THE SAINT-CHAMOND-GRANAT PRECISION TIDE-GAUGE

SAINT-CHAMOND-GRANAT TIDE-GAUGE

OF THE NAVY HYDROGRAPHIC SERVICE

as used by

FRENCH POLAR EXPEDITIONS

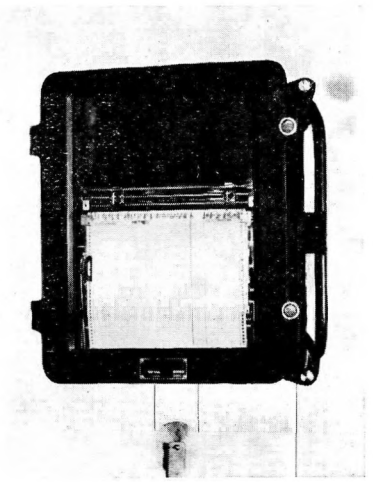


Fig. 1
Front view

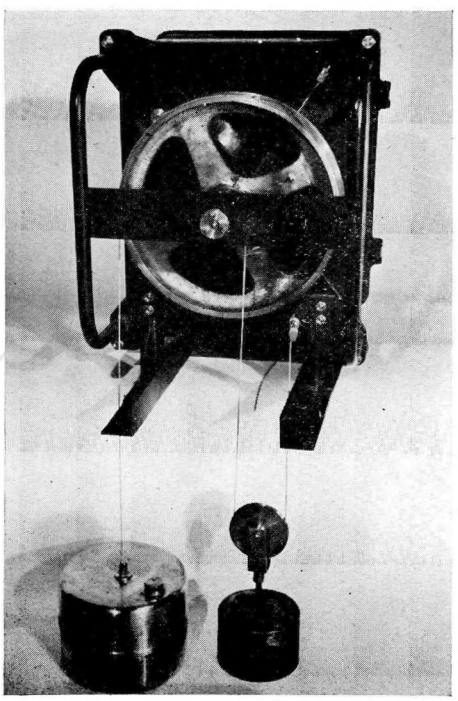


Fig. 2
Back view

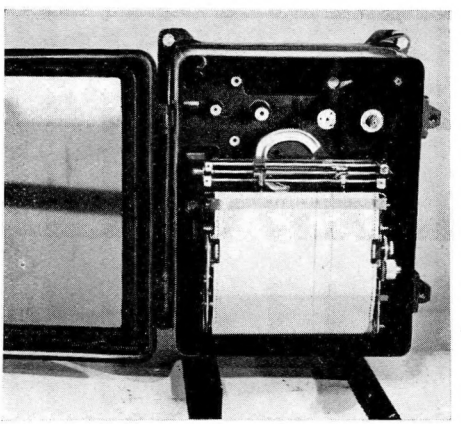


Fig. 3
View with cover open.

The recording mechanism and continuous unwinding tape can be seen.

