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

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

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

II. SOME RECENT ULTRA-SONIC INSTRUMENTS.

ULTRA-SONIC PROJECTORS :

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

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

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

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

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

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

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

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

The advantages of sounding machines using ultra-sounds are as follows:–

The electric connection between the parts of the ultra-sonic sounder being *uninterrupted*, no lag can intervene in the measurement of the "echo interval", that is to say, *no error in the soundings*. Moreover, the receiver being "progressive" and not "all or nothing" (relay), *the appliance analyses the shape of the echoes* which may have undergone modification through the nature or form of sea-bottom. Besides the depth, therefore, an intelligible representation of the form and nature of the bottom is obtained.

As a result of the projector having *sharp resonance* and *very high frequency*, the ultra-sonic sounding machine is specially protected against parasitic water noises within the sonic range, due to the advance and motions of the vessel — and this is the case up to the highest navigational speeds.

The use of *a single projector*, transmitter and receiver alternatively, makes the installation particularly easy and allows smallest depths to be read *without any correction.*

The directive quality of the ultra-sonic projector, assured without the use of any part reflecting or otherwise, enables the true (vertical) depth under the keel to be measured without risk of error when the bottom is irregular.

The fairly large aperture of the transmitting cone and the frequent repetition of the transmissions mean *continuous sounding* and render the instrument insensitive to the rolling and pitching of the vessel.

TRANSMISSION AND RECEIVING ELEMENTS ,

At regular intervals the chronographic unit induces in the projector, by means of the transmitter, a train of high-frequency damped electric oscillations. This train of very brief oscillations (duration of the order of one-thousandth of a second) is transformed by the projector, which is in contact with the water, into a train of submarine, ultra-sonic elastic oscillations of the same frequency and duration.

As the piezo-electric projector possesses a "natural frequency" of mechanical vibrations, the electric oscillations of the transmitter (single spark shock circuit and oscillating circuit of the transmitter), are tuned exactly to this frequency.

The chronograph device, indicator or optical analyser or recorder, usually carries a constant-speed rotating shaft which serves to combine the time interval measuring element and the regularly spaced transmission departures (cam actuating the transmission break).

Soundings are automatically repeated at a predetermined cadence which depends on the chronographic interrupter used.

At each revolution of the cam the interrupter closes for some tenths of a second (establishment of the current in the primary of the transmitter induction coil), then opens suddenly. A sudden rise in electro-motive force in the secondary of the induction coil, which induces excitation "by impulsion" in the shock circuit and the oscillating circuit of the projector, follows this break of primary current. At each break a single oscillating spark flashes in the subdivided spark gap of the shock circuit. As is well known in W/T, this phenomenon produces a *single* train of damped electric oscillations in the oscillating circuit of the projector (always connected to the amplifier). As noted above, the piezo-electric projector then transmits a damped ultra-sonic elastic wave-train which is propagated towards the bottom of the sea, the echo of which is transformed into a current impulse by the projector, its oscillating circuit and the amplifier. We have here the phenomenon of saturation of the amplifier valves which limits the amplitude of the chronographic impulse corresponding to the transmission and makes it comparable in magnitude to the amplified echo impulse.

There is no need to readjust the shock circuit on board as it is calibrated at the factory The oscillating circuit of the projector must on the contrary be calibrated after installation on-board to a frequency of electric oscillations equal to the natural frequency of the elastic oscillations of the projector.

The latter adjustment is very simply accomplished, as in W/T, by means of a buzzer or heterodyne frequency-meter. The resonance of the circuit tuned to the known frequency of the projector is obtained by an adjustment by connecting the plugs of one of the self-induction coils and varying the sliding coupling of the two coils of the circuit. (1)

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(1) When the transmitter-receiver is fitted with a small size projector, the fore coil has no connecting plugs. The adjustment of the oscillating circuit to the proper frequency of the projector must then be made : 1) by judicious unwinding of the fore coil (rough adjustment) ; 2) by variation of the coupling (accurate adjustment). (The wire of the front coil is fixed by a drop of resin or melted lacquer).

This adjustment must be made on board, *after completion of the installation*, so that there may be taken into account the parasitic capacity of the screen protected cable line, depending on the length of the latter (capacity in parallel with that of the projector and which consequently intervenes in the calibrations).

The transmitter-receiver is constituted by a two-story metallic cabin containing, in the lower half, the transmission elements and in the upper half the amplifier.

TRANSMISSION ADJUSTMENTS :

The fixed resistance transmission, connected in series with the primary of the induction coil and which serves to limit the maximum intensity to be admitted into this winding, must be adjusted once for all immediately after installation of the sounding machine on board.

Immediately after installation, the frequency of the oscillating circuit constituted by the projector, the protected cable-line and the two self-induction coils, will be regulated once for all by means of the connecting plugs of the front coil and the sliding of the last-mentioned along its axis.

The calibration of the circuit is made to the frequency N (or the equivalent λ in W/T) of the projector used. For instance, for the projector

S. 4 *ter* : N = 37500 ∿ (λ = 8000 metres)
S. 7 *bis* : N = 29000 ∿ (λ = 10300 metres)
S. 16 : N = 39000 ∿ (λ = 7700 metres)

This adjustment is easily made with the help of a W/T transmitter wave-meter of, for instance, the buzzer type, the transmission of which is regulated on a large range of frequencies (including that of the projector) and the resonance of the oscillating circuit is determined by listening to the wave-meter by means of the amplifier, and the telephone of the receiver. One must then seek out the best connection with the front coil and the coupling of same with the middle coil to obtain resonance at the known frequency of the projector. Naturally as loose a coupling as possible must be used between the wave-meter and the circuits.

Calibration being obtained, the coil with plug will be fixed in position, on the wooden axis, by means of the wood screw of the insulating tube carrying this coil.

The resonance adjustment of the oscillating circuit to the frequency of the projector is very important. It should be verified (and corrected if necessary) after every change of projector or of the screen protected cable line.

Now the correct adjustment of the spark-gap to the *maximum sparking limit* is obtained. This is necessary in order to avoid "resparking" or multiple wave-trains which would occur at each transmission if the spacing of the spark-gap were too weak (when there is resparking the duration of the apparent transmission increases and soundings in shallow water can no longer be obtained).

CALIBRATION OF THE RECEIVER :

The amplifier permanently connected to the projector, has been specially devised for transforming the short transmission and echo oscillating wave-trains into current impulses representing as faithfully as possible the enveloping contours of the corresponding oscillation wave-trains detected. This enables us to obtain by means of the optical or recording chronographic unit, in addition to soundings from depths of a few metres, a detailed representation (generally oscillograph) of the form of the echo.

The 7-valve amplifier, heated by 3-4 volts, must be fitted, from left to right, with :

1. A special entry valve with highly insulated grid (the S.C.A.M. "lampe à corne" (horn valve), the filament of which *in pure tungsten* consumes about 0.7 amp. The horn grid must be connected by a supple wire, insulated by beads, to the terminal P opposite (terminal on which is fixed the highly insulated cable leading to the projector).

2. Five triode valves, type R. 36. If it is desired to increase the sensitivity of the receiver, a T.A. 15 or A. 415 valve might be substituted for the R. 36 valve of the last stage but one.

3. A low-frequency exit valve which must be :

a) when the sounding machine is fitted with an optical chronograph (Analyser, Indicator) : a T.A. 15 or A. 415 valve. In this case the tension of negative polarisation of the grid of this valve must be selected experimentally usually in the neighbourhood of —4 volts.

b) when the sounding machine is fitted with a LANGEVIN-TOULY electrolytic recorder : a penthode B. 443 valve. In this case the tension of negative polarisation of the control grid of the valve must be selected experimentally, usually in the neighbourhood of —13 volts.

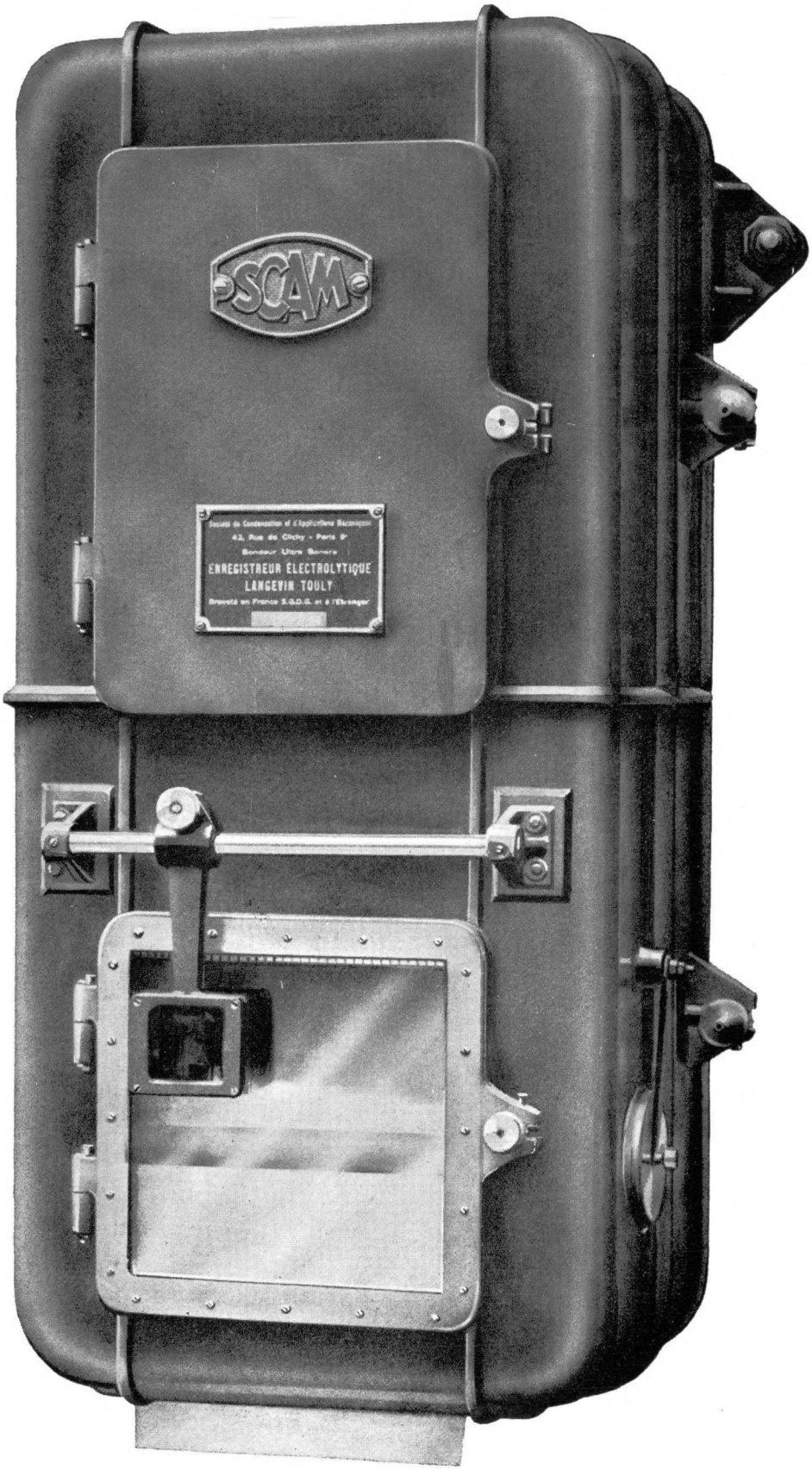

PLANCHE III.

PLATE III.

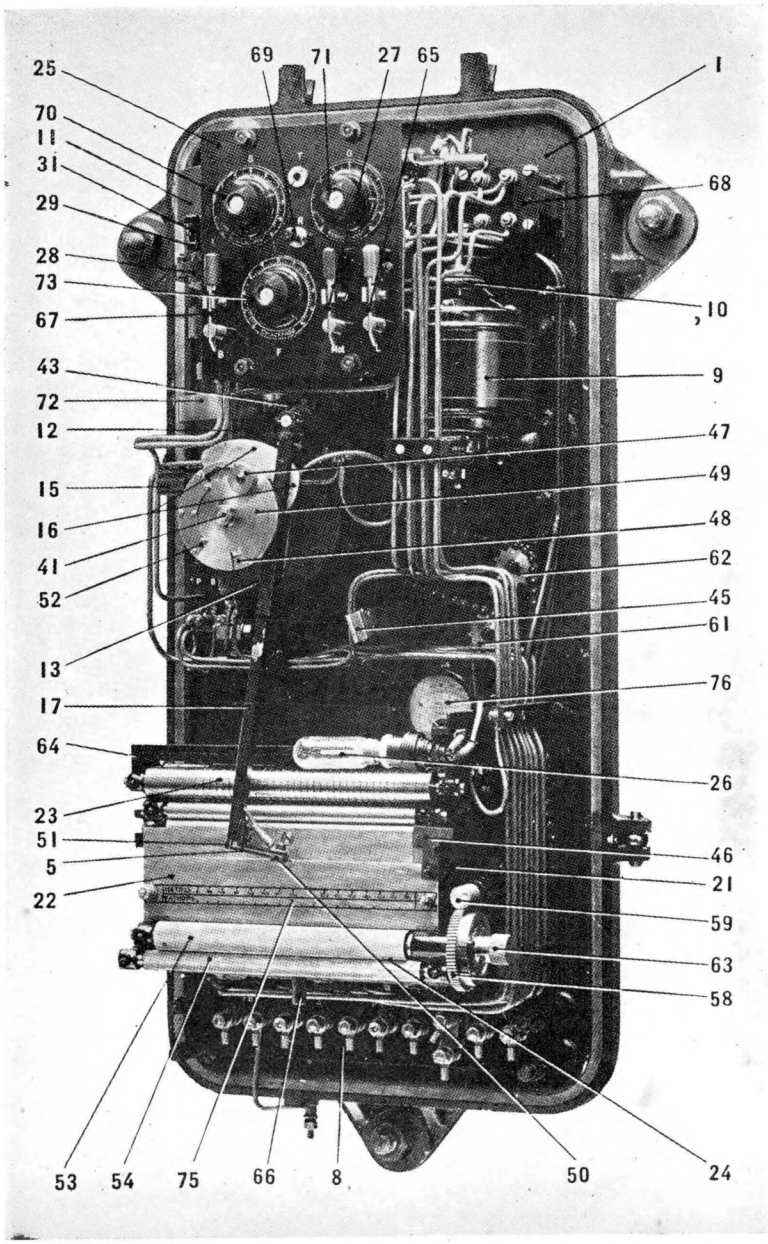

Planche IV

Plate IV.

Enregistreur électrolytique S.C.A.M.

S.C.A.M. Electrolytic Recorder.

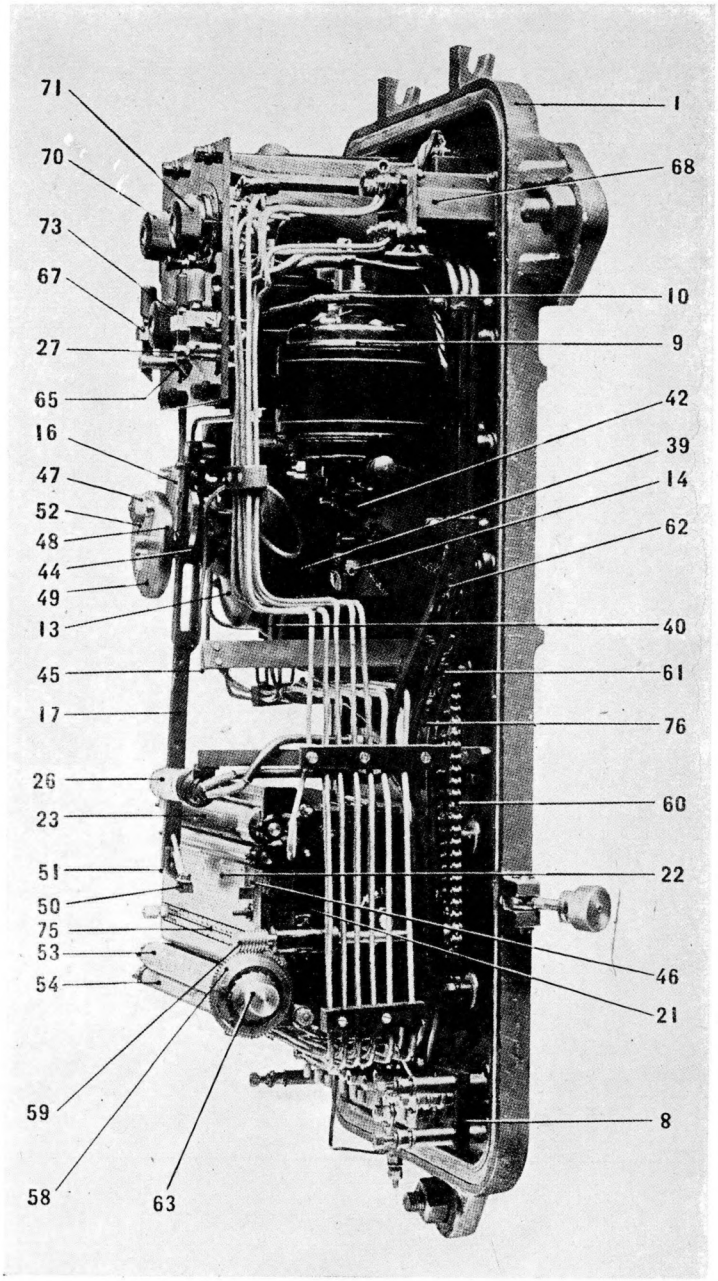

Planche V

Plate V.

