Dec. 12, 1961 C. S. THOMAS 3,012,534

PRESSURE MINESWEEPING

Filed July 16, 1954

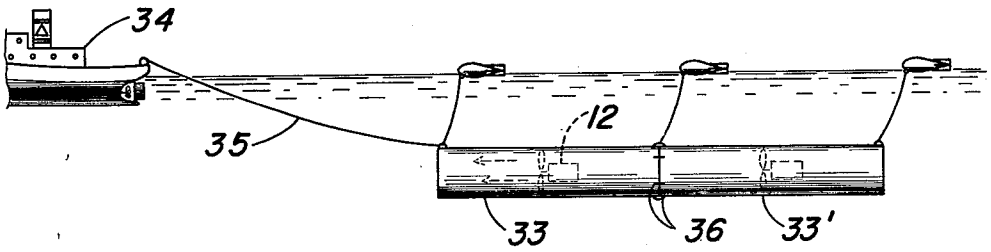


Fig. 4

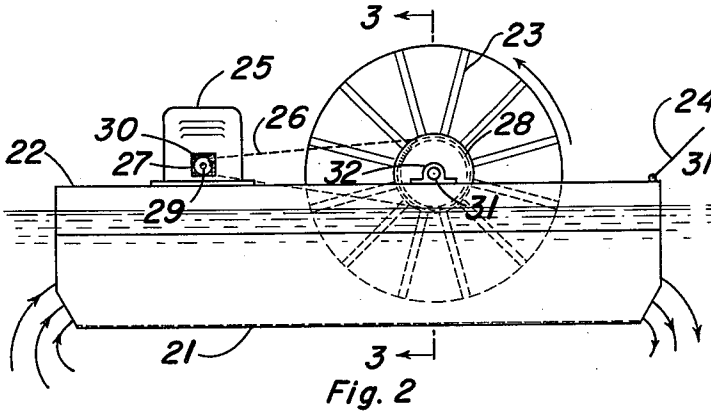


Fig. 2

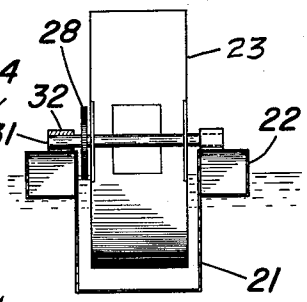


Fig. 3

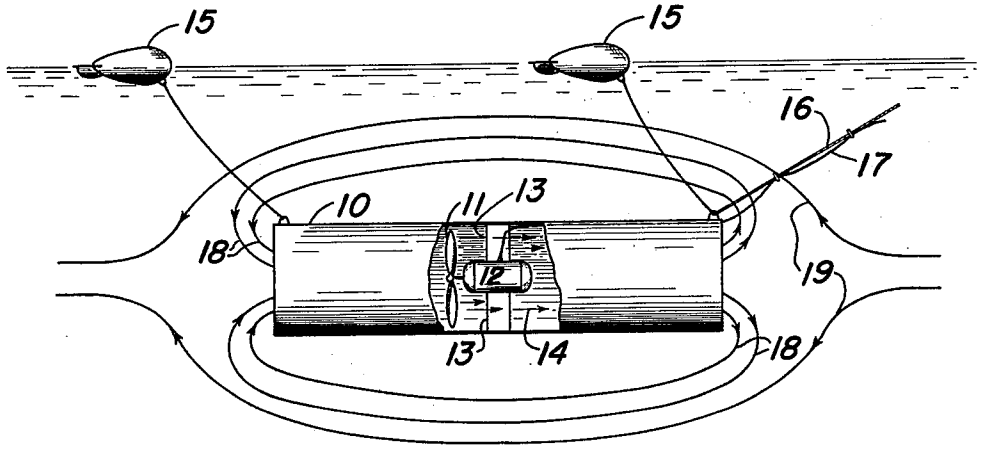


Fig. 1

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PRESSURE MINESWEEPING

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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.

