ATLAS ECHO SOUNDERS

General characteristics of Atlas Echo Sounders.

Magnetostrictive oscillators are used throughout for transmitting and receiving. These oscillators are made up of a stack of thin oxidized nickel laminations with slots for the winding. The rectangular radiation surface may be seen in Fig. 1. The oscillators are installed in a hole of the ship's skin or in a stream-lined fairing fitted to the hull on the side of the keelson. This mode of installation minimizes the losses which are always associated with radiating sound through the shell plating. The transmitting oscillator is excited by the discharge of a condenser. The oscillatory energy of the resonance circuit consisting of the discharge condenser and the self induction of the winding of the oscillator is converted into mechanical oscillatory energy of the nickel pack within about two oscillations. The transmitting oscillator in turn imparts this energy to the adjoining water in the form of a damped wave train of approx. 1 millisecond duration. The efficiency of this conversion is somewhat below 50 %. In comparison with the excitation of the transmitting oscillator by keying a valve oscillator it is an advantage of the above mentioned method of excitation that the maximum amplitude of oscillation is arrived at very rapidly. A steep rise of the transmitted impulse is desirable for exactly measuring the interval of time required for the return of the echo.

The cable length between the discharge condenser and the oscillator should not exceed 20 metres as the self induction of the cable will otherwise be too high in a relation to the self induction of the oscillator and the strength of the generated sound pulse will suffer. Therefore aboard large ships, the high-tension source, the discharge condenser and the emitting switch actuated by a relay assembled in a separate casing (high-tension exciting unit) are installed in the hold near the oscillator. In installations in small ships it is possible to incorporate the discharge condenser and the transmitting switch in the sounder casing eliminating the relay for the transmitting contact.

In case a special receiving oscillator is provided it is fitted at a small distance from the transmitting oscillator. If depths below 1 metre are to be measured, e. g. in surveying a river, the distance between the transmitting and receiving oscillator is reduced to about 30 cm. To an increasing extent, installations are provided with a common oscillator for transmitting and receiving in order to save costs and to facilitate the installation of the oscillators in the ship's skin. In this case the minimum depth which can be measured is approx. 1 metre.

In most installations the emitted sound signal has a frequency of 30 kilocycles. In echo sounding apparatus intended for the measurement of depths below 150 metres, especially in apparatus for the survey of coastal waters and rivers, a frequency of 80 kilocycles is employed. As the error in measuring depths by echo is cet. par. proportional to the wave length of the sound, in this case, the accuracy of measurement is increased. Moreover, oscillators operating at a frequency of 80 kilocycles are smaller and easier to install than oscillators operating at 30 kilocycles.

The well-known method of rotating a neon tube along a circular scale is used for the visual indication of the depth. « Teledeltos » chart paper, a product of the International Standard Electric Corporation, New York is used for recording. As in the case with the well-known electrolytic paper impregnated with a solution of potassium iodide, « Teledeltos » paper is blackened when an electric current is passed through it, without it having to be moistened on account of the chemical substances involved. The advantage of a continuous recording of the depth passed over, especially on board fishing vessels and for the detection of shoals of fish is easily seen. Therefore, besides the simple echo sounders solely providing either for visual indication or recording of depths, the recording method has been combined on the one hand with the visual indication of the depth on a circular scale and on the other hand, especially for fishing vessels, with the enlarged representation on the screen of a cathode-ray tube of a small depth range, which can be shifted along the depth scale. In recorders markings are produced by means of a marking stylus consisting of a tungsten wire of 0.2 mm. diameter which is moved across the recording paper along a straight line by means of a rubber-coated endless belt running over two pulleys at uniform speed.

As the circular length of the belt is in general four times the width of the chart paper and a sound pulse is transmitted for each revolution of the belt, the sounding period, that is the interval of time between pulses, is four times the period required by the marking stylus to traverse the chart paper. Depending on the type of the apparatus the width of the chart paper varies between 125 and 180 mm.

Two methods are employed in order to change the scale range of the sounders. The first of these methods is employed with the recording echo sounders. The sound pulse is normally released by a contact cam at the moment when the marking stylus passes the zero-line of the graduation on the chart paper. In case depth has increased beyond the fundamental range so that the echo arrives only when the marking stylus has moved across the chart paper, the echo will no longer be recorded. By means of a selector switch other cam contacts are now made operative which advance the moment of the pulse emission by 1, 2 or 3 times the period which is necessary for the marking stylus to pass over the width of the chart paper. The possibility is thereby acquired of recording in any one of the partial measuring ranges all echoes arriving until the emission of the following sound impulse, the interval between impulses being four times the time necessary for the marking stylus to pass over the chart paper. It is an advantage of this method that the scale of the records is the same for all the partial measuring ranges. The total measuring range obtained by this method is four times the fundamental range corresponding to the width of the chart paper.

Although likewise applicable to recorders, the second method is preferably applied to the visual indication along a circular scale by means of a luminous pointer. This method consists in reducing the speed of revolution of the gearing so that for instance the time taken for one turn of the neon tube is 10 times the period normally required and the interval of time between the emission of sound pulses is augmented in the same ratio. The scale range is extended to 10 times the original value; however, the scale length remaining the same, the reading of depths are less accurate. For practical reasons, the speed of the driving motor is kept unaltered and only the gear ratio is changed by means of an electromagnetic clutch actuated by the selector switch.

This method is made use of both to enlarge the scale range of the visual indication and in order to obtain a clearer picture of the profile of the seabed with rapidly changing depths, which would require a frequent shift of the partial measuring ranges obtained by the first method.

In the Atlas echo sounder, for surveying purposes, provision is made for varying the speed of the marking stylus by interchangeable gears. By this means the sounder may be adapted to various tasks requiring different magnitudes of the fundamental scale range simultaneously while retaining its simplicity of construction.

The speed of the driving motor, the constancy of which determines the accuracy of the depth measurement, is controlled by a centrifugal governor.

The degree of maximum amplification is chosen at such a level that it is possible to record only slightly the noise level caused by thermal fluctuations in the input circuit. Normally, the noise level originating from the ship's course through the water sets a lower limit to the degree of amplification to be utilized. Provided that a location of the oscillators reasonably free from interferences by water noises has been chosen, it is important that a high degree of amplification be available for the detection of the weak echoes originating from fish in large depths. The resonance of the receiving oscillator combined with that of the circuits of the amplifier causes a selection of the emitted frequency relative to the frequencies of the interferences with increasing selectivity; however, the building-up time at the receiving end is augmented and is accompanied by a diminution of the accuracy of the time measurement and the sensitivity for a given pulse length. Therefore, the degree of selectivity chosen results from a compromise between opposite requirements.

The « Teledeltos » paper and the use of the cathode-ray tube borrowed from the technique of radar are only the outer signs of the progress made since the end of the war. In addition, the general progress of engineering has made possible a reduction of the dimensions of the apparatus and of electrical power consumption so that there is no difficulty in operating the equipment aboard small fishing vessels from the ship's battery. Due to the use of subassemblies in the form of separate units installed in a common casing which can be easily exchanged, maintenance and repairs are facilitated.

