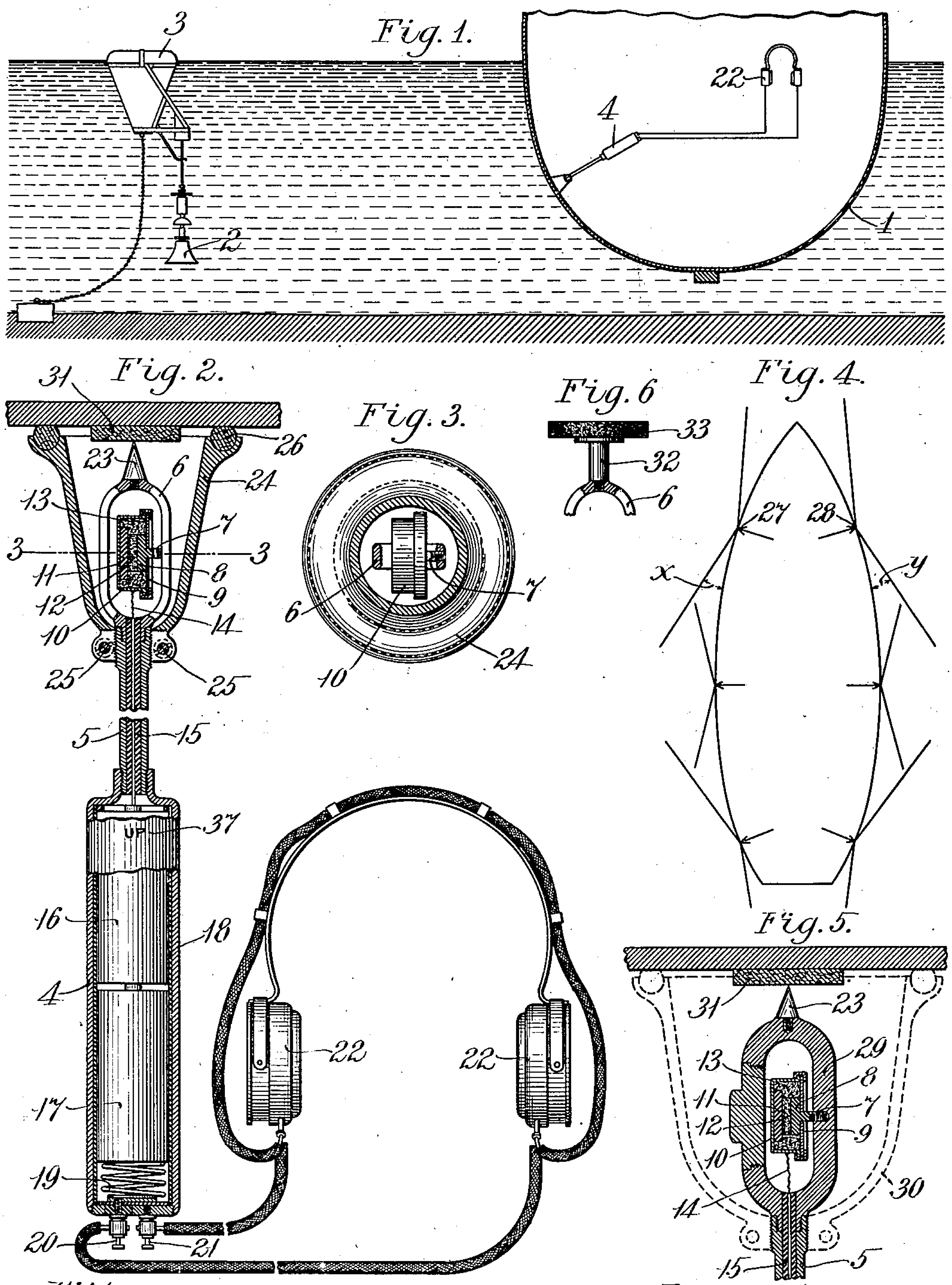
976,822. **Patented Nov. 22, 1910.**



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SUBMARINE SIGNALING.

976,822. Specification of Letters Patent. Patented Nov. 22, 1910.

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To all whom it may concern:

Be it known that I, JOSIAH B. MILLET, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented an Improvement in Submarine Signaling, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to submarine signaling, being more particularly intended to provide a simple form of detecting apparatus and a simple and efficient method of determining the direction of a source of submarine sound.

