Fig. 1. — Stockholms skärgård in winter (air photo).

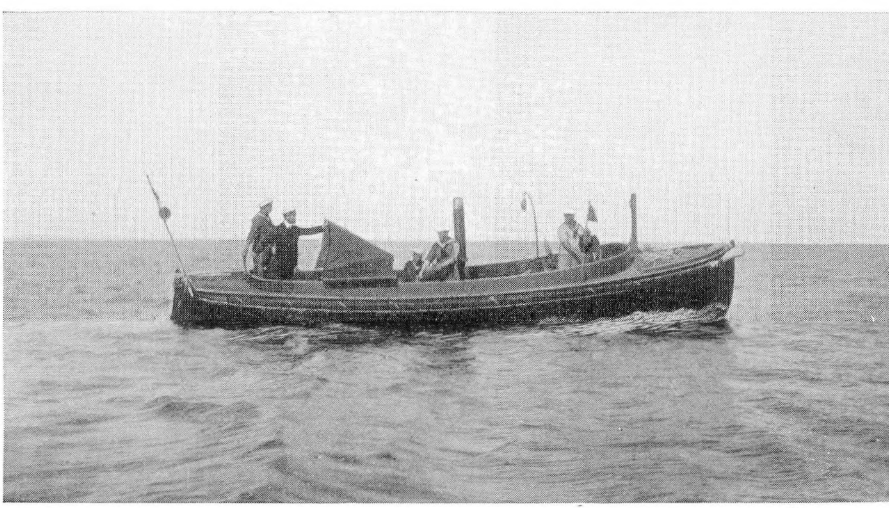


Fig. 2. — Sounding boat.

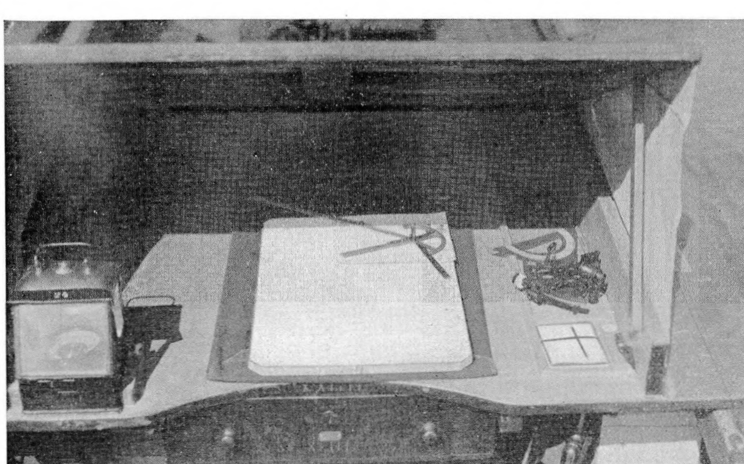


Fig. 3. — Boat work-table with sounding-chart and instruments.

BOAT SOUNDING
AND EXAMINATION OF SHOALS IN SWEDEN

by Captain G. REINIUS, Hydrographer,
Mr H. OHLSSON-ODELSIÖ, and Mr P. COLLINDER, Hydrographic Engineers.
Illustrations by Mr O. JAHNKE, 1st Hydrographic Engineer.

THE submarine topography off the Swedish coasts is, as a rule, much more complicated than in the great majority of other countries where the sea bottom is underlaid by regularly bedded, sedimentary rocks. This is also true of some parts of the Swedish coast, especially in the province of Scania and the islands of Öland and Gotland, where the sea bottom is fairly uniform.

But along the greater part of the coast the Archean rocks of gneiss and granite are not concealed by that smooth covering of sedimentary rocks elsewhere so common, but form a most uneven seabottom, being cleft by innumerable old fissure and pressure belts. These lie occasionally in somewhat regular directions, but often seemingly without any order. As the weathering and other factors determining the land sculpture have principally followed such lines of weakness, the result is the innumerable mass of islands, skerries, and shoals which forms the renowned Swedish *"skägård"* or that widespread archipelago in Sweden, which makes such uncommonly great demands on hydrographic surveying ; *see* fig. 1, which shows a characteristic portion of the Stockholm *skägård* in winter.

As the most important parts of Sweden, politically as well as nautically, are situated within the most violently accidented portions of the coast, where the channels are generally narrow and difficult, the need was felt early for rigorous methods of sounding and examination of shoals. The principle underlying the present methods has been in use during some sixty years ; and it is considered that a description of the essential features of the Swedish methods and appliances for sounding might be valuable in leading to contact with methods employed by other countries and eventually encouraging discussion.

In order to obtain a more complete comprehension of the sounding work, short introductory notes on triangulation, water-level and determination of the shore line have been included. Exhaustive description of instruments and appliances has not been possible, but the Hydrographic Office will gladly endeavour to meet any wishes expressed in this respect.

Triangulation.

The triangulations along the coasts necessary for hydrographic surveys are performed by the Hydrographic Office. This geodetic work, though satisfying principally the requirements of hydrography, is executed is as close contact as possible with the main geodetic survey of the country.

The spacing of the triangulation points depends, of course, upon the scale to be employed for the inshore hydrographic surveys. These being generally made on scales of 1:10000 to 1:20000 the distances between the stations are kept within 1.5 to 2.5 nautical miles.

The positions of the triangulation points are made ready for the sounding parties by computing their plane co-ordinates on Gauss' conformal projection (transverse mercator's).

All triangulation work is kept ahead of and performed absolutely separately from the other hydrographic surveying work.

Plane of reference.

The influence of tide along the coasts of Sweden is very inconsiderable, in the Baltic it does not exceed a few centimeters. The variations of the sea level therefore are small, a fact which is of great advantage to the hydrographic survey as it simplifies essentially the correction of the soundings.

By means of eight permanent automatic watergauges, distributed at roughly equal distances along the coast, and which have been in operation for about 30 years, very good values of mean sea level and of the secular uplift have been computed for the different sections of the coasts.

All temporary watergauges, whether automatic or not, necessary to hydrographic work are erected by the surveying vessels and are referred to the nearest permanent gauge by hydrographic levelling.

The mean sea level between the permanent gauges thus determined is preserved by marking a permanent bench mark, the altitude of which is then checked, if practicable, by running a line of levels to the nearest mark of the precise levelling net.

When plotting on the surveying chart *all soundings are reduced to mean sea level.*

Locating the shore line.

The sounding work is preceded by the location of the shore line in detail. As the Hydrographic Office now makes no topographic survey of the coast it prefers to make a complete resurvey of the shore line. The survey, based directly on the triangulation points, is made by plane tabling and the larger sounding marks as well as the smaller which are built along the beach, are plotted on the chart either by graphic cutting or by tacheometry.

The most characteristic phase in this process, which is of essential value to the precision of the sounding work, — and as far as we know, it is not adopted by any other country — is the fixing of the multitude of small marks located immediately on the shore line at a distance of 50 to 100 meters from each other. By aid of these marks the sounding-boat can obtain very accurate positions even when close to the shore.

When locating the shore line the magnetic variation at the plane table stations is roughly determined by means of a compass. These observations are mainly made in order to discover any anomalies which may exist in the magnetic field.

Sounding.

Method. — The coastal waters of Sweden are developed by the well known "parallel sounding method". This method, however, is probably carried out more consistently and systematically than in many other countries, as may be seen on the attached chart.

The spacing of sounding lines must depend largely on two circumstances : on the importance of the waters and on the features of the topography of the region. Each particular region to be surveyed is examined from these points of view and this study, combined with the results of long experience, gives the data for determining the scale and for the arrangement of sounding line systems in such a manner as to obtain the best results from the work. Thus it is not possible to give rules of general application in this respect.

