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(54) APPARATUS FOR THE GUIDANCE OF THE EFFECT OF THE UNDERWATER DETONATION OF UNDERWATER EXPLOSIVE CHARGES

(71) We, FRITZ WERNER INDUSTRIE-AUSRUSTUNGEN G.M.B.H., a joint stock company organised under the laws of Germany, of 6222 Geisenheim/Rheingau, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to explosive charges to be used exclusively underwater, (hereinafter and in the claims referred to as "underwater explosive charges"), having provision for the guidance and intensification of the effect of the underwater detonation.

It is known that the effect of the detonated explosive charge with underwater explosive charges is better than that of the same explosive charge in air. This is due on the one hand to the higher specific density of water relative to air, and on the other hand to the incompressibility of the water. It is known to use explosive charges under water in order to bring about destruction of objects to be found in the water. These explosive charges generally have a spherical or cylindrical shape apart from a special sheathing directing the detonation. This leads to the pressure wave propagated by the detonation spreading more or less uniformly in the space surrounding the explosive charge, so that with the target to be found at only one location a comparatively small part of the pressure wave is effective for the destruction or deformation. The hollow-charge principle of an explosive charge, customary in air, cannot be carried over to an underwater explosive charge, as the hollow-charge blast would interact directly with the water and in so doing be substantially dissipated before it reaches the target object. Even if the blast were allowed to pass through air in the first instance, the use of the energy of the hollow charge is trifling and the effect is concentrated only on one small area.

The object of the invention is to increase considerably with underwater explosive charges the effect of the explosive charge under water by concentration in a predetermined direction.

According to the present invention, we provide an underwater explosive charge which is free from cavities in its external surface from which extend in different directions an igniter and means defining or adapted temporarily, to create a cavity elongate along an axis in a direction away from the explosive charge and spaced with peripheral clearance within the confines of the volume swept by the projection along said axis in said direction and parallel to itself of the charge at its maximum cross-section normal to said axis, the direction of extension of the igniter being such that the igniter does not intercept the cavity defined or created. The result of the provision of said means defining or adapted to create a cavity is that the energy of the detonated explosive is forced in a predetermined direction, the greater part of the energy produced by the detonation of the explosive charge being turned towards the cavity and thus being induced into a predetermined direction. This is to be ascribed to the fact that the high-density gases produced by the detonation chooses the path of least resistance. This path is determined by the aforesaid cavity, whereas, elsewhere about the underwater explosive charge, there is a barrier to the spreading of the gases produced by the explosion, this barrier being considerably stronger than that in the direction of the cavity. The penetration is considerably less in the direction of water than in the direction of the cavity. As the high-density gases can develop high speeds in this cavity, a considerable momentum is gener-

ated therein. On emerging from the end of the cavity, the high-density gases thrust on the water and the penetration attained thereby is not only high but is directed.

The cavity may be created in different ways. On the one hand it is possible to form the cavity shortly before the detonation of the explosive body, by an occlusion extending in the direction of the target. On the other hand the cavity may be formed by a hollow member which has an end plate of low strength in the direction of the target. It is essential in both cases that the cavity be directly adjacent the explosive charge, so that the gases resulting from the detonation of the explosive charge have the opportunity to accelerate without coming into contact with water, and then to strike with higher momentum against the water, at the explosive-charge-remote end of the cavity. To set up the cavity coming into being in the form of an occlusion, use may be made of a small bursting charge or the like which is provided in the direction of the target on the explosive and is held *in situ* by a suitable mounting. The firing of the bursting charge may be so set by means of a fuse that it takes place earlier than the firing of the explosive charge itself.

The cavity may also be provided by a hollow member extending lengthwise in the direction of the target and having sides of strong material. This hollow member in that case receives a flexible diaphragm at its end facing the target, so that the hollow member is completely closed to the surrounding water.

The hollow member may have different shapes. It may be cylindrical, or it may converge or diverge in the direction away from the explosive charge. The hollow member is fixedly connected with the explosive charge, the connection being watertight. In the drawing there are represented several exemplified embodiments for the construction of the underwater explosive charge according to the invention. Figures 1 to 3 show in elevation and diagrammatically an underwater explosive charge according to the invention with a cavity formed by a hollow member to be aimed at the target to be hit.

Figure 4 illustrates diagrammatically a further manner of forming the direction-indicating cavity on the underwater explosive.

The underwater explosive charge 1 is of circular cross-ection and free from concavities. It has on a predetermined side, namely that intended to face a target (not shown) a hollow member 2 which is connected in a watertight manner with the explosive charge 1 and is elongate along an axis in a direction away from the charge. The hollow member 2 is cylindrical in form in Figure 1 and is closed off in a watertight manner at the end nearer the target when aimed at the target by a wall 3 of low resistance to force. For example, a diaphragm may be used as the closing wall. There is produced by the cylindrical hollow member 2 and the charge external surface portion masked thereby a cavity 4 which is spaced with peripheral distance within the confines of the volume swept by the projection along said axis parallel to itself of the charge 1 at its maximum cross-section normal to said gases. Consequently the pressure wave resulting from the detonation of the explosive charge 1 can easily spread within said cavity, without hitting the volume of water elsewhere surrounding the explosive charge 1. The cavity 4 has such a volume and length that the high-density gases resulting from the detonation of the explosive charge have the opportunity in the cavity 4 of accelerating to high speeds before they shatter the closing wall 3 and thus encounter the volume of water confronting the latter. The explosive charge 1 is provided with an igniter 5 which is preferably transversely to the hollow member 2 and the cavity 4.

