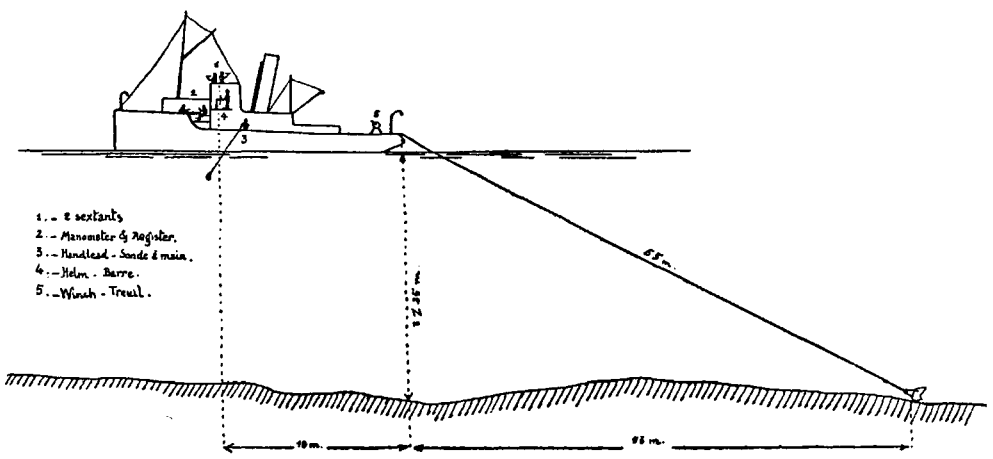
THE TOWED SOUNDER USED BY THE CONSERVANCY DEPARTMENT OF THE NAVAL YARD AT WILHELMSHAVEN AND THE EXPERIMENTS MADE THEREWITH.

THE JADE REQUIRES A TOWED SOUNDER.

The Naval Yard of Wilhelmshaven is responsible for the up-keep of the channel of the Jade. The bottom of the Jade is very uneven, so that it is difficult to ascertain its formation correctly with a hand lead. As it is an inlet of the sea, and as shipping is not very heavy, one does not expect to find many wrecks or floating tree-trunks therein. It was necessary therefore to endeavour to use a towed sounder for measurement of depths.

As there is generally a heavy sea running in the Jade, there was no question of using the STECHER sounding-apparatus, as used in rivers; the BUZEMANN gauging apparatus which was used so successfully in the Trave, or the iron ball, attached to a high mast, with a fine, graduated wire, which indicates the depth by the secant of the angle between the measuring line and the water line. It was therefore decided to obtain the depth on board by the water pressure at the sea-bottom.



This scheme was first thought of by Captain MENSING and the firm of JULIUS PINTSCH of Berlin had on the market a suitable sounding-apparatus. The apparatus consists of a hose, on the open lower end of which a weight is suspended. At the upper end of the hose there is a pressure gauge. The hose is kept free from water by means of an air-pump which works continuously, so that the gauge constantly indicates the pressure of the water at the bottom, although the oscillations are influenced by the pulsations of the pump. This apparatus did not fulfil the requirements.

In 1908 an understanding was reached with Friedrich H. C. HEYN concerning the sounding-apparatus which he proposed.

After many trials and improvements the sounding apparatus which is described below has been in constant use since 1909 by the River Department.

MISCELLANEOUS.

The sounding-apparatus consists of an elbow-kite, a hose, a hawser and a pressure gauge. The working of this apparatus is based on the fact that the air which is in the air-vessel, the hose and the gauge, is compressed, in proportion to the depth, by water which penetrates into the air-vessel through a pipe. The compression is shown by the gauge on board. The depths of water can be read off the gauge to within 1 dcm. Owing to their capacity to be used in deep water, the kite and the air-vessel remain on the bottom a long time without ploughing through it; in soft mud, however, they sink in too deep. The sounding apparatus easily overrides light obstacles that lie on the bottom, such as stones, brushwood, piles, *etc.*, without its working being affected. Sometimes it catches on wrecks and large boulders, and is damaged; on three occasions it was lost completely. Consequently, there are always two sounding appliances on board so that the work may not be interrupted should one apparatus be unavailable.