Enregistreur électrolytique S.C.A.M.

S.C.A.M. Electrolytic Recorder.

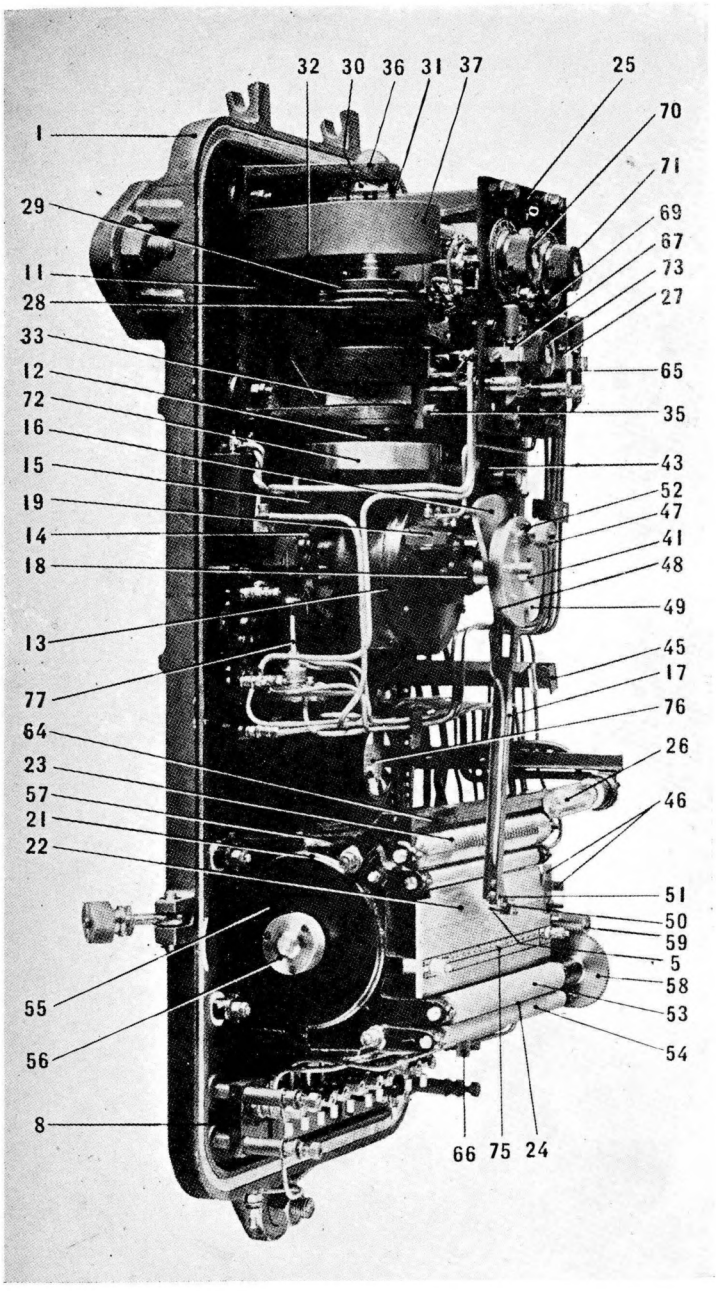

PLANCHE VI

PLATE VI.

Enregistreur électrolytic S.C.A.M.

S.C.A.M. Electrolytic Recorder.

The accelerating grid of the penthode must be connected to the + 80 v.
For more complete details see Pamphlet US 136-2 published by the S.C.A.M.

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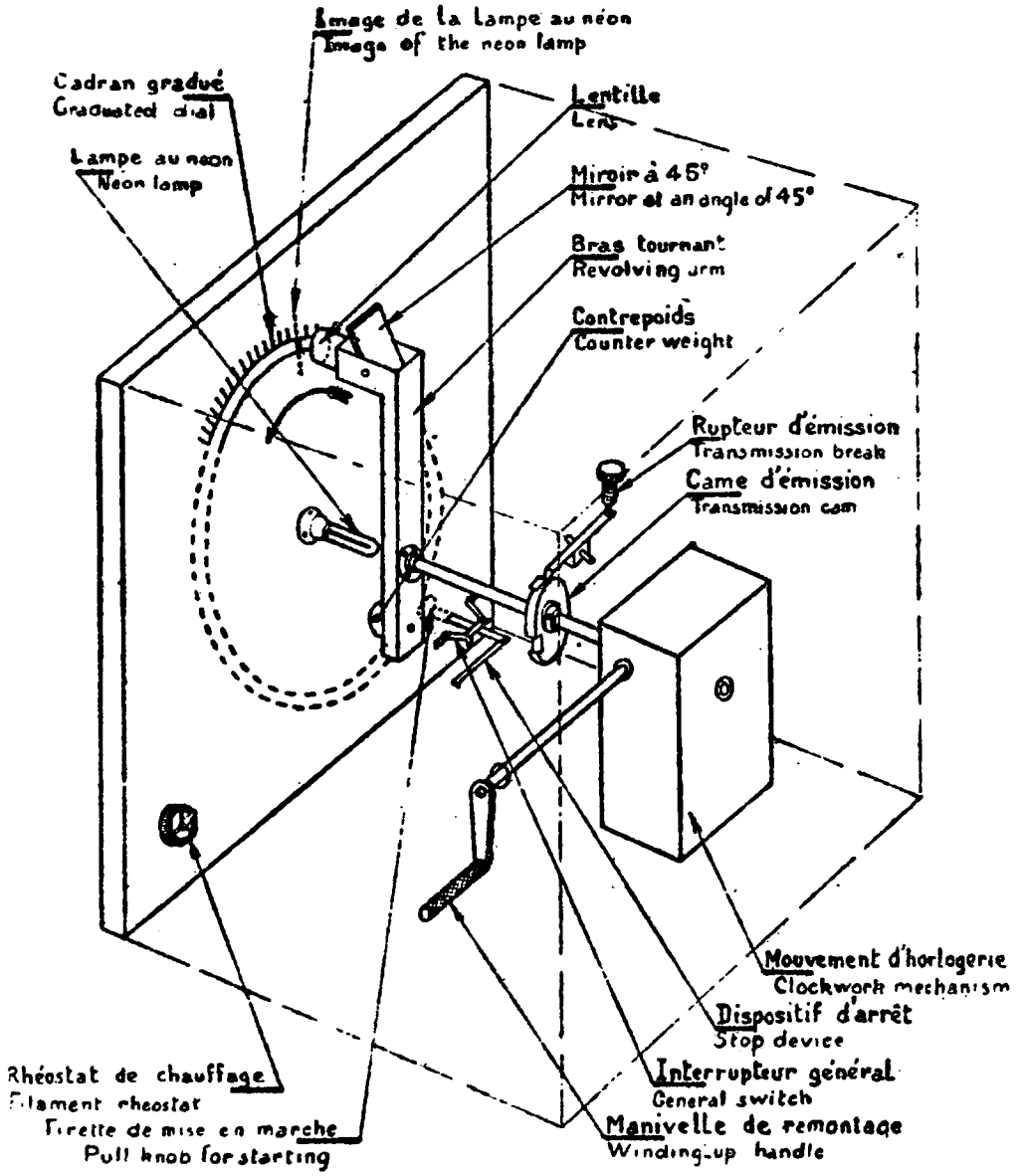
a) *SCAM-TOULY INDICATOR — "NAVIGATION" MODEL :*
(See *Hydrographic Review* Vol. XI N° 2, p. 48 &
Vol. XIII N° 2, pp. 110-113).

(See fig. *Hydrographic Review.* Vol. XIII. N° 2. facing p. 113).



Indicateur SCAM Touly
SCAM_Touly Indicator.

FIG. 1

In this apparatus a constant speed rotating shaft carries the transmission cam and a rotating arm with 45° mirror and converging lens.

In the prolongation of the axis, in the centre of and behind the dial, is fitted a rectilinear electrode neon lamp, a true image of which is formed within the plane of the dial by the mirror and the lens carried by the rotating arm. When the lamp is lighted this true image which is produced in a transparent space of the dial arranged between the two graduations (metres and fathoms), has the appearance of a luminous radial dash.

The Indicator being in operation, each impulse corresponding to the transmission induces the lighting-up of the lamp, whence the appearance of a luminous red dash at the origin of the graduation. The echo impulse following immediately afterwards (at the end of the time interval, t proportional to the depth sounded) produces a second luminous line, the angular divergency of which from that relating to the transmission, measures the depth. As the speed of rotation of the shaft is constant and known, and as the dial is divided directly in depths, the observer reads the depth sounded opposite the luminous stroke representing the echo.

SPEED OF ROTATION AND GRADUATION OF THE INDICATOR :

The speed of rotation is 1.875 revolutions per second (or 15 revolutions in 8 seconds) corresponding to 400 metres (or 219 fathoms) range for a complete revolution on the dial. The connection between the amplifier and the oscillating circuit connected to the projector being absolutely uninterrupted, even during transmission, the dial presents no "dead" reading space. As a result the announcement of an echo corresponding to a depth between 400 and 800 metres, occurs, for a given transmission, during the period of a second revolution on the dial by the optical system, and so on. The Indicator therefore enables depths to be read down to the "limit of visible reception of the echo", corresponding to the type of projector used and to the adjustment of sensitivity of the receiver. A push-button switch, placed below and to left of the dial frame enables the transmission to be suppressed by the pressure of a finger, which facilitates the reading of soundings greater than 400 metres.

CORRECTION OF SOUNDINGS :

In certain special cases such as soundings in fresh or only slightly saline waters, very cold or very warm waters, and for very accurate hydrographic or oceanographic soundings, it is advantageous either to correct the indications of the sounding machine (the Indicator of which is regulated in advance for a velocity of sound of 1500 metres/sec.) by means of a table of the velocities of sound in the different oceans, or to modify the speed of the Indicator in proportion to the true velocity of sound within the zone of operations and thereafter to read the exact depths directly on the dial.

CONSTANT SPEED DEVICE :

In the new models the shaft carrying the arm and transmission cam is put into constant speed rotation by a string clockwork movement with centrifugal regulator.

This movement, which is easily regulated to the speed of 15 revolutions every 8 seconds by means of a screwdriver and the friction brake of the regulator, assures at each rewinding (by means of the lever situated to the right) continuous functioning of the Indicator at constant velocity for about ten minutes.

The speed once regulated remains constant for several weeks on end without adjustment of the regulator brake. Speed value should be verified about twice a month (by means of an ordinary watch with second hand) and, if necessary, the adjustment of the regulator seen to. The rod with split head governing the regulator brake crosses the upright plate supporting the clockwork movement, a little below the principal shaft. An adjacent set-screw fixes the brake in the position selected.

STARTING AND STOPPING THE SOUNDING MACHINE (Pull Knob situated to left and below the frame) :

The Pull Knob pushed home frees the rotating arm and shuts the general breaking-device of the sounder (Low Tension and High Tension Batteries). This simple manipulation, accomplished after rewinding the clockwork movement, puts the sounding machine in operation.

The machine is stopped by a pull on the handle (which immobilises the clockwork movement and opens the interrupter).

FORMS OF THE LUMINOUS LINE ON THE DIAL :

The width of the luminous transmission and echo line varies with the duration of the transmission and echo phenomena, at the exit of the amplifier.

a). *When the sea-bottom is plane, or only slightly sloped,* the duration of the reflected wave-train (echo) is equal to that of the incident wave-train (transmission). A plane or slightly sloping bottom therefore appears on the frame as a single narrow echo line.

b). *When the bottom is sloping but uniform* the reflected wave-train is "spread out in time" and the echo, while being less intense, all other things being equal, has a longer duration than that of the transmission ; the luminous echo line is wider and less luminous.

c). *When the bottom is sloping and irregular,* the reflected wave-train is prolonged and presents maximums of intensity corresponding to the horizontal planes tangent to the "hollows" and to the irregularities of the sea-bottom. Such a bottom is represented on the dial by a broad echo, streaked with more luminous dashes.

d). When the bottom configuration is remarkably irregular : submarine cliffs, wreck, etc..., the principal horizontal planes of the bottom irregularity produce separate echoes, and consequently multiple echo-dashes appear on the dial. The spacing of the dashes indicates the vertical distance relating to the principal planes of the bottom irregularity.

e). Where sea-bottom shows a thick bed of ooze (in harbours, river-mouths, etc...) two echoes are often observed, one coming from the surface of the ooze and the other from the hard bottom underneath. The thickness of the bed of ooze may thus be determined by the sounding machine. .

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b) *SCAM-TOULY INDICATOR — "COASTAL" MODEL :*

See *Hydrographic Review,* Vol. XI N° 2, p. 48.
Vol. XIII N° 2, pp. 110-113.

ROTATION SPEED AND GRADUATION OF THE INDICATOR :

In this model the correct rotation speed is also 1.875 revolutions per second (or 15 revolutions in 8 seconds), corresponding to a "time interval" of 1/5th second for the Working range 0-150 metres (or 0-82 fathoms) of the dial.

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c) *ELECTROLYTIC RECORDER : LANGEVIN-TOULY SYSTEM (License Marti) :*

See : *Hydrographic Review,* Vol. XIII N° 2, Nov. 1936, p. 110.

The LANGEVIN-TOULY electrolytic recorder is the part of the ultra-sonic sounding machine which releases the transmissions at equidistant time intervals and records them with their respective echoes transversally on a band of paper graduated directly in depths, the successive sounding records on the band constituting the curve of sea-bottom under the moving ship.

The following are a few additional details concerning the construction of this recorder (numbering refers to figures on plates III to VI accompanying this article).

ELECTRIC MOTOR (9) :

This motor, with vertical axis, is fixed to the socket by means of anti-vibration india-rubber washers. It is directly connected to the feed terminals by means of the starting and stopping switch N° 27.

SPEED REGULATOR (11) :

A friction regulator is used in which the bearing pressure of the driven plate upon the driving plate is adjusted by means of a centrifugal device.

The driving plate 28 (pulley), mounted on ball bearings, is connected to the motor by the leather strap 10 ; it revolves freely about axis 12 at a speed which may be variable (this speed follows the fluctuations of voltage in the mains) but which must be greater than the speed of the driven plate 29 by some hundreds of revolutions per minute.

The latter plate may slide a little along axis 12 with which, in rotation, it forms one. The adjusted axis 12 is fitted with fly-wheel 72. Plate 29 is connected to a collar 30, carried by the axis, by means of three spring-blades 31 each carrying, in its centre, a dead-head 32. The initial bearing pressure (at "stop") of the driven on the driving plate (force which determines the constant speed of the driven axis) is obtained with the help of a milled collar with screw 33

which, by means of a sliding hub and ball bearings, enables the position of the driving plate 28 to be slightly altered in relation to the driven plate 29. This alteration causes a slight arched curving of the three spring-blades 31 and from this it follows that an initial known and adjustable bearing pressure of the two plates may be thus obtained.

The functioning is as follows: immediately the motor, *i. e.* the driving plate, is started, the driven plate which at this moment bears with initial force on the first, follows the movement without sliding. The driving speed becoming greater, the centrifugal force tends to drive the dead-heads (32) apart and it follows that the bearing pressure on the two plates is diminished. Sliding then occurs at contact level of the two plates and stable speed is established for the driven plate (*i. e.* axis) (12) at which the functioning of the recorder requires constant power taken by friction from the driving plate.

The amount of this constant speed, which is a function of the initial bearing pressure, that is to say of the longitudinal position, on the axis of the driving plate (pulley) is adjustable by means of the milled flange (33).

The adjustment being carried out, the milled collar is blocked by means of a jaw contact and set-screw (35) which prevents rotation of the collar.

SPEED ADJUSTMENT — CORRECTIONS IN TERMS OF THE VELOCITY OF SOUND:

The speed of the machine should be regulated to obtain exactly *one* sounding *every three seconds*, at any rate in the case of sea-water for which the velocity of sound is 1500 metres/sec.

