ECHO SOUNDING - XVIII

In continuation of the series of articles on echo sounding machines published in various volumes of the *Hydrographic Review* a list of which is given in the *Index to the Hydrographic Review* pp. 12 *et seq.*, some additional information concerning modern instruments collated by the International Hydrographic Bureau during 1938, is given below. In particular, this information deals with:-

I. The new British Admiralty Recording Echo Sounders :- Magneto-striction System "Universal" Type-M.S. XII - M.S. XV.

II. Some recent ultra-sonic instruments :-
   a) SCAM-TOULY Indicator - "Navigation" model ;
   b) SCAM-TOULY Indicator - "Coastal" model ;
   c) Electrolytic Recorder : LANGEVIN-TOULY system (License MARTI) ;
   d) MARCONI Echometer - Type 421 * ;
   New Electrolytic Recorder - Type 439 ;
   e) MARCONI Echometer - Type 424 * ;
   f) The MARCONI (quartz-steel) Portable Shallow Echo Sounder (1 - 120 feet) ;
   g) LANGEVIN-FLORISSON Ultra-sonic Sounding Machine with Echoscope for coastal and river surveying.
   h) LANGEVIN-FLORISSON Ultra-sonic Sounder with Divided Echoscope - Type 2.

III. The MARCONI Magneto-striction Supersonic Echo Sounding Equipments:-
   a) Navigational Equipment, 0 - 150 fathoms ;
   b) Deep Sea Equipment, 0 - 3000 fathoms.

IV. The new high frequency magneto-striction sounding apparatus called the "Atlas ECHOLOT-Hochfrequenz" constructed by the Atlas WERKE, g.m.b.H. of Bremen.

I. THE NEW BRITISH ADMIRALTY RECORDING ECHO-SOUNDERS : MAGNETO - STRICTION SYSTEM.

Descriptive articles concerning the various types of sounders manufactured by Messrs Henry HUGHES & SON Ltd., London, within the last few years, have appeared from time to time in the *Hydrographic Review*, more particularly in Volume XI N° 2, November 1934, page 38 ; Volume XIII N° 2, November 1936, page 78 and Volume XIV N° 2, November 1937, page 211. Volume XIII (2), pp. 87 to 106, contains a very complete theory of the magneto-striction system. This system works on a frequency of the order of 16,000 cycles per second, so that the magneto-striction oscillators are supersonic, remain unaffected by ordinary noises and, in practice, their functioning is absolutely silent.

Although it cannot be assumed that echo-sounding instruments have reached their final state of perfection, it may even now be stated that the purely experimental period is finished and that the instruments now constructed respond in a large measure to all requirements.

The magneto-striction apparatus fitted with a recording mechanism described in *Hydrographic Review* Vol. XIV N° 2, pp. 221 *et seq.* under the name of the British Admiralty Universal Echo Sounder works on a lower frequency (about two times less) than the electro-piezo-quartz instruments, the working frequency of which is of the order of 30,000 to 40,000 per second. This lower frequency assures easier penetration through the particles of the liquid mass and enables depths exceeding 1,000 fathoms to be attained without difficulty. Undoubtedly for greater depths, for deep-sea sounding and in oceanographic work, the sonic system possesses greater penetrative power but the use of such devices implies special installations such as those, for instance, on the British surveying vessel *Challenger*, or on the research vessel *Mabahiss* of the John MURRAY expedition :- the pneumatic or magnetic hammer transmitters specially adapted for the work, functioning on frequencies of about 1250 to 1500 cycles per second.

Within recent years, improvements have mostly been connected with the recording systems of the machines.

Models M.S.III and M.S.IV described in the *Hydrographic Review* Vol. XIII N° 2, pp. 78 *et seq.* were fitted with straight scale recorders. In this type, emissions are of the order of 96 per minute which means, for a speed of two knots, a record of soundings spaced little more than three metres apart on the bottom.

In the new apparatus, M.S.XII, the recording mechanism is of the rotating arm curved scale type; in addition a gear ratio 6 - 1, enables a much more open recording scale to be obtained.