The direction of the sounding lines is usually North and South or East and West, but sometimes is perpendicular to the general trend of the coast or its topography. Strong currents or wind make it necessary to turn them in other directions, viz. that of the current or wind.

In Swedish waters, with their extremely uneven bottom, the *main* sounding lines are spaced as follows:

on a scale of 1:10000 . . . . . . 50 meters apart,
on a scale of 1:20000 . . . . . . 100 meters apart,
on a scale of 1:50000 . . . about 300 meters apart.

It is prescribed that, on scales up to and including 1:20000, the intervals between soundings must not exceed half the distance between the main sounding lines in depths of 30 meters or less. In depths exceeding 30 meters and with an even bottom the intervals should be kept about equal to the main line spacing. In order that the spacing of soundings should be constant, secondary lines are run midway between the main sounding lines out to the 30 meters depth contour. By developing in this way the result will be a good representation of the submarine topography of the area and, even in Swedish waters, all shoals and practically all other dangers with depths of crictical importance to navigation are indicated more or less conspicuously.

However, the detail of the form of the shoals as well as of very small dangers such as bowlders, wrecks, etc. (pinnacle rocks do not exist in this country) will not as a rule be determined by regular parallel sounding. These details are examined by special processes such as those described below.

Sounding boat. — Fig. 2 shows a sounding boat. It is a half-decked motor-launch of small dimensions: length 9,2 m. (30 feet) beam 2,2 m. (7 feet) and draft 1,06 m. (3 feet 4 inches). The engine is an "Avance" motor of 8. H. P. manufactured by a Swedish firm. It is a very hardy engine which withstands the intensive strain of sounding work well. The engine has to be reversed from full speed ahead at almost every sounding and these amount to about 500 in number per boat in a full working-day. Aft there is a table with a spray-hood sheltering the field sheet and the instruments of the surveyor. The sounding machine is placed on a thwart before the engine.

During the last two summers interesting tests have been carried out, with successful results, as to the availability of the Kitchen rudder for sounding boats. It is probable that the Kitchen rudder system will be adopted in the near future.

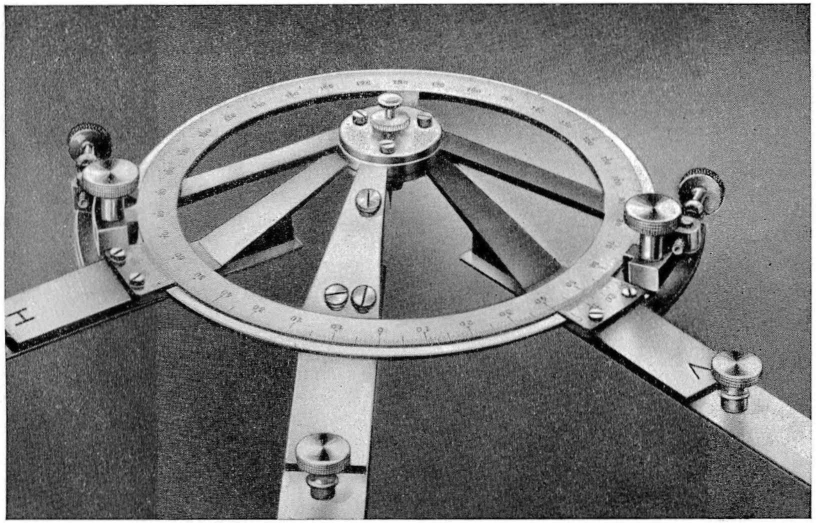


Fig. 4. — Large station pointer, latest model.

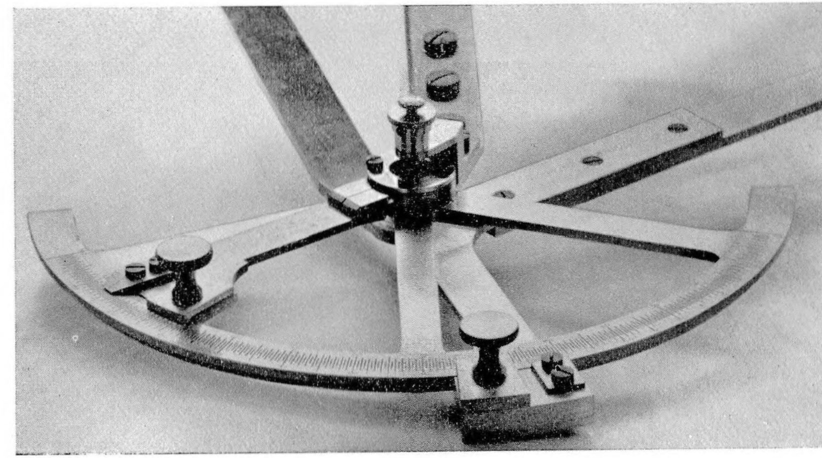


Fig. 5. — Station pointer for inshore work.

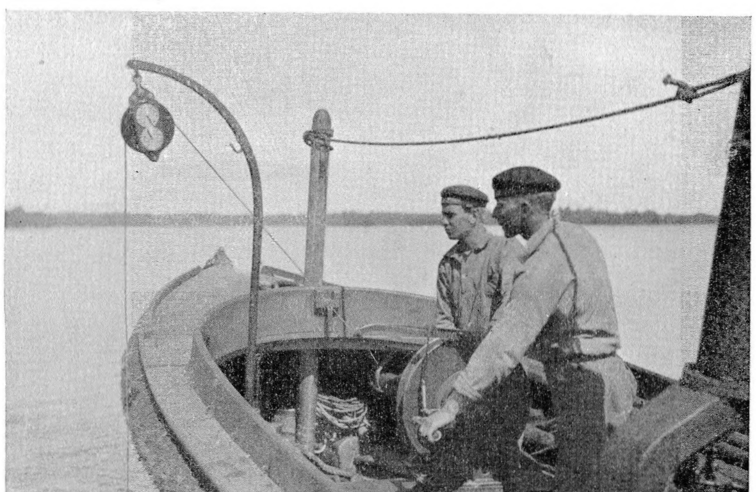


Fig. 6. — Boat sounding-machine and registering block.

Fig. 7. — Big block on the coast of Öland.
Note the man close to the block.

Crew of sounding boat. — The sounding boat is in charge of one surveyor and manned by four seamen, i. e, helmsman, motor engineer, and two leadsmen operating the sounding machine. Sometimes, when sounding on very large scales, 1:10000 and above, or in strong currents the crew is increased by adding a recorder or a second surveyor.

Surveying Instruments. — Fig. 3 shows the table, field sheet and instruments of the surveyor. The sextants now used are manufactured by the firm C. Plath of Hamburg and are found to be very good instruments. As to the station-pointers (protractors) the two different types shown in figs. 4 and 5 are used. They are manufactured by various instrument makers in Stockholm. A new model, now being constructed at the Hydrographic Office, from the design of one of the writers of this article, Captain Reinius, and characterized by the raised centre of the circle (fig. 4), will gradually supersede the old flat model.

The sounding machine (fig. 6), which is automatic in so far that the running out of the wire is stopped instantly when the lead reaches the bottom, is constructed at the Hydrographic Office and is specially suitable for sounding boats. It is worked by hand but can easily be coupled to the motor. The lead weighs about 4 kgs. (8 3/4 lbs.) and the line is a 1,5 mm. (0.06 inch) diameter wire to which a complete turn round the sheave of the separate registering block is given.

Sounding. — The lines of soundings are run on compass courses. Occasionally, however, ranges of natural topographic objects can be used advantageously. The regulation of the intervals between soundings is not determined by time but a dial-counter is used. An empirical scale showing the distances on different natural scales of the amount registered by the dial-counter is of considerable value in the frequent movements within the surveying district. In shallow waters with depths of about 12 meters (40 feet) or less, the usual lead line is used. In deeper waters soundings are taken with the sounding machine and under these circumstances the boat is stopped for every sounding. This makes it possible for the single surveyor to get good determinations of positions. These are regularly made at every third or fourth sounding and always by sextant angles to three marks. The surveyor himself keeps the record. The compass course, dial reading, depth, bottom and angles are entered in special columns of a field-book. Notes on weather, current, time and so on also are recorded occasionally.