In conclusion reference is made to development work aiming at improving the characteristics of the recording method for special purposes. It is a disadvantage of the « Teledeltos » paper, which it has in common with other recording methods, that the range of amplitudes of the received echo intensities, which is represented by a different degree of blackening of the paper, is comparatively small. From the different amplitudes obtained at the amplifier output for any setting of the gain control only a small portion, corresponding to the amplitude ratio of 1 :3, is recorded with a perceptibly different degree of blackening ranging from a light grey to a deep black. The output amplitudes below this level are not recorded, whereas the higher amplitudes are recorded in a uniform black. By means of an amplifier of special design which produces a recording current which increases more slowly than proportionally to the receiving amplitude, or which records the total range of amplitudes in two or three clearly distinguishable steps of blackening, differences can be detected between echoes, the intensity of which is above or below a critical value which can be selected at will, even when using a high degree of amplification. This has an important application when recording shoals of fish occuring close to be seabed, as the markings obtained from

these frequently merge with the recorded depth line when using the normal method of recording and cannot be distinguished from elevations of the seabed.

This improved method of recording is also interesting when it is necessary to investigate the stratification of the seabed, that is the thickness of the mud and sand layers above the solid ground. This method resembles the procedure of applied geology when prospecting for ore and oil by means of sound waves. Of course the energy used for echo sounding only penetrates to small depths below the seabed. Nevertheless, data can be obtained as regards the structure of the seabed and the modifications it has undergone in the course of time. In order still better to differentiate between layers, the method has been improved by simultaneously taking soundings with different frequencies, as for instance 30 and 80 kilocycles, which have a different power of penetration for different kinds of soil. It is thus possible to obtain a more detailed record of the individual layers than when using only one frequency.

A list of the sounders manufactured by the *Atlas-Werke A.G.*, Bremen, and of their characteristics is given below.

Prefatory note to list.

(1) If the distance between sounder and transmitter does not exceed about 20 metres as on small vessels, the high-tension transmitting unit may by incorporated in the sounder casing. Otherwise, a separate casing is provided.

(2) Visual indication is obtained by rotating a neon tube along a circular scale. Recorders utilize electrographic « Teledeltos » paper.

(3) « Small vessels » signifies vessels up to about 500 tons.

(4) Scales and chart paper gratuated in fathoms are likewise available.

(5) Power supply voltages may be 12, 24, 110 or 220 volts direct current or any value of alternating current voltage.

(6) Sounders are manufactured for either one or the other alternative.

(7) The different ranges are obtained by means of a selector switch.

(8) The fundamental range may be altered by interchangeable gear wheels.

Description of the various echo sounders manufactured by The Atlas-Werke A.G., *Bremen*

Monotype.

With this sounder, depth is indicated by means of a neon tube rotating along a circular scale. A simplified model of this sounder, having two scale ranges of 0-100 m and 0-1000 m, selected by switching, which is particularly intended for installations aboard coastal vessels, is made up only of the indicator unit and 1 or 2 oscillators. The indicator unit incorporates all component circuits in form of exchangeable assemblies, viz. : the motor with gearing, keying contacts and indicator disc; high-tension supply unit and discharge condenser for the excitation of the transmitting oscillator; the amplifier; the power supply unit; the control assembly with control knobs, voltmeter, etc.

Monograph.

With this type, depth is measured by recording. As this sounder is intended for operation abord small vessels, the circuit for shock excitation of the transmitting oscillator is incorporated in the casing of the recorder. The speed

of the paper advance is 30 cm/hr. The sounder is shown on Fig. 2 and 3 with cover closed and open respectively.

Echograph.

This sounder records depth by the same method and is intended for large ships. For this reason a special casing is provided for the circuit for shock excitation of the transmitting oscillator.

Duotype.

In this sounder visual indication of the depth, which can be seen from a considerable distance, is combined with a recorder. The choice among the available scale ranges (see foregoing list) depends upon whether the sounder is merely used for ship's navigation or whether this equipment will be used on board a fishing vessel. It is possible solely to operate the visual indicator, the frequency of the sound pulses being increased automatically. Gear shift to slow speed for changing the scale range to 0 to 1000 m. is effected by means of a magnetic clutch. Fig. 4 and 5 show the sounder closed and open with indicator disc removed.

Fishfinder.

This sounder combines two methods of observation which experience has shown to be useful for fishfinding, namely recording the echo signals and an enlarged representation of the undistorted echo image of a small section of the depth comprising a partial range of 25 m., the position of which can be chosen at will. In fishing with a trawl this section is shifted to give an image of the water layer immediately above the seabed.

The mode of operation of the Fishfinder may be seen from the schematic drawing in Fig. 6. Different scale ranges can be selected for recording by phasing the transmitting contact or by changing over the magnetic clutch 2. The closing of contact 14 determines the beginning of the vertical travel of the luminous spot across the screen of the cathode-ray tube 17, which occurs once during each sounding period. This contact is mounted on a disc which can be rotated by means of a control knob and a cable connected with this disc moves a pointer 18 along the graduation of the chart paper, thereby indicating the position in depth of the section seen in enlargement.

Figures 7 and 8 show views of this sounder. The scale ranges of this sounder will be found in the preceding list.

Surveying echo sounder.

This sounder is intended for the use of hydrographic offices and is specially designed for precision measurements. In order to make the markings on the graduated chart paper correspond to true depths the speed of the marking stylus must be adjusted to be in definite relation to the speed of sound in water. The latter is found from a table giving its value as a function of the temperature and the salt content of the water. The speed of the driving motor and, thereby, that of the stylus is adjusted according to this value by means of a control knob, the speed being indicated by a vibrating-reed frequency meter which instead of a frequency scale, is provided with a scale of sound velocities ranging from 1400 to 1560 m. per sec.

In order to preclude the possibility of a constant error being present in the recorded depths the position of the stylus in relation to the graduation of the chart paper at the moment of the emission must be known exactly. For this purpose, on each emission a short electrical impulse is transmitted to the marking stylus causing a point to be marked at the beginning of the first partial depth range, whereas the signal due to the direct excitation of the receiving oscillator is effectively suppressed. The individual point markings merge into a thin line which, by means of a control knob displacing the transmitting contact, can be shifted to a depth value which may be made to equal the draft of the oscillators, for instance, in order to obtain direct recordings of the depths relative to the surface of the water in all partial ranges. The moment of the emission can be advanced in from 1 to 3 steps by means of exact displacements of the transmitting contact so that the width of the chart paper will correspond to different partial measuring ranges, e. g. from 0 to 22.5, 20 to 42.5, 40 to 62.5 and 50 to 82.5 m. In addition, it is possible to change the speed of the marking stylus and consequently the fundamental scale range corresponding to the width of the chart paper according to the maximum depths occurring in the survey so that, after decreasing the speed to one fourth of the normal value, the following scale ranges will be available by using the selector switch: 0 to 90, 80 to 170, 160 to 250, 240 to 330 m.

In the model having a fundamental scale range of 18 metres, 1 cm. of the chart is equivalent to 1 metre of depth. The speed of the paper advance can be adjusted to 2.5 or 5 cm. per min. By pressing a button a line running transversally across the width of the chart paper can be drawn in order to mark spots of special interest. The glass pane through which the chart paper is seen can be pushed aside so that notes can be made on the chart paper without opening the cover.

Fig. 9 is demonstrative of the easy accessibility of all component parts of the apparatus. The sounder is manufactured for fixed installation aboard a survey vessel or as portable equipment (Fig. 10). The type 646 sounder with separate high-tension excitation unit is intended for use on large vessels and has a somewhat better performance than the type 645 sounder intended for smaller vessels. The choice of the operating frequency (30 or 80 kilocycles per sec.) depends upon the desired accuracy and the maximum depth to be measured. For sounders used on small craft an operating frequency of 80 kilocycles is customary. In order to enable measurement of depths near zero the surveying-echo sounder is always provided with two separate oscillators for transmitting and receiving. The centre to centre distance of the oscillators is 25 cm. for an operating frequency of 80 kilocycles and 35 cm. for 30 kilocycles.

