NOTES ON WIRE-DRAG SURVEYS.

prepared by

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With the increasing draught of surface vessels and the greater mobility of submarine craft when submerged, the question of the means for providing safe navigation may almost be said to have assumed a different aspect.

Before the advent of deep draught vessels of the present day, it was customary to consider the five-fathom contour as a danger line more or less; nowadays the 7-fathom contour line must take its place and the area of water requiring close examination during a survey must in consequence be largely increased.

Recourse has been had to sweeping, a laborious and lengthy operation, requiring immense patience and unflagging zeal.

The United States Coast and Geodetic Survey has experimented a great deal for some years in the conduct of wire-drag surveys, and the results have been fully commensurate with the cost and labour involved. A very large number of hitherto unknown shoals, some of them lying in well-sounded areas, have been discovered and fixed; in one area of 4,000 square miles, no less than 3,500 new shoals were found with the wire drag.

A brief description of the method adopted and of the gear used is therefore of interest. Of the first importance is the selection of the vessels to be employed as drag vessels. The nearest approach to the type of vessel employed by the United States Coast and Geodetic Survey is the steam launch of the Dockyard Harbour Launch type, that is to say, about 50 feet in length, 12 feet beam, and with a draught of about 5 1/2 feet.

It should be fitted with a short stout mast, the necessary winches for dealing with the drag rope, a davit for hoisting in the buoys, and a suitable position and arrangements for plotting the fixes obtained during the progress of the sweep; guide shoots for the drag wire and sufficient storage for the wire gear, buoys, sinkers and floats require attention.

One or two smaller craft are also necessary to act as tenders for clearing the wire when foul of the bottom, adjusting the depth wires and sounding on the newly discovered shoal. These vessels should possess good weatherly qualities and should be able to remain under way for so long as it is possible to continue the sweep, and one of them should be able to take the place of one of the drag vessels in the event of a breakdown.

The following general description of the wire drag is taken mainly from the United States Coast and Geodetic Survey special publication No. 56 published in 1919. The wire drag consists primarily of a wire, called the bottom wire, towed at a certain distance below the surface of the water for the purpose of finding or proving the non-existence of hidden dangers to navigation. The remainder of the gear consists of various parts, the objects of which are to maintain the bottom wire at a constant known depth, to enable changes to be made to conform with tidal movements or to pass over known shoals, to prevent the bottom wire which is not caught on an obstruction from sinking to a greater depth when a shoal is found, and to float the ends of the bottom wire in case of a break.

The drag is controlled by two vessels, one at each end, known as the "guide" and the "end" vessel respectively.

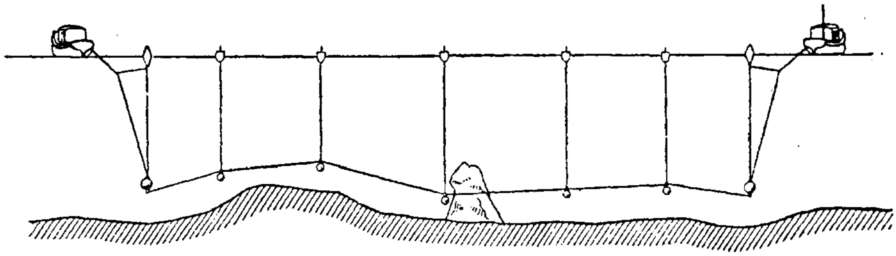


FIG. 1.—DRAG SET AT DIFFERENT DEPTHS.

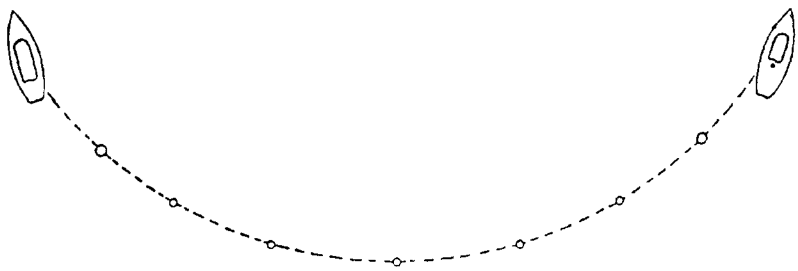


FIG. 2.P—LAN OF DRAG UNDER WAY.

