ECHO SOUNDING — XIII.

As a result of the many articles published in the *Hydrographic Review* since 1924 on the subject of Echo Sounding Machines, the International Hydrographic Bureau frequently receives enquiries as to the various kinds of apparatus in commercial use, their capabilities, bulk, weight, method of installation on board, their price and the method of obtaining them.

The Bureau has tried to reply to these enquiries as best it could from such information as had reached it.

At the same time, owing to the continuous evolution of echo sounding and the progress in the details of the many appliances which constant experience has made possible, some revision of the information given in the course of the articles is necessary.

In consequence, the International Hydrographic Bureau has recently applied to the various makers for the latest information of a practical and commercial nature with regard to the machines which they manufacture.

The International Hydrographic Bureau has particularly demanded:

(1) the exact name given to the machine by the makers, and by which it should be designated, its type, number or mark;

(2) the kind of emission (sound, ultra-sound, hammer-blows, detonations, etc.);

(3) the different elements of which it consists: transmitter, receiver, repeater, recorder, etc.

(4) the use for which it is intended: big ships, trawlers, surveying boats, oceanography, deep or shallow water;

(5) its limits of range, i. e. -
least depths measured,
greatest depths measured;

(6) information concerning the reading or recording scale, the standard speed and method of adjusting;

(7) facilities for installation on board, current required etc.

(8) weight, bulk;

(9) price and conditions of delivery.

Further, the Bureau has requested the makers to supply it with detailed publications concerning their apparatus, such as descriptive notices, catalogues etc., with a view to making these publications known to the Members and to be able to distribute them on request among those interested.

Hereunder will be found a summary of the latest improvements in the various apparatus according to the information provided by the makers.

In this summary we shall not repeat the general principles of the appliances which have already been described in the Hydrographic Review but will confine ourselves to indicating modifications of detail or assembly in the units.

GERMANY.

The ATLAS-WERKE AKTIENGESELLSCHAFT of Bremen manufactures echo-sounding apparatus under the name of ATLAS-ECHOLOT, the principle and description of which were given in *Hydrographic Review*, Vol. V, No. 1, May 1928, page 153. The general arrangements of these machines are the same as in the FATHOMETER of the SUBMARINE SIGNAL CORPORATION of Boston, described on page 143 of the same Review and on page 176 of *Hydrographic Review*, Vol. VIII, No. 2, November 1931.

The ATLAS-WERKE have now improved their gear and construct the following series of models:

(1) ATLAS-ECHOLOT, current pattern, type 20, for sounding from 4 to 250 metres (2.2 to 137 fms.).

(2) ATLAS-ECHOLOT, current pattern, type 22, for sounding down to depths of 500 metres (273 fms.).

In these two models the depths are indicated by a flash of red light which moves round a circular scale. The indications appear every 2 1/2 seconds and may be read without any difficulty from a distance of several metres. In addition to this optical indication, the depths given by the apparatus can be registered on a supplementary recorder called the ATLAS-ECHOGRAPH.

(3) The ATLAS-WERKE AKTIENGESELLSCHAFT has also adapted for hydrographic purposes a *universal type of* ATLAS-ECHOLOT, which measures not only the least depths beneath the keel but also the greatest oceanic depths; thus during the German oceanographic expedition in the *Meteor* it was possible to measure depths down to 8,300 metres (4,538 fms.) with this apparatus. This type is still being improved.

(4) Another type of ATLAS-ECHOLOT uses ultra-sonic waves and enables depths to be measured from about 0.5 m. (1.6 ft.) beneath the keel within an accuracy of 10 cm. (4 in.) over the whole range of the scale.

(5) As the requirements of the various hydrographic offices are not always the same, the ATLAS-WERKE AKTIENGESELLSCHAFT is in a position to modify the lay-out of the instruments so as to adapt them to the smallest or the largest scales according to the requirements of each case.

The addition of the ATLAS-ECHOGRAPH supplies a continuous record of the depth profile. The indications are scratched in a thin coating of wax carried by the strip of recording paper in such a way that the dark red ground colour of the paper becomes visible. This dry method of recording affords a high degree of reliability and accuracy of recording in the conditions of use on board.

ATLAS-ECHOLOT.

A general description of the current model of ATLAS-ECHOLOT, types 20 and 22, is given in booklet No. 220 E published by the ATLAS-WERKE A. G. of Bremen, which is supplied on demand.

We shall confine ourselves here to mentioning the recent improvements introduced into the apparatus, which comprises:

(1) The indicating apparatus, which controls the emitter and contains the reading mechanism.

(2) The Impact Oscillator.

(3) The hydrophone receiver.

(4) The amplifier, interposed in the circuit from the receiving hydrophone to the indicator.

Plate I shows the new model of indicator.

INDICATOR. — The indicator contains the time measuring device together with a series of contacts for controlling the emitter. The time measuring device consists, as we know, of a disc with an indicating lamp which is revolved close to a specially gauged scale by a motor. The disc rotates at a speed of 180 r. p. m. The motor which drives it runs at 1800 r. p. m. A governor keeps the speed constant. Three cam contacts actuate the oscillator automatically. They operate in a definite sequence under the action of the rotation of the disc. The controls on the face of the indicator have been reduced to three: at the lower left-hand corner the regulator for the control resistance of the hydrophone, by means of which the sensitiveness of the receiver can be regulated; at the lower right-hand corner the master switch; and at the top, a small resistance unit for controlling the oscillator current. The indicator further contains a voltmeter across the supply circuit and a milliammeter in the anode circuit of the second amplifier valve. Type 22 has an additional switch over the scale, for interchanging the 250 m. or 500 m. scales at will.

IMPACT OSCILLATOR. — This consists of a strong cast-iron casing to the lower side of which a steel diaphragm is attached. The casing contains a coil which induces a magnetic field and inside of which is an iron plunger. When the coil is energised the plunger is drawn up into the coil, thereby putting a strong steel spring under tension. After the plunger is attracted, the current is switched off stepwise down to a single power current without the plunger being released. It is only when the reduced current is itself cut off that the spring drives the plunger forcibly against the diaphragm, thereby producing a short sound impulse.

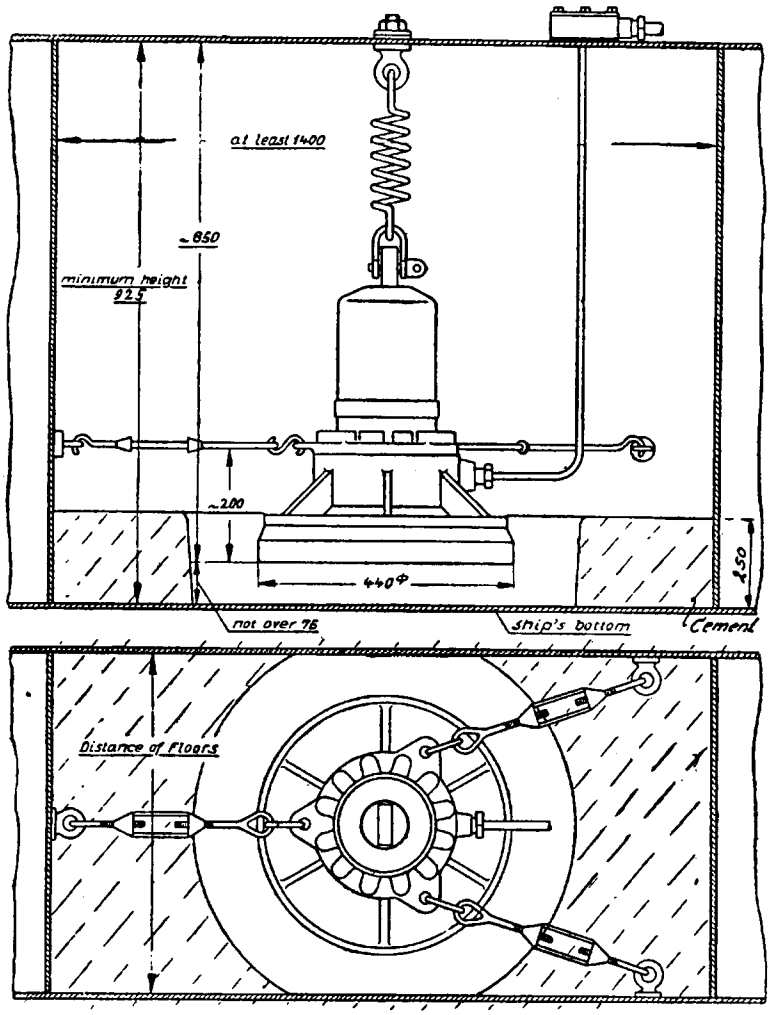


FIG. 1

Tank mounting of oscillator — Montage de l'oscillateur en caisson intérieur

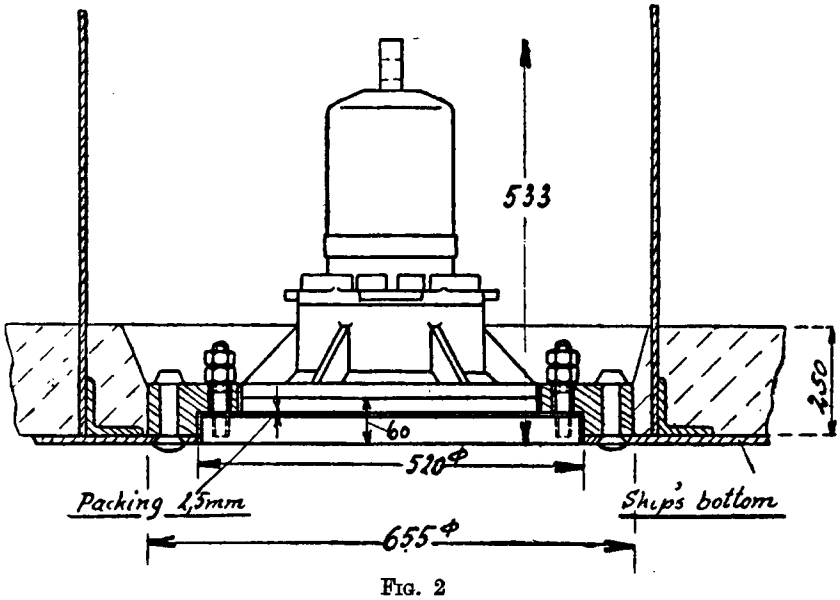


FIG. 2

Flush mounting of oscillator — Montage de l'oscillateur à fleur de coque

ATLAS-ECHOLOT — TYPES 20 & 22

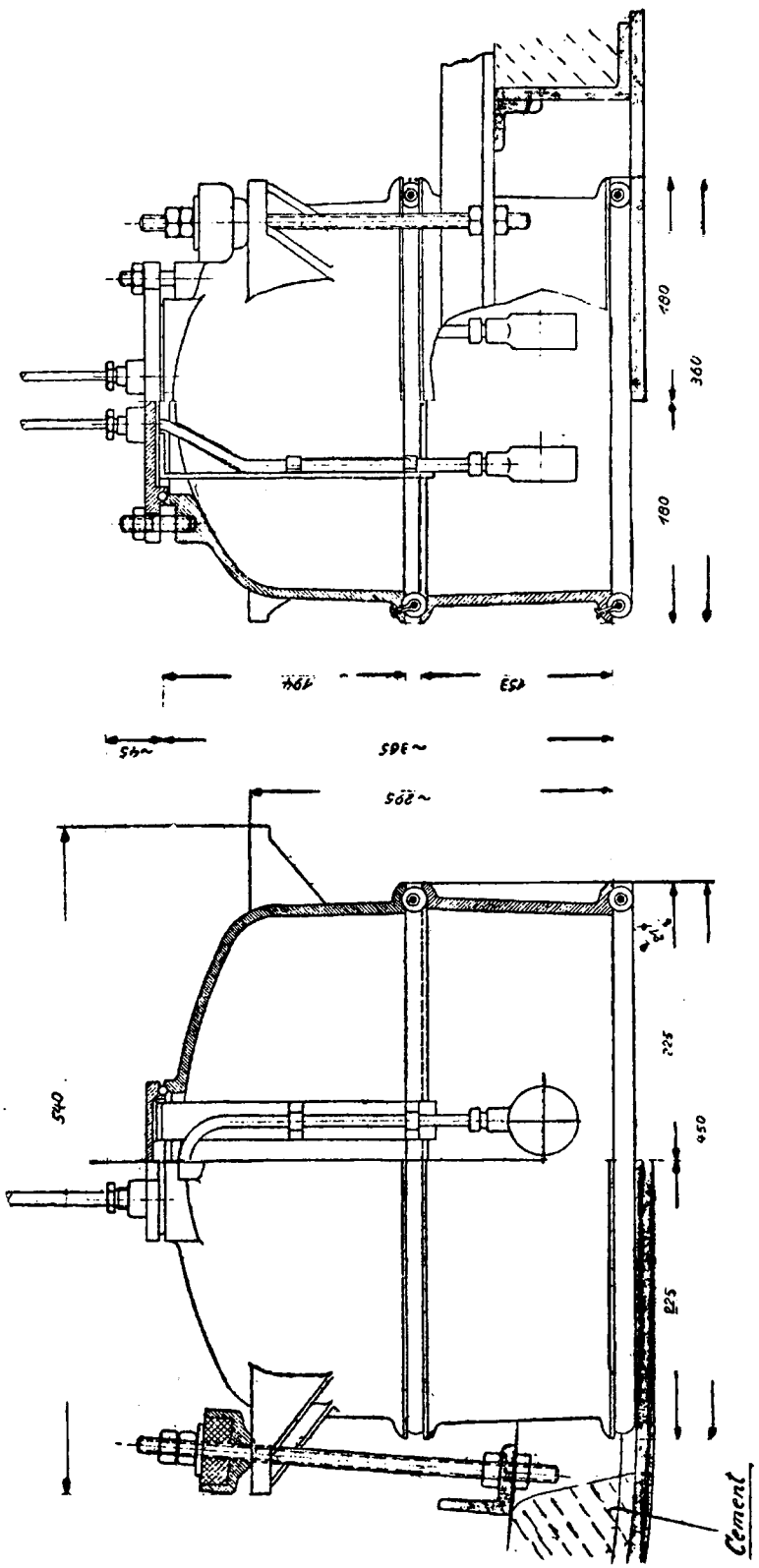


FIG. 3

ATLAS-ECHOLOT, TYPES 20 & 22

Tank with two hydrophones — Caisson à deux hydrophones

The current for operating the oscillator is taken from the ship's mains and is switched in by means of the cams in the indicator. The impact oscillator is often suspended in a special water tank (Fig. 1) so that the sound produced passes outboard through the water of the tank and the hull. In some cases the impact oscillator is attached directly against the ship's bottom from the inside or, better still, bolted directly to the hull itself by a flange (Fig. 2), so that the diaphragm lies flush with the outer skin. This latter type of mounting is only applicable to type 22.

HYDROPHONES. — The Hydrophones (Fig. 3) are of the microphone type. The vibrations of their diaphragms, due to the impact of the echo, cause grains of carbon to be shaken up, and the variations of current produced are transmitted to the amplifier. Alternatively, for echo soundings two *N* type hydrophones can be used. These hydrophones are suspended in a tank *T*. The tank is filled with water and bolted to the inside of the ship's bottom.

AMPLIFIER. — The amplifier is fitted near the indicator. It contains two amplifier valves. The first valve receives its anode potential from the 135-volt anode battery included in the amplifier, while the second valve is fed direct from the ship's mains. The filaments for both valves are likewise fed from the ship's mains. A switch is provided in the front cover of the amplifier for alternatively switching in the hydrophone.

ATLAS-ECHOGRAPH.

This apparatus is described in booklet No. 206 E published by the ATLAS-WERKE A.G., Bremen.

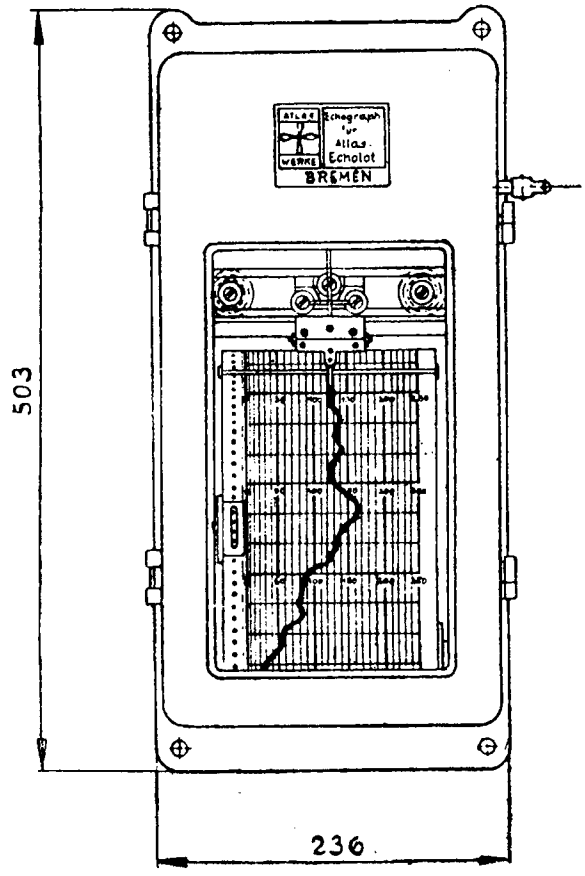


FIG. 4

ECHOGRAPH FOR USE WITH ECHOLOT

The Echograph is installed next to the indicating apparatus and is put into action simultaneously with the latter by a lever. It is therefore always possible to read off simultaneously, and to compare with one another, both the indications of the main apparatus and the records made in the form of a continuous curve.

The Echograph is mounted in a closed metal casing on the front side of which is a window (Fig. 4). The recording strip moves vertically downwards behind the window. The paper strip is fed through the apparatus by clockwork at 24 cm. (9 1/2 in.) per hour. The length of the paper strip containing the record can be read for about an hour, after which time it is wound round a storage roller. The upper part of the casing contains the magnetic recorder which is automatically set in motion by the geared motor of the indicating apparatus. At each sounding the magnetic recorder is moved across the registering strip; thus the moment the echo arrives, a stylus marks a short stroke in the white wax film with which the paper is covered, so that the red ground colour of the latter becomes visible and marks the depth. The single strokes follow so closely to one another that they result in an uninterrupted depth curve as shown in Fig. 5.

The actual width of the record paper is 120 mm. (4 3/4 in.), with the scale showing 0 to 250 m , i. e. 1 mm. for 2 metres of water. The scale can also be used to show 500 metres depth, or switched over to show 0 to 250 m. or 250 to 500 m., in each case utilising the full width of the recording strip. The supply of paper enables the apparatus to work for about 125 hours.

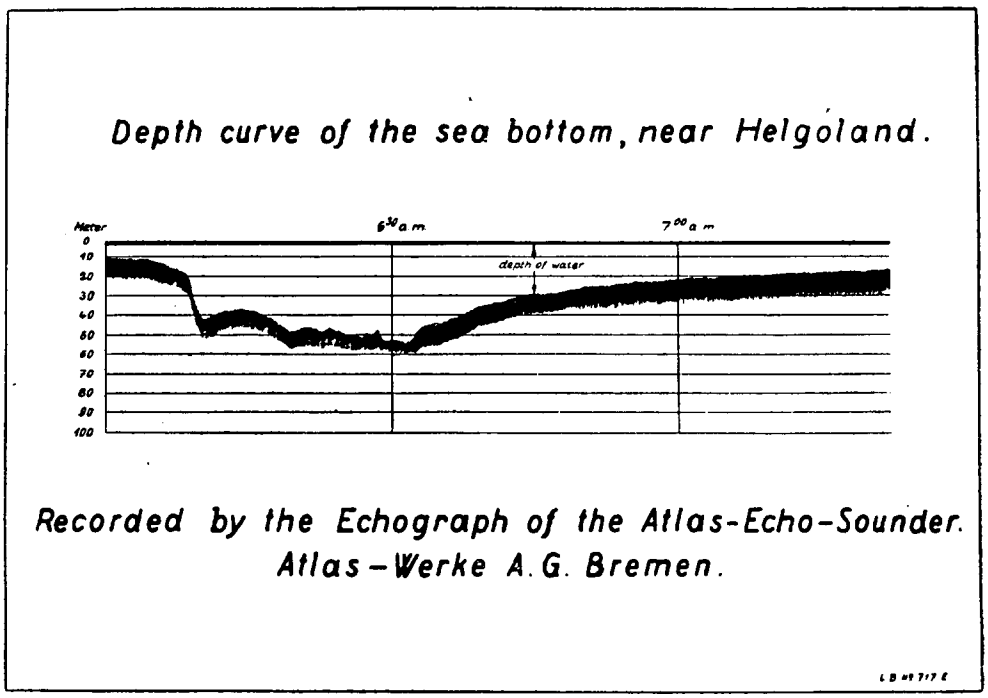


FIG. 5

The wax-coated paper renders the use of ink unnecessary and has the advantage of unlimited durability. The paper strips are graduated in metres so that the depths can be read off directly. Fig. 5 reproduces an example of a bottom profile near Heligoland taken by the ATLAS-ECHOLOT with the ECHOGRAPH recorder.

GREAT BRITAIN.

The firm of HENRY HUGHES & SON, LTD., 59 Fenchurch Street, London, E.C. 3, constructs the BRITISH ADMIRALTY ECHO-SOUNDING MACHINES.

