A "VERTICAL LOG" CURRENT-METER

by

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"Vertical Log" is the convenient name which, for brevity, and to avoid confusion, it is proposed to give to a simple, cheap, and very sturdy current-measuring apparatus recently constructed.

The instrument has been recently described in the *Journal du Conseil International pour l'Exploration de la Mer*, in the issue of August 1935. In that article the earliest sample records were presented. The present article follows closely on the lines of the earlier one but, since a considerable amount of work has now been done with the instrument from a number of lightvessels, it has been possible to give here the results of later observations.

THE PURPOSE OF THE INSTRUMENT.

The instrument to be described was designed in the hope that, by use of it, action could be taken along the lines of two resolutions of a committee of the International Council for the Exploration of the Sea. At the 1930 meeting of that body, the Southern North Sea Committee resolved that the following suggestion be forwarded to the appropriate quarter :

> "That the continuous current investigations as carried out on the Varne Lightvessel be extended so as to embrace lightvessels on both sides of the Southern Bight."

Two years later the resolution of 1930 was repeated in effect, if in different terms.

In the writer's opinion useful progress along the lines indicated could be expected only if some cheap and robust apparatus incorporating no self-recording device for direction became available. The use of an instrument employing a compass needle would seriously limit the possibilities of work at shallow depths from steel vessels.

With the above considerations in view, the apparatus described below was designed. At all stages the fact was borne in mind, that to perform the work required of it, the instrument would have to be able to work continuously under very exacting conditions indeed. As will be realised later, its utility need not be restricted to the purposes of fishery research by any means.

Many readers of this Review will be familiar with the nature and performance of most existing types of current-meter. If reference be made to a recent book by Thorade (**1**) (*) where good descriptions of the various instruments are to be found, it will be agreed (so we think) that, if it be desired

(*) See "List of References" at the end of this paper.

to carry out observations which will provide an unbroken series of records concerning the water-flow past, say, a lightship moored at an exposed station, the choice of instrument is by no means wide. Any current-meter which it might be proposed to use for the purpose would be quite useless unless it could survive such treatment as it would receive if submitted to the rigours of a month of winter storms. Submission to such treatment would be a suitable preliminary test of fitness as enabling one to judge the likelihood of an instrument being able to remain in operation for something like a whole year without disaster. It will probably be agreed that no fine precision instrument of the propeller type would be able to do so. Even in the very unlikely event of such an instrument suffering no visible major damage, the "sand-blasting" to which it would be subjected could hardly fail to wreak serious havoc to the propeller and mechanism — at least at such an observing post as a lightvessel off the continental coast.

We may recall SCHUMACHER's statement (**2**, page 20) :

> "Ein schwer vermeidbarer Nachteil des überaus empfindlichen Instruments besteht darin, dass bei Beobachtungen in grossen Tiefen beim Fieren und Hieven trotz aller Vorsicht häufig die Propellerblätter verbogen werden",
>
> (A disadvantage of the extremely sensitive instrument, which it is difficult to avoid, resides in the fact that, with observations at great depths, veering and hauling, in spite of every precaution, frequently result in the propeller blades becoming bent).

and may readily picture the damage which would result if one of those instruments were "hung out" from an exposed lightvessel for even quite a few days during severe weather. The value to the fishery researcher (and perhaps to others) of such current data relating to open-sea positions as have come from the use of fine precision current-meters in the North Sea, would be much greater than it is, if one knew how justifiable it is to generalise from them. It is, however, hard to see how one can expect ever to know this, since such data as *are* available relate only to very brief periods, and the instruments in question can never be used for long enough to produce continuous data for even one whole year. Even if they could survive rough usage for a considerable time, their factors would have to be called in question as the propeller and mechanism became eroded through " sand-blasting ". Moreover, judging by the amount of "weed", etc. which is to be seen drifting by on many occasions, (*) one would have to expect observations to be frequently spoilt because the propellers have far too little strength to work themselves free from such material. Also, one could not hope to remain free from trouble for long in respect of real damage resulting from collisions with pieces of waterlogged wood or jelly-fish.