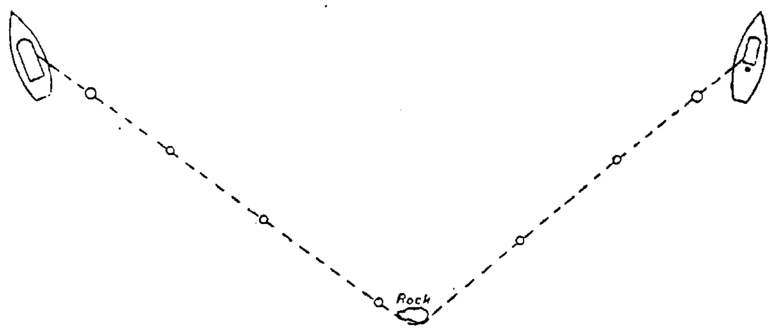


FIG. 3.—PLAN OF DRAG AGROUND.

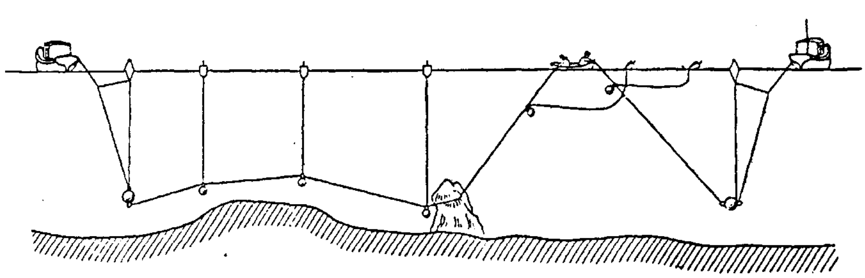


FIG. 4.—CLEARING DRAG.

The function of the former is to keep the drag moving along in the required direction, and that of the latter is to stretch the drag to an effective length and to assist the "guide" vessel to advance.

The wire drag when operating freely takes the form of a curve. On striking a submerged object, indication is given by the increased pull on the tow line, the extra strain brought upon the engines, and the capsizing of the floats in the vicinity of the apex of the wire, that is, of the obstruction, which is caused by the removal of tension from the uprights connecting the buoys with the bottom wire. (See Figures 1, 2 and 3).

As soon as a shoal is found, the tender and possibly the "guide" vessels proceed to the spot to obtain soundings, every effort being made to discover the least depth: the position is carefully fixed and finally the drag is removed from the shoal, re-adjusted to clear the known depth, and set in motion again. (See Figure 4).

The clearance is often a tedious business and may occupy a long time, but with practice it should be possible to maintain an average of about a quarter of an hour for this work.

The United States authorities have found a wire sweep of 12,000 feet quite easy to manipulate; it takes about half an hour to lay this out, and the rate of progress in clear water and given good weather conditions is about 1 1/2 knots.

Sweeping is carried out in the direction in which the tidal stream is setting as it has been found very difficult to work directly against the stream or diagonally across it unless it is very weak.

Experiments have been made using a sweep 24,000 feet in length using four drag vessels, and successful sweeps have frequently been made with a 15,000 feet drag wire.

DEFINITIONS OF THE GEAR USED IN WIRE DRAG WORK

Length of upright :– The distance from the water-line of the buoy, when the drag is at rest, to the point of attachment of the upright to the bottom wire.

Drag Depth :– The distance between the water surface and the bottom wire when the drag is under way.

Effective depth :– The difference between the plane of reference, such as mean low water, and the bottom wire when the drag is under way.

Length of Drag :– The length of bottom wire between the ends of the drag.

Section :– That part of the drag between two uprights.

Unit :– The part of the bottom wire between the sockets which break its continuity (in practice, 100 feet).