All inshore surveying work is done by motor launches. No outer limit is fixed for their work but this is extended offshore as far as the circumstances permit. Thus it often happens that the developing, on a scale of 1:50000, of deep waters as far out as 10 nautical miles from the shore (and even more) is performed by sounding boats.

Examination of shoals.

General. — After the regular sounding-work the next step is to examine the shoals indicated. These investigations generally require more time than ordinary sounding. The following are some typical indications for coast waters of average navigability.

Very faint indications : a sounding of 23 m. surrounded by 25 m., 19 m. surrounded by 20 m., 16 m. surrounded by 17 m.

Faint indications : 26-30, 18-20, 14-15, 11-12, 7,7-8.

Strong » : 22-30, 15-20, 12-10, 10-13, 9-11, 5-7.

The spacing of soundings is here assumed to have been the same as on the attached surveying chart, i. e. one sounding every 50 to 100 meters.

The methods used in Sweden for examination of shoals are the following, the last three are given in the order of increasing precision.

(1) Sounding with the lead line, (2) submarine sentry, (3) sentry-sweep, (4) spar-sweep towed by or (5) attached to vessel.

The first method, *sounding with the lead line*, is still the fundamental one; the others are used as a check on the first for dangerous shoals and in navigable channels, and in case of the submarine sentry, mainly for speedy reconnaissances.

The wire-sweep has been used only in the form of the sentry-sweep which will be described below. As the sea-bottom is very uneven and the channels of very varying width and often somewhat narrow, the use of a large wire-sweep, e. g. of the American model, would necessarily be very restricted.

There are also two circumstances contributing to make a good survey possible without a wire-sweep. The first is the non-existence of pinnacle-rocks (except in the neighbourhood of the island of Gotland), caused by the quaternary glaciation, which has given to the rock-bed fairly low gradients in one or more directions.

The second circumstance is related to the erratic blocks that occur frequently on the Swedish coast and, in exceptional cases, have dimensions up to 6 to 7 meters (19 1/2 to 23 feet) (*see* fig. 7). These are the surveyor's greatest bugbear. Owing to the absence of strong tidal currents there is generally some accumulation of soft material round an isolated block, thus giving an indication during the regular sounding. As this cannot always be expected, sweeping is necessary over shoals and in shallow passages, but in the deeper hollows and channels this is not required, and thus only a small portion of the navigable area has ultimately to be swept.

Examination with the lead-line.

This method is a special case of parallel sounding. The principal features are the use of a very large natural scale for plotting the soundings and the extensive use of small buoys for delimiting the area examined and for locating the individual soundings within this area.

The first step is to search the sounding-chart for indications of rocks and shoals. This is always done by an experienced surveyor.

The complete examination of an indication involves the following steps :

(a) Marking the area with buoys.
(b) Preparation of the record in the sounding-book.
(c) Parallel sounding of the area and plotting the record. Buoys dropped on any indications.
(d) Close investigation of the summits and the extent of the shoal.
(e) Finding the position of and transit marks for the summits.

(a) *Marking the area to be examined.* — The buoys used are generally wooden buoys of a semi-oval form (*see* fig. 8) with a small red and yellow flag, which colours together show very well against the water in almost any light. If currents are prevalent barricoe buoys are used (*see* fig. 8).

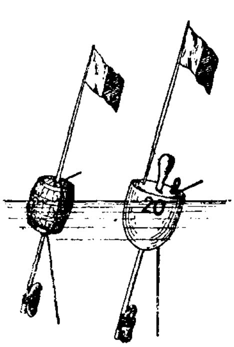


Fig. 8. - Small buoys for examination of shoals, etc.

The area about to be examined is generally laid off in an approximately rectangular form in order to facilitate sounding as well as plotting, and this rectangle is oriented so that one of its sides lies in the direction of the prevailing wind or current, so that the sounding-lines can be made with and against the more powerful of these.

Fig. 9 shows a fairly extensive indication on the scale of the sounding-chart (1:20000) with the limits of the area and the buoys in the corners. The positions of the buoys are determined by sextant angles and laid down on the chart by means of the station pointer.

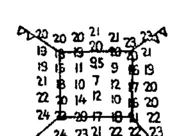


Fig. 9. Shoal-indication.

If the shoal is situated far off shore, large buoys (*see* fig. 15) trigonometrically fixed are often used for position-fixing.

(b) *Preparing the record in the sounding-book.* — The examination of a shoal is plotted on squared paper with squares of 3 to 4 millimeters. The relative positions of the limiting buoys are transferred to the record by proportional dividers and plotted on seven times the scale of the chart, i. e. approximately 1:3000, which scale has been found to be that most useful for the purpose. This makes the length of a sounding-boat nearly equal to a side of the squares on the paper and thus gives a very serviceable scale of distance. The relative positions of the buoys having been transferred to the record, straight lines are drawn between the angles of the rectangle so formed thus giving the sides and diagonals thereof.

Generally one or more additional buoys will be necessary for locating the soundings. *See* fig. 10, which gives an ideal picture of an examination record, when the examination is about half completed. The flags are buoys dropped before the sounding, the circles are buoys dropped during the sounding at all shallow casts.

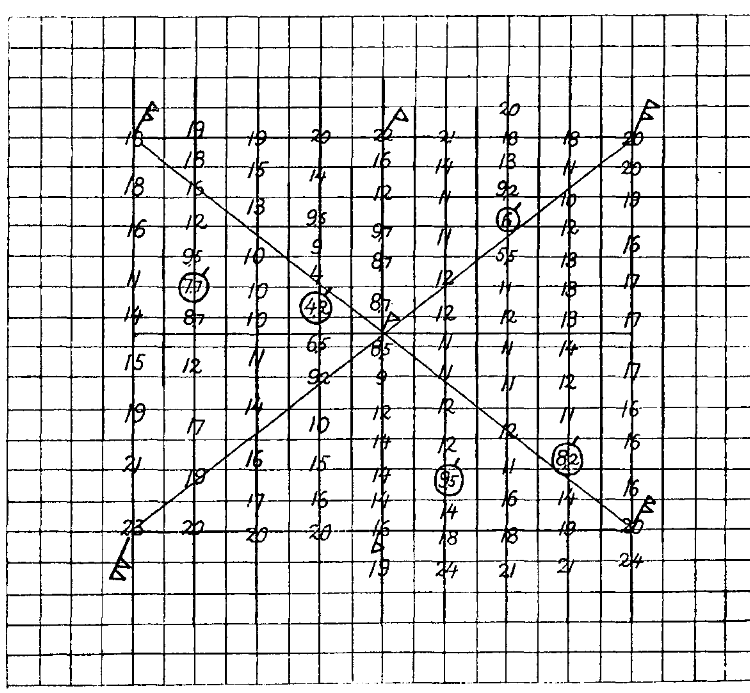


Fig. 10. — Examination-record, not finished.

(c) *Parallel sounding and plotting in the record.* — Before the sounding begins, the parallel lines to be run are drawn on the record.