In view of these considerations, the writer finds it difficult to see how

(*) During a stay of some six hours aboard the Owers lightship in July, large patches were almost always to be seen floating by.

the records standing to the credit of fine precision current-meters are to be rightly appraised in point of real utility in fishery research connections.

It is worth emphasising that there is no lack of opportunity for at least attempting all-weather continuous current measurements, and attempted they should be unless one is to remain content with the very one-sided picture provided by fair-weather data. Lightships are invaluable observation posts and from them observations can be made all the year round.

Also, given the special anchoring gear and experience at the disposal of some ships, a certain amount of continuous observing could be done at positions in the North Sea under circumstances which would be beyond the resources of ordinary fishery research vessels. Rear-Admiral SPIESS has recently given a full and clear account of the technique of deep-sea anchoring for current measurements (**3**). In that article he has much to say concerning the problems inherent in current-measuring from anchored vessels, and cites the experiences and opinions of many well-known investigators.

If, as we surely must admit, it is often during bad weather and in seasons when continuous observations on currents are least easy to keep in train, that we should most like to know how various organisms in the sea are being affected, then serious efforts to carry out more continuous current-measurements must be made.

It is well to state here that the prime desideratum "continuity" accounts for our paying no attention to the practice of current-measuring from a vessel not at anchor. Admiral NARES has described a method of doing that (**4**), but it would seem impracticable to keep a vessel under steam for long enough periods to produce data of the kind here in question.

About ten years ago it seemed to the writer that there was a need for some current-measuring instrument which would permit observations to be carried out for long periods under not merely the worst conditions in which it is possible to anchor, but under the worst conditions which ever occur off the coasts washed by the English Channel and the North Sea, and in 1926 (**5**) he described an instrument designed to do so. An up-to-date account of the instrument in question is given in "Fisheries Notice" No. 17 and a report has recently appeared (**6**) presenting about eight years' records obtained from the continuous use of it at the Varne lightvessel in Dover Straits. Certain of the results obtained in recent years at the Varne lightvessel are not, however, easy to understand fully. To ascertain the meaning of a long-enduring set on to the Kent coast — in terms of contemporaneous current conditions in the southern North Sea — we require continuous current data from coastal lightvessels, and this could be forthcoming if such an instrument as that to be described were put into use.

With the Drift-Indicator, only about a quarter of an hour has usually been lost each three days; with the instrument to be described below no time at all need be lost as it need not stop working even momentarily for the records to be taken.

Drift-Indicators (which have now been in use for nearly ten years) are not however cheap, and, although no one of them has ever been lost from the Varne lightvessel, it cannot be pretended that an observer is completely free from all anxiety in view of their cost.

With the Drift-Indicator, observations of the kind desired cannot be made at shallow depths except from wooden vessels. This is a serious disadvantage — for many reasons which are obvious enough.

Although continuous observations upon the water-flow past many steel lightvessels off the continental coasts are very much to be desired for the elucidation of certain important fishery research problems, it was not for that reason alone that the instrument to be described below was devised. Another reason resided in the wish to test certain opinions recently advanced by TAIT (**7**) concerning the currents in the North Sea — particularly in the middle and northern parts of it. If TAIT is right in his idea of stream currents, it may be the case that the dispersal of important organisms is usually less diffuse than might be supposed — to mention only one point of interest. TAIT'S opinions concern the uppermost water layer, and to test them adequately, many measurements of surface currents would have to be made from steel research ships at many places. It would be an achievement of first-rate interest if one could discover even one lane of water moving at, say, about ten miles a day between bands of water moving at a substantially less speed, and could later proceed to delimit the various swirls to which so much interest attaches. In this connection, co-operation from such a vessel as the *Meteor* with her experience of anchoring in deep waters, would be invaluable when the search for the eastern periphery of TAIT'S Great Northern North Sea Eddy was in train.

An ambitious programme of current-measuring is planned for the area occupied by the South-West Dogger Bank Swirl in conjunction with salinity distribution investigations and experiments with drift-bottles which remain afloat only for a time.