The principle of these machines and their successive models have been described in previous numbers of the *Hydrographic Review* (1) ; we shall therefore describe hereunder :

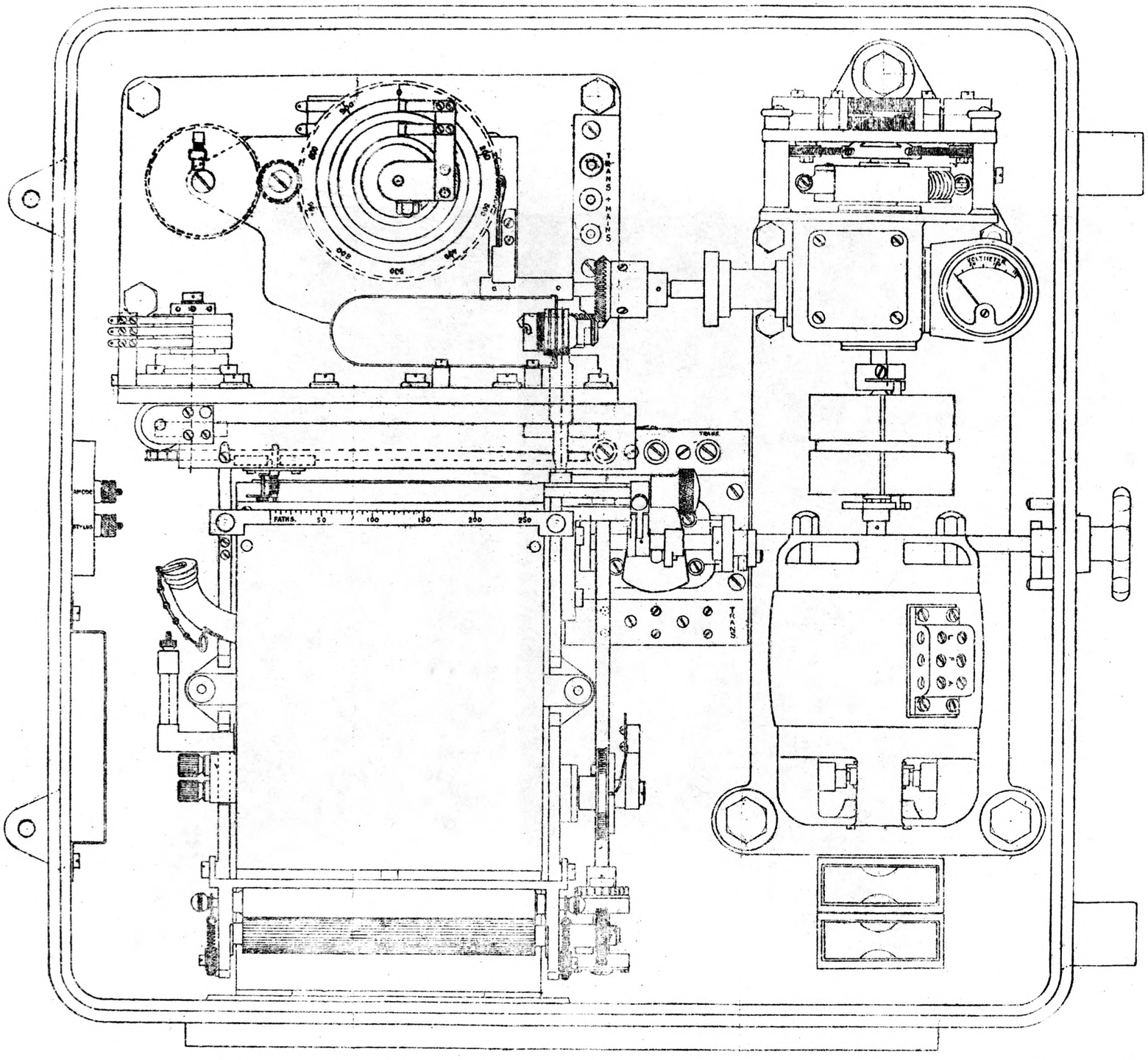
---

(1) *See :* (1) Hydrographic Review, *Vol. II, No. 2, May 1925, page 143, giving the principle of the British Admiralty Echo-Sounder and*

Hydrographic Review, *Vol. III, No. 2, July 1926, page 99, describing the first model of this apparatus. It permits of normal sounding from 8 3/4 to 35 fathoms, and greater soundings by listening in on the headphones.*

(2) Hydrographic Review, *Vol. V, No. 1, May 1928, page 131, describing the British Admiralty Echo-Sounding Machine (Shallow Water Type, Mark II, Types A and B), with or without repeating transmitter, permitting soundings to be taken from 0 to 780 feet (0 to 130 fathoms).*

(3) Hydrographic Review, *Vol. VII, No. 1, May 1930, page 99, describing the British Admiralty Echo-Sounder, Shallow Water Navigation Pattern, Mark III, equipped with a powerful 100 lb. transmitter and permitting of soundings from 0 to 250 fathoms.*



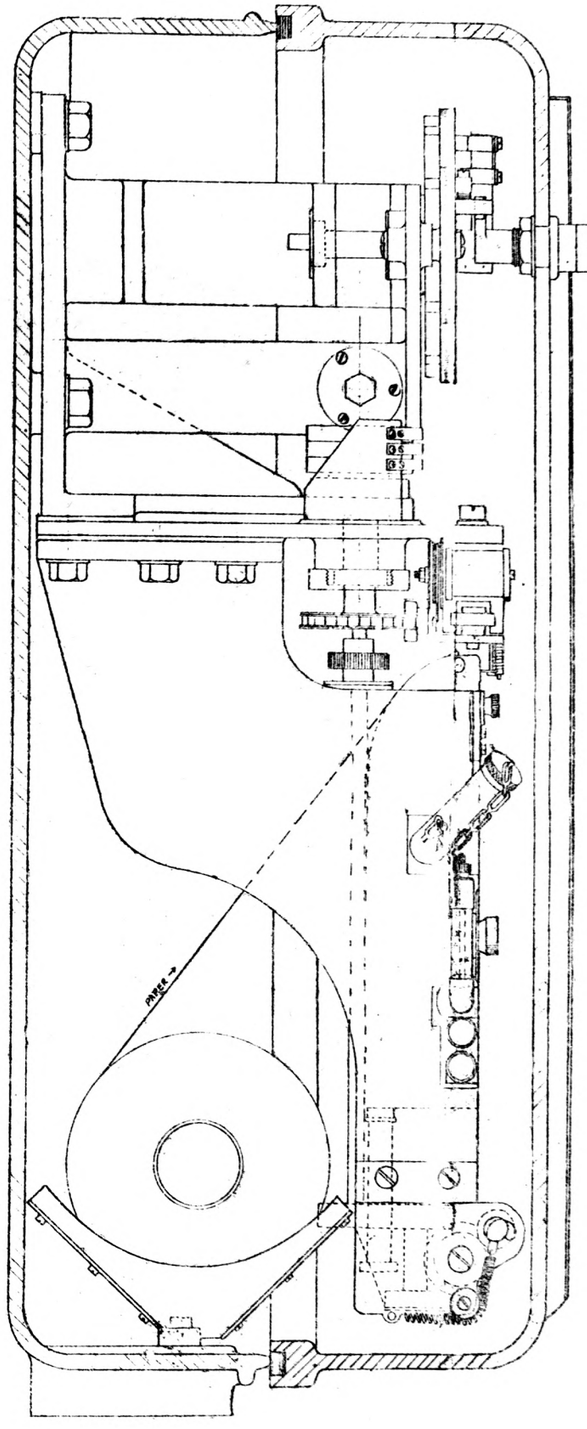


Fig. 6

BRITISH ADMIRALTY DEEP WATER ECHO SOUNDING MACHINE, MARK X.

RECORDING GEAR

SONDEUR PAR LE SON, TYPE AMIRAUTÉ MARK X, POUR GRANDES PROFONDEURS.

MÉCANISME DE L'ENREGISTREMENT

I. — The improvements introduced into the BRITISH ADMIRALTY DEEP WATER ECHO SOUNDING MACHINE, STANDARD PATTERN, MARK X with Recorder, which is the latest pattern of apparatus manufactured by Messrs. HENRY HUGHES & SON, Ltd., London ; this is the apparatus fitted in H.M.S. *Discovery II.*

II. — The new BRITISH ADMIRALTY SUPER-SONIC ECHO SOUNDER which utilizes a magneto-striction element as transmitter.

I. BRITISH ADMIRALTY DEEP WATER ECHO SOUNDING MACHINE, STANDARD PATTERN, MARK X.

At the present time, a considerable number of these machines have been fitted in ships and the results of the experience gained of late have been embodied in the pattern initially devised for use in H.M.S. *Challenger,* the result constituting the present Standard Pattern, Mark X.

The unit includes the Receiving Gear, Admiralty type 752 ; the Recording Gear is mounted in the same case and operated by the above (see Fig. 6). The stylus moves horizontally across the strip of recording paper. A special heater drys the record after its passage through the sensitizing liquid. The phasing system enables records to be obtained from 20 to 6,000 fathoms in steps of 250 fathoms. The Transmitter, of the latest type, consists of a pneumatic hammer in a stainless steel tank, the unit (together with the compressor) being fixed to the ship's plating. The Hydrophones, 1 shallow and 1 deep water, are also contained in casings fixed to the ship's plating.

The total price of the gear thus equipped, exclusive of the wiring which varies with the installation on board, is £900.

The principle and component parts of the gear have already been described in previous issues of the *Hydrographic Review,* particularly Vol. IX, No. 2, November 1932, page 135 and Vol. X, No. 2, November 1933, page 130. Some details of the new features of the Mark X unit follow herewith.

---

(4) Hydrographic Review, *Vol. VII, No. 1, May 1930, page 100, describing the British Admiralty Echo-Sounder, for Fast Liners and Trawlers, Mark IV, also equipped with the 100 lb. transmitter, permitting of soundings from 0 to 500 fathoms.*

(5) Hydrographic Review, *Vol. V, No. 1, May 1928, page 138, describing the British Admiralty Deep Water Echo-Sounder, Oceanic Pattern, Mark V, permitting of soundings from 30 to 4,500 fathoms, with headphones.*

(6) Hydrographic Review, *Vol. VIII, No. 2, November 1931, page 168, describing the British Admiralty Echo-Sounder, Pattern 752, permitting soundings from 0 to 135 fathoms to be taken with the hand key.*

This model is also made with Automatic Recorder (former Mark VI) including a phasing system permitting shallow water soundings to be taken from 0 to 500 fathoms and deep water soundings from 0 to 5,000 fathoms.

Hydrographic Review, *Vol. IX, No. 2, November 1932, page 135, describes the British Admiralty Echo-Sounder, Challenger Pattern, Mark VI, (new) equipped with the Deep Sea Recorder which records depths from 0 to 250 fathoms, with phasing system permitting of soundings down to 6,000 fathoms.*

(7) *The same number of the* Hydrographic Review *gives, on page 137, particulars relative to the Echo-Sounder, Mark VII, permitting of soundings from 0 to 500 fathoms, thence by phasing system down to 6,000 fathoms.*

Hydrographic Review, *Vol. X, No. 2, November 1933, page 130, gives additional information on these models of sounders which have been tested in H.M.S.* Challenger *and* Ormonde *in the course of 1932.*

(8) Hydrographic Review, *Vol. X, No. 2, November 1933, page 160, describes the British Admiralty Super-Sonic Shallow Water Echo-Sounding Gear, which uses a magneto-striction transmitter permitting of soundings from 1 1/2 foot below the keelson to 200 feet (or 125 feet).*

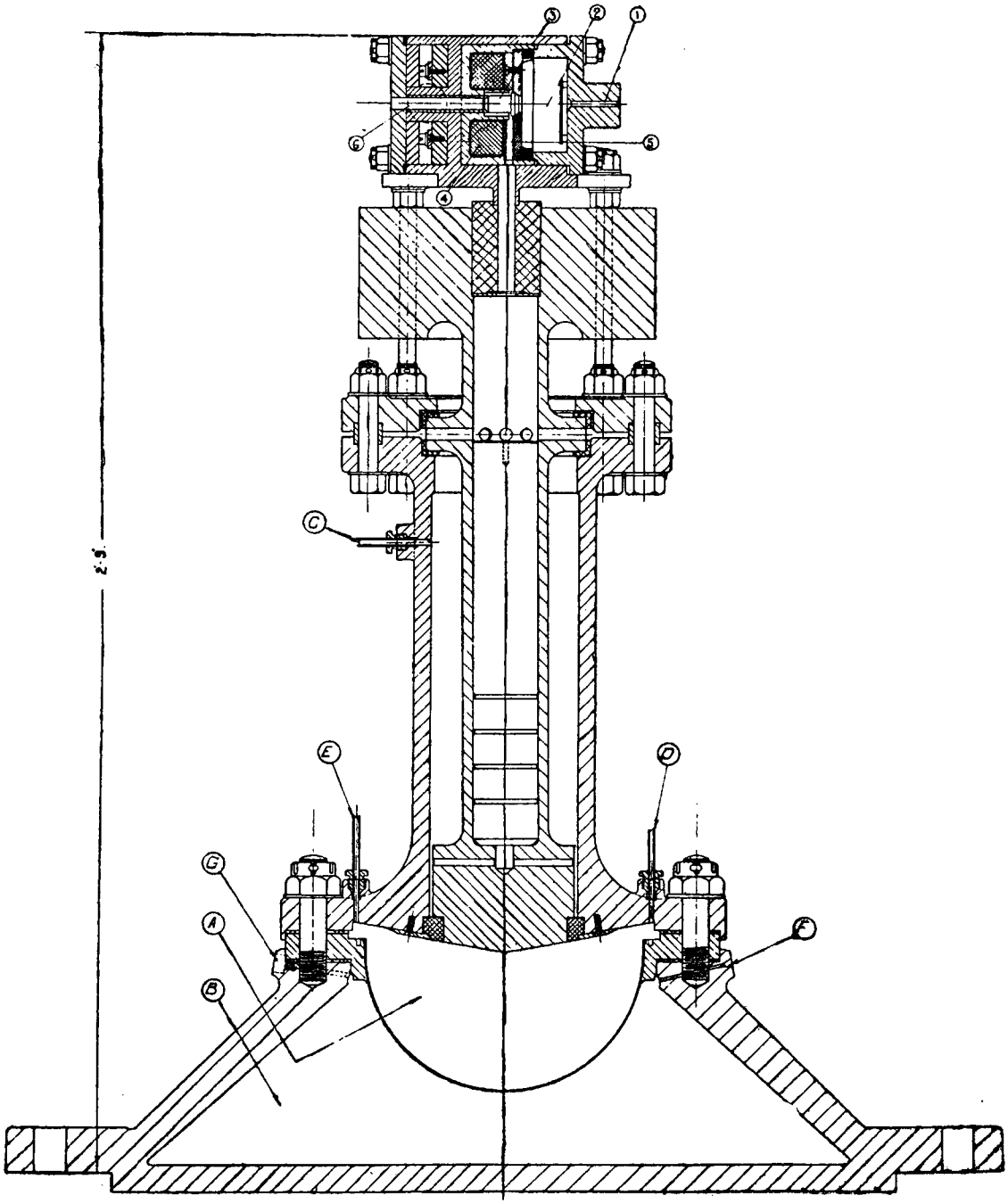


FIG. 7

BRITISH ADMIRALTY DEEP-SEA BALANCED TRANSMITTER

EMETTEUR COMPENSÉ, TYPE AMIRAUTÉ, POUR GRANDES PROFONDEURS

1. *TRANSMITTER.*

Fig. 7 shows the British Admiralty type deep sea balanced transmitter. The plunger is made of a special alloy steel and works in a special alloy steel cylinder, the whole functioning as a hammer.

Air at a pressure of 100 lbs/sq.in. passes through inlet *1* into chamber *2*. While the current is on the coil *4* the valve *3* is shut and no air pressure passes out, but when the circuit is broken by the switch on the machine, the air forces the valve away. When the air forces it back, air can only escape down the hole *5* and force the plunger down. The plunger is returned by means of air at a pressure of 5 lbs. through *C* from the reducing valve which is mounted on a separate board. When the plunger rises, the air above it passes out through the hole *5* and back through the tube *6*.

Oiling the plunger is now considered unnecessary, as sufficient oil for the plunger is supplied in the air from the compressor.

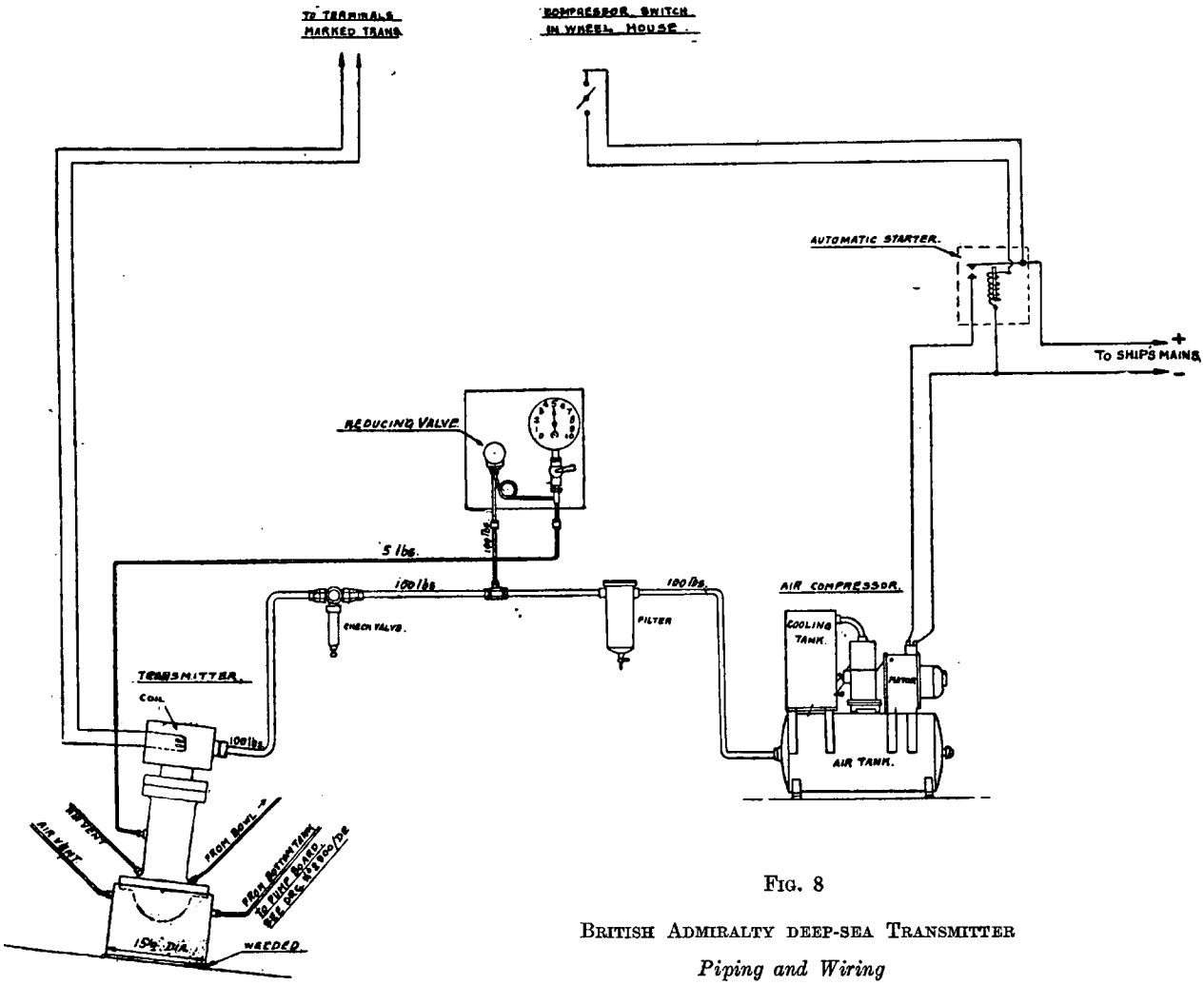


FIG. 8

BRITISH ADMIRALTY DEEP-SEA TRANSMITTER

Piping and Wiring

The blow is distributed through a high pressure water chamber *A* to a low pressure water chamber *B*, and thence to the ship's plating. The diaphragms of both the water chambers are of stainless steel. A small air compressor driven by an electric motor supplies the compressed air. Fig. 8 shows the piping of the compressed air system.

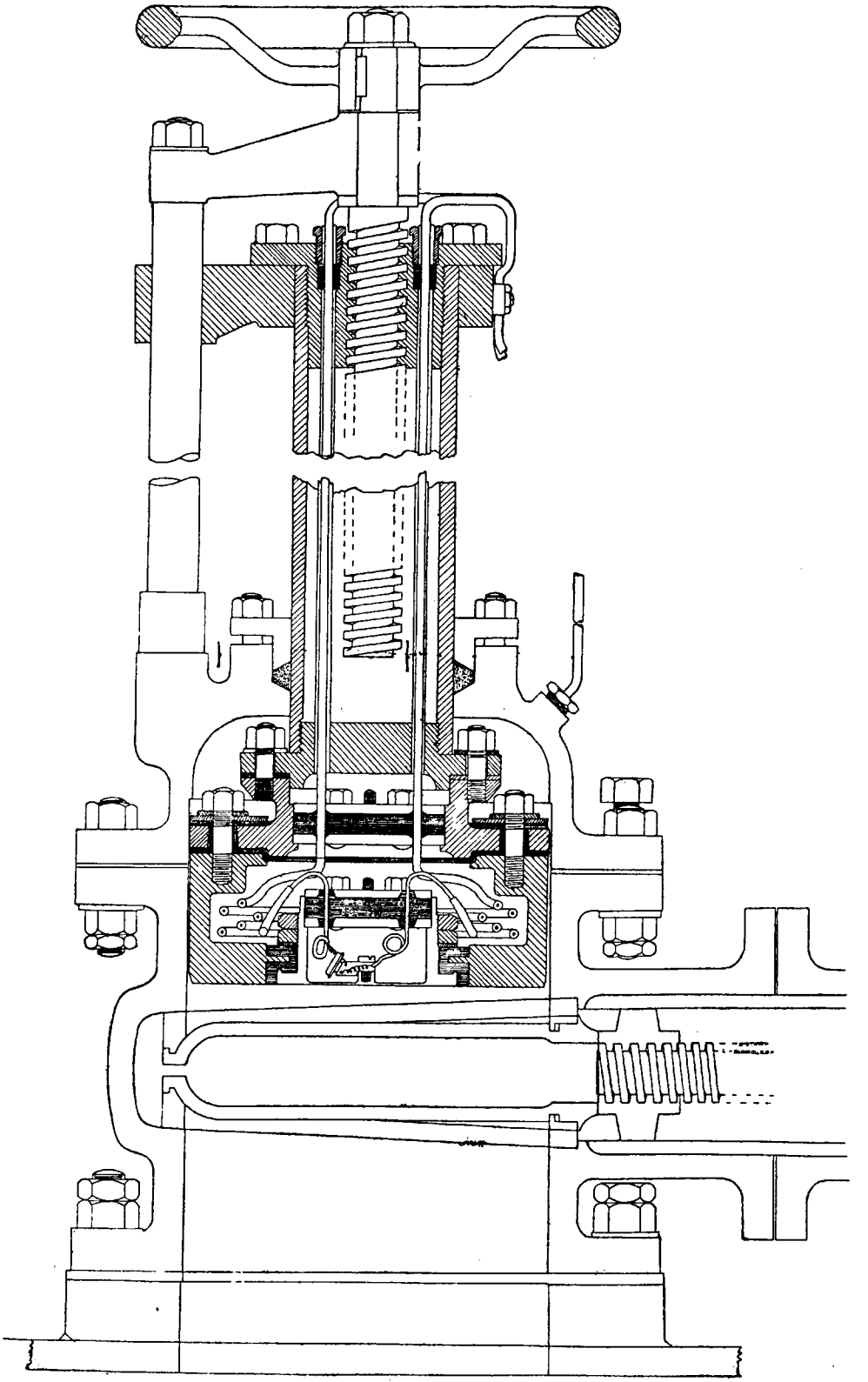


FIG. 9

BRITISH ADMIRALTY DEEP-SEA HYDROPHONE, SLUICE VALVE TYPE

HYDROPHONE, TYPE AMIRAUTÉ, POUR GRANDES PROFONDEURS, TYPE A ROBINET-VANNE A ÉCLUSE

2. *HYDROPHONE.*

The hydrophone is the Standard Admiralty Echo Sounding Deep Water Hydrophone and is mounted in a sluice valve (see Fig. 9), the vibrations of the incoming echo being transmitted through a diaphragm to the microphone button. The microphone is set in resonance with the frequency for which the transmitter emits maximum energy.

