UNDERWATER HYDRODYNAMIC ACOUSTIC PROJECTOR

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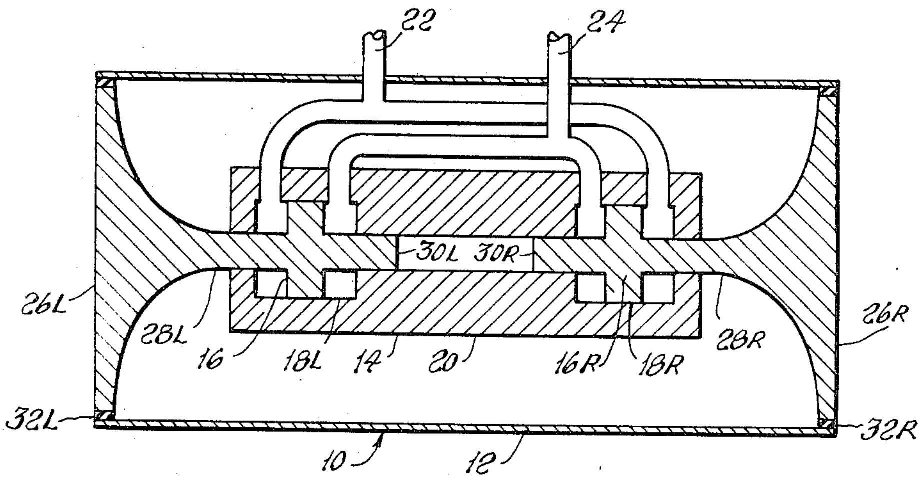

Fig. 1

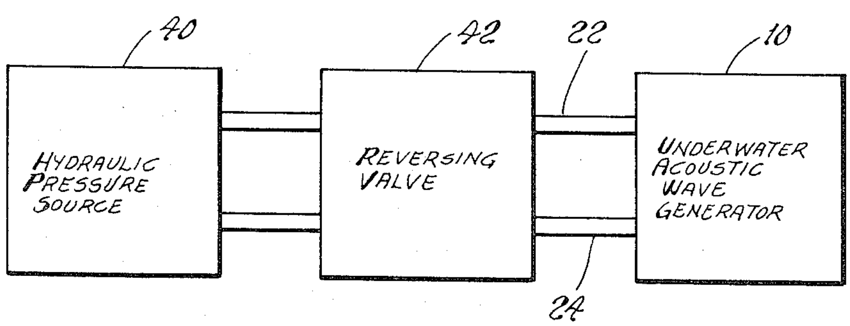

Fig. 2

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UNDERWATER HYDRODYNAMIC ACOUSTIC PROJECTOR

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ABSTRACT OF THE DISCLOSURE

An underwater acoustic energy projector having two oppositely directed planar pistons mounted in the opposite ends of a tubular housing, hydraulic motor means in the housing, and hydraulic conduits extending from the hydraulic motor means through the wall of the tubular housing for transmitting driving force to the planar pistons forcing them to execute mirror image displacement. The perimeters of the pistons are yieldably secured to the housing by elastomeric means to form a fluid tight structure.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

An object of this invention is to provide a more rugged underwater acoustic wave projector.

A further object is to provide a high power underwater acoustic wave projector that has a smaller ratio of overall volume to power handling capacity relative to other units available heretofore for this purpose.

A further object is to provide an underwater acoustic wave generator that is flexible in operation and can be used to impart power to the water in the character of a single hammer-like pulse, a single implosion-like pulse, spaced apart periodic pulses, continuous duty, nondescript noise, or message bearing waveforms.

A further object is to provide an underwater acoustic wave projector that is not readily damaged by rough handling, is of simple construction, does not require delivery of electric power underwater, is of comparatively low cost to construct and operate, and is readily adaptable to very high power applications.

Other objects and advantages will appear from the following description of an example of the invention, and the novel features will be particularly pointed out in the appended claim.

FIG. 1 is a simplified longitudinal sectional view of a hydraulically operable underwater sound projector embodying the principles of this invention and not including ordinary details of construction, e.g., seals, joints, fastenings, and FIG. 2 is a block diagram of a hydrodynamic system including a sound projector of the type shown in FIG. 1.