Heretofore, for the purpose of ascertaining the direction of a source of submarine sound on a vessel or the like, it has been customary to equip the vessel with two sets of detecting devices arranged, one at a point on one side of the vessel's hull, and the other at a point on the opposite side of the hull. Through a comparison of the intensity of the sounds received by these different sets of devices an estimation is made of the direction from which the sounds come.

As the ship's skin or plating gradually curves from stern to bow, its hull constitutes in effect a curved receiving surface by which the sound waves are received with the greatest intensity at those points where the ship's plating lies at right angles to the line of their propagation.

At the points where the line of propagation is more or less oblique to the ship's skin the sound is received with a diminished intensity. Where the angle between the plating and the direction of sound propagation is less than the critical angle the sound is largely reflected and is without substantial effect upon a sound detector acoustically applied to the ship's plating at such point. Where the ship's hull, therefore, has been utilized as a receiver of submarine sound, it has been usual heretofore, in order to obtain exact direction, to swing the vessel or deflect it from its course more or less until the sounds heard on each side are alike in intensity, thereby locating the source of sound as directly ahead. Or the vessel may be swung until the sound as received by the detector on one side is at its greatest intensity showing that the source is at right angles to the vessel's side at that point. Since it is often impossible, and frequently inconvenient, to swing the vessel from its course, it has often become difficult to obtain accurate determination of submarine sound direction on a floating structure. For example, if the source of sound were over the stern quarter of the vessel it would be necessary to turn the latter partly around before the sound could be heard at all. Moreover, even where the source of sound is so located with respect to one or the other of the two sound detectors as to enable the sound to act upon one with greater intensity than upon the other, the employment of two or more detectors, particularly where electro-microphonic detectors have been employed, is more or less unsatisfactory, because the detectors, if equally sensitive at one time, are apt to undergo more or less change, and as time passes, become unequally sensitive so as to render comparative tests for sound intensity unreliable. This is particularly true of granular carbon microphones where the carbon not only tends to pack in the course of time, but also to deteriorate or to pack in a few minutes through continued heating by the electric current. With the use of a plurality of granular detectors, therefore, what appears to the listener to be the direction of greater intensity of sound may, in fact, be the direction of lesser intensity owing to the unequal sensitiveness of the two detectors.

In carrying out my invention I arrange for the acoustic application of a sound detecting device, and preferably the same sound detecting device, to different points on the interior of the ship's skin or plating. By this method the same detector can be transferred from one point to another and the entire ship's plating followed around if necessary, until the point is found at which the sound is received with the greatest intensity.

The point of greatest intensity obviously will be located somewhere between the stern and the bow, and on one side or the other of the vessel. The line of propagation of sound being substantially normal to that part of the ship's skin against which it acts with greatest intensity, the precise direction can readily be ascertained from a comparison of the intensity of the sound at different points on the interior of the ship's hull.

The direction of the source of sound, therefore, can be ascertained readily, in a simple and convenient way, without altering the vessel's course.

My invention, furthermore, in certain of its aspects relates to an improved form of apparatus intended more particularly, though not exclusively, for use as a portable apparatus and one which may be acoustically applied at different points on the ship's hull or to parts in good acoustic contact therewith.

My invention has other objects both related and unrelated to the foregoing, but these as well as the purposes already specified will be best understood by reference to the following description when taken in connection with the accompanying illustration of one specific embodiment thereof, while its scope will be more particularly pointed out in the appended claims.

In the drawings: Figure 1 shows diagrammatically a system of submarine signaling in conjunction with which one form of my invention may be utilized. Fig. 2 is a central, longitudinal section taken through the portable detecting apparatus shown in Fig. 1; Fig. 3 is a section in plan on the line 3—3 in Fig. 2; Fig. 4 is an illustrative diagram; Fig. 5 is a section showing a modified form of detector; and Fig. 6 is a detail showing another modification.

While my invention as to certain of its aspects is susceptible of application to widely different uses, for the sake of illustration and without restricting its employment to any one particular purpose, I have herein shown its application to a system of submarine signaling wherein the submarine sounds are detected by acoustical contact with different parts of the ship's hull.

