Sept. 25, 1934. H. HECHT 1,974,920

SUBAQUEOUS SOUND DEVICE WITH INCLINED DIAPHRAGMS

Filed Aug. 26, 1931

Fig. 1

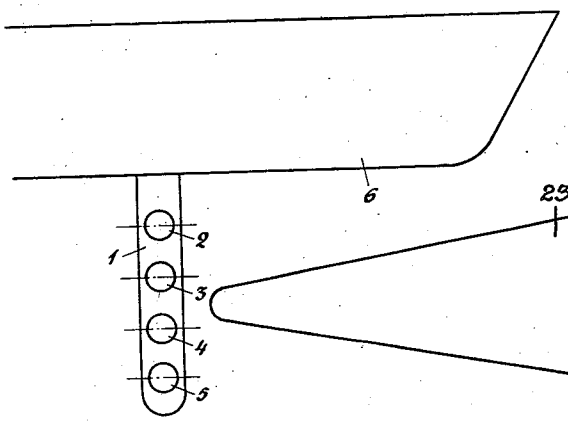


Fig. 4.

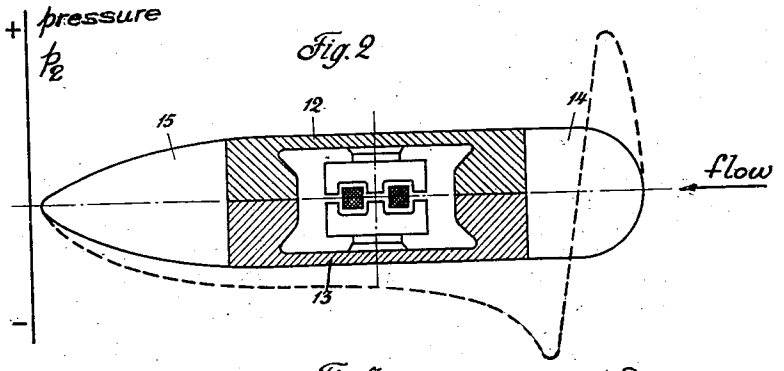


Fig. 2

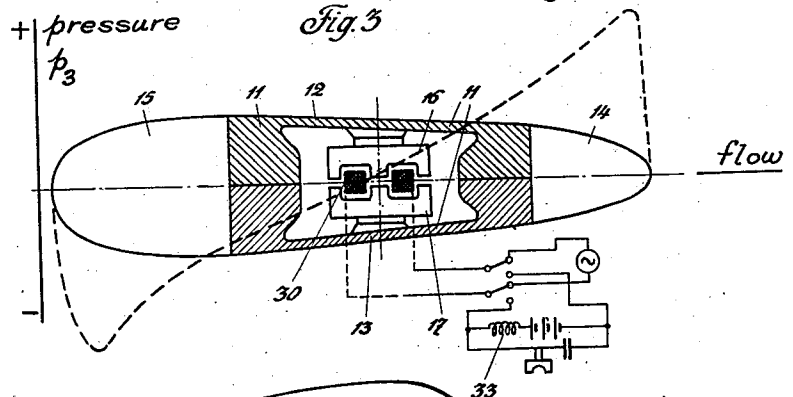


Fig. 3

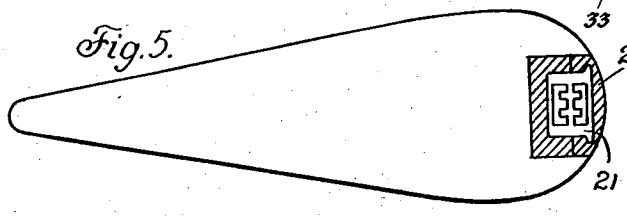


Fig. 5.

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SUBAQUEOUS SOUND DEVICE WITH INCLINED DIAPHRAGMS

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6 Claims. (Cl. 177—386)

Subaqueous sound signalling installations are, as is well-known, generally constructed in such a manner that one or more radiators, which can serve under certain circumstances as transmitters and receivers, are arranged in a sword-shaped apparatus which can be protruded from the bottom of a ship. Since these swords are supposed to produce as small a resistance to motion as possible, it is well-known to give them a streamline form as much as possible. The profiles hitherto employed are characterized by two parallel lateral planes, in which the diaphragms of the radiators are mounted and, moreover, by a round leading edge and a pointed trailing edge, which give to the section of such a radiator carrier the approximate shape of a raindrop.