DETAILS OF WIRE-DRAG GEAR AND METHODS OF USING

The bottom wire is made of double galvanised, 7-stranded steel wire, one-eighth of an inch in diameter, with a tensile strength of about 2,000 pounds.

This wire is cut up into 100-ft. lengths and a special drop-forged, open socket is attached at each end. A larger wire may be required in places where the current is unusually strong, in which case a wire three-sixteenths of an inch in diameter is recommended. These 100-ft. units are connected by quarter-inch galvanised, drop-forged, steel swivels. To facilitate the attachment of floats and weights, a long link of quarter-inch round iron, about 3 inches long, is welded into one of the eyes of the swivel. (See Figure 5).

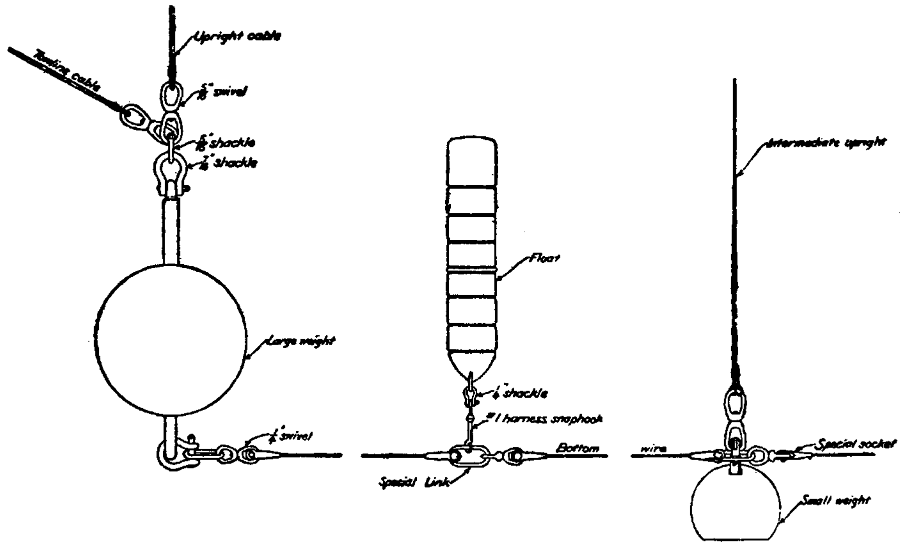


Fig. 5

Large and small weights are used, the former for the two extremities of the sweep, and the latter for the intermediate points at distances of 300 and 600 feet apart, depending on the length of the wire drag.

The longer the drag, the further apart is it permissible to space the weights. The details of these floats and weights are shown in Figure 6.

The large and small buoys shown in Figures 7 and 8 require some explanation.

The large buoy is constructed of No. 71 galvanised, rust-proof iron, except the top plate which is of 3/16 in. galvanised boiler plate. All joints are made watertight and it is strengthened against crushing by internal bracing. A central galvanised pipe, 1 1/2 in. diameter, the projecting ends of which are threaded to take bell-shaped leaders, passes through the centre of the buoy, and through it passes the upright. When in use the buoy is protected by rope netting, in which a strong eye is worked for the tow-line attachment. The winch on top of the buoy (see Figure 7) is fitted with upper and lower shafts with brass 4-1 reducing gear and locking pawl; it is secured to the buoy by 6 machine bolts which screw into the top plate. Wooden washers are inserted between the hoist and buoy top on all buoys. A protective framework of strap iron is fitted on the large buoys.