Type of Machine	1st Scale	Phasing Details	Maximum Scale Reading
M.S. II	35 fathoms	Optional 3×25 fathoms	100 fathoms
M.S. II	70 metres	„ 3×50 metres	220 metres
M.S. III	90 fathoms	4×50 fathoms	290 fathoms
M.S. III	142 „	4×100 „	542 „
M.S. III	214 metres	3×150 metres	664 metres
M.S. X	40 feet 40 fathoms	Optional 75% „ 75%	70 feet 70 fathoms
M.S. X	60 feet 60 fathoms	„ 75% „ 75%	105 feet 105 fathoms
M.S. X	12 metres 24 „	„ 75% „ 75%	21 metres 42 „
M.S. X	40 „	„ 75%	70 „
M.S. X	12 „ 36 „	„ 75% „ 75%	21 „ 63 „
M.S. XII	60 feet 120 „	„ 66% „ 66%	100 feet 200 „
M.S. XII	60 „ 60 fathoms	„ 66% „ 66%	100 feet 100 fathoms
M.S. XII	90 feet 90 fathoms	„ 66% „ 66%	150 feet 150 fathoms
M.S. XII	120 feet 120 fathoms	„ 66% „ 66%	200 feet 200 fathoms
M.S. XII	25 metres	„ plus 15 metres	40 metres
M.S. XII	25 „ 50 „	„ „ 15 „ „ „ 30 „	40 „ 80 „
M.S. XII	25 „ 125 „	„ „ 15 „ „ „ 75 „	40 „ 200 „
M.S. XII	62.5 „ 312.5 „	„ „ 40 „ „ „ 200 „	102.5 „ 512.5 „
M.S. XII	90 „ 450 „	„ 66% „ 66%	150 „ 750 „
M.S. XII	125 „ 625 „	None	125 „ 625 „
M.S. Special "Veslekari" Type	214 „ 142 fathoms 350 metres 533 „	11 phases of 150 metres 11 „ 100 fathoms 9 „ 300 metres 11 „ 375 „	1800 „ 1200 fathoms 3000 metres 4500 „

TABLE I

Soundings in shallow water may be carried out at the rate of 220 soundings per minute for high-speed and 60 soundings per minute for low-speed. On the first of these cadences, and steaming at three knots, a record of soundings at intervals of about 40 cm. on the bottom may be obtained, thus allowing a study of detail hitherto impossible to obtain by means of any of the old sounding methods by line or wire.

At the present time the firm of Henry HUGHES & SON constructs different models of equipment according to the circumstances to be taken into account. Table I is a standard tabulation of the equipments most currently used for British Admiralty Supersonic Echo-Sounders — magneto-striction system.

All M.S. instruments are magneto-striction system supersonic. The machines M.S.II, M.S.III, M.S.IV are straight-scale recorders; models M.S.X, M.S.XII, M.S.XIV, M.S.XV are curved-scale recorders.

Type M.S.II recorder has a scale of record of 35 fathoms or 7 per inch; the range is 100 fathoms in three phases of 25 fathoms. The scale of record of type M.S.III, straight scale, is from 0 to 90 fathoms, or 18 per inch, phasing up to 250 fathoms in four phases of 50 fathoms. Type M.S.IV is similar to MSIII, but with extra power oscillators suitable for high-speed ships, such as cruisers, destroyers, etc. Type M.S.X carries a rotating arm curved-scale recorder and is specially constructed for survey work; it may be supplied with one or more scales, the largest being from 0 to 40 feet. This equipment is suitable for survey work of all kinds: phasing 75 %. Type M.S.XII or *Universal*, carries a rotating arm curved-scale recorder; of much reduced dimensions, it is particularly adapted for surveying boats; it has several phasing systems and scales adapted to different powers as indicated in the annexed tabulation. The *Veslekari* model is a special supersonic deepwater instrument for depths up to 4500 metres.

The accompanying tabulation I shows the arrangement of the scales and the following table gives the weight and dimensions of the different models.

