DESCRIPTION AND DIRECTIONS FOR USE OF THE MERCURY TIDE GAUGE

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I. — *GENERAL INFORMATION.*

Designed more especially for tide recording to supply the needs of hydrographic expeditions, this instrument can operate unwatched during 30 consecutive days.

The recording operation is effected by means of a pen which writes with ink on an endless strip of paper 30 centimetres (12 ins.) wide unrolled at the rate of 20 millimetres (0.8 in.) per hour by a weight-actuated clock. The strip is graduated in advance in water-levels and time, so that the reading of the tide at any moment is immediate.

The instrument consists of (Fig. 1) :

A metal bell deposited on the bottom of the sea, somewhat deeper than the level of the lowest low water.

A mercury registering pressure gauge installed on land close by the foreshore.

A watertight pipe line, full of air, communicating between the two former devices, and thus transmitting to the pressure gauge the pressure of the air imprisoned in the bell, from whence the water level may be deduced.

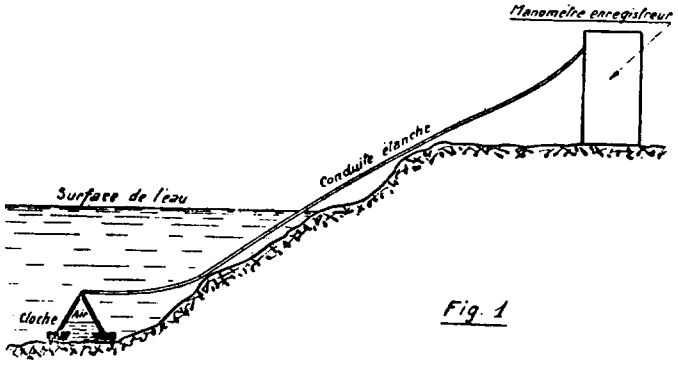

Fig. 1

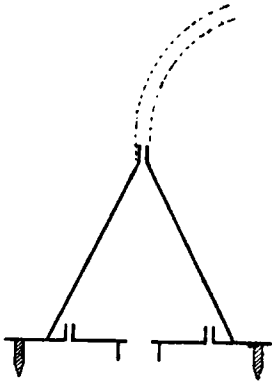

Fig. 2

II. — *DESCRIPTION OF THE VARIOUS COMPONENT PARTS.*

1. THE BELL.

Owing to the compressibility of the air imprisoned in the bell, the variations in the height of the tide are accompanied by small variations of the

level of the water within the bell. In order to avoid errors in the recording of the tide resulting therefrom, the size and shape of the bell are such that the water in it shows variations in level practically equal to a hundredth part of the variations of the tidal movement, and the graduation of the registering strip is proportioned in such a way as to correct automatically by 1/100 of its value the pressure recorded by the pressure gauge; thus all occurs as though the instrument were to indicate exactly the variations of the water-level.

Made of galvanized sheet-iron, the bell consists of a conical casing welded on to a rigid bed plate (Fig. 2). The vertex of the cone terminates in a special fitting to which the pipe line connecting the bell with the pressure gauge is joined up. At the four corners of the bed plate, spikes are secured to anchor the bell to the ground; a certain number of orifices are drilled in it to allow the water to penetrate from below into the bell.

In cold countries, a layer of oil is maintained on the water within the bell, to prevent the evaporation of the water and its condensation in the pipe line. In order to retain a certain quantity of this oil within the bell when topping it up with air as explained farther on, the lateral orifices of the base plate are fitted with bits of tubing directed upwards into the bell, the central orifice, on the other hand, having a bit of tubing of larger diameter directed outwards.

2. THE PIPE LINE.

The pipe line may, if necessary, be several hundred metres long. It consists of a canvas-covered rubber hose of relatively small section, housed in a flexible casing. The latter, shaped like a long spiral spring with joined turns, is made simply by the winding in spirals of a stout copper or galvanized iron wire round the rubber hose.