Hitherto we have been restricted to the observation of currents at a magnetically safe depth in this interesting area. Considerable interest would attach to a repetition of an experiment made eight years ago (**8**) dealing with the interpretation of salinity distribution charts — if it became possible to carry out shallow current observations in addition to deep ones such as were then made. It might be that we should be able to obtain a completely acceptable velocity reference datum for hydrodynamic calculations. The instrument described below does enable continuous data upon water-flow past an anchored steel ship at levels near the surface to be obtained — but at a price. It is, like another simple instrument (JACOBSEN'S Libelle Meter), not automatic in point of direction recording. Therein lies its cheapness and an admission that it is not a substitute for the more expensive Drift-Indicator. The latter needs no attention at all for days on end and, where deep observations are acceptable, it is intended to go on using it as hitherto. The new instrument needs fleeting attention (often no more than a glance however) "every now and again". Sometimes, as experience will show, it will be possible to leave it unlooked-at for four and more hours on end; at other times it will call for a glance every quarter-hour or so for a time.

DESCRIPTION OF THE INSTRUMENT.

The instrument comprises two main parts. The part which is submerged when in use consists of a system of very strong iron cups below which a heavy weight is suspended. This heavy weight is a cylindrical steel tube weighing 58 lbs. (26.3 kg.). It is about 6 feet (1.8 m.) in length and somewhat more than 6 inches (15.2 cm.) in circumference. An eye at one end of it is joined to an eye at the bottom of the cup system by a short length of 2 1/2 inch rope. The cup system (see Fig. 5) is a very sturdy and a heavy affair. It was made so in order that no trouble could result from jelly-fish, floating weed, or even pieces of waterlogged timber. The cup arms are borne on a steel rod of hexagonal cross-section and are welded on to it. Each of the six faces of this rod is 1/2 inch (12.7 mm.) wide, and the rod is about 54 inches (137 cm.) long. The cup arms are made from steel rod 5/8 inch (15.9 mm.) square in cross section, and are of such length that a cup centre is about 14 1/2 inches (36.8 cm.) from the vertical rod. The arms are not entirely straight but have a slight bend in them near where they are attached to the rod. The purpose of this is to approach the arrangement in the Drift-Indicator where the cup fronts are in line with the axis around which they turn. The cups are of cast iron and are 6 inches (15.2 cm.) in diameter. They are secured to the arms by very strong nuts. Viewed from above as the rod hangs, the cup arms are spaced round the circle at angular intervals of 60°. Vertically, they are disposed along the rod at equal intervals.

The entire cup system weighs 42 lbs. (19 kg.). At the top of the hexagonal rod is an eye into which is secured one end of a length of 2 1/2 inch rope about a fathom longer than the distance the ship's rail is above water-level. This rope can be made of greater length if observations are most frequently to be made at a depth exceeding a fathom. In that case the rope can very conveniently be sheepshanked or otherwise dealt with to shorten it for occasional shallower observations — so long, of course, as nothing but single rope is left below water. The upper end of the rope (we are describing the apparatus as rigged for use) is secured into the eye at the end of the steel spindle shown in the illustration (see Fig. 2). This is the attachment to the registering part of the instrument which may now be described. A very strong box made of hardwood and strengthened by iron bands, houses the simple recording arrangement. This box is about a foot (30.5 cm.) square and little over half that depth — and has no lid. In the centre of the bottom of it is borne a vertical steel spindle mounted in a ball-bearing collar; at the bottom of this spindle (below the box) is the eye into which the rope is secured. Downwards-pull on the spindle is taken on a steel ball race, and the whole affair is of great strength. On the top of the spindle a large nut is secured, and mounted vertically in this is a steel pin about an inch long which describes a circular path as the spindle is rotated. The box is provided with two rope beckets secured in the sides which face towards and away from the ship when rigged for use. These beckets are slipped over a circular wooden pole which projects from the ship's rail a few feet and which is guyed strongly to prevent any movement. This pole and the beckets can, with