3. *RECEIVER.*

The receiver is contained in a box of aluminium silicon alloy. It is of the type already described in *Hydrographic Review*, Vol. IX, No. 2, November 1932, page 137. The speed of the motor in spite of variations of the supplied voltage is kept constant by means of a centrifugal governor controlling a variable resistance in the field winding circuit, the control compensating for voltage variations up to plus or minus 20 %.

The Maltese Cross arrangement, which enables the emission interval to be regulated, permits of the moment when the recording stylus passes zero being advanced by five steps of 200 fathoms each: (see *Hydrographic Review*, Vol. IX, No. 2, November 1932, page 138). This makes it possible to obtain phase differences of 200 fathoms and so to keep the record within the width of the paper strip, no matter what the sounded depth may be, from 20 to 6,000 fathoms.

4. *RECORDING GEAR.*

This was described in broad outlines in *Hydrographic Review*, Vol. IX, No. 2, November 1932.

The incoming signal picked up by the hydrophone is passed through a transformer coupling to a valve amplifier and thence to the recording stylus. This stylus traverses horizontally across the strip of recording paper; it is mounted on ball bearings running between fixed guides. Any disturbance reaching the hydrophone during the passage of the stylus across the paper is recorded on the paper in the following manner. The paper is sensitised with an iodide and is kept moistened, which renders it sensitive to the passage of a weak electric current, and this weak current from the stylus passes on to the paper on which it produces the appearance of a sharply defined sepia stain. This sepia stain is due to the liberation of iodine.

The stylus is moved along its track by a special adaptation of a dog-clutch type of mechanism driven by a chain; the chain carrying the dog completes its cycle in the echo-time of 1,000 fathoms, and the time of traverse of the stylus across the paper is the echo-time of 250 fathoms. At the end of the paper the stylus is lifted off the paper, returned to its starting point by a return spring, and again lowered on to the paper in readiness for the dog-clutch to take up the drive on its return, the dog going round with the chain.

A scale from 0 to 250 fathoms is fixed over the paper so that the position of the stain record made by the stylus can be read off immediately. Other scales are provided, compensated for the shrinkage of the paper in drying, for reading off the depth shewn on the dried paper when the results are worked up.

The power of the transmitter which enables echoes returning from 6,000 fathoms to be picked up is too strong in comparatively shallow depths; consequently a regulator for the sensitivity of the hydrophone has been included in the gear. This system enables stray disturbances arising during the passage of the stylus across the paper, and recorded on the strip, to be eliminated; but they do not affect the use of the apparatus in any way as the effect is to produce a random scattering of dots or short dashes, which in no way affect the legibility of the contour due to the real echo which comes in at perfectly definite intervals.

The general functioning of the gear is therefore as follows: as the depths of water increase from zero, the interferences due to the hammer blow, which occurs at the zero moment of time, rapidly die out and the echo may be recorded in all four cases quite free from interference up to 1,000 fathoms depth.

At 1,000 fathoms, interferences from the succeeding hammer blow will occur when the hammer is operated at intervals of 2 1/2 seconds but this is at once removed by changing the interval between successive hammer blows to 5 seconds.

No interference is now met with up to 2,000 fathoms depth and this, when reached, can again be removed by changing the hammer blow interval to 7 1/2 seconds.

Similarly, interference is not again found till 3,000 fathoms and this time the interference is removed by changing the hammer blow interval back to 5 seconds.

The interference at 4,000 fathoms is removed by changing the interval to 7 1/2 seconds and beyond this point no interference is met with up to 6,000 fathoms.

The recording at 5,000 fathoms can be made clearer by changing the transmitter interval to 5 seconds. Thus, except at depths which are an exact multiple of 1,000 fathoms and small regions just a shade below these, a hammer blow interval of 2 1/2 seconds will enable at least 90 % of all the depths to be recorded. Besides, the number of revolutions of the rotating switch arm may be counted, in any case, by using the telephones, thus ascertaining the exact number of thousands of fathoms concerned.

One strip of paper lasts for 60 hours. An electric pen is supplied with the apparatus which enables notes to be made on the record itself.

II. (a) BRITISH ADMIRALTY SILENT SUPER-SONIC ECHO SOUNDER.

The firm of HENRY HUGHES & SON Ltd. now have in regular production a new type of echo-sounder utilizing super-sonic waves, the operation of which is silent.

This new line of apparatus is intended for navigational purposes and for depths not exceeding 500 fathoms. The system of transmission comprises a transmitter operating by magnetostriction. The principle of the working of this transmitter has already been outlined in connection with the BRITISH ADMIRALTY SUPER-SONIC SHALLOW WATER ECHO SOUNDING GEAR employed in British survey work (see *Hydrographic Review*, Vol. X, No. 2, November 1933, page 161). By this means extraneous interference is eliminated and the soundings are obtained with silence and extreme accuracy.

The transmitter (Fig. 10) comprises a small cylindrical tank welded or clamped to the ship's plating and containing the magnetostriction element and a reflector. The tank is kept full of water, a small pipe from a feed tank making up any loss by leakage or evaporation.

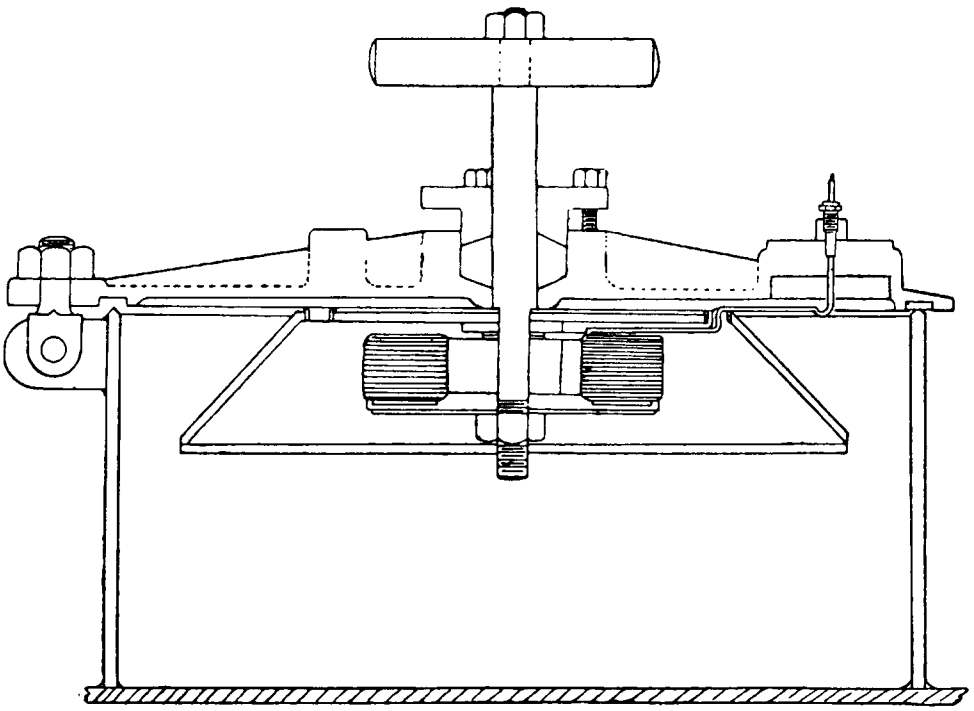
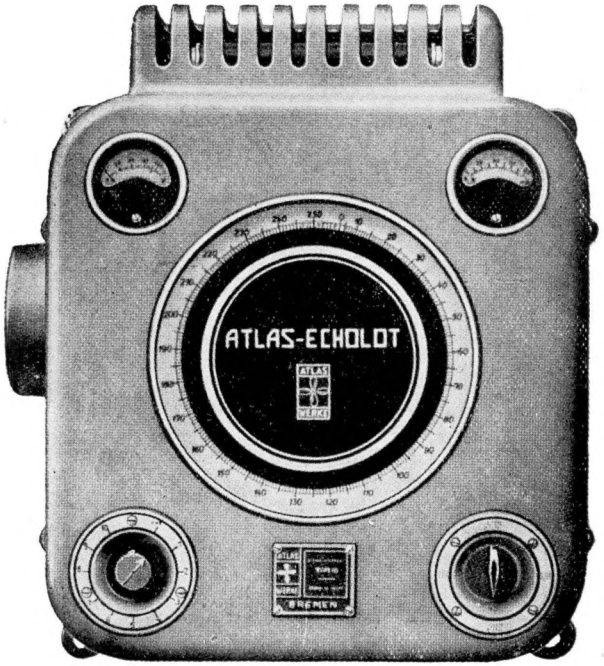


FIG. 10

BRITISH ADMIRALTY BOAT SUPER-SONIC ECHO SOUNDER

Oscillator Tank

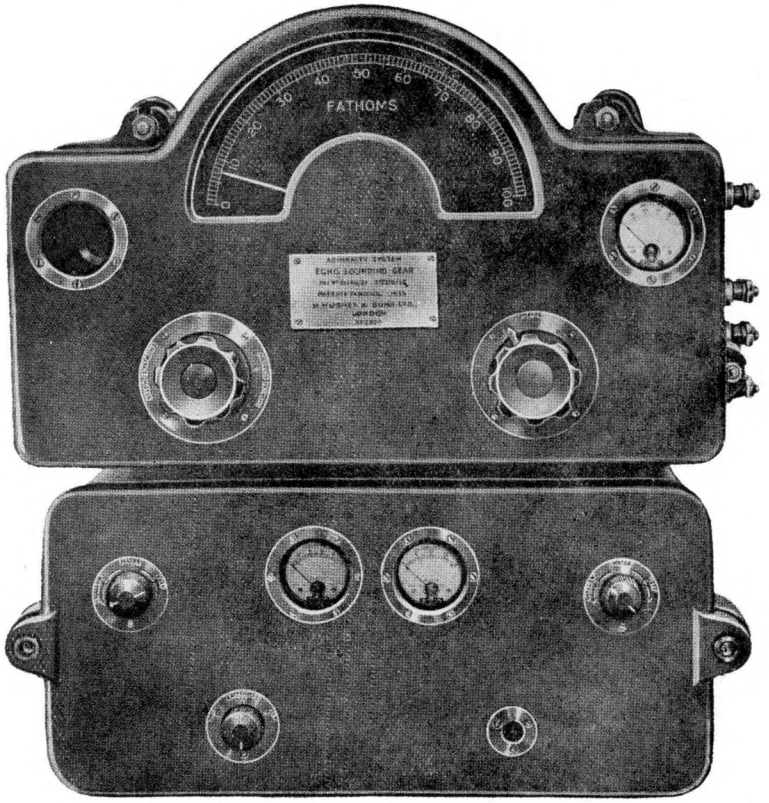
PL. I



ATLAS ECHOLOT, TYPE 20

Indicator — Indicateur.

PL. II



THE HUSUN DIAL INDICATOR — INDICATEUR A CADRAN HUSUN.

The receiver is exactly similar to the transmitter and is attached to the hull like the transmitter but on the opposite side of the keelson. The transmitter and receiver tanks are cut to match the floor angle at the point chosen for their installation; they are then clamped down on rubber seating rings or electrically welded.

The receiver is contained in a non-corrosive aluminium metal box which is fitted in a suitable position on the bridge. The instrument is made either with pointer dial indicator or with recorder.

INDICATOR (Plate II).

The case contains all the controlling elements, i. e. a constant speed motor and a disc carrying 3 rotary switches in step with a rectangular solenoid the speed of which is proportional to the velocity of the transmitted sound waves, having regard to the particular scale for which the instrument is calibrated. A soft iron needle is mounted inside the solenoid so that its axis of rotation coincides with the axis of rotation of the solenoid. If the solenoid is energised by passing a current through it, the needle tends to set itself parallel to the magnetic axis of the solenoid. The pointer which moves over the dial is coupled by a shaft to this magnetic needle, and indicates the depth given by the echo against the graduations of the scale.

The electric energy is supplied by a box containing a contactor, generally fitted in the engine room, which houses the following components:

1. — A Converter to convert the ship's voltage from 110/220 to 1,000 volts.

2. — A transmitting Condenser.

3. — A Contactor operated either electrically or mechanically which discharges the condenser through the transmitter windings.

4. — A fixed Resistance for limiting the current from the converter.

5. — An electrostatic Voltmeter connected across the converter terminals.

6. — Two Door Switches which break the supply circuit when the door of the box is opened.

When the echo returns from the sea bottom, the impulse received is applied, after amplification, to the grid of a gas discharge tube allowing the discharge of a second condenser to take place through the windings of the rotating solenoid. The needle within the solenoid sets itself in the magnetic axis of the coil at the moment of discharge, and since the angle turned through by the coil up to the moment of discharge is proportional to the echo-time, the pointer indicates the true depth on the scale.

The instrument is at all times ready for immediate use. The navigator turns the starting switch and instantly the pointer moves to the correct reading. Successive soundings are taken at the rate of three per second in the case of the 100-fathom pattern. In going into deeper water the coil is energised later and the needle is pulled round in the direction of the solenoid, and with it the pointer is moved to its correct position on the scale. If the depths remain constant, the pointer remains stationary.

The operation of the instrument is silent, and there is no winding or other attention required. The case of the machine is damp-proof and needs no special supervision apart from a periodical inspection for oiling which is done through the agency of the makers.

RECORDER.

Instead of the Indicator the receiving gear may include a Recorder. The recorder is of the type we have already described. The speed of travel of the stylus is proportional to the speed of sound in water having regard to the scale for which the instrument is calibrated. The successive marks on the slowly moving paper, form into a continuous contour chart shewing clearly the smallest variations in depth, and even affording an indication of the constitution of the sea-bed.

These appliances are very economical, the power consumption being only 200 watts. Soundings may be taken to within 3 feet of ship's bottom.

Messrs. HENRY HUGHES & SON Ltd. produce the following types of equipment:

TYPE M. S. I. RECORDER for shallow water, coasting and ferry boats, also survey vessels. Scale of chart: 35 fathoms or 7 per inch. Price, £350.

TYPE M. S. II. RECORDER for cross-channel steamers, yachts, submarines, etc. Scale of chart 35 fathoms or 7 per inch. Range: 100 fathoms in three phases of 25 fathoms. £350.

TYPE M. S. III. RECORDER for merchant vessels, trawlers, sloops, etc. Scale of chart: 90 fathoms or 18 per inch. Range: 250 fathoms in 4 phases of 50 fathoms. £350.

TYPE M. S. IV. RECORDER, with specially powerful transmitter and receiver, for high speed ships, destroyers, cruisers, etc. Scale of chart: 90 fathoms or 18 per inch. Range: 250 fathoms in 4 phases of 50 fathoms. £400.

TYPE M. S. V. INDICATOR for liners, merchant ships, coasting ships, submarines, etc. Scale: 0 to 100 fathoms. £300.

TYPE M. S. VI. INDICATOR. Scale: 0 to 125 fathoms. £300.

TYPE M. S. VII. INDICATOR. Scale: 0 to 250 fathoms. £300.

TYPE M. S. VIII. INDICATOR. Scale: 0 to 400 fathoms. £300.

II (b) BRITISH ADMIRALTY BOAT SUPER-SONIC SHALLOW WATER ECHO SOUNDING GEAR WITH MAGNETOSTRICTION TRANSMITTER.

This apparatus recently produced by Messrs. HENRY HUGHES & SON Ltd. is described in *Hydrographic Review*, Vol. X, No. 2, November 1933, pages 160 to 165. Price, £330.

FRANCE.

CONTINUOUS ECHO-SOUNDER USING RIFLE-SHOTS FOR DEEP WATER USE.

(Produced by the SAMUEL MARTI factory at Montbéliard (Doubs), France).

The echo sounder using rifle shots has been made use of since April 1922 for sounding the profile of the Mediterranean between Marseilles and Philippeville (Algeria). In the *Hydrographic Review*, Vol. II, No. 2, May 1925, p. 141, we described the principle of the MARTI recording apparatus for measuring echo times, and descriptions of the large model recorder (radius 225 mm.) and small model recorder (180 mm.) were given in the *Hydro-*

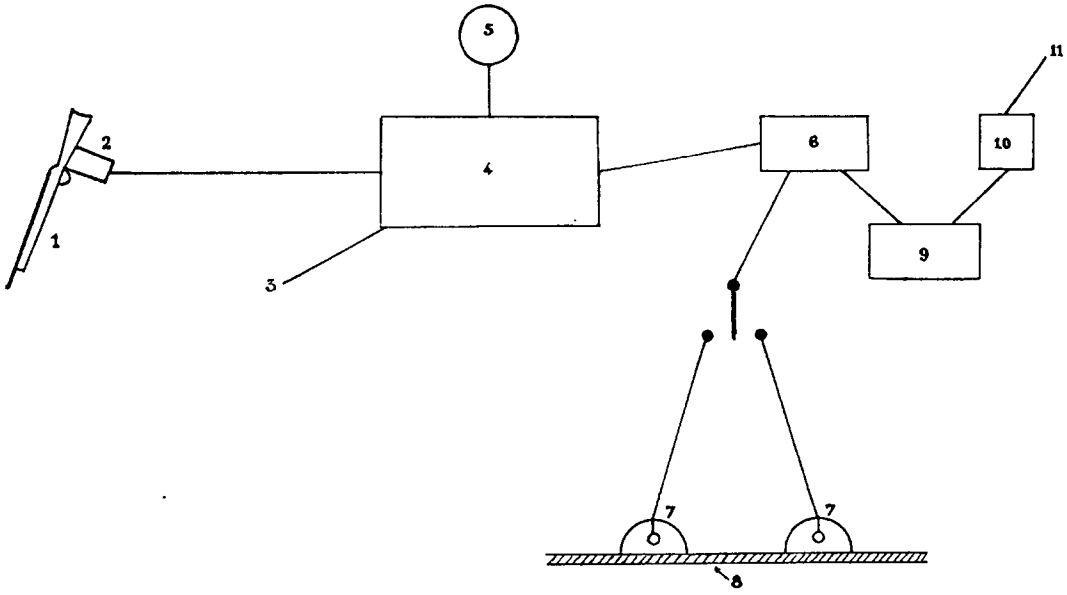


FIG. 11

MARTI ECHO-SOUNDER, USING RIFLE-SHOTS, FOR DEEP WATER USE

Diagrammatic Sketch

graphic Review, Vol. III, No. 2, July 1926, p. 89. Further details and descriptions of sounding gear using single blows, hammer-blows and detonations, on the MARTI 1927 system, were given in the *Hydrographic Review*, Vol. V, No. 2, November 1928, p. 121. An analysis of the different appliances then in existence will be found in *Hydrographic Review*, Vol. VIII, No. 1, May 1931, p. 132.

The Samuel MARTI works at Montbéliard have recently produced an improved model of continuous echo sounder using rifle-shots, particularly suitable for the hydrographic examination of great depths.

As will be seen from the diagram (Fig. 11) the machine comprises :

1. A Rifle with electrical firing gear, generally mounted on a sort of gallows in the eyes of the ship and depressed towards the surface of the water. It is fitted with an electrical firing mechanism which enables it to be controlled by the MARTI continuous sounding recorder, the use of which is now general in France for depth surveys.

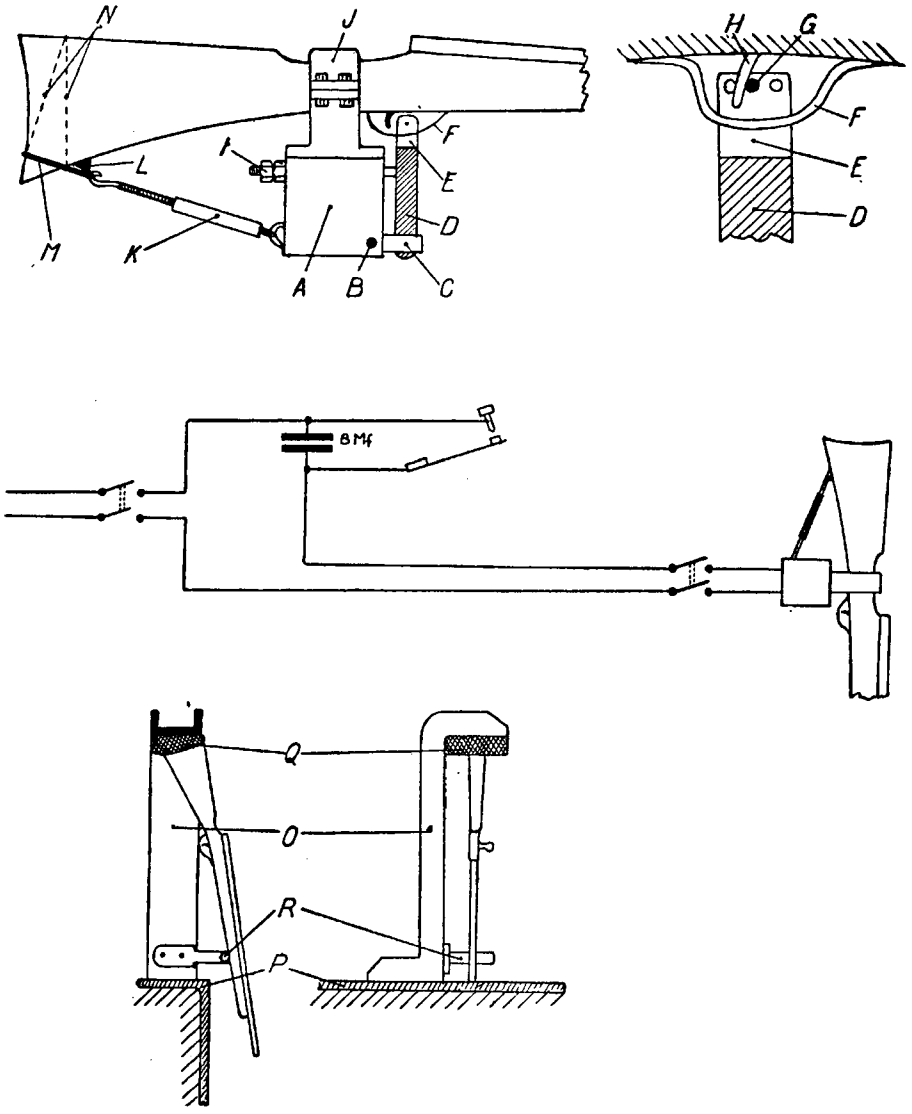


FIG. 12

MARTI ECHO-SOUNDER, USING RIFLE-SHOTS, FOR DEEP WATER USE

Electrical firing mechanism

2. A Microphone, attached to the inside of the hull, which receives the submarine sound waves. It first takes in the violent sound wave formed in the mass of water by the entry of the bullet, then the echo of this sound wave returning from the bottom; the time elapsing between these two sounds gives the depth.

