THE MARCONI MAGNETO-STRICTION ECHO-SOUNDER.

The Marconi Company has recently introduced a new range of echo-sounders under the registered trade names of "Seavisa", "Seagraph" and "Visagraph". These use the magneto-strictive properties of nickel for sounding in depths of from about 3 feet to a maximum of 750 fathoms.

Nickel projector type 838. — The projector consists of a cylindrical pile of annular nickel rings loosely clamped, so that each lamination is free to vibrate individually. Energised by a toroidal winding threaded through a series of holes equally spaced near the outer edge of the ring, the pack vibrates radially at the fundamental frequency of approximately 14 kc/s. This element is mounted horizontally and the vibrations from the edges of the nickel rings are redirected conically downwards by means of a surrounding reflector shaped like a cone.

The magneto-strictive effect being reversible the transmitter may also be used as a receiver provided some magnetism is present in the nickel after transmission; or a separate identical nickel oscillator may be used for reception.

In this Marconi system the transmitting projector is shock-excited by a strong pulse of energy suddenly set free and dissipated in approximately 250 microseconds. The current in its winding is uni-directional, thus the projector is re-magnetised during each transmission and is, therefore, maintained in a very efficient condition for reception purposes.

These projectors, known as type 838, are mounted near to the keel on the inner side of a ship's shell plating, which may or may not be pierced as required. If pierced (and this is the recommended method), a twelve-inch hole is cut in the ship's shell, over which is mounted a hollow cylindrical steel casting or fabricated fitting to house the projector. The cavity so formed is completely filled by a thin stainless steel cover enveloping the projector. This not only preserves intact the stream-lining of the ship's hull, but also avoids turbulent water in the vicinity of the projector. Since the thickness of the steel cover is very small compared with the wavelength of the sound vibrations in steel, the losses incurred in penetrating the cover are not great. By this method only one projector is necessary as the transmitted pulse virtually dies away in a period of time equivalent, in terms of the velocity of sound in water, to a distance of about three feet. Soundings of a few feet may therefore be measured without difficulty and without introducing the triangulation error inherent to dual projector working in shallow water.

Although only one projector is necessary when the hull is pierced, two are normally fitted, frequently at opposite ends of the ship, and either projector is selected by the navigator by means of a convenient switch. Since aeration beneath a ship's hull is not always predictable and does indeed vary with different conditions of weather, speed, draught and trim, particularly in smaller vessels, the selection of two different projector sites increases considerably the overall efficiency of the equipment and ensures maximum results when difficult conditions prevail. Apart from this the advantages of an additional projector need not be emphasised.

If the hull is not pierced much of the available energy is lost in the shell plating of the ship and, although sufficient energy is developed to obtain echoes from depths in excess of the maximum for which the indicators are designed, there can be little reserve of power for use when conditions for echo-sounding deteriorate. Separate receiving and transmitting oscillators must also be used, as penetration of the shell plating by sound waves produces many persistent internal reverberations which screen echoes returning from shallow depths if single projector working is attempted. In order to lessen these adverse effects still further, each projector is clamped to the shell on opposite sides of the ship in its own small steel tank which is completely floated on rubber. The separate receiver is identical with the transmitting projector. In order to ensure that it has sufficient residual

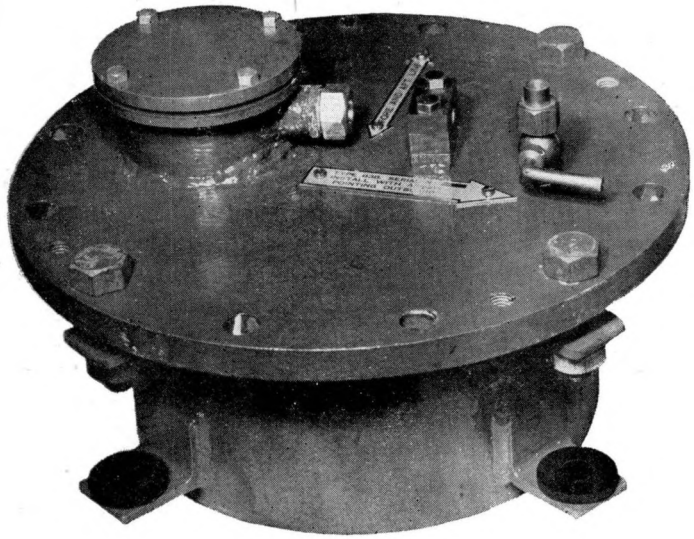


FIG. 1
Projector assembly for Marconi " Seagraph " and " Seavisa ' echo-sounders.
(Internal installation.)

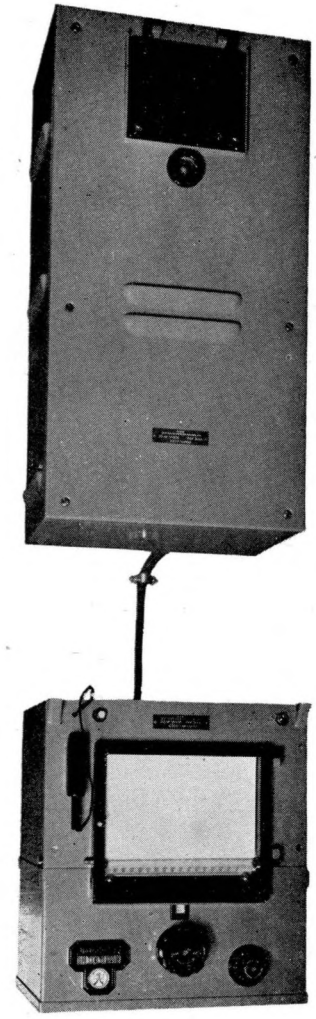


FIG. 3
Marconi " Seagraph " echo-sounder : Depth recorder and transceiver unit.