SAINT-CHAMOND-GRANAT TIDE-GAUGE

PORT OF HAVRE

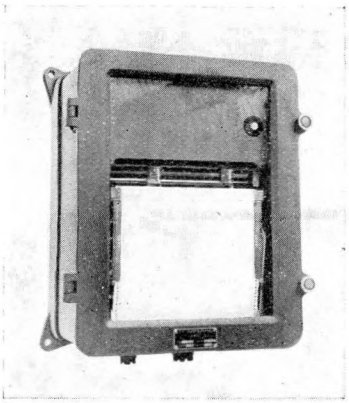


Fig. 4

View of long-distance recorder

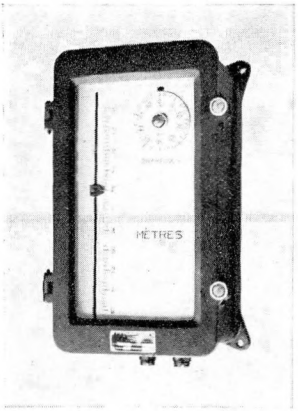


Fig 5

View of long-distance indicator

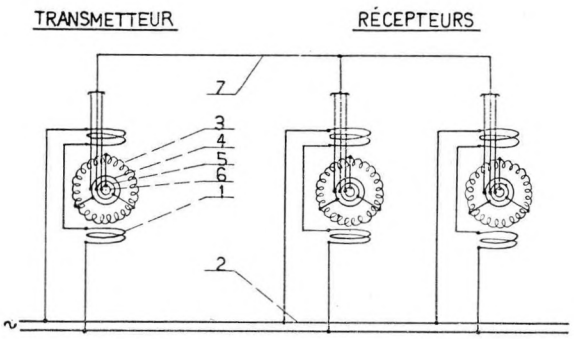


Fig. 6

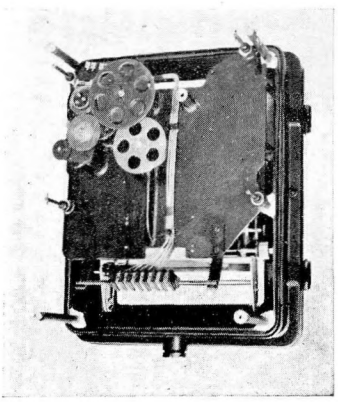
Diagram of synchronous long-distance control device

1. Inductor.
2. A.C. Mains.
3. Rotor.
4, 5 and 6. Rotor rings.
7. Tri-phase lines connecting the rotors of the machine.

Fig. 7

Back view of long-distance recorder with cover removed.

The receiver motor that drives the recording styluses can be seen in the upper left-hand corner.



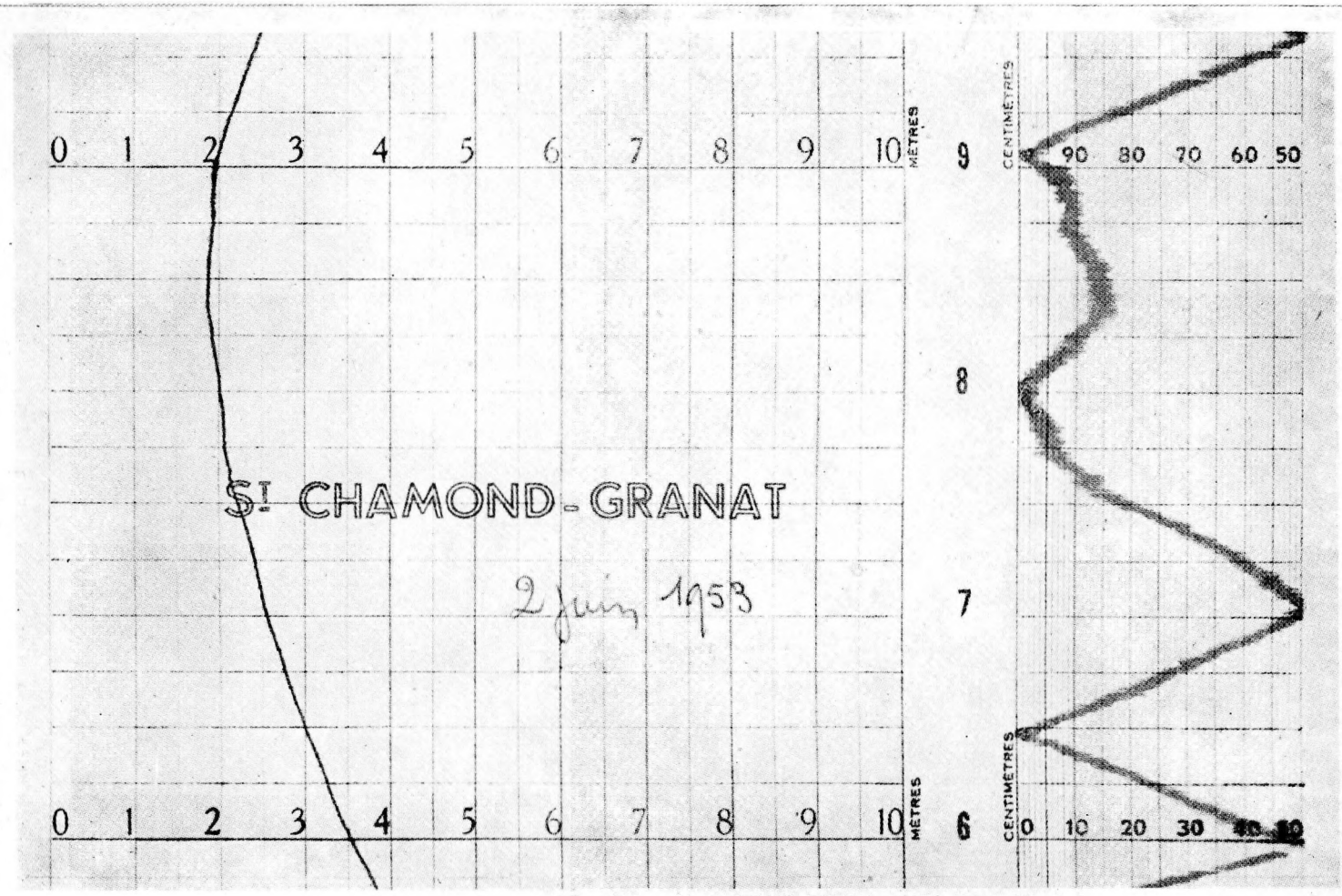


Figure 8 — *Diagramme relevé le 2 Juin 1953 par le marégraphe du Havre (en vraie grandeur)*