This invention relates to the sweeping of pressure responsive mines and more particularly to a method and apparatus for producing within a mine infested body of water pressure variations of the type and pattern to which the mines are supposedly responsive.

Pressure responsive mines, hereinafter referred to simply as pressure mines, are provided with an actuating mechanism which is responsive to a predetermined reduction within a limited time interval in the pressure of the surrounding water functions to detonate the mine. Pressure mines are usually provided with an electroresponsive detonator operatively connected to a firing circuit adapted to be closed when the reduction in pressure of the water has been continually maintained for a predetermined limited period of time so as to prevent premature detonation by pressure variations which might result from the action of waves as well as to prevent detonation by slow, long term variations of pressure such as result from tides and seiches. These operative pressure requirements are met for the purpose of providing an actuating mechanism which is selectively responsive to pressure changes such as are induced by the passage of a large vessel through a seaway, such pressure variations when plotted against time being commonly referred to as a pressure signature. Some pressure mines are designed so as to require for actuation an accessory signal; usually magnetic or acoustic.

The primary desideratum in pressure minesweeping can thus be said to amount to no more than counterfeiting the pressure signature of the type ship for which the mines are designed with means other and less valuable than such ship, the production of the accessory signal being relatively simple. Ideally, of course, the minesweepers should be able to actuate and thus destroy a mine without being damaged in the process. Also, since areas that are mined are frequently restricted it is highly desirable that the minesweeping gear employed be readily maneuverable.

In accordance with the present invention a pressure signature corresponding to a large vessel is produced by a device whose physical bulk is considerably less than that indicated by its pressure signature. This may be achieved by producing in the water a horizontal flow of water transversely confined for a fixed length and advancing this confined flow of water in the direction of the flow, the arrangement being such that the flow of water creates a source and sink discontinuity, several times larger in cross section than the cross section of the flow confining means, which when moved through the water at a constant speed produces the desired uniform moving field for creating in terms of pressure and flow lines the effect of a solid body moving through the water.

An object of the invention is the provision of a new and improved method and apparatus for sweeping pressure responsive marine mines.

Another object of the invention is the provision of apparatus for simulating under water the pressure signature of a moving vessel.

A further object of the invention is to provide a pressure-mine sweep which can be controlled while in use to simulate selectively the pressure signature of ships of different sizes.

Still another object of the invention is the provision of a method for producing large-ship pressure signatures with a relatively small device.

Another object of the invention is the provision of a device which produces underwater pressure changes accompanied by an accessory signal or signals for sweeping mines having actuators responsive only to multiple influences.

Another object of the invention is the provision of a pressure-mine sweep which is so designed and constructed as to be relatively immune to damage from the explosion of a swept mine.

The invention itself, as well as other objects and advantages thereof, will become manifest from the following description of specific embodiments thereof when read in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing:

FIG. 1 is a side elevation partly in section of a mine sweeping apparatus according to the invention;

FIG. 2 is a side view of an alternative embodiment of the invention;

FIG. 3 is a section taken along the line 3—3 in FIG. 2; and

FIG. 4 shows sweep units connected in cascade being towed through water.

As shown in FIG. 1 a circular hollow cylinder or tube **10** is provided with a propeller type pump **11** adapted to be driven by suitable motive power such as an electric motor **12** mounted axially in the tube **10** by means of diametrically extending spars or spiders **13** for pumping water through the tube **10** in the direction indicated by arrows **14**. The tube **10** may be supported at the desired level below the water surface by suitable buoys **15** and moved through the water by a towing line **16** in a well-known manner. When the pump driving means **12** is an electric motor, power may be supplied thereto through a suitable flexible current carrying member **17** which preferably is married to the tow cable **16** as indicated. It is to be understood that the pump means employed is not important to the invention as long as the desired volume of water is circulated through the tube **10** in the direction it is to be towed through the water. As indicated by the flow lines **18** the water pumped through the tube **10** tends to recirculate as in a closed system, and when the tube **10** is moved longitudinally through a body of water in the direction in which the water is flowing in the tube **10** it creates, at least for pressure minesweeping purposes, the effect of a solid body having a considerably larger cross section than the physical cross section of the tube **10**. Without referring to strict theory of rigorous proof, it is believed to be reasonably accurate to say that this greatly increased effective cross section is brought about somewhat as follows:

The couplet (i.e., closely adjacent source and sink) normally appearing in the vicinity of a propeller operating in the water is expanded by the baffling effect of the tube **10** so that the source and sink become separated by approximately the length of the tube **10** whereby the recirculating water constitutes closed streamlines **18** around which flow lines **19** are formed, it being well known that a closed streamline and a solid body are interchangeable without affecting the flow, hence the movement of the tube and its satellite body of water having an envelope indicated by the outermost closed streamline **18** through the water produces the same flow, as indicated by the line **19**, as would the movement of a solid body of the size and shape of the closed streamline **18**.

Since the device functions as a closed system, at any given towing speed the volume of flow determines the diameter of the discontinuity produced, i.e., the distance separating the outer streamline **18**. Thus, for example, if the tube **10** is made fourteen feet in diameter and towed at six knots, water pumped through the tube at a velocity of thirty feet per second will create a discontinuity approximately twenty-eight feet in diameter and of a length determined by the length of the tube **10**.

If the tube **10** is constructed of paramagnetic material such as iron or steel it will be evident that in addition to producing the desired pressure variations the device will simultaneously produce a magnetic discontinuity which can sweep magnetic mines as well as furnish the magnetic "look" for pressure mines requiring an accessory magnetic signal. Also, the motor **12** and the propeller pump **11** employed for moving so much water will furnish the acoustic "look" for pressure mines requiring an accessory acoustic signal. It will also be evident that the power cable leading from the device to the towing vessel may in itself constitute a magnetic sweep.

When sweeping operations are to be conducted in relatively shallow water the operating principles described above may be incorporated in a more efficient device shown in FIGS. 2 and 3 as comprising a U-shaped channel **21** made buoyant by suitable sponsons **22** and provided with means such as a paddle wheel **23** for moving water through the channel **21** in the direction of tow through a tow cable **24**, it being understood that the particular means employed for moving the water forward through the channel **21** is unimportant. The paddle wheel **23** may be driven in any suitable manner as by an internal combustion engine **25** mounted above water on the channel sponsons **22** and connected in driving relation to the paddle wheel **23** by suitable means such as a chain **26** trained over sprockets **27** and **28** carried, respectively, by the output shaft **29** of a speed reduction gear box **30** connected to the engine **25** and the paddle wheel **23**. More specifically, the paddle wheel **23** may be provided with axially disposed trunnions **31** journaled in bearings **32**, suitably mounted on the sponsons **22**. The sprocket **28** may be mounted on one of the trunnions **31** or secured to the side of the paddle wheel proper. Also, the operation of the internal combustion engine **25** is preferably remotely controlled from aboard the towing vessel in any suitable well-known manner.

With this channel arrangement the efficiency is considerably increased by reason of the fact that the downwardly extending flow, which is the most effective for producing pressure variations at the water bed, is primarily employed. In this connection it may be noted that the arrangement shown in FIG. 1 necessarily dissipates a considerable amount of energy in the flow taking place above the horizontal plane defined by the axis of the tube **10** but this apparent inefficiency can be tolerated or, more accurately, compensated by submerging the device to the optimum depth, thereby reducing attenuation of the pressure change at the relatively deep water bed. This optimum distance from the water bed depends upon so many variables, including the magnitude of pressure change needed at the water bed, the rate of attenuation in the water, the nature of the water bed, and the effective area at the water bed it is desired to sweep at each pass, that it must be determined separately for each particular area to be swept.

It being postulated that to sweep a given pressure mine a predetermined reduction Δp in pressure must be continuously maintained for a period of time t, it becomes apparent that with the device of the present invention the values for Δp and t can be separately varied by altering the rate the water is pumped through the device independently of the speed of tow. The time t varies directly with the towing speed while the value of Δp is a function of both the towing speed and the pumping rate; thus, within the operating capabilities of the device and the towing vessel, the pressure signature of any ship can selectively be simulated.