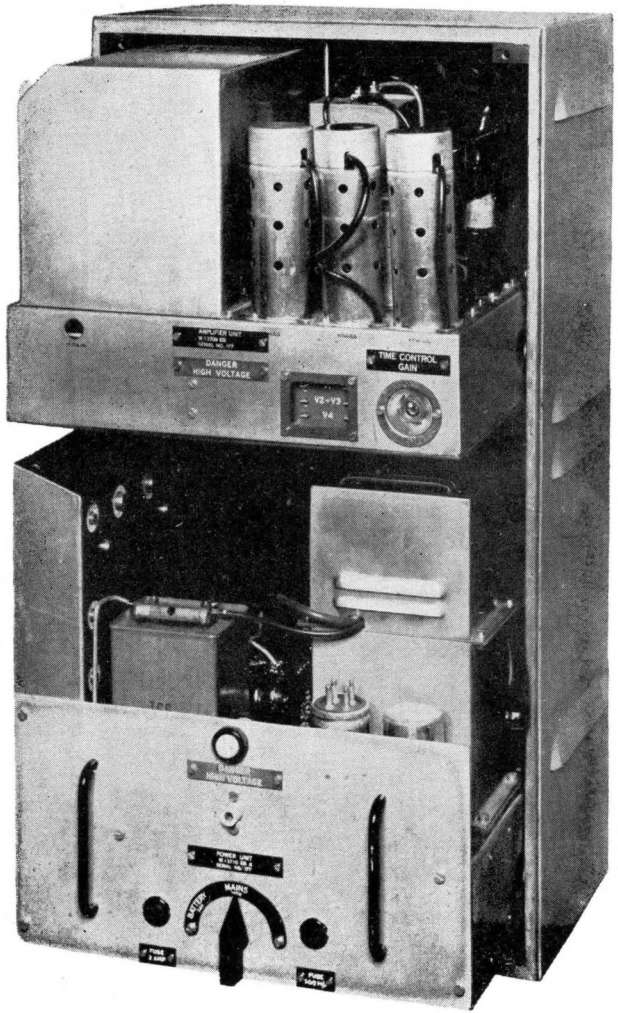


FIG. 4
Marconi " Seagraph " or " Seavisa " echo-sounder.
Transceiver unit opened for servicing.

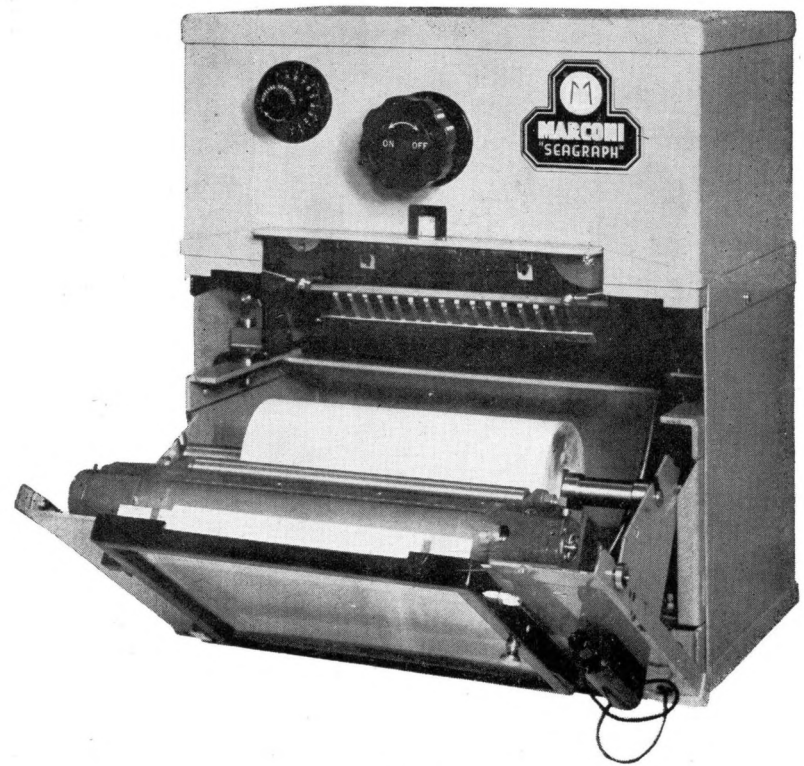


FIG. 8
Marconi " Seagraph " echo-sounder : Depth recorder type 840 series
with paper-box open.

magnetism for the satisfactory reception of echoes it requires magnetising by a strong direct current at periodic intervals of a few months or less. Thus, although satisfactory penetration of a ship's shell plating by sound waves is an accomplished fact, the method has many disadvantages compared with the single projector pierced hull system. The projector assembly with internal tank is shown in figure 1, and one method of mounting a pierced hull assembly is shown in figure 2.