3. A Vacuum Tube Amplifier, fed from a standard type of accumulator, which reinforces the waves entering the microphone sufficiently for them to be recorded graphically.

4. A continuous Recorder of the soundings thus taken, of the type utilizing a rotating oscillograph and previously graduated scale; the use of this is particularly advantageous in hydrography because it automatically records the various soundings alongside each other, thus to some extent giving a profile of the depths met with during the ship's movements; such an arrangement forms the best safeguard hitherto discovered against errors of interpretation in this type of work.

RIFLE AND ELECTRICAL FIRING GEAR. — Any service rifle is used; and it is usually possible to take soundings down to 3,000 or even 5,000 m. (1,640 or 2,730 fms.) without having to reduce the speed of the ship. The rifle is generally secured to the stem on a gallows so that the bullet will enter the water a few yards ahead of the ship, where the water is not yet aerated by the bow wave. The firing lock, controlled by the emission switch of the sounding recorder, actuates the trigger of the rifle exactly at the required instant so that the bullet will enter the water at the same time as the recording stylus crosses the first line of graduation on the record strip.

Description (see Fig. 12). The electrical firing lock comprises a metal casing *A*, inside which is an electromagnet acting on an iron palm free to move round an axle *B*. To the continuation *C* of this palm, outside the casing, is rigidly fixed an arm *D* which branches at its end into two lugs *E* astride the trigger guard *F*. These lugs have holes at their ends, and a pin *G* is passed through them and the trigger guard *F*. This pin bears on the trigger *H* to fire the shot.

The end of the arm *D* is drawn towards the casing *A* by a strong spring hidden inside the latter; the point of attachment of this spring can be moved by actuating two nuts *I* at the opposite side of the casing. The locking nut must always be very well set up to avoid easing back during the firing. The lock is attached to the rifle by a metal collar *J* firmly bolted round the small of the butt. When the current is flowing the iron palm flattens itself against the electromagnet which works it, the arm *D* moving away from the casing and putting the spring in tension. When the current is broken, the magnetic attraction ceases to exist and the spring immediately pulls back the moving part. Owing to its momentum, this moving part overshoots the position of equilibrium imposed upon it by the spring, and the pin *G* presses the trigger beyond the point necessary to fire the shot.

The time interval between the breaking of the electric circuit and the bullet's entry into the water is about 0.04 second, corresponding to a distance of 30 metres (16 1/2 fms.) on the depth graduation of the recorder. This interval is constant to within about 0.0015 second, which is equivalent to saying that it is possible to make the start of the acoustic phenomenon coincide with the passage of the stylus across the first line of the depth graduations, with a tolerance of about one metre on this scale.

A two-pole switch is fitted alongside the recorder to enable the operator to start and stop the apparatus at will. A similar switch is fitted near the rifle to enable the rifleman to stop the lock working altogether if he should think it necessary for any reason.

In great depths, even a detailed examination does not necessitate any very great frequency of soundings. It is usually sufficient to obtain a sounding every two or three minutes. In this case the switch near the recorder is kept normally broken, and whenever it is desired to take a sounding the switch is made during one turn of the recorder. If, on the other hand, the recorder is provided with gearing enabling the number of emissions to be reduced automatically, this arrangement can be utilized to make use of a frequency of one emission only in every twenty turns of the recorder (see below).

MICROPHONE. — The microphone proper is composed of a small watertight box containing a cell of granulated carbon such as is commonly used for telephonic purposes; it is housed inside a cast-iron tank attached to the inside of the ship's hull plating. A

rubber washer ensures watertightness between tank and hull. The tank is filled with water. Under these conditions the microphone is in acoustic communication with the liquid mass surrounding the ship. As a rule two microphones are fitted in each ship so as to have a spare microphone available ; these are best fitted one to starboard and the other to port.

AMPLIFIER. — The amplifier is of a kind specially designed for sounding by blows ; it is for preference fitted in a sheltered place. It is connected to the receiving microphone by an electric cable. Other cables connect it to its supply accumulators and to the recorder, which are generally mounted near it.

RECORDER. — The MARTI continuous sounding recorder consists essentially of an electric motor which causes a disc *A* to turn at constant speed in a horizontal plane, on the disc being mounted an oscillograph in permanent electrical connection, through commutator rings, with the amplifier of the sound-receiving circuit (see Fig. 13).

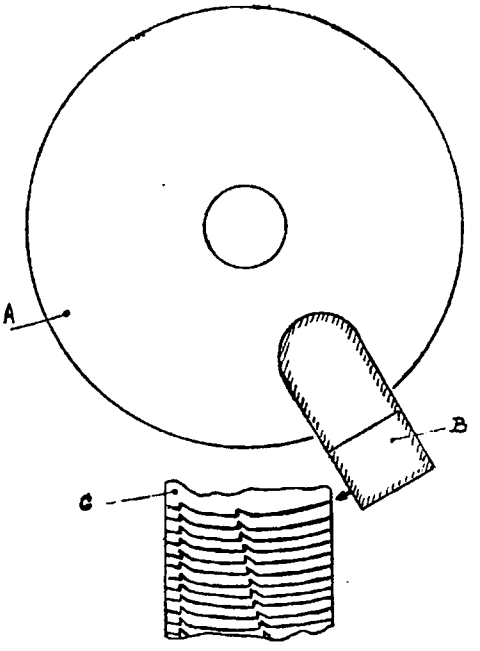


FIG. 13

MARTI CONTINUOUS RECORDER

In the course of its rotation, the registering stylus of the oscillograph traces an arc of a transversal circle across a strip of paper *C*, which unrolls slowly so that the arcs traced by the pen do not become superimposed.

At each turn the machine automatically causes the emission of a sound wave, in such a way that the acoustic phenomenon occurs exactly at the instant when the pen is crossing the first line of the longitudinal graduations of the paper strip. The pen thus makes two datum marks on the arc of a circle which it is tracing — one at the moment of departure of the sound wave, the other at the moment when the echo, returning from the bottom, activates the receiving gear ; the distance apart of these two nicks is a measure of the time elapsed between the departure of the sound wave and the return of the echo, and consequently of the depth of the sea. The first nick always occurring at the first line of the graduations, and marking, as it were, the "zero", the second nick always shows the depth of the sounding directly against the graduation.

The repetition alongside each other, at each turn of the recorder, of all the second nicks, corresponding to the echoes, gives a remarkably clear graphic representation of the depth profile along the track of the vessel.

The record strip is driven by an element in a special metal cage which can be unshipped from the instrument if desired. The strip is guided by rollers on to the table where the recording takes place, and from there it is guided towards the outside of the machine, at the same time providing a rest for the operator on which he can make any appropriate notations.

The time is automatically registered by a chronometer watch fitted near the recorder and connected to it by a twin-core cable. This watch contains a small switch which completes the circuit for a few seconds every time the minute-hand passes a 5-minute mark on the dial. Thus a time record is obtained in the shape of a group of nicks marked every even five minutes by the watch.

Emission switches. — At each turn of its disc the recorder causes two quick-acting switches to break. These switches are mounted on a movable dial concentric with the main axis of rotation of the machine and fitted on the upper panel of the machine. This dial can rotate about its own axis and be fixed on the panel by a peg, in any one of ten positions. This makes it possible to shift the position of the emission switches ten times in succession by a fixed amount corresponding exactly to the width of the graduated part, and thus to use the recorder over a range of depths ten times greater than the extent of the scale. Thus, for example, the recorder, the graduations of which extend from 0 to 200 or 500 metres (109 or 273 fms.), can be used down to depths of 2,000 or 5,000 metres (1,094 or 2,734 fms.). Index marks scribed on the fixed panel show, against a mark on the movable disc, the depths to which the outer marks of the graduations of the recording band correspond.

Further, an adjusting screw enables the position to be regulated to get the zero exact, i. e. to make it coincide exactly with the first nick made on the record at the moment of emission of the sound wave.

There is an arrangement for reducing the number of soundings taken normally by the machine, which gives three modes of working :

(1) *Continuous working,* in which this device is short-circuited ; the striker acts at each turn of the recorder.

(2) *Periodic working,* in which the striker only acts at every fifth turn of the recorder.

(3) *Slow-motion working,* in which the striker only acts at every twentieth turn of the recorder.

Finally, to allow the operator to make the emission nick appear whenever he requires it to do so, a press-button with recall spring, marked "Réglage du zéro", is placed on the upper panel of the machine.

In the case of sounding by rifle-shots, the type of recorder used revolves at a speed of one revolution in 7 1/2 seconds (8 r.p.m.) ; the total width of the graduations of the record strip corresponds to a depth of water of 500 metres (273 fms.) ; and the machine can be used down to a depth of 5,000 metres (2,734 fms.) by successive steps of the emitter.

In examining great depths it is not generally necessary to take soundings at very short intervals. Consequently it is usual to make use of an automatic reducing device

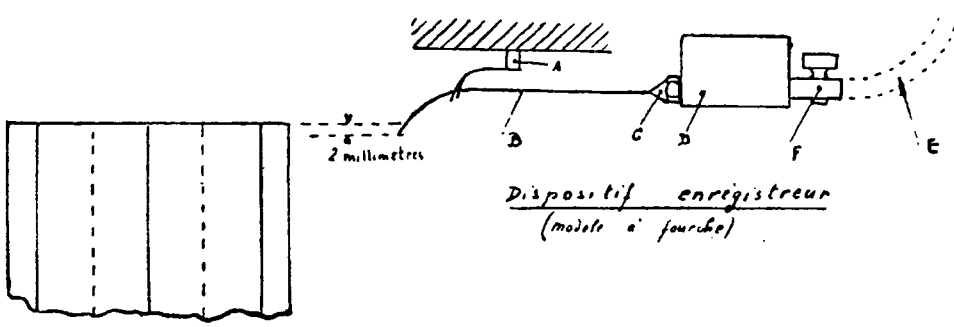


FIG. 14

MARTI RECORDER, FORK MODEL

for the frequency of emission, which is fitted to the recorder and which limits the shots at will to one shot every 37 1/2 seconds or even one shot every 2 1/2 minutes. In spite of this deliberately wide spacing of the shots, the recorder produces sounding diagrams of very great clearness, on which the depth profiles can be traced without the least ambiguity.

The constant speed regulator of the motor is on the principle already described in *Hydrographic Review*, Vol. III, No. 2, July 1926, p. 90.

The following improvements have been made in the recorder:

In the *fork model* (Fig. 14), the oscillograph carries a fork *A*, in a branched socket at the end of its movable axis, the branches of which straddle (without holding) a pen composed of a fine metal tube *B* soldered to a base *C* which is screwed to the fixed block *D*. At its free end this metal tube is bent slightly downwards, its end coming about 2 mm. (5/64 in.) below the level of the surface of the paper, so that the pen bears lightly against the record strip. Any rotation of the moving part of the oscillograph is transmitted by the fork to the pen, the point of which marks a nick.

In the *flexible drive model*, the oscillograph carries the metal tube itself, again fixed in a branched socket at the end of its movable axis. This tube also is bent slightly downwards, at its free end, so that the pen bears lightly on the record strip. The other end of the pen, which ends in a nipple, is joined by a very fine rubber tube to a small nozzle screwed into the fixed block *D*.

In both models, the appliance includes an ink-well at a higher level than the pen, on the actual axis of rotation of the revolving disc. This ink-well is connected to the fixed block *D* by a rubber tube *E* and a tap *F* which enables the flow of ink to be cut off when the recorder is not in use.

The block *D* usually includes a valve in the channel leading to the pen, allowing the ink to flow only when the pen is crossing the paper band. This valve is normally kept closed by an arm at the end of which is a knob; at each revolution of the recorder, at the moment when the pen is crossing the paper, this knob meets a fixed cam, the arm is raised, and the valve opens, allowing the ink to flow.

A circular gutter collects any drops of ink which the pen may drip during its rotation, and leads them to two auxiliary reservoirs; a small brush wipes the tip of the pen before it touches the paper, to absorb the drop of ink which generally adheres to it by capillary action.

To avoid choking of the fine metal tube forming the pen, only the special ink provided with the apparatus should be used; also the ink bottle should be kept well stoppered. If at any time the tube does become choked, it is easily cleared by reaming it with a piece of fine wire which is supplied among the accessories of the recorder.

The installation of this type of machine on board is extremely expeditious, and entails very little cost, the acoustic devices being fixed without piercing the hull. For the same reason the sounding machine can be very easily transferred from one vessel to another.

LIST OF ECHO SOUNDING MACHINES PRODUCED BY THE FACTORY OF S. MARTI AT MONTBÉLIARD (DOUBS), FRANCE.

(All prices are in French francs).

SONDEUR PAR CHOCS TYPE PRÉCISION (PRECISION TYPE HAMMER-BLOW SOUNDER).

Purpose: Shoal water surveying.
Emitter: Hammer-blows.
Components: Continuous hammer emitter, microphone receiver, amplifier, continuous type recorder.
Depth register: (i) Scale : 1/400 or 1/250.
(ii) Range: 40 metres or 30 metres.
Usual limits of use: From 3 metres below the keel to 200 metres.
Accuracy: 1/4 metre.
Power required: 5 amperes at 50 volts, preferably from batteries.
Approximate price: 39,000 francs.

SONDEUR PAR CHOCS TYPE HYDROGRAPHIE (HYDROGRAPHIC TYPE HAMMER-BLOW SOUNDER).

Purpose : General surveying.
Emitter : Hammer-blows.
Components : Continuous hammer emitter, microphone receiver, amplifier, continuous type recorder.
Depth register : (i) Scale : 1/1,000.
(ii) Range : 100 metres.
Usual limits of use : From 3 metres below the keel to 800 metres.
Accuracy : 1/2 metre.
Power required : 3 amperes at 110 volts from dynamo, or
5 amperes at 50 volts from batteries.
Approximate price : 39,000 francs.

SONDEUR PAR CHOCS TYPE NAVIGATION (NAVIGATIONAL TYPE HAMMER-BLOW SOUNDER)

Purpose : General navigation.
Emitter : Hammer-blows.
Components : Continuous hammer emitter, microphone receiver, amplifier, continuous type recorder.
Depth register : (i) Scale : 1/2,000.
(ii) Range : 200 metres.
Usual limits of use : From 3 metres below the keel to 800 metres.
Accuracy : 1 metre.
Power required : 3 amperes at 110 volts from dynamo, or
5 amperes at 50 volts from batteries.
Approximate price : 39,000 francs.

SONDEUR PAR CHOCS TYPE PÊCHE (FISHERY TYPE HAMMER-BLOW SOUNDER).

Purpose : Open-sea fishing.
Emitter : Hammer-blows.
Components : Periodic hammer emitter, microphone receiver, amplifier, periodic type recorder.
Depth register : (i) Scale : 1/2,000.
(ii) Range : 200 metres or 100 fathoms.
Usual limits of use : From 5 metres below the keel to 1,500 metres.
Accuracy : 1 metre.
Power required : 3 amperes at 20 volts, usually from batteries.
Approximate price : 39,000 francs.

SONDEUR PAR COUPS DE FUSIL TYPE EXPLORATION (EXPLORATION TYPE RIFLE-SHOT SOUNDER).

Purpose : Deep water surveying.
Emitter : Rifle shots.
Components : Rifle with electric lock, microphone receiver, amplifier, continuous type recorder.
Depth register : (i) Scale : 1/5,000.
(ii) Range : 500 metres.
Usual limits of use : From 50 metres to 4,000 metres.
Accuracy : 2 metres.
Power required : 1 ampere at 110 volts from dynamo, or
5 amperes at 20 volts from batteries.
Approximate price : 35,000 francs.

SONDEUR PAR DÉTONATIONS TYPE GRANDE EXPLORATION (HIGH-SEAS EXPLORATION TYPE OF DETONATION SOUNDER).

Purpose : High-seas oceanographic expeditions.
Emitter : Explosive charges.

Components : Explosive charges, microphone receiver, amplifier, exploration type recorder.
Depth register : (i) Scale : 1/40,000.
(ii) Range : 10,000 metres.
Usual limits of use : From 100 metres to 10,000 metres.
Accuracy : 10 metres.
Power required : Hand-wound clockwork.
Approximate price : Under consideration.

SONDEUR GÉNÉRAL TYPE COUP PAR COUP (SINGLE BLOW TYPE OF GENERAL SOUNDER).

Purpose : Isolated soundings at all depths.
Emitter : Hammer-blows, rifle-shots, or explosive charges.
Components : Emitter appropriate to the depth, microphone receiver, amplifier, single blow type recorder.
Depth register : (i) Scale : 1/5,000 or 1/2,500.
(ii) Range : no limit.
Usual limits of use : From 5 metres below the keel, with no downward limit.
Accuracy : 1 or 2 metres.
Power required : Hand-wound clockwork.
Approximate price : 24,000 francs.

NOTES COMMON TO ALL TYPES OF MARTI SOUNDERS :

(1) All the MARTI sounders are provided with graphic recorders, using smoked paper or ink.

(2) In steel ships they can be installed afloat without making any holes in the hull.

(3) They can be used in any ship, large or small, steel or wood, which can provide shelter from damage.

(4) The accuracy of measurement shown in the above table for each type of sounder is in principle, for all the machines, limited to 1 % of the depth when the latter is great ; but the High-Seas Exploration type and the Single Blow type can be fitted with gear ensuring an accuracy of 1/1,000 in the depth measurement.

(5) The weight and total bulk of the various components is about as follows : the whole of the gear fitted to the hull, 200 kilograms and 1/10 cubic metre (441 lbs. and 35.3 cu. ft.) ; the whole of the gear fitted on the bridge, 100 kilograms and 1/5 cubic metre (220 1/2 lbs. and 70.6 cu. ft.).

Further information can be obtained on demand either of the manufacturer, Samuel MARTI, Montbéliard (Doubs), or his agent, the SOCIÉTÉ « LA GRANDE UNION », 35, rue de Liège, Paris, VIII^e.

SOCIÉTÉ DE CONDENSATION ET D'APPLICATIONS MÉCANIQUES (S. C. A. M.)

42, rue de Clichy, Paris (9^e).

This firm manufactures ultra-sonic sounding machines the nature and arrangement of which have already been described in several numbers of the Hydrographic Review, viz :

(1) *Hydrographic Review*, Vol. II, No. 1, November 1924, p. 57.
Principle of the Langevin-Chilowski piezo-electric quartz projector for ultra-sonic use.
(2) — Vol. III, No. 2, July 1926, p. 76.
Langevin-Florisson ultra-sonic sounder with optical analyser, for soundings from 4 to 360 metres (2.2 to 197 fms.).
(3) — Vol. V, No. 2, November 1928, p. 114.
Description of the Langevin-Florisson optical analyser.
(4) — Vol. VII, No. 2, November 1930, p. 105.
Langevin-Florisson ultra-sonic sounder, small model, with echometer, for soundings from 3 to 660 metres (1.6 to 361 fms.).

(5) — Vol. VIII, No. 1, May 1931, p. 132.
(6) — Vol. VIII, No. 2, November 1931, p. 184.
Examples of records obtained with ultra-sonic apparatus.
(7) — Vol. X, No. 2, November 1933.
(i) p. 168 — Langevin-Florisson Echometer for soundings from 3 to 360 metres (1.6 to 197 fms.).
(ii) p. 170 — Langevin-Florisson Echoscope, for soundings from 1.2 metres to 20 or 50 metres (0.7 to 11 or 27 fms.).

Each of these ultra-sonic sounding machines comprises essentially the following elements :

The LANGEVIN quartz Projector, used both foi emission and for echo reception ;

The Emitter-Receiver ; and finally —

The device for measuring the echo time, which may be either optical or of recording type.

Here follows the latest information on the various types of apparatus manufactured by the S.C.A.M.

PROJECTOR. — The chief characteristic of the projector is the diameter ot the emitting diaphragm. The commonest is the *S. 4 ter* with a 220 mm. (8.67 in.) diaphragm. It is described in the firm's pamphlet US. 85-2. A variation of the *S. 4 ter* projector is the LANGEVIN-TOULY three-ply projector, detachable while afloat, model *S. 16.* A half-wave steel diaphragm separates the three-ply diaphragm from the water, making it possible to change a damaged quartz from inside the ship without having to dry-dock. The effective diameter is again 220 mm. (8.67 in.). The *S. 16* projector is described in pamphlet US. 107.

The *S. 7 bis* projector is the most powerful projector manufactured by the S.C.A.M. It is 310 mm. (12.21 in.) in diameter and is described in pamphlet US. 37-2.

For sounding in very shallow water, Messrs. S.C.A.M. have produced a projector of 100 mm. (3.94 in.) diameter called the *S. 23* projector (pamphlet US. 120).

The above projectors may be used with different models of sounding machines and thus a certain number of combinations are possible. There are, however, four main categories of apparatus which we shall now describe :

I. LANGEVIN-FLORISSON-TOULY SOUNDER.

In this type of sounder the apparatus on the bridge is a LANGEVIN-TOULY neon lamp indicator. The sounder consists essentially of an ultra-sonic projector, type *S. 16,* ot 220 mm. (8.67 in.) diameter, three-ply, detachable while afloat ; of an emitter-receiver, and of a TOULY indicator. The latter is graduated, according to the model, from 0 to 350 or from 0 to 700 metres (0 to 191 or 0 to 383 fms.). Soundings may be taken from about 10 metres (5.5 fms.) downwards. It is chiefly used on board French trawlers. The machine with 350-metre scale takes two soundings per second, that with the 700-metre scale takes one per second. All the soundings may be read from a distance of several yards.

The machine is described very completely in pamphlet US. 69-3. Here is a brief description of the different parts of the apparatus.

A. LANGEVIN ULTRA-SONIC PROJECTOR — "SOUNDING" TYPE S. 16. — The ultra-sonic projector takes the form of a round box of cast metal, of which the central part of the plane under-surface, being in contact with the water, forms the emitting surface for the ultra sonic waves.

Fig. 15 shows the assembly of the various components.

The piezo-electric condenser consists of two metal armatures *1* and *3,* in the shape of specially worked steel plates, between which is mounted the piezo-electric quartz sheet *2* ; the area of the latter is of the order of 400 cm^2. (62 sq. in.) ; it consists of a mosaic of elementary piezo-electric quartz segments, all of exactly the same thickness and with the electrical axis of the crystals rigorously normal to the face.