THE ANGULAR KITE.

The angular kite serves only to keep the air-vessel at the bottom and to protect it from damage. It is towed along the bottom by means of a rope which is made fast to a span. In reality the kite consists of two sloping planks, which form an angle of 110° and are kept apart by iron bars; they are protected against damage when being dragged over rough ground and when touching bottom while the ship turns. The lower edges of these planks are covered with iron sheeting. The short arm of the span is fixed to a strong, trailing weight and the long arm to the upper part of the kite.

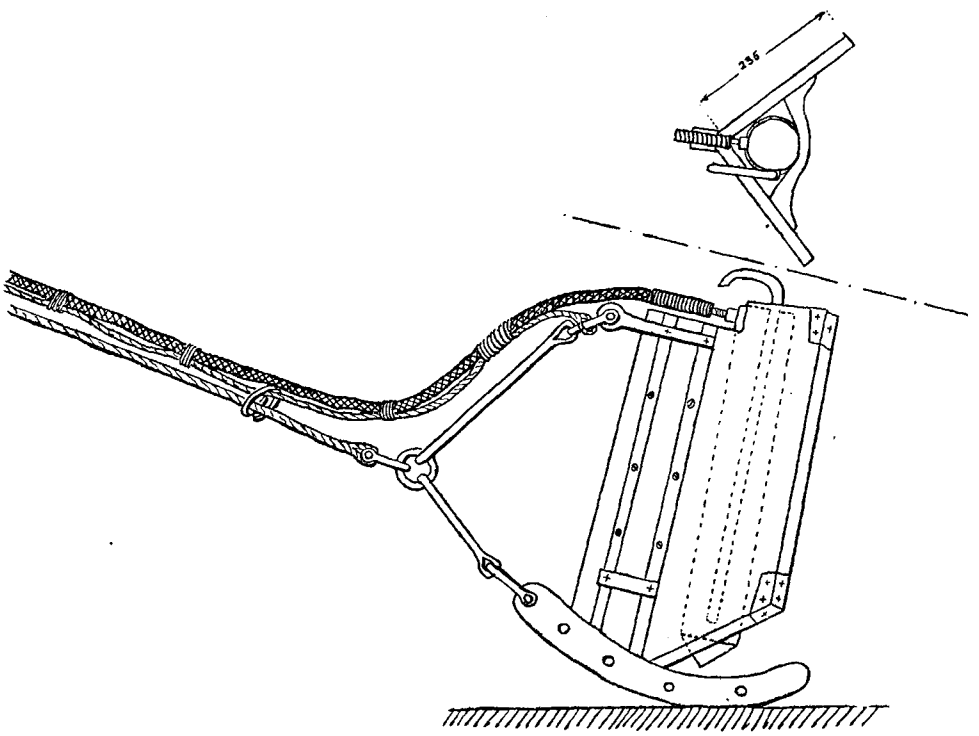
THE AIR-VESSEL.

The air-vessel has a circumference of 130 $^{m}/_{m}$ and is inserted behind the angle of the planks for protection against damage. Inside the air-vessel, under the end of the hose, baffle-plates consisting of three sheets of tin, are soldered

in quite close to each other. These sheets are set at a slight inclination to one another, there being a hole at the lowest extremity of each. If the kite capsizes, no water can penetrate into the hose because the air-trap therein prevents it; any water which is forced into it flows out again after the kite has righted itself. Penetration of water into the hose must be prevented, otherwise the pressure in the air-vessel is not correct. Should water, notwithstanding this arrangement, have penetrated into the hose by leakage, it is blown out, and for this purpose a large tyre-pump was formerly used, but this is now replaced by a large steel bottle of compressed air.

THE HOSE.