Transceiver type 839. — The transceiver, shown in figures 3 and 4, contains a power supply unit, a transmitter and an amplifier, divided into two chassis. It may be fitted up to 500 feet of cable run from the type 838 projectors and is, therefore, normally fitted adjacent to the indicator.

The power supply unit, contained in the lower chassis, requires a source of D. C. mains supply of 110 or 220 volts, or a 24 volts supply, normally obtained from a battery of accumulators. Alternatively either of the former may be connected in addition to an emergency supply of 24 volts. The appropriate input voltage is selected by means of a switch on the front panel. This voltage is converted to A. C. by means of a vibrator and then transformed, and rectified where necessary, to the various voltages required to energise the transmitter, the amplifier, the marking circuits in the recorder and the dial illumination.

The amplifier, together with the transmitter, is contained in the upper chassis of the Transceiver.

The small electro-motive force developed in the winding of the receiving oscillator is stepped up by the amplifier input transformer which has a tuned secondary. The echo is further amplified at its signal frequency of 14 kc/s. by four resistance capacity coupled valve stages using four variable-mu H.F. pentodes (Marconi type KTW-63 indirectly heated valves), and thence passed on to a metal rectifier, the rectified output being fed directly to the indicator.

The transmitter consists of a condenser, a mercury vapour tube (Marconi type MPS-1 A), together with an ignition circuit. A simplified diagram is shown in figure 5.

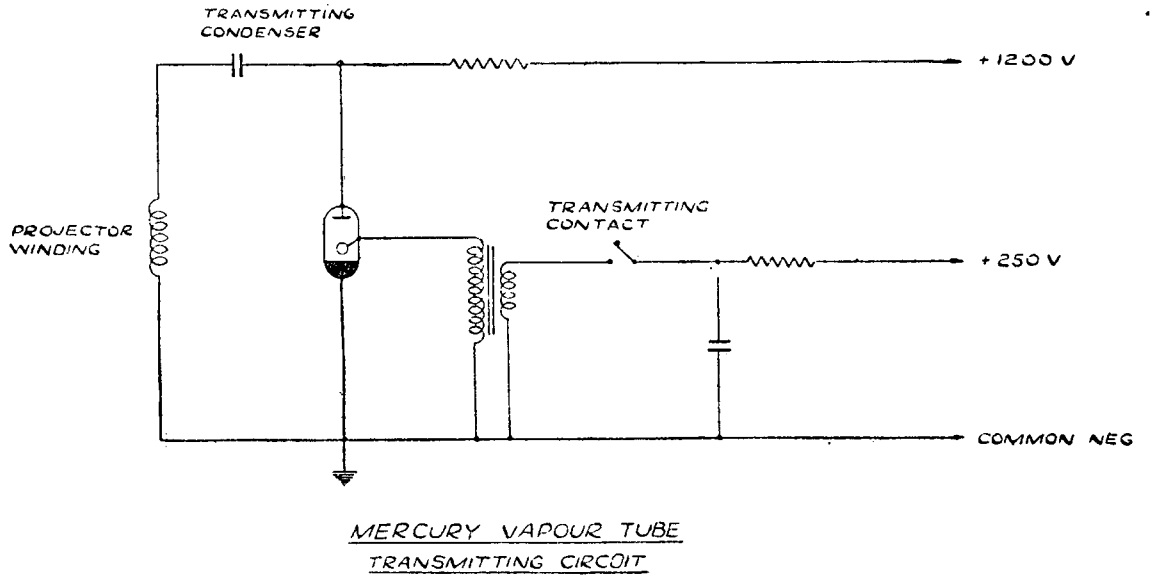


FIG. 5
Mercury vapour tube transmitting circuit for Marconi "Seagraph" and "Seavisa" echo-sounders.

In the intervals between transmissions the transmitting condenser is charged to approximately 1200 volts obtained from the power supply unit. At the appropriate time a cam-operated contact in the indicator closes the ignition circuit and permits another condenser, previously charged to approximately 250 volts, to

discharge itself through the low impedance primary of the ignition transformer. This produces a very high voltage pulse in the transformer secondary which ignites the mercury tube. The ignited tube immediately provides a very low resistance path which permits the transmitting condenser to discharge through it and the projector winding. The presence of the mercury tube in the circuit prevents the condenser from discharging in an oscillatory manner. Due to the unilateral conductivity of the tube. which extinguishes as soon as the condenser is discharged, all of the energy from the latter reaches the projector in the form of a very short-lived but powerful shock-exciting pulse. This development of the mercury vapour tube avoids dependence upon the less satisfactory electro-mechanical relays formerly used for this purpose.