The adjustment is made by successive readjustments of the milled collar of the regulator and observation, for each adjustment, of the number of records produced during a fairly long time, say one minute.

When the instrument is in service, the speed adjustment should be verified almost every week.

TRANSMISSION INTERRUPTER (15):

The slow-speed axis (41) (1 revolution every three seconds) carries, situated towards the back, the transmission cam (14). The latter raises the lower blade of the transmission interrupter (15) and thus enables the upper blade (with tungsten contact-stud) to rise by its own elasticity, its tungsten stud then bearing on the corresponding contact-stud of the fixed screw of the interrupter device, this operation closing the primary circuit of the transmitter induction coil (preparation for transmission). The cam, continuing its rotation, frees the lower blade which, falling back into place, strikes the upper blade and breaks the contact (transmission).

CORRECTION FOR DRAUGHT (IMMERSION) OF PROJECTOR:

The group formed by the blades and the screw of the interrupter (15) is carried by a part which slides laterally and which, by means of an antagonistic spring, bears on an adjustment screw (42). The last-mentioned enables the phasing of the transmission to be modified at will in relation to the movement of the stylus on the band, and it follows that the initial position of the transmission stain may be adjusted to the depth corresponding to the known draught (immersion) of the projector on board ship (automatic correction for the immersion of the projector, enabling the depths to be recorded on the band from the surface downwards). This adjustment having been carried out, tighten the lock-nut of this screw.

INSULATION INTERRUPTER OF THE STYLUS:

Towards the fore-part, the slow axis carries, against the gear-box, cam (18) of the insulation interrupter of the stylus 19. This interrupter, in series with the stylus and the paper in the receiving circuit, breaks this circuit during the return movements of the stylus to zero, in order to avoid recording a "return dash" on the band.

RECORDER CAM AND ARM:

At its fore end the slow axis carries the recorder cam (16) and the device for changing the scale (52). This recorder cam and arm (the latter fitted with spiral spring (43) for bringing the arm to bear on the cam) are combined so that the constant speed rotation movement may be transformed into an alternative movement of the arm at known speed of the stylus on the paper during the travel from left to right (working record travel) then a rapid return of the stylus towards the left.

A stop with spring-catch (45) is situated on the right. This is for use during the "rest" periods of the recorder and each time that any manipulation whatever has been carried out affecting the paper band.

CHANGE OF SCALE DEVICE (52) :

The working range of sounding on the band is 300 metres (about 164 fathoms). So as to be able to use the recorder in greater depths, when the echoes are perceptible (this depends on the type of projector used, calibration of the transmitter-receiver, state of the sea, configuration and nature of sea-bottom, etc...) the recorder cam may be set back in relation to the transmission cam by angles corresponding to successive multiples of 300 metres.

When the depth-line reaches 300 metres, in increasing depths, to continue the records it is sufficient to proceed as follows :

Stop the recorder and secure the recorder arm in spring-catch (45). Unscrew as required the conical milled nut (47) which stops the cam (situated on disk (48) of the slow axis). Rotate the cam (which is one with disk (48)) on its axis (41) until the indication 300/600 appears opposite the window of the fore disk (49) and screw home the "stop" nut (47) of the cam. Bring back the contact arm of the cam and restart the recorder. To read depths recorded in those conditions it is naturally necessary to add 300 metres to the value read on the band (or, in fathoms, the 164 fathoms of the first scale, to the number of fathoms indicated).

A similar procedure is followed for the succeeding scales (600/900 metres, etc...) when necessary.

PAPER CONTAINER AND CONNECTED PARTS (21) :

The paper container, in cast metal, constitutes the semi-watertight vessel which contains the reserve-roll (20) of moist chemical paper ; it supports the recorder tablet (22) and scale-marking cylinders (23) and driving cylinders (53) and (54) of the band. On its left surface the box carries the opening for placing the paper supply (55), closed by a circular door with central milled screw (56). The paper leaves the box by means of a cover, (57), with felt-protected edges, situated towards the upper part ; the paper band then comes in contact with the inscription tablet (22) (metal disk parallel to the plane described by the arm constituting the cathode, in contact with the receiving circuit), then passes under driving cylinder (53) against which it is brought to bear by a roller with push-spring (54). The driving cylinder is led by pinion 58 and a tangent screw (59), the last-mentioned being actuated by the slow axis of the cams by means of an endless chain (60) carried by the ratchet wheels (61) and (62), this chain being adjustable. The driving cylinder (53) carries, to the right, a milled head (63) with pawl which, operated by hand, enables the paper to be quickly unrolled, or rolled. This is useful when a new roll of paper is being put in place and also, in normal service, for making a suitable length of moist paper leave the box instantaneously at the moment the recorder is started, after a period of "stop" (paper exposed to the air dries up and consequently loses its sensitivity).

The scale marking cylinder (23) is carried by a swinging insulated cap (64). By its weight it bears upon the paper and, constituting the anode of a special circuit with continuous current adjusted by the potentiometer (71), marks electrolytically the graduation dashes every 10 metres on the moist paper. In this way any sounding error due to expansion or contraction of a band graduated in advance, is avoided.

A graduated ruler (75), adjustable transversally, facilitates reading on the band.

During the "rest" periods of the recorder, cylinder (23) must be swung backwards so as to avoid its contact with the band of paper.

In front of and above the recorder tablet is situated an illuminating lamp (26), masked under the recorder hood, which illumines the band and enables soundings to be read at night. This lamp is controlled by the switch (65).

MANUSCRIPT INSCRIPTIONS ON THE BAND :

The band of chemical paper being moist, any interesting information it is desired to preserve (time, position, remarks, etc...) may be inscribed on it during its travel across the recorder tablet by using a "copying" lead-pencil. It is convenient to keep such a pencil near the recorder for the use of observers.

PANEL OF ELECTRIC CONTROLS (25) *AND CIRCUITS OF THE RECORDER :*

On the upper panel are the three starting and stopping switches of the recorder, the calibration potentiometers, the sensitivity rheostat, the time marking button and a telephone jack.

Switch (67) controls the circuits fed by the low tension battery of the sounding machine : transmission circuit, amplifier heating circuit, circuits of the stylus potentiometer and of the potentiometer of the scale marking cylinder. The manipulation of this switch actuates the starting

and stopping of the sounding machine proper. Switch (27) controls the motor. Switch (65) controls the illuminating lamp. Opening those three switches causes complete stoppage of the recorder and the sounding machine.

The object of *stylus potentiometer* (70) is to keep the stylus constantly at a weak positive potential adjustable in relation to the paper (current supplied by low tension battery), so that the arc described by the stylus on the paper may be marked by a continuous and feebly-coloured *foundation stroke*. This enables the correspondence of the echoes and of the transmissions which have given rise to them respectively to be better followed. By manipulating potentiometer (70), this track left by the stylus is rendered more or less apparent at will. When the potentiometer is adjusted near zero, the foundation stroke is suppressed.

The *potentiometer of the scale marking cylinder* (71) enables the intensity of coloration of the graduation lines on the band to be adjusted as may be desired.

The *time marking button* (69) enables soundings and foundation lines to be suppressed so long as one presses on it. This gives the user the possibility of making a conventional sign on the band, in default of inscription.

RHEOSTAT FOR ADJUSTMENT OF SENSITIVITY (73):

This element is in reality the amplifier heating rheostat contained in the transmitter-receiver. By manipulating it during operations the sensitivity of reception, that is to say, the intensity of coloration of the electrolytical records, may be varied as desired.

In very shallow water: it is useful to diminish the sensitivity (rotation anticlockwise of the button of rheostat (73)) to bring it to the exact value necessary for the inscription of the echo. Indeed the *reduction of sensitivity causes shortening of the transmission track*, whence the possibility of sounding in shallower waters.

As soon as depths of about 10 metres (below the projector) are exceeded, the sensitivity may be left adjusted at its maximum; there is no necessity to readjust it until the highest echo-ranges are reached.

RECORDER OF THE "ACCUMULATOR" TYPE:

This instrument differs internally from the "mains" type only by the substitution for the continuous current 110- volt motor of a d. c. 7 volt motor (to function on the 8 volt battery of the sounding machine) and the addition of an antiparasitic filter.

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d) *MARCONI ECHOMETER — TYPE* 421* (Plates VII & VIII)

The MARCONI piezo electric sounding devices work on the LANGEVIN-CHILOWSKY system and are similar in principle, but not in all details, to those made by the Société de Condensation et d'Applications Mécaniques.

The ultra sonic echometer type 421* includes an ultra sonic piezo-electric projector fitted in the hull plating of the ship together with the usual transmitting and amplifying units.

For indicating the depth either or both of the following may be fitted:

(*a*) An Oscillographic Indicator, which indicates the depth by a "peak" of light on a scale.
(*b*) An Electrolytic Recorder which records each sounding on sensitised paper.

The oscillographic indicator is particularly useful when a quick sounding is required, as it can be brought into use instantaneously, whereas it takes about a minute to pull paper through the recorder and get it into use, if it has not been in use for some time previously.

With the indicator, the oscillograph mirror works when it receives the echo impulse, and causes the light spot to "peak" at the point on the scale where it is at that instant, thus indicating the depth of water.

The amplifier is joined across the projector the whole time, and thus receives two impulses, one at transmission and another at the reception of the echo. Thus, two marks on the recorder or "peaks" on the indicator are made for each sounding, one for transmission and one for the echo.

In the case of the stylus, the current from the amplifier discolours the paper at the point where the stylus is at that instant. That is, a mark is made on the paper corresponding to the depth of water.

The sequence of operations is repeated:

30 times per minute when recorder Type 429 is in use; (recorder with two scales, usually 0-75 and -150 fathoms);

60 times in 70 seconds when indicator is in use. (Type 421, 160 fathom, 360, or 720 fathom instruments).

In the case of the indicator, a great deal of information can be obtained by watching the shape of the echo peak. When working under normal conditions the echo peak is usually about one-third of an inch high. Its left-hand is practically vertical, its right-hand edge sloping down steeply, as indicated in Fig. 2*a*.

The echo peak will only assume this form when the sea bed is firm and reasonably smooth, being free from rocks and large boulders.

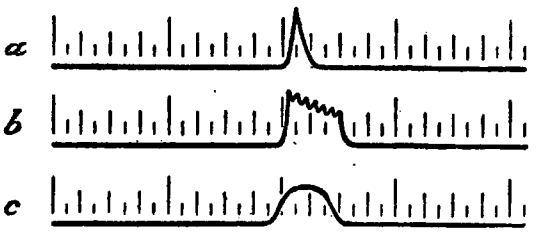

FIG. 2.

a) *Shape of normal echo peak.*
b) *Echo peak over boulders and rocks.*
c) *Echo peak over very soft mud.*

If the sea bed is covered with rocks and boulders the echo peak takes a distinctive form which can be recognised very easily. Its left-hand edge is practically vertical, but instead of its right-hand edge sloping down sharply it comes down slowly in a sort of saw edge, as shown in Fig. 2*b*. This difference is very clear and well marked and can be noticed at a glance.

Further information can be obtained by watching the peak more carefully. If it is wider at the base than usual, but otherwise normal, it indicates a very soft bottom; ooze or soft mud as shown in Fig. 2*c*.

If the bottom is shelving very rapidly, the echo peak appears its normal shape, but smaller. That is to say, the amplification has to be increased to bring the peak up to its normal size.

If the indicator is required, set switch at right-hand side of recorder to "Visual", see that clockwork is wound up and pull out the starting knob at right-hand side of the instrument.

The spot light should run across the scale from left to right; its height can be adjusted by the knob marked "Spot".

There are two adjustments for the sensitivity of the receiver:
H. T. Control at left-hand side of the indicator.
Peak Control at centre of bottom section.
Always read the left-hand side of the echo peak.

IF THE RECORDER IS REQUIRED:

Wind round the knurled knob at the bottom right-hand side, so that paper is pulled across the inscribing plate until damp paper is in the path of stylus.

Put switch to "Recorder". This starts the motor; see that paper starts to feed through correctly and without creases. If graduation marks are required, see that the graduation roller is resting on the paper, and adjust the knob of the graduations rheostat until marks of the required intensity are obtained.

Release the stylus from its clip; the cam will start to drive it across the paper.

Transmission marks will start to appear at the left-hand side of the paper. Adjust the knob marked "Stylus" between 5 and 10 until the stylus draws a faint mark across the paper at each passage. The higher the setting the greater will be the sensitivity.

The adjustments of H. T. Control and Peak Control, according to the depth of water to be sounded, are the same as described for the indicator.

Once a minute the stylus draws a darker line across the paper to mark the minutes. This is done by the toothed wheel beside the arm making a contact once per revolution. The

darkness of the minute lines is controlled by the stylus rheostat, which should not be set below 5.

An electrolytic pencil on the end of a flexible lead is supplied for writing notes, such as times, fixes, etc., on the record paper.

To stop the recorder, it is merely necessary to put the switch at right-hand side to "Off", and to clip back the stylus arm.

When paper is taken off to be preserved as a record, it must be allowed to dry before it is rolled. Do not hang it up in a wet atmosphere. The paper will fade seriously if rolled wet.

When really dry the record should be either rolled and put in one of the special tins or folded and put in a cover such as can be made from old charts and kept in a dry drawer.

DRAUGHT ADJUSTMENT.

In order that the sounding read off may be the depth of water from the surface and not from the projector in the bottom of the ship, the transmission should occur not at zero on the scale but at the figure corresponding to ship's draught at the projector.

In the Indicator. — This is done by a slot marked "Draught". This slot should be turned by a coin or screwdriver until the left-hand edge of the transmission peak occurs at graduation on the scale representing the draught of ship.

In the Recorder. — There are two pairs of sounding contacts, one pair for each range. If the recorder is a single range instrument the bottom pair of contacts is in use.

The start (left-hand side) of the transmission mark should be shifted from the zero on the scale by the amount of the draught. The position of the contacts (and thus that of the transmission) is governed by two knurled headed screws with lock nuts, which hold the contact assembly in place. The draught adjustment can be changed by slacking one screw and tightening the other. To increase the draught adjustment the contact assembly should be moved round in a clockwise direction — the same direction as that in which the cam revolves.

TO CHANGE RANGES IN A TWO RANGE RECORDER.

The stylus arm should first be clipped back in its holder. The head should then be pulled out or pushed back as directed in the instructions engraved on the head. This changes the stylus drive cam and the sounding contacts in use. Thus in a 2-range instrument, two draught adjustments must be made, one on each pair of contacts, each adjustment to its appropriate scale.

SPEED.

The speed of the spot light in indicator, or stylus arm in recorder, is of paramount importance, as the accuracy of either instrument depends directly on this.

The speed of all MARCONI Sounding Machines is adjusted for a velocity of sound of 1,500 metres/second (4,920 feet/second).

In the Indicator. — The spot light is moved by a mirror actuated by a steel wire drive from a clockwork mechanism.

In 160 fathom and 360 fathom sets the instrument should give 60 ticks in 70 seconds — in 720 fathom sets, 30 ticks in 70 seconds. The clockwork can be seen when the top cover of the indicator is removed. The speed adjustment consists of a knurled head with lock nut; arrows show the direction of movement required for an increase or decrease of speed.

In the Recorder. — The stylus is driven through gearing and a suitable cam by an electric motor. The number of transmissions per minute is 30. A stroboscope is fitted to check the motor speed. At the top of the motor spindle is a stroboscope wheel with black and white vertical marks. The wheel is normally still and not joined to the spindle. To test speed, clutch the wheel to the spindle by working the lever at the right-hand side.

In front of the wheel is a tuning fork; displace this and let it go. Look at the wheel through the tuning fork. If the speed is correct the black and white marks will appear to stand still. If they seem to go to the right the motor is going too slow and vice versa.

To change the motor speed, the governor must be adjusted. There is a large knurled nut above the gear box and below the governor. To adjust, remove the clamping piece which holds the nut and screw it upwards (to the right-viewed from the front) to increase motor speed and vice versa.

Do not let any oil come near the governor surfaces.

The rheostat in the centre of the panel marked "Speed" is permanently locked. It is a shop adjustment for different motors. The speed should, therefore, always be corrected by the governor adjustment as described above.

PRESSURE OF STYLUS.

This is adjusted before fitting, and should not require much alteration. In general, the pressure should be as great as possible, consistent with not tearing the paper.

At the bottom of the arm is a small screw with a lock nut. Unlock the lock nut and adjust pressure carefully with a screwdriver. Lock lock nut when adjustment is completed.