The hose, made of rubber, is of 4 $^{m}/_{m}$ internal diameter, 90 m. long and its walls are 4 $^{m}/_{m}$ thick and consist of two layers of rubber and a layer woven specially to resist high pressure; it has lately been put on the market by FELTEN & GUILLAUME in Cologne. It constitutes the air-tight connection between the air-vessel and the pressure gauge. If the hose becomes worn in places, or if it is violently torn the damaged portion is cut out and a metal tube — 10 $^{c}/_{m}$ long and of the same internal diameter as the hose — is inserted half-way into each end of the hose. The joint is then tightly seized with yarn, thus re-establishing its former strength. To avoid any strain on the hose when fixes are being taken, it is stopped every 25 $^{c}/_{m}$ to an auxiliary cable. This auxiliary cable is connected every 5 m. by split rings, to the towing hawser. One end of this auxiliary cable is shackled to the kite and the other is sec-



ured to the deck. It thus takes the brunt of the strain which acts on the hose due to the speed of towing. The greater the diameter of the tube, the more quickly will the difference in pressure at the sea-bottom be registered by the gauge and consequently the air vessel and the towed sounder must be proportionately large. If the internal diameter of the hose is 4 $^{m}/_{m}$ and its length 90 m., the delay in registering when the difference in depth is 1 metre, amounts to 2,5 seconds, which does not upset the scale of the measurements, for in the Jade there are no greater drops at the bottom. The air-vessel is calculated for a hose 90 metres long with a diameter of 4 $^{m}/_{m}$ and for a depth of water of 35 m.

THE TOWING HAWSER.

The towing line, the length of which is adjusted according to the depth of the water, is fastened to the central shackle of the span of the kite. The towed sounder is lowered and hauled in by means of a reel at the stern. While being lowered, the speed of the ship is diminished; then the kite is put overboard by means of a davit at the stern the reel with the auxiliary cable being slowly unwound, the hose, which is loosely coiled on deck, being attached to the towing hawser with the split rings. The towed sounder is hauled in in the same way, only the operations are carried out in reverse order. It is generally towed from a bollard, but if the reel is strong enough, it can be towed from the reel. At a depth of twenty metres, 55 m. of towing hawser measured from the stern, are necessary; at a depth of 25 m., 60 m., must be paid out; at a depth of 30 m., 75 m.; and at a depth of 35 m., 90 m.

THE PRESSURE GAUGE.

A SCHAEFFER & BUDDENBERG (Magdeburg) tubular spring pressure gauge is used with the towed sounder. It must be built large enough and with such precision as to register depths with precision within 10 $^{c}/_{m}$. The gauge is tested and corrected at least twice a year. To do this the kite is dropped and raised metre by metre at a deep spot at slack water. A scale, corresponding to the depths to which the towed sounder has been sunk is made on a paper disc; the depth being read off from a marked lead-line. If the spring has lost some of its elasticity, the error is thus corrected on the paper disc.

DETERMINATION OF THE FORM OF THE TOWED SOUNDER.