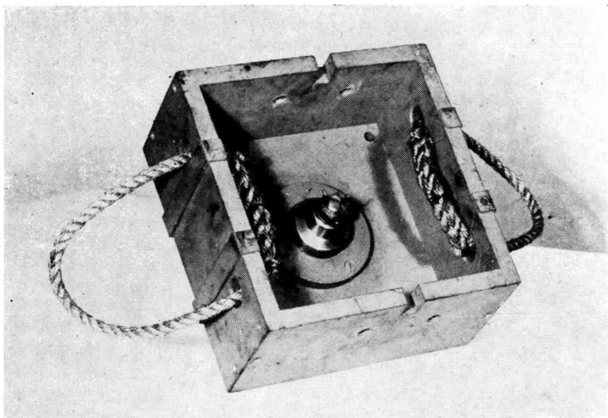

Fig. 1

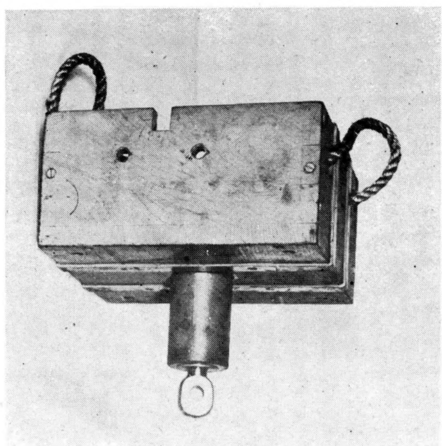

Fig. 2

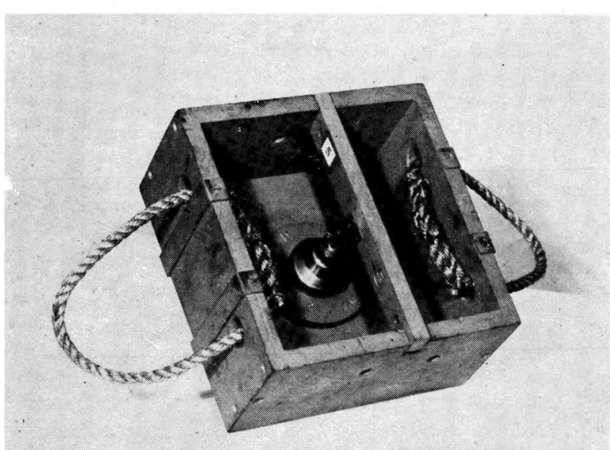

Fig. 3

VERTICAL LOG CURRENT-METER — ENREGISTREUR DE COURANT A LOCH VERTICAL

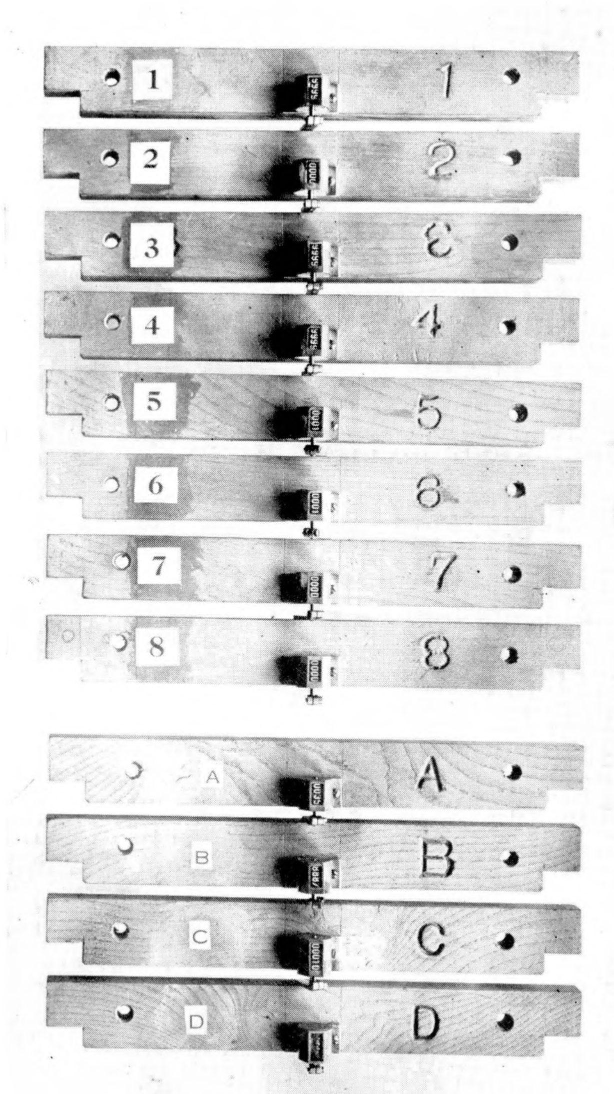

Fig. 4.

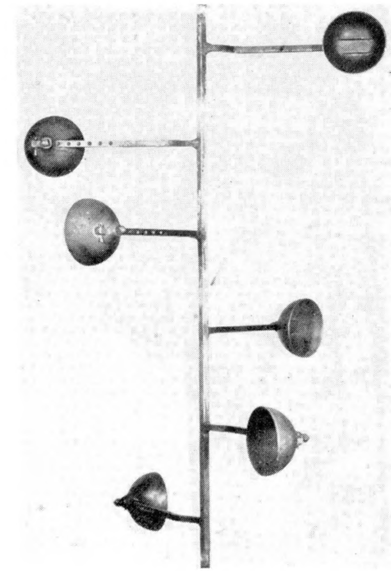

Fig. 5.

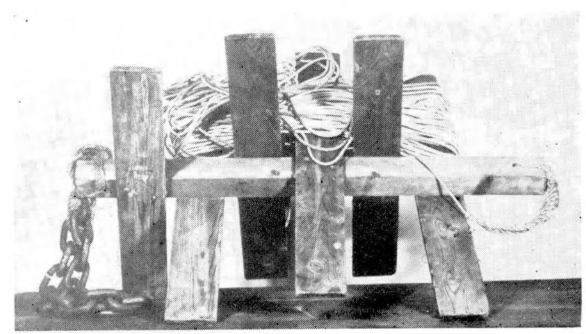

Fig. 6

advantage, be smeared with grease. In the fore and after sides of the box a slot is cut as shown in the illustration. Into these slots one of a number of hardwood slats (Fig. 4) can be shipped. On each of these slats a revolution counter is mounted as shown and when a slat is in position and the instrument working, the "handle" of the counter is carried round by the vertical steel pin already mentioned. These slats are very easy to place in position or remove, and each one is labelled for a specific sector of the compass. In the instrument tested, each revolution counter was labelled for one octant, thus :

No. 1 relates to the four points *NNW-NNE* ;

No. 2 relates to the four points *NNE-ENE* ;

and so on round the compass to No. 8.

Each sector straddles one of the eight main directions. It is possible that eight counters will prove to be the best number to have, and that 45° sectors will prove to be as small as can conveniently be dealt with. Experience will show. In the illustration (Fig. 4), the counter slats labelled *A*, *B*, *C*, and *D*, are emergency substitutes — to be re-labelled as necessary to take the places of any which might be damaged or carelessly dropped overboard. It is not expected that in normal use ordinary wear will give any trouble for long periods ; the counters are turned fairly slowly and are under no strain.

It should be mentioned here that the counters throw one number for each revolution of the cup system, and that in future instruments they will read up to 99999. It is well to mention also that a preventer rope is slipped through the inner becket of the box and made secure on deck when the apparatus is working. As to "the best" number of counters further remarks will be made later.

When the apparatus is working, the counter in operation records the actual number of revolutions made by the cups, there being no gearing up or down. This makes for simplicity and cheapness and, as trial has shown, is convenient.

As we said above, direction recording is not automatic. When we first had the idea to design some simple current-measuring apparatus akin in a way to a patent log, we attempted to design something which should incorporate a self-registering device for direction. This would not have been at all impossible had we decided upon an instrument using a type of rotator drifted astern. The difficulties of devising anything reliable in the way of a rotator were too great however — as can easily be imagined, for one had to cater for slack water. Any rotator which was heavy enough to remain properly submerged when a good stream was running, would sink when the stream was dead, and any floating rotator would not submerge properly.