Sounding is carried out at very low speed so that the individual casts are regularly spaced and generally between one and two boats lengths apart. Every sounding is plotted immediately on the record by eye with the aid of the buoys and the lines previously drawn. It is not usual to take more than three lines of soundings between each pair of buoys. While sounding along these lines buoys have been dropped wherever a cast has indicated the proximity of a summit. The record now gives an idea of the general character of the shoal and its extent, where the summits may be expected to lie and where new lines of soundings should be interposed (fig. 10). The positions on these lines are determined and the soundings plotted with the aid of

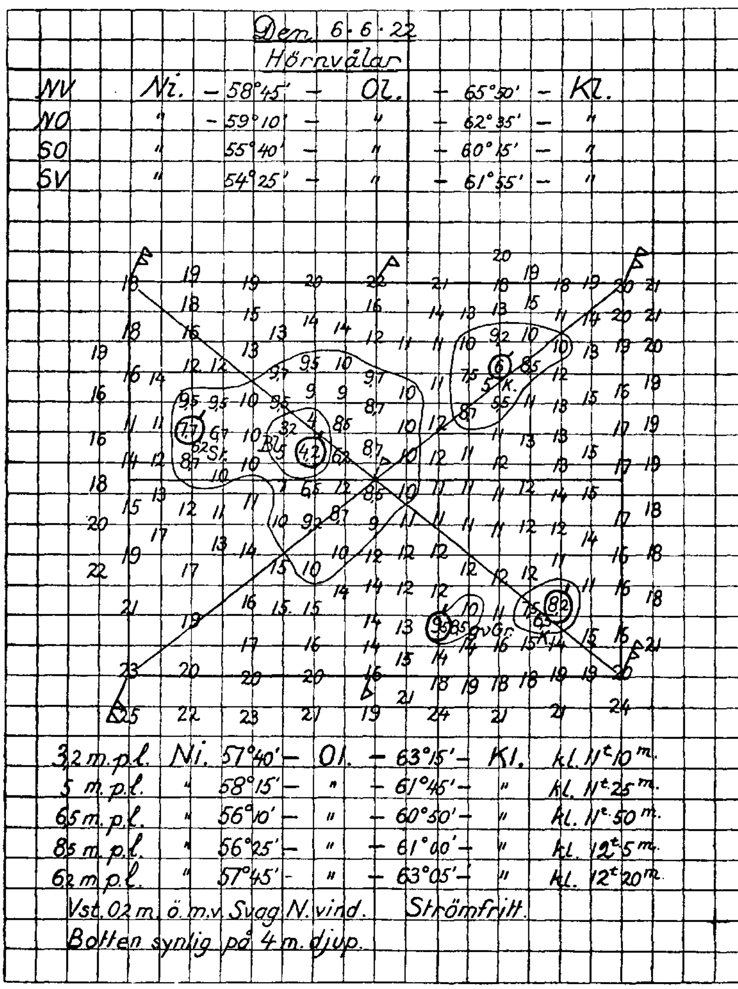


Fig. 11. — Examination-record, finished.

the original buoys as well as of those dropped during the previous sounding. These additional lines having been interposed, as shown in fig. 11, the surveyor draws with a black or some coloured pencils the depth-lines necessary to give a clear idea of the form and extent of the shoal.

(d) *Close examination of the summits and projecting points of the shoal.* — For this a special lead-line is used made of a thin wire with a lead weighing only 2 kg. (4 1/2 lbs). The boat is laid to windward of the buoy on the supposed summit and allowed to drift very slowly over it. One man is placed at the bow, one amidships and one aft, each one sounding continuously, lifting the lead only a couple of decimeters (6 or 7 inches), dropping it again and calling out the depth whenever it changes. This is continued until the whole suspected ground is covered and the highest summit found ; if necessary new buoys are dropped to facilitate orientation. The summit is thoroughly examined and its position determined by angles which are written down in the record. Fig. 11 gives the examination record completely plotted. Above the soundings are given the angles for the original limiting buoys, and below are the angles taken when over the summits found. Some remarks are added with reference to the state of wind, current and visibility of the bottom, enabling an estimate of the reliability of the results to be made.

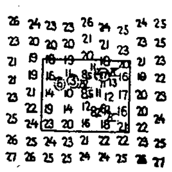


Fig. 12. - Examination plotted on the sounding-chart.

The results of the examination (exact depth, curves, etc.) should be inserted on the sounding chart (*see* fig. 12) immediately after returning on board, while the memory of the examination is still fresh.

If the shoal has not been previously known and is dangerous to navigation, angles should be taken between permanent clearly visible objects on shore ; this is necessary in order to enable pilots to find the shoal by angles.

Two or three hours are required to make a complete examination of a shoal such as that described above.

THE SUBMARINE SENTRY.

The construction and details of this apparatus are shown by figs. 23 to 26 of "Handledning i sjömätning"*. Its adaptation to boats is illustrated by fig. 13.

General. — The sentry is used only to indicate whether shoals exist within a certain area. The exact depth is determined by means of the lead or by sweeping.

The apparatus is used in the following manner. The area is delimited by small buoys in the same manner as when examining with the lead-line, except that the distances between the buoys are made

* Published by the Hydrographic Office of Sweden, 1923 edition.

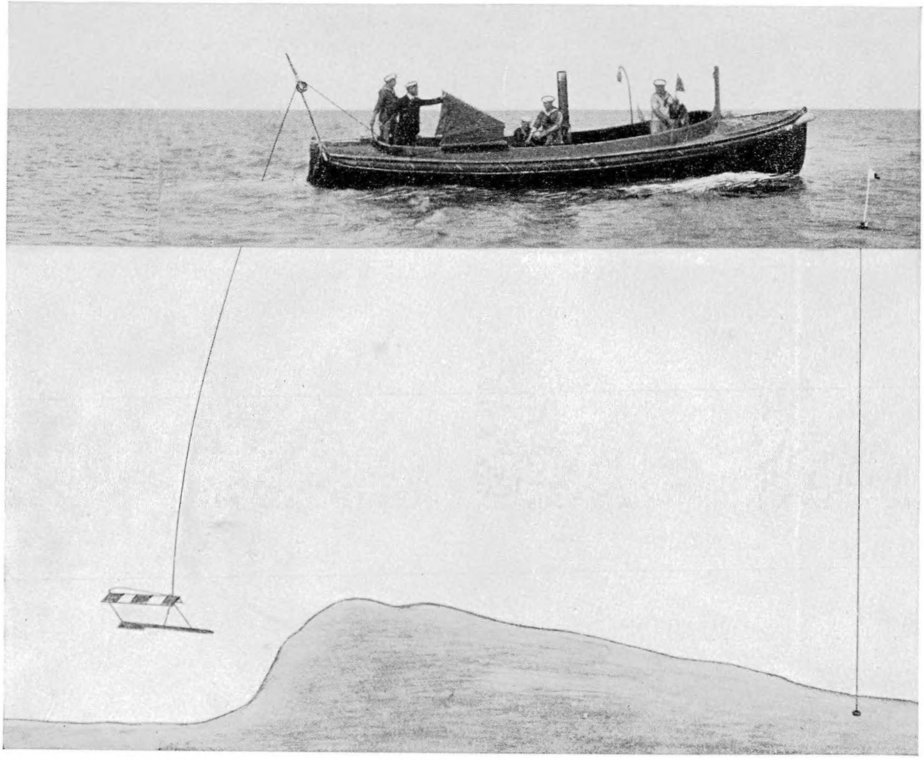


Fig. 13. — Submarine sentry in operation.