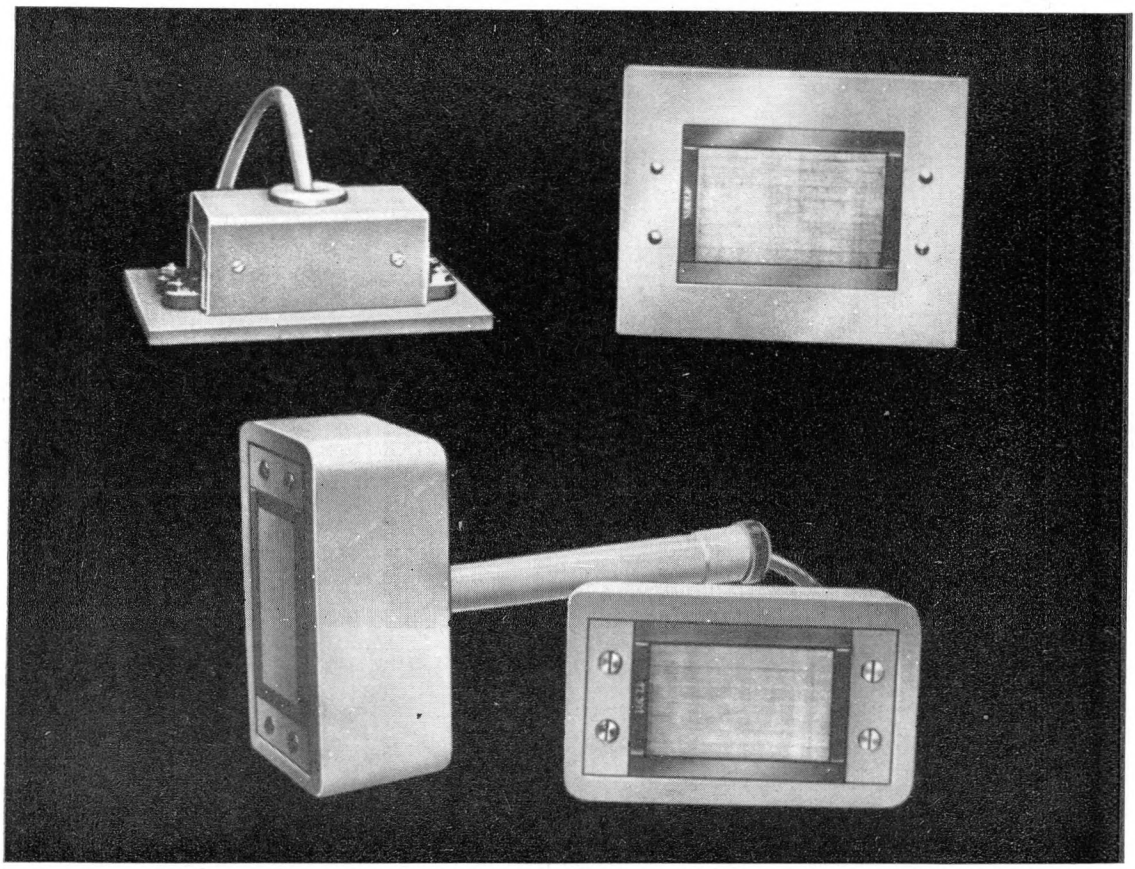

Fig. 1. — Magnetostrictive oscillators, frequency 30 kilocycles.
At the top : for a wooden hull ship.
At the bottom : for an iron hull ship.

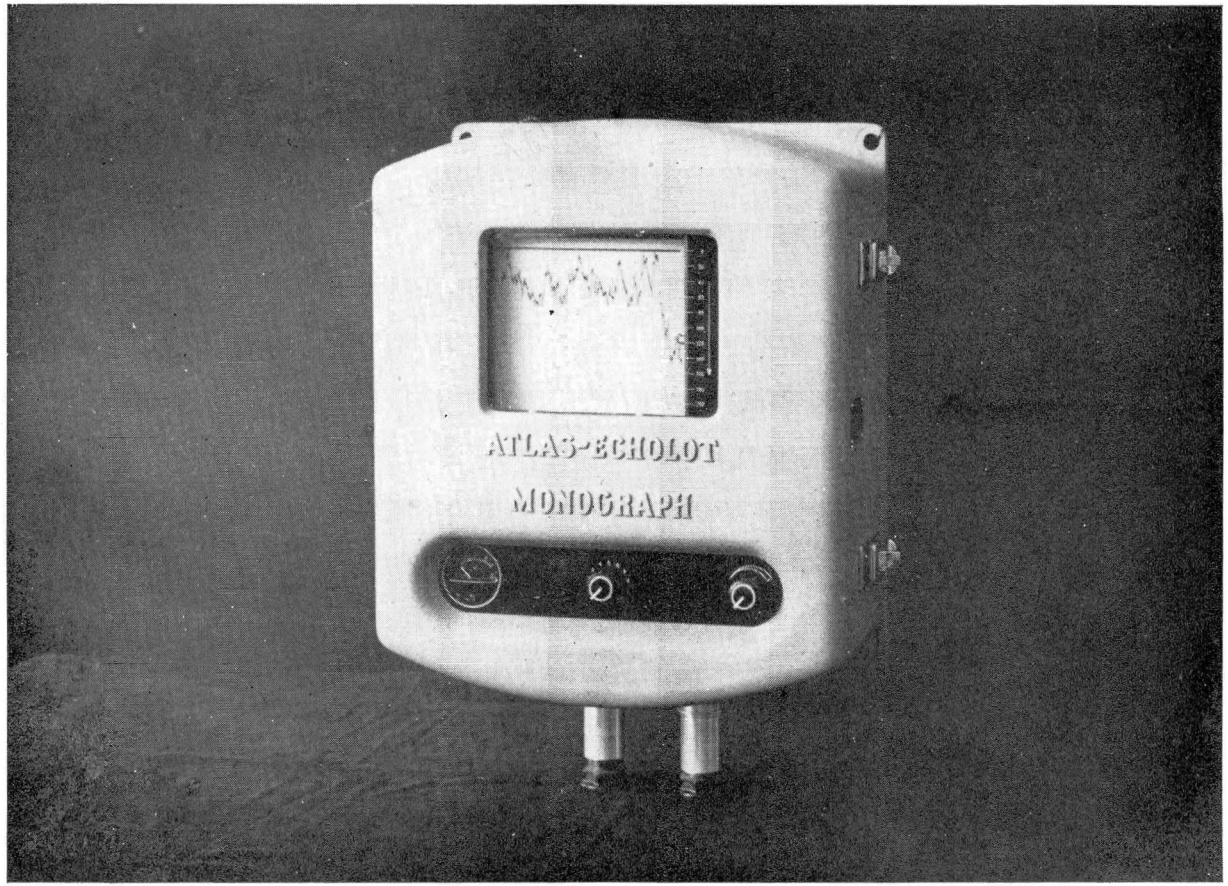

Fig. 2. — Echo-Sounding Equipment « MONOGRAPH »
made by the Atlas-Werke, Bremen.