DESCRIPTION	Weight				Height		Width		Depth	
	cwts.	qrs.	lbs.	kilos.	ins.	cms.	ins.	cms.	ins.	cms.
M.S. II	2	0	0	102	36	92	26	66.1	12	30.5
M.S. III	1	3	0	89	34	86.4	23	58.5	12	30.5
M.S. IV	2	0	0	102	34	86.4	23	58.5	12	30.5
M.S. X	1	3	0	89	32	81.3	22	55.8	9	22.9
M.S. XII	0	3	0	38½	16	40.7	11	28.0	11½	29.3

TABLE II

RECENT EXAMPLES OF RESULTS OBTAINED.

Let us examine a few of the effects obtained by the application of echo-sounding and, first of all, the demonstration given during the International Hydrographic Conference held at Monaco in April, 1937. It was intended to demonstrate with a recording echo-sounder of the British Admiralty standard two-scale type, and for this purpose one of the local fishing boats of the *Dyco* type was hired and a temporary rig was made. The oscillators for this demonstration were of the small boat type, enclosed in streamline form. This streamlined combined oscillator was mounted over the bow of the boat from a stout plank purchased locally and clamped down to a cross beam which was itself clamped to the gunwale of the boat. The Echo Sounder itself was simply laid flat on the stern benches with the amplifier alongside it, and not secured in any way, and the whole outfit was run off a car battery. The accompanying record is typical of the results obtained, uniformly over a very large number of runs, and the little track chart shown to the left of the record will assist in appreciating what the instrument was doing. It will be noted that proceeding close inshore, soundings were obtained down to within one foot of the bottom of the oscillators, after which the boat went out into the Harbour Pass, over the mooring chains of a yacht, which were clearly shown on the record.

The two peaks shown in the middle of the record are profiles of the two conical supports to the end of the breakwaters, very much compressed on the distance scale, and the extreme depth in the mouth of the Harbour, 87 feet, was clearly recorded between them.

Another interesting survey was recently carried out under the auspices of the Freshwater Biological Association, which had established an experimental station on Lake Windermere. Messrs Henry HUGHES & SON, Ltd., were approached and asked to hire one of their boat gear echo-sounders for three weeks, and subsequently a survey of Lake Windermere was carried out

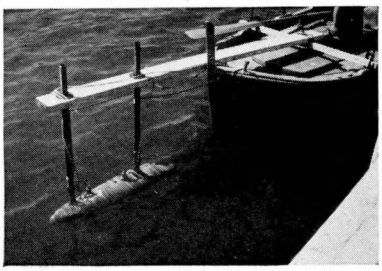


PLANCHE I

PLATE I.

Gréement de fortune pour les oscillateurs profilés.

Temporary rig for streamlined oscillator.
British Admiralty Echo Sounder Boat Gear.

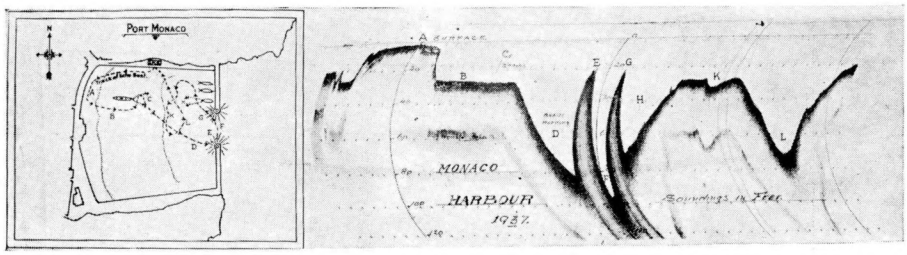
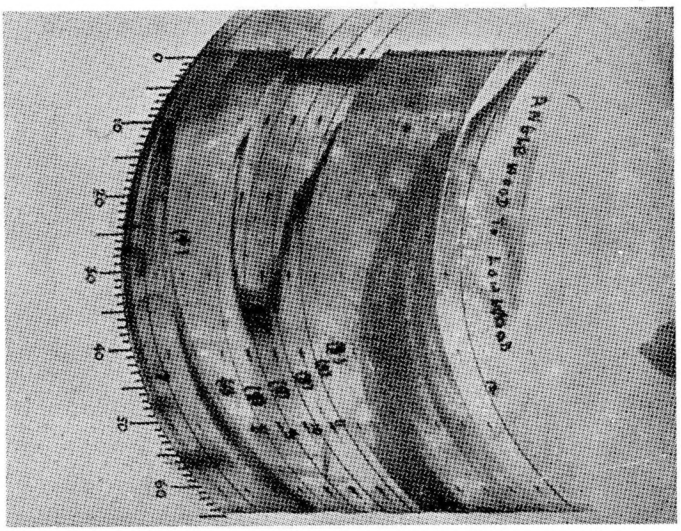