Referring to Fig. 1 I have there represented a sending station for sending submarine signals to a distant receiving station, the latter being represented as a vessel or other partly submerged structure, having its hull provided with the skin or plating 1. The sending apparatus may be of any usual or suitable type, but herein the same is conventionally represented by a well-known form of submarine sound producer comprising the submerged bell 2 sustained by the float 3 and adapted to be moved or struck for the creation of sound vibrations within the water through means well understood by those skilled in the art. The sound vibrations thus originating within the water are transmitted through the water to the vessel and impinge against the skin thereof.

At the vessel the sound vibrations are caused to act upon suitable microphonic detecting apparatus, preferably, though not necessarily, employing a carbon or other electro-microphonic agency for electrically converting the submarine sound vibrations into sound audible at a telephone or other receiver.

While this apparatus may be constructed in various ways, and as regards certain features of the invention may be either portable or non-portable, preferably I employ a portable apparatus having the handle 4, by means of which the detector may be conveniently applied to the interior of the ship's skin or a body acoustically connected thereto.

As shown in Fig. 2, the handle is attached to the hollow stem 5, to the end of which is secured, as by threaded engagement therewith, the microphone support 6, herein in the form of an open elliptical ring-like frame.

The microphone may be of any desired construction or type, my invention broadly considered having no particular reference to the detailed construction of the microphone itself. In the illustrated form, however, it is shown as of the variable resistance type, in the form of a common microphone button, rigidly and mechanically attached by the threaded stem 7 to the support 6. The stem supports the carbon electrode 8, which latter is secured to the mica disk or diaphragm 9. The mica disk is attached to and supports the thin cup-shaped casing 10 for the button, to the inner end wall of which casing is secured the remaining carbon electrode 11. The space between the two electrodes is filled or partially filled with carbon granules 12 which, together with the electrodes, are held in place by the surrounding annular ring 13 of cotton or other suitable material.

For the microphone there are provided connections to an appropriate listening device. These may be of any suitable character, but herein the electrode 8, being attached to the support 6, is thereby electrically connected to the stem 5 and handle 4. The electrode 11 is connected through the casing 10 to a conductor 14, which latter is embedded in the tube 15 of insulating material fitting tightly within the connecting stem 5. The conductor 14 passes through the stem to the handle 4 where it is appropriately connected to the battery cells 16 and 17, which are conveniently mounted in the handle and within the insulated lining 18 therefor. The batteries are serially connected with each other, and, through the spring contact 19, also with the binding post 20, a binding post 21 being employed for contact with the casing and the electrode 8. The two binding posts in turn are connected to a suitable listening device, herein in the form of a head telephone 22, having two receivers connected by a resilient band which holds the receivers in position against the ear of the listener.

In using the apparatus the operator, having placed the head receivers in position, can hold the detector in his hand and carry the same from place to place, manually applying the detector to such points of the ship's hull as he wishes to test, the entire apparatus, detector, batteries, receivers and connections being thus readily portable to different parts of the vessel and easily applicable when and where desired.

To secure a good acoustical connection or contact between the microphone and the ship's hull, the microphone support 6 may be provided with a contact member 23 having a small contact area, as for example, a point or sharp edge, and herein consisting of a pointed metallic projection secured to the microphone support 6 and preferably substantially in line with the handle and stem so that when pressed against the ship's skin, or a body having acoustical connection therewith, a good contact may be secured with such body and a good sound conducting connection maintained between the said body and the microphone through the point 23 and the metallic support 6. In acoustically applying the detector to the ship's hull it may be directly applied to the interior of the ship's skin itself or to some good sound conducting body in acoustical connection with the ship's skin. Through the manual application of the contact point to the ship's skin or other connected part an excellent acoustical connection is secured to the microphone, rendering the latter delicately responsive to sounds which are thus received directly by acoustical contact from the ship's hull.

The microphone being otherwise openly exposed to the influence of the ship's noises propagated through the air within the ship, means are preferably provided for protecting the microphone against such extraneous sounds so as to exclude from influencing the microphone substantially all sounds except those propagated through the ship's hull.

For the purpose of excluding air-propagated sounds there is shown attached to the stem 5 an open-ended protecting casing 24 which may be made of metal, but is preferably of such material and thickness as to be capable of excluding such sounds as are propagated through the air within the ship. Such casing has threaded engagement with the end of the stem 5, the head of the casing being split and provided with the clamping screws 25 so that it may be adjustably positioned on the stem relatively to the contact member 23. To the edge of the open end of the casing there is preferably secured a yieldable sound-excluding wall, such as the rubber gasket or other packing 26 of suitable size and thickness, which is adapted to rest against any solid body to which the detector may be applied. This not only makes a tight joint, excluding the ship's noises from within the casing, but also assists in manually applying the contact member 23 to the solid body and, moreover, prevents the transmission of sound vibrations from the ship's skin to the microphone except through the contact member.