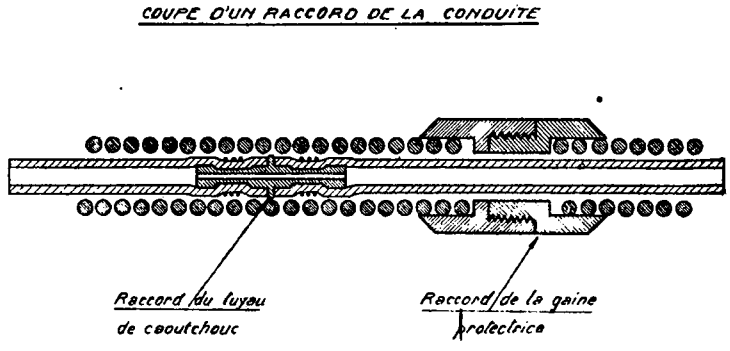

Fig. 3

The pipe line is supplied in pieces 10 to 20 metres long, which are joined end to end in the following manner (Fig. 3):

Having drawn the ends of the rubber hose to be joined somewhat out of their protecting sheath, they are pushed over and carefully bound to the ends of a small brass tube devised for that purpose which is to be found among

the accessories of the tide gauge. Then, after introducing the rubber hose thus joined up into the protecting sheath, the threaded ferrules of the latter are simply screwed together. Each piece of pipe line carries at one end a male ferrule and at the other a female ferrule. Arrangements are made for the male end of one section of pipe line to be joined for preference to the female end of the next; if, however, it were to become necessary to join sections of pipe line ending in similar ferrules, double male or double female adaptors, such as will be found among the accessories of the tide gauge, should be used.

In cold countries, although the precaution may have been taken to maintain a layer of oil within the bell in order to protect the imprisoned air from moisture, it is advisable to insert in the pipe line, for preference at a short distance from the exit from the sea, an exsiccating flask primed with calcium chloride.

3. THE REGISTERING PRESSURE GAUGE.

MANOMETRIC DEVICE :

The pressure of the air contained within the pipe line is measured by a mercury pressure gauge (Fig. 4) the ascending branch (*A*) of which is open to the atmosphere, the descending branch (*B*) being subjected to the pressure it is required to measure.

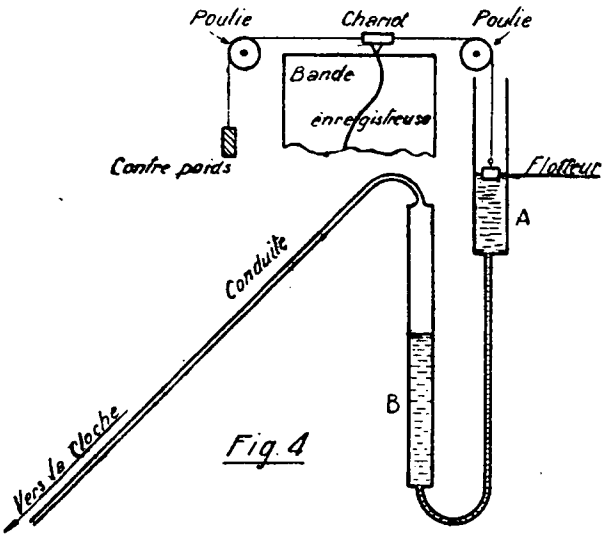

Fig. 4

In order to reproduce on the recording strip the variations of the measured pressure, the apparatus has a movable carriage on a horizontal slide connected by fine threads passing over small blocks, on the one hand to an iron

weight floating in the mercury of the open branch (*A*) of the pressure gauge, and on the other hand to a counterpoise weight which keeps the threads taut. The thread connecting the carriage to the float of branch (*A*) must be unstretchable; it is made of very thin wire (German silver, diameter 15/100 $^{m}/_{m}$ =0.006 in.) a small reserve of which is to be found among the accessories of the tide gauge.

On the other hand, the thread connecting the carriage to the counterpoise may be a plain sewing thread.

The counterpoise which keeps the threads taut is guided into a small vertical chimney consisting of a brass tube on the left-hand side of the framework of the apparatus.

The scale of the heights recorded depends on the ratio of the diameters of the tubes (*A*) and (*B*) of the pressure gauge. As a rule, the tide gauge is provided with one single open tube (*A*), but with three closed one (*B*1), (*B*2), (*B*3). The recording of the tide is obtained:

With the first of these tubes on the scale of 1/60 for which the divisions of the graduation of the strip are equivalent to heights of 30 centimetres (12 ins.), this graduation extending from 0 to 15 metres (45 feet);

With the second of these tubes on the scale of 1/40 for which the divisions of the graduation of the strip are equivalent to heights of 20 centimetres (8 ins.), this graduation extending from 0 to 10 metres (30 feet);

With the third of these tubes, on the scale of 1/20 for which the divisions of the graduation of the strip are equivalent to heights of 10 centimetres (4 ins.), this graduation extending from 0 to 5 metres (15 feet).