With single projector working (pierced hull) the amplifier is protected from the high voltage of transmission by a choke placed in series with the primary of the input transformer. In addition, an auxiliary anode in the mercury tube, placed between the main anode and the cathode, is directly connected to the signal grid of the first amplifier valve (shown in figure 6). During the transmission period this auxiliary anode assumes, approximately, the potential of the chassis

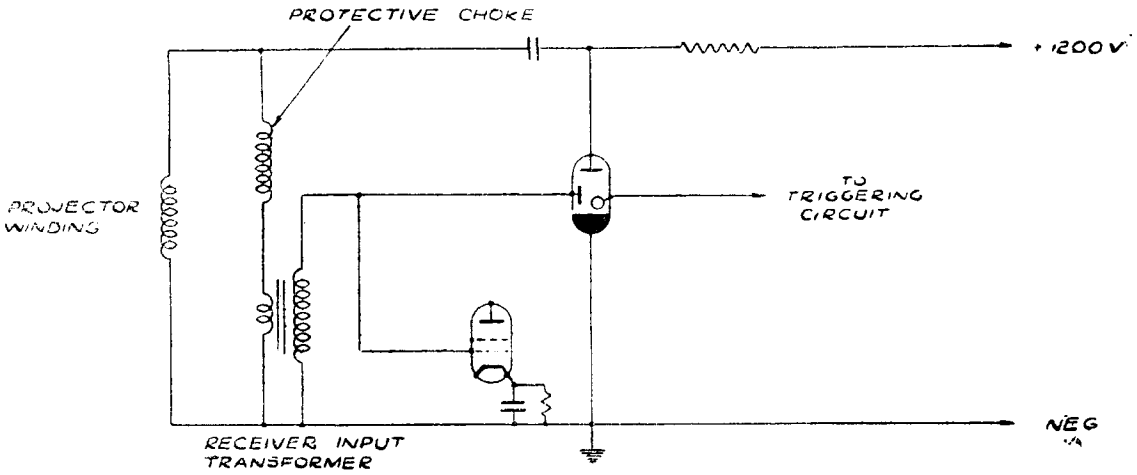


FIG. 6

Marconi transmit-receive circuit showing receiver protection using auxiliary anode of mercury vapour tube.

by virtue of the short-circuiting effect of the transmission current through the mercury tube. The amplifier is thereby short-circuited and protected for the exact period that transmission persists and, obviously, synchronisation is assured. In internal equipments, with a separate receiver, amplifier protection is no longer essential but serves similarly in keeping down to a minimum the effects of transmission on the indicator.

Another feature of the amplifier is a time-swept gain system that automatically reduces the amplifier gain to a very low order when the indicator is showing zero on the scale and permits the gain to increase gradually and automatically at a pre-determined rate related to the progress of the indicator over the depth scale. This device is operated by two additional auxiliary anodes in the mercury vapour switch which as in the case of the protective auxiliary anode, are "grounded" during the period transmission persists through the tube and, again, cannot fail to synchronise. These two auxiliary anodes are each connected to two different voltage dividing systems, one of which fixes the value of the standing negative bias of the second and third valves, and the other that of the fourth valve. They are connected in such a way that, when the auxiliary anodes are grounded by transmission, a condenser (C in figure 7) is discharged and the negative bias to the valves is immediately increased due to the short-circuit, by the mercury tube, of part of the potential dividers connected to the signal grids of the valves. As soon as the mercury switch extinguishes, the increased valve bias is gradually reduced

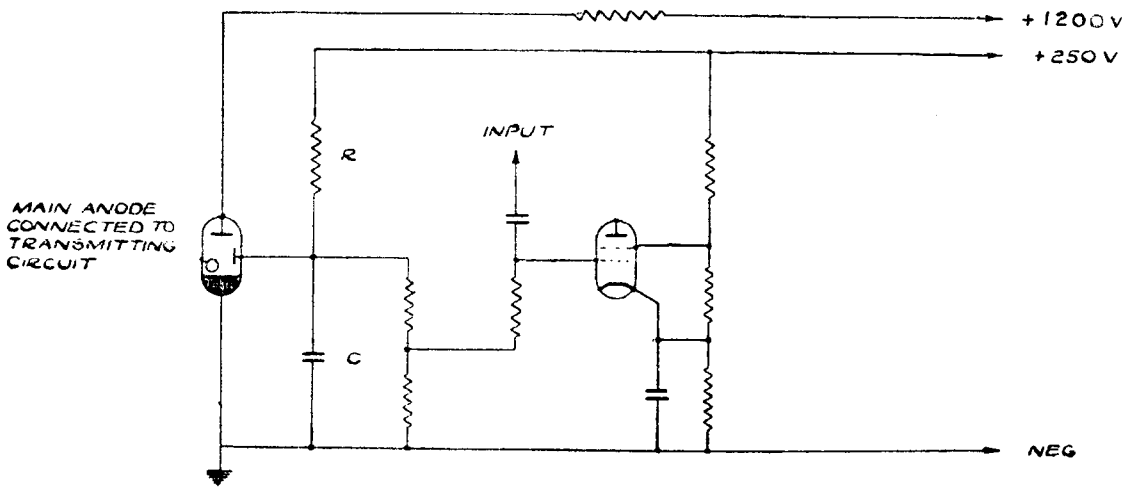


FIG. 7
Marconi receiver swept gain system controlled by auxiliary anode of mercury vapour tube.

at a rate controlled by the C. R. constant of the circuit. Final smooth control of the amplifier gain is obtained manually by means of a variable resistance connected so that the negative bias of the first valve may be varied over a fairly wide range.

