BRITISH ADMIRALTY MARK IV OROPESA SWEEP.

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This is a single-ship sweep for use at speeds up to about 12 knots and was originally designed for mine clearing. For surveying purposes it has been modified in certain particulars and has proved extremely valuable in locating wrecks and shoal patches. It can be used as a single sweep, *i.e.*, on one quarter only, with a maximum useful spread of about 600 feet, or as a double sweep with twice that spread. The principal items of the equipment are :—

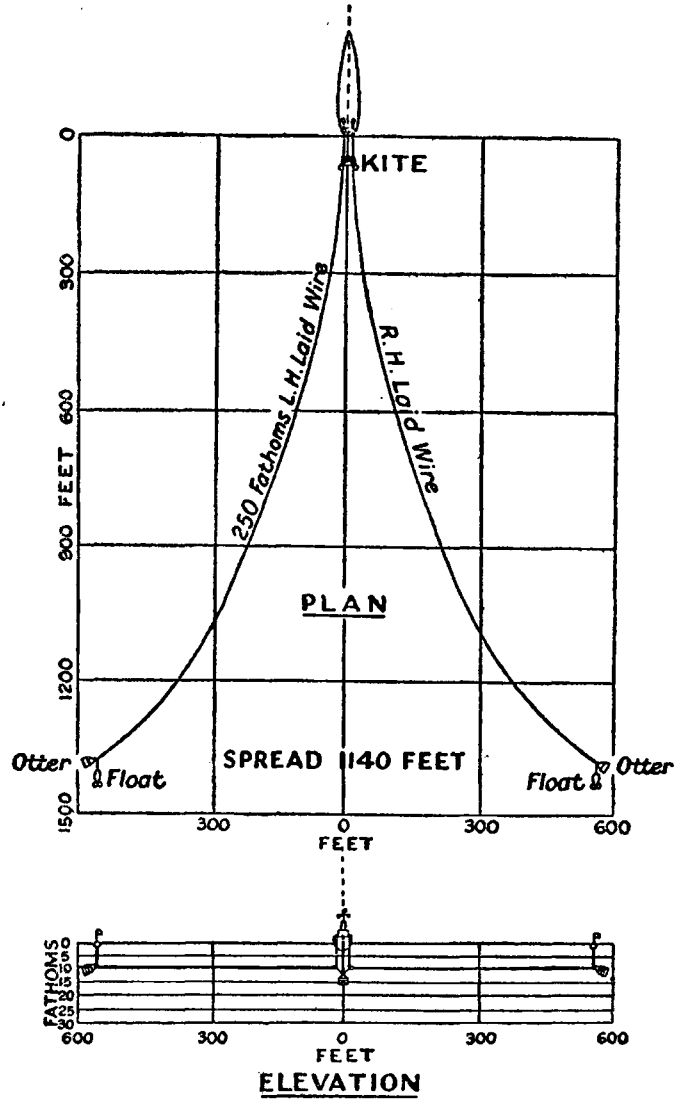

FIG. 116.

(1) *Three Kite Otter Multiplanes:* rectangular steel box-frames fitted with vanes. Two are used as *otters* for pulling the sweep out on either quarter and the third as a kite for keeping the ship end of the sweep down; the construction of all three is identical.

(2) *Two Sweep Wires:* each of 450 fathoms of 1 1/4" British mine-mooring wire, one right-hand laid for use on the starboard quarter and one left-hand laid for use on the port quarter.

(3) *Kite Wire:* 100 fathoms of 1 3/4" E.S.F.S. Wire.

(4) *Two Floats:* for supporting the otters.

(5) *Two Snatch Blocks and* 1 1/4" *Wire Pendants:* for connecting the sweep wires to the kite.

(6) *Two four-legged chain Slings:* fitted on a beam with bottle-screw adjustment, for securing the sweep wires to the otters.

(7) *Three-legged Chain Slings:* one leg fitted with bottle-screw adjustment, for securing the kite wire to the kite.

(8) *Float Wires* (1 1/4"): in various lengths up to about 30 fathoms.

