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A NEW CONCEPT FOR A DEPOLLUTING SHIP

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ABSTRACT

Accidental oil discharge into sea either from oil tankers or oil terminals demands immidiate surrounding and containments and then removal from the water surface to an empty tanker or to shore facilities. Removing the oil from water surface normally termed oil Skimming is a difficuilt operation. Several methods have been tried with certain degrees of effectiveness due to the high water to oil ratio of the mixture.

The following paper gives as a skimmer the Archimidean Screw which skims the oil from the water-oil interface, collects it in a ship of proposed design where it collects and the water settles down and eventually finds its way to the sea leaving the oil to be collected in a separate compartment to be finally pumped to a tanker or shore reservoir.

1. INTRODUCTION

Skimming of oil spilled from a tanker or a pipe line is the concern of authoroties and public opinion all over the world. Various types of skimmers have been designed, produced and operated in different parts of the world. However a widely accepted design so far has not been developed which satisfies all requirements.

The main function of an oil skimmer is to remove as much oil in the shortest time from the sea surface. Pumps, though they are capable of pumping large volumes of liquid, yet they cannot pump oil only due to the relatively thin oil layer and the possibility of air suction. Usually skimmers remove a mixture of oil and water, the higher the oil to mixture ratio, the more efficient the skimmer is.

The design described here after for a depolluting ship comprises two parts, viz the skimmer and the depolluting ship.

1.1 The Skimmer

In 1972, the Author red a paper before a conference arranged by the University of Alexandria Egypt, and put foreward the use of the Archmedian Screw as an oil skimmer, based on some experimental laboratory tests. (1).

Since then the subject has undergone further studies. The characteristics of the Archmedian screw as on oil skimmer

were the subject of a thesis submitted to the University of Alexandria by Dr. Hathoot for which the Author was the principal supervisor.

The Archemidian Screw as an oil skimmer has several favourable characteristics; among these are the following:

1. It skimms oil from the water surface without disturbing the water. Therefor it can skim pure oil with very little or no water if the thickness of oil layer is thick enough.

2. It is a slow running device hence oil and water do not form emulsion. Hence final separation of oil and water will be much easier.

3. The lifting capacity of the screw is fairly large and may be multiplied by fixing more than one screw on one depolluting ship.

4. The diameter of the screw can be chosen to suit the expected thickness of oil layer.

The efficiency of the Archmidean screw as an oil skimmer depends on the following factors:

1. Ratio of oil layer thickness to the screw diameter.

2. The immersion of the screw in the oil and whether its tip pierces the oil-water interface.

3. The angle of inclination of the screw and amount of lift.

4. The pitch angle of the screw.

5. the turning speed of the screw.

6. The vertical position of the screw axis above the fluid surface.

The volume discharged by an Archimidean screw becomes maximum if the center of the screw end lies on the upper surface of the oil layer. If the thickness of oil layer is equal to or greater than the screw radius then the screw will skimm pure oil. Even if the tip of the screw pierces the oil water interface the ratio of the water in the mixture will be small, due to the pointed geometric shape of the tipped end of the screw.

The Depolluting Ship

The depolluting ship is supposed to operate in connection with booms towed by tugs Fig. (1), which surround, the oil spill and confine it within a limited space where the depolluting ship operates.

The design of the ship itself is based on a constant draft principle. This is achieved by making the compartment where the oil-water mixture is collected to be open to sea through openings controlled by valves. Before skimming operation

takes place this compartment will be full of water and the ship will float at a draft corresponding to the weight of the ship. When skimming takes place and the oil-water mixture finds its way into the collection compartment, the head inside the compartment increases above the head of water outside the ship thus the water inside the compartment escapes to sea. The water in the water-oil mixture will fall downwards leaving the oil,being lighter, in the upper part of the compartment. Thus the water in the mixture will, eventually, find its way to sea. This process will lead to a high degree of water-oil separation. The oil will either be stored in the compartment, if it is of smaller quantity or pumped to an attending oil tanker if the spill size is large.

The ship itself is open at its foreward part for the whole depth except for some sort of double bottom which is supposed to be used for ballasting. The sides in the foreward part will be voids to give the ship the required buoyancy and may be used as stores, chain lockers etc.

The ballast tank will be used to give the ship the necessary trim compatible to the thickness of the oil layer.