The armatures *1* and *3,* and the piezo-electric quartz *2* are cemented together when hot by a special process, so as to form a single, extremely solid block.

The total thickness of this steel-quartz-steel sandwich has been so calculated that the whole vibrates at half wave length, i. e. the amplitude of the vibrations is nil in the mid-plane of the triad (nodal point of vibration) and is a maximum at the two boundary surfaces (amplitude loop).

In this projector, actually, a very thick half wave transmitting slab *4* (i. e. which is penetrable by the ultra-sound emitted by the internal three-ply element or returning as an echo from the bottom), forms the bottom of the watertight box or shell in which is mounted this three-ply emitting diaphragm of steel-quartz-steel. A watertight and very robust joint is made between the penetrable slab and the shell, by a thick collar turned out of the solid. Elastic continuity between the three-ply element and the penetrable slab is maintained by a thin film of oil.

The result of this arrangement is that the slab, which is *mounted flush with the ship's side,* can sustain pressure or blows without, as a rule, any damage to the three-ply element.

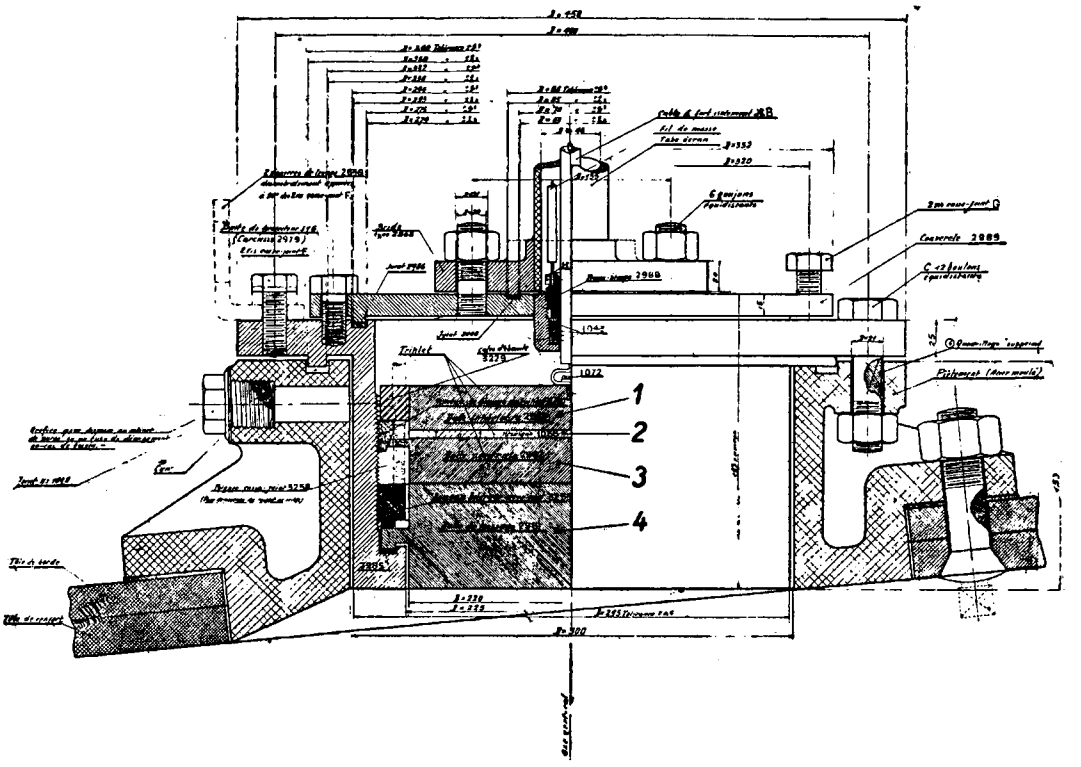


FIG. 15

LANGEVIN-FLORISSON-TOULY SOUNDER

Assembly of S. 16 Projector

The very sturdy projector does not require any upkeep from the electrical point of view. It is delivered ready for use and must never be dismantled.

Further, it requires no adjustment. Its proper mechanical frequency of vibration N_0 is determined by its construction (and usually measured by making use of the corresponding wireless wave-length λ_0). The optimum condition for functioning is that the frequency N of the electrical oscillations produced by the emitter should be equal to this frequency N_0 (or else that the length of the wireless wave λ of the emitter should be equal to λ_0). Thus, N_0 being invariable, N must be regulated, by adjusting the electrical emitter, so as to be equal to N_0.

The values of N_0 and λ_0 vary according to the dimensions of the type of projector used.

With the 220 mm. projector,

$$N_0 = 37{,}030 \text{ and } \lambda_0 = 8{,}100 \text{ metres.}$$

With the 310 mm. projector,

$$N_0 = 29{,}100 \text{ and } \lambda_0 = 10{,}300 \text{ metres.}$$

The hull fitting by which the ultra-sonic projector is attached to the ship's side consists of a cast steel bed-plate secured in a watertight manner to the side plating by bolts or rivets. A tube, which also forms an electromagnetic screen against parasitic induction from the different electrical circuits on board, contains the leads running between the projector and the emitter-receiver. It forms a watertight conduit, protecting the cables from damp.

B. EMITTER-RECEIVER. 1. *The Emitter proper.* (see Plate III). — As sounding in very shallow water, of the order of 10 metres (5 1/2 fms.) is of very great importance in navigation, it is necessary to emit a very short ultra-sonic signal. For this reason use is made of an emission composed of a single train of damped ultra-sonic waves, produced by an impulse-excited spark emitter. This emitter is fed by a 4-volt battery of accumulators which also supplies current for the filament of the amplifier.

The choke coil *111* and the coil *101* of the oscillatory circuit are fixed on an ebonite sleeve carried on the insulated bar *118* by a clamp which keeps them at maximum coupling (they are separated by an ebonite disc).

The auxiliary coil *102* is carried on an ebonite sleeve which can easily be slid along the bar *118* and fixed when its position has been adjusted.

All these coils are contained in the lower part of the cabinet.

The discharger of the impulse circuit is marked *109* in the Plate. The spark distance is adjustable by the milled knob. The hand key *104* is only used for adjusting the sounder. A resistance *107*, with adjustable clamps, in series with the primary circuit of the induction coil, limits the current in this circuit.

2. *Receiver.* — This comprises a triode valve amplifier whose supply terminals are connected permanently with the oscillatory circuit of the emitter, the latter circuit including the projector. This amplifier is housed in a copper cabinet which gives electromagnetic protection to the amplifier circuit (Plate IV) against parasites of external origin. *P*, *G* and *M* are the three supply terminals of the amplifier; *211* and *212* are the return terminals. The voltmeter *202*, actuated by the knob *204*, enables the voltage of the plate battery to be checked. The voltmeter *203* (of 0 to 50 volts), actuated by the knob *205*, makes the following possible: (i) observation of the filament voltage, and (ii) observation of the voltage across the terminals of the 4-volt battery.

The upper terminals are connected to the depth indicator.

The amplifier rests on a sponge rubber mat, which absorbs mechanical vibrations, on the floor of the cabinet.

C. BOTTOM INDICATOR. S.C.A.M.-TOULY SYSTEM. — This apparatus performs the following functions:

(*a*) Release of the ultra-sonic emissions at equal time intervals;

(*b*) Electrical and optical indication of the echoes;

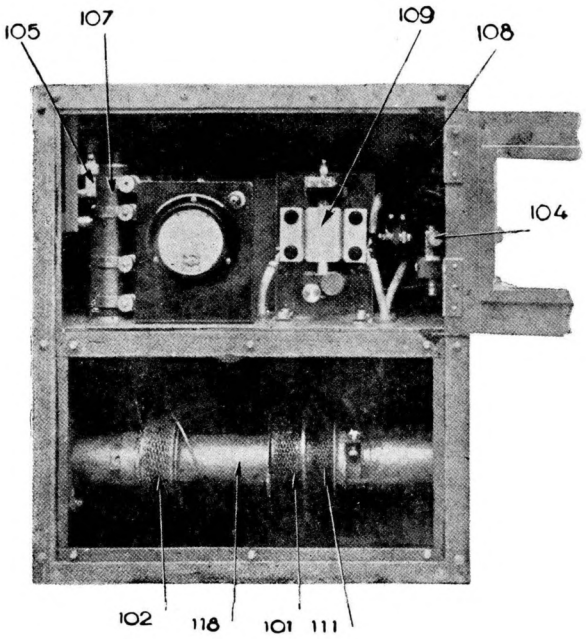
(*c*) Measurement of the echo time;

(*d*) Centralisation and carrying out of the various controls automatically exercised by the sounder.

(a) *Release of the ultra-sonic emissions at equal time intervals.* — As the apparatus has to give a continuous record, it is necessary to take soundings as frequently as possible.

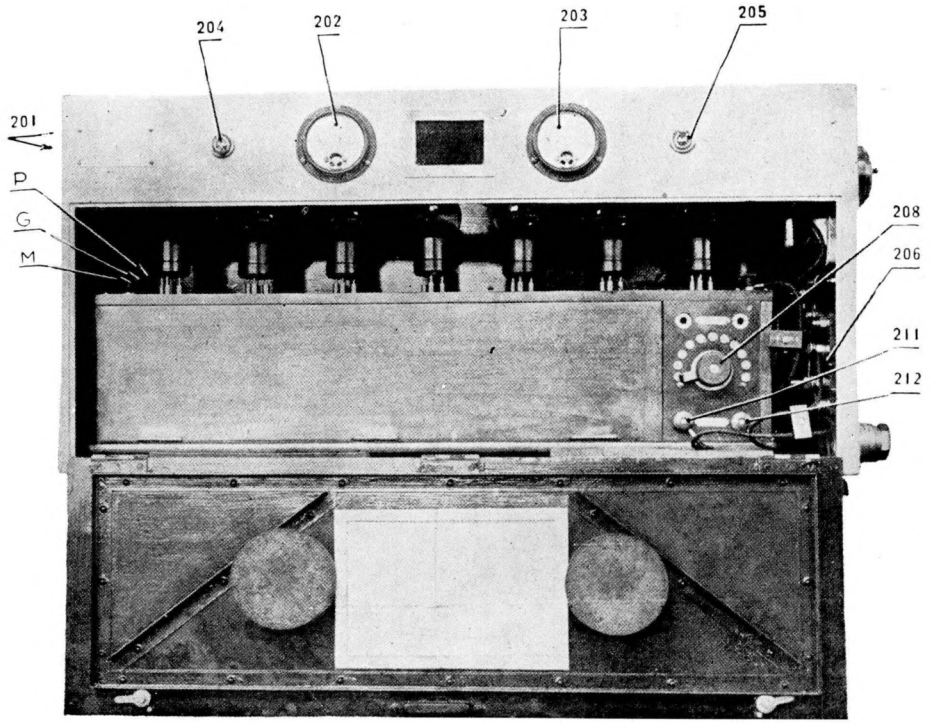
The frequency of the soundings depends on the maximum range of the indicator; the latter being graduated to 700 metres (383 fms.) corresponding to an echo time of just under a second, a frequency of one sounding per second has been adopted. A motor, adjusted to a well-determined speed, (Plate VIII), drives through gearing a shaft on which is a cam *72* keyed by three screws. At each turn of the shaft, this suitably-shaped cam makes, then sharply breaks, the primary circuit of the induction coil, by acting on the contact *51*. This contact forms part of the emission circuit (Fig. 16). At each revolution of the geared shaft of the motor, an emission is produced. As the shaft turns at constant speed the emissions are at equal time intervals.

Pl. III



Single wave-train emitter — Émetteur à train d'ondes unique

Pl. IV



Receiver-Amplifier — Récepteur-Amplificateur

THE LANGEVIN-FLORISSON-TOULY ULTRA-SONIC SOUNDER
SONDEUR ULTRA-SONORE LANGEVIN-FLORISSON-TOULY

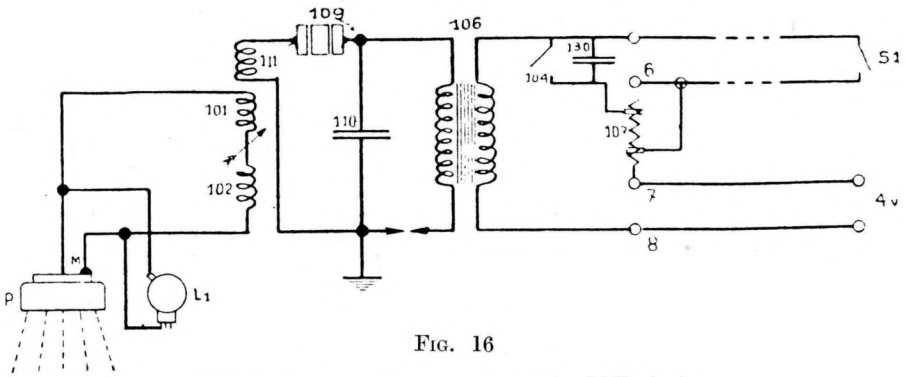


FIG. 16

Sketch showing principle — Schéma de principe

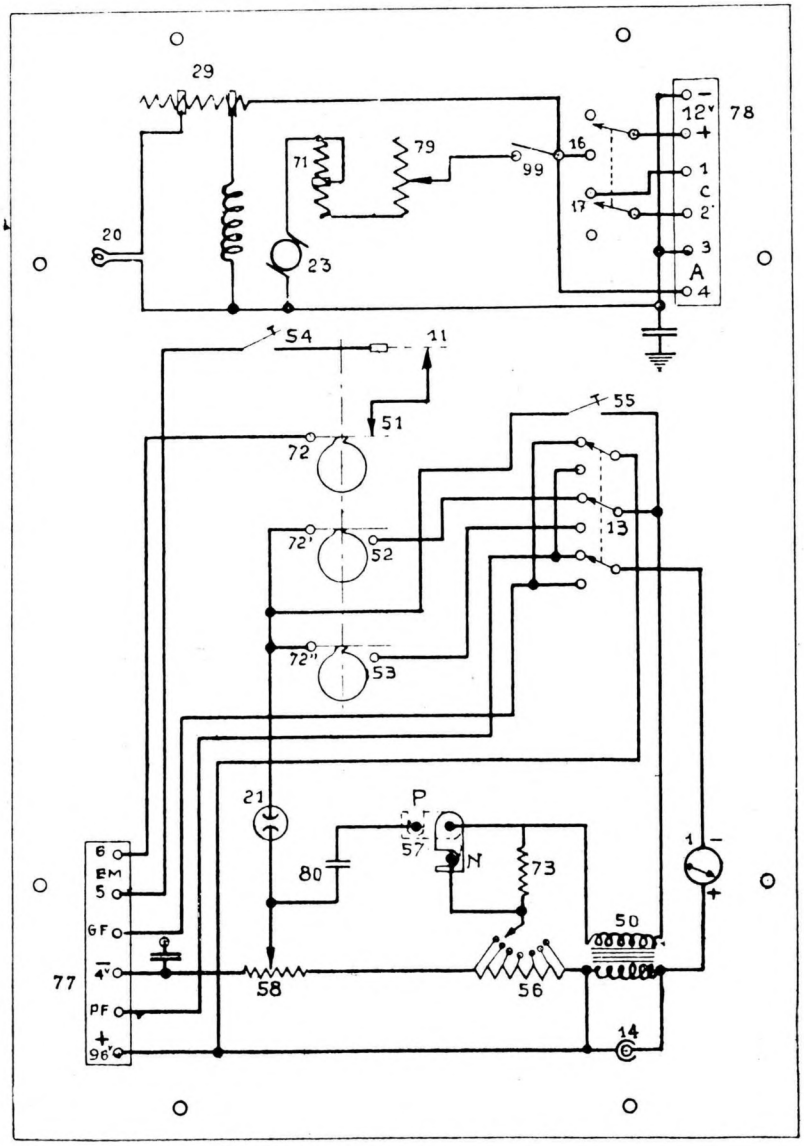


FIG. 17

Receiving circuits — Circuits de réception

(b) *Electrical and optical indication of the echoes.* — The device for reading the echoes consists of a neon lamp: this lamp has the property of lighting up and "blacking out" very quickly.

Under certain conditions of use, the voltage at which a discharge of light takes place is exactly defined, to within a fraction of a volt. Further, when the discharge has commenced, it is necessary to decrease the pressure by several volts to extinguish the lamp.

Arrangement of receiving circuits. — Fig. 17 is a wiring diagram of the receiving circuits. The actual position of the various elements may be seen at the same time in the photographs (Plates V, VI, VII and VIII).

The emission control circuit is connected to the terminals marked *5* and *6* on the terminal-bar *77* of the bottom indicator. This circuit, broken by a hand switch *54* and a push button *11* which are used only when making adjustments, is also periodically made and broken by the contact *51* actuated by the cam *72*.

If slight amplification is used, the cam *72'* actuating the contact *52* puts the neon lamp into the circuit 1/75 of a second after the beginning of the emission, while if strong amplification is used, the cam *72''* actuating the contact *53* puts the lamp into the circuit 1/8 of a second after the beginning of the emission.

These two cams are identical in shape but are keyed to a different timing upon the driving shaft.

A three-pole change-over switch *13* enables sounding to be carried out at great or small depths, and carries out the following three functions:

(1) One of the poles connects the primary circuit of the transformer *50* either to the small amplification circuit (by the terminal *P.F.*) or to the strong amplification circuit (by the terminal *G.F.*).

(2) The second pole connects the secondary circuit of the transformer *50* to the contact *52* or *53* actuated by the cam whose position corresponds to the amplification in use.

(3) The third pole short-circuits the amplification not in use by joining the terminal not in use (*G.F.* or *P.F.*) to the 96-volt positive terminal. This action avoids local parasitic oscillations being set up in the amplifier.

A small hand switch *55* enables the contacts *52* and *53* to be short-circuited and is used for adjusting purposes.

In series with the primary circuit of the transformer *50* is placed a milliammeter *1* with which it can be ascertained that the current in this circuit is correct. When the accumulators are normally charged and the lighting circuit is made, the milliammeter should indicate at least 1.5 milliampere.

A jack *14* enables a telephone to be plugged into the receiving circuit so that the echo may be heard telephonically. The telephone is then in parallel with the primary circuit of the transformer *50*.

The potentiometers *58* and *56* enable the voltage across the terminals of the neon lamp *21* to be regulated continuously as requisite. They are fed by the two terminals — 4 volts and + 96 volts on the terminal-bar *77*. The movable link *57*, at "N" (i. e. at the position of "normal reception"), short-circuits the resistance *73*. In the position "P" (i. e. "parasites") the resistance *73* and the condenser *80* are put into circuit.

With a view to avoiding parasitic action from the 12-volt circuits on the receiving circuits, all terminals in which a 12-volt current flows are concentrated on the bus-bar *78*. This bus-bar, the starting and stopping buttons *16* and *17*, and all the 12-volt circuits within the indicator, are concentrated in the right hand part of the machine.

The receiving circuits, the terminal-bar *77*, as well as the reception controls *1*, *58*, *13*, *14*, *11* and *56*, are at some distance from the 12-volt circuits and concentrated, generally speaking, in the left-hand part of the machine.

The milliammeter *1*, marked "Ampl" is visible from the outside.

The starting and stopping pushes *16* and *17* also have tallies marked "Sondage" (sounding) and "Arrêt" (stop).

The three-pole change-over switch *13*, the two positions of which are marked on the machine by tallies "petits fonds" (shallow water) and "grands fonds" (deep water), the sliding-contact potentiometer *58* tallied "réglage" (adjustment), the press-button *11* for

breaking the emission circuit marked "Em", and the jack *14* for the telephone tallied "tel + ind" (telephone and indicator in parallel), are outside the depth indicator.

The small switches *54* and *55*, respectively tallied "em" and "cames hors circuit" (cams out of circuit), as well as the contact-stud potentiometer *56* and the movable link *57*, which are much less used, are inside the machine.

It should be noted that when the switch *55* is made, the circuit-breaking action of the cams is thrown out of use. This is why the switch *55* is tallied "cames hors circuit".

Rotating optical system (Plate IX). — The neon lamp *21* (Plate VI) is mounted horizontally on the prolongation of the geared shaft of the motor. As this shaft revolves at constant speed, it carries, and drives by its rotation, not only the system of cams but also an arm *28* (Plate IX) on which are mounted a small tilting mirror *66* and a lens *67*. This rotating optical system produces a reduced image of the luminous part of the lamp in the transparent circle between the two sets of graduations. When the optical system rotates, the image of the lamp moves and a circle of light appears between the two graduations.

(c) *Measurement of the echo time. Reading of depth.* — The method of mounting the optical system with respect to the emission cam is such that the departure of the elastic wave train occurs when the left-hand edge of the image of the lamp passes through the zero of the graduation. At the same time, the neon lamp is extinguished and put back into circuit at the proper moment by the contact *52* or *53* (according to the amplification). During the interval between the departure of the signal and the return of the echo, the neon lamp is extinguished and the optical system continues to turn. When the echo arrives, it lights the lamp, the image appears and occupies on the graduated scale a position different from that which it had at the moment of departure. The image continuing to turn gives the impression of a luminous arc. The place where the image of the lamp begins to appear indicates the required depth on the scale, which is suitably graduated.

The graduation of the scale having been established once for all, the speed of rotation of the optical system must remain constant and accurately determined during the soundings. This speed has been fixed at one revolution per second.

The speed of 2,400 r.p.m. of the shaft of the driving motor corresponds, when geared down, to the above speed. The speed of the motor must therefore be adjusted to this value by means of an arrangement which we shall now describe.

Motor and speed controller. — Use is made of a shunt motor fed from the 12-volt battery. The speed of this motor, which is thus supplied at constant voltage, remains constant for practical purposes and can readily be regulated to the figure of 2,400 r.p.m. by a rheostat in series with the armature. A sturdy belt-driven centrifugal tachometer shows the speed at which the motor is turning by means of a needle moving over a quadrant. To read the exact depths on the graduation of the indicator, it is only necessary previously to bring the needle of the tachometer on to the 2,400 mark, which is a stronger and longer line than the remainder; this is done by setting the adjusting rheostat.