To work the gear, two winches (or a double winch) to take the sweep wires and fitted with friction brakes are required on deck, and a third winch or capstan to take the kite wire. Hand cranes for hoisting the floats and otters in and out should also be fitted. The manner in which the sweep operates is shown in Figs. 116 and 117.

Fig. 116 shows the sweep in plan and in elevation from astern; fig. 117 shows it in side elevation. As the ship steams along, the kite pulls down on snatch blocks through which the sweep is rove and so keeps the ship end of the sweep down to a set depth, whilst the otters pull out on each quarter and spread the sweep. The otters have a tendency to dive but are restrained by the floats to which they are connected by float wires. The natural tendency of a wire being towed through the water would be to take the form of a catenary, but, by using right-hand laid wire on the starboard leg and left-hand laid wire on the port leg, the wash of the water on the lay provides a lifting action which increases with speed. The speed of the ship can be adjusted in relation to the spread of the sweep so that a practically flat sweep is obtained. For example, if 140 fathoms of sweep wire are veered (giving a spread of about 435 feet on each leg), the speed through the water to obtain a flat sweep must be 7.7 knots; with 240 fathoms veered (giving a spread of about 570 feet on each leg) the speed must be 8.3 knots.

The depth of the sweep wire at the otter ends depends primarily on the amount of float wire used and to a lesser extent on the speed at which the sweep is towed. To alter the set depth of the otter end, it is necessary to heave in the sweep and hoist in the otter and float so that the length of float wire can be changed. The depth of the sweep at the ship end is regulated by the depth of the kite which can be altered at any time by veering or heaving in the kite wire which should be marked at every fathom of its length.

Each float carries a staff and flag so that the outer ends of the sweep are indicated and can be seen from the bridge of the ship. Thus by bearings and rangefinder distances of the floats, the spread of the sweep can be checked at any time.

Depth recorders are available for testing the accuracy of the depth-keeping of the sweep wire, to which they can be shackled between puddings at any convenient point. They are only intended for use when testing the gear and should not be attached at other times.

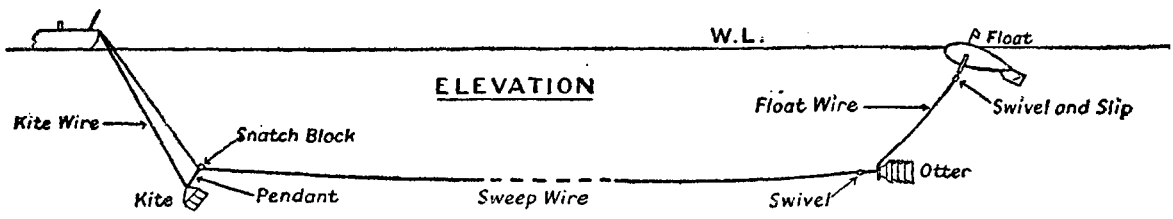

FIG. 117.

Preparation of Oropesa Sweep Gear for running. — — To prepare gear for running, the various items of equipment may be considered *seriatim* as follows :—

(a) *Kite Wire :* this should be marked in a similar manner to a lead line at every fathom 5 to 50. An eye and thimble for shackling to the kite slings should be worked at its outboard end. The kite wire is usually operated from an after capstan in surveying ships.

(b) *Kite :* if the gear has not been run previously, it will be necessary to "balance" the kite, an operation which is carried out as follows.

Lay the kite flat on deck, leading edge forward and with towing eye bolts on top. No difficulty will be experienced in recognising the leading edge if it is remembered that the lug on the centre strut (*see* Fig. 118) is on the *after* edge. Shackle on the *three*-legged slings; the shortest leg shackles on at the lug on the centre strut, the leg with the bottle screw (which should be adjusted to about its central position) to the ring of the *port* leading eye bolt, the third leg to the starboard leading eye bolt. All legs must be entirely free from turns.

Shackle the kite wire (led through the after fairlead) only to the towing ring of the kite slings, put the ship to slow speed and veer until the 5-fathom mark is awash. Increase to 6 knots and if the kite wire tows central, *i.e.,* fore-and-aft increase gradually to, say, 10 knots. If, however, the kite sheers to port or starboard, slow down, heave it up and adjust the bottle screw. If the sheer is to port, lengthen the port leg and *vice versa,* turning the bottle screw as much as three or four turns if the kite sheers at low speed. Lower the kite again and repeat the process as necessary with smaller adjustments until the kite runs true at full speed.