The instrument is therefore always usable in advantageous conditions of sensitiveness, whether a small or a large range of tide be concerned.

REGISTERING DEVICE:

By means of perforations on the edge of the recording strip, the latter is moved at a precisely determined speed by a toothed roller securely adjusted on one of the pinions of a robust circular spiral balance-wheel clock. The motive power of the clock is furnished by the slow descent of a heavy weight of oblong shape, suspended by an endless chain (Fig. 5); a comparatively light counterpoise keeps the idle parts of the driving chains taut, thus ensuring the proper meshing of the chains with the teeth of the pinions. A crank, to be found among the accessories of the tide gauge, enables the heavy weight of the clock to be wound up when setting the apparatus going.

The path of the weights is such that the instrument can keep going for 30 days without being wound up; this property is particularly valuable when it becomes necessary to install the apparatus absolutely unwatched in a place where there is no certainty of being able to return regularly, for instance on an isolated rock out at sea.

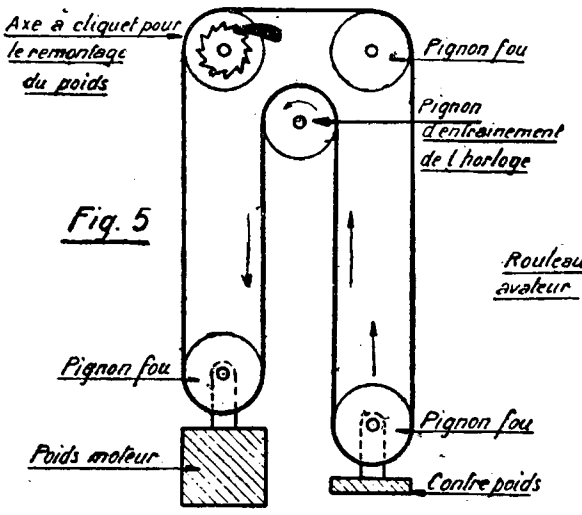

Fig. 5

DISPOSITION DE L'UNE DES CHAÎNES SANS FIN

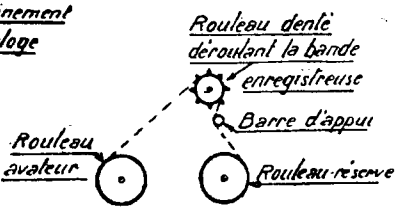

Fig. 6.

The weights of the clock must be removed from the apparatus during transportation and must travel in the specially resistant case designed for the purpose. They are very easily detached from the registering gear by withdrawing the axles of the idle wheels by which they are suspended to the chain, these axles being merely kept in their place by split-pins.

The escapement of the clock-work mechanism, a component which should always be carefully handled, must also be removed from the apparatus during transportation and travel in a special casket meant for this purpose. In order to detach it from the registering gear, it is sufficient to unscrew by means of a small screw-driver the four screws which clamp it to the frame of the clockwork mechanism.

The recording strip issues from a supply roller; after its passage over the toothed roller which moves it at a set speed, it is automatically rolled up on a storage roller where it will be found each time the apparatus is visited (Fig. 6).

In order to put it in its place, the roll of paper is placed on a brass mandrel which is to be found among the accessories of the tide gauge; the mandrel should jut out of the supply roller as much to one side as to the other, so that the paper strip may be correctly placed with respect to the teeth of the driving roller which must enter the perforations of the strip.

The driving roller is mounted in firm frictional contact on the pinion of the clock; a milled part at its end permits it to be turned in either direction with respect to this pinion. This arrangement enables the paper strip to be moved rapidly backwards or forwards and is used for its setting to the correct time. The time scale of the registering strip includes a broader line each 6 hours. Arrangements are made for this broader line to correspond to Midnight, 0600, Noon or 1800.

The storage roller, mounted on ball bearings so that it may rotate very freely, is actuated by two light brass-wire cylindrical spiral springs, their ends brought together to form belts connecting the driving and storage rollers. These belts have a tendency to drive the storage roller at an excessive speed, but slip readily in the grooves of the rollers; they exert but a light effort on the storage roller, sufficient to rotate it and roll up the strip delivered by the driving roller, but weak enough however to cause the tension on the paper strip to remain inconsiderable and without effect on the tooth action of the driving roller. Among the accessories of the tide gauge will be found a spare pair of these springs in case of loss.