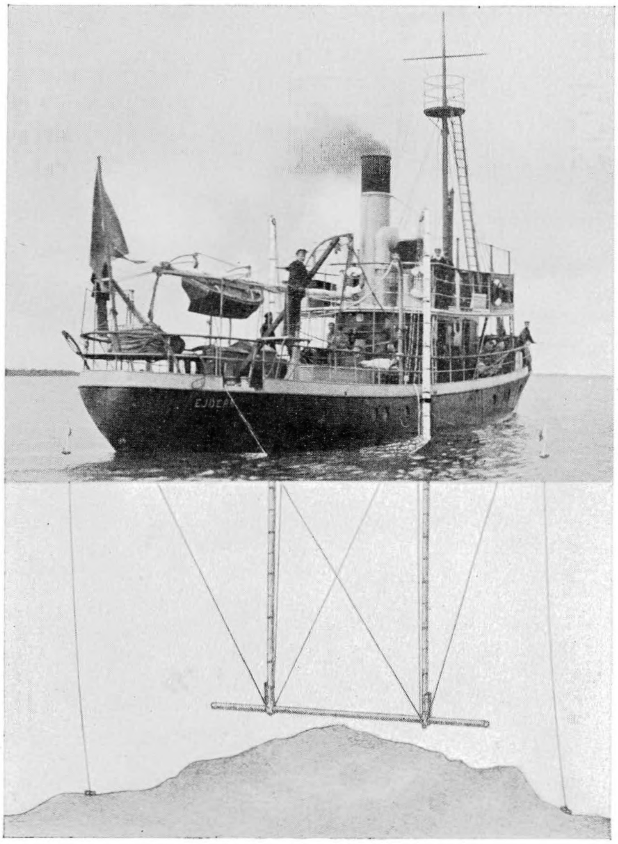


Fig. 14. — Surveying vessel with spar-sweep attached.

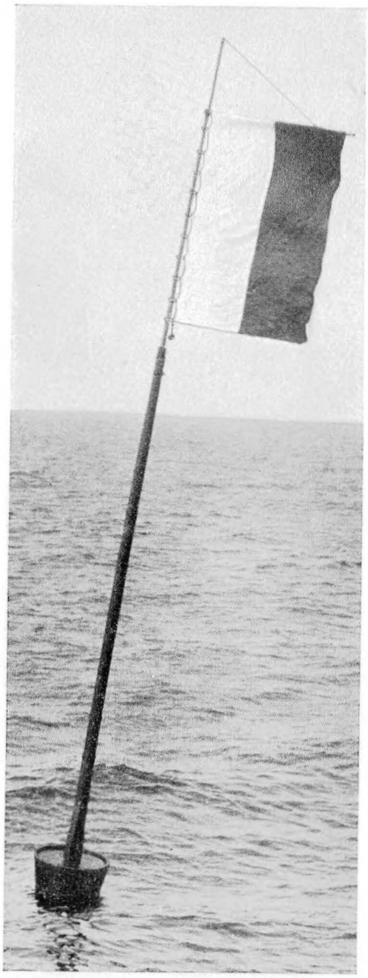


Fig. 15. — Large flagbuoy, used for offshore work.

considerably greater. With the sentry lowered to the required depth, the area in question is covered by parallel lines, the surveyor himself conning the boat. With aid of the buoys and the compass the straightness and spacing of the lines can be maintained with sufficient accuracy within certain limits. When running a line the surveyor constantly keeps one hand on the wire to the sentry in order to feel at once when it touches bottom. One man has a weighted stick ready to be dropped astern when bottom has been signalled. In such cases the sentry is immediately hove up, and a buoy is moored as soon as possible close to the stick previously dropped.

The question as to the depth to which the sentry should be set in order to give the greatest possible effect is one demanding experience and judgment for its solution. The surveyor should send the sentry down to as great a depth as possible, but at the same time he should be careful not to set it too low.

Spacing. — The spacing of the lines depends on the topographic character of the bottom, on the depth to which the sentry has been set and the closeness of the previous sounding.

Experience in Swedish waters has shown that, if the bottom-character be normal and the average depth of a certain area be 16 to 17 meters, in order to make certain of the absence of any shoal of less depth than 8 meters with the sentry set at 15 meters, the space betwen the lines of sounding should not exceed 15 meters.

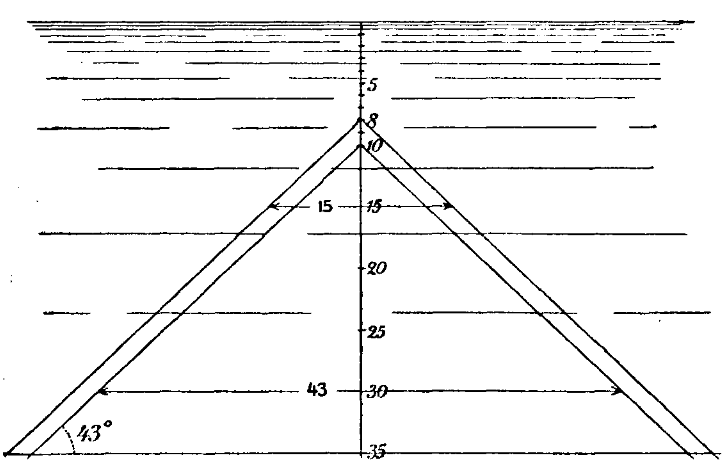


Fig. 16. — Submarine sentry. Relation between depths and spacing.

Accepting this as a basis for a general rule, the spacing corresponding to other depths may easily be deduced.

If the average depth is 10 meters or less, the sentry should under no circumstances be used, as in such cases the lines must be so closely spaced that they cannot be run with precision.

In fig. 16 the cones give the greatest elevation of a shoal that may be expected within an area represented by the base thereof. Thus the figures on the vertical line indicate the depth to which the sentry is set, the diameter on the base at the depth chosen gives the required spacing of the lines and the distance from the apex to the water-level gives the least probable depth. If there is reason to expect a steeper slope than that assumed in the figure, the spacing must of course be reduced in proportion.

The submarine sentry is used for the following purposes : —

(a) Examination of single indications of considerable depth.

(b) Determining whether shoals exist within "indication areas" of greater extent on relatively even bottoms.

(c) Searching for shoals reported in waters where older surveying charts only exist.

(d) Examination of certain parts of a channel known by older surveys.

If conditions permit, the simultaneous use of two sentries (e. g. from a small surveying vessel) will give an increase in speed as well as in accuracy. The sentries are then set to different depths ; a difference of 2 meters (1 fathom) has been found useful. If the deeper sentry touches bottom, the speed is instantly reduced and the second sentry is lowered to the depth of the first one. The vessel continues after having buoyed the place where the sentry touched bottom. This is best done by dropping a self-mooring buoy.

As space considerations do not allow a detailed description of the procedure in all cases referred to above, an example of case (d) only will be given.

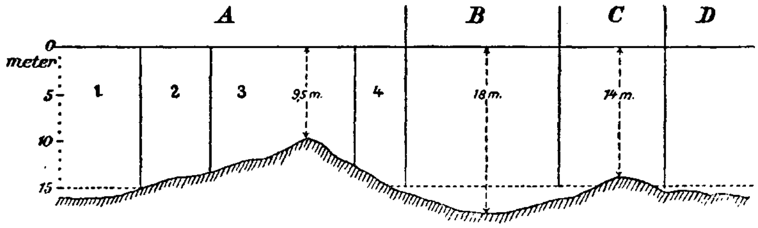


Fig. 17. — Channel reconnaissance with the submarine sentry.

In a channel not recently surveyed, the bottom-profile of which is represented by fig. 17, it is desired to find all shoals with a depth of less than 7 meters.