(c) *Kite Pendants and Blocks.* — Two kite pendants are required for the double sweep. These should be made of 1 1/4" British mine-mooring wire and fitted with an eye and thimble at each end. Each pendant should be about 5 feet in length — it *must* be long enough to reach across from the midship fairlead, which takes the kite wire, to the quarter fairlead, which takes the sweep wire. One end of the pendant is shackled to the ring of the kite slings and the other to a snatch block through which the sweep wire is rove.

(d) *Floats.* — A wooden stave with a small flag should be fitted in the flagstaff socket on the top of the float. A swivel-piece is shackled to the towing saddle and a small sen-house slip should be fitted below the swivel so that the float is quickly detachable from the float wire. The floats are hoisted out by hand cranes or davits : tripping hooks should be fitted on the whips for dropping them.

(e) *Float Wires :* a sufficient number of float wires (1 1/4" British mine-mooring wire) should be made to allow for various lengths from 5 to 30 fathoms being made up. Lengths of 20, 10, 5, 4, 2 and 1 fathoms should be cut off and fitted with an eye and thimble at each end : these will be required in duplicate when the double sweep is used.

(f) *Sweep Wires :* to wind a coil onto the sweep winch, it should be hung on a turn-table so that the whole coil can be turned as it is wound on; if an attempt is made to wind on directly from the coil as it lies on deck, the wire will become hopelessly kinked. Wire with *right-hand* lay must be wound on the starboard winch, and *left-hand* lay on the port winch. The outboard ends of the sweep wire can be secured to the otter slings by means of bulldog grips. The wire is difficult to splice and, as frequent breakages may occur when sweeping for obstructions, it is a waste of time to eye-splice it.

(g) *Otters :* if these have not been previously used, it will be necessary to attach the slings and adjust them so that the otters run properly. To attach the slings, place the otter on its edge, on the side of the ship it is going to be used, leaning it up against the bulwarks or rail with its leading edge forward and with the sling attachments inboard. The *four*-legged slings are used for the otter and these are shackled on with the bottle screw *below* the towing beam and the *longer* legs to the *forward* edge of the otter. The link for attaching the float wire is at the top of the beam. See Fig. 118.

When shackling on the slings, it is most important to see that all legs are free from turns. Assuming the otter has not been run before, place the bottle screw in about the central position.

To "balance" the otter, get the sweep out and run it as later described. Each otter should be balanced independently. For correct running, the float should tow in a moderately calm sea almost wholly submerged but with the whole staff showing. The water should be seen lifting over the nose of the float but not breaking until the tabernacle of the flagstaff is reached. If the float rides lighter than this, or if the otter breaks surface, heave up the sweep and shorten up the bottle screw; if the float tows with the flagstaff partly or wholly submerged, lengthen the bottle screw and continue adjustments until the float runs correctly. After these adjustments have been carried out, a depth recorder may be used to test their accuracy.

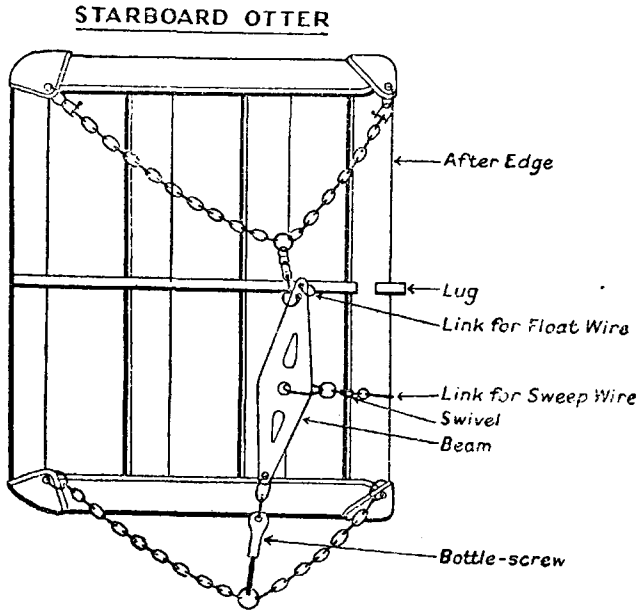

Fig. 118.