PLANCHE II
PLATE II.

Diagramme des résultats obtenus au cours d'une démonstration à Monaco.
Oscillateurs hors-bord.

British Admiralty Echo Sounders.
Record of results obtained from a demonstration at Monaco.
Outboard oscillators.



Enregistrement typique obtenu avec les oscillateurs hors-bord en coffres profilés.

Typical Echo Sounder Record.
Outboard Oscillators in Streamlined Case.

with a view to determining the precise conformation of the bed of the lake. The British Admiralty Hydrographic Department co-operated with the Freshwater Biological Association in this survey which was, in fact, directed by the British Hydrographer.

The underlying idea was that a really accurate map of the lake floor should be obtained for detailed biological work and which might serve by comparison to analyse the changes which take place in the lake floor when the survey is repeated at some future time. The instrument used was the Universal M.S.XII model, having two scales, 0-60 and 0-240 feet. The instrument was designed to run off 12 volt batteries and the oscillators were fitted in a streamlined case, carried out on a spar over the stem of a motorboat. The installation was, therefore, portable.

The survey occupied three weeks and was the most complete of any lake that has been attempted in the British Isles. Transverse runs across the lake were made at every 50 yards for the whole of its length and an immense number of soundings recorded. In this connection it has to be remembered that the echo sounder recorder on the high speed, that is to say on the 0-60 scale, actually makes no less than 220 soundings per minute, and on the low speed about 60 soundings per minute.

The important point that emerges from this fact is that while only a fraction of these soundings are actually recorded on the subsequent chart of the lake, the intermediate depths between these soundings are accurately known and no important difference is left unmarked. This is what gives to such a survey that invaluable quality of reliability which was of necessity absent in all the earlier forms of hydrographical soundings.

DEPOSITS SHOWN :

A perusal of the records resulting from the survey of Lake Windermere not only enabled the first objects of the Freshwater Biological Association to be most accurately and intimately achieved, but also revealed that on the bed of the lake there was a deposit of mud or silt, and in some cases this deposit was arranged in strata of varying density. The mud deposit showed in the records very clearly because it consists of relatively soft material overlying the hard rock basin, or in some cases boulder clay, which formed the original lake floor. A reference to the figures (Pl. II) will show this very clearly. Whenever the rock floor is exposed, the record is marked by a single hard line to mark the bottom, together with periodic re-echoes caused by repeated reflection of the sound-waves to and from the rock floor and the water surface.

These results immediately open up to the scientists a new field of interest, enabling them to forecast the possibility of reading from these strata the geological history of the district since the Ice Age. The matter was so interesting that permission was asked to retain the instrument for a longer period in order to investigate the conditions of some of the other lakes in the district, and this was readily granted by the firm. As a consequence six other lakes were surveyed in a more cursory manner than Lake Windermere, but sufficiently thoroughly to establish the valuable information required on the varying deposits on the beds of the different lakes.

We now pass to a demonstration which took place on the River Loire in the neighbourhood of the port of St. Nazaire. Before describing the demonstration, it may be of interest to touch on some of the technical features of these harbour survey instruments. The instrument used in this instance was mounted in the vedette *Echo* and had two scales — zero to 25 metres and zero to 125 metres. The changeover from the one scale to the other was effected by a neat switch arrangement operating a 5 to 1 reduction gear. In this particular case the magneto-striction oscillators were fitted outboard in a streamline form. The streamline case was suspended from one of the leadsman's sounding platforms on the side of the vessel by steel tubes cross braced and welded and bolted to the outer edge of the sounding platform in such a manner that the bottom of the oscillators lay about one metre below the surface of the water, and the streamline form was parallel to the fore and aft line of the vessel.

