Aug. 23, 1932. H. HECHT 1,872,946

ARRANGEMENT OF SOUND TRANSMITTERS AND SOUND RECEIVERS ON SHIPS

Filed Nov. 16, 1928

Fig. 1.

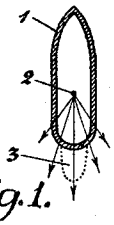


Fig. 2.

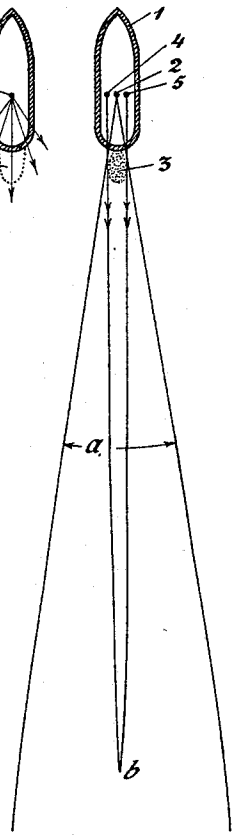


Fig. 3.

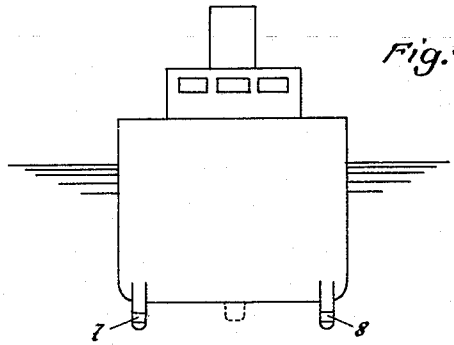


Fig. 7.

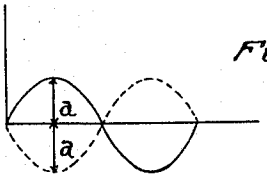


Fig. 8.

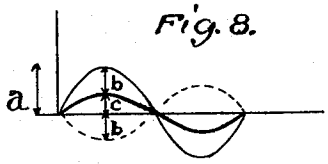


Fig. 4.

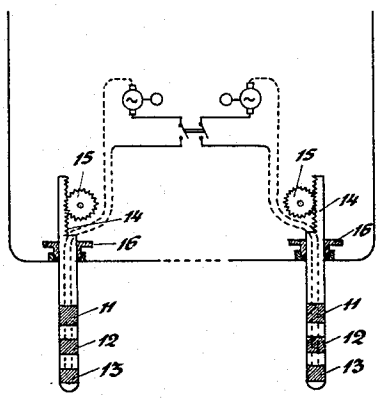


Fig. 5.

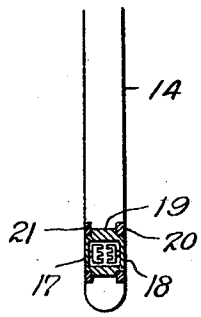
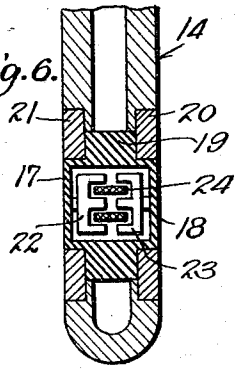


Fig. 6.



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UNITED STATES PATENT OFFICE

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ARRANGEMENT OF SOUND TRANSMITTERS AND SOUND RECEIVERS ON SHIPS

Application filed November 16, 1928, Serial No. 319,831, and in Germany November 25, 1927.

The invention relates to a particularly advantageous arrangement of sound transmitters or sound receivers on ships. The invention is based upon the observation that on reaching certain speeds of travel, which in the case of different types of ships are of various values, it is not possible to transmit signals from the ship in the aft direction within a certain angular zone or to receive signals from a transmitter located within this zone. The reason for this phenomenon very probably resides in the fact that a volume of water carried along by the ship in the neighbourhood of the stern post begins to be released at a particular speed of travel, is set into turbulent circulation and is converted into a mixture of water and air impermeable to sound.