Operation and Management of the Oropesa Sweep. — For surveying purposes the sweep must normally be run as a flat sweep at some pre-arranged depth below the datum of soundings and it is therefore necessary to predict the tidal movement for the period that the sweep will be in use. A predicted tidal curve should be drawn and the heights above datum at, say, each hour taken off, so that the required running depth of the sweep *below the surface* at any time will be known. This information determines the amount of kite wire to be veered (*see* tables C and D in this chapter) and the length of the float wires (*see* table B) which must be altered as the tide rises or falls. As alteration of the float wires involves heaving up the sweep and takes some time, it is hardly feasible to alter the setting very frequently; as a rule settings within, say, 2 feet of the required mean can be accepted. For example, if it was intended to start sweeping at 0700 at a depth of 8 fathoms below datum and if the predicted heigh of the tide was 16 feet at 0700, failing to 12 feet at 0800, the sweep might be set at 10 fathoms 2 feet during the first hour, giving depths below datum varying from $7\frac{1}{2}$ to $8\frac{1}{2}$.

To get the sweep out, the sequence of operations is as follows :—

(1) Reeve the sweep wires through their respective quarter fairleads and attach to the slings of the otters; the latter can then be lifted over the rails and the sweep wires hove in until the otters hang close up to the fairleads with their leading edges forward and outboard, and without any turns in the slings. Set the winch dials to zero.

(2) Hoist the floats outboard with the cranes or davits and lower them level with the bulwarks. Then shackle on the required lengths of float wire between the floats and otters, keeping the bights clear of the water.

(3) Reeve the kite wire through the after fairlead, shackle to the kite slings and lift the kite over the stern, leaving it hanging close up by the kite wire. Shackle on the pendants and snatch blocks to the ring of the kite slings.

(4) Steam at about 6 knots and lower and slip the floats which will then tow astern by the float wires. See that the latter lead clear from the otter slings over the top of the otters.

(5) With the winch engine clutched up, veer about 30 fathoms on *one* otter at full speed. Stop the engine, and the sweep wire and float should draw out on the quarter. If they do not do so, it is probable that the float wire is foul of the otter which may have taken an unusually violent sheer when it entered the water or the otter may have struck the bottom whilst veering; alternatively there may have been an undetected twist in the slings. In this case, reduce to slow speed, heave the otter in close up to the fairlead where it can be reached, and clear the slings and float wire. Then increase to 6 knots and repeat the operation until the otter runs properly. Similarly with the other otter and sweep. It is not advisable to veer *both* at the same time at this stage as, if one otter runs foul, it will probably jump over the other sweep wire and lead to a bad foul. Disconnect the sweep engines and ride on the brakes.

(6) When 30 fathoms are out on each sweep wire, it may be termed the "short stay" position and everything is now ready to veer and set the sweep as the ship approaches the scene of operations. The short stay position is useful as the ship can be manoeuvred under almost full helm and the drag of the otters does not greatly increase her normal turning circle.

From the short stay position it takes five to eight minutes to veer 250 fathoms of sweep wire and to lower the kite, so that with the tidal stream behind the ship it may be necessary to arrange a "run up" of as much as two miles to the sweeping area to ensure that the sweep is set in time. It is obviously necessary to arrange for the run up to be made where there is sufficient depth of water to prevent the sweep fouling the bottom.

(7) Increase to sweeping speed. As previously explained, this must conform to the spread of sweep it is proposed to use, if a flat sweep is to be obtained : *vide* table A in this chapter. It must be remembered that, when it is set, the sweep exercises a considerable drag on the ship and it may be necessary, with the double sweep out, to do revolutions of 10 knots to attain a speed of 8 1/2 knots through the water. For surveying purposes the most useful speeds are 7 to 9 knots, corresponding to spreads of about 140 and 210 yards respectively on each leg.