Fig. 8. — Full-size reproduction of the record taken on 2nd June, 1953, by the Havre tide-gauge.

THE SAINT-CHAMOND-GRANAT PRECISION TIDE-GAUGE

by Bertrand IMBERT, *Hydrographic Engineer,* French Navy.

The water-level recorders produced by the Saint-Chamond-Granat Company for operation in hydro-electric dams may be used without any alteration for tide recording. This type of tide-gauge is used by both the autonomous port of Havre and by the Navy Hydrographic Service.

The special feature of this apparatus (the sensitive part of which is the float) is its ability to provide, on a comparatively narrow diagram, a constantly accurate record, whatever the range of the tide. It might be useful to give here a description of this simple device, which is particularly interesting in view of the very small load it places on the tide-gauge apparatus.

Several other details will be given concerning this apparatus, as well as a description of the long-distance control device which may be connected with the float for governing from a distance one or more recorders or level indicators..

Another characteristic of this apparatus is the winch to which are attached the connection cables of the float and of the counter-weight. When there is a wide range in the differences of level to be recorded, the progressive winding-up of the cable of the float in the grooves of the drum displaces gradually the suspension point of the float. In order therefore to avoid the rubbing of the latter against the sides of the well, or having to use an over-large well, a drum has been designed with compensating axial movement which prevents the lateral displacement of the suspension cable of the float and consequently any irregularity in the apparatus.

Recording Device

The principle involved is that of the double reading which is to be found in many precision apparatus. A first round reading is made on a wide graduation and the supplement on a closer graduation (Fig. 1, Plate I, ad Fig. 8, Plate III .

For this purpose, the water-level recording tape, which is a little more than 20 centimetres wide, is divided into two parts on each of which a recording is made.

The left-hand part of the tape, which is 15 centimetres wide, is fitted with a rough-estimation stylus which moves transversally to the tape by means of a driving screw actuated by the float through a reduction gear. As the tape unwinds, the stylus traces the tidal curve exactly as in the ordinary tide-gauge. The reduction should be such as to allow for the largest possible tide range to be included within the 15 centimetres of the tape. In the port of Granville, for example, a reduction of 1/100th is necessary; for other ports, 1/50th or 1/20th is sufficient. The record shows the water level in graduations of 50 to 50 centimetres.

On the right-hand part of the tape, which is only 5 centimetres wide, is fitted a second stylus, called a «precision stylus», which is actuated in a backward and forward movement across the tape by means of a cam. When the water level reaches a round metre, which can be seen on the left-hand part of the tape, the precision stylus is at zero; when the level rises, the stylus moves towards the right and, in the event of a 50-centimetre displacement of the float, reaches the extremity of the tape. As the tape is 5 centimetres wide, the record is made on a scale of 1/10th. If the water level continues to rise, the stylus returns towards the left and reaches zero again when the level is once more at a round metre. In this way, the stylus continually traces a tidal curve on a scale of 1/10th, but in order

that the record should be contained within this 5-centimetre band, the curve reverses its track with each rise of 50 centimetres of water.

The smaller-scale curve traced by the rough-estimation stylus is used exclusively for ascertaining in which 50-centimetre sub-division the float is situated and for allowing the general trend of the recording to be more easily followed.

In terms of time, the unrolling of the tape is a continuous movement. It is governed by clock-work action or by means of a synchronous motor, the speed ordinarily used being 10, 20 or 40 millimetres per hour. As soon as the record is completed, the tape is automatically re-wound, thus allowing time for the renewal of the strip without the necessity of superimposing the different records on the same sheet. In order to facilitate the readings, the tape is also divided into numbered graduations printed in two colours.

Long-distance control device

In operations in ports, it is often useful for information regarding the level of the water to be made available to the various port services by means of either dial indicators or of recorders controlled by the movement of the float. For this purpose, the Saint-Chamond-Granat Company uses an electric long-distance control device. This device, incidentally, has been put to many other uses.