According to the invention, this difficulty is overcome by arranging a device both at the port side and at the starboard side at the widest point of the ship, and appropriately on a carrier that projects from or can be moved out of the outer skin of the ship. It is desirable at the same time to make use also of one of the so-called group arrangements well-known of themselves, which allow the sound to be concentrated chiefly in particular directions or to be received chiefly from particular directions.

The invention is explained with the aid of drawing in greater detail in the following description.

Fig. 1 shows diagrammatically what happens at the stern post at low speeds of travel.

Fig. 2 shows what happens above the critical speed of travel when using a transmitter arranged in the longitudinal axis of the ship, and a pair of transmitters arranged at port and starboard.

Figs. 3 and 4 show diagrammatically transmitter arrangements according to the invention.

Figs. 5 and 6 show, partly in longitudinal section, in small and larger scale respectively the construction of one of the sound devices 11, 12, 13 of Fig. 4, and the manner in which they are inserted into the device 14 of Fig. 4, and Figs. 7 and 8 show different phase relations of the two sound waves emanating from two transmitters.

In Fig. 1, 1 shows the outline of a ship, in the middle of the bottom of which is located a transmitter 2. When travelling, the ship drags a more or less large mass of water 3 behind it, which, however, at relatively low speeds still consists of acoustically clear water. A sound emitted from the transmitter 2, in this condition, penetrates this mass of water still unweakened, as represented by the radial lines, drawn as arrows.

On exceeding the critical speed of travel, the mass of water 3 suddenly begins to be released from the rear end of the ship and to turn into a turbulent circulation. In this condition, separation of air also takes place and the water behind the ship becomes acoustically turbid for a large portion of the width of the ship (Fig. 2). Signals from 2, which just previously were still perceivable in the angular zone indicated by a, disappear suddenly in the entire width of this zone, whilst they appear just as suddenly again if the receiver is taken out of this zone laterally. The invention accordingly consists in arranging instead of one sound apparatus in central position, two of them (4 and 5) near the outer bottom edge of the ship. The sound beams now run from aft as parallel tangents (double pointed arrows in Fig. 2) past the turbulent zone 3, and in consequence of the flexion phenomenon of acoustic waves intersect close behind the ship (point b), so that therefore the signals can already be heard even at a moderate distance (for instance several ships lengths) from the ship in any direction, and vice-versa also signals coming from there to the ship can be picked up, by using for reception either the one or the other apparatus or both. The correctness and practical

value of this idea have been confirmed by many practical and successful tests on vessels on the high seas, especially in signalling to and receiving from vessels travelling in keel line formation.

In Fig. 3, arrangements of sound apparatuses on protrudable members are illustrated diagrammatically, and 8 constituting the members, each of which is equipped near its end with a sound device.

In Fig. 4 are illustrated two protrudable members arranged in the same way each equipped with a group of sound devices. Each member contains in this case three sound devices which are indicated by hatched lines at 11, 12 and 13. The mounting of these sound devices is shown more detailed in Figs. 5 and 6. In Fig. 5 the general arrangement of the sound device in the protrudable device or sword 14 of Fig. 4 is shown, and Fig. 6 shows further details in cross-section of the manner in which such a sound device is fastened. In these figures 17, 18 represent the two diaphragms which are arranged flush with the surface of the sword 14. These diaphragms constitute the sides of a casing 19 which contains the armatures 22 and 23 coupled respectively with diaphragms 17 and 18. These armatures are jointly energized by coil 24 which is connected by cables (shown in dotted lines in Fig. 4) passing through the hollow sword 14 with the apparatus shown in Fig. 4. As shown in Fig. 6 each casing 19 is inserted into a transverse opening provided in sword 14 and held therein by flush rings 20 and 21 which may be either threaded into or bolted to the sword (not shown). These details described hereinbefore form, however, no part of the present invention. Thus, use is made here of the well-known group arrangement of the sound devices spaced in a vertical straight line at a distance of $\lambda/2$ from one another, so as to emit sound in substantially only a horizontal plane for the present purpose. 14 and 15 indicate simple movable mechanisms (rack and toothed wheel) with the aid of which the apparatus can be moved in the gland 16.