Operation of the Depolluting Ship

First the ship will be trimmed such that surface 1 in Fig. (2) will be just below the water-oil interface. If this surface is above the water-oil interface, oil may find its way under the ship's bow bottom escaping to the sea.

When the ship moves foreward under the effect of tugs through the booms and its own engines, the oil will be trapped and forced into the ship's open bow, into space A. This is helped by the rotation of the vaned wheel (2).The mixture entering space A will contain oil and water, the oil being lighter will float up and the water will fall down. The bottom of space A is sloped downwards to help the separation of water from oil and increases the thickness of oil layer which the Archimidean Screw skimms.

The Archimidean Screw(s) will discharge into a transverse channel(3) leading to two longitudinal ducts(4),one port and one starboard which slope downwards into the collecting compartment(5), where any remaining water will be separated and finds its way to the sea as explained before.

Positioning of Archimidean Screw(s)

The Archimedean Screw is positioned in the ship in a way such that its intake will be as near as possible to the centre of flotation of the water plane. In this way its vertical movement caused by ship pitching will be minimal.

The intake end can be made adjustable in the vertical direction to control the immersion of the intake position according to the thickness of the oil layer. In addition screws of different diameters can be used according to the size of the spill and its thickness. Such arrangements viz, the change of the vertical position of the screw intake end

and/or changing the screw diameter will help to control the ratio of water to mixture lifted by the screw.

Water-Oil Separation

The operation of the ship in the way described before gives the mixture ample time to separate the water going downwards and the oil floating upwards. The Archimidean Screw is a slow running device and the liquid will glide on the spiral surfaces smoothly, hence, conditions are such that emulsion does not take place.

Pumping of Oil Overboard

The intake of the discharge pump is taken from the top part of the containing compartment. When the pump works the head inside will be reduced allowing sea water to flow inside raising the oil upwards to be pumped overboard. This operation will continue until the pump starts to pump water.

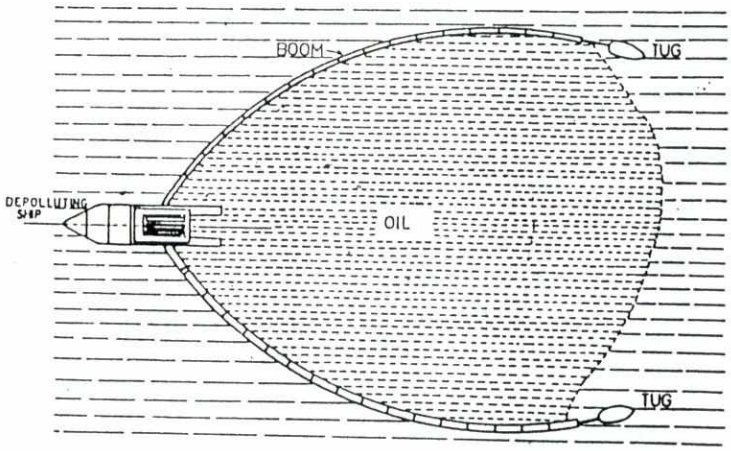
Skimming Capacity of The Proposed Ship

An Archimidean Screw can lift quantities of water varying to more than 150 m^3/hr depending on its diameter, r.p.m., the inclination, lifting head, the amount of immersion of the intake end etc. with multiple screws the ship can handle hundreds of tons/hr mixtures with a very high oil ratio.

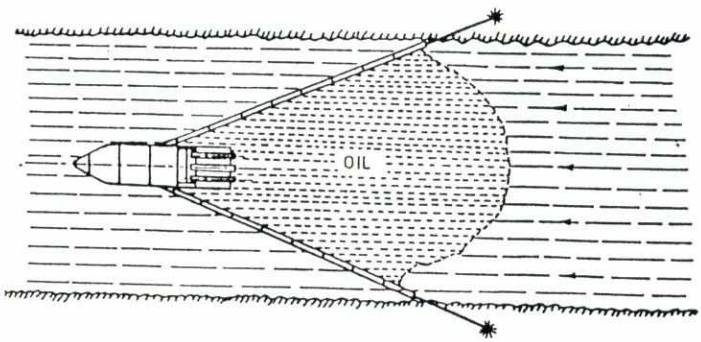
This makes a depolluting ship fitted with Archimidean screws very suitable to handle large spills.