Small buoys (see Figure 8) are constructed of rust-proof iron 3/32 in. thick, with a top of 1/8 in. boiler plate. The manufacture is similar to that

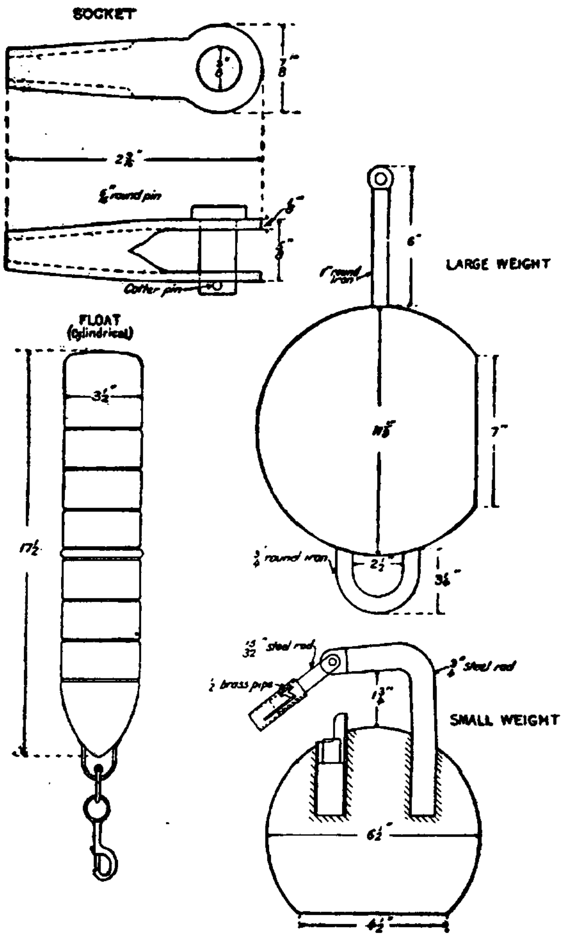


FIG. 6

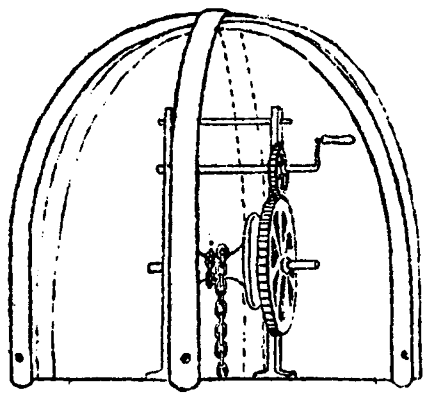
of the large buoys; they must be capable of being submerged to a depth of 50 feet without crushing and should be galvanised when completed.

The iron frame of the winch is curved in such a way that a line projected from the centre of the pipe will fall half way between the drum core and the outside of the flange. The inside distance between the frame uprights is 2 inches. The drum which is keyed to the shaft consists of a hard wood core 1 7/16 in. wide and 3 in. in diameter, to which galvanised iron flanges 7 in. in diameter are attached by countersunk screws. A ratchet and pawl are fitted to each hoist.

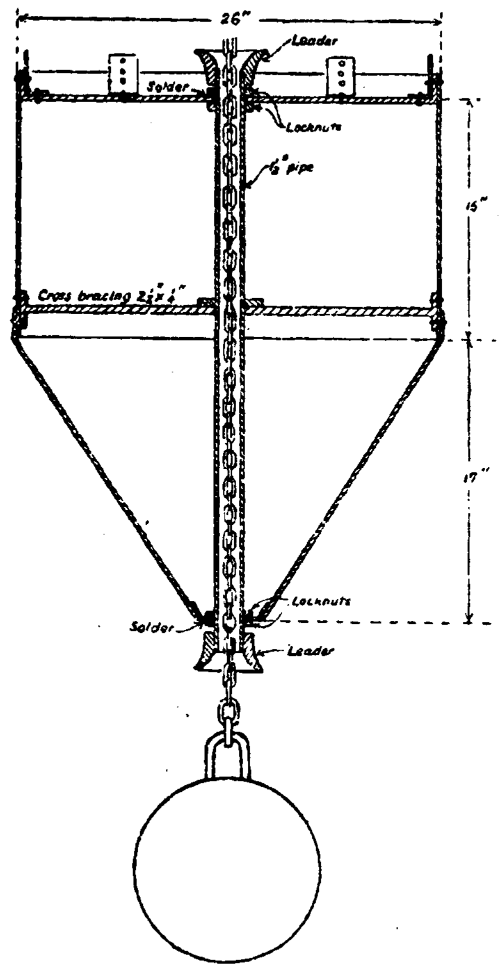
The projecting pipe at the lower end of the buoy is fitted with a threaded case-hardened steel leader with a bell-shaped mouth which should be about 4 in. long and 2 1/2 in. in diameter and should be sufficiently heavy to steady the buoy in the water.