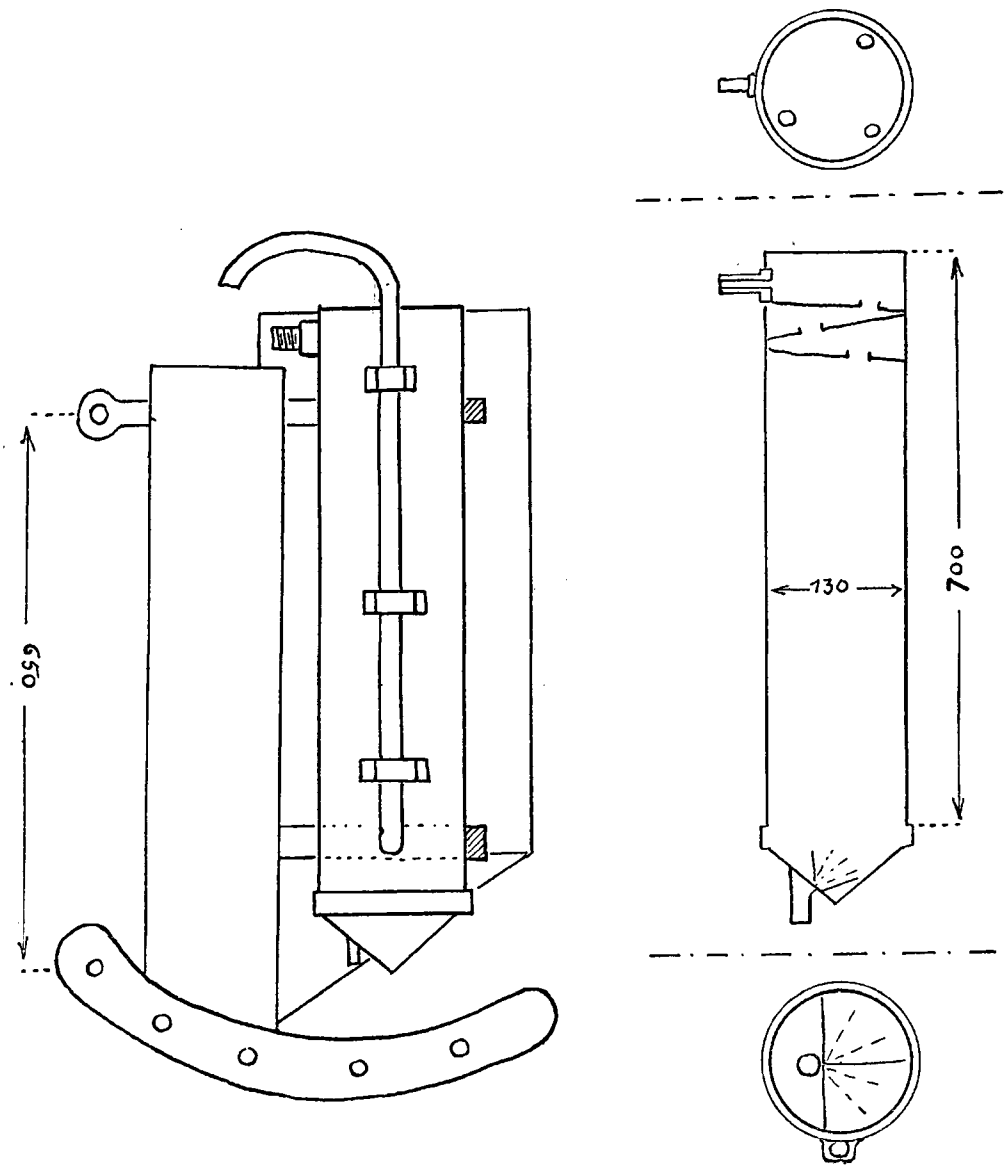
It is assumed that the towed sounder would give incorrect depths of water on account of the pressure applied to the orifice for admission of water due to the speed of towing. Consequently the towed sounder was tested at the institution for examining towed sounders in Berlin at the various speeds which are used in practice. Special types of apertures for admitting pressure into the air-vessel were discovered and by using these the pressure in the air-vessel is not influenced by the speed of towing and the depth of the water is correctly registered.

On the upper edge of the kite is a bent inlet pipe which enters the air-vessel below; below the air-vessel is an exhaust-pipe through which the mud and sand which may have penetrated into the air-vessel can flow out.

From careful tests it has been observed that the shape of the sounder, which has been ascertained to be correct, should in no way be altered when making repairs, for the smallest alteration of the shape might influence the distribution of pressure over the whole apparatus.

USE OF THE TOWED SOUNDER.