In the embodiment of Figure 2, the hollow member 2 *a* is formed outwardly convergent in the direction towards the target. In the embodiment of Figure 3 provision is made for the hollow member 2*b* to extend divergently in the direction towards the target. However, in Figures 2 and 3 the cavity 4 is again spaced with peripheral clearance within the confines of the volume swept by the projection along said axis of the charge at its maximum cross-section normal to said axis. In the case of such underwater explosive charges, the detonation action of the fused explosive charge proceeds first of all in air through the hollow member fastened to the explosive charge and so is essentially concentrated on the cavity produced by the hollow member. After breaking through the strong wall portion of the hollow member, the course taken by the accelerated high-density gases is that aimed by the hollow member through the water onto the target. An underwater test can be carried out by arranging two metal plates normal to the axis of the hollow member, each at a predetermined distance from the explosive charge with one in front of the hollow member and the other on the opposite side of the explosive charge from the hollow member. On detonation of the explosive charge the plate at the hollow member side is broken through to a considerable extent whereby a hole is formed in the plate, whilst the rearward plate i.e. the plate at the opposite side of the explosive charge suffers no damage or collapsing of any kind.

In the embodiment of Figure 4 a bursting

charge 6 or the like is placed at the side of the explosive charge 1 facing the target and this serves the purpose on detonation of forming a gas occlusion which is of elongate form along an axis in a direction away from the charge 6, and defines a cavity spaced within peripheral clearance with the confines of the volume swept by the projection along said axis of the charge 1 at its maximum cross-section normal to said axis. The bursting charge 6 is connected through a fuse 7 or a priming element with the igniter 5 in such manner that, along with ignition of the explosive charge, the bursting charge 6 is first of all ignited, before the detonation of the explosive charge 1 takes place.

In this way there can be built up in the water surrounding the explosive charge 1 a gas occlusion 8 into which range the pessure waves of the detonation gases. A gas occlusion generated in this way has the same effect as the hollow member of the embodiments of Figures 1 to 3. The bursting charge 6 preferably has an elongate form, which consequently results in a gas occlusion of elongate form, which is aimed at the target to be hit.

WHAT WE CLAIM IS:-

1. An underwater explosive charge which is free from cavities in its external surface from which extend in different directions an ingniter and means defining or adapted temporarily to create a cavity elongate along an axis in a direction away from the explosive charge and spaced with peripheral clearance within the confines of the volume swept by the projection along said axis in said direction and parallel to itself of the charge at its maximum cross-section normal to said axis, the direction of extension of the igniter being such that the igniter does not intercept the cavity defined or created.

2. An underwater explosive charge as claimed in claim 1, wherein said means adapted to create a cavity as defined is a bursting charge connected through a fuse or priming element in such manner that the bursting charge is ignited before the explosive charge is detonated.

3. An underwater explosive charge as claimed in claim 1, wherein said cavity-defining means comprises a hollow member with a side wall or walls of strong material to deflect surrounding water, and an end wall remote from the explosive charge and of low resistance to force.

4. An underwater explosive charge as claimed in claim 3, wherein said end wall is a diaphragm.

5. An underwater explosive charge as claimed in claim 3 or 4, wherein said hollow member is cylindrical.

6. An underwater explosive charge as claimed in claim 3 or 4 wherein said hollow member converges in the direction away from the explosive charge.

7. An underwater explosive charge as claimed in claim 3 or 4, wherein said hollow member diverges in the direction away from the explosive charge.

8. An underwater explosive charge substantially as hereinbefore described with reference to Figure 1 of the accompanying drawing.

9. An underwater explosive charge substantially as hereinbefore described with reference to Figure 2 of the accompanying drawing.

10. An underwater explosive charge substantially as hereinbefore described with reference to Figure 3 of the accompanying drawing.

11. An underwater explosive charge substantially as hereinbefore described with reference to Figure 4 of the accompanying drawing.

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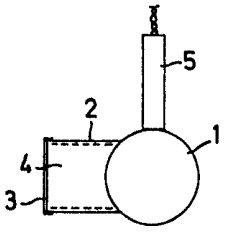

FIG. 1

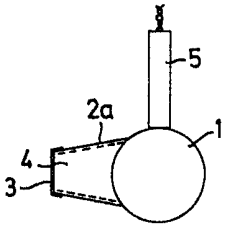

FIG. 2

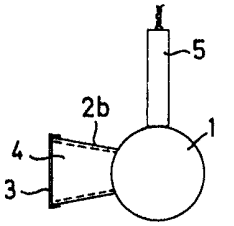

FIG. 3

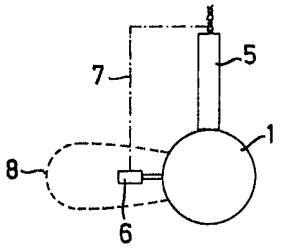

FIG. 4