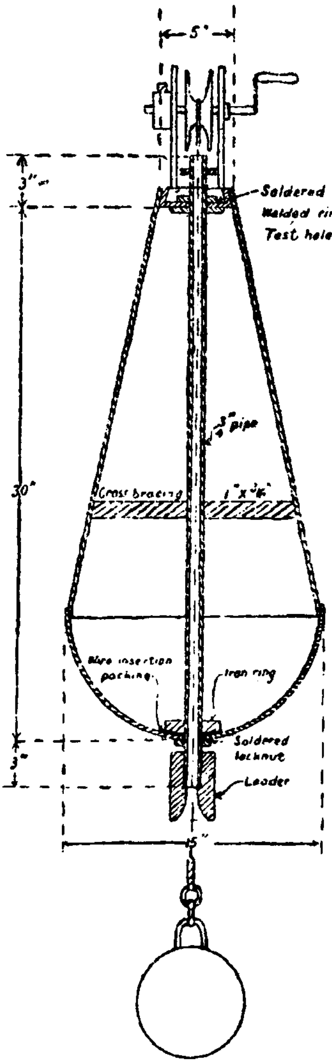
A lanyard is attached to each buoy to secure the buoy when making depth changes.

LARGE BUOY



Elevation of upper portion





SMALL BUOY

(Sectional view of centre)

FIG. 7

Sectional view of centre

FIG. 8

FLOATS

The Float is shown in Figures 5 and 6. It is hollow and constructed of aluminium plate. It is strengthened by corrugations and internal webbing, since it must stand submerging to 200 ft. without crushing. The float is attached to the bottom wire by a swivel and spring hook, which is shackled to the small fixed eye at the end of the float.

A welded iron float has been used, and also cedar wood floats, but they are not so satisfactory, and in the case of the latter it becomes necessary to boil them in paraffin and thoroughly dry them after every ten days' use, as they become saturated with water.

UPRIGHTS

For use with small buoys (see Fig. 8) the uprights are made of 3/16 in. extra flexible steel wire rope, composed of 6 strands of 19 wires each. The drum on the top of the buoy will hold 65 feet of this rope, which is cut into lengths of 67 feet to allow for spare rope, a 5/16 in. galvanised drop-forged swivel being attached to one end of each length with a served clove hitch. The reference point on all buoys is the top of their central pipe and it is therefore necessary to commence the marking of the uprights at a distance from the swivel equal to the height of the pipe top above the water surface when the drag is at rest. Beginning at this point the upright may be marked in any convenient manner in feet, using paint instead of bunting or leather, and serving with twine where necessary to mark the intermediate feet.

When working the drag at a depth of over 65 feet, additional fixed length uprights are attached. These are fitted with a spring hook at one end and a swivel at the other.

For use with large buoys the upright is made of 3/16 in. galvanised chain cable and is marked in the same manner as the small uprights, except that as the drum of the winch will only hold 45 feet of chain, the lower portion is replaced by an unmarked 20-foot length of 5/16 in. steel wire rope.

The upright is attached to the top of the rod on a large weight, and it has been found that, when dragging, the weight forms an angle of 20° with the horizontal. The index correction for the large upright is therefore obtained by subtracting 1/3 of the total length of the weight from the height of the reference point above the water surface.