Various ways out of the difficulty suggested themselves but were not proceeded with. One of the chief reasons for this was the fear (a well-grounded one) that, used from a lightship, there would be a real danger of having the apparatus (even the "on-deck" part) torn away by passing craft. This would be especially likely during foggy weather.

Again, one wanted if possible to have an instrument which could be rigged in the waist of the ship. It was finally decided that prospective cheapness and sturdiness would more than make up for the omission of any self-recording device for direction.

The direction is taken from a log streamed astern. Clearly, if the instrument is to be used in the waist of the ship, one could, if desired, take the direction from the showings of a bubble in a level after the manner of JACOBSEN'S meter, but one wants to work in bad weather, and the bubble movements in a JACOBSEN meter dial are then very lively — as anyone who has had much experience with that instrument will know.

There was one paramount consideration in view all the time and that was one which cannot be too much emphasised — the desirability of arranging to get records which should call for the very minimum of office work ashore later.

The writer aimed to get records as similar as possible to those simple ones coming from the Drift-Indicator so that one could easily keep up to date with the large number of records which would come in. This important desideratum accounts for the arrangement decided upon and which has been used in the trials.

The log-ship drifted astern for direction-viewing purposes, is the type which has been used for log-ship current measurements by the writer for over eight years. It is figured in the illustration (Fig. 6). The "upright" is a 33 inch (about 84 cm.) long piece of wood which is 2 inches (5 cm.) square in section. Each of the six wooden cross slats is 24 inches (about 61 cm.) long, 3 1/4 inches (82.5 mm.) wide, and 1/2 inch (12.7 mm.) thick. Each slat is firmly screwed into the upright at right angles — the attachment being made at the middle of the slat. Alternate slats are at right angles to each other.

This object floats in the water with the top just awash — the length of old chain attached having been chosen to arrange for that. The log-ships described have been long soaked in creosote or painted (when the wood was undressed) with cellulose paint — to obviate waterlogging. One of them is streamed out astern on a fairly long length of sash-cord, since on a long lead one gets the direction better when the ship's stern is swinging about at all.

It is intended later to try using a large heavy galvanised bucket hung from a spherical trawl float and streamed on a one-inch line (*). This will be done to get a stronger pull to suit a convenient arrangement already used and which will be described. If one were current-measuring at depth, then the bucket or other object could be suitably hung low enough down to reach the level concerned.

An observer could suit himself in respect of the log-ship used however.

It is clear from what has been said that one could proceed using only one counter. This could be read at desired intervals of time and the direction of the stream noted as precisely as possible on each occasion. For some purposes this would be all that would be necessary, and such a practice

(*) This is now always used.

would produce results of the type needed if one wanted to know the amount and direction of flow during specified hours related to the high-water times of a standard port. In the case of a research ship, the amount of attention needed to observe in that manner would not matter much, since if anchored for the express purpose of current-measuring, the necessary observer would certainly be available. Obviously the instrument in that (as in any other) form could not be used from an unattended buoy, but, desirable as unwatched working from a buoy is, the fact remains that much the most current-measuring has been done from anchored ships and will almost certainly continue so to be done.

Hence the need for an observer is not as serious a disadvantage as might on first thought be supposed. In the case of a lightship, however, one must cut down the work to be done by an observer to the very minimum. The need for even a small amount of clerical work every quarter-hour or so would never do. Moreover, above all things we want very simple records if we are to get the continuous flow data we aim at for fishery research problems — since troublesome office work on the records must be avoided.

For this reason, a number of counters are made use of, and the direction recording is performed in a way which calls for a mere three minutes' "clerking" once a day — or even less frequently — as desired.

We will describe the arrangement we have employed as it could be modified for use on lightships which have the convenience of a more or less unobstructed after-deck.