A clock dial and hands are mounted on the left-hand face of the clock which unrolls the recording strip. This device has no other object than to allow a more precise check of the proper rate of the clock. The setting to time of the hands of this dial, totally independent of the setting to time of the recording strip, is effected simply by removing the protecting glass of the dial and moving the hands with the finger.

ASSEMBLY OF THE APPARATUS :

The manometric tubes and the clock serving to unroll the paper are mounted in a sort of frame-work. The whole is generally housed in a rain- and spray-proof sheet-iron hood, which permits the apparatus to be installed in the open air without troubling over shelter. A baffled inlet is fitted in the side of this hood for the pipe line connecting the pressure gauge to the bell; a threaded anchorage enables the end of the protecting sheath of this pipe line to be secured.

III. — *METHOD OF INSTALLATION OF THE APPARATUS.*

1. INSTALLATION OF THE BELL.

The bell must be installed for preference in a place sheltered from swell and currents; it is of advantage that it should not be too far from the foreshore. It must be immersed at a depth such that it never uncovers; on the other hand, one should avoid immersing it too deeply, as the height of the water-level above it at high water should not exceed 5, 10 or 15 metres (15, 30 or 45 feet) according to the registering scale adopted.

Before proceeding to the installation of the bell, the pipe line is connected to it and the open end of the latter is closed by compressing the rubber hose with a screw-clamp to be found among the accessories of the tide gauge.

The pipe line not being actually capable of withstanding high tensile stresses, the bell is slung with a steel-wire rope and this rope is stopped to the pipe line for a sufficient distance to be able to recover it when it comes to weighing the bell.

The bell is then lowered and deposited on the bottom, in a place where it stands practically upright and at the desired depth.

It is naturally recommended that the operation should be carried out at low water, if possible during a spring low water; having then to work at a

small depth only, convenient installation of the device is much more easily ensured.

In cold countries, as already stated, a certain quantity of oil (for example 1 litre = 0.22 gallon) is introduced into the bell before lowering it, in order to avoid evaporation of the water in the bell and its condensation in the pipe line. The oil is poured into the bell by the central hole of the bed plate, the bell being tilted sufficiently for this purpose. The bell must only be set upright again at the moment when it is immersed, or the oil will flow out through the same central hole of the bed plate.

2. INSTALLATION OF THE PIPE LINE.

The pipe line must be deposited for preference on a bottom of sand or mud; it will then not be long before it buries itself somewhat, thus ensuring perfect protection.

On pebbly beaches, it is recommended that it should be deposited in a small trench, cleared between the pebbles, and covered again afterwards. In rocky ground, it is led as far as practicable in the natural fissures of the rocks, to which it is secured here and there with cement patches or by any other means. If, the bell being already lowered, it were necessary to lengthen or to shorten the prepared length of pipe line, care would have to be taken to keep it closed from below by a screw-clamp while joining up, and until the pipe line was closed anew from above, so as to avoid the escape of the air imprisoned in the bell.

If by accident the bell were to fill with water after its installation, it would suffice, to restore it to working order, to pump air into the pipe line by means of the pump to be found among the accessories of the tide gauge, until the bell let this air escape to the sea through the holes in the bed plate.

3. INSTALLATION OF THE REGISTERING PRESSURE GAUGE

Assembly of the apparatus.

The registering pressure gauge is installed for preference in sheltered quarters. But it may if necessary be installed in the open air, after having housed it in its hood; the latter, whose base plate is not large, will then have to be made fast to mooring posts or cramps, in order to avoid its being knocked down accidentally; it carries for this purpose some eyebolts spaced around its central part.

In any case it is advisable to padlock the cover of the hood if strangers can obtain access to the apparatus in the absence of a caretaker.

The registering gear must be clamped in such a way that the registering carriage is truly horizontal; this can be ensured by means of a spirit-level to be found among the accessories of the tide gauge.

Registering gear.

In order to put the registering gear in working condition, it is necessary, first of all, to remount the escapement of the clockwork mechanism, which, as

already stated, travels in a casket. The two weights, which, as also already stated, travel in a special case, have then to be remounted. The escapement must always be remounted before the two weights, and, conversely, the weights dismounted before the escapement, so as not to incur the risk of damaging the teeth of the pinion of the escapement or of the crown-wheel which actuates it.

Having started the clockwork mechanism, it is expedient to proceed to the accurate rating of its speed by gently working the "Fast-Slow" lever of the escapement in the proper direction, the rate of the instrument being compared with that of a very reliable watch. The apparatus should, as a matter of fact, keep practically correct time even if left unwatched for 30 days.