TOW-LINES

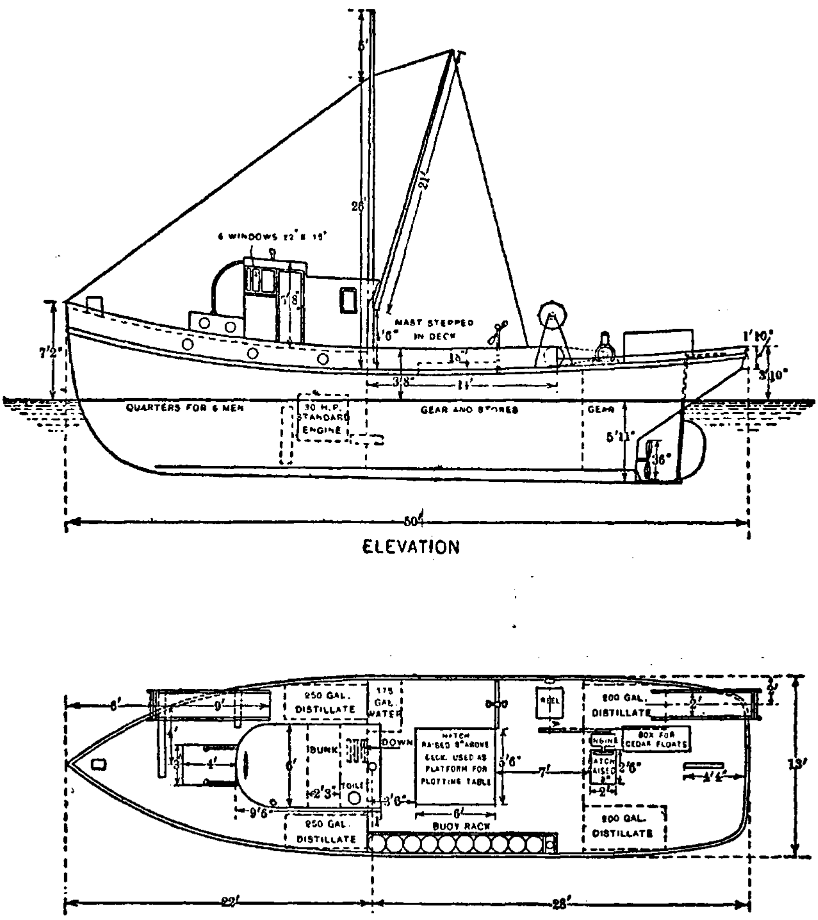
The tow-line consists of one part rope and one part 5/16 in. galvanised steel wire. The rope tow-line will be described later.

The wire tow-line is made up in 100 foot units at each end of which a thimble is fitted. A 5/16 in. swivel is inserted in one eye of each unit and the units are connected by 5/16 in. shackles. The tow-line consists of a bridle and a straightaway; the object of the straightaway and the lower part of the bridle is to transmit tension from the towing launches to the drag, while the upper part of the bridle keeps the large buoy directly over the large weight and ensures an invariable tow-line base.

A swivel eye and galvanised iron spring hook are shackled on to the free end of the upper bridle for securing to the large buoy. Floats are attached to the tow-line which is 300 to 500 feet in length, in the same way as on the bottom wire.

THE LAUNCHES

Elevations and plans of typical "guide" and "end" launches are shown in Figures 9 and 10 and require little further description.



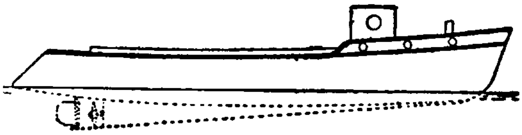
DECK PLAN

PLAN OF LAUNCH "ROOSEVELT."
Showing arrangements.

FIG. 9

Two important features of satisfactory wire drag vessels are, single control when setting out and taking in the drag, and the fitting of the exhaust (if the vessel has an internal combustion engine) at some point where the exhaust vapours will not interfere with observing and plotting angles.