Within the region A, where a shoal with 12 m. depth was shown on the older charts, work was begun in area 1 with the sentry set to a depth of 15 m. and with a spacing of 15 m. In area 2 the sentry-depth was 12 m. and the spacing 10 m., and in area 3 the sentry-depth was

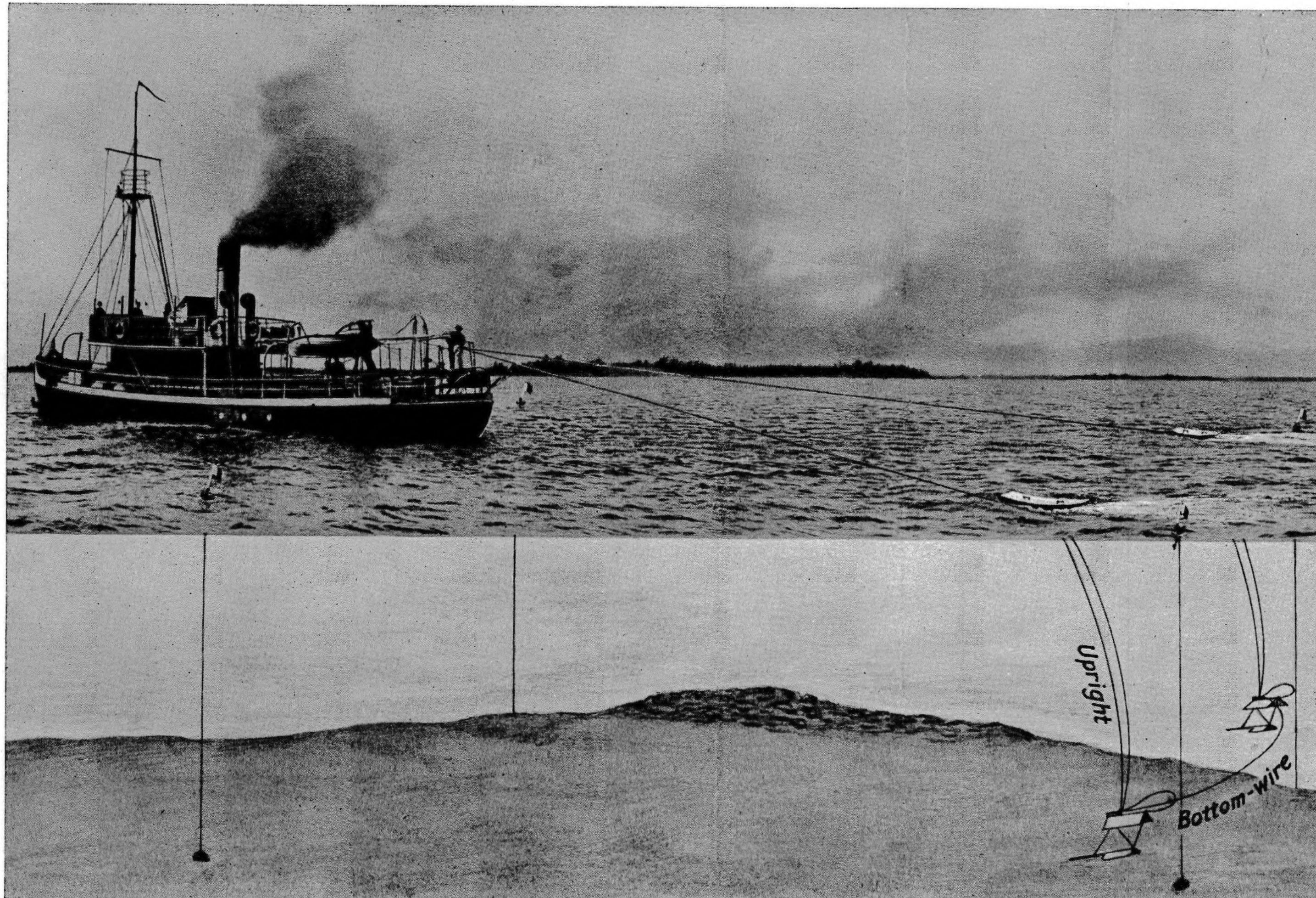


Fig. 18. — Surveying vessel with sentry-sweep.

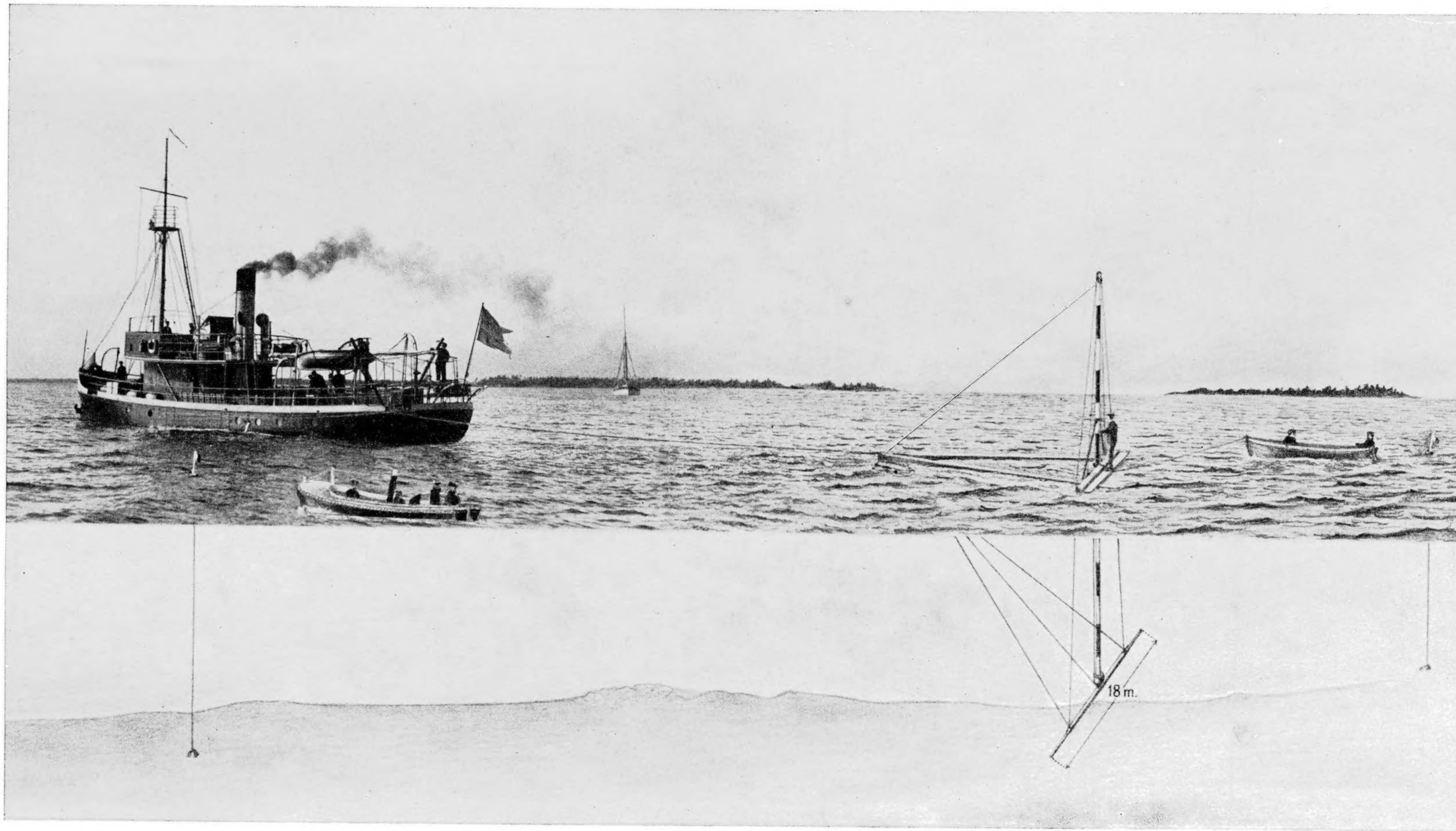


Fig. 19. — Surveying vessel towing a spar-sweep.

11 m. and the spacing 8 m. Within this area the sentry struck bottom. The place was examined with the lead and the least depth found was 9,7 m. which, when examined with a spar-sweep, was reduced to 9,5 m. Then area 4 was examined with the sentry at a depth of 12 m. with a spacing of 10 m.