(8) Veer both sweep wires slowly "on the brake" until the required amount of sweep wire (as shown on the winch indicators) is out. This operation must not be hurried or the otters will probably hit the bottom and run foul. As the wires run out, the floats should be carefully watched to see that they always pull out a little on the quarter. If a float is seen to be coming almost dead astern, put the brake hard on and wait a few moments until it has pulled out again on the quarter. When the necessary amount of sweep wire is out, put the brakes on just hard enough to prevent the drums rendering *unless* any additional strain comes on the sweep wires.

(9) As the sweep wires run out, snatch the kite pendant blocks onto them and veer the kite with the after capstan, stopping it when the required length of kite wire is out, as noted by the fathom mark awash.

Manoeuvring with Sweep Set. — When the ship is under way with the double sweep fully veered and requires to make any large alteration of course, the sweep on the side to which the ship turns, should be hove in whilst the turning movement is in progress, and the kite should be lifted about one-third of the amount of kite wire out. The ship should not use more than 20° of rudder and should straighten up temporarily whenever the inner float comes before two points abaft the beam. Having turned to the required course, the inner sweep can be veered again and the kite lowered to its correct setting. The drag of the sweep strongly opposes turning movement and the normal turning circle diameter is nearly doubled with the sweep out.

It is sometimes found more advantageous to use a single sweep (which is rigged in exactly the same way as the double sweep, except that only one snatch block and pendant are required on the kite), as the manoeuvring capacities of the ship are less seriously impaired. Using a single sweep, it may be possible to arrange any large alterations of course to be made away from the sweep and the ship can then turn under almost full rudder. The single sweep is especially useful when sweeping near the bottom in a small area, in the vicinity of shipping, or where obstructions are numerous.

Running the Oropesa Sweep. — Lines for the ship to follow should be drawn on a field board at distances apart about 40 yards *less* than the total spread of the sweep. This will provide a reasonable overlap to allow for failure to follow the lines exactly. Fixing and plotting are carried out by means of sextant and station pointer in a similar manner to that employed for sounding and, as the ship steams along, the positions of the floats, which mark the ends of the sweep, should be shot up from time to time by compass bearings and rangefinder distances or depressions from the horizon. This will enable the actual position and spread of the sweep relative to the ship to be plotted at any time on the board and prevent gaps being left in the work. If beacons are used for fixing it is better to double moor them; otherwise the fix will not be sufficiently precise to ensure that no gaps are left, unless very large overlaps are allowed.

Any convenient scale may be used for sweeping work but it is not advisable to use one *smaller* than about 1/30,000 (2 1/2 ins. to the nautical mile), or there may be difficulty in re-locating an obstruction which has been found by the sweep.

No attempt should be made to sweep too close to the bottom. It must be remembered that the kite and otters extend some little distance below the sweep wire and, to allow for this and for minor variations in depth keeping, a margin of not less than 1 1/2 fathoms clear of the bottom is indicated. As the ship steams along, the floats should be constantly watched. If one or both tend to come in towards the wake of the ship and the winch drums render in *little* jerks, it is probable that the sweep wire is foul of the bottom. When this happens, *increase* speed, if possible, and the sweep will probably clear itself as will be evident by the float pulling out again on the quarter. There is never any doubt when an actual obstruction is fouled, for the drum renders rapidly and continuously and the float is seen to draw quickly into the wake of the ship.

Location of Wrecks with Oropesa Sweep. — For the operation of the sweep it is essential to have good communication from the quarterdeck to the bridge. As soon as an obstruction is fouled, the bridge should be informed and the engines put to full speed astern, and stopped as soon as the way is off the ship. About 40 to 60 fathoms of sweep wire will have rendered off the winch whilst the way is being taken off the ship. It is therefore advisable to have at least 75 fathoms remaining on the winches after the sweep has been veered and set. The coils of wire (450 fathoms) are amply long enough but, if wrecks are numerous, there will be a constant expenditure of small lengths of sweep wire. For example, assuming the sweep is veered to 250 fathoms, there should not be less than 325 fathoms of the original coil left, to ensure that there is enough spare wire to prevent it running out to a clinch.