The tendeı is shown as an inset in Figure 10. Its work is to patrol the drag, change the setting of the depth, i.e. of the uprights, clear the drag



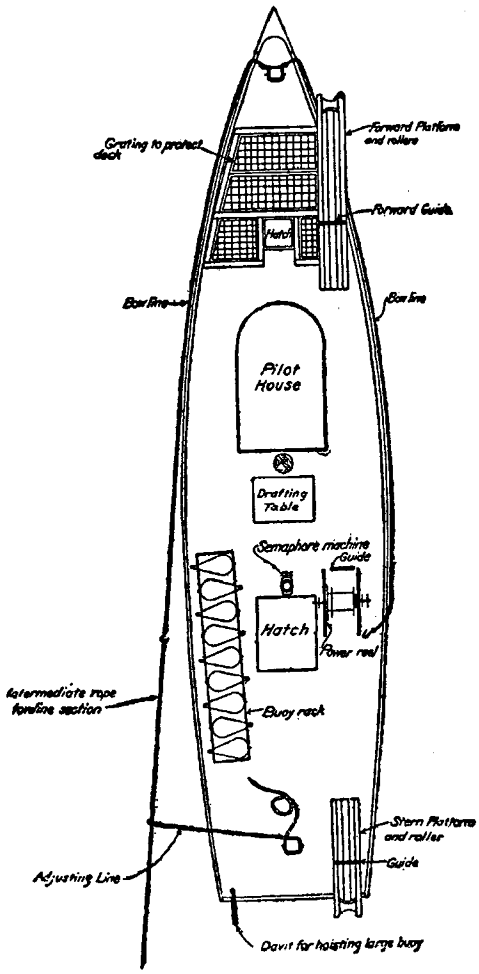


FIG. 10

from shoals and remove any visible obstructions, such as "crab-pots" etc., from its path.

The "guide" and "end" launches are fitted with an electrically driven winch, on which is a drum divided into two portions for tow-line and wire, and securely keyed to the shaft; it is fitted with brake and operating levers, and can be worked by hand in the event of a breakdown of the current.

The rope tow-line is of 1 3/4 in. hemp and is in two parts.

A bow line is attached at the bow and led off on both sides to a point about 10 feet abaft amidships, a steel hook being spliced into each end. A section about 35 feet long with an eye spliced in each end connects the wire tow-line to the bow line hook; an adjusting line of the same size rope is used to distribute the towing strain and to keep the tow-line clear of the propeller. It is as well to fit a tripping device to one end of the rope connecting the bow line with the wire tow-line, so that in case of necessity the drag can be slipped instantly.

OPERATION OF THE WIRE DRAG

In order to carry out a wire drag survey efficiently the following are necessary :–

1. A trained staff of officers and men.
2. The usual instruments and surveying stores required for sounding, together with a field board in each launch and if possible in the tender.
3. Approximate tidal predictions.
4. All available data regarding soundings in the area to be swept.

The sweep is carried out by setting the uprights to the necessary depth and towing the drag wire through the water over the area required to be examined. The area thus covered must be overlapped in subsequent sweeps, so as to ensure the whole being thoroughly gone over.

An examination to a depth of 50 feet is considered sufficient for surface navigation and 100 feet for sub-surface craft in deep water approaches etc., but local circumstances must often be the determining factor in narrow or comparatively shoal areas.

When the drag is towed through the water there is usually a slight lifting of the bottom wire. This rarely exceeds two feet, but the actual amount must be determined by the tender. For this purpose a tester is used, consisting of a half-inch brass rod, about 3 feet long, secured to a small chain, the rod and chain being marked in the same way as the uprights. The method of use is as follows :–

The tender stops at a point ahead of the drag opposite to the point to be tested, and lowers the tester to a depth approximately equal to the upright length; when the bottom wire strikes the rod, the tester is hauled up until it clears. The difference between the depth given by the tester when it clears the bottom wire and the setting of the latter gives the lift.

A little experience will give sufficient data to enable the uprights to be set with the lift allowed tor, and only a small alteration in the uprights will be necessary.

The tendency to lift decreases as the effective drag depth is approached. The most efficient effective width is about 90 % of the total length of the drag.

In deep water the drag is usually set to one depth and it is customary to avoid altering the uprights by setting them for the maximum height of the tide for the day.