In addition to the ship's noises or extraneous sounds propagated through the air, there ordinarily arise a variety of confusing noises, originating partly without but chiefly within the vessel, which are propagated through the material of the ship's plating. Means are therefore preferably employed for also excluding such noises from the microphone, leaving the latter substantially responsive only to the more purely musical notes of the signal bell. In this connection I have discovered that, by interposing a properly proportioned solid body of suitably selected material in the acoustical conducting path between the microphone and the vibrating solid or liquid mass to which it is applied, sounds that are unmusical and sounds that are of slight intensity, or of low pitch, or such as have vibrations of short duration as compared with the sustained periodic vibrations of a more purely musical tone, may be largely intercepted and excluded from access to the microphone while still leaving the more intense sounds of sustained duration, and particularly the musical sounds of regular periodicity and relatively high pitch, only slightly impaired in strength. This fact may be utilized to provide a selective device in submarine signaling by interposing such a body between the microphone and the ship's skin, such body serving to eliminate in a large measure the so-called ship's noises while permitting the musical note of the signal bell to pass through to the microphone.

I have found that many substances having low elasticity in relation to their density, and which are generally considered to be poor or relatively poor conductors of sound, such as rubber, leather, soft paper, and the like, have this property of selective conductivity of sound so that, by interposing a suitably proportioned body of rubber, for example, in the conductive path of the microphone, the result above described can be attained.

In Fig. 2 I have shown a body 31 interposed between the contact member 23 and the ship's plating, such body herein consisting of a plate or disk of rubber, although, as stated above, paper, leather, and a great variety of other materials may be employed for this purpose. The thickness and the material comprising the interposed body may be selected according to volume and intensity of the ship's noises to be dealt with. In Fig. 2 I have shown the rubber disk 31 as fixedly or permanently applied to the ship's skin. If desired, however, it may be attached to the contact member and be transported therewith from place to place. Such construction is shown in Fig. 6 where the contact member 32 has cemented or otherwise secured to its end the disk 33 of rubber or other material of low conductivity. The disk may, if desired, be of much greater thickness than is shown. The contact member 32, being removable from the microphone support, the latter may be provided with a number of such contact members equipped with similar attachments of different thickness or material from which selection may be made according to the amount and character of the ship's noises which it is desired to exclude from the microphone.

In Fig. 5 I have shown a modified form of detector wherein a microphone of substantially the same construction as that shown in Fig. 2 is secured to a support consisting of a solid metallic casing 29 completely surrounding and inclosing the microphone. This gives a direct metallic sound conducting connection between the contact member and the microphone, so that the vibrations of the submarine bell are transmitted by contact from the ship's plating. It is not necessary that the entire casing 29 should be of metal, but it is preferably of sufficient thickness and suitable material to exclude the gaseously propagated sounds, and it is preferably provided with the metallic or other solid conducting path referred to of relatively great mass. While the casing 29 attached to the stem 5 may be used alone to protect and carry the microphone, if desired, a protecting casing 30 similar to the casing 24 may be additionally employed, such construction being indicated in dotted lines. By the use of the sound-obstructing material as described, suitably proportioned to exclude the local sounds in any given case (ships differing in this regard), and combined with a sensitively constructed and positioned microphone, the bell sound may be made to distinctly predominate for signaling purposes, thus securing in a large measure the function of the usual tank filled with water, in which in ordinary practice, the microphone is suspended.

Heretofore, where a granular microphone has been employed, it has been customary, in order to secure the greatest sensitiveness, to arrange the electrodes parallel with the sides of the ship, *i. e.* lengthwise the ship. This, however, is transverse to the plane of the maximum ship's motion so that the effect of the rolling of the ship is to tip the electrodes back and forth. The granular material thereby undergoes a limited movement, but such movement is by way of partial withdrawal alternately from each electrode, thereby changing the contact relations between the microphonic material and the electrodes, and is without substantial beneficial effect in preventing the packing of the granular material.