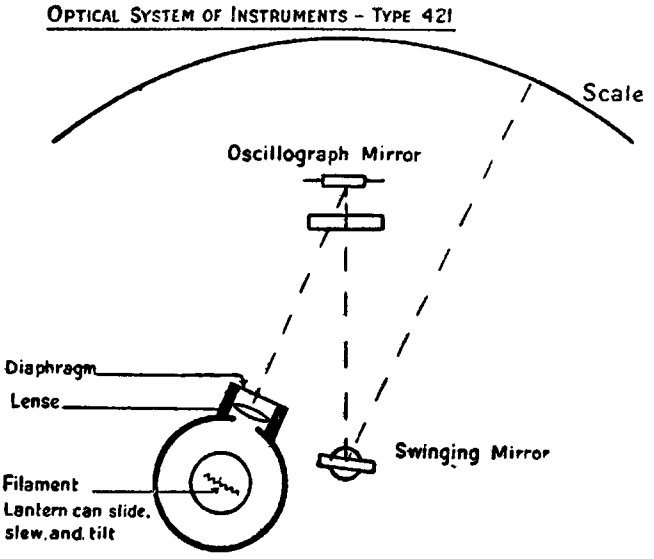

FIG. 3.
Optical System of Instruments MARCONI *Type* 421

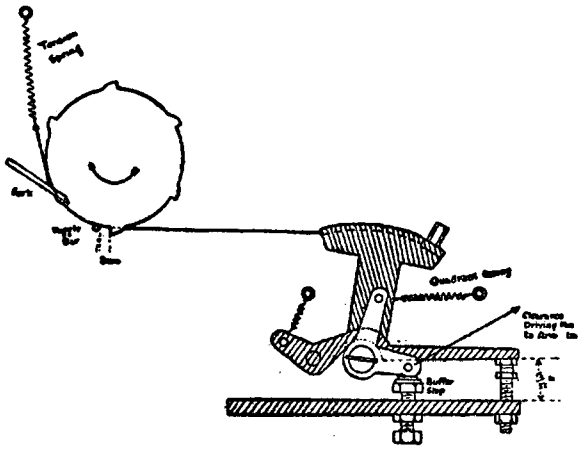

FIG. 4.
Steel Wire Transmission System.

PRECAUTIONS WITH ELECTROLYTIC PAPER.

When the paper is impregnated with starch and iodine slight traces of mercuric chloride may be left. This latter substance is poisonous and, although it is not present in sufficient quantities to do any serious harm, it is advisable, after fingering the paper, not to touch the eyes or mouth before washing.

NEW RECORDER TYPE 439. (Plate IX)

This Recorder is exactly like type 429 in external appearance but has a number of improvements. These are listed below and in each case the resulting difference in method of operation is pointed out.

1. An electrical governor (CREED type) is fitted in lieu of the mechanical clutch type governor. Speed: the operation of the stroboscope is different. When the reed is displaced and the pointed wheel is observed through the reed, a diamond-shaped object will be seen. This should remain stationary if speed is correct. If it goes to the left, speed is fast, and vice versa.

Adjustment of the CREED governor should not be necessary, but if speed is incorrect the regulating resistance on the panel may be changed. Turn clockwise to raise speed.

2. The cam shaft revolves at 90 revs./minute and the machine takes 90 soundings per minute.

3. There is only one cam fixed rigidly to the cam shaft. The scale of this cam is 75 fathoms. Owing to its shape and speed it is difficult to put the stylus arm on the moving cam without a jar. The stylus arm should therefore always be left in contact with the cam except when reeving more paper. A hook is provided to catch the stylus arm aside when this is being done.

4. Two scales are provided, one 0-75 fathoms as stated above, and one 70-145 fathoms by having an extra sounding contact set to transmit an appropriate interval before the arm starts. Other scales can be supplied on request.

A switch on the panel selects whichever range is required.

The Draught Adjustment is now different. Since the phasing system described above depends on the two sounding contacts being set an exact amount apart, these cannot be moved for draught adjustment. The scale and graduation roller must be moved so that the left hand side of the transmission mark is in line with the draught of the ship.

It will be noticed that there are three Contacts disposed radially about the cam shaft. Sounding Contact 0-75 is Red. Sounding Contact 70-145 is Blue. The Yellow Contact breaks the stylus circuit during its return stroke.

5. The paper drive is by Bowden wire from the gear box. Speed is about 1 cm. per minute. This gives a life of about 60 hours for a standard roll.

6. Every one-third minute the stylus draws an arc of 2 ½ fathoms graduation dots across the paper.

This time interval was one minute in 30 soundings per minute Recorders.

7. Where a Recorder is fitted with no optical indicator, the H. T. control is contained in a separate box, conveniently placed; not on the Recorder panel.

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e) *MARCONI ECHOMETER - TYPE* 424* (Plate VIII)

This apparatus consists of a piezo-electric ultra sonic projector fitted in the ship's hull plating, of a spark transmitter and amplifer together with a system for indicating the depth.

This is a more compact and cheaper instrument than the type 421*. Its principle is exactly the same. Both type 421* and type 424* are driven by clockwork and since the power required is very small, a 100 ampere-hour 4 - volt battery and dry H. T. battery are sufficient power supply, and electric power in the ship is not necessary to work the sounder. This is very convenient in fishing and other small craft.

As the light spot is moving across the scale at a speed proportional to that of sound in sea water, the two "peaks", caused by the oscillograph, will occur on the scale, one at zero and one at the true depth of water.

The set (45,90 or 110 fathom types) transmits 45 times per minute.

TO WORK THE SET.

Set the battery switch to "Discharge". Wind the clockwork by the handle at the middle of the Echometer. Do not let it run down.

Set the starting switch at the right of the Echometer to "Shoal" for depths of 10 fathoms and under, and to "Deep" for other depths.

Adjust the shade plate so that the scale can be seen comfortably. The light spot should now be seen running across the scale.

The first (or transmission peak) should have its left hand edge in line with the graduation on the scale corresponding with the draught of the ship.

The left hand edge of the second (or echo peak) will indicate the true depth of water.

Two controls are fitted to vary the sensitivity of the amplifier and thus vary the size of the two peaks:

H. T. Control on the left side of the Echometer.

Peak Control on the left side of front of Echometer.

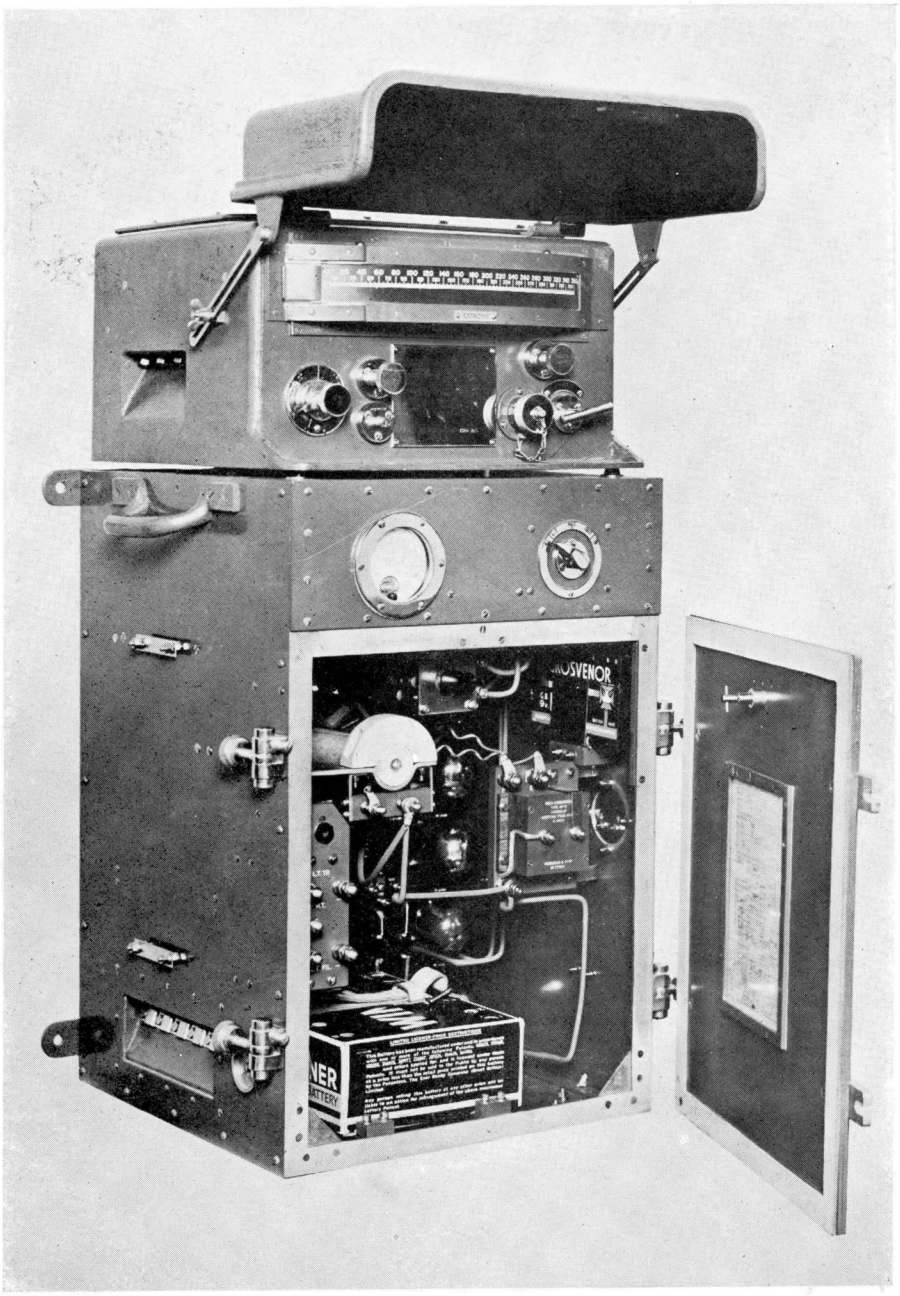


PLANCHE VII
PLATE VII

Echomètre MARCONI, *Type* 421* - *partie inférieure ouverte.*

MARCONI Echometer, Type 421* with bottom open.

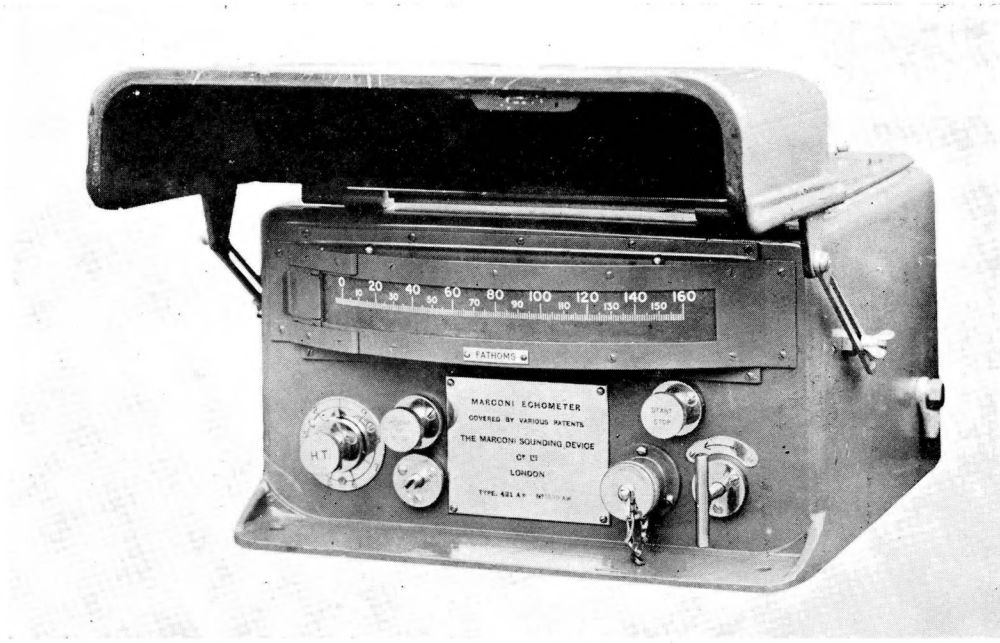
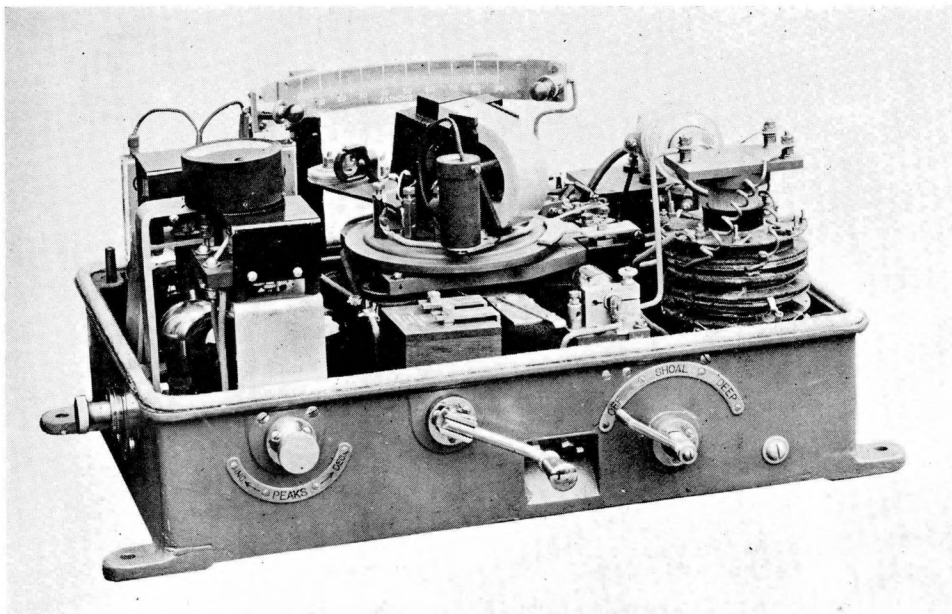


PLANCHE VIII
PLATE VIII

Echomètre MARCONI, *Type* 421* - *partie supérieure.*

MARCONI Echometer Type 421* Top section



Echomètre MARCONI, *Type* 424* - *couvercle enlevé.*

MARCONI Echometer Type 424* with cover removed.

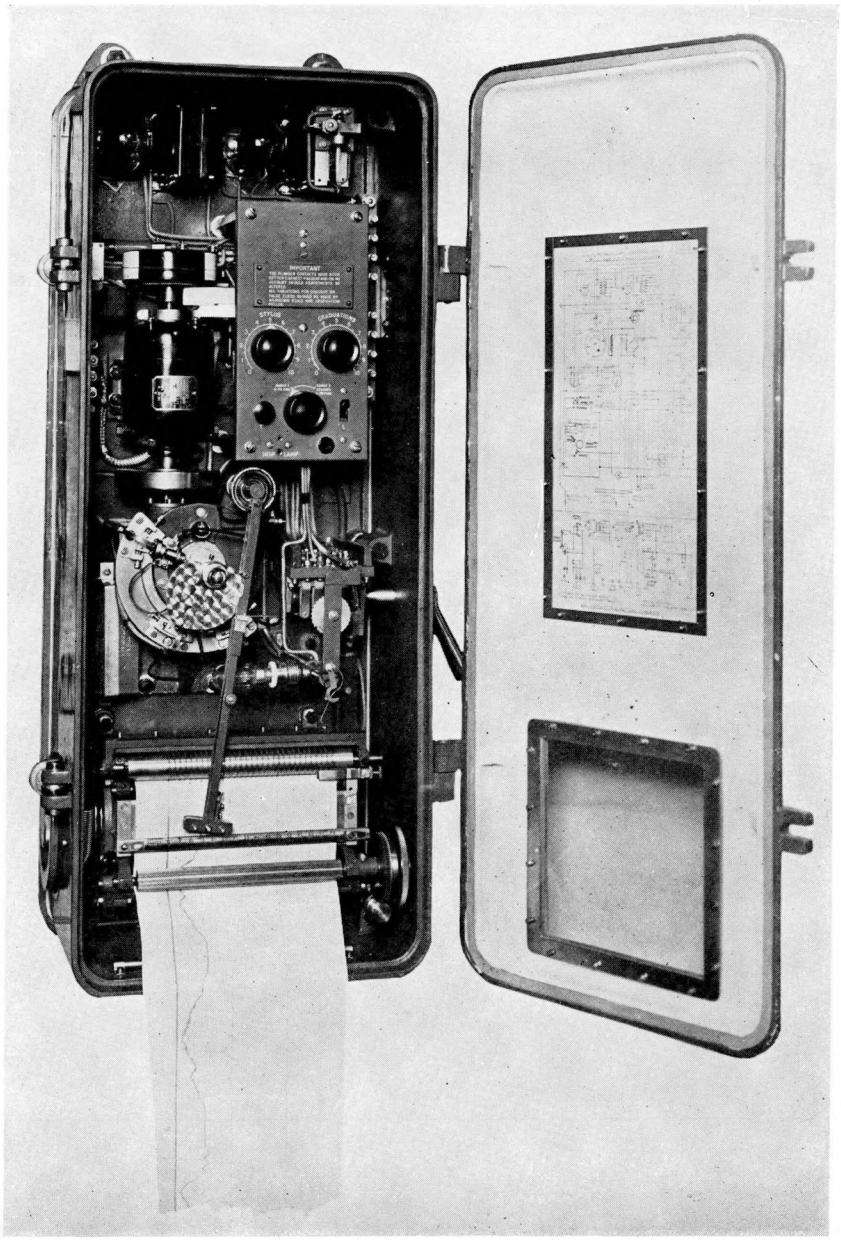


PLANCHE IX
PLATE IX.