Indicators. — The indicator used with Type 838 Projectors and Type 839 Transceivers may be either a recording type, or non-permanent visual presentation, as desired. The latter type is known as the "Seavisa", and the former the "Seagraph" equipment while, if both types of indicators are fitted with one transceiver only, the equipment is named "Visagraph". In the latter case, either indicator is selected at will by means of a Switch Unit Type 843.

Marconi "Seagraph" recorder. — The Recorder, type 840 series, shown in figures 3 and 8, has a stylus attached to a narrow endless metal belt which is rotated at uniform speed in such a way that the stylus moves repeatedly from left to right across a band of moist chemically impregnated paper that is, at the same time, slowly unrolled in a direction at right angles to the stylus track. The stylus and a stainless steel roller that drives the paper, and which forms the stylus track, are connected across the amplifier output. Whenever the stylus potential becomes positive with respect to the roller, due to the arrival of an echo for example, current flows between the two through the moist paper and a brownish stain is produced on the uppermost side of the paper at the precise point occupied by the stylus at the time.

The forward movement of the paper is very small for each revolution of the belt that carries the stylus. Transmission is arranged to occur at the scale zero once for each revolution of the belt and the marks on the paper, produced by the echoes, join up one with the other and build up a continuous line of soundings. The depth may be read off directly from the calibrated scale on the instrument. Since the stylus moves across the paper in a straight line a completed record shows a compressed but undistorted contour line of the sea bed.

The recorder is driven by a series wound 24-volts motor. It is electrically controlled to run at a uniform speed by means of a centrifugal contact that switches in and out of circuit a resistance which is in series with the input supply to the motor. The latter is connected directly to the source of supply when this is 24 volts and through a suitable resistance when the input is taken from 110 or 220 volts mains. The motor is coupled by a belt drive and friction gears to a drum that drives the stylus belt.

The latter is held taut by a spring loaded jockey wheel and rotates in a vertical plane in a counter-clockwise direction. The gear box is arranged for three

speeds so that each instrument has three ranges. The various types differ, one from the other, only as regards their ranges. These, together with the number of soundings per minute, are as follows :—

TYPE	RANGE 1	S. P. M.	RANGE 2	S. P. M.	RANGE 3	S. P. M.
840	0-150 feet	291	0-150 fms	48.5	0-600 fms	12.1
840-A	0-150 fms	48.5	0-300 fms	25.25	0-600 fms	12.1
840-B	0-60 fms	121.25	0-120 fms	60.6	0-600 fms	12.1
840-C	0-150 feet	291	0-150 fms	48.5	0-750 fms	9.7

The rotating stylus belt also carries a small raised button that operates the key in the ignitor circuit of the transmitter once per revolution of the belt. The button is so placed that it closes the key and thus causes transmission to occur when the stylus is exactly at the scale zero.

A calibrated scale is printed on the record by means of a series of stationary stylii within the paper box, to facilitate reading of the depths, particularly after removal of the record from the instrument. Similarly, one, two or three thick lines appear in the right-hand margin of the record to identify the range on which it was taken. These are produced by applying, regularly, at appropriate intervals and by means of the keying button, the requisite number of voltage pulses to the stylus when it reaches the margin.

The stylus may be made to draw a line across the record simply by pressing a switch which causes a voltage to be applied to the belt. This facilitates identification of soundings at particular times. Additional notes may be made on the record by means of the electrolytic pencil provided.

A switch is provided for bright or dim illumination of the record and scale, for day or night operation respectively. Examples of short lengths of typical sounding records are shown in figure 9.

Marconi "Seavisa" depth indicator type 841-A. — A special neon gas relay tube, type XL-600, is rotated uniformly at a rate of 163 r.p.m. immediately behind a vertical circular dial on the front of the instrument. The dial is transparent at the radius at which an aperture in the neon tube rotates and the fathoms scale adjoins the outer edge of this circular track (see figures 10 and 11). The neon tube is driven by a series wound 24 volts motor, electrically controlled for constant speed by a centrifugal contact. The motive power may be a 24 volts battery directly connected, or 110 or 220 volts mains connected via a suitable resistance. The required speed is obtained through a fixed ratio reduction gear box fitted underneath and integral with the motor.

The fathoms scale covers an arc of 312° at a radius of approximately 4 ½" and, therefore, has a linear dimension of over two feet. It is equally divided into 130 divisions, each 3/16" wide and each representing one fathom, thereby providing a very open scale.

In order to increase the range of the indicator and, at the same time, retain the wide discrimination of 3/16" per scale fathom throughout, a phased system is used. By this means an effective scale of over 8 feet long is obtained for a maximum range of 530 fathoms. There are five phases arranged as follows :—

Range 1 : 0-130 fathoms.
— 2 : 100-230 —
— 3 : 200-330 —
— 4 : 300-430 —
— 5 : 400-530 —