Elaborate experiments and calculations by the applicant have shown that the profile customary up to the present involves certain defects which are due to the manner of streamlining. The object of the present invention is to provide a new profile with a radiator of new form, the essential quality of which resides in the fact that the acoustically active surface of the radiators arranged in the sword is always met by streamlines approaching from the direction of travel, in such a manner that no detachment of water eddies will take place in front of this surface in the direction of motion, as will be explained more fully hereinafter. The invention is explained in detail with reference to Figs. 1 to 5, in which:—

Fig. 1 shows a so-called sword with four radiators, arranged at the bottom of a ship,

Fig. 2 shows the cross-sectional form of a sword and radiator as previously proposed,

Figs. 3 to 5 show the cross-sectional form of the sword and radiator according to the invention.

Referring to Fig. 1, beneath the hull of the ship can be seen the carrier of the sound apparatus, the so-called sword 1, in which the sound apparatus (transmitters or receivers) 2, 3, 4 and 5 are arranged. This sword is thus exposed to the water on all sides. Hitherto, the sword and sound apparatus had a form as is shown by the horizontal section in Fig. 2, that is, the two diaphragms 12 and 13 of the sound apparatus were parallel and were completed into a streamlined body by a rounded leading portion and a tapering trailing portion.

The apparatus constructed according to the invention has a cross-sectional form which greatly differs from this. It is illustrated in Fig. 3 and is characterized by the feature that it has no parallel side lines and is divided into three parts, the middle part, which consists of the actual sound apparatus 11, an additional tip 14, widening towards and joining the middle part, and the heel 15 rounded off at the trailing edge of the sword. It is characteristic of this arrangement that the two radiating diaphragms 12 and 13 of the sound apparatus are not parallel with one another, but are forwardly inclined towards one another by a certain angle with respect to the direction of travel.

The energizing or sound transforming system in the sound apparatus itself is of no importance for the present invention. However, one of the features of the invention involves a special form of construction of the sound apparatus, in which only a single driving system is provided, the main parts of which are arranged as in a system with parallelly arranged diaphragms. It is also possible, however, to provide a special system for each diaphragm. In Fig. 3 a single electromagnetic system is shown as an example. 16 and 17 are the two halves of the magnet which are arranged exactly like the two halves 16 and 17 of the magnet of the radiator with parallel diaphragm surfaces as shown in Fig. 2. For excitation use is made of the coil 30 which, in the case of transmission, is connected to an alternating current generator 31 and, in the case of reception, is connected to a telephone 32. For excitation during reception, the battery 33 is used.

The problem in view is, generally, solved by so shaping the carrier of the oscillator or oscillators and so placing the diaphragms of the oscillator in the surface of the carrier that, looking in the direction of travel, no rise of pressure occurs between the point where the water first strikes a diaphragm, and the point where it leaves the diaphragm at its trailing edge, but only a continuous pressure drop, as gradual as possible occurs.

With prior art shapes of the sword, namely with approximately stream line shapes, as shown in Fig. 2, and with shapes according to the present invention Fig. 3, comparative experiments have shown the following results.

Assuming the water streaming toward the sword in the direction of the arrow. Now it is a well-known fact that pressure of flow is inversely proportional to the speed of flow (Venturi tube law). The experiments made with a sword of the cross-section Fig. 2 show a pressure curve between the leading and trailing sword edge approximately shaped as shown in dash lines. This would indicate that with such a sword contour the pressure rises very abruptly at the blunt head and immediately drops from a positive to a nega-

tive maximum within the length of the sword head, and ahead of the diaphragms 12. Negative pressure values then prevail all along the diaphragms and zero pressure is restored only at the trailing edge of the body. Thus along the diaphragms, due to the low pressures, eddies or whirls are likely to occur which, as is well-known, travel along the body surface and eventually detach themselves from the body surface and float away. While this occurs vacuous spaces and burbling noises are produced at the diaphragm surface which seriously interfere with the efficient acoustic function of the diaphragm, as is also well-known.

The body shape according to the invention and as shown in Fig. 3, when subject to similar pressure tests, is characterized by a pressure curve, approximately shaped as shown in dash lines in Fig. 3.