Echomètre MARCONI
Nouvel enregistreur, Type 439.

MARCONI Echometer.
New Recorder Type 439.

SHALLOWS (*below* 10 *fathoms*).

It is neccessary to have a very small transmission peak, so that the echo peak (which will be very close to it) can be seen distinctly.

Put H. T. Control to full "Decrease". Work Peak Control from "Decrease" to "Increase" to get the setting for the most distinct echo peak.

If no echo peak appears raise H. T. Control a little towards "Increase" and work Peak Control again for the most distinct reading.

The best results for very shallow reading are obtained with the lowest possible H. T. Control setting.

When the starting is to "Shoal" only one of the four gaps is in circuit. The variable resistance near the gap is then in the spark coil circuit. It should be adjusted to the maximum value so that this gap just sparks at each transmission.

DEEPS (*above* 10 *fathoms*).

Set H. T. Control at maximum "Increase" and leave it there. Vary Peak Control for the most distinct echo reading.

The set should never be allowed to stop by the clockwork running down, as this leaves the circuits switched on with the set not working. The Echometer should always be left with the starting switch "off" when not in use.

SPEED OF MOTOR.

This should be 45 revs. per minute (that is 45 "ticks" of sounding contact each minute). There is a speed regulator arm on the side of the motor. To adjust, ease set screw and move to the right to increase speed, left for reducing speed. Re-clamp with set screw when adjusted.

The above applies to instruments with Scales 0-55 fms, 0-90 fms, 0-110 fms. In instruments with 0-45 fms. scales the clockwork speed is double, *i. e.* 90 revolutions or "ticks" per minute.

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f) *THE MARCONI (QUARTZ-STEEL) PORTABLE SHALLOW ECHO SOUNDER, ONE FOOT TO* 120 *FEET.* (Plates X to XIII b)

GENERAL DESCRIPTION.

This equipment has been developed in a portable form for giving demonstrations of shallow soundings in a small motor boat. The gear can be easily shifted from one launch to another. Such an equipment will be of great interest to Harbour and River Authorities who are anxious from time to time to check the depths in the various channels. Such depths may vary due to silting and may require to be checked after dredging.

In the case of channel surveys depths of 20 to 40 feet are those likely to be tested but in the case of rivers lower depths of the order of a few feet may require to be checked for navigational purposes with shallow draught river steamers.

The equipment has been designed in two essential components:

(*a*) The outboard projector scheme.
(*b*) The inboard echo sounder itself.

It is only necessary to erect a rough platform on the bow of a motor boat in order to instal the outboard projector scheme which is situated over the bow of the vessel. This outboard projector scheme can be swung inboard when not in use or when approaching a landing stage.

The echo sounder itself is completely housed and wired in a canvas covered framework and in order that it may be used immediately on any vessel the equipment is entirely battery operated.

Therefore this equipment is portable in the sense that it can be shipped to any part of a coast or to any part of a particular river and then immediately installed on any local motor boat in order to carry out a survey for a certain period.

The equipment is completely wired and adjusted for immediate action and consists of an electrolytic recorder which actually plots out the contour of the sea or river bottom in the form of a graph for record purposes.

A photograph, Plate X, is attached showing the total equipment installed on a small motor boat for trials on the Thames together with various photographs showing the outboard projector scheme (Plate XIII) and the apparatus inside the echo sounder itself.

Typical records obtained with this sounder in the Thames (Plates X to XI) are also attached and it will be observed on the graphs produced by the electrolytic recorder that the fathom graduation dots are automatically marked on the paper itself at intervals of every ten seconds so that the finished graph will give depths and times for future analysis.

This particular model has a range of one foot to 120 feet which means in effect that it can discriminate quite easily a depth of one foot under the projectors themselves or can discriminate to an accuracy of one foot in any depth within its range. Such discrimination is, in the first case, useful for shallow river surveys and in the second case, for checking the actual dredging operations.

For still further improved discrimination a recorder with a lower range of 0 - 10 fathoms with phasing arrangements for 10 - 20 fathoms can be supplied with scale divisions nearly double those shown in the photographs and a sketch, fig. 5, is attached giving the comparative scales between the 20 fathom instrument here described and the 10 fathom instrument just referred to.

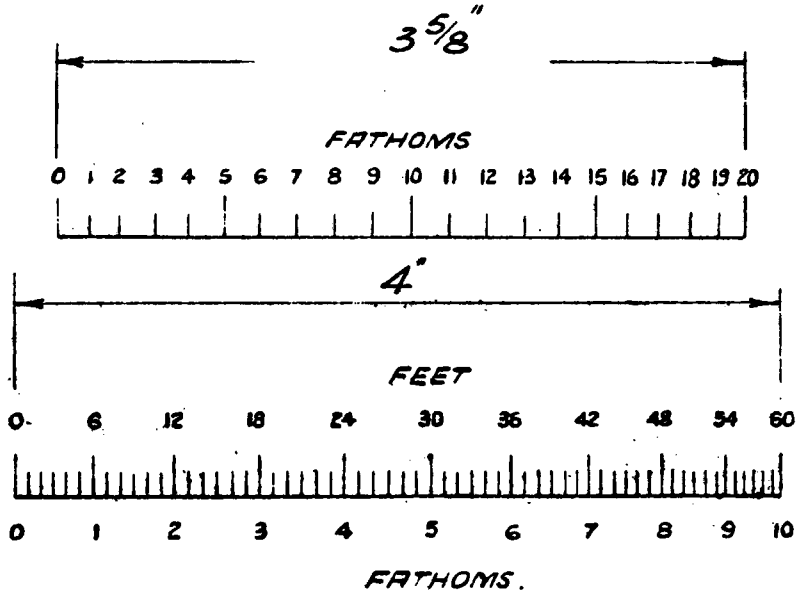

FIG. 5.

Comparative Scales of 20 Fathom and 10 Fathom Link Motion Recorders.

The number of soundings taken on this 20 fathom equipment is 187 per minute so that there are sufficient marks on the paper to accurately plot out the contour of the sea or river bed.

This portable battery operated shallow echo sounder is capable of continuous operation for fifteen hours without recharging the accumulators.

The paper is fed out from the recorder at the rate of 3.75 cms. per minute into which space are plotted the 187 soundings. (Plate XII)

Attention should be drawn to the very short duration marks made by transmissions and echoes in the photographs of records enclosed. Even at these high speeds of stylus movement where one fathom or six feet only represents 1/400 second, the echo mark at low controls for shallow working is of the order of 1/4000 second, thus giving a thin decided line of contour instead of a long smudge.

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g) *LANGEVIN-FLORISSON ULTRA-SONIC SOUNDING MACHINE WITH ECHOSCOPE.*

(See : *Hydrographic Review* Vol. X N° 2, Nov. 1933, p. 170
Vol. XI N° 2, Nov. 1934, p. 59.

This instrument is a LANGEVIN-FLORISSON ultra-sonic sounder for coastal and river surveying

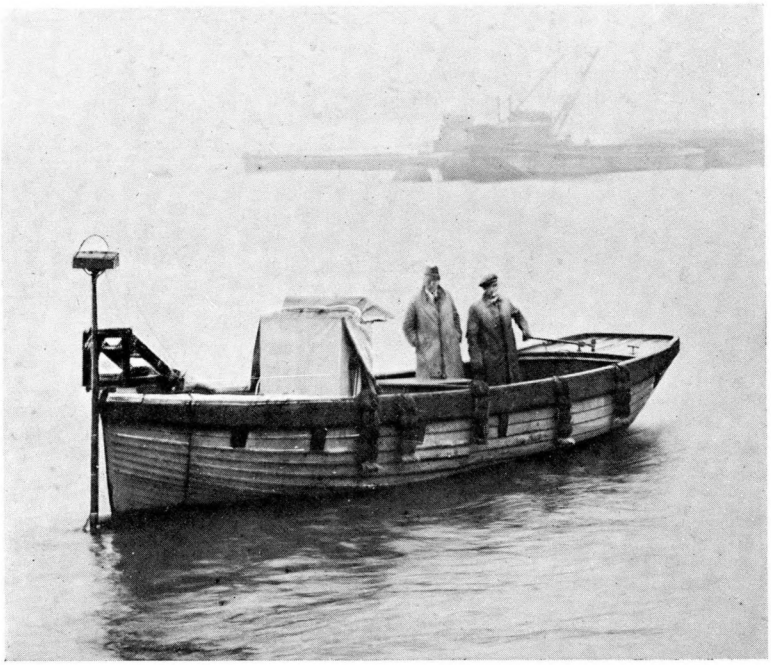
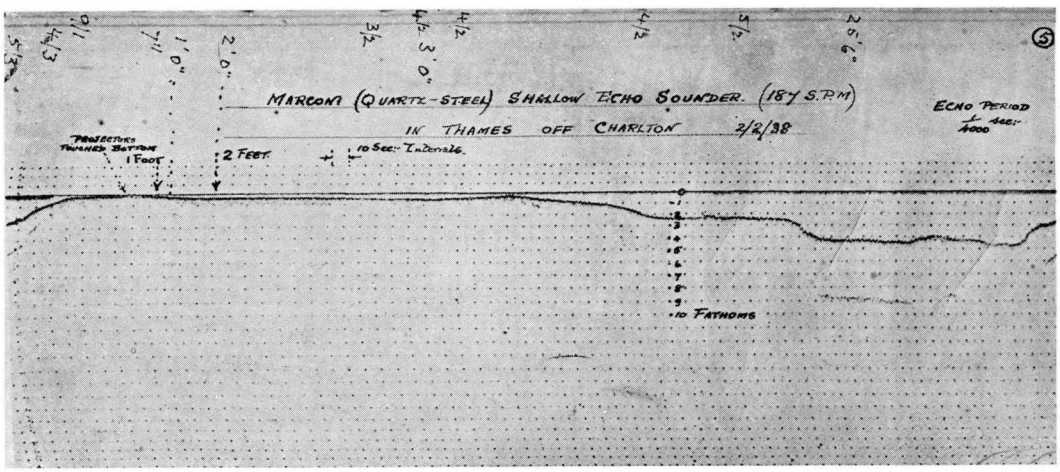


PLANCHE X
PLATE X.

Equipement de sondeur pour petits fonds MARCONI *monté sur embarcation dans la Tamise.*

MARCONI shallow sounder equipment on small boat on Thames.



Essais en Rivière.

River Test.

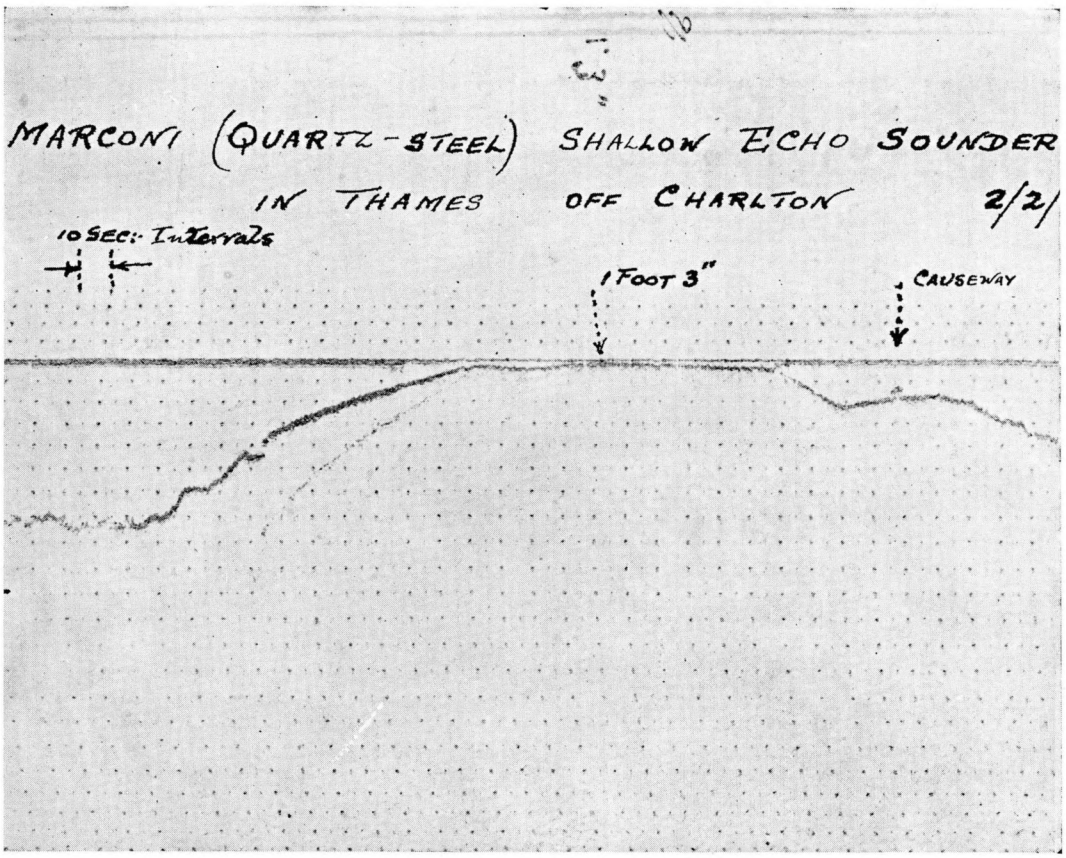
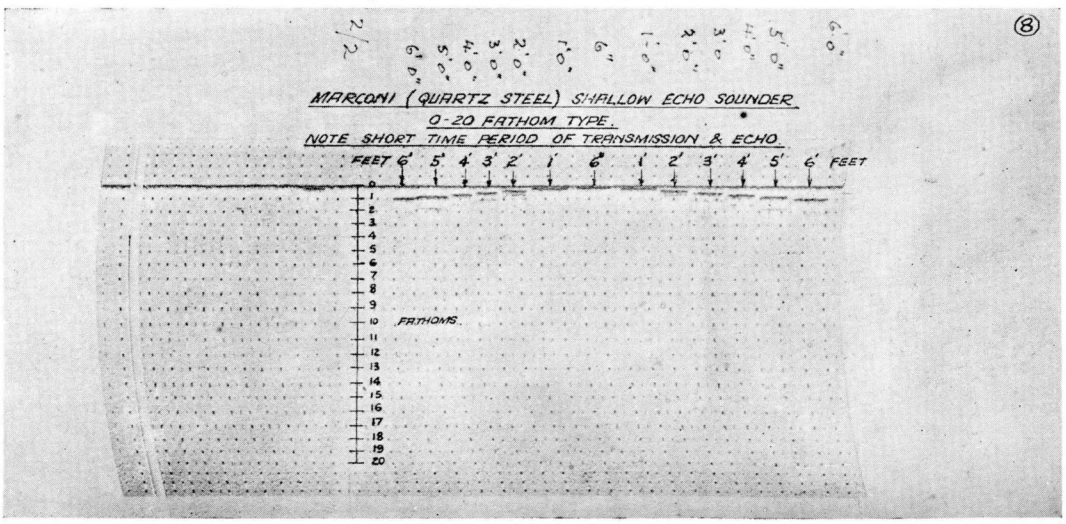


PLANCHE XI

PLATE XI.

Essais en Rivière — Enregistrement presque en vraie grandeur

Nearly full size record — River test.



Enregistrement d'essai au bassin

Tank test record.