CONCLUSIONS

a. The Archimidean screw can be used as an oil Skimmer which can skim large quantities of oil. It is a slow running device hence it does not cause the formation of emulsion, hence oil water separation will be much easier and in a short time.



DEPOLLUTING SHIP IN OPEN SEA.



DEPOLLUTING SHIP IN A RIVER.

FIG.(1)

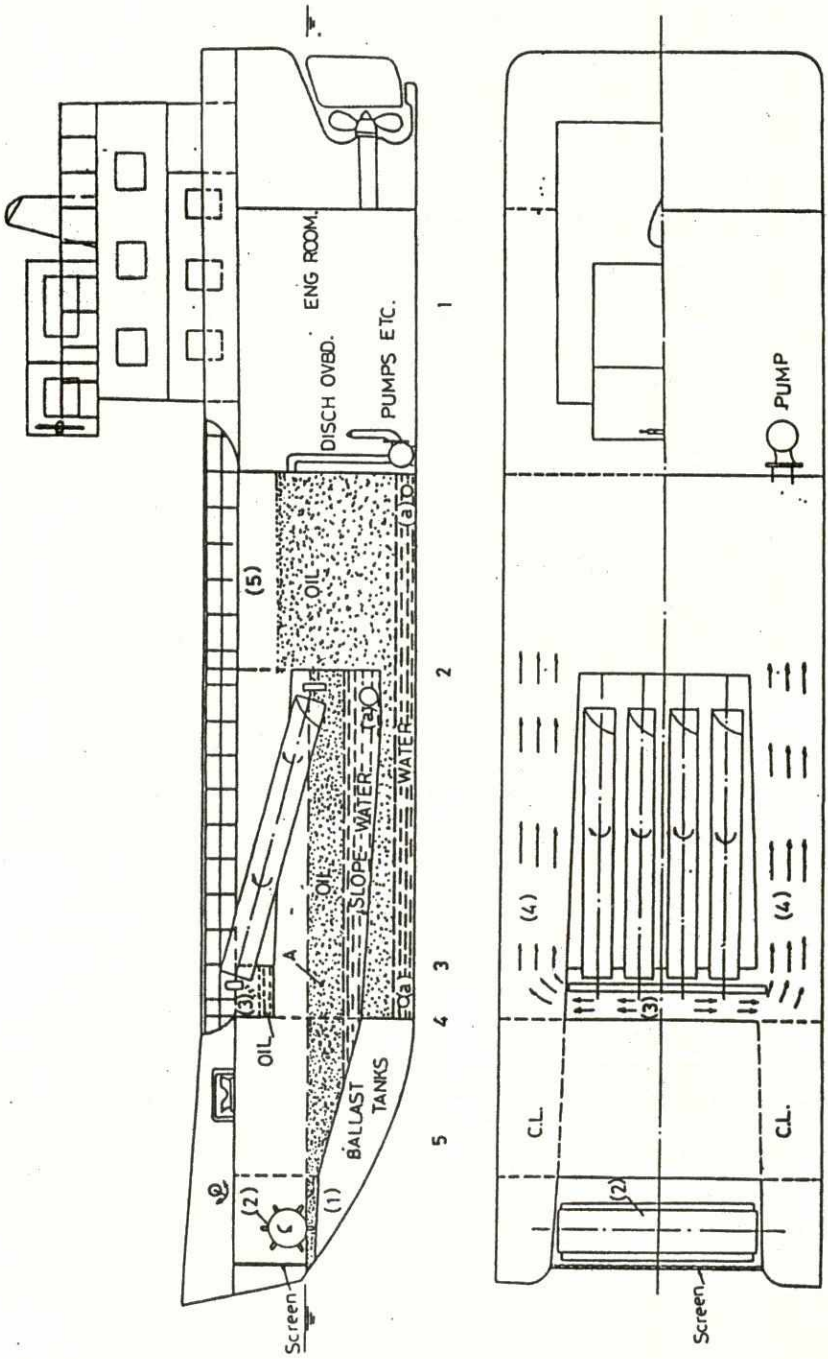


Fig.(2)
GENERAL ARRANGEMENT
SCHEME FOR A DEPOLUTING SHIP
Scale 1:100

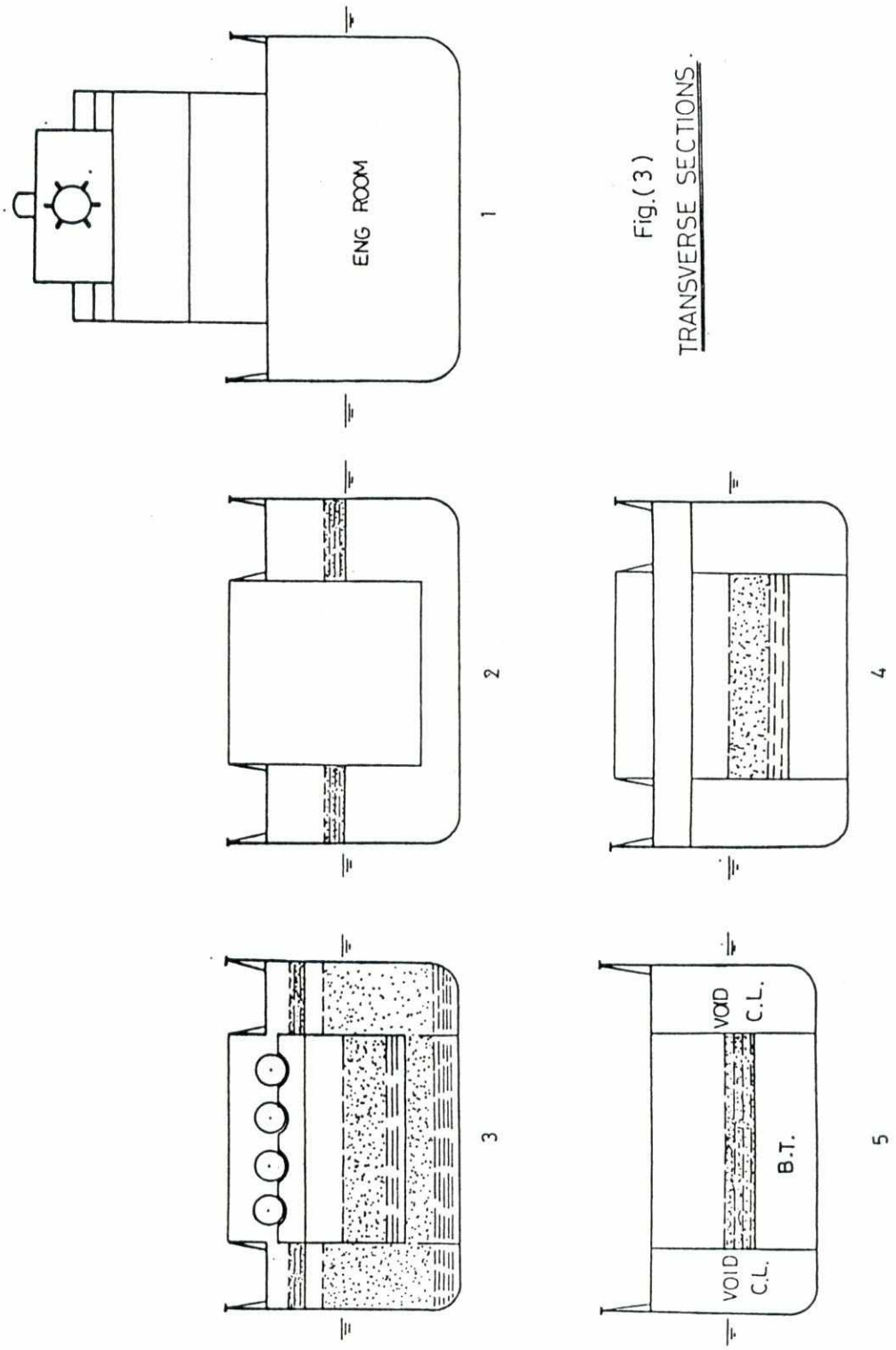


Fig.(3)
TRANSVERSE SECTIONS.

b. The proposed ship works on the constant draft principle which is suitable for the use of the Archimidean screw. It can keep the oil in its own holds if the oil slick is small or the oil can be pumped to an attending tanker in case of large volume slicks.

c. Experiments show that the oil to mixture ratios coming from an Archimidean Screw skimmer may be nearly 100 % if the oil layer thickness is large enough.

d. Mechanical problems such as the type of drive of the screws and their installation are not much difficult and can be decided upon as a part of the design details.

e. The movements of the depolluting ship i.e. pitching heaving and or rolling will not impair the function of the screws more than any other method of skimming.