When, as is often the case, time is not available to compare methodically during several weeks the readings of the tide gauge dial with those of the testing watch, the rating can be effected by listening comparatively to the escapements of the tide gauge and of the testing watch (assuming the latter to be provided, like the tide gauge, with an escapement beating in fifths of a second), and operating the "Fast-Slow" lever until both escapements are in step, the one lagging behind the other by a constant amount over a long period. In order that the error of the tide gauge clock may not exceed 5 minutes in 30 days, it is necessary that its escapement and that of the testing watch should keep in step with a precision such that any two coincidences of their ticks are separated by at least half-an-hour.

Besides this, the registering gear must be provided with a roll of graduated paper, fitted beforehand on its supporting mandrel. This roll must be placed in its bearings, the strip being drawn from the rear side and brought up to the driving roller (Fig. 6).

The strip is passed between the driving roller and a bearing rod situated below this roller, this arrangement being made for the purpose of meshing the strip well with a sufficient number of teeth on the driving roller.

After setting the strip round the driving roller, with the teeth of the latter entering its perforations, it is unrolled a certain amount by hand-turning the driving roller by means of the milled part provided. Then, while keeping it thoroughly straight and in the middle of the space reserved for it, the strip is made to adhere to the storage roller by engaging its end on the line of small points carried by the roller, and then, finally, a certain length of the strip is again unrolled by hand-turning the driving roller to make sure that the unrolling takes place normally. This test unrolling is completed by setting the strip of paper to time.

In order to be able, later on, to satisfy oneself readily and accurately that the instrument has kept time, the hands of the dial on the left-hand face of the apparatus are also set to time.

Lastly, the pen of the registering carriage must be armed by introducing into the little tube of which it consists a woollen thread previously impregnated with a special glycerinated ink, a small bottle of which may be found among the accessories of the tide gauge. The loose end of this thread is tied to a very small weight (for instance a pin) which is deposited in a small cup close by the pen, the woollen thread forming a small arch (Fig. 7). A few

drops of the special ink with which the wick has already been impregnated are poured into the cup; capillarity will cause this ink to pass very slowly through the woollen thread, from the small cup to the pen.

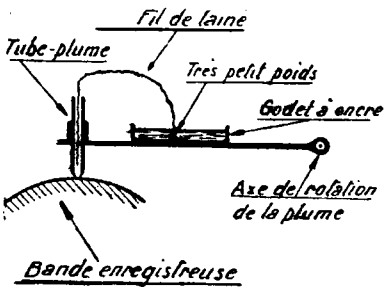

Fig. 7.

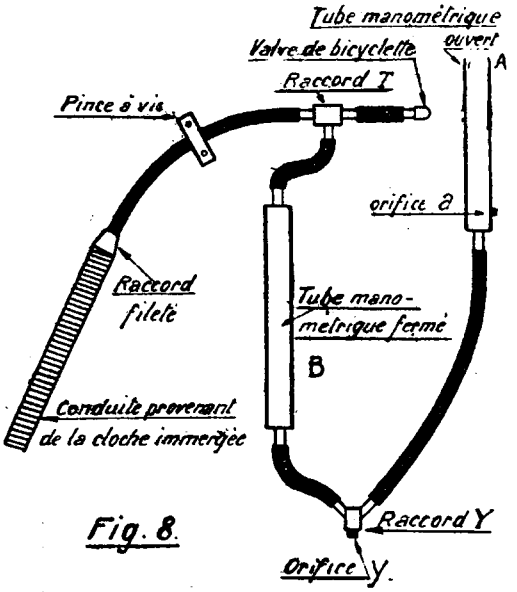

Fig. 8.

MANOMETRIC DEVICE.

To set the manometric device in working order, the following operations must be affected in sequence (Fig. 8):

A) With a small piece of rubber tube connect the bottom neck of the one of the three sealed manometric tubes (*B*) which is being utilized to one of the upper branches of the junction piece (*Y*), and with a longer piece of rubber tube, the other upper branch of the junction piece (*Y*) to the neck of the open manometric tube (*A*).

B) Make certain that orifice (*y*) (in the under part of the junction piece (*Y*) and serving to drain the mercury when the working of the apparatus is suspended), and orifice (*a*) (near the lower end of tube (*A*) and serving to control the level of the mercury when the pressure gauge is at rest) are both properly closed by their screw-caps, the heads of which must bear on the leather washers, thereby ensuring absolute watertightness of the orifices.