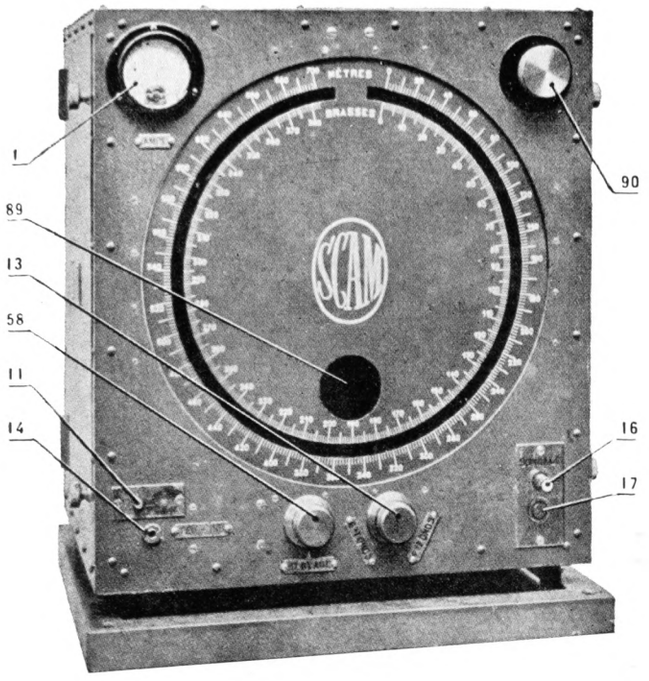
The arrangement of these items is as follows (Plates V, VI, VII and VIII).

The motor *23* carries on the end of its shaft the driving pulley *24*. Under the motor, and driven by the belt *82*, is the tachometer *25* on whose shaft is the driven pulley *26*. (The two pulleys are of the same diameter). The dial of the governor faces the front of the indicator, and is tilted back about 20° from the vertical; the observer can see it clearly through a circular window *89* just below the centre of the front panel. A small lamp *20* illuminates its dial, and its brilliancy can be regulated once for all to the desired intensity (very dim as a rule, so as not to interfere with the image of the neon lamp), by means of the upper clamp of the resistance *29* (the lower clamp of which governs the excitation of the motor).

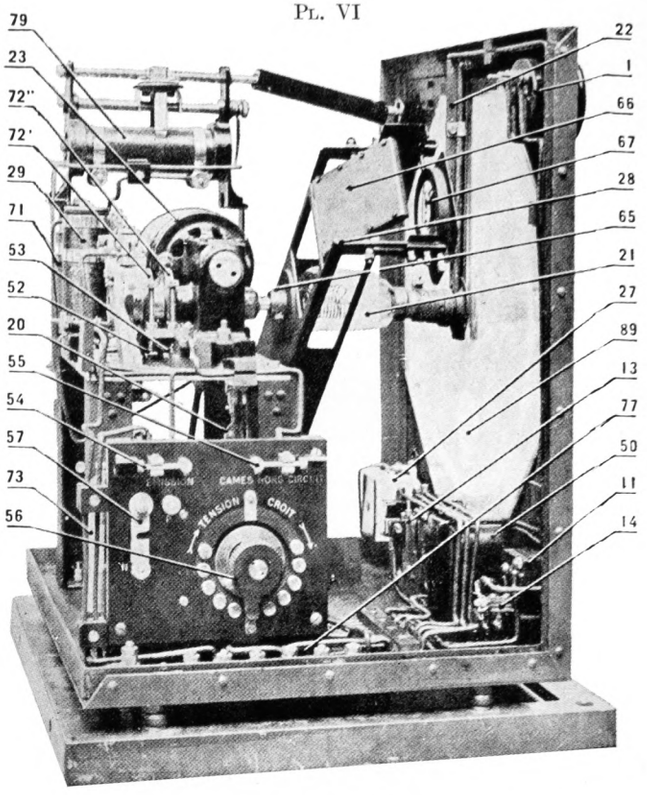
At *79* is seen the rheostat for regulating the speed of the motor, and at *90* is the knob on the face of the indicator which governs the movement of its slider.

At *71* there is a resistance with an adjustable clamp, in series with the rheostat *79*. With this resistance, the slider for the speed adjustment can be made to work over a different portion of the rheostat.

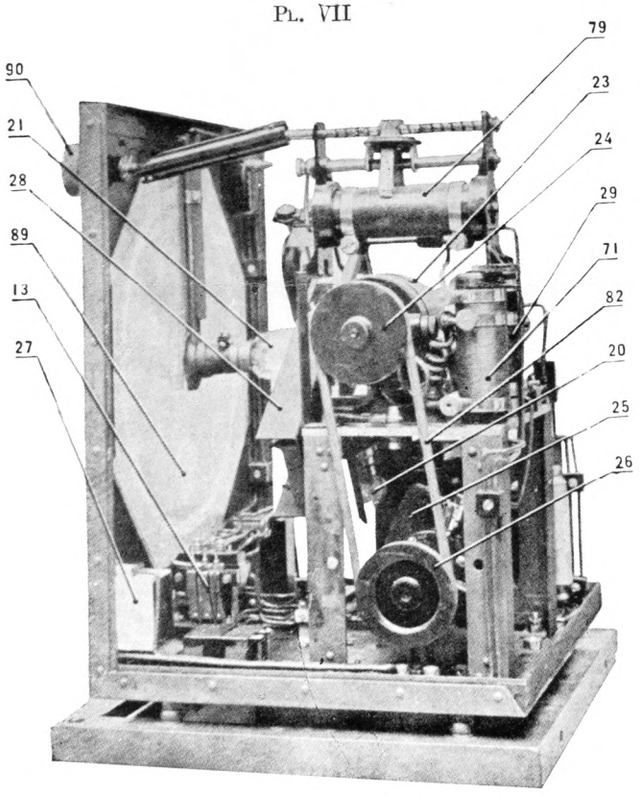
Pl. V



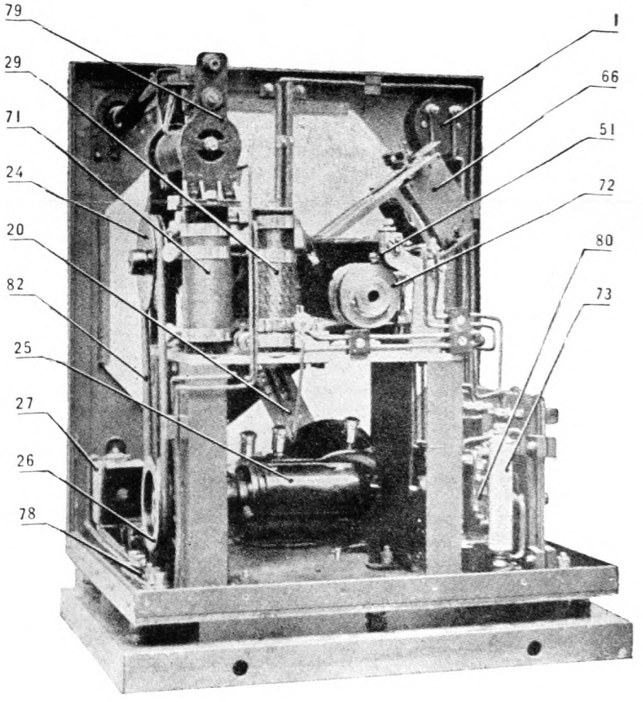
Pl. VI



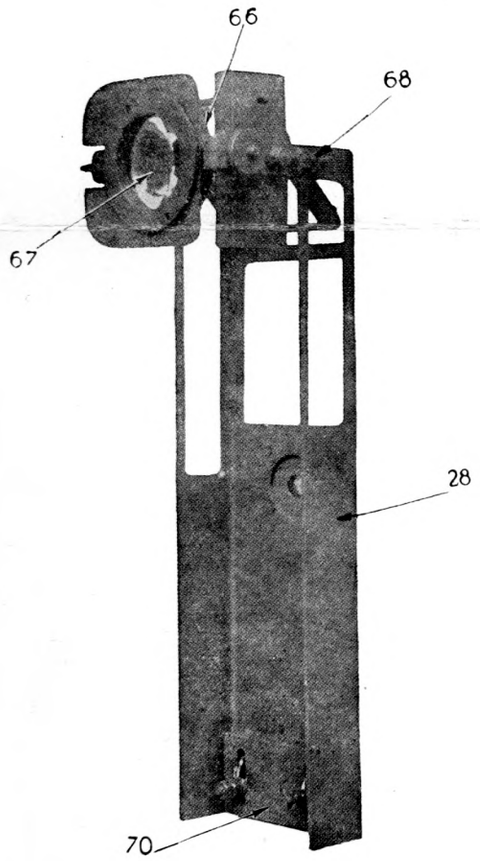
Pl. VII



Pl. VIII

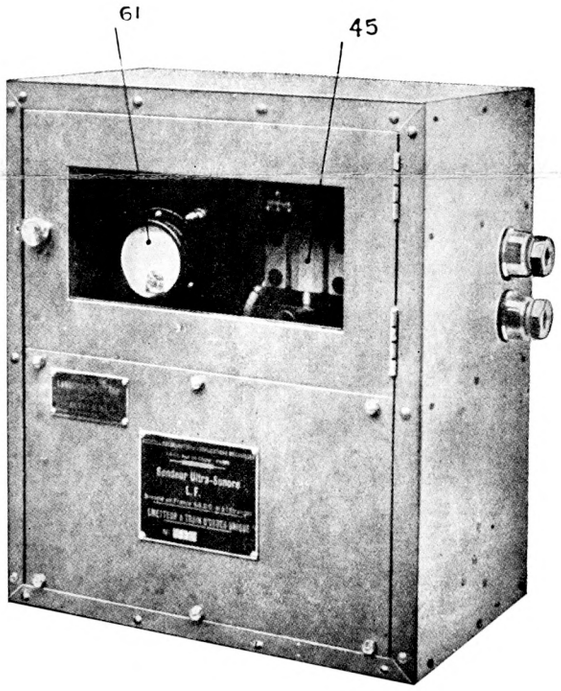


Pl. IX



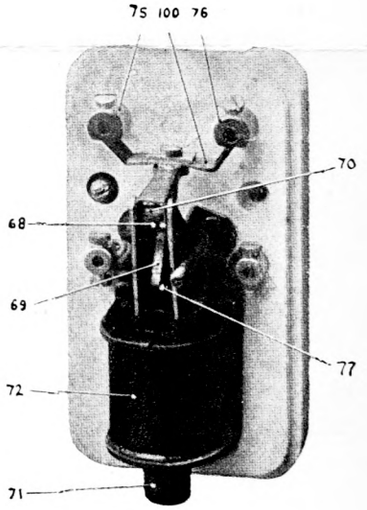
S C.A.M.-TOULY INDICATOR — INDICATEUR S.C.A.M.-TOULY
Rotating optical System — Système optique tournant

Pl. X



LANGEVIN-FLORISSON ULTRA-SONIC SOUNDER
SONDEUR ULTRA-SONORE LANGEVIN-FLORISSON
Single wave-train emitter — Émetteur à train d'ondes unique

Pl. XI



Remote-control switch — Télérupteur

Further, a resistance for the field of the motor (and for regulating the tachometer lamp) is fitted at *29*, above the resistance *71*; its lower clamp is used to make a preliminary adjustment of the speed of the motor to about 2,400 r.p.m.

Accuracy of soundings. — The ultra-sonic sounder, uncorrected, shows the depth with a relative error of less than 2 %, the absolute error of reading which may have to be added to that being not more than half a metre.

This maximum relative error of 2 % is due on one hand to slight variations in the velocity of sound around its mean value of 1,500 m/s. (4,921 ft/s.), depending on changes in the temperature and salinity of the sea — an error which in practice it is unnecessary to correct (*); on the other hand to any minute variations in the speed of the motor which the operator may overlook.

(d) *Centralisation and carrying out of the various controls automatically exercised by the sounder.* — The electrical lay-out of the depth indicator and allied apparatus has been so designed as to make all the actions necessary for starting or using the sounder as automatic and handy as possible.

Pamphlet US. 69 - 3 of the S.C.A.M. gives full details of the method of using the sounder, i. e. starting, working, stopping and maintenance.

II. LANGEVIN-FLORISSON SOUNDER COMBINED WITH MARTI RECORDER.

The apparatus consists essentially of the ultra-sonic projector (generally the large *S. 7 bis* model so as to make it possible to sound the greatest depths), the emitter-receiver and a MARTI recorder using lamp-black or ink.

The recorder must be provided with a special valve amplifier to amplify the signal when it leaves the ordinary amplifier of the ultra-sonic installation. The latest model registers the depths from about 4 metres (2.2 fms.) below the face of the projector to a depth of 200 metres (109 fms.). There is a mechanical device for obtaining phases of 200 metres (109 fms.) from 200 to 400, 400 to 600, etc. The range is thus determined by the capabilities of the ultra-sonic apparatus and the state of the sea. In practice, with an *S. 4 ter* projector, a depth of 500 metres (273 fms.) can be sounded and, with an *S. 7 bis*, a depth of 1,000 metres (547 fms.). Soundings are taken every three seconds.

There is a modified version of these appliances giving records from 4 to 100 metres (2.2 to 55 fms.) and another giving records from 4 to 500 metres (2.2 to 273 fms.).

The machine is mainly used in liners and surveying ships. It has already been used on many surveys.

Fig. 18 shows diagrammatically the LANGEVIN-FLORISSON Sounder installed on board. *I* shows the bottom compartment containing the hull apparatus (projector) *A*; *II* is a compartment below decks containing the emitter *B*, the receiver *C* and their batteries *D*; *III* is the bridge compartment containing the recorder *E*.

PROJECTOR : The ultra-sonic Projector is on the lines of the sketch, Fig. 19, which is a cross-section of the projector in its housing; the two metal armatures *2* and *3* form a piezo-electric condenser in which is the quartz diaphragm *1*. This steel-quartz-steel sandwich has a proper fundamental vibratory frequency depending on its thickness;

(*) *As an exception, where the velocity of sound may be very different from the normal value of 1,500 m/s. (4,921 ft/s.), the correction can be made automatically by running the motor at a speed which is to 2,400 as the true velocity of sound is to 1,500. The conversion table is as follows :*

Velocity of sound.	Speed of motor.
1440 m/s.	2304 r.p.m.
1460	2336
1480	2368
1500	**2400**
1520	2432
1540	2464

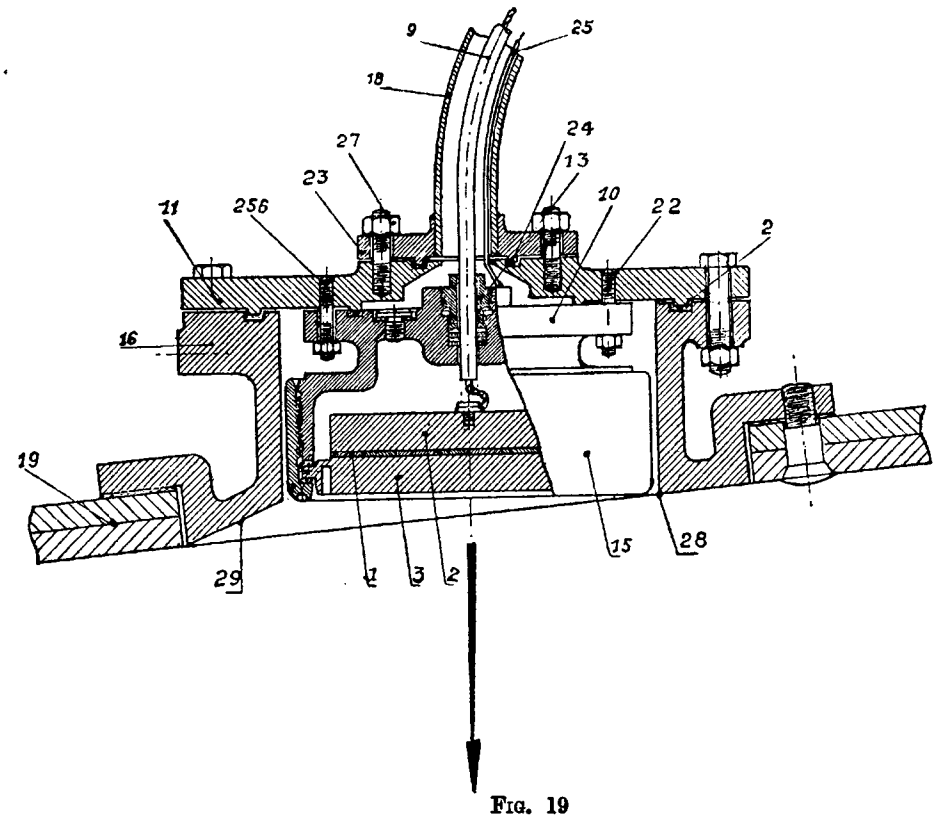


FIG. 19

Ultra-sonic Projector and hull attachment — Projecteur d'ultra-sons avec appareil de coque

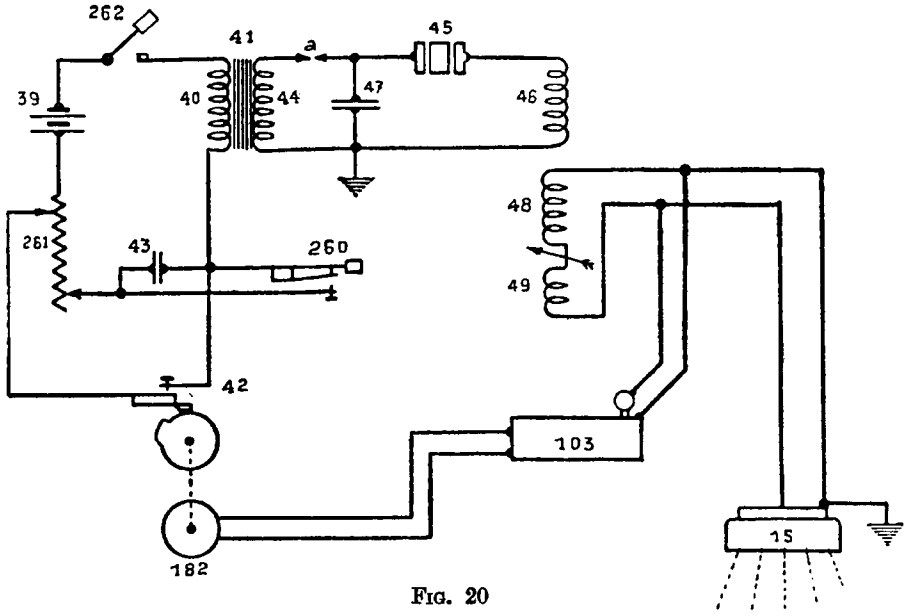


FIG. 20

Electrical connections — Schéma de principe

LANGEVIN-FLORISSON
ULTRA-SONIC SOUNDER

SONDEUR ULTRA-SONORE
LANGEVIN-FLORISSON

this frequency determines that of the alternating current which must be supplied to the piezo-electric condenser to obtain the electro-mechanical resonance required to increase the ultra-sonic energy emitted by a given voltage at the projector terminals.

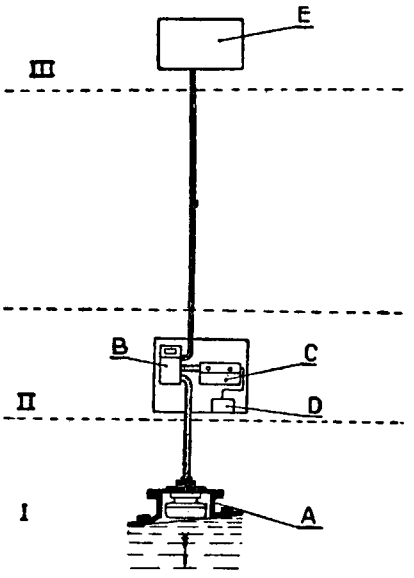


FIG. 18

ARRANGEMENT OF LANGEVIN-FLORISSON ULTRA-SONIC SOUNDER

EMITTER : As in the case of the previous apparatus, the Emitter is an impulse-excited spark motor, which emits but a single train of waves at each signal. Fig. 20 is a wiring diagram showing the principle of the electrical emitter and its connections with the projector and receiver and with the recorder. Plate X shows the outside of the machine. Fig. 21 is a wiring diagram for the emitter itself, the inside view of which has already been shown (Plate III).

Referring to Fig. 20, the discharge circuit of the battery of accumulators *39* consists of the primary *40*, a transformer (induction coil) *41*, and a special contact breaker *260* or *42*, in parallel with a condenser *43*.

The secondary *44* of the coil *41* feeds a *spark circuit* composed of a multiple discharger *45*, the self-inductance exciting coil *46*, and a condenser *47* (the positions of the discharger and the condenser may be exchanged indifferently).

The fixed values L of this exciting coil and C of this capacity are adjusted at the factory so as to give approximately :

$$\frac{1}{N_0} = 2\pi\sqrt{L.C.}$$

N_0 being the frequency of mechanical resonance of the projector.

For the small projector (effective diameter 220 mm.),

$N_0 = 37{,}030$ (corresponding to $\lambda_0 = 8{,}100$ m.).

For the large projector (effective diameter 310 mm.),

$N_0 = 29{,}100$ (corresponding to $\lambda_0 = 10{,}300$ m.).