The hydraulic sound projector embodiment **10** shown in FIG. 1 includes a tubular housing element **12** of rigid, tough material impermeable to seawater. Centrally located and rigidly mounted in the housing element with braces that are not shown on the drawing, is a hydraulic motor **14** which includes two double-acting, substantially identical, driving pistons **16L** and **16R** reciprocable in respective in-line cylinders **18L** and **18R** in motor block **20**. A pair of separate hydraulic conduits **22** and **24** extend through and are sealed fluid tight in the wall of housing element **12** and are in fluid communication with the remote ends and proximate ends respectively of cylinders **18L** and **18R**. Identical radiating pistons **26L** and **26R** are rigidly joined by connecting rods **28L** and **28R** to driving pistons **16L** and **16R**. The effective areas of

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both faces of each double acting driving piston are made equal by the addition of area compensation rods **30L** and **30R** that have cross sections equal to that of connecting rods **28L** and **28R** secured to and extending from the faces of the driving pistons opposite to the faces joined to the radiating pistons. The area compensation rods **30L** and **30R** are of sufficient length to extend beyond the inner ends of the cylinders **18L** and **18R** toward one another and are separated by an air space in the motor block **20**. The perimeters of the radiating pistons **26L** and **26R** are joined fluid tight to the ends of housing element **12** by compliant elastomeric annuli **32L** and **32R**. The interior of the housing element **12** contains dry air. If intended for operation at shallow depth, air at atmospheric pressure or at the pressure corresponding to the operating depth occupies the housing element, but if the projector is intended for use at greater depths, a static pressure head compensating apparatus may be used. The pressure compensating system includes a differential valve subject to the pressure inside and outside the housing element for bleeding air out of the housing element when the pressure differential exceeds a preselected amount; the system also includes a compressed gas bottle and a valve responsive to pressure differential between exterior and interior of housing element in excess of a preselected amount to open and admit gas from the bottle into the housing element until the differential is reduced enough to close the valve.

The unit shown in FIG. 1 is recoilless because the reactions of the two halves are equal and opposite. However, the invention may be practiced by constructing a unit having one radiating piston only, utilizing half the structure shown in FIG. 1. The latter requires reaction mass or rigid support structure. The structure disclosed may be readily constructed empirically to satisfy specifications such as operating depth and power handling capacity displacement, and the like.

The projector **10** is driven by a hydraulic pressure source **40** and reversing valve **42** as shown in FIG. 2. Suitable valves for this system are the commercially available electrohydraulic servo units, such as those made by Moog Valve Co. and Cadillac Company. Also valve mechanisms that have been used in hydrodynamic shake table equipment of the type manufactured by MB Electronics Company of New Haven, Conn., may be used as reversing valve **42**. A solenoid operated hydraulic reversing valve for switching the hydraulic connections between the conduits **22** and **24** and the pressure and return lines of the hydraulic pressure source **40** may be used. Regardless of the type of reversing valve selected, each time the valve operates to reverse connections, the radiating pistons are displaced outwardly or inwardly. The acoustic wave projector **10** may be located a considerable distance away from the reversing valve **42**; as for example when the projector is suspended from a ship into deep water at the end of a supporting cable. In that case, the conduits **22** and **24** may be flexible high pressure hoses.

This invention is of comparatively low cost to construct and operate, lends itself to very high power applications, is of simple construction, does not require delivery of electric power underwater, is rugged and can readily absorb considerable abuse from rough handling and impacts with solid objects in the water without being damaged. Also, it is compact and for a particular overall size and weight is capable of delivering more power to the water compared to other projectors available heretofore. It lends itself readily to continuous duty operation or to impart one pulse to the water and it may be used to generate acoustic noise or message bearing acoustic waveforms.

It will be understood that various changes in the details, materials and arrangements of parts (and steps), which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claim.

We claim:

1. An underwater acoustic projector comprising
a hydraulic motor including a pair of in-line identical cylinders,
identical driving pistons reciprocable in line in the respective cylinders,
two pockets of hydraulic fluid occupying the interior of each cylinder on opposite sides of the respective driving pistons, the pockets of liquid in each cylinder being isolated by the respective driving piston,
a pair of in-line oppositely directed identical planar-faced radiating pistons rigidly joined to the respective driving pistons and disposed exterior of the respective cylinders,
a tubular housing supporting the hydraulic motor therein and the radiating pistons across the ends within the housing,
elastomeric means yieldably joining the perimeters of

the pistons and the inside perimeters of the housing in fluid-tight relationship,
one conduit joined to the further apart interior portions of the cylinders,
another conduit joined to the closer interior portions of the cylinders, said conduits extending through the housing wall in water-tight relationship therewith,
said conduits being filled with hydraulic fluid identical to the hydraulic fluid in the cylinders,
the interior volume of the housing not occupied by radiating pistons, hydraulic motor, and conduits being occupied by gas,
hydraulic means coupled to the other ends of said conduits to transmit equal and opposite forces through the hydraulic fluid to the driving pistons.

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