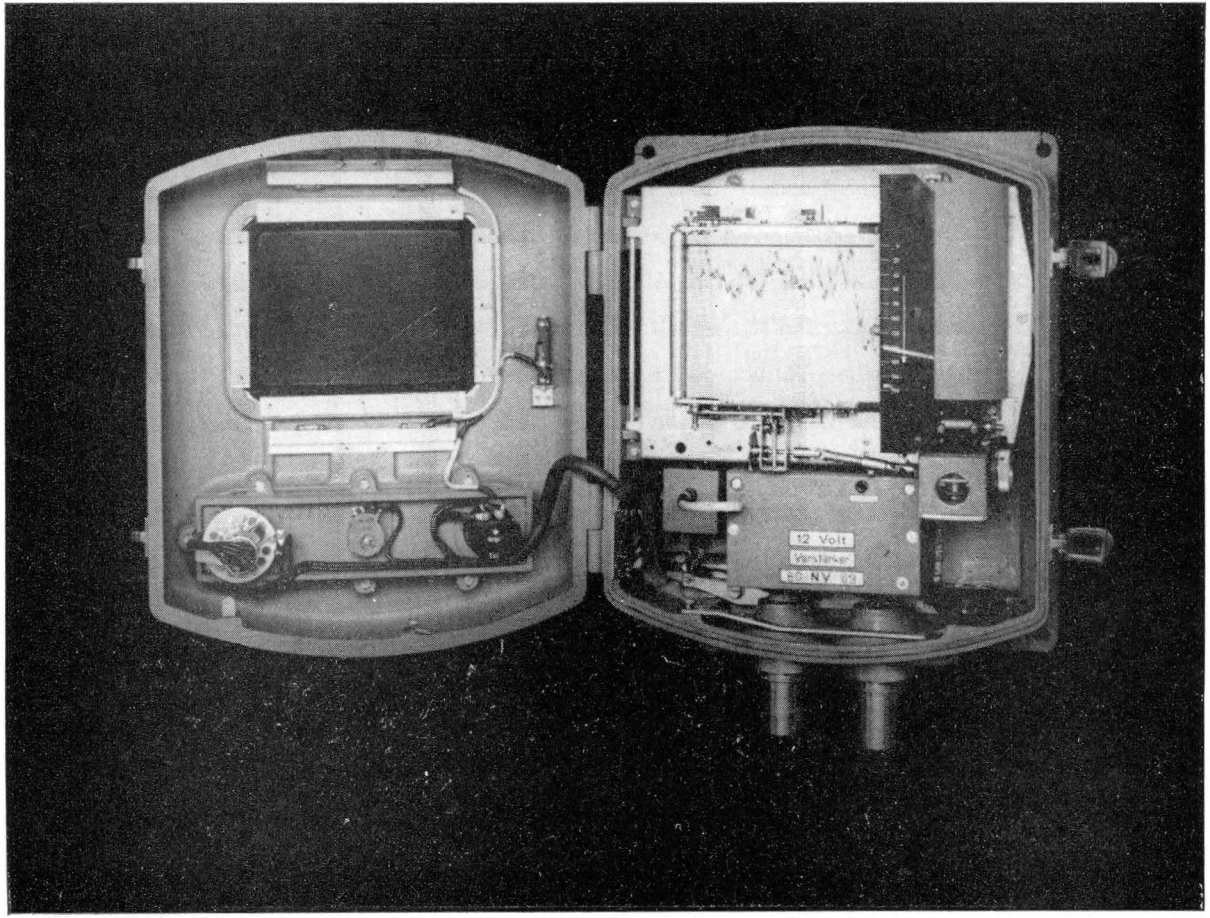

Fig. 3. — Echo-Sounding Equipment « MONOGRAPH »
made by the Atlas-Werke, Bremen.

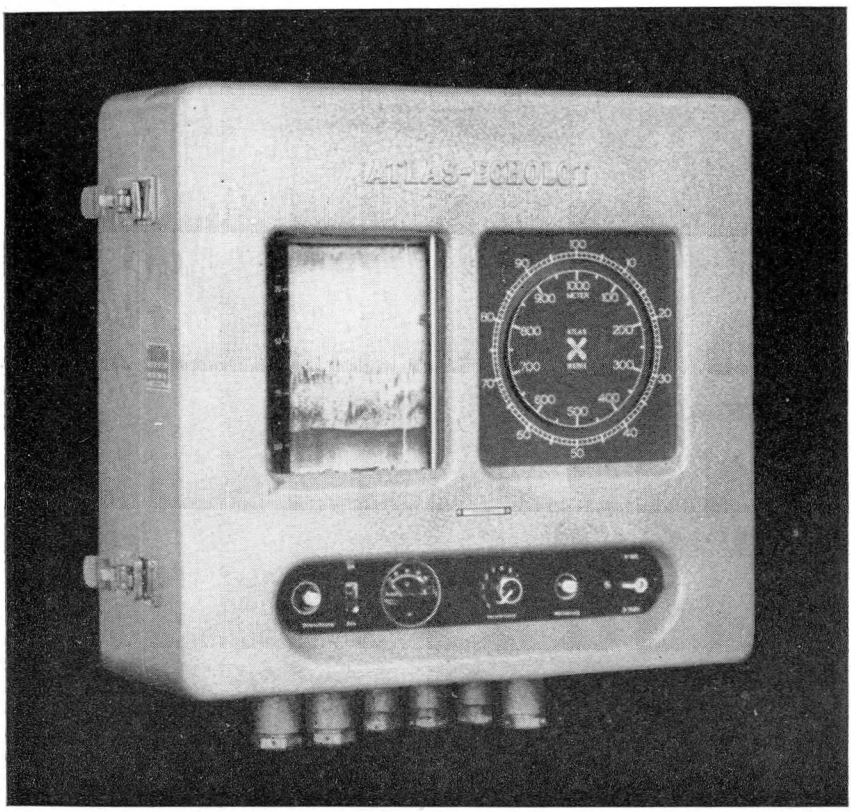

Fig. 4. — Echo-Sounding Equipment « DUOTYPE », made by the Atlas-Werke, Bremen.