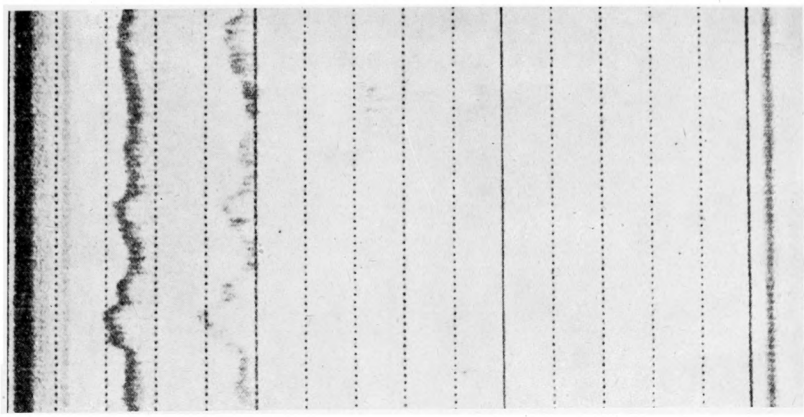
On all ranges the reading is given directly in fathoms. This is made possible by the use of a special scale on which only the appropriate figures for the range in use are visible. The change is made by gearing a disc, on which the numbers are engraved, to the range selector switch.

A cam on the same shaft as the neon indicating tube is arranged to close a keying contact to the transmitter at an appropriate moment (e. g. when the neon tube is at the scale zero, for range 1). When an echo arrives some little time later,

MARCONI " SEAGRAPH " RECORDER

Typical Sounding Records.

Range 1 : Types 840 and 840C (0-150 feet). Type 840A (0-150 FMS.)

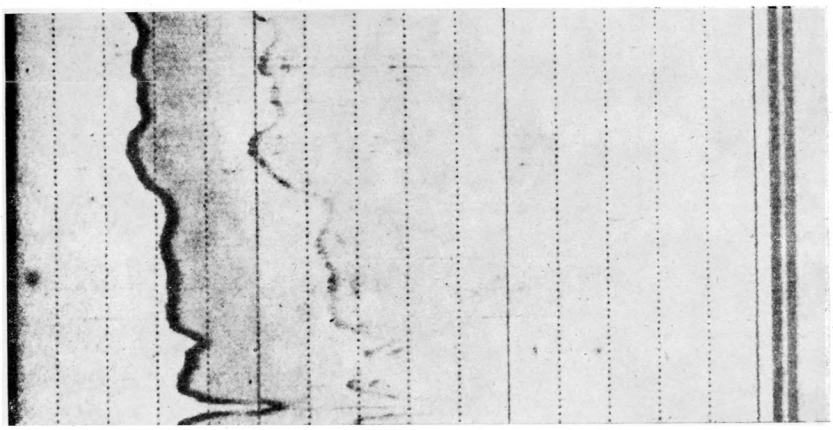


Single line indicates Range 1.

Sounding line Re-echo

Types 840 and 840C : Scale calibration lines every 10 feet.
Type 840A : Scale calibration lines every 10 fathoms.

Range 2 : Types 840 and 840C (0-150 FMS.) Type 840A (0-300 FMS.)

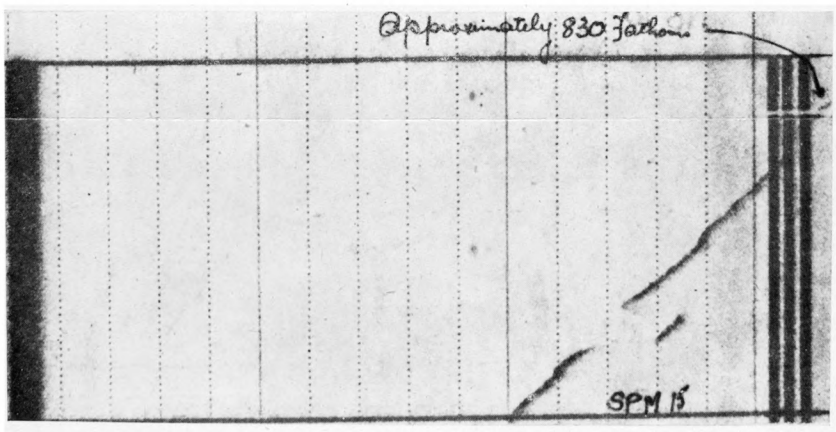


Two lines indicate Range 2.

Sounding line

Types 840 and 840C : Scale calibration lines every 10 fathoms.
Type 804A : Scale calibration lines every 20 fathoms.

Range 3 : Types 840 and 840A (0-600 FMS.) Type 840C (0-750 FMS.)



Three lines indicate Range 3.

Type 840 and 840A : Scale calibration lines every 40 fathoms.
Type 840C : Scale calibration lines every 50 fathoms.

Sounding line

FIG. 9
Typical sounding records taken on Marconi " Seagraph " recorder, type 840C.

FIG. 10
Marconi " Seavisa " depth indicator, type 841-A.