This method of rigging the oscillators is very effective for inland water work, and oscillators mounted in this manner have been successfully run at various speeds up to 18 knots without causing any interference in the efficiency of the soundings. The method is particularly applicable for confined spaces and for very shallow waterwork such as estuaries.

The demonstration took place primarily at the port of Donges in the area between Donges and Paimbœuf in the vicinity of Des Brillantes bank where it was known that rocky formations existed.

The party embarked at St. Nazaire and proceeded by the route of the proposed new channel to the position selected and here a series of runs of varying courses were made, cross-sectioning the channel at this point; it was ascertained that the echo sounder faithfully recorded the depth

to a proved accuracy of 10 centimetres and at the same time indicated where there was rock strata underlying mud at various points where this peculiarity occurred. The accuracy of the instrument was tested over a portion of hard ground, being checked against a measuring pole put in the water alongside the oscillators. A similar instrument has already been thoroughly tested by the Hydrographic Services in a tank, and its accuracy of measurement definitely calibrated against positive measurements at the tank side and showing an accuracy to within 10 centimetres over a distance of 24 metres. The fact that under these conditions it is possible to measure the error proves the accuracy of the system.

On the following day a further demonstration was given. This time the boat worked solely in the two basins at St. Nazaire, and the echo-sounder detected the presence of a sunken boat lying on the bottom, the existence of which was not known to anyone on board. The echo-sounder's observation was promptly confirmed by careful sounding with sounding pole over the spot when the vessel stopped.

One of the great advantages of the magneto-striction system lies in the fact that, while being supersonic, it possesses, like the sonic system, great penetrative power and an immediate effect of this is that the oscillators need not be fitted outside the hull plating of the ship, and at the same time considerably greater depths than will ever be required for navigation purposes can be obtained.

II. SOME RECENT ULTRA-SONIC INSTRUMENTS.

ULTRA-SONIC PROJECTORS :

There exist several different models of piezo-electric projectors used with ultra-sonic appliances of the LANGEVIN-CHILOWSKY system :-

	Diameter of the transmitting plate.	*Period of vibration proper per second.*
(1) Projector S. 4 *ter*	220 mm.	37,000
(2) Projector S. 7 *bis* (for great depths).....	310 mm.	29,000
(3) Projector S. 16, triple-ply, may be dismounted afloat, special for trawlers.....	220 mm.	39,000
(4) Projector S. 23, coastal type.....	100 mm.	65,000

These projectors and the method of securing them to the hull of the vessel are fully described in various pamphlets issued by the Société de Condensation et d'Application Mécanique (S.C.A.M.), 42, rue de Clichy, Paris 9e (Pamphlets US-85-2, 37-2, 107 and 120).

Spare projectors kept on board, or in store, must be placed with their axis vertical and in a place where the temperature to which the quartz triple-ply is exposed never becomes too high.

Indeed, if by any oversight the projector is kept flat with the transmitting plate turned upwards, the weight of the inner steel diaphragm is borne by the cement assembling the quartz. In such conditions a rise of temperature, above 30° C. (86° F.), inducing a slight softening of the cement, may finally cause an alteration of the transmitting properties of the projector.

In the case of the projector placed flat, transmitting plate downwards, (*projector in use*, or projector correctly stored), *the temperature can rise to* 50° *C.*, (113° F.) *and higher, without altering the transmitting properties and the good preservation of the instrument.*

In this position, in fact, the inner steel diaphragm bears on the quartz and the cement ; as, moreover, it is maintained sideways by insulating wedges, the softening of the cement does not involve any risk of the parts becoming unstuck.

Experience has even shown that the projector being in a position such that the transmitting plate is in a vertical plane, is of no importance.