C) Pour the mercury into tube (*A*) and make certain that no leakage occurs anywhere along the rubber tube which connects the tubes (*A*) and (*B*).

D) When equality of the mercury level in the tubes (*A*) and (*B*) is established, let the excess of mercury run out by slacking back the screw-caps of orifice (*a*), the level of which is precisely that to which the mercury must rise when the pressure gauge is at rest. The excess of mercury which runs out in this manner can easily be collected by means of a strong paper funnel.

E) When the excess of mercury has run out, replace the cap-screw of orifice (*a*).

F) Having secured the iron float to the end of the piece of fine wire which is to connect it to the registering carriage, stream the float in the mer-

cury of tube (*A*), pass the thread over the two small blocks fixed for the purpose on the right-hand side of the registering gear, and secure it to the carriage; to do this, pass it under the lateral strut of the carriage, lay it in the groove of the central strut and secure it to the little eye-bolt with which this central strut is provided (Fig. 9); the length of wire must be such that the registering pen of the carriage is situated approximately at the right-hand end of the graduation of the strip when the pressure gauge is at rest, i.e. so long as the upper joint of tube (*B*) is open to the atmosphere.

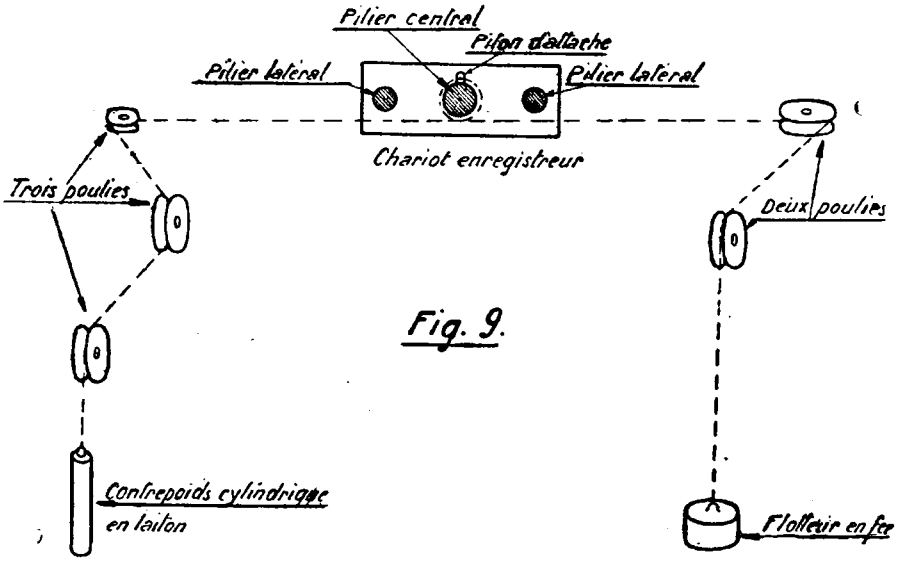

Fig. 9.

G) Having in like manner fastened the small brass counterpoise weight to the end of a piece of sewing thread, place this counterpoise in the small upright brass chimney which guides it, pass the thread over the three small blocks secured for this purpose on the left-hand side of the registering gear, and fasten it to the carriage as was done for the wire leading from the iron float, the scope of the line being such that the counterpoise is in the upper part of the chimney when the pressure gauge is at rest.

H) Bring the registering pen of the carriage in exact coincidence with the first line of the graduation on the strip, the pressure gauge being at rest; to do this, loosen somewhat the two screws which hold the central strut of the carriage, rotate this strut in the proper direction until the required adjustment is obtained, the effect of this operation being slightly to coil or uncoil the wire connecting the carriage to the float, then tighten up again the two screws of the strut.

I) With a piece of rubber tube connect the upper joint of the tube (*B*) utilized with the lower joint of the junction piece (*T*) (Fig. 8).

J) Over the right-hand joint of the junction piece (*Y*) fit a small piece of rubber tube ending in a bicycle inner-tube valve, and close this valve.

K) Secure the rubber hose of the pipe line from the submerged bell to the left-hand joint of the junction piece (*T*), and screw the protecting sheath of this pipe line on the threaded anchorage of the hood.