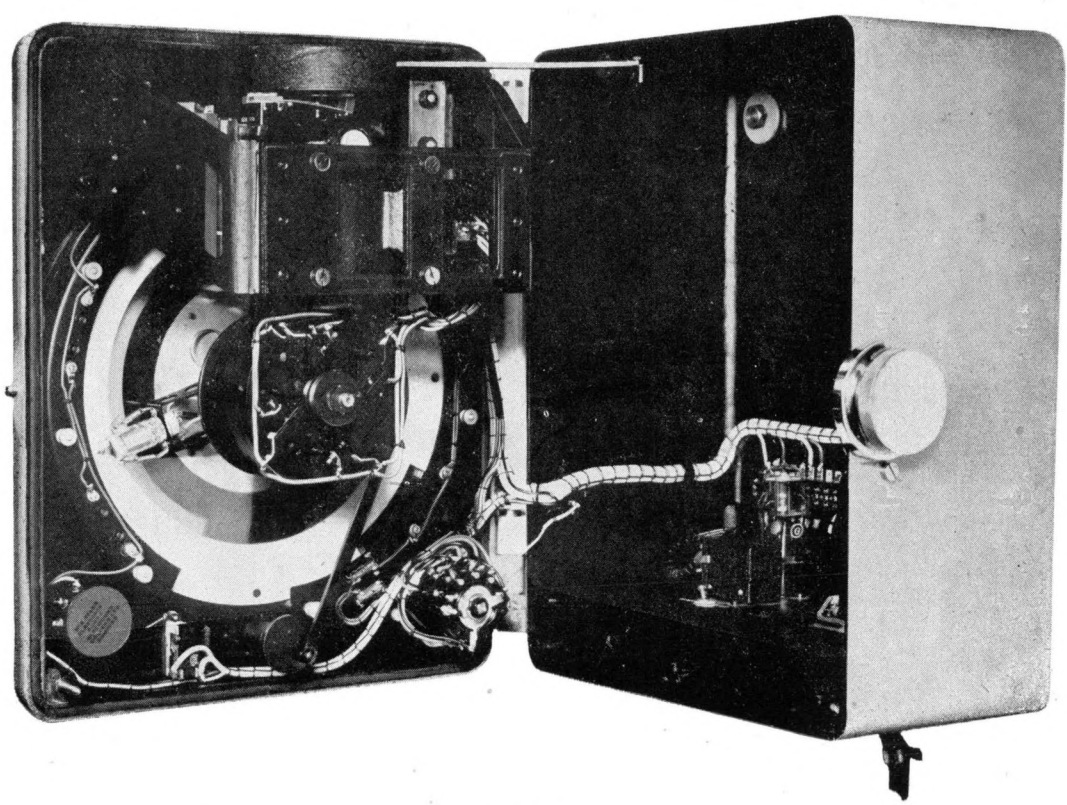
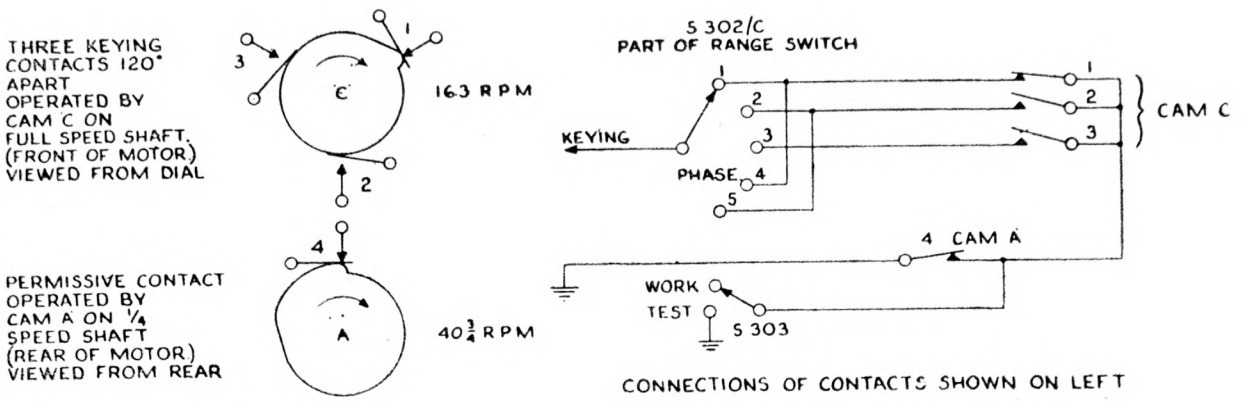
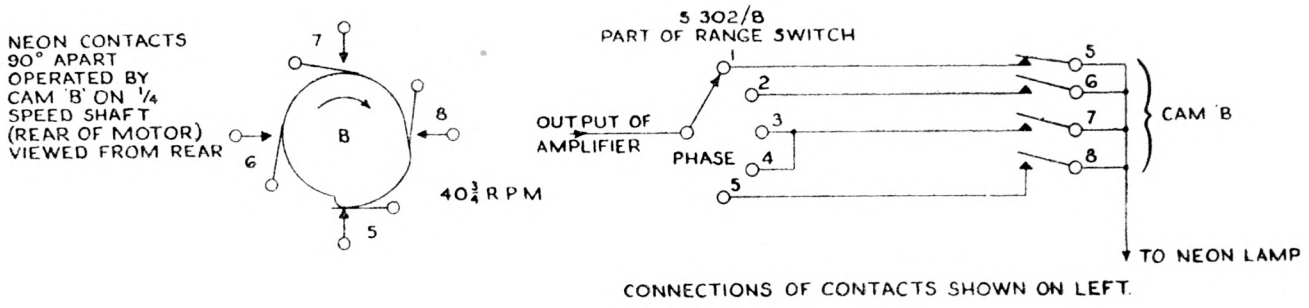