Within region B the sentry was set to a depth of 15 m. and the spacing was 15 m. Within region C work was begun at a setting of 14 m. with a spacing of 15 m., and, the sentry having struck bottom, the rest of the region was completed with 13 m. depth and a spacing of 10 m. Region D was examined in the same manner as region B.

The sentry sweep.

The sentry-sweep is an adaptation of the submarine sentry that has been largely used by the Swedish Hydrographic Office. This sweep was invented in 1907 by a Swedish engineer, Mr S. Sjöstrand. Its general construction and use are shown by fig. 18.

The sentry-sweep is used to ascertain whether shoals exist in areas with relatively great but variable depths. This method alone is not sufficient if the depth is to be determined very accurately.

It has been found by experience that the *effective depth of the bottom-wire* is generally :—

7,6	m.	with	uprights	of	8,0	m. in	length.
8,0	»	»	»	»	8,5	» »	»
8,5	»	»	»	»	9,0	» »	»
9,0	»	»	»	»	9,5	» »	»
9,4	»	»	»	»	10,0	» »	»
9,7	»	»	»	»	10,5	» »	»
10,1	»	»	»	»	11,0	» »	»
10,3	»	»	»	»	11,5	» »	»
10,7	»	»	»	»	12,0	» »	»
11,0	»	»	»	»	12,5	» »	»

A complete description cannot be given here but is to be found in "Handledning i Sjömätning" 1923 edition, pp. 51 to 56 and 204 to 209.

The sentry-sweep needs careful management, and before work is begun, the whole personnel must be well trained in laying out and taking in the sweep.

The sweep should be towed at a speed not exceeding 3 knots. It has been found to do the best work with towing wires of 35 to 40 m. in length and bottom-wire of 40 m., which will make the effective sweeping-width about 30 m. With 50 m. towing wires and 50 m.

bottom wires the effective width is increased to 40 m., but this augmentation of the effective width reduces the sensitiveness of the apparatus somewhat.

When striking bottom with one of the kites, the corresponding float automatically detaches itself from the towing-wire. If the bottom-wire catches in the bottom, both floats are instantly detached and remain anchored on the shoal by means of the kites.

The method of buoying out the area largely depends on its form and extent. When sweeping a winding channel the bottom-wire will often get slack as the ship yaws and therefore the buoys should be placed in such a manner that the whole area is effectively swept.

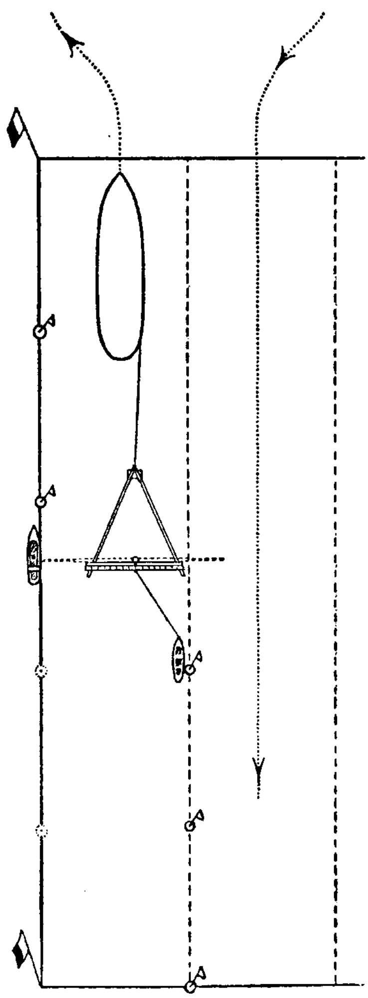


Fig. 20.
Method of drag-sweeping with a towed spar-sweep.

The sweep has been tried by sweeping shoals of very accurately known depths. On a very smooth rocky ledge the bottom wire was lifted up 0,4 meters before the sweep was detached; on bowlders and uneven rocks the reaction was instantaneous.

Drag-sweeping with the Spar-sweep.

The towed Spar-sweep, which originated in Finland, is used for drag-sweeping rather extended areas. Depths may be determined with an accuracy of about 0,2 meter by this apparatus — the construction and details of which are shown in fig. 19.

Material. — For operating this sweep the following material is needed : a small surveying vessel or two or three ordinary motor-boats to tow the sweep, a jolly-boat for placing, and a small motor-boat for lifting buoys.

Dragging. — (fig. 20) The area to be dragged is marked out inrectangular form with buoys, if possible in the direction of wind or current. The sweep may be set at not more than 0,5 meter less depth than that shown by any of the soundings within the square. If the square is not turned quite in the direction of the current, the towing night begin against the current. Just astern of the lee end of the bottom spar, buoys are dropped by the towed jolly-boat at roughly constant intervals. It is necessary that the surveyor should pay attention to the placing of these buoys.

The next strip is run close to the preceding one, the windward end of the bottom spar just catching the buoys, which are lifted by the small motor-boat, a new line of buoys being placed to show the limit of the area dragged.

It is necessary to keep the strips as straight as possible and this rule causes overlaps of the strips here and there. If the bottom-spar strikes, the spot is marked with a buoy without a flag and the position is fixed by the motor-boat.

When the whole square has been dragged, the bottom-spar of the sweep is raised somewhat, the amount depending more or less upon the violence with which it struck. The marked spots are then redragged and if necessary the bottom-spar is raised again until it travels free.

The sweep should be towed at a speed not exceeding 1,5 to 2 knots. If towed more rapidly it is apt to rise from the water and to jump.

Sweeping with a spar-sweep attached to the vessel.

This form of sweeping is used for fixing exactly the depth on a shoal (fig. 14). Due to the small length of the bottom spar the work, however, is time-consuming and is affected by the heave of the sea. Accordingly the areas to be sweep in this way are narrowly limited.

Sweeping a shoal of very small extent. — The shoal is marked by a buoy on both sides permitting the vessel with the sweep to pass midway between the buoys, if possible against wind or current. It is advisable to arrange a mark, ashore or moored, leading right over the summit of the shoal.

After this is done the vessel is steered on the range towards the shoal at very low speed. The bottom spar of the sweep is submerged to the depth obtained during the examination with the lead.

Close to the shoal the engines are stopped and the men at the fore-guys and downhaul-tackles are ready to slack or to shift the tackles. If the bottom spar touches lightly it suffices to ease the downhaul-tackles only, if harder, however, it is necessary to slack away the fore-guys as well.

In this way the shoal is reswept until the depth, just affording the bottom spar free passage, has been determined.

Sweeping shoals of some extent or narrow fairways. — While sweeping, buoys are placed close astern of the sweep showing the route covered by that end of the bottom spar which lies towards the water to be swept. On the next strip — a length of the bottom apart from the preceding — these buoys are lifted and other buoys