L) Lastly, and then only when all the connections are made and properly secured, establish communication between the pressure gauge and the submerged bell by removing the screw-clamp which has hitherto closed the end of the pipe line. Immediately, owing to the rise of the mercury in tube (*A*), the carriage will be seen to move from right to left, its registering pen marking the level of the water above the bed plate of the submerged bell.

IV. — *SUPERVISION OF THE TIDE GAUGE IN OPERATION.*

The supervision of the tide gauge in operation only entails the observance of the following routine :

Visit the apparatus at least once every 30 days to wind up its clockwork mechanism. At each visit, ascertain that the instrument shows exactly the right time both on the registering paper and the dial, and if necessary reset the paper and the hands of the dial to the right time. In case of systematic losing or gaining, readjust the escapement by actuating the small "Fast-Slow" lever.

At least once every 30 days remove the strip rolled up on the storage roller ; for this purpose, it is sufficient to cut the strip and to pull it forward, thus causing the spiral springs which draw it along to slip in the grooves of the roller. Then reset the registering strip in engagement with the storage roller, and to the correct time.

Every month (or better still every fortnight), and preferably at low water springs, pump air into the pipe line through the valve affixed to the right-hand joint of the junction piece (*T*), by means of the bicycle pump to be found among the accessories of the tide gauge, so as to refill the submerged bell. Cease pumping when air is seen to escape by the orifices of the bed plate of the bell.

Top up the small cup of the registering carriage with the special ink.

In cold countries, if use is made of an exsiccating flask interposed in the pipe line, periodically inspect this flask and if necessary renew the active matter (calcium chloride) there in. In this case, care should be taken thoroughly to close the pipe line during the operation, on both sides of the flask, by means of screw-clamps, so as to avoid any loss of the compressed air in the bell, the pipe line and the manometric tube (*B*).

APPENDIX.

USE OF A FLOAT FOR THE RECORDING OF SMALL RANGE TIDES.

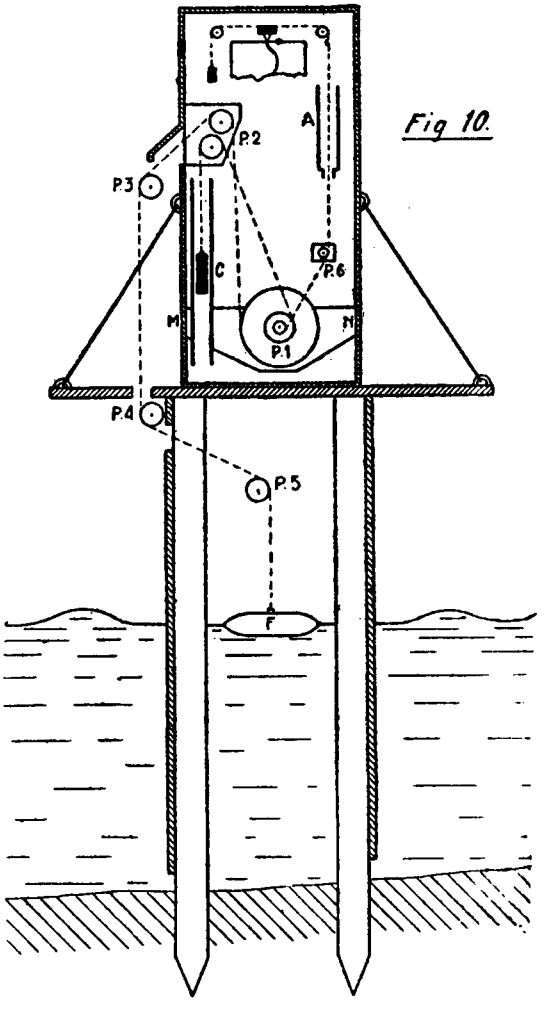

Fig 10.

The registering gear of the tide gauge may be utilized for the recording of small range tides by means of a float borne directly by the water of a well in communication with the sea. The accessories necessary for this are (Fig. 10) :

— a lenticular float (*F*),

— a leaden counterpoise weight (*C*),

— a large block (*P*1) with several threaded sheaves, mounted in a sheet-iron case,

— a double-sheave block (*P*2) mounted in a small brass case,

— a few single blocks (*P*3), (*P*4), (*P*5)...

— a small block (*P*6) mounted on a brass bracket.

These accessories are assembled and supplied only on request; when necessary, they can easily be mounted on the tide gauge, their securing holes being drilled in advance in the frame-work of the apparatus.