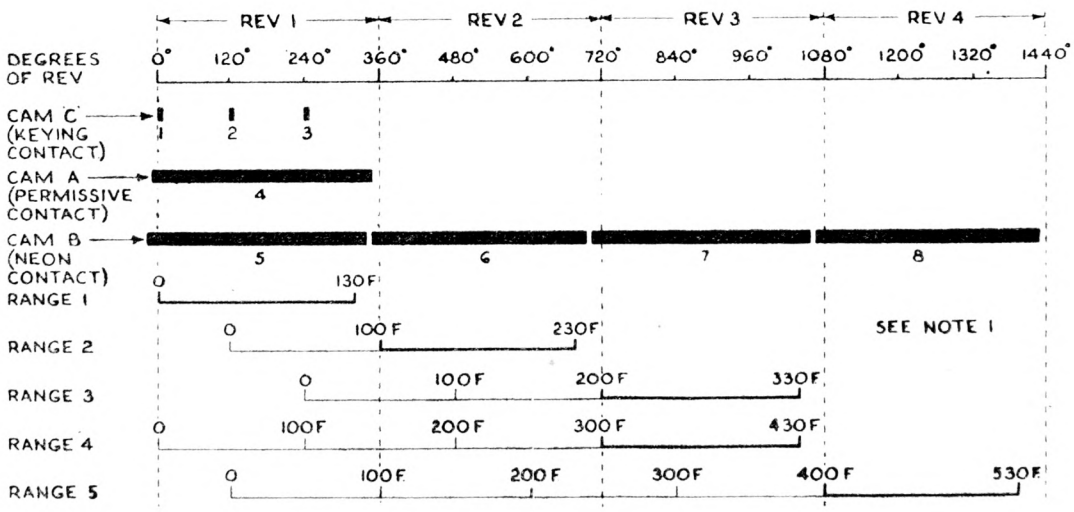
FIG. 11
Marconi " Seavisa " depth indicator type 841-A with door open for servicing.



KEYING AND PERMISSIVE CONTACTS



NEON CONTACTS



NOTE 1.
THICK LINE INDICATES ACTUAL PORTION OF RANGE INDICATED ON SCALE.

RANGE Nº	PHASE Nº	RANGE FATHOMS (SCALE READING)	DEGREES OF REV.	KEYING CONTACT MADE (CAM 'C')	PERMISSIVE CONTACT MADE (CAM 'A')	NEON CONTACT MADE (CAM B)
1	1	0 - 130	0 - 312	1	4	5
2	2	100 - 230	120 - 672	2	4	6
3	3	200 - 330	240 - 1032	3	4	7
4	4	300 - 430	0 - 1032	1	4	7
5	5	400 - 530	120 - 1392	2	4	8

OPERATIONAL SEQUENCE FOR 4 REVOLUTIONS

FIGURE 12 : FUNCTIONAL DIAGRAM OF CONTACT OPERATION OF MARCONI TYPE 841A "SEAVISA" DEPTH INDICATOR

it causes the rotating neon tube to become illuminated for a very short period, of from one to three milliseconds, producing a brilliant line of orange light at the correct position across the engraved scale.

The rectified output from the Transceiver is magnified by a transformer-coupled output stage, contained within the indicator, using an indirectly heated triode valve Marconi type L-63. Its output is connected to the neon tube by means of three slip rings and brushes.

The complete cycle of events within the indicator takes place in four revolutions of the neon tube. Four contacts, electrically in series with the neon, are equally disposed 90° apart around a cam that rotates at 40 ¾ r. p. m. The cam is so shaped that each contact closes in turn for one quarter revolution of the cam, which is equal to one revolution of the neon tube. Only one of these contacts is connected in circuit at one time, the selection being made by the range switch. Echoes can thus be indicated only on the first, second, third or fourth revolution of the tube in the complete cycle, according to the contact selected. As the selection is known the time interval between transmission and receipt of the echo can be accurately measured and there is no ambiguity.

In order to obtain a 30 fathoms overlap between each range, three keying contacts are used, spaced 120° apart around the cam that rotates at 163 r. p. m., the appropriate contact again being selected by the range switch. A further contact is placed in series with the keying contacts and is closed for one revolution and open for the following three revolutions of the neon tube. For mechanical convenience the cam that operates this contact is on the same spindle as that for the neon tube contacts and rotating at 40 ¾ r. p. m. The setting of this cam is such that transmission can occur only on the first revolution of the four in the cycle.

The full sequence of operation of the eight contacts is clarified further in the functional diagram in figure 12.

Provision is made for adjusting the transmission to occur at the scale zero or the vessel's draught, as desired, by means of a knob on the front panel. This is linked to a movable plate that mounts the three keying contacts, so that the radial position of the latter with reference to the cam that activates them may easily be adjusted to advance or retard transmission as required.

The rate of soundings on all ranges is 40 ¾ per minute.

A "work-test" switch is included, that, when in the "test" position, short-circuits the permissive contact which is in series with the keying contacts. Transmission then occurs once for *each* revolution of the neon tube and, as this will be indicated on the dial at different positions for different ranges, according to the keying contact selected, a ready means is provided for checking that the contacts remain in correct phase and are functioning properly. At the same time, provided each range is tested, this also checks that the neon tube contacts are each in satisfactory order.