In shoal water frequent depth changes are unavoidable when there is any large range of the tide, and it is not good practice to have the difference in length between adjoining uprights less than 1/40 of the distance between them.

SETTING OUT THE DRAG

Woik is arranged on the field board in the same manner as for a day's soundings, that is, the area to be covered is indicated by drawing in the proposed track of the "guide" and "end" vessels.

The drag is usually set out from the launches when under way. Two floats are attached to the end of the bottom wire and it is passed overboard through the after "guide".

In laying out, the setting of each upright will be checked by an officer, a second officer will attend the electric winch for paying out and controlling the wire. One man attaches the floats, another the weights, while a third tends the buoys. At each connection the winch is stopped and a float is attached, and weights and buoys are similarly dealt with until the final section is paid out and the large weight attached. The bridle and tow-line together with their floats are then connected and the large weight is lowered down on a bight and slipped.

The end launch picks up the end of the bottom wire, first laid out by the "guide" launch, as soon as she can, shackles on the large weight and buoy, attaches the tow line and lowers the large weights; she is then ready to commence towing.

If the "end" launch is required to set out any of the drag, she connects with the floating end first dropped by the "guide" launch and continues to lay out the wire in the same manner as the latter.

In narrow channels, it is best to anchor the launch and allow the tender to tow the bottom wire, stopping as required for the attachment of weights etc.

After the drag is set out, the launches proceed, each heading outwards from 10° to 20° from the line of advance; when there is considerable current it will be found necessary to head outwards considerably more than this. The rate of advance is limited, because if too rapid a rate is attempted, the small buoys will capsize and there will be too much lift on the bottom wire.

As the drag proceeds, the position of the towing launches is fixed from time to time and the large buoys are observed at the same time; their distance from the launches being known, they can then be plotted.

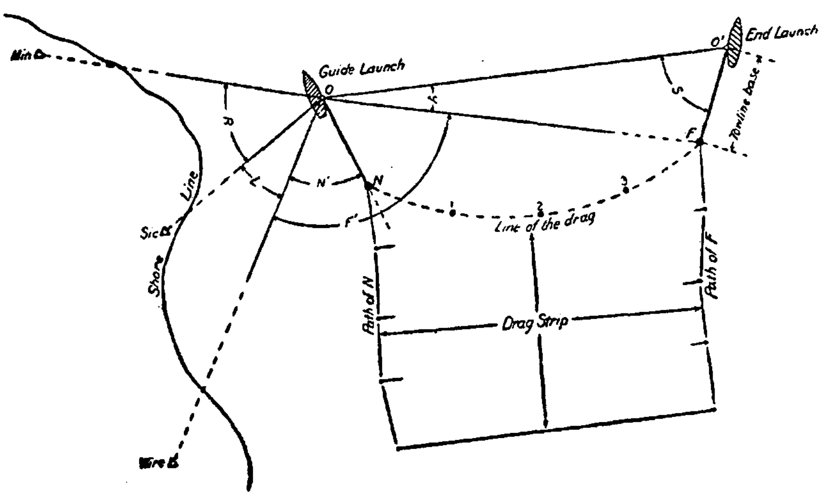


Fig. 11

It is possible, as indicated in Figure II, to plot all positions from the "guide" launch, provided the angle *S* is signalled from the "end" launch at the time of fixing, but space does not permit of this method and the special instruments required, viz. position protractor, computer, and buoy spacer, being fully described in this article.

TAKING IN THE DRAG

To take in the drag, the electric winch is started and the launch stops and goes astern a little so that the end of the wire tow-line can be hauled on board. This is detached from the rope tow-line and secured to a line leading forward from the fore platform and back to the winch where it is secured to the tow-line compartment. The launch then heads towards the large buoy while the tow-line is reeled in.

Floats and weights are detached as they come in, and the operation of setting out the drag is repeated in reverse order.

A considerable quantity of spare stores is necessary, particularly wire swivels, shackles, thimbles, marline, paint, etc., etc.