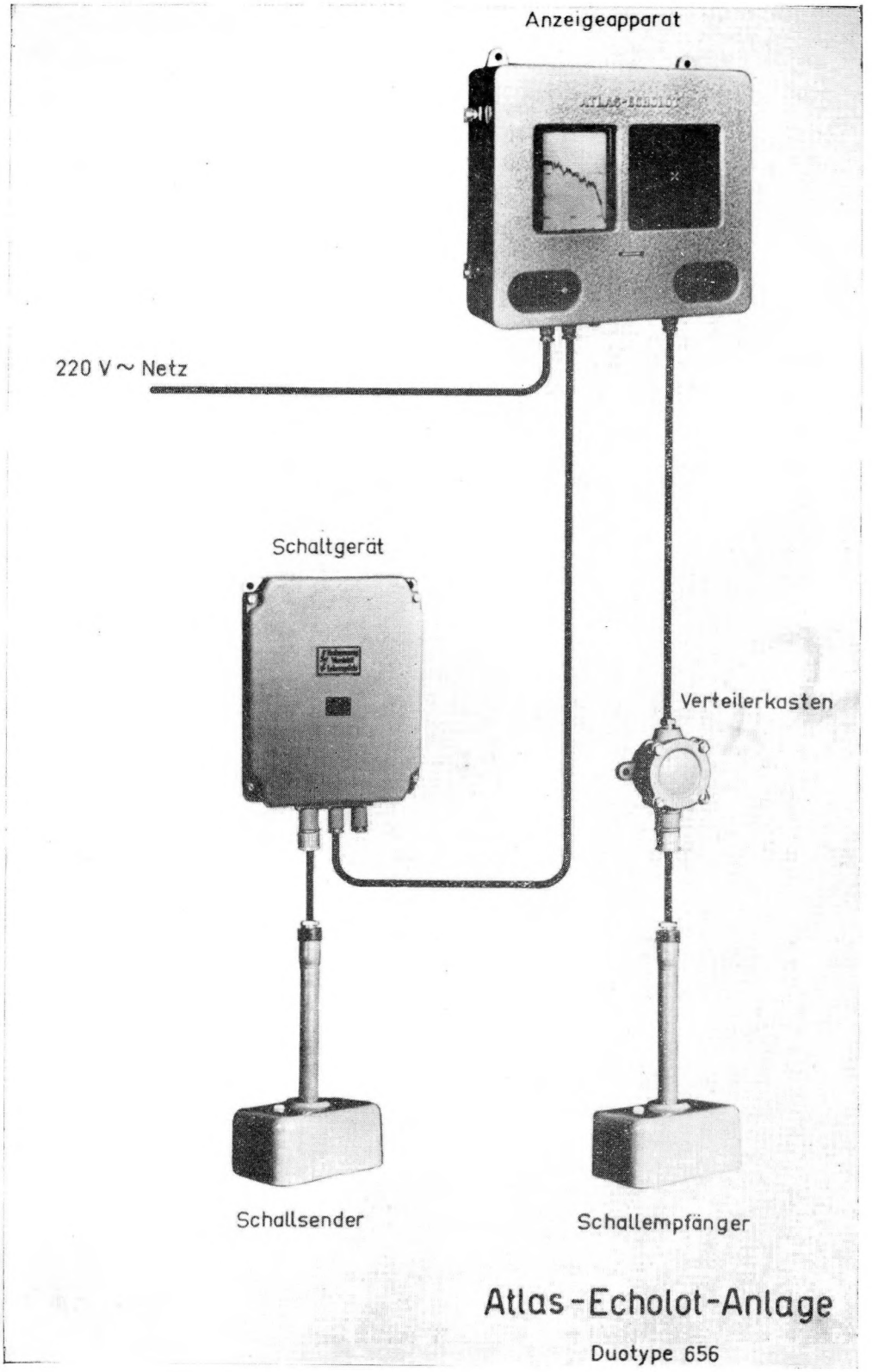

Fig. 4 a. — Echo-Sounding Equipement « DUOTYPE » made by the Atlas-Werke, Bremen.
Complete equipment.

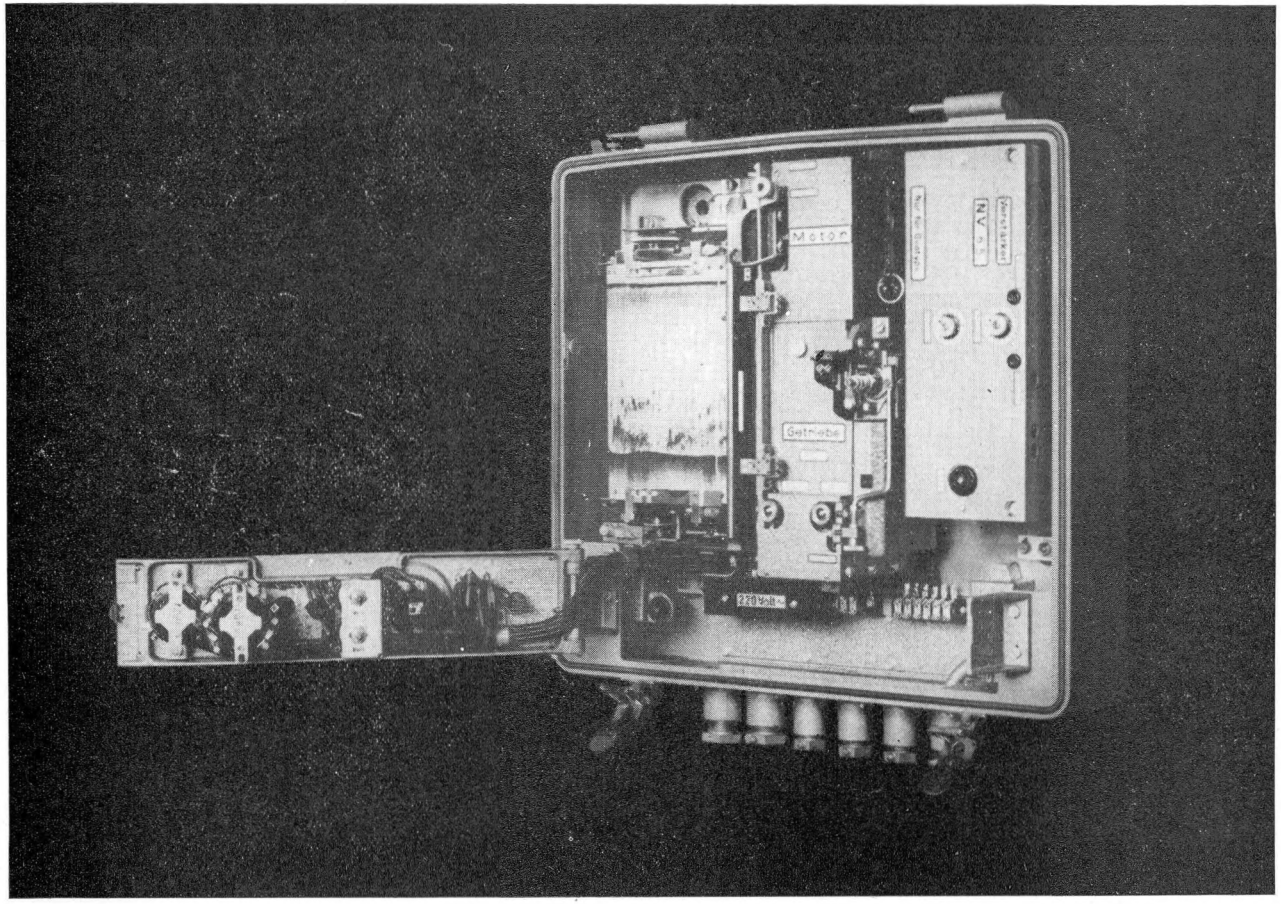

Fig. 5. — Echo-Sounding Equipment « DUOTYPE »
made by the Atlas-Werke, Bremen.
Indicator disk removed.