I preferably apply the microphone to the ship's side with its electrodes lying in planes substantially transverse to the vessel, so that the lateral or transverse rolling movement, which is the maximum ship's movement, can be utilized to agitate the carbon granules without substantially changing the contact relations between the granules and the electrodes. Thus, it will be seen that with the detector applied, as shown in Fig. 2, the rolling of the ship will act to shift the entire mass of granular microphonic material between the two electrodes, thereby tending to maintain it in the permanently loose and free condition in which it was originally introduced into the apparatus. Because the electrodes lie in the plane of the ship's rolling movement, however, this movement of the granular material does not affect the area of contact which it maintains with each of the two electrodes.

In order that the microphone may be held with its electrodes lying transversely the vessel so that transverse rolling of the vessel may be utilized to move the carbon granules and prevent packing, not only is the microphone so mounted as to facilitate this, but a gage or reference mark or character 37 (Fig. 2) may be employed upon the handle to indicate to the operator when the microphone within the casing is in the desired position.

Heretofore it has been attempted to determine direction by fixed detecting instruments located ordinarily at opposite sides of the vessel, as, for example, at the points 27 and 28 (see Fig. 4). As above stated, however, not only does the comparison by two different instruments of the sounds received at opposite sides of the vessel introduce more or less unreliability, but, with the vessel holding to a fixed course, sounds propagated by a source which is located without the critical angle (roughly indicated by x and y in Fig. 4) are the only ones which differentially affect the two parts 27 and 28 of the ship's skin, and the exact determination of direction as to those sounds cannot be reached by the method hitherto employed without turning the vessel.

In making use of the above described portable apparatus the operator can carry it from one point to another, quickly ascertaining the quarter from which the sound comes. Having ascertained the general direction, the location of its source can be more precisely determined by testing adjacent portions of the vessel's skin. It will be seen that, by following around the ship's hull, the entire 360° of the horizontal plane may be investigated as to sound direction, irrespective of the ship's course, and the intensities of the sounds received at all desired points may be compared by using the same instrument.

When a sound wave is received by the ship's skin the latter tends to break up into nodes so that, even at that part of the ship's skin where the sound is most intense, there are frequently local points but a short distance apart of relatively greater and lesser intensity. The extent of this local variation will differ with the character of the construction of the vessel's hull, the nature of the sound and other conditions, but where a permanently fixed detector is employed it may result in detecting the sound at a point in the ship's skin where it is relatively weak as compared with a point perhaps in the same plate of the hull and but a short distance away. By the use of a portable detector, however, as above described, not only may that part of the vessel's hull be located whereat the sound is received with the greatest intensity, but the particular point in that part of the vessel's skin which is subjected to the most intense vibrations can be ascertained and utilized and no mistake can follow from the application of the detector to a nodal point in the ship's skin.

While I have herein shown and described one specific form of my invention and one particular method of determining the direction of sound, it is to be understood that the invention is not limited to the particular details disclosed, nor to the specific construction or form or relative arrangement of parts described, but that extensive deviations may be made from the disclosure without departing from the spirit of the invention.

Having thus described my invention, what I claim is:

1. The method of determining on board a vessel or the like the direction of a source of submarine sound, which consists in acoustically applying a microphonic sound detector to one part of the ship's hull, transferring and acoustically applying the same detector to another part of the ship's hull, and comparing the relative intensities of the sounds produced.

2. The method of determining on board a vessel or the like the direction of a source of submarine sound, which consists in electro-microphonically converting a submarine sound received at one part of the ship's hull into audible sound, similarly converting through the same agency sound received from the same source at another part of the ship's hull and comparing the intensities of the two audible sounds.

3. The method of determining on board a vessel or the like the direction of a source of submarine sound, which consists in ascertaining that point in the ship's hull at which the sound is received with the greatest intensity, and estimating from the location of said point and the curvature or shape of the vessel's hull thereat the direction of the said sound source.

4. The method of determining on board a vessel or the like the direction of a source of submarine sound, which consists in transferring from one part of the vessel to another an electro-microphonic detection agency, applying the same agency by acoustical contact to different points in the vessel's hull, and comparing the relative intensities of the sounds received at different parts of the vessel's hull.

5. The method of microphonically detecting submarine signals on shipboard which consists in placing the microphone in acoustic connection with the side of the ship and so maintaining it as to utilize the transverse rolling of the vessel to agitate the granules without substantially changing the contact relations between the granules and the electrodes.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

JOSIAH B. MILLET.

Witnesses:

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