The transmitter and the receiver, which are of similar construction (Fig. 6, Plate II), are each composed of a stator (inductor), fed by a monophase alternating current, and a rotor (armature) consisting of a tri-phase coil connected to three rings. They are joined by three conductors leading respectively to the three rings of each of the apparatus and are directly excited by the monophase a.c. mains.

As soon as they are under tension an alternating induction field is created in each of them and this causes induced tension in the winding of the receiver-rotor, which can be regarded as a transformer with mobile secondary winding. If the terminal tension in the three rings of the receiver is not equal, then circulation currents are produced which create a torque in the free rotor. As the transmitter-rotor is connected to the controlling device, it remains in its own position, whereas the receiver-rotor moves until it reaches the corresponding position in which the synchronising currents in the connection lines are reduced to a minimum. Consequently, for each new position of the transmitter, there is a counter-balancing position for the receiver, which moves constantly in time with the transmitter. The adjustment of the apparatus is automatic as soon as the electric power is «on». Several receivers can be used when mounted in parallel.

This long-distance control device, of which the receiver has a high torque, allows for very great accuracy. Centimetre-and even half-centimetre sensitivity can be easily obtained whatever the difference of level to be recorded. This characteristic, which is very useful for tide recording in which the differences of level are sometimes of the order of ten metres, is even more valuable in the case of dams where variations of level may exceed 100 metres. (The apparatus in operation at Tignes is constructed for a difference of level of 150 metres with sensitivity of more than 1 centimetre.)

In addition, the apparatus are sturdily built without any delicate parts and their upkeep can be maintained by a staff of ordinary electricians. Lastly, the system as a whole is not susceptible to line drop.

The apparatus are enclosed in water-tight containers lined with sheet-iron and are equipped with cable feeders through stuffing boxs and hinged observation panels. The extremity of the transmitter shaft is mechanically coupled with the drum which is drawn by the suspension wire of the float. The receivers may be composed of hand indicators with a dial, or by graph recorders.

It is possible to connect a single receiver with two transmitters with a view to producing a differential movement indicator. Such an arrangement might, for instance, be used for recording swell in connection with a horizontal plane by the automatic elimination of the drift due to tide.

Special Arrangements

The tide-gauge of the Hydrographic Service is going to be used for tide recording at MacRobertson Land during the next Australian-Antartic Expedition which is to begin early in 1954. In view of the difficulties which might be encountered in connection with the transport and setting-up of the apparatus, efforts have been made to make it as strudy and compact as possible. Accordingly, the system of drum and counter-weight actuated by the vertical movement of the float has been arranged on the rear side of the recorder container. The drum face has fine grooves in which the cable of the float is wound. The cable is made of 1.8 mm. stainless steel. The counter-weight weighs 12 kilos and acts in a ratio of 1 : 10 to balance the torque of the float. The latter is cylindrical in shape and has a diameter of 20 centimetres. Figs 1, 2 and 3 of Plate I show this special arrangement.

It should be mentioned that this tide gauge will be mounted on the ice-pack as in the previous expeditions (1) and that consequently the float will not be used.

In addition, the recording table of the tide-gauge has been tested in a refrigerated chamber at a temperature of less than —40°C. by the French Polar expeditions. The mechanism had been lubricated with Saint-Gobain 500 D.C. silicone oils, the freezing point of which is somewhere around —60°C. Under these conditions, the clockwork movement lost one minute every 24 hours, whereas with the same adjustment at a temperature of + 19°C, it had gained 10 seconds every 24 hours.

The long-distance control tide-gauge of the autonomous port of Havre consists of a long-distance recorder of the same type as the previous one, but with an auto-synchronous receiver. Fig. 7, Plate II, shows the rear part and the control mechanism of the apparatus. A long-distance indicator (Fig. 5, Plate II) is added to this recorder. The index moves in front of a rectilinear scale which indicates the approximate height of the tide while a hand allows for this reading to be made with an accuracy of within 1 centimetre. It is interesting to note that the recording apparatus itself can include a direct-reading indicator.

Fig. 8 shows in full-size a curve taken on 2nd June, 1953, by the tide-gauge installed in the port of Havre.

(1) See Information Bulletin IV, 5 May, 1952, page 197, of the « Comité Central d'Océanographie et d'Etudes des Côtes (C.O.E.C.) ».