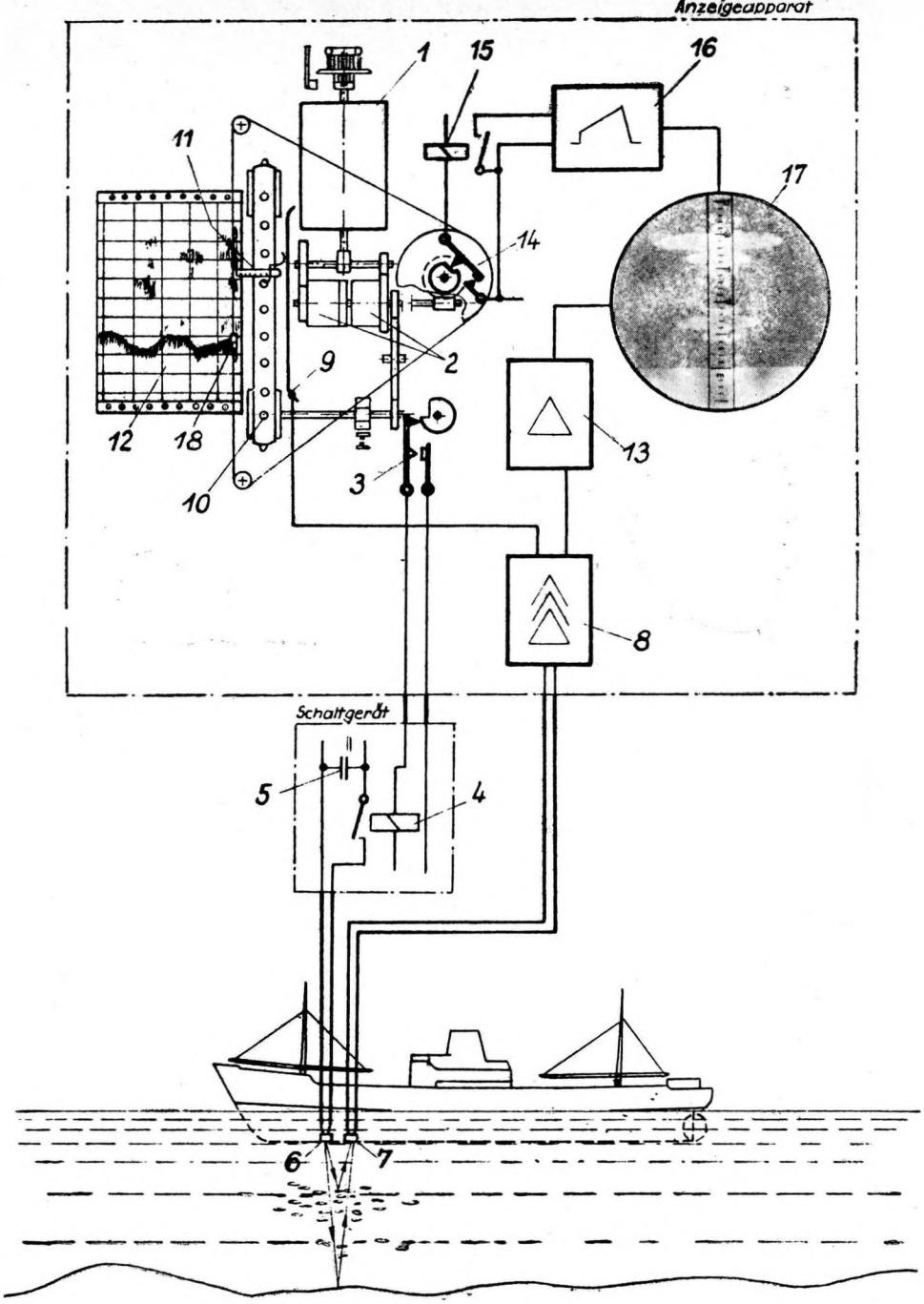

Fig. 6. — Diagram of Atlas « Fishfinder ».

1) Motor with speed governor.
2) Electromagnetic clutch for two speeds.
3) Contact actuating the transmitting relay.
4) Transmitting relay.
5) Discharge condenser.
6) Transmitting oscillator.
7) Receiving oscillator.
8) Amplifier.
9) Lead conducting recording current.
10) Endless belt and driving pulley.
11) Recording stylus.
12) Recording strip.
13) Amplifier for the horizontal deflection of the luminous spot.
14) Rotatable contact controlling the beginning of the perpendicular traverse of the luminous spot over the screen.
15) Sweep release.
16) Sweep generator.
17) Screen of cathode ray tube.
18) Sliding depth mark.

Fig. 7. — Echo-Sounding Equipment « FISHFINDER »
made by the Atlas-Werke, Bremen.

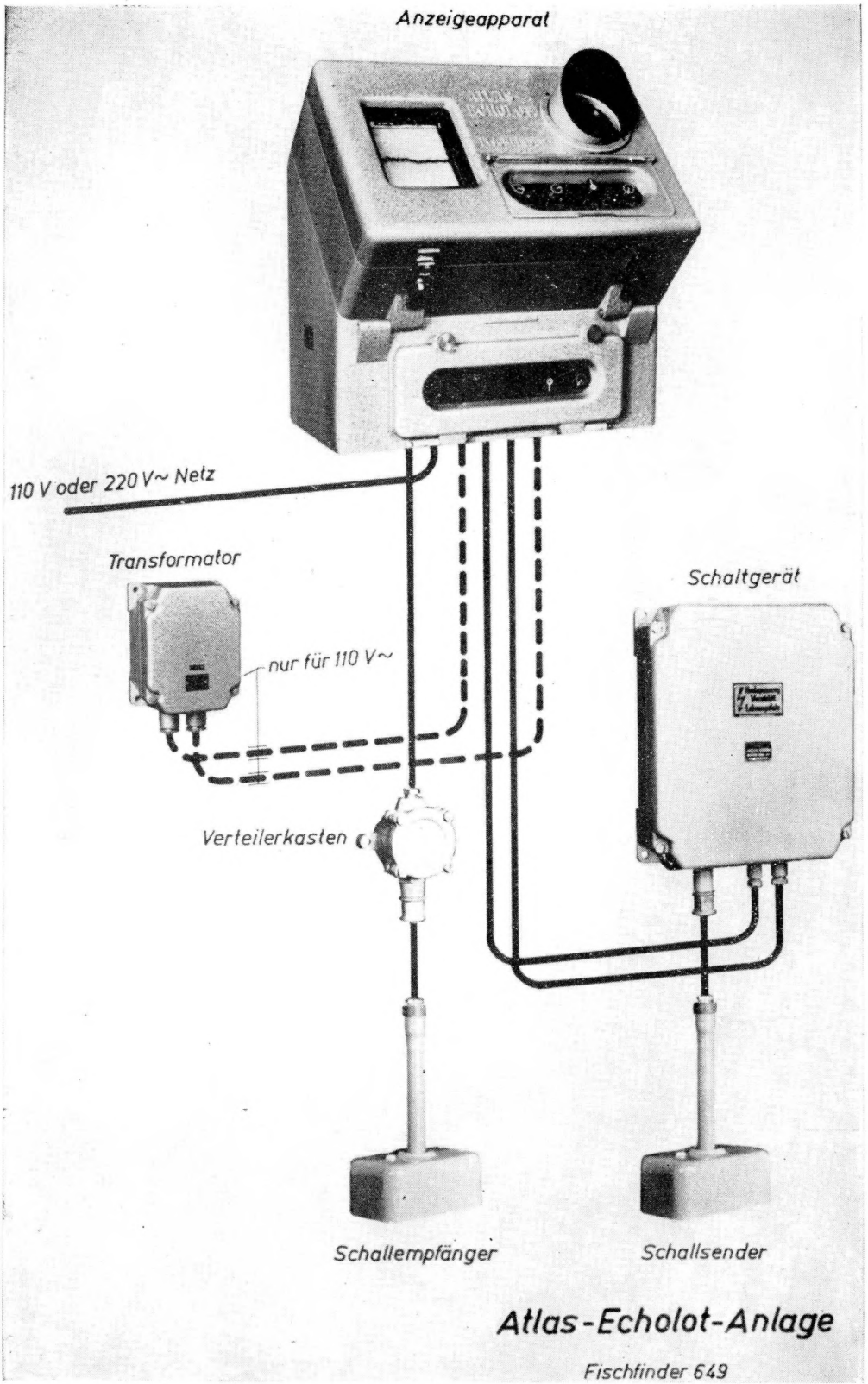

Fig. 7 a. — Echo-Sounding Equipment « FISHFINDER » made by the Atlas-Werke, Bremen.
Complete Equipment.