The registered scales by the float are :

Either 1/20, which may be obtained already, as we have seen, with the mercury manometric device, and for which the graduation of the registering strip covers a range of 0 to 5 metres (15 feet) with a distance between adjacent lines of the graduation corresponding to 10 centimetres (4 ins.) of height ;

Or 1/10 for which the graduation of the registering strip covers a range of 0 to 2.5 metres (7 ½ feet) with a distance between adjacent lines of the graduation corresponding to 5 centimetres (2 ins.) of height.

INSTALLATION OF THE FLOAT.

The float must rest on the water in a kind of well which will shelter it from the wind, current and ripples. This well must be in communication with the sea by one or several small orifices ; one, at least, of these orifices must lie below the level of the lowest low water.

Such a well may be made by simply driving four upright piles a few decimetres from one another, and connecting them by planks (Fig. 10), the watertightness of the structure being purposely left insecure in its lowest part which must lie below the level of lowest low water.

The float is supended by a wire of from 3/10 to 4/10 millimetre (0.011 to 0.015 in.) in diameter, which, passing over the requisite number of blocks, connects it to the registering gear.

INSTALLATION OF THE REGISTERING GEAR.

The registering gear must be installed as near as possible to the float. Often it may be installed, in its own housing, directly over the well in which the float moves, a small platform enabling the observers to stand at the height of the instrument during visits (Fig. 10).

The wire by which the float (*F*) is suspended is secured to the largest of the threaded lateral sheaves of the block (*P*1), the iron shell of this block being secured by its two ends (*M*) and (*N*) to the lower part of the frame of the registering gear. The sheave of block (*P*1) is drilled for this purpose with a tiny hole through which the wire may be passed to attach it.

A certain number of turns are then taken round the block (*P*1), in the spiral groove of the large sheave, then it passes over one sheave of block (*P*2) whose brass shell is fixed in the left-hand part of the framework of the registering gear. Finally, emerging from the hood through the baffled orifice on the left-hand side of the instrument, the wire passes through a certain number of single blocks (*P*3), (*P*4), (*P*5), arranged to lead it to the axis of the well. The length of the wire must be such that the tidal movements neither cause its paying out to a bare end nor its completely filling the spiral groove in which it rests.

In order to keep the wire which carries the float permanently taut, a second line is fastened in a similar way to the other threaded sheave of block (*P*1), the diameter of which is about 6 centimetres (2.4 ins.) and a certain number of turns are taken, contrariwise to the first line, round block (*P*1), in the spiral groove of this second rim. This second line, which may be of a plain resistant twine, passes over the second sheave of block (*P*2); a leaden counterpoise weight (*C*) is suspended thereto, the movement of which is guided by placing it within an upright chimney formed by a big iron tube secured in the left-hand part of the frame-work of the registering gear. The number of turns taken by the second thread round block (*P*1) must be such that the tidal movements cause neither its paying out to a bare end, nor its completely filling the spiral groove in which it rests; the length of this thread must also be such that the counterpoise (*C*) always stays in the guiding chimney.

Thus equipped, block (*P*1) makes exactly one revolution about its axis when the height of the tide varies by one metre (3 feet).

In order to record the movements of this block on the diagram, a third line is attached, in a similar way to the first two, to the central threaded sheave of block (*P*1), which has two spiral grooves, one of about 16 millimetres (0.6 in.) diameter corresponding to the registering scale 1/20, the other

of about 32 millimetres (1.3 ins.) diameter corresponding to the registering scale 1/10. This third line must be of the type (German silver, diameter 15/100 millimetre = 0.006 in.) used for suspending the iron float on the mercury when the tide is recorded by means of the manometric device; a certain number of turns are taken in the same direction as the second thread round block (*P*1), in the bottom of whichever of the two spiral grooves is utilized. The number of turns taken by this thread round block (*P*1) must be such that the tidal movements cause neither its paying out to a bare end, nor its completely filling the spiral groove in which it rests. Passing next over the small block (*P*6), the brass bracket of which is fixed on the right-hand part of the frame-work of the registering gear, this fine wire enters the axis of the open manometric tube (*A*1) of the registering gear and runs through this tube from end to end; finally, by the arrangement already described, it is secured to the right-hand side of the carriage of the registering gear and is kept permanently under a slight tension by the action of a small brass counterpoise connected to the left-hand side of this carriage. The length of this fine wire must be such that the tidal movements only give rise to a travel of the registering pen contained between the furthermost lines of the graduated strip.