The *oscillating* circuit proper comprises the main self-inductance coil *48* coupled with the exciting coil *46*, and an auxiliary self-inductance coil *49* (variometer) in variable coupling with the former, for adjusting the frequency of the train of waves and the piezo-electric condenser of the projector *15*. This oscillating circuit is adjusted on board

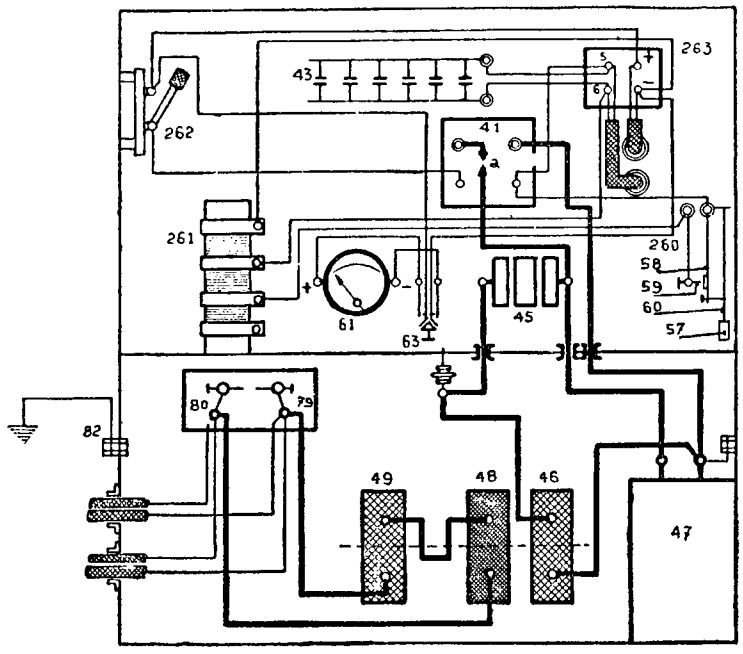


FIG. 21

Emitter wiring diagram — Schéma de l'émetteur

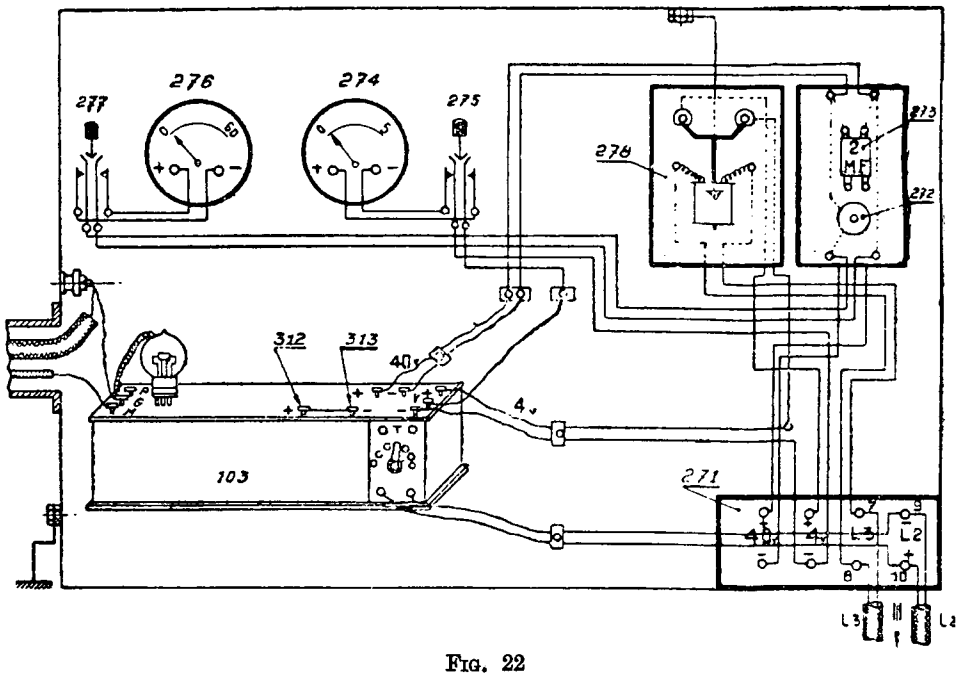


FIG. 22

Receiver wiring diagram — Schéma du récepteur-amplificateur

LANGEVIN-FLORISSON
ULTRA-SONIC SOUNDER

SONDEUR ULTRA-SONORE
LANGEVIN-FLORISSON

by means of the variometer, so as to get a proper frequency of electrical oscillations exactly equal to N_0 for bringing into play the properties of mechanical resonance of the projector.

On closing the contact-breaker *260* or *42*, the current from the battery *39* flows in the primary of the induction coil *41*.

On opening the same contact-breaker, either by hand (switch *260*) or by the working of the recorder (chronograph, analyser, recorder, etc. — contact-breaker *42*) the battery current is sharply broken. A very rapidly growing electromotive force is set up in the secondary of the coil. When the difference of potential produced by the latter at the terminals of the spark gap *45* reaches the disruptive limit imposed by the size of the divisions of this multiple spark gap, the condenser *47* discharges in a few oscillations, thus inducing in the oscillatory circuit a single train of damped waves, lasting a matter of one-thousandth of a second, which is transformed by the projector into a train of ultra-sonic waves of the same form, constituting the submarine emission signal.

RECEIVER : The Receiver comprises the special amplifier contained in the screening cabinet as already described ; its wiring is shown in Fig. 22. The remote control switch *278* (illustrated on Plate XI) controls the filament current of the amplifier. The record is taken by a MARTI recorder, as already described above (page 41).

There are two models of this apparatus.

The first (HYDROGRAPHIC) model is suitable for accurate soundings that may be required during surveying in relatively shallow water.

The second (NAVIGATIONAL) model is suitable for the ordinary purposes of navigational sounding which may be required near the land and on shoals.

The following are the principal characteristics of the two models :

	HYDROGRAPHIC MODEL.	NAVIGATIONAL MODEL.
Width of roll of record paper.....	0.150 m.	
Width of graduated portion of strip.....	0.125 m.	
Rate of travel of strip, per hour.....	2 metres.	1 metre.
Frequency of soundings ..... *one every* ...	1.5 second.	3 seconds.
Unit of graduation..... *a line every.*	5 metres.	10 metres.
Normal effective limits of depth on the machine...	From 0 to 100 metres.	From 0 to 200 metres.
Extreme mechanical limits of use, using the full available extent of the phasing.....	1,000 metres.	2,000 metres.

The recorder itself releases the emissions of the trains of ultra-sonic waves by means of the following arrangement.

The electric contact, by means of which the recorder governs the ultra-sonic emitter to which is it connected, first closes the primary circuit of the induction coil, then sharply breaks it at the moment of the ultra-sonic emission.

The recorder includes a pair of terminals for this emission contact, marked "Emission".

The emission contact is actuated by a cam fixed on the rotating arm carrying the oscillograph ; it is carried by an ebonite block *A* (Fig. 23), which can be displaced somewhat in a direction tangential to the path described by the cam of the rotating arm ; the object of this arrangement is to enable the operator to adjust the recorder in such a way that at each turn it releases the ultra-sonic emission exactly at the correct

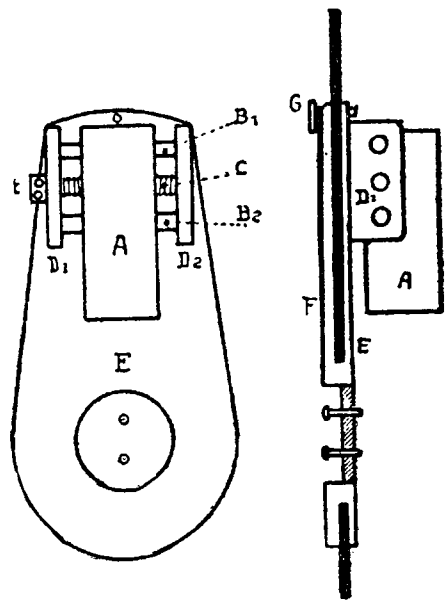


FIG. 23

MARTI RECORDER — *Adjustment of emission contact*

ENREGISTREUR MARTI — *Réglage du contact d'émission*

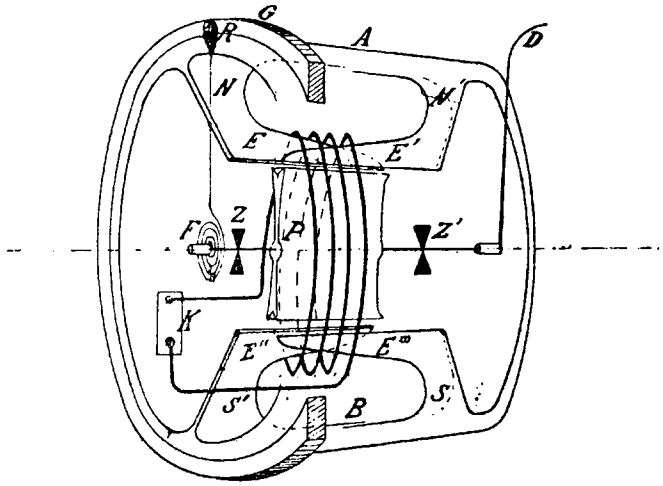


FIG. 24 *a*

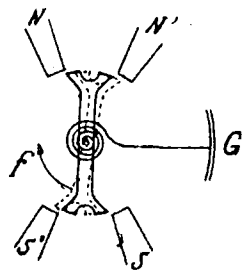


FIG. 24 *b*

MAGNETO-OSCILLOGRAPHE ABRAHAM-CARPENTIER

moment so that it will then indicate the depth directly on the graduation by the "echo nick".

In this possible displacement, the ebonite block *A* is guided by two rods *B1* and *B2* and set at the proper position by an endless thread *C* (Fig. 23). *B1*, *B2* and *C*, which all three pass right across the block *A*, are mounted between two fixed cheeks *D1* and *D2*. Thus, to displace the block *A* on its guides, it is only necessary to turn the screw *C*; this is done by a tommy inserted in holes made for the purpose in the head *t* of the screw; the block *A* then remains, without any locking device, at whatever position it is set at.

The emission contact can furthermore be displaced by a large amount in the direction which actuates the contact (and consequently releases the emission) before the pen passes the origin of the graduation; the quantities by which the contact can thus be displaced being exactly determined and corresponding each time to the total width of the graduation of the strip. In this manner nine consecutive displacements of the contact are allowed for. This arrangement, by causing fictitious displacements of the graduation of the machine, makes it possible to use it down to depths ten times greater than the extent of its graduation.

To remind the operator continuously of the depth phase to which the graduation of the strip corresponds a small window is fitted in the left-hand panel of the machine above the circular opening in which the segment *E* pivots; and this small window allows two figures to be seen (for example 0 and 200, 200 and 400, 400 and 600, etc. as far as 1800 and 2000, which always indicate the depths corresponding to the extreme marks of the graduation).

It is of course the *beginning* of the nick marking the echo which gives the depth reading. In the same way the departure of the emission corresponds to the *beginning* of the signal nick. It is the latter point which must be set on the strip opposite the graduation corresponding to the depth of the projector below the waterline (by means of the adjusting device for setting the emission contact).

The receiving circuit is composed of a specially designed type *M.S.* amplifier and an ABRAHAM-CARPENTIER oscillograph, mounted on the end of the rotating arm of the recorder. Fig. 24*a* shows a sketch of this magneto-oscillograph, which is particularly suitable for graphically recording ultra-sonic soundings on smoked paper, at very shallow depths; the moving element has very little inertia. The torque of the motor is sufficiently strong to enable the needle easily to overcome the friction on the smoked paper. (The sensitivity is of the order of 1.5 to 2 mm. (.06 to .08 in.) of displacement of the end of the needle per milliampere).

The proper frequency of oscillation of the movable element is of the order of 120 periods per second.

The cylindrical permanent magnet *A* (imagined to be transparent in the figure for the sake of clearness) has its field concentrated towards the axis by four radial poles *N*, *N'*, *S*, *S'*, grouped in pairs at opposite ends of two diametrical planes of the magnet. Between these poles can oscillate a soft iron blade *P*, (the axis of rotation being the same as that of the cylindrical magnet). The pole-pieces *E*, *E'*, *E''*, *E'''* of the four poles are arranged in such a way that each group of two diametrically opposed poles *N-S* or *N'-S'* builds up a field opposed to that of the other pair and passing through the axis of the cylindrical magnet so that the movable blade tends to be polarised axially in opposite directions by these two magnetic fields.

The spindle of the blade passes through the end flanges of the magnet by the sapphires *Z*, *Z'*. On the ends of the spindle proud of the flanges are mounted, on one side the recording needle or stylus *D*, on the other a spiral *F* whose outer end *R* is constrained to follow the angular movements of a collar *G* mounted on the end of the cylindrical magnet. Needle and spiral are mounted on sleeves pressed on to the ends of the spindle. The milled collar *G*, to which the outer end of the spiral is attached, may be turned one way or the other so as to impose slight angular displacements on the spindle of the blade, thus regulating the position of equilibrium and of sensitivity of the apparatus.

Working of the magneto-oscillograph. If no current is flowing in the exciting winding, the movable blade is in *stable equilibrium* under the action of the two opposite fields of the pairs of poles *N-S* and *N'-S'* (as shown by full lines in Fig. 24*b*).

If a current is flowing in the winding in a direction such that its field is opposed to that of *N-S* and in accord with that of *N'-S'*, the blade pivots around its axis in the direction of the arrow *f* to a new position of equilibrium (broken line).

The amplitude of the swing of the blade, and so of the needle, is a function of the intensity of the current in the coil. Obviously a deviation in the opposite direction is obtained by reversing the direction of flow of the current in the coil.

The price of the complete installation, with recorder, is about £ 1,000 sterling.

III. LANGEVIN-FLORISSON SOUNDER WITH ECHOMETER.

This gear has already been described in *Hydrographic Review*, Vol. VII, No. 2, November 1930, p. 105.

Generally speaking, it uses a 220 mm. ultra-sonic projector, type *S. 4 ter*, as Emitter. Pamphlet US. 102-2 of the S.C.A.M. gives a full description and instructions for the use of this machine.

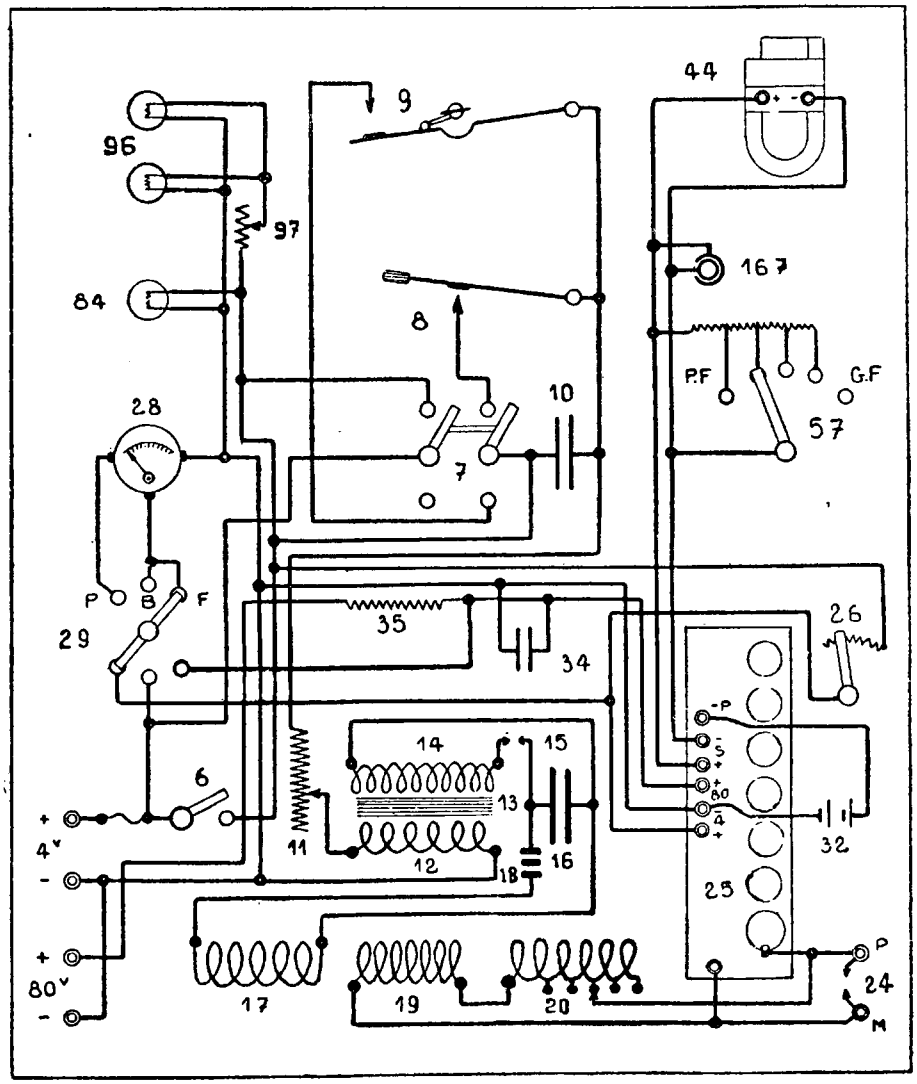


FIG. 25

LANGEVIN-FLORISSON SOUNDER WITH ECHOMETER

Echometer circuits

ECHOMETER : The circuits of the Echometer are shown in Fig. 25. In this figure, *6* is the reversing switch ; *18* the multiple discharger ; *7* the change-over switch for use or adjustment ; *8* the hand transmitting key ; *9* the emission contact breaker ; *11* the rheostat for regulating the strength of emission ; *17* the coil of the discharge circuit ; *19* the main coil of the oscillating circuit ; *20* the auxiliary coil with sixteen sockets ; *25* the amplifier ; *26* the valve filament rheostat, worked by the knob *27* (Plate XIV) ; *28* the voltmeter showing the heating voltage at the actual filament terminals.

Plate XII is the inside view of the Echometer. Plates XIV, XV, XVI and XVII show the details of the optical analyser, the luminous spot of which is provided by the spherical mirror of a DUBOIS oscillograph. The source of light for the optical system is at *36* ; the ray is redirected by the two rectangular prisms *37* and *38*. At *39* is the spherical mirror of the oscillograph, of which the horizontal axis is at *40*. The plane mirror *41* is movable round its vertical axis ; it directs the rays of light towards the scale *43*, which is a portion of a circular cylinder having as axis the spindle *42* of the swinging mirror.

The DUBOIS oscillograph is at *44*. Plate XVII shows the details of the support of the oscillograph, enabling the spot of light to be adjusted. The clockwork movement is housed at *108*. An accurate centrifugal governor *109* assures constant speed. A complete winding of the movement gives about 10 minutes of constant speed. The normal speed is one turn of the ratchet wheel in 7 seconds, and as this wheel has six teeth there are six soundings every seven seconds. The apparatus is started by pulling the knob *146* of the clockwork. A telephone jack *167* enables the operator to listen to the signals and echoes with earphones.

The new type *421* instruments differ slightly from the previous type *414*, in the control system and in the path of the light ray of the optical system, the prisms of which have been abolished. They include also a new control knob which governs the sensitivity of the instrument, i. e. the size of the nicks in the signals appearing on the scale.

The machine takes approximately one sounding per second, and readings can be taken from about 3 metres (1.6 fms.) below the face of the projector down to depths of 660 metres (361 fms.). It is the easiest machine to handle, and is used in a great number of ships, trawlers, tramps, liners, warships, submarines, etc.

The price of the gear is about £ 575 sterling.

IV. LANGEVIN-FLORISSON SOUNDER WITH ECHOSCOPE.

This apparatus has been specially designed for sounding in very shallow water from small ships or boats. It enables depths to be read from 1.2 metre (3.9 ft.) below the face of the projector, and the scale is graduated to 60 metres (33 fms.). Soundings are taken every 10/11 of a second, and one winding of the clockwork gives about 15 minutes of working. The scale is graduated in millimetres, one metre of water being represented by 5 mm. (about 1/20 in. to the ft.). The machine can be either fixed on a wall bracket or portable. It can be used with either an *S. 23* projector (100 mm.) or an *S. 4 ter* projector (220 mm.). This sounder is chiefly used for coastal hydrography, the examination of ports, estuaries, river-beds, etc.

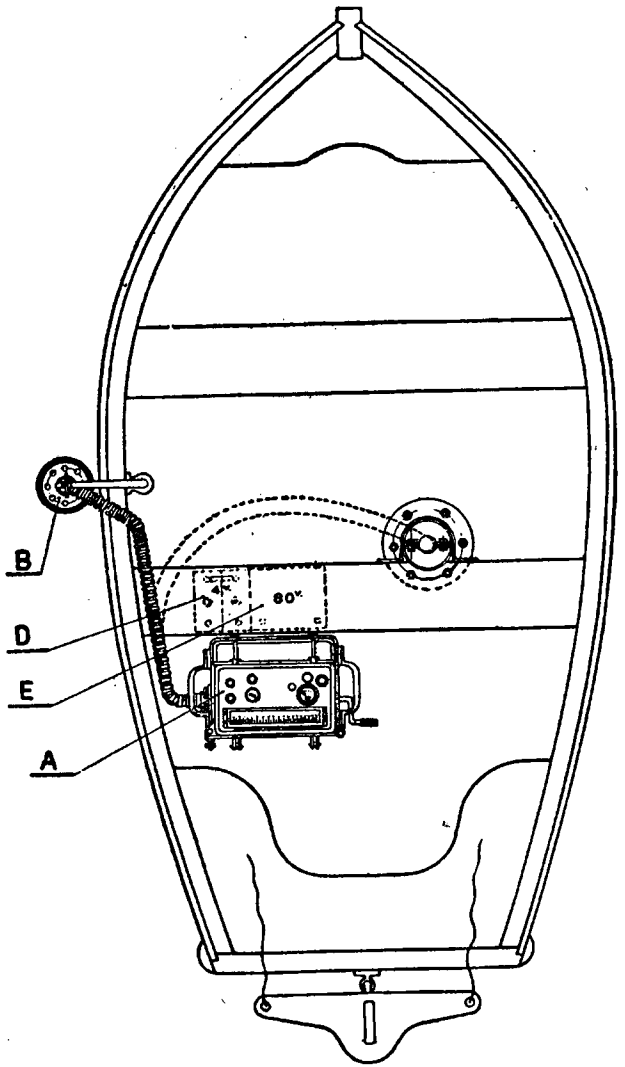
We have already described the principle of the LANGEVIN-FLORISSON ECHOSCOPE in *Hydrographic Review*, Vol. X, No. 2, November 1933, p. 170.

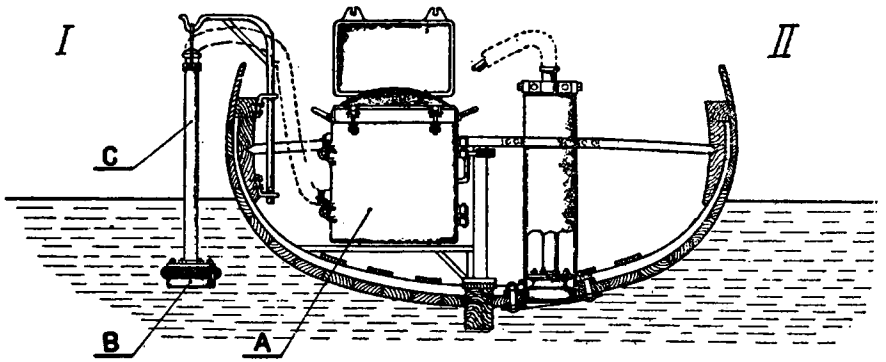
In this portable type for boat use (Plate XVIII) the *S. 23* projector can be rigged outboard on a bracket, or else in an internal tube to enable the boat to sound at normal speed (Fig. 26).

The machine is fed from a battery of 4-volt accumulators and an 80-volt battery.

The whole of the Echoscope is contained in a watertight wrought metal cabinet containing the emitter, receiver and analyser.

Fig. 27 shows the emission circuits ; Fig. 28 is the wiring diagram and Plate XIII shows the interior view of the machine. The battery *5* charges the condenser *6* ; a clockwork movement turns the cam which causes the sudden discharge of the condenser *6* in the choke coil *13*, thus emitting a single train of ultra-sonic waves. The proper frequency of the oscillating circuit *14-15-16-17* must be exactly equal to the proper fre-





I/ Disposition du projecteur hors bord (Cas du sondage sur embarcation stoppée ou à très faible vitesse).

Fitting of the projector outboard (Case of sounding on a small boat either stopped or sailing at low speed).

II/ Disposition du projecteur en tube interieur (Cas du sondage sur embarcation en marche à vitesse normale).