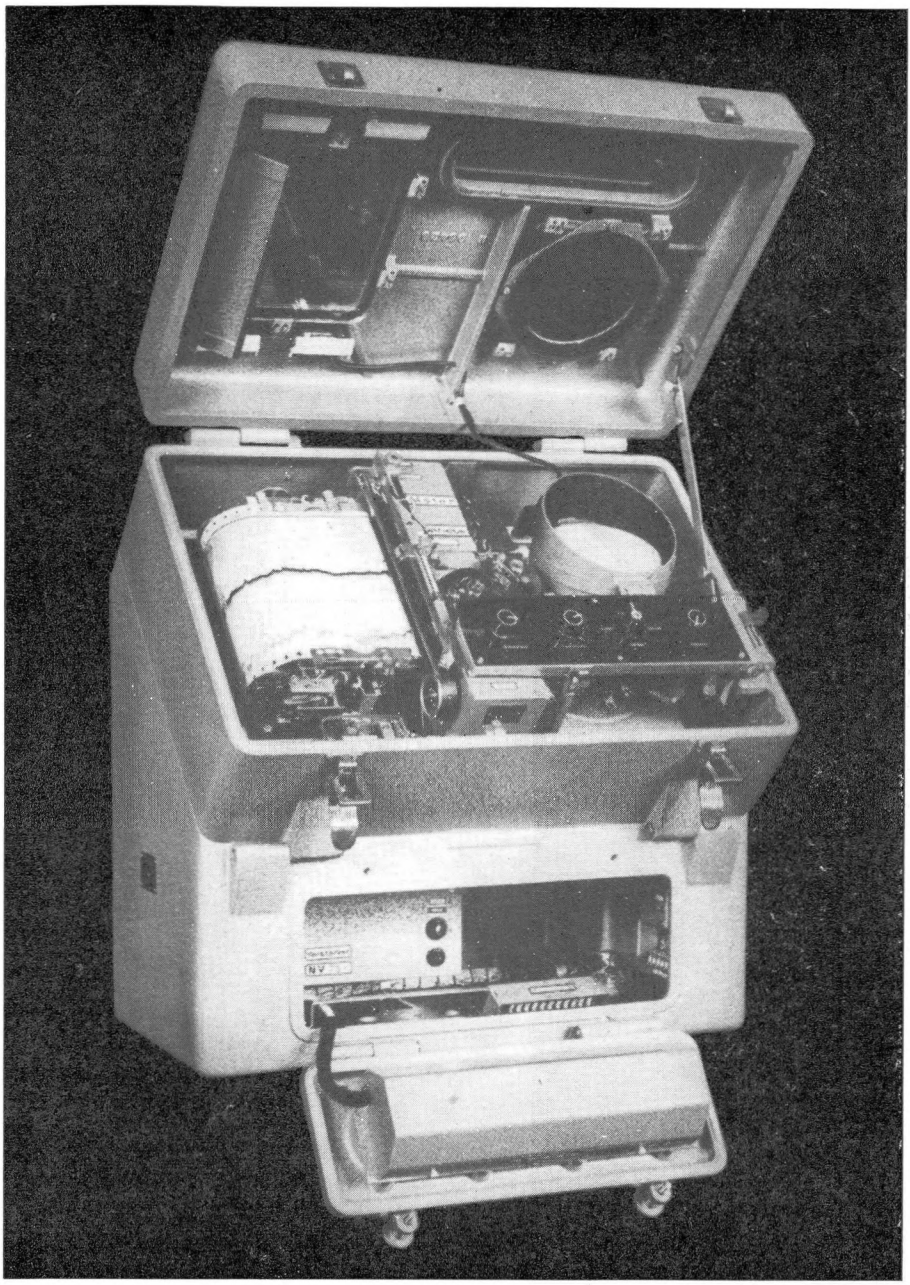

Fig. 8. — Echo-Sounding Equipment « FISHFINDER »
made by the Atlas-Werke, Bremen.

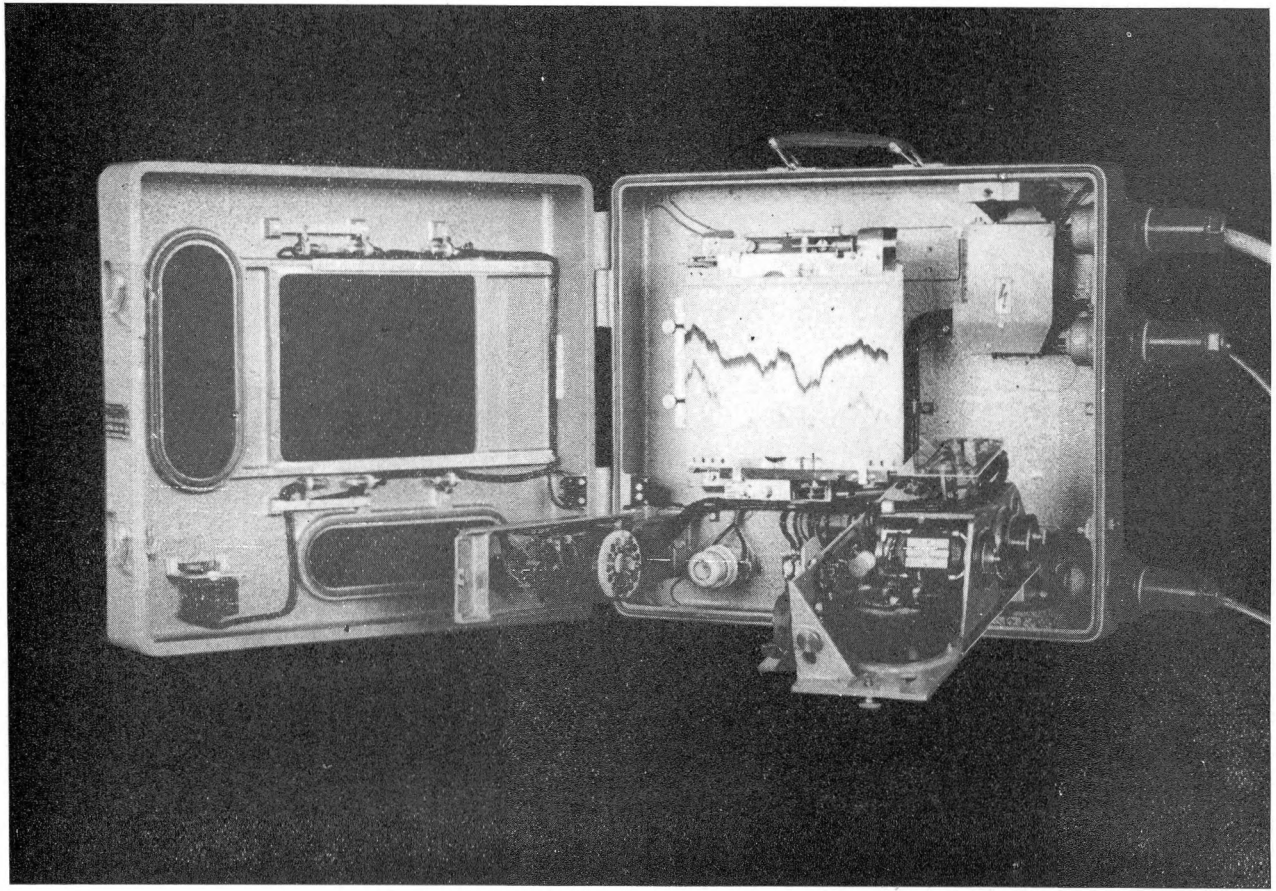

Fig. 9. — ATLAS Surveying sounder.