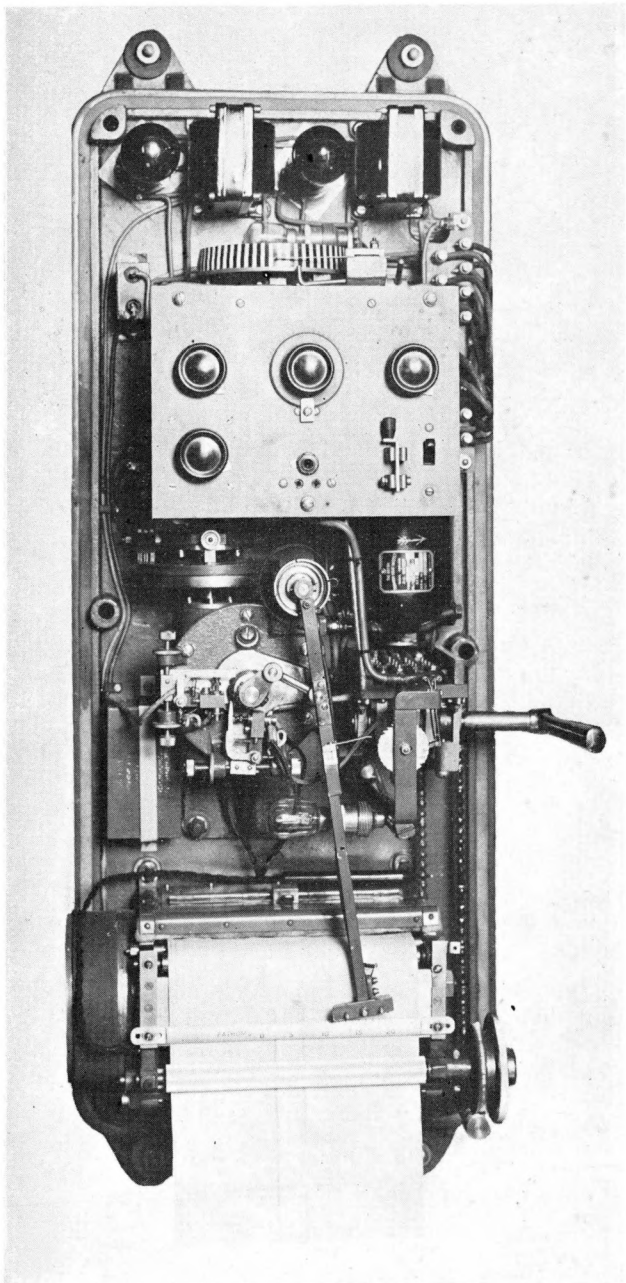


PLANCHE XII
PLATE XII.

Enregistreur électrolytique MARCONI *S.C.A.M., à mouvement alternatif* 187 *sondages par minute de* 0 *à* 30 *mètres*

Electrolytic recorder — Link motion Type MARCONI S.C.A.M. 187 soundings per minute 0 to 120 feet.

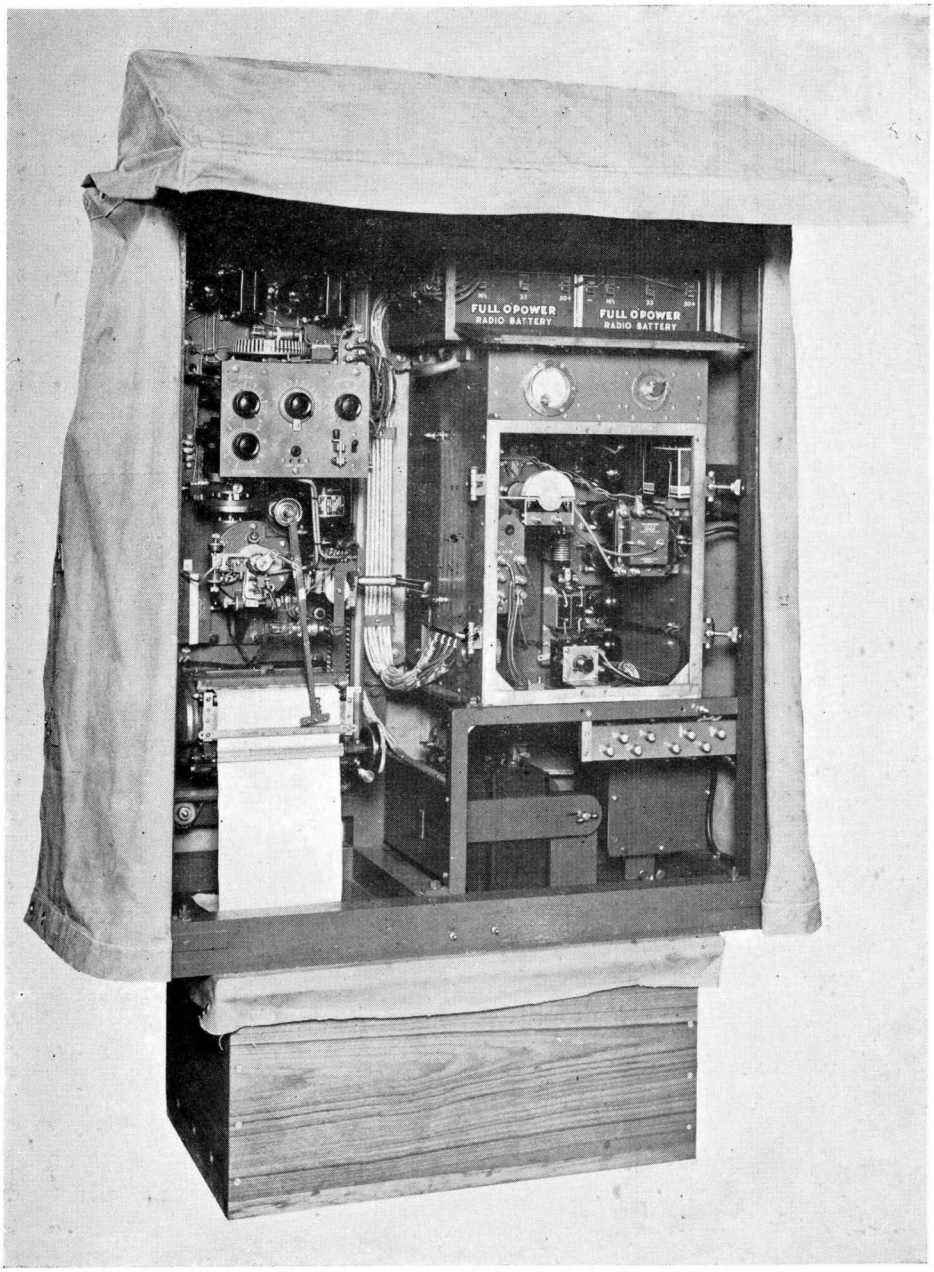


PLANCHE XIII

PLATE XIII.

Appareil de sondage par le son pour petits fonds MARCONI *(Quartz-Acier) de 30 centimètres à 36 mètres*
Ensemble ouvert

MARCONI (Quartz-Steel) shallow echo sounder : 1 foot to 120 feet
Instruments open.

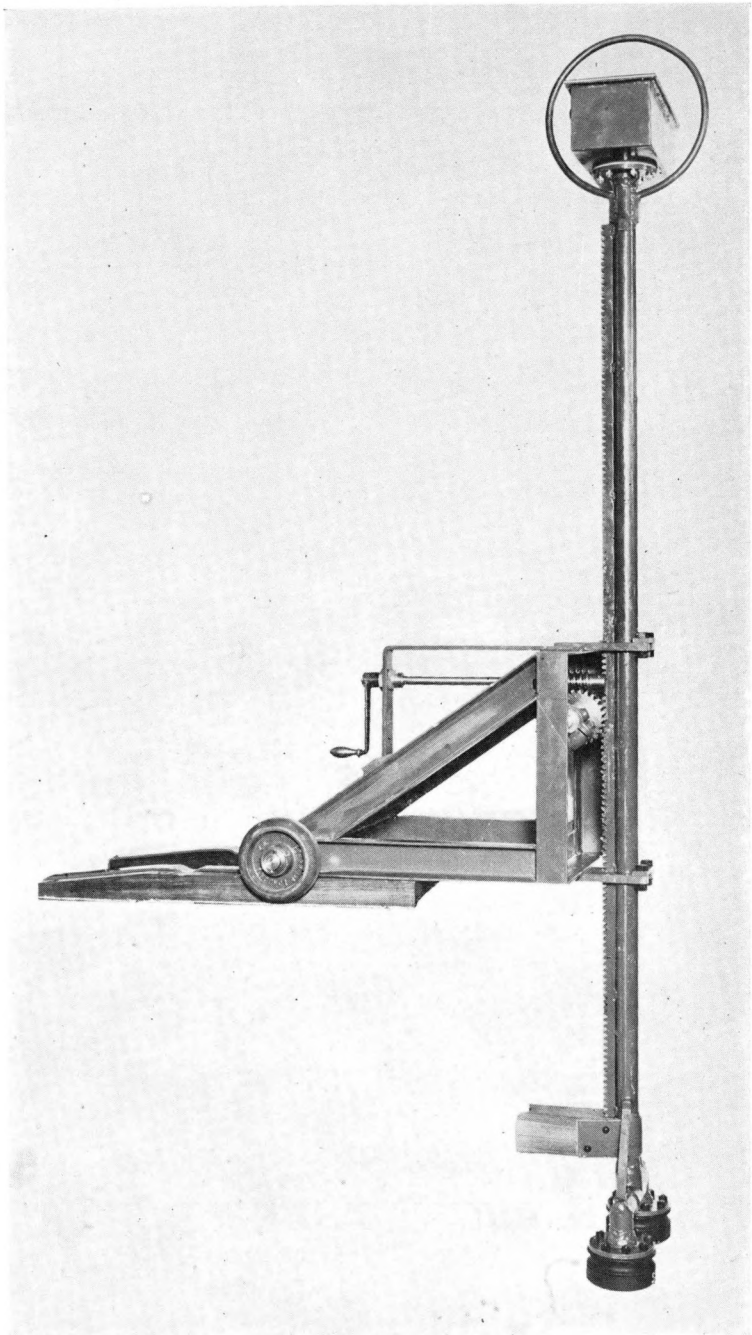


PLANCHE XIII*a*
PLATE XIII*a*

Montage de projecteur d'étrave jumelé (Quartz-Acier)
pivotant sur rails jusqu'à sa position hors-bord sur l'étrave

Twin (Quartz-Steel) outboard bow fitting rotated on tracks to outboard position on bow.

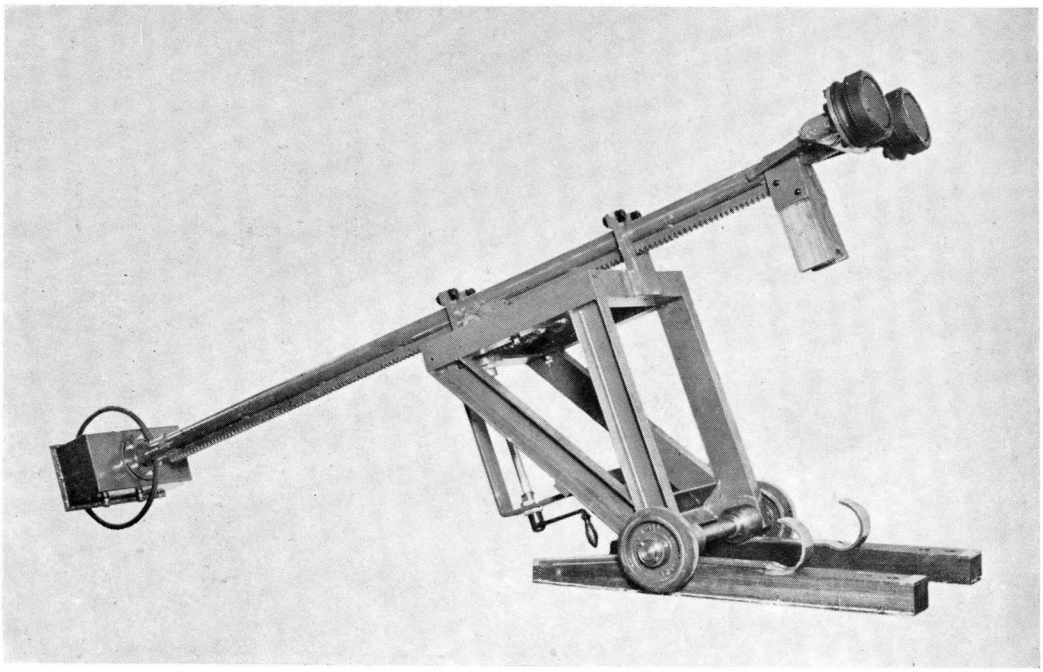


PLANCHE XIII *b*

PLATE XIII *b*

Projecteur hors-bord jumelé (Quartz-Acier)
Montage d'étrave et rails de rentrée à bord

Twin (Quartz-Steel) projector outboard
Bow fitting and tracks inboard.

Ranges : 1.20 to 60 metres.
Accuracy of soundings : 10 cm.
Frequency of soundings : 66 per minute.
Length of graduation : 30 cm.
Output of battery of 4-volt accumulators : about 1 amp.
Output of battery of anode cells : about 5 milliamp.

Weight of Echoscope proper : 36 kg	(79.40 lbs)		
Weight of Projector and tube : 12 kg	(26.50 lbs)	}	Total : 58 kg. (127.90 lbs).
Weight of batteries (about) : 10 kg	(22.00 lbs)		

The working of the sounding machine is very simple and its upkeep reduced to the charge of a battery of 4-volt accumulators.

Each transmission is shown, so that there is a permanent check of the zero.

The echo being oscillographed, its magnitude and form give an indication of the nature and configuration of sea-bottom.

The use of a single Projector (transmitter-receiver), gives vertical sounding, with linear scale from the smallest depths down-wards.

The Echoscope may also be installed on board large vessels. In this case the Echoscope (*mural* type) and its batteries are placed on the bridge ; the projector is carried by a stationary bed-plate fixed to the hull ; the electric transmitter-receiver is placed near the projector.

IMPORTANT NOTE : When the boat or vessel on which the sounding machine with echoscope is installed has an internal combustion motor (ignition device by spark plug, magneto or delco) the line going from the echoscope to the projector must be carefully protected against the parasitic inductions of the motor ignition device. The line going from the echoscope to the projector must be placed under metal screening connected to the main body. If the motor is very near the sounding machine and not enclosed in a metal motor-box, it may be necessary to place metal screens connected to the main body on the lighting devices and circuits.

SPECIAL FEATURES OF TRANSMISSION :

The ultra-sonic projector being used for transmitting, and then for receiving the echo, this method of functioning requires that the transmission of the signal be terminated when the echo produced by sea-bottom reaches the projector. When sounding in very shallow water the "echo interval" is very small because of the great velocity of the propagation of sound in the water ; for instance a time interval of 0.01 second corresponds to a depth of 7.5 metres. As the echo-

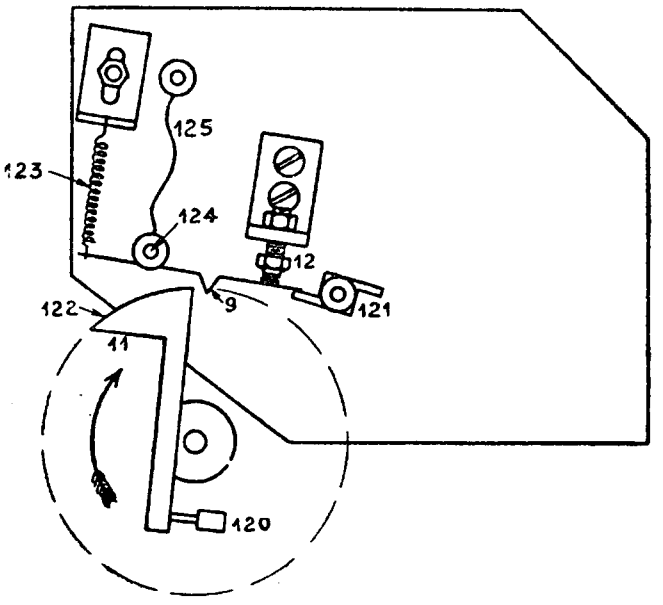


FIG. 6.

scope is chiefly for sounding in shallow water, it is necessary to transmit a *very short* ultra-sonic signal.

For this reason a transmission formed by a single, *damped ultra-sonic wave-train* is used. The duration of such a wave-train (of the order of one-thousandth second) is short compared with durations of time-interval corresponding to the smallest depths which may have to be measured in practice.

This special transmission is electrically produced by means of a step-by-step excitation transmitter (*with condenser discharge*) transmitting at each signal only a *single wave-train.*

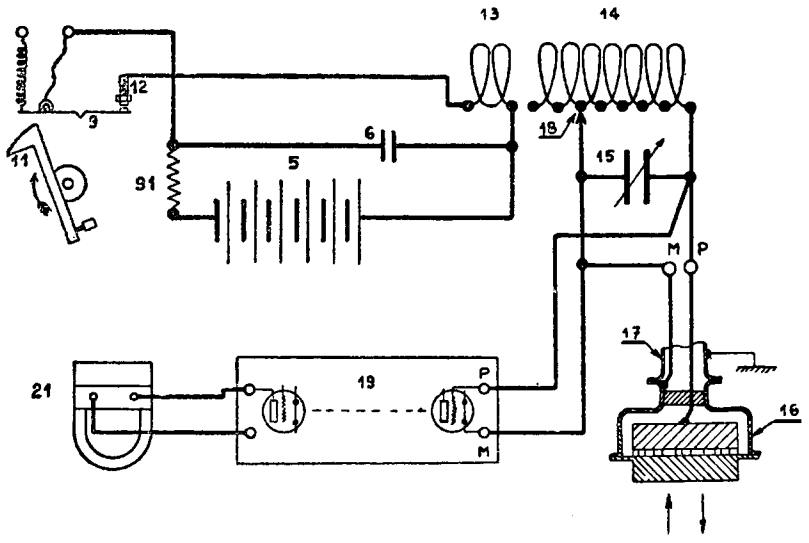


FIG. 7.