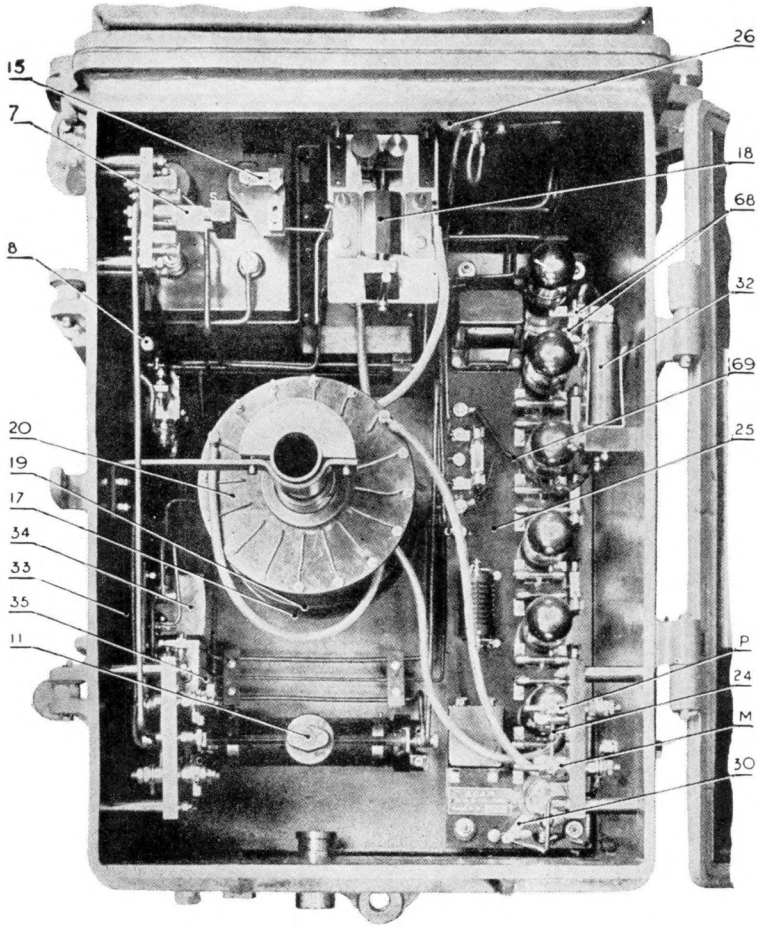
Fitting of the projector in an internal tube (Case of sounding in a small boat sailing at usual speed).

A	Echoscope type portatif	Echoscope, portable type
B	Projecteur type S 23	Projector S 23 type
C	Tube porte-projecteur	Tube supporting the projector
D	Batterie de 4 volts	4 volt battery
E	Batterie de 80 volts	80 volt battery

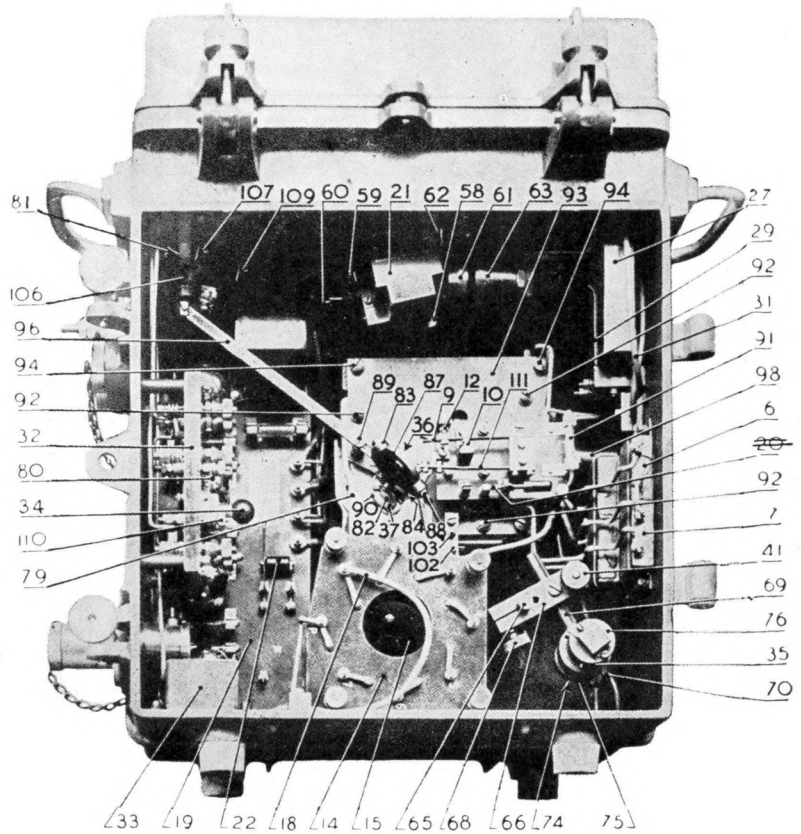
FIG. 26

SONDEUR ULTRA-SONORE LANGEVIN-FLORISSON AVEC ECHOSCOPE
Modèle portatif, pour embarcation

LANGEVIN-FLORISSON ULTRASONIC SOUNDER WITH ECHOSCOPE
Portable type for small boats

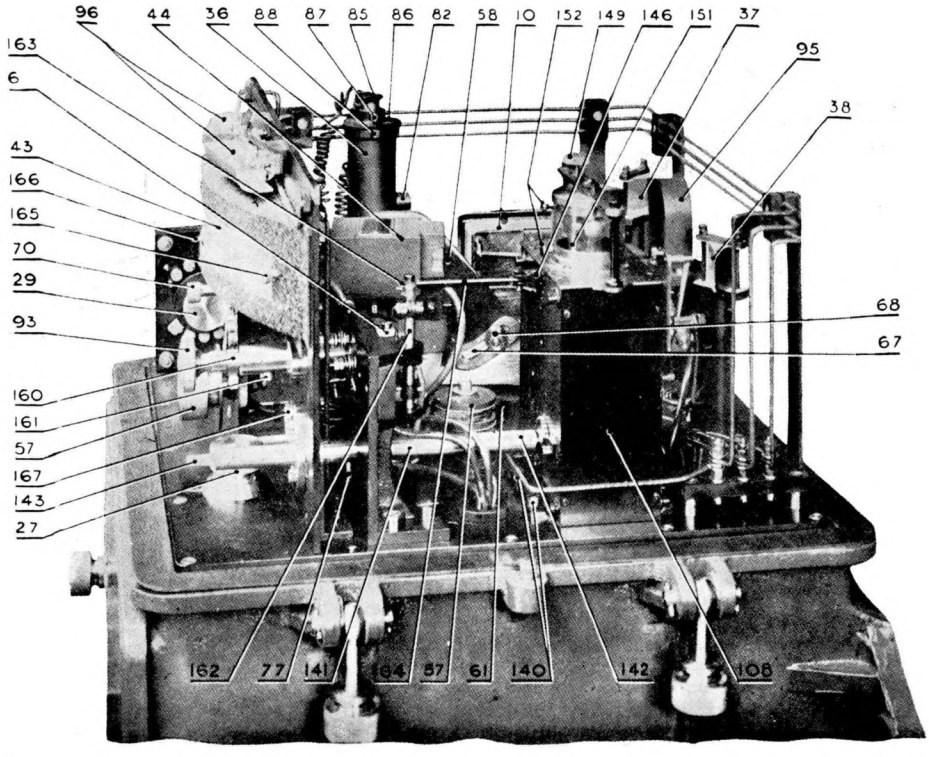


FLORISSON TYPE ECHOMETER — ECHOMÈTRE SYSTÈME FLORISSON
View of interior — *Vue intérieure*

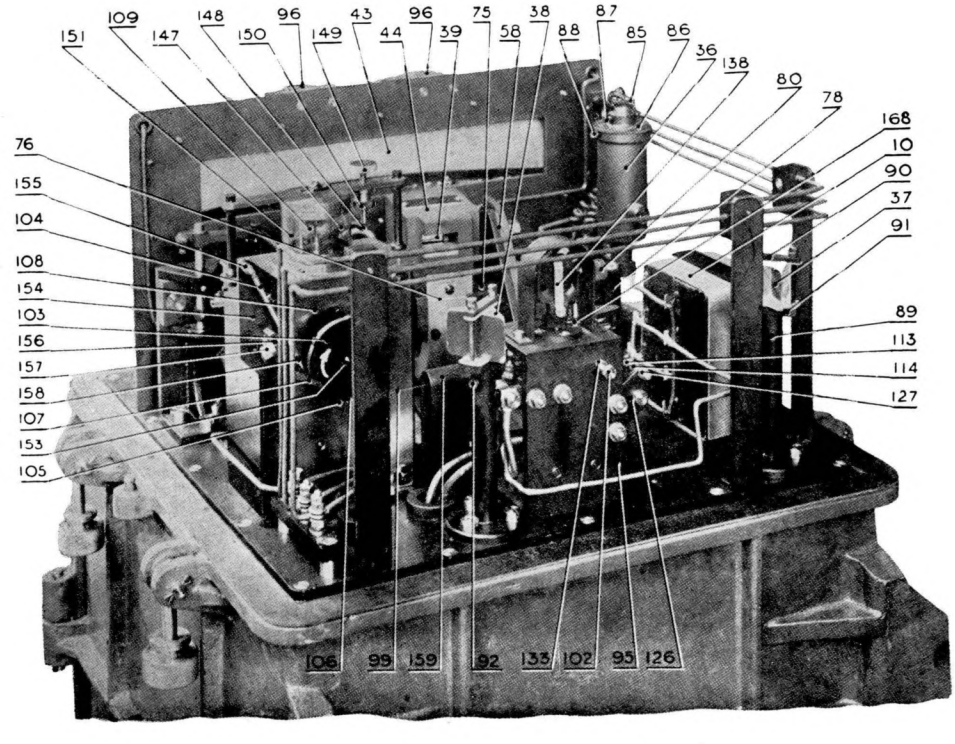


ECHOSCOPE
View of interior — *Vue intérieure*

Pl. XIV



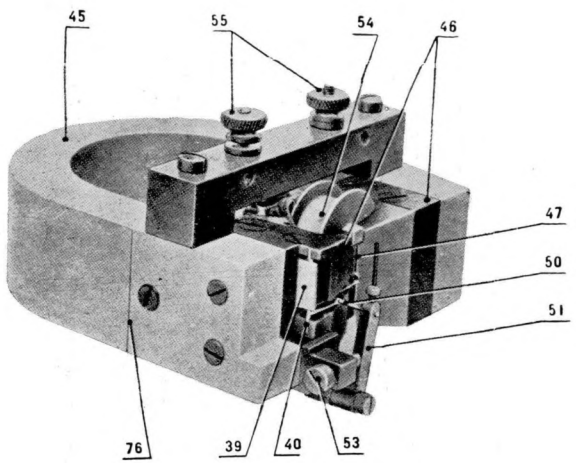
Pl. XV



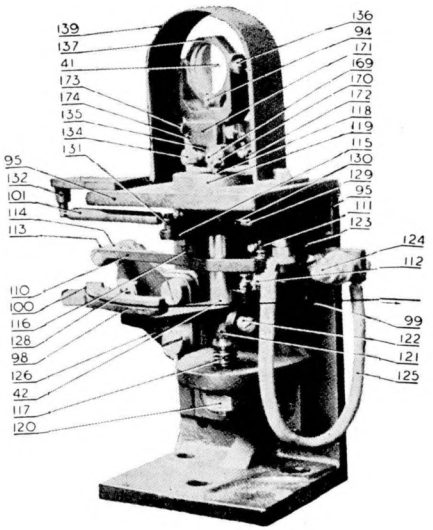
FLORISSON TYPE ECHOMETER
Views of interior

ECHOMÈTRE SYSTÈME FLORISSON
Vues Intérieures

Pl. XVI

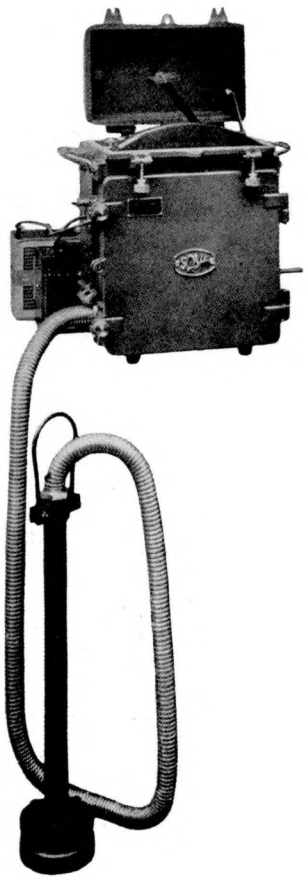


Pl. XVII



FLORISSON TYPE ECHOMETER — ECHOMÈTRE SYSTÈME FLORISSON
Dubois Oscillograph — *Oscillographe Dubois*

Pl. XVIII



LANGEVIN-FLORISSON ULTRA-SONIC SOUNDER WITH ECHOSCOPE
General view

SONDEUR ULTRA-SONORE LANGEVIN - FLORISSON AVEC ECHOSCOPE
Vue d'ensemble

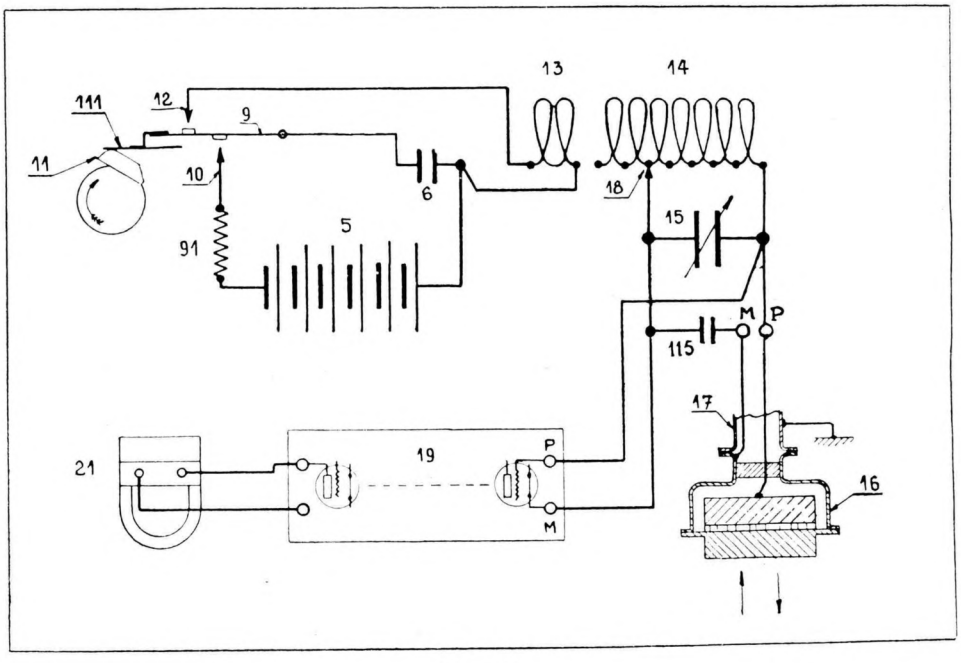


FIG. 27

Emission circuits — Principe de l'émission

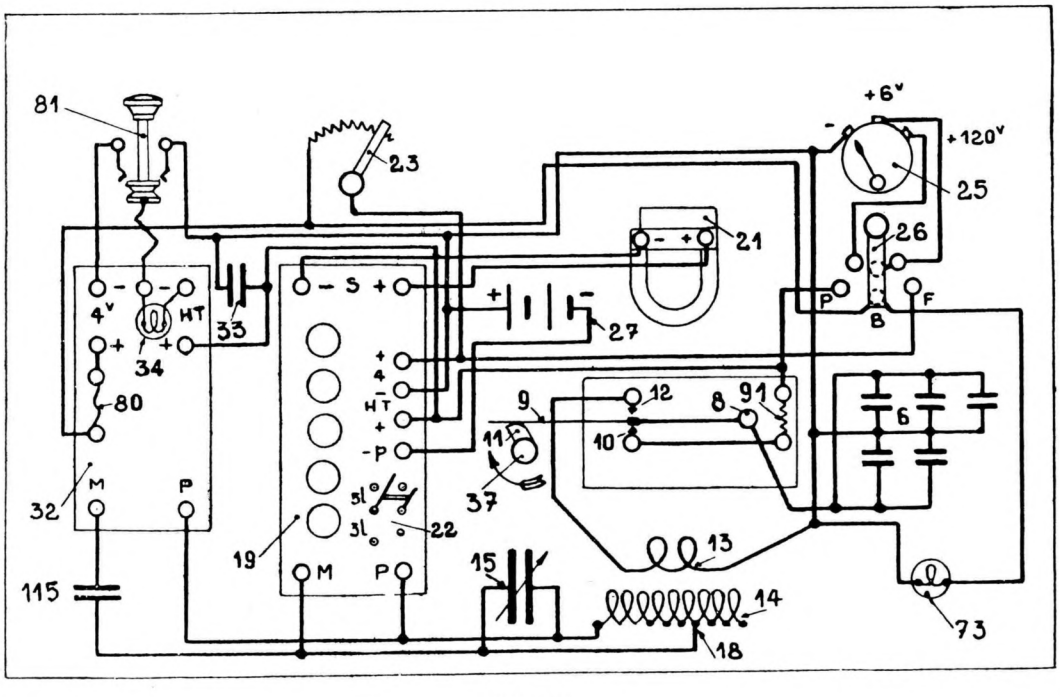


FIG. 29

Echoscope wiring diagram — Echoscope : schéma des circuits

LANGEVIN-FLORISSON ULTRA-SONIC SOUNDER WITH ECHOSCOPE

SONDEUR ULTRA-SONORE LANGEVIN FLORISSON AVEC ECHOSCOPE

quency of mechanical vibration of the projector in use. This adjustment is made by means of the variable condenser *15*. Sensitivity is adjusted with the aid of a filament rheostat *23*.

The mirror of the optical system of the analyser can be set to allow for the depth of immersion of the projector.

The source of light is at *35*; *36* is the mirror rotating about its horizontal axis *37*, which concentrates the beam on the scale; the DUBOIS oscillograph, shown at *21*, is supported by a fitting which enables the optical system to be adjusted; the clockwork movement is housed at *79*; it is wound up by the spindle *98*; its speed can be adjusted by the rod *102* and the check screw *103*. The axle must make 11 revolutions in 10 seconds. A jack is fitted for listening telephonically to the echoes, at *109*.

The S.C.A.M. has published numerous pamphlets giving full descriptions of the method of use and handling of these appliances; these will be supplied on demand to them or to their agents, particularly to:

The MARCONI SOUNDING DEVICE Co., Ltd.,

Marconi House, Strand,

LONDON, W. C. 2.

(England)

The INTERNATIONAL MARINE SOUNDING DEVICE S.A.

16, rue Thérésienne,

BRUSSELS.

(Belgium)

STA. DI CONDENSAZIONE ED APPLICAZIONE MECCANICHE,

7, Via Arcivescovado,

TURIN (1)

(Italy).

A complete list of the agencies of the S.C.A.M. at home and abroad will be sent on demand to the S.C.A.M.

BIBLIOGRAPHY.

Information concerning Echo Sounding is given in the following publications of the International Hydrographic Bureau. Articles containing descriptions of appliances are marked by an asterisk:

HYDROGRAPHIC REVIEW:
Vol. I, No. 1, March 1923, p. 71.
Vol. I, No. 2, May 1924, p. 39* ECHO SOUNDING (and Special Publication No. 1, December 1923*).
Vol. II, No. 1, Nov. 1924, p. 51* ECHO SOUNDING (and Special Publication No. 3, October 1924*).
Vol. II, No. 2, May 1925, p. 135* ECHO SOUNDING (and Special Publication No. 4, March 1925*).
Vol. III, No. 1, Nov. 1925, p. 69.
Vol. III, No. 2, July 1926, p. 75* ECHO SOUNDING-IV (and Special Publication No. 14, Aug. 1926*).
Vol. IV, No. 1, May 1927, p. 229.
Vol. IV, No. 2, Nov. 1927, p. 205*.
Vol. V, No. 1, May 1928, p. 131* ECHO SOUNDING-V, pp. 257* and 277.
Vol. V, No. 2, Nov. 1928, p. 107* ECHO SOUNDING-V and p. 141.
Vol. VI, No. 1, May 1929, advertisements*.
Vol. VI, No. 2, Nov. 1929, pp. 21, 163*, 226, 227, 228.
Vol. VII, No. 1, May 1930, p. 99* ECHO SOUNDING-VIII and p. 190.
Vol. VII, No. 2, Nov. 1930, pp. 50 and 105* ECHO SOUNDING-IX.
Vol. VIII, No. 1, May 1931, pp. 122, 124*, 140, 265.
Vol. VIII, No. 2, Nov. 1931, p. 168* ECHO SOUNDING-X and p. 242*.
Vol. IX, No. 1, May 1932, pp. 157, 183, 254.
Vol. IX, No. 2, Nov. 1932, p. 135* ECHO SOUNDING-XI and pp. 234*, 251, 254.
Vol. X, No. 1, May 1933, pp. 38, 41, 131, 178*.
Vol. X, No. 2, Nov. 1933, p. 130* ECHO SOUNDING-XII and pp. 172, 180.
Vol. XI, No. 1, May 1934, p. 138.
Vol. XI, No. 2, Nov. 1934, p. 25* ECHO SOUNDING-XIII.

INTERNATIONAL HYDROGRAPHIC BULLETIN:
No. II, February 1928, p. 41*.
No. VII, July 1928, p. 163.
No. IV, April 1929, p. 85.
No. V, May 1929, p. 118.
No. VIII, Aug. 1929, p. 184*.
No. XI, Nov. 1929, p. 226.
No. III, March 1930, p. 50.
No. IV, April 1930, p. 72.
No. VI, June 1930, p. 134*.
No. X, Oct. 1930, pp. 225*, 226.
No. X, Oct. 1931, p. 251.
No. III, March 1932, p. 54.
No. V, May 1932, pp. 96-99, 114, 115.
No. XI, Nov. 1932, p. 259*.
No. 2, Feb. 1933, pp. 36, 39.
No. 7, July 1933, p. 122.

REPORT OF PROCEEDINGS OF THE INTERNATIONAL HYDROGRAPHIC CONFERENCE, MONACO, 1929 — pp. 29, 30, 80, 83, 85, 86, 218, 244, 245, 284, 293, 303, 327, 395,

REPORT OF PROCEEDINGS OF THE INTERNATIONAL HYDROGRAPHIC CONFERENCE, MONACO, 1932 — pp. 27, 35, 88, 93, 94, 99, 148, 161, 171, 177, 180, 217, 224, 232, 258, 260, 383, 385, 411, 412.