In deep water the work is carried out with a boat 29 metres long and drawing 2 metres, provided with a 400 H. P. engine. In shallow water a



smaller, sea-worthy, twin-screw motor boat, 15 m. long, drawing 1,3 m. and with an engine of 120 H. P. is used. Very little power is required during sounding. The fixing of the ship's position is done usually by means of two sextant angles between landmarks. During the run the fixes are plotted and the course is maintained thereby. Afterwards the fix is carefully replotted and generally the scale is enlarged, so that there may be room enough for the figures of the various soundings taken. The depths which are registered by the pressure gauge are recorded automatically. As a rule 12 soundings per minute are registered whereas, with the hand-lead, at a depth of 15 m., at the most 3 soundings can be obtained. The depths obtained with the towed sounder are checked for accuracy every 30 minutes by a cast of the hand-lead, and by means of special hooks which are on the kite, the towed sounder is brought to the surface from time to time. Failure of the towed sounder to act, or the fact that water has penetrated into the hose, are soon noticed because the gauge registers a continuous and even pressure. When there is a heavy sea running, the check by the hand-lead does not take place, on account of its inaccuracy, for experience extending over many years has proved the correct working of the towed sounder and that the work should not be interrupted even when a heavy sea is running. The depths which have been read off from the towed sounder are plotted according to the length of the towing hawser paid out, which is generally 55 metres *i.e.* 77 metres abaft the spot which has been fixed by sextant angles. Hence it follows that the length of 77 m. is, by the plotting sheet, 18 m. from the Ship's station to the stern of the ship, 53 m. from the towed sounder to the stern and 6,5 m. delay in recording. The last is calculated for a speed of 5 knots, or 2,6 metres per sec. × 2,5 sec. — 6,4 metres.

For surveying there are employed for a 12 hour day :

1 Senior Surveyor, 1 Piloting Officer, 4 Sextant Observers, 1 Angle Recorder, 1 Pressure-gauge Recorder, 2 draughtsmen, 2 engine-room hands, 1 cook.	The men are relieved when necessary and according to their capacity.

To these must be added the draughtsmen for the careful drawing and for the enlarging or reducing of the plans, and a calculator for the computation of the figures which the towed sounder shows.

The plans are reproduced on scales of 1/5000 and 1/15000, each of them representing two areas of soundings of the outer Jade. The places where these are are shown on a General Chart ; for the year 1908 the depths obtained by hand-lead are shown. Also for the determination of the shift of shoals a reliable method of measurement is necessary.

When it is desired to deepen such a region, for instance by dredging, the depths must be ascertained with as great precision as the plans permit. Without a towed sounder, however, such a representation is impossible. The

towed sounder indicates the depths of the water within ten centimetres which is proved at the crossings of the lines of soundings on an even bottom. If the ship makes too sharp a turn, then the fixing of the spot is uncertain for the towed sounder lies over on one of its sides, in such cases the figures are left out on the sounding sheet.

THE ADVANTAGES OF THE TOWED SOUNDER COMPARED WITH THE HAND-LEAD.

The towed sounder has the following advantages over the hand-lead :

(*a*) The towed sounder indicates the depth continuously, whereas with a hand-lead the depth is indicated only at the spot where the lead falls.

(*b*) During runs against the current the towed sounder readily indicates the depth of water over the air-vessel, whereas it is impossible to get line of the hand-lead in a perpendicular position. Consequently the depths appear greater than they really are.

(*c*) When there is a heavy sea running, the reading of the depth of the water by the line of the hand-lead is inaccurate on account of the height of the waves, whereas the pressure of the water on the bottom of the sea, and consequently the reading of the depths on the pressure gauge is but very slightly influenced by the waves.

(*d*) In winter the men heaving the hand-lead suffer greatly through frost, cold and wet, whereas the Pressure gauge Recorder reads off the depths of water from the gauge in a sheltered place.

(*e*) The towed sounder may be used at a speed of 5 to 6 knots, whereas, when the hand-lead is used, a speed of 2 or 3 knots cannot be exceeded.

Consequently with a towed sounder, the output, the accuracy and the reliability of the work are increased.

WHY THE TOWED SOUNDER IS USED SO SELDOM.

Though the use of the towed sounder may seem easy, nevertheless it makes great demands on the attention and skill of the Senior Surveyor; therefore it is obvious that the towed sounder is only used by those who cannot dispense with it. For the present the towed sounder cannot be replaced by echo-sounding, the use of the latter being far too costly.

Whilhelmshaven, 26th *October* 1926.

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