Here we find that while the pressure p_3 also rises abruptly at the leading edge or head of the sword, it drops only very gradually toward the trailing edge, attaining a substantial negative value only near the rear portions of the diaphragms, while along the forward diaphragm portions a very substantial positive pressure prevails. This indicates that the water attains its maximum speed very much further back of the leading edge than is the case with a shape Fig. 2. Therefore, the possibility of the formation of eddies and vacuous spaces can arise in Fig. 3 only after the water has passed the diaphragms, i. e. at a surface portion of the sword body where its burbling can no more interfere with the efficient acoustic function of the diaphragms.

Speaking from a constructional point of view, this means that such a diaphragm must lie within and flush with the contour of the carrier in such a position that the approaching water "strikes" against the diaphragm when first encountering it, in contradistinction to "gliding along" the diaphragm as occurs in the prior art arrangements. The contour of the carrier must, therefore, be such that, during the travel of the water along the diaphragm, the absolute pressure of the liquid constantly decreases up to the end of the diaphragm. Moreover, there must not be any condition in front of the diaphragms which would cause a reversal of the decreasing pressure, that is, a rise in pressure. Broadly speaking this effect can be accomplished with a diaphragm which faces the direction of travel either squarely or, as is stated in one of the appended claims, "at least at an angle", by which I mean that these positions are distinguished from a diaphragm position heretofore used, in which the diaphragm plane is in line with the direction of travel and thus in no way "faces" the direction of travel.

A further mode of construction according to the invention which always satisfies these conditions is illustrated in Figs. 4 and 5. It is characterized by the feature that the diaphragms are arranged within the contour of the leading edge of the protrudable apparatus or carrier, so that they are directly exposed to the approaching water. In Fig. 4, 21 is a sound apparatus which is closed at the front by a flat diaphragm 22. This diaphragm 22 can also be curved as illustrated in Fig. 5, in order to round off the profile at the leading edge. It will be noted that in both of these modifications the water after striking the center of the diaphragm will flow off toward its edges, and that thus the pressure will constantly decrease.

I claim:—

1. In an arrangement for submarine sound communication on vessels, a sound apparatus carrier protruding from the vessel's hull and a sound apparatus for each carrier side mounted within each side of the carrier, the diaphragms of said sound apparatus being flush with the carrier wall and including an angle open toward the trailing edge of the carrier.

2. In an arrangement for submarine sound communication on vessels, a sound apparatus carrier protruding from the vessel's hull and an electromagnetic sound apparatus mounted within said carrier and comprising a diaphragm on each side of the carrier arranged flush with the carrier contour and a common electromagnetic energizing system having two similar armatures disposed in parallel to one another, each armature being connected to one of said diaphragms, said diaphragms being disposed at an angle to one another, open toward the trailing edge of the carrier.

3. In an arrangement for submarine sound communication on vessels, a submarine sound apparatus including a diaphragm and a carrier for said apparatus protruding from the vessel's hull and having a rounded leading edge, said diaphragm being mounted in the leading edge portion of said carrier, to squarely face the direction of travel.

4. In an arrangement for submarine sound communication on vessels, a submarine sound apparatus including a diaphragm and a carrier for said apparatus protruding from the vessel's hull and having a rounded leading edge, said diaphragm being mounted in the leading edge portion of said carrier and being curved in accordance with the carrier contour, so that it squarely faces the direction of travel, whereby water striking the diaphragm travels along the latter toward the trailing edges of the diaphragm at a constantly decreasing absolute pressure.

5. In an arrangement for submarine sound communication on vessels, a submarine sound apparatus including a diaphragm, and a carrier for said apparatus protruding from the vessel's hull so as to be freely exposed to the water on all sides, and having a contour of increasing width at least at the leading edge, said diaphragm being mounted within the surface and flush with said carrier portion of increasing width so that the diaphragm plane becomes inclined at an angle with respect to the direction of travel, whereby water striking the diaphragm travels along the latter toward the trailing edge of the diaphragm at a constantly decreasing absolute pressure.

6. In an arrangement for submarine sound communication on vessels, a sound apparatus carrier protruding from the vessel's hull and a sound apparatus including a diaphragm mounted within and flush with the contour of said carrier, said carrier having a cross-section of increasing width, said increase extending at least to the trailing edge of said diaphragm, so that the latter is inclined at an angle with respect to the direction of travel, whereby water striking the diaphragm travels along the latter toward the trailing edge of the diaphragm at a constantly decreasing absolute pressure.

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