TRANSMITTER (*Principle and adjustment of frequency.* See Figure 6) :

The high tension battery of the sounder (5) (about 80 volts), in uninterrupted connection with the terminals of the condenser (6) by means of the large resistance (91), charges this condenser during the "rest" periods between successive transmissions. At each revolution of the axis of the clockwork movement the insulating finger clip (11) raises the blade (9) (movable contact) and puts it in contact with the screw (12). This causes the sudden discharge of condenser (6) in the shock coil (13) consisting only of a few turns. The abrupt front of the discharge current excites by shock the oscillating circuit connected to the projector and causes the transmission by the projector of an ultra-sonic wave-train. The maximum tension at the projector terminals during the transmission is of the order of some hundreds of volts.

(14) is the self-induction coil fitted with connecting plugs, of the oscillating circuit the total capacity of which is formed by the sum of the capacity of the variable adjustment condenser (15), of the projector (16) and of the parasitic capacity of the screen-protected line (17).

The natural frequency of the oscillating circuit (14 - 15 - 16 - 17) must be exactly equal to the natural frequency of mechanical vibrations of the projector used (value indicated on delivery of the projector).

This *frequency adjustment* (or equivalent W/T wave-length) is carried out by means of the connecting plugs (18) of the coil (14) (rough adjustment) and the variable condenser (15) (accurate adjustment) after installation of the projector and of the screen-protected cable-line (17) (1). The frequency adjustment is carried out with the help of a transmitter wave-meter, buzzer type for instance, lightly coupled with coil (14), by listening to the maximum of reception by means of the receiver-amplifier (19). Care must be taken to carry out the adjustment keeping blade (9) in contact with screw (12) (closed shock circuit).

The variable condenser (15), placed behind and in the centre of the coils (13) and (14), must be manipulated with a long screwdriver with insulated handles (the axis of rotation carries a split

(1) In order to obtain the maximum possible tension at the terminals of the projector and those of the amplifier, an adjustment with high self induction and low capacity must be used.

head). A set-screw device enables the movable armature of the condenser to be keyed in the selected position.

The proper frequency of the shock circuit need not be tuned with that of the projector.

Regarding amplifier (19) and oscillograph (21) which have been shown for clearness on the schematic diagram details as to these will be found further on in relative chapters. The elements or parts marked above will be found with the same indicating marks in the following figures or diagrams.

REMARK : When the echoscope is used in conjunction with a projector of 220 mm. working diameter, shock coil (13) (two turns for small model projector) must be replaced by a 4-turn shock coil. In this case, also, a supplementary oscillating circuit coil must be added in series (and at concordant flux) with coil (14). The shock coil is then arranged in "sandwich" between the two oscillating circuit coils. The object of this modification is to allow of the oscillating circuit being tuned to the frequency of the 220 mm. projector.

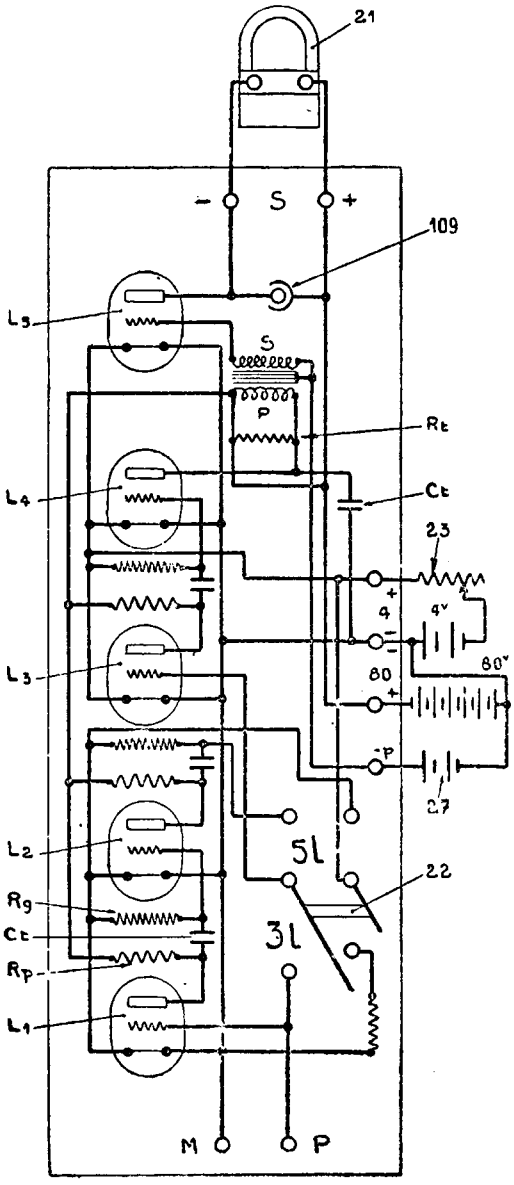


FIG. 8.

CHARACTERISTICS OF RECEPTION :

At the instant of transmission the projector, the functioning of which is reversible, encounters the wave-train of electric oscillations (maximum amplitude, some hundreds of volts) due to the functioning of the transmitter and transforms it in ultra-sounds. The oscillating circuit and the projector returning instantaneously to their original position, the projector causes in this circuit, at the instant of receiving the ultra-sonic echo, a wave-train of *very low tension* electric oscillations. The electric receiver, *in uninterrupted connection* with the terminals of the projector, must at its exit transform these two very short oscillation wave-trains, which limit the "echo interval", into current impulses of identical form and *comparable range*, capable of causing the oscillograph of the analyser to deviate and enabling the depth to be measured, as will be seen further on. This is obtained by leaving, *permanently* connected to the terminals of the projector, the filament-grid space of the first lamp of the special *amplifier* which in its turn is permanently connected to the *oscillograph*.

At the instant of transmission, the well-known phenomenon of *saturation* of the triode lamps automatically *limits* to the required value the magnitude of the impulse corresponding to the signal.

At the instant of the echo, on the contrary, the wave-train of very low tension oscillations is *amplified* and transformed into an echo pulsation of magnitude comparable to that corresponding to the transmission.

AMPLIFIER (Fig. 8 & Plate XIV)

This is a special amplifier for oscilloscopy, with 5 valves, the first three of which, L1, L2, L3, connected by resistance, amplify in high frequency, the fourth, L4, connected to the third also by resistance, detects, while the fifth, L5, connected to the preceding by a transformer and a polarisation cell, amplifies and detects in low frequency.

It is necessary to note the respective position, at each stage, of the resistance of plate *Rp*, of the resistance of grid *Rg* and of the connecting condenser grid-plate *C*1 ; that of the condenser putting in shunt the primary of the transformer *Ct* and of the damping resistance *Rt*. *Naturally care will be taken, when dismounting and assembling, not to invert accidentally* those different parts which are externally of similar form.

The amplifier is fitted with a bipolar reversing switch (22) enabling the sensitivity of the instrument to be altered. In the position of the reversing switch marked 3L (used for depths of about 1 - 4 metres below the projector), the entry *P* is connected to the grid of the third valve L3 and the first two valves L1 and L2 are extinguished, but a resistance is substituted for them so as to keep constant the voltage at the terminals of the filaments. The instrument then works with three valves and its sensitivity is relatively weak (transmission tooth very short — in time). In the position of the reversing switch marked 5L, the 5 valves are lighted and in service (soundings from about 4 metres to the maximum range of the sounding machine).

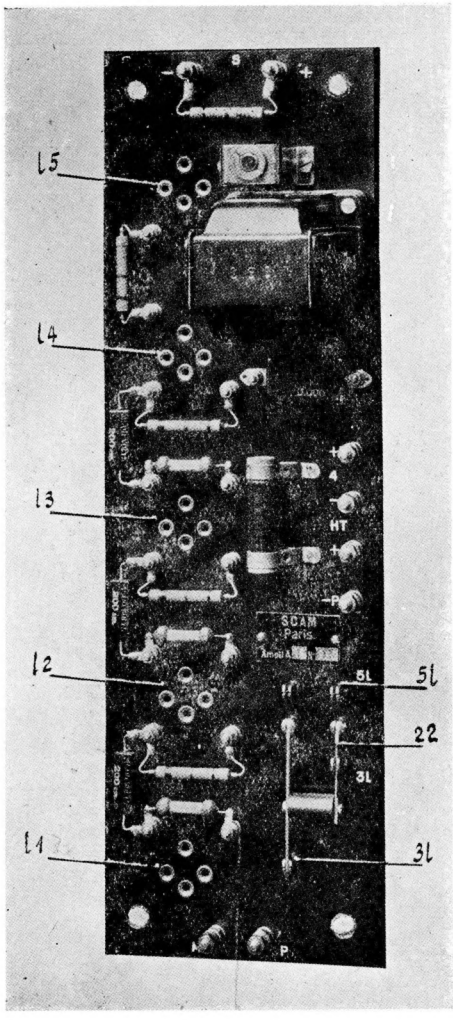
OPTICAL ANALYSER :

This apparatus is a high precision chronoscope which automatically releases the successive ultra-sonic transmissions and which, by producing *an oscilloscopic tracing of each sounding*, allows the depth to be read and its variations to be followed.

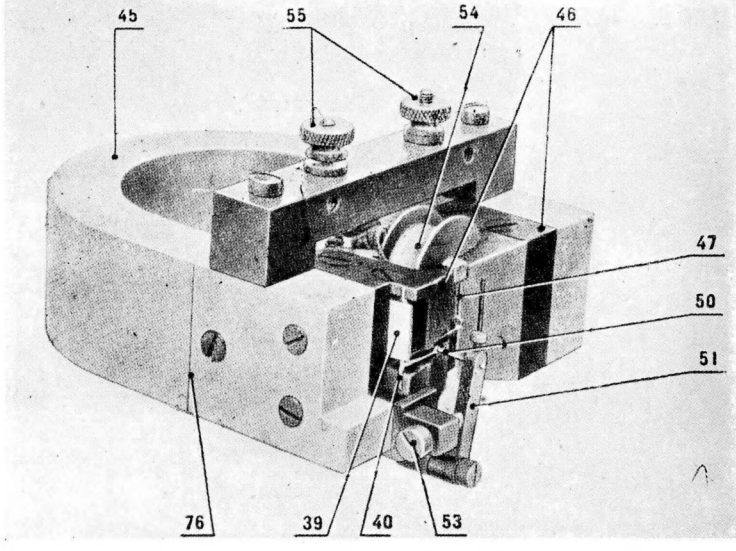
The principle of the instrument is given in *Hydrographic Review* Vol. X N° 2, pp. 170-171.

For the observer the operation which constitutes a *sounding* develops in the following manner on the reading scale of the echoscope.

A luminous point starting from the left end of the scale moves horizontally towards the right, at *constant speed*, it thus sweeps the whole extent of the graduation from small towards great depths. When this luminous point passes opposite the zero of the graduation (or, rather, opposite the depth corresponding to the draught at projector level), it undergoes in its horizontal movement a sudden deviation upwards, with immediate return to the original level. This deviation is the *transmission tooth* (or signal) to the occurrence of which corresponds, in time, the departure of the ultra-sonic wave-train towards sea-bottom. The luminous point, the horizontal speed of which is constant and accurately known throughout its travel (chronoscopic movement) continues its movement towards the right. On the other hand the wave-train is propagated to sea-bottom, then returns to strike the projector at the end of the "echo interval". At this instant the luminous point, its movement being uniform, passes in front of the graduation which corresponds to the depth. This depth is optically indicated to the operator by the display of a second "tooth" the *echo tooth*, described by the luminous point. The luminous point then continues its travel towards the right and disappears at the end of the scale.



Amplificateur



oscillographe
DUBOIS

PLANCHE XIV
PLATE XIV.
Sondeur LANGEVIN-FLORISSON *à Echoscope*
LANGEVIN-FLORISSON Echoscope.

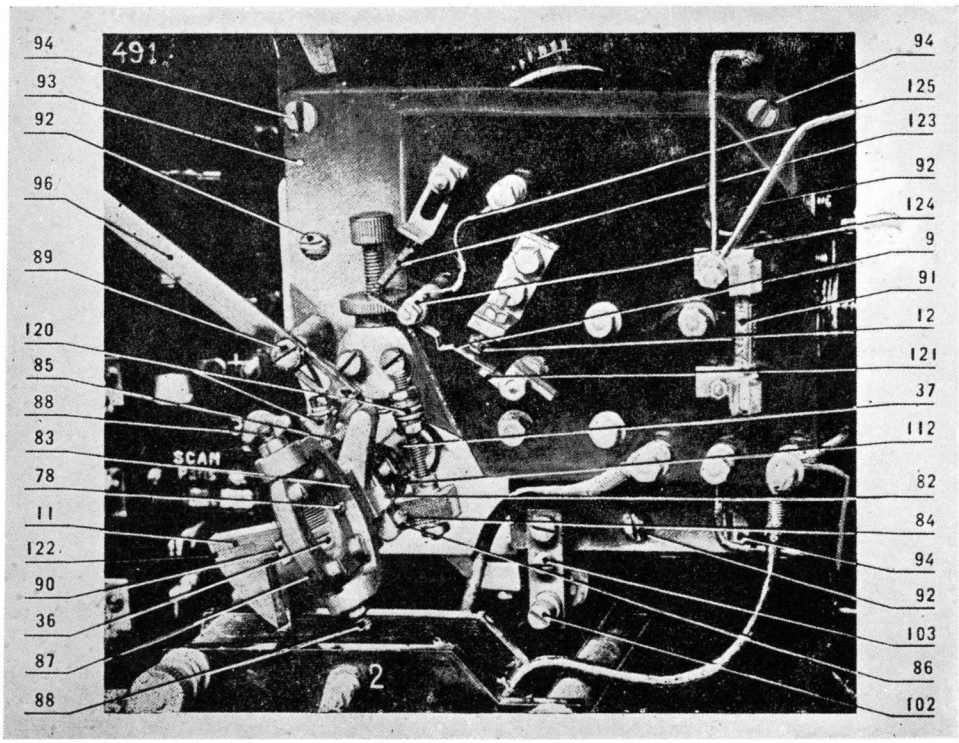


Planche XV
Plate XV.

Sondeur Langevin-Florisson *à Echoscope*
Miroir tournant et détails

Langevin-Florisson Echoscope.
Rotating mirror and details.

The sounding operation is completed.

Simply by the functioning of the analyser this operation is repeated every 10/11ths of a second. (1) Consequently the operator, who observes only that part of the scale which corresponds to the depth under the vessel at the moment, sees the echo "teeth" (upright dashes) succeed each other and can easily read the depth and its successive variations.

The brief antero-posterior displacements of the luminous point on the scale, which occur *without any lag* at the instant of the transmission and of the echo, are caused by slight and brief angular displacements of the DUBOIS oscillograph mirror turning about a horizontal axis; this oscillograph is *permanently* connected to the amplifier (which in turn is permanently connected to the projector).

The left-to-right constant speed movement of the luminous point on the scale, a uniform movement which enables the "echo interval", that is to say the depth, to be measured, is caused by the turning of the *rotating mirror* about a horizontal axis at constant speed ; in this mirror, which is spherical, the luminous rays are reflected after reflection on the oscillograph mirror.

The movement of the luminous point on the scale is thus repeated at every revolution of the axis of the clockwork device carrying the mirror.

The deviation of the luminous point *in the antero-posterior direction* (rapid deviation which, taken together with the slower lateral displacement, constitutes the transmission tooth and the echo tooth) is caused by the DUBOIS oscillograph permanently connected to the amplifier, which is itself permanently connected to the projector.

This oscillograph is a sort of galvanometer with mirror, very sensitive, with magnet, inductor-alternator and stationary field-winding, with very rapid and at the same time periodical movements. Fig. Plate XIV shows the oscillograph with open cover. Fig. 9 is a diagrammatic representation of the instrument.