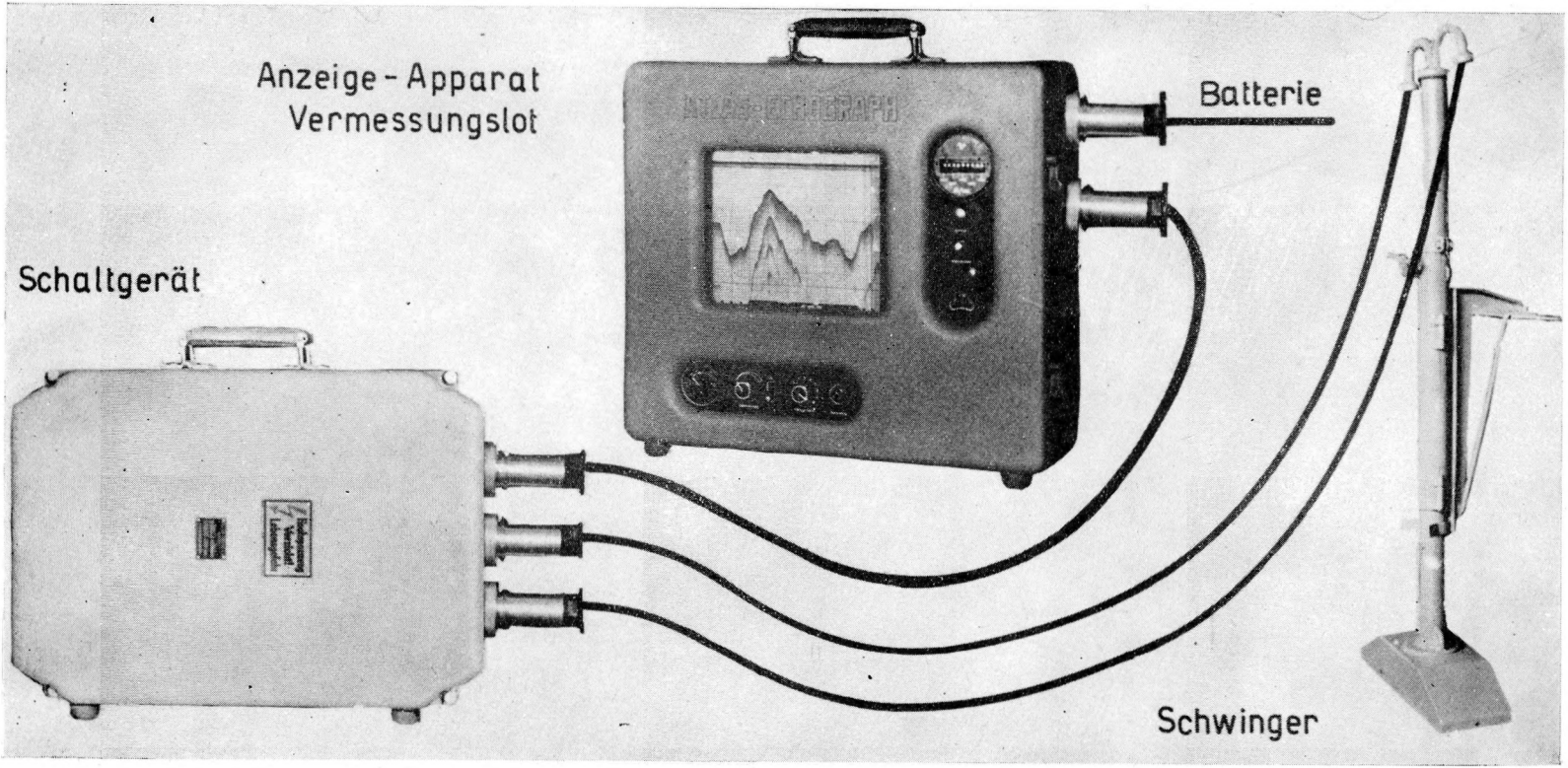

Fig. 10. — Layout of portable type 646 Atlas surveying type sounder.

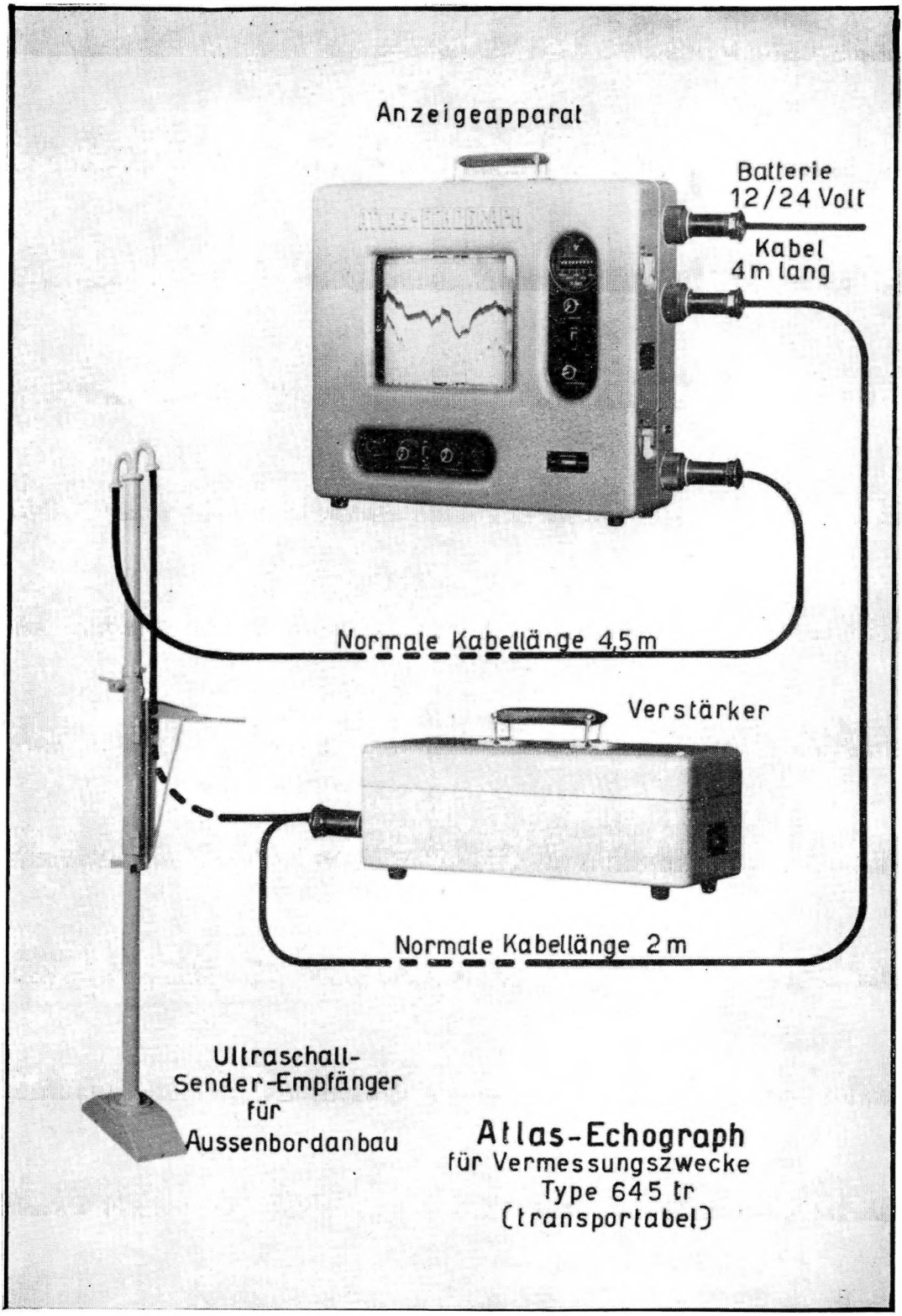

Fig. 10 a. — Layout of portable type 645 Atlas surveying souder.