Of course, if required, group arrangements differently disposed with regard to number and position can also be used. Likewise the type of the sound device itself is immaterial for the invention. It is only essential that the sound apparatuses are used in pairs and are placed as much as possible on to the outermost ends of the largest beam of the hull and actually in such a position with respect to the acoustically turbid layer of the wake that the sound beams to aft emitted from them unite behind the acoustically turbid layer.

On account of the simultaneous radiation of two transmitters, if the latter are worked absolutely in phase, interferences might occur in the sound field, which might lead to dead sound spots at definite points of the sound field. For instance, as shown in Fig. 7, the sound wave emanating from one transmitter may be represented by the full line curve, and that emanating from the other transmitter at the same time, may be represented by the dotted line curve. It is obvious that with the time relation of the sound waves shown, they would neutralize one another, and no sound at all would be received. The two transmitter groups should therefore not be energized from the same source of alternating current, as would appear obvious, but from two sources of alternating current entirely independent of one another as shown in Fig. 4. Two of such sources are never continuously in phase or of the same frequency and the formation of fixed dead points is impossible.

On reception, particularly in the case of an unknown position of the transmitter to be picked up, likewise both apparatuses would be used. Also in this case interferences are possible and in order to avoid complete extinction it is desirable to allow the receiver to work on the telephone with a considerable difference of energy (1:2 or more).

The reasons for this expedient are as follows: If sound is received from a source of sound (for instance a submarine transmitter), whose position is unknown, it could happen, if the reception is made with only one instrument, that the shadow zones of the wake lie between the transmitter and the receiver. For this reason, at least at the beginning, reception must be carried on with both receivers on both sides of the ship. Then correct reception is always insured, because the instruments are arranged so that even in the most unfavorable position of the sound source to be received at least one receiver will be struck by the sound wave. If now both instruments receive the sound energy at the same magnitude, but if the phase between the two received sound waves should differ by 180°, no sound would be perceived when connecting the two sound devices to the same telephone. This case is illustrated in Fig. 7 of the sketch. The full line curve may represent the sound wave received by the port instrument of the vessel and the dotted one the sound wave received by the starboard instrument. Both have the amplitude a with opposite phase and their effect would thus amount to zero. If, on the other hand, the energies received by the two sound apparatuses are transmitted to the telephone at a different magnitude relatively to each other a condition will exist as is illustrated in Fig. 8 of the enclosed sketch. There the port instrument may transmit its energy to the telephone at the amplitude a and the starboard instrument at b, still assuming that they are received at opposite phase. In this case the amplitude

difference *a*—*b*, namely the amplitude *c* would be heard in the telephone. It is well known in practice that the energy supplied to a telephone can be controlled for instance by connecting a resistance either in parallel or in series with the receiving telephone.

I claim:—

1. An arrangement for submarine transmission and reception of sound on all sides on ships in motion undisturbed by the ships wake, comprising sound transmitting and receiving devices spaced apart as far as possible to port and starboard, to cause the sound waves to straddle the ships wake, said devices being so arranged as to project below the bottom of the ship.

2. An arrangement for submarine transmission of sound on all sides of a ship in motion, undisturbed by the ships wake, including a ship, sound transmitting devices mounted on the ship and being spaced apart as far as possible to port and starboard to cause the sound waves to straddle the wake, and being so arranged that they project below the bottom of the ship, different means, independent of one another for supplying alternating current of ever varying frequency to each sound transmitting device at the same time to maintain an ever varying phase relation between the two sources.

3. An arrangement for submarine reception of sound on all sides of a ship in motion, undisturbed by the ships wake, comprising sound receiving devices spaced apart on the ship as far as possible to port and starboard, to permit reception of the sound waves which straddle the wake, said devices being so arranged that they project below the bottom of the ship, and a common indicator connected to both receiving devices, and means for varying the amount of energy supplied to the indicator by one device with respect to that supplied by the other, whereby different amounts of energy are received by said indicator at the same time.

In testimony whereof I affix my signature.

HEINRICH HECHT.