When an obstruction is fouled, it is generally correct to assume that by the time the way is off the ship the otter has been pulled into the obstruction and that the float therefore marks its position. A fix should at once be obtained and the bearing and distance of the float observed and, as a check, a series of these should be made whilst the sweep is being hove in and the ship is being pulled back towards the obstruction. When sweeping against the tide, the otter will sometimes fall clear of the obstruction as soon as the way is off the ship and the sweep wire has slacked up. The otter will then drift or be dragged away hanging from the float, so that it is important to lose no time in getting a fix and shot into the float before this can happen.

Clearing the Sweep from a Wreck. — When the sweep meets an obstruction, such as a wreck, the drum renders quickly and the float is seen to draw rapidly in towards the wake of the ship. As soon as the way is off the ship the winch engines should be clutched up and the sweep hove in. Normally only one leg of the sweep fouls; the other falls to the bottom and can be hove in fairly quickly. The kite should be lifted at once and the blocks unsnatched from the sweep wires. As the ship is being hove astern towards the wreck, some help may be given with the engines but great care must be taken not to over-run the wire or to get the other sweep wire foul of the propellers. When the fouled sweep wire is nearly up-and-down under the stern, the otter may be pulled clear of the wreck, but more usually it will be too firmly wedged and, if there is any sea, the sweep wire will part or else may be cut with a hammer and cold chisel. Assuming that this has been done, the otter will be left hanging from the float by the float wire, and the ship should be turned head to tide or wind and brought up head on the float which can be hooked on

to the fore derrick whip. The float can then usually be lifted high enough out of the water to enable the slip on the float wire to be reached. A picking-up pendant should be shackled on to the float wire and, after knocking off the slip, brought to the forward capstan. On heaving in, the otter is pulled in the opposite direction to that in which it was previously drawn by the sweep wire and it will usually come clear of the wreck so that it can be weighed by the float wire. The only expenditure of gear is the few fathoms of sweep wire which reached from the stern vertically down to the wreck.

It sometimes happens that, when the ship is being hove back to a wreck in which the otter is foul, the strain on the sweep wire will pull the otter through part of the wreckage and the float is dragged under water, remaining submerged after the sweep wire parts or is cut. In such cases the gear can often be recovered by running over the position with the other leg of the sweep set to a shoaler depth so that it clears the wreck but catches the float wire. The latter *may* part when the sweep wire fouls it, but the loss is then confined to the otter and a few fathoms of wire only as the float immediately rises to the surface.

Normally it is found that the otter receives little damage by contact with a wreck unless a "direct hit" is scored; the vanes sometimes get bent but can easily be hammered back to shape again. A direct hit, however, will probably render the otter or kite unfit for further service.

Notes on Oropesa Sweeping. — In an area where obstructions are numerous it often pays to use a short sweep, *e.g.*, 150 fathoms of sweep wire veered, giving a spread of about 1 1/2 cables with the double sweep. This saves time at each foul as heaving in and veering the sweep is quicker and the ship is handier to manoeuvre than with the longer sweep out.

If it is necessary to sweep on a line between two known obstructions, approach the first one against the tide with the sweep fully veered, but the kite up. As soon as the first obstruction is passed, lower the kite at full speed. Just before the second obstruction is reached, stop the ship and heave in the sweep. By this means a minimum area is left unswept. It is, of course, essential that the ship should pass exactly over the first obstruction in the approach.

In rigging the Oropesa gear it is essential to mouse all shackles. If this is done and if care is taken to see that the kite and otter slings have no turns in them, little trouble should be experienced in running the gear.

The following tables give the necessary data for operating the sweep at speeds of 7 to 9 knots. The tabulated spread of sweep for various amounts of sweep wire veered are approximate only; they vary somewhat with the depth at which the sweep is run and should always be checked by direct observations of the floats from the bridge.

TABLES FOR MARK IV OROPESA SWEEP.