As indicated in FIG. 4, two or more units **33** and **33'** may be connected in cascade and towed by a surface ship **34** through a suitable cable **35**. The two units **33** and **33'** as shown are connected in end to end relation by suitable metal rings or links **36** which preferably provide a limited amount of play so as to obtain the benefit of a small amount of articulation which renders the device less cumbersome to handle. This cascade or tandem arrangement, in addition to making it possible to adapt the length of the sweep to suit a particular operating situation, also offers the advantage of making it possible in many cases to localize damage resulting from the explosion of a swept mine, it being obvious that one segment or section can be more readily, as well as less expensively, replaced than if the entire unit was an integral mass. Although this cascade arrangement, illustrated in FIG. 4, shows the use of the cylindrical tube form of the device, it will be appreciated that the advantages of the cascade arrangement accrue equally well when using other forms such as the buoyant channel of FIGS. 2 and 3.

The cascade arrangement indicated in FIG. 4 becomes even more advantageous if only the forward unit **33** is provided with pumping apparatus **12** leaving the aft unit **33'** to perform merely the function of confining the flow of water and therefore inexpensive enough to be considered expendable. When this modified arrangement is employed in operation the sweep can be towed at a speed such that the time t elapses just as the rear portion of the aft section **33'** passes over a mine, the result being that a swept mine is exploded beneath or behind the least vulnerable and most readily replaceable portion of the sweep (i.e., a plain confining section containing no pumping equipment). As was discussed above, it is possible to vary the time t with any given sweep system while maintaining the desired value for Δp so that in practice, after the critical time t has been ascertained for the mines being swept, by suitably altering the pumping rate the speed of towing can be chosen to the end that mines when swept will explode at the moment which is most opportune from the viewpoint of damage to the sweeping gear. It might be well to here note that a water filled circular cylindrical tube wholly submerged in water is relatively immune to explosions because the shock waves are transmitted rather than absorbed by the water filled tube, it being a well-known fact that the portions of a submerged body suffering the most damage from underwater explosions are those containing gas filled cavities.

When it is remembered that the pumping action of the water within the sweep exerts a strong driving force opposite the direction of tow the possibility exists for sweeping restricted blind harbors by simply permitting the device to propel itself in a backward direction into the harbor and then towing it forward. No other pressure sweep is known permitting this sometimes very desirable maneuver.

In describing the invention to enable those skilled in the art to understand and practice it, only two embodiments have been illustrated and these only in their essential form since details of fairing, streamlining, finning for dynamic stability, etc., can readily be provided by those skilled in the art, and any description of such details would serve to obscure rather than make clear the real inventive features constituting the present invention.

Although only the preferred embodiments for two different sweeping operations have been described for the purpose of disclosing the invention, it is to be understood that the invention is not limited to these particular embodiments but is of the scope indicated in the appended claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In the art of submarine pressure minesweeping the

method of creating for a given interval of time a desired negative pressure on the bottom of a seaway which comprises producing in the seaway a horizontal flow of water transversely confined for a fixed distance and advancing this said confined flow of water in the direction of said flow at a speed such that said fixed distance is traversed in the given interval of time.

2. In the art of sweeping sea submerged mines responsive to a pressure reduction Δp maintained for a time interval t the method which comprises producing a transversely confined flow of water between two points spaced horizontally a distance d to create in the seaway a source and sink separated approximately by the distance d, advancing said confined flow of water in the direction of its flow at a speed substantially equal to but no greater than d divided by t, and adjusting the rate of flow in said confined flow as an inverse function of the speed of advance, whereby the required reduced pressure Δp may be obtained independently of the speed of advance.

3. The minesweeping method in accordance with claim 2 wherein when said confined flow of water cannot be advanced the full distance d over any fixed point on the water bed or when a running start is impracticable, the

steps consisting in adjusting the rate of flow from below the rate to the rate at which the reduced pressure Δp is produced and maintaining this latter rate for at least the time interval t.

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