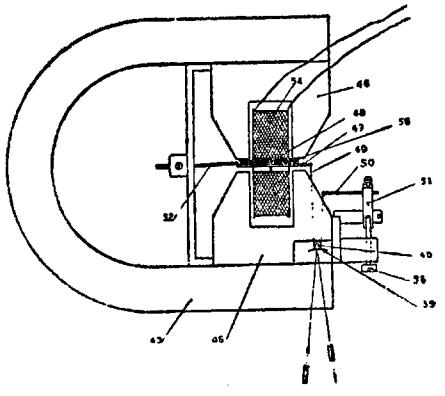


FIG. 9.

The movable element of the oscillograph has a natural mechanical oscillation frequency of the order of about 1500/sec. The instrument is made *aperiodic*, which is necessary for the *faithful* oscilloscopy of sounding pulsations, by introducing, at the factory, a drop of thick oil (Mobiloil *C*) between one of the faces of blade (47) and the opposite side of the tubing which contains the latter. The drop of oil (56) is kept in place by capillary attraction, by means of a small cotton pad. It is recommended not to retouch the damping of the oscillograph except in cases of continuous service in tropical or arctic countries.

The portable echoscope may be transported daily, with the oscillograph in place, by *taking care not to let any violent shock be transmitted to the echoscope when it is placed on the ground, but the echoscope should* NEVER BE SENT *with its oscillograph in place on its support.* The oscillograph should be moved from the instrument and fixed in its special case.

ROTATING MIRROR AND TRANSMISSION RELEASE CLIP : (Plate XV)

The rotating mirror (36) and clip 11 are carried by a sleeve (112) prolonging the axis (37) of the clockwork device (this sleeve is firmly fixed in block with the axis). The sleeve (112) carries on the one hand, at its end, the adjustment cap (83) and its stand (82) ; on the other hand, at the level of the movable transmission contact (9), the insulated clip (11) which at each revolution of the axis (37) releases the transmission. The stand (82) is fitted with a radial set-screw so that,

(1) In certain echoscopes with special scales the transmission spacing, which may be different, is indicated on delivery

once the keying of the mirror and the insulated clip (the latter solid with sleeve (112)) determined, the stand (82) may be blocked on sleeve (112). The insulated clip (11) carries a counterweight (120), *adjusted at the factory*, so that the rotating part may be put in equilibrium.

KEYING OF THE CLIP AND MIRROR ON AXIS (37) :

The keying process must be carried out in such a way that the blade (9) bears (by the tungsten contact *ad hoc*) on screw (12) exactly when the luminous point passes opposite the zero of the scale (or rather opposite the graduation corresponding to the immersion of the projector).

CLOCKWORK DEVICE :

A complete rewinding of the device assures continuous functioning, at constant speed, for about 15 minutes.

The speed of the clockwork movement is kept constant by a centrifugal absorption regulator. The principle of this regulator is that of the ordinary phonograph regulator ; the bob of spring blades, being driven apart by the centrifugal force, causes a metal disk to bear more or less upon a small brake block, which makes the speed constant.

If the average velocity of sound through sea water is taken as 1500 m/sec., the correct speed of the clockwork device (which must be proportional to that of sound through water) is *eleven* revolutions of the axis in *ten* seconds (or 66 revolutions per minute).

SEARCHING THE ECHO :

Listening-in by telephone : It is recommended to keep the headphones always at the immediate disposal of the observer. The echo "tooth" is often more easily found on the scale when listening by telephone is combined with visual examination of the scale.

CASES OF FEEBLE, INVISIBLE, BUT STILL AUDIBLE ECHOES :

These may be caused, for instance, by ooze or sea-weed bottoms, by very sloping bottoms, or at the instant of some accidental diminution of sensitivity of the sounding machine (batteries discharged, bad valve, etc...). The headphone being more sensitive than the oscillograph, the echo may still be heard although it no longer shows a luminous "tooth" visible on the scale.

In such a case, when the echo has been carefully detected by hearing, the depth may be found by following the luminous point on the scale. After a few trials, the point of the graduation, *i. e.* the depth, opposite which the luminous point passes when the echo is heard, may be easily determined.

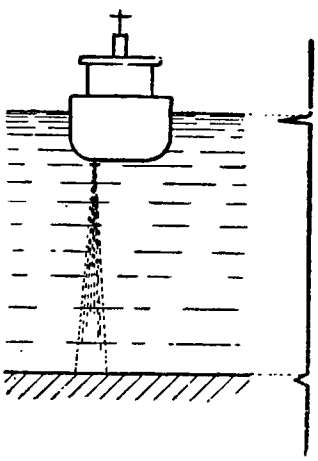


FIG. 10.

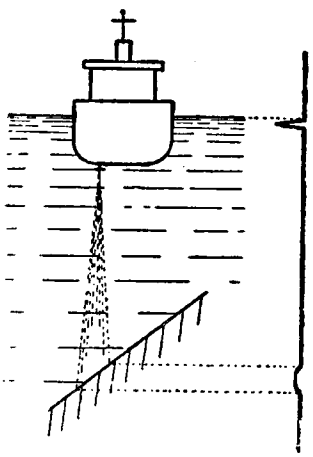


FIG. 11.

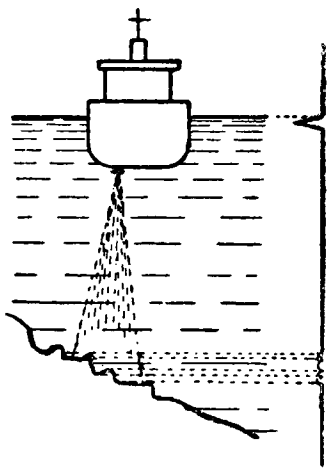


FIG. 12.

INFLUENCE OF BOTTOM CHARACTERISTICS ON THE FORM AND MAGNITUDE OF THE ECHO "TOOTH". — INFORMATION GIVEN BY THE SOUNDING MACHINE.

A) *Influence of the nature of the bottom :* This is minimum on the functioning of the ultrasonic echo sounding machine. Notwithstanding, for equal depths and identical adjustments of

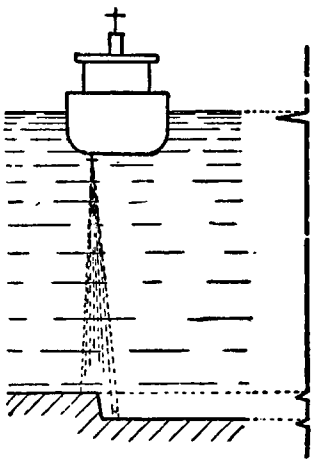


FIG. 13.

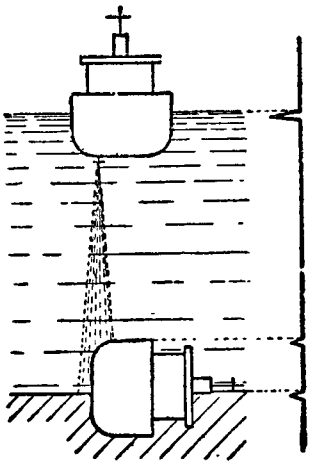


FIG. 14.

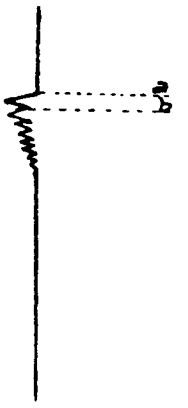


FIG. 15.

the sounding machine, ooze and sea-weed bottoms throw less powerful echoes than sand or rock bottoms. Certain bottoms of very soft ooze throw very weak echoes.

B) *Influence of bottom relief :* The ultra-sonic beam, which has a spacing of several degrees, "feels" the bottom over a certain surface which depends, besides, on the depth. An instrument with a trustworthy oscillograph analyses (whence the name *analyser*) the form of the ultra-sonic reflected wave-train which may be modified by accidents of this surface, for instance :

If the bottom is plane and horizontal : the form and duration of the wave-train remain the same as those of the incident wave-train ; the echo tooth is then identical, in form and width of base, to the transmission tooth (diagrammatic representation : fig. 10).

If the bottom is plane but sloping on the horizontal : the progressive reflection by different bottom-levels lengthens out the reflected wave-train and the echo "tooth" itself becomes lengthened and rounded. (Fig. 11).

If the bottom shows remarkable irregularities within the "felt" surface, the echo tooth is irregular and shows successive retrogressions corresponding to the principal successive bottom levels encountered by the wave-train. This is the case of a passage over rocky bottom (Fig. 12), a submarine cliff (Fig. 13), or a wreck (Fig. 14).

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h) *LANGEVIN-FLORISSON ULTRASONIC SOUNDER WITH DIVIDED ECHOSCOPE TYPE* 2. (Fig. 16 & 17)

The Sounder with Echoscope Type 2 is no longer intended for launches and very small craft in which the Transceiver contained in the Echoscope may be close-by the Projector, but for ships of any tonnage. In other words, the Echoscope Type 2 is intended for the equipment of ships in which the reading device, or Analyser, (on the bridge), is located, *a priori*, at a considerable distance from the Projector.

For this purpose the Echoscope proper is divided into two component parts :

(1) The Echoscope containing now only the Analyser and the controlling units (to be placed on the bridge).

(2) The Transceiver (to be placed in the bottom of the ship, close-by the Projector, so that the high frequency line, in screened tube, may be less than three metres in length).

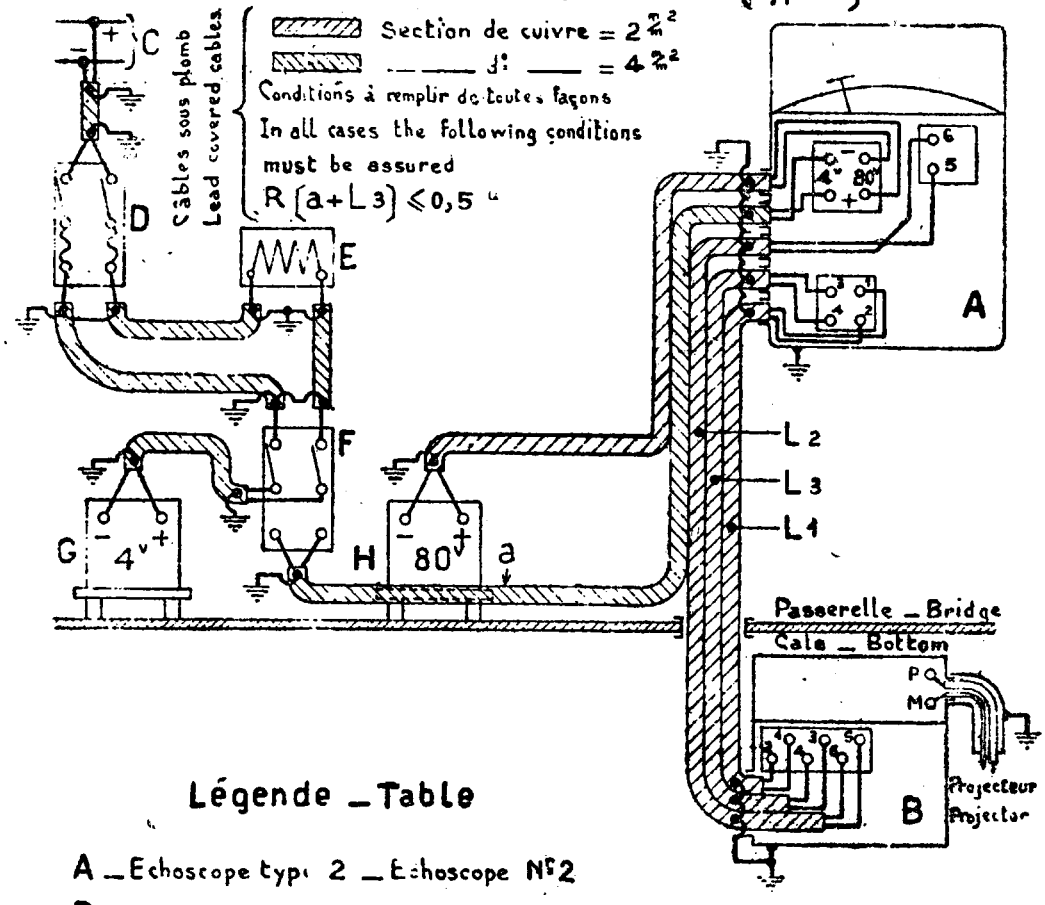
These two main component parts of the sounder are interconnected by three low tension current lines, which may be of any length.

These three two-core lines must be constituted by three well-insulated lead-screened cables, with lead sheathing in body contact at several points.

In order to avoid stray inductions, these three lines should be run in a bundle at some distance from the mains of the ship traversed by variable currents (bells, motors, etc...).

The high frequency circuits are located entirely in the Transceiver and are connected to the Projector by the usual short line, in screened dry tube. (Immediately after placing the cables in the screened tube, the upper end of latter must be sealed off hermetically by means of a rag pad cemented with hot pitch).

Schema de câblage du Sondeur ultra-sonore Langevin-Florisson avec Echoscope divisé (Type 2)



Légende _ Table

A _ Echoscope type 2 _ Echoscope N° 2

B _ Emetteur-récepteur pour échoscope type 2 _ Transmitter-receiver for echoscope N° 2

C _ Réseau _ Main

D _ Interrupteur bipolaire avec coupe-circuit _ Switch with fuse

E _ Résistance de charge (4v) _ Charging resistance (4v)

F _ Inverseur bipolaire (4v) _ Two directions switch (4v)

G _ Batterie 4v 4v Battery

H _ Batterie 80v 80v Battery

FIG. 16.

The 4-volt and 80-volt batteries are located on the bridge, or not far from it, and are connected to the nearby Echoscope as shown in the diagram.

The transmission is brought about by the making of relay 124, the latter being controlled by the making of the upper contact 12 of the transmission change-over switch 8 of the Echos-

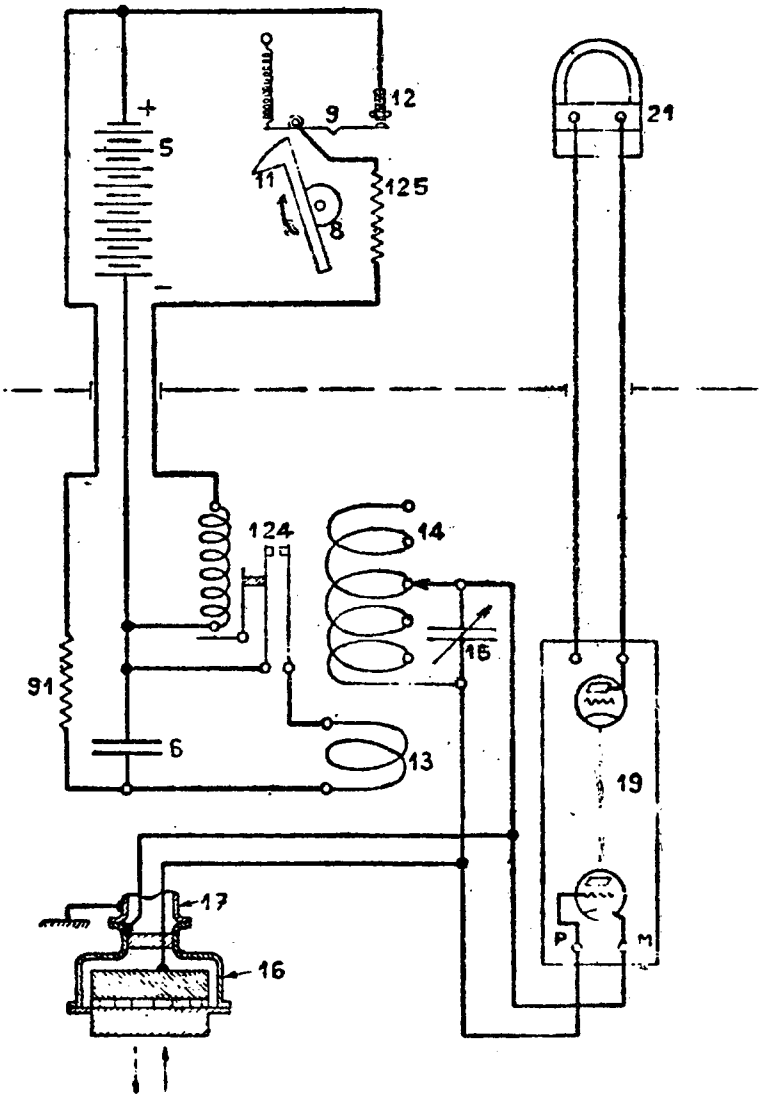


FIG. 17.
Wiring Diagram.

cope. The making of this contact sends in the windings of relay 124 an 80-volt current tapped off the battery and the intensity of which is governed by the resistance 125. It will be noted that the making lag of this relay (an actually constant lag) is of the order of 4 metres sounding; the making of the contact must therefore be phased angularly *ahead* of the required quantity in order that the transmission peak be made at the zero of the scale (or of the draught of the Projector).