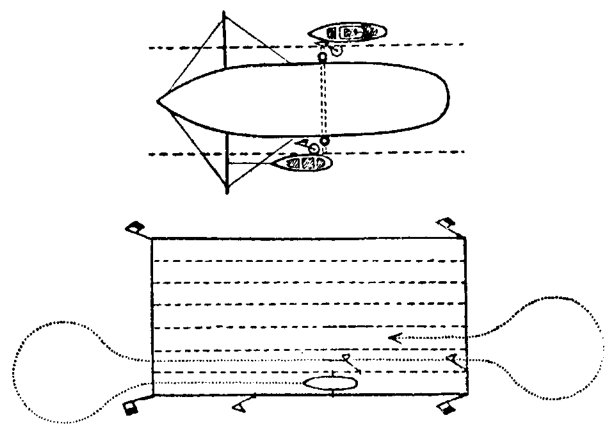


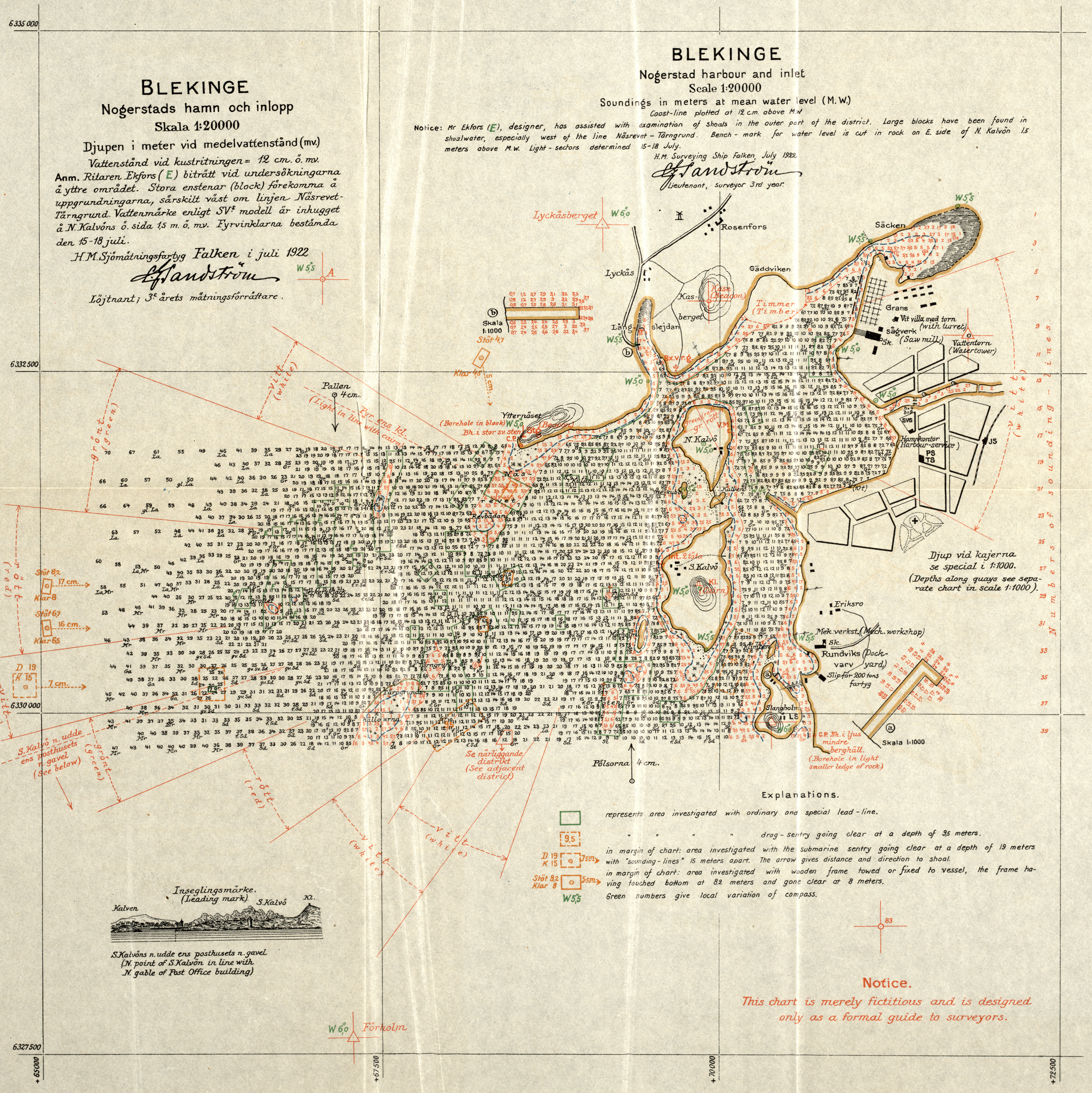
Fig. 21. — Method of sweeping with an attached spar-sweep.

placed. As it is often difficult to lift and place buoys from the vessel, this work is generally done by a towed boat for lifting, and by motor-boat forplacing the buoys (fig. 21).

Personnel and routine.

The Swedish surveying vessels are manned by personnel from the Navy. Most of the surveyors are Naval Officers and P. O's., attached to the Hydrographic Office during the surveying season and only a small proportion are civil officers and draughtsmen from the Office.

Owing to the difficult waters and to the short surveying season, May to September, it has been necessary and possible to make the working day long. At 5 o'clock in the morning the sounding boats leave the vessel and in fine weather bear out to the districts in the open sea. Breezy weather forces the work into sheltered waters and as a rule the whole working-day, ending at 5 P. M. can be utilised.


BLEKINGE
Nogerstads hamn och inlopp
Skala 1:20000
Djupen i meter vid medelvattenstånd (mv.)
Vattenstånd vid kustritningen = 12 cm. ö. mv.
Anm. Ritaren Ekfors (E) biträtt vid undersökningarna å yttre området. Stora enstenar (block) förekomma å uppgrundningarna, särskilt väst om linjen Näsrevet-Tärngrund. Vattenmärke enligt SV:s modell är inhugget å N. Kalvöns ö. sida 1,5 m. ö. mv. Fyrvinklarna bestämda den 15-18 juli.
H.M. Sjömätningsfartyg Falken i juli 1922
Löjtnant; 3:e årets mätningsförrättare.
BLEKINGE
Nogerstad harbour and inlet
Scale 1:20000
Soundings in meters at mean water level (M.W.)
Coast-line plotted at 12 c.m. above M.W
Notice: Mr Ekfors (E), designer, has assisted with examination of shoals in the outer part of the district. Large blocks have been found in shoalwater, especially west of the line Näsrevet - Tärngrund. Bench-mark for water level is cut in rock on E. side of N. Kalvön 1.5 meters above M.W. Light-sectors determined 15-18 July.
H.M. Surveying Ship Falken, July 1922
Lieutenant, surveyor 3rd year.
Lyckåsberget
Rosenfors
Lyckås
Gäddviken
Säcken
Kasberget
Timmer (Timber)
Grans
Vit villa med torn (with turret)
Sågverk (Saw mill)
Vattentorn (Watertower)
Skala 1:1000
Pallen 4 cm.
Ytternäset
(Borehole in block) Bh. i stor sv. sten
N. Kalvö
Kalven
Hamnkontor (Harbour-service)
S. Kalvö
Djup vid kajerna se special i 1:1000. (Depths along quays see separate chart in scale 1:1000).
Eriksro
Mek. verkst. (Mech. workshop)
Rundviks (Dock-yard)
Slip för 200 tons fartyg
Slangholm
C.P. Bh. i ljus mindre berghäll. (Borehole in light smaller ledge of rock.)
Skala 1:1000
Pölsorna 4 cm.
Se närliggande distrikt (See adjacent district)
S. Kalvö n. udde ens posthusets n. gavel (See below)
grönt (green)
rött (red)
vitt (white)
Numbers of sounding-lines
Stöt 8.2 Klar 8
Stöt 6.7 Klar 6.5
D 19 K 16
Inseglingsmärke. (Leading mark.)
Kalven
S. Kalvö
S. Kalvöns n. udde ens posthusets n. gavel (N. point of S. Kalvön in line with N. gable of Post Office building)
Explanations.
represents area investigated with ordinary and special lead-line.
" " " " drag-sentry going clear at a depth of 9.5 meters.
in margin of chart: area investigated with the submarine sentry going clear at a depth of 19 meters with "sounding-lines" 15 meters apart. The arrow gives distance and direction to shoal.
in margin of chart: area investigated with wooden frame towed or fixed to vessel, the frame having touched bottom at 8.2 meters and gone clear at 8 meters.
Green numbers give local variation of compass.
Notice.
This chart is merely fictitious and is designed only as a formal guide to surveyors.
Förholm
6335000
6332500
6330000
6327500
65000
67500
70000
72500