A. Flat Sweep.

Sweep wire veered less kite wire.	*Spread of* single *Sweep.*	*Speed through the water.*
Fathoms	Yards	Knots
140	145	7,7
190	170	7,9
240	190	8,3
290	205	9,3

B. Amount of Float Wire in fathoms.

Speed through water in knots.	*Swept Depth in fathoms.*											
	5	6	7	8	9	10	11	12	13	14	15	16
7	4	5¼	6½	8	10	12	14¼	16¾	19	21	23	25¼
8	4¼	5½	7	8½	10½	13	15¼	18	20¼	22½	24¾	27¼
9	4½	5¾	7½	9¼	11¼	14	16¼	19	21½	24	26½	29

C. Amount of Kite Wire awash in fathoms for Single Sweep.

Speed through water in knots.	*Swept Depth in fathoms.*											
	5	6	7	8	9	10	11	12	13	14	15	16
7	9½	11¼	13¼	15	17	19	21	23½	25¾	28	30½	32¾
8	9¾	11½	13½	15¼	17¼	19¼	21½	23¾	26¼	28½	31	33½
9	10¼	11¾	13¾	15¾	17¾	19¾	22	24¼	26¾	29	31¼	33¾

D. Amount of Kite Wire awash in fathoms for Double Sweep.

Speed through water in knots.	*Swept Depth in fathoms.*											
	5	6	7	8	9	10	11	12	13	14	15	16
7	14¾	17¾	21	24	27¼	30¼	33½	36¾	40	43½	47	50¼
8	15½	18½	22	25¼	28½	31½	35	38	41¾	45¼	49	53
9	16	19	22½	26	29¼	32½	36	39¾	43½	47	50¾	55

MOTOR BOATS' SWEEP.

The use of the Mark IV Oropesa sweep is obviously restricted to areas in which the ship can safely navigate. For shallow water a smaller type, working on similar principles, has been evolved for use in 28-ft. surveying motor boats. Owing to the low power of these boats and the absence of space for engine-operated winches, the gear is much lighter and is modified in the following respects :—

(1) The sweep is used as a *single* sweep only, *i.e., either* to port or starboard, with a maximum of 80 fathoms of sweep wire (from kite to otter) veered, giving a spread of about 80 yards.

(2) The speed of the boat with the sweep set must be over 2 knots; speeds of 3 to 4 knots, according to the conditions, should be obtainable with the power available.

(3) The sweep wire (3/4 in. British mine-mooring wire) is operated from a hand-worked reel secured in the stern sheets. The kite wire (1 1/4 in.) is veered by surging round any convenient cleats and is hauled in by hand.

(4) Three floats and float wires are necessary; one, as with the Mark IV sweep, on the otter, one shackled on between puddings half way along the sweep wire as the latter is veered, and one shackled on the kite slings.

(5) The length of kite wire veered should be two and-a-half times that of the kite float wire; the length of the latter and of the other two float wires for various sweeping depths are given in table E.

(6) If a recorder is used, it should be shackled on by a tail to the sweep wire above a pudding placed about 3 ft. from the otter slings.

(7) As there is no central fairlead at the stern, the sweep wire is led through the port or starboard one and the kite wire on the opposite side. A chafing plate, fitted over the coaming in the way of the sweep wire which is most conveniently worked from forward, is a necessary fitting.

Manoeuvring the Boat with the Sweep out. — Small alterations of course can be made with the rudder in the usual way, but once the sweep grows on the quarter, the speed of altering course is very slow indeed. By partly closing the kitchen rudders, however, as large alteration of course as desired can be made in either direction but, whilst this is in progress, the sweep wire will drop much below sweeping depth and is liable to foul the bottom. With the wind on the beam difficulty may be experienced in steering, and it is therefore best to sweep up and down wind when possible.

LENGTH OF FLOAT WIRES FOR DEPTHS OF SWEEP. BOAT'S OROPESA SWEEP.

Table E.

Depth of Sweep in fathoms.	LENGTH IN FATHOMS OF		
	Otter Float Wire.	*Kite Float Wire.*	*Mid Float Wire.*
2	1¼	2½	3½
3	2¼	3¾	4¾
4	3¼	5	6
5	4½	6	7¼
6	5½	7¼	8½
7	6½	8¼	9¾
8	7¾	9½	11
9	8¾	10½	12¼
10	9¾	11¾	13½