Arrange to set up vertically at a position as conveniently near the ship's compass as possible, a strong thin mast with a stop on it at about waist level. Let the top of the mast be somewhat higher than surrounding obstructions — well above rail level at least. On one face of a flat circular disc of clean hardwood about a foot in diameter, stick a photo-copy of a good compass card. Let there remain an annulus about an inch wide uncovered by the "compass". Divide the rim so left blank into compartments in a manner which will be obvious from what has been said above, and paint in the numbers 1, 2, 3 and so on to suit (*). Apply several coats of varnish to the wooden "compass" so prepared, and provide it with a central hole so that it can be slipped down the mast to rest upon the stop. From the fore-side of the stop let a stiff wire pointing to the ship's head project, and bend it upwards and backwards so that its end points downwards on the rim of the wooden "compass" — which latter can of course be turned round with the mast as axis. Let the inboard end of the log-line be attached to the top of the mast and arrange to let the direction of the line reproduce itself lower down— just over the dumb compass. This can be done in an easy manner by hanging a light rod underneath the log-line by means of several vertical strings. The forward end of the rod can conveniently carry a light ring which is round the mast. It is easy to arrange that this rod is only an inch or so above the wooden compass. In this way one gets a convenient arrangement which renders it unnecessary to peer over the side at night-time or in fog,

(*) See the illustration which appears as Fig. 7 in this article.

and matters become very simple if there is a good pull on the line. This can, as suggested above, be easily arranged for.

The technique is now simple, recording reduced to the minimum, and all set for the simple type of record desired. The observer records the initial readings of all his eight counters and does no more recording until the next day.

Having next observed the ship's head and set the dumb compass accordingly, he puts into registration the appropriate counter. He knows which this is by noting over which sector the log-line leads.

His job thereafter is to give an occasional glance at the dumb compass to see whether it needs turning at all to keep it set to the ship's course, and to learn when it becomes necessary to substitute another counter in the recording box. Quite often on such a ship as the Varne, it would be unnecessary to do anything at all for hours on end since, when the ship was properly riding the ebb or flood, the line would stay in one sector for a long time. Clearly, with suitable marks visible — such as the Watch Buoy of a light-vessel or a prominent shore feature or other object whose bearing was well-known, the routine could be much simplified. The dumb compass could be set to such a mark — a practice which would even be easy in the dark on clear nights if, say, a tack were put in the rim of the dumb compass at the proper place. If the circumstances were such that it was convenient to set to a distant object in this way, then for night use the sectors could be picked out with luminous paint and working would be further simplified.

If long-maintained observations from an anchored research vessel were contemplated, it would be very convenient to anchor a dan-buoy to the true north of the position at which it was intended to work. If the buoy were lighted and were far enough away to ensure that the swinging of the ship on her cable introduced no direction errors, then, given the absence of fog, all would be easy and there would be no need to watch the ship's course — as would have to be done in thick weather or in the absence of a buoy mark.

After the observer had carried on as explained for the time appointed (24 hours 50 minutes or any other chosen period) he would record the readings of all eight counters. The record he would "send in" would be a very simple one indeed. With an apparatus using eight counters he would have record sheets which would serve for a week or more. His final readings of one observation would be the initial ones of the next — since the apparatus does not need to be stopped for the records to be taken. Different workers would have different ideas as to the type of record sheet desirable, but the data would come in a form permitting very easy treatment. Having simply converted from revolutions to miles for each counter (and this could be done in a very few minutes on reference to a prepared table) one would know how many miles of water had flowed towards the different directions. It would be a very simple matter to make the further step and work out a residual — by means of a simple schedule such as is used in treating the large numbers of Drift-Indicator records received at the Lowestoft Laboratory. Thus one would get the type of data suitable for application to fishery research problems, very easily.

As stated earlier, some other number than eight counters could be used if desired — though eight would be very suitable for routine work on a lightship. Twelve might be suitable for use on a research vessel, but it may be recalled that, in the course of the Four-Nation Cattegat researches of August 1931, stream directions observed from the drift of a Finnish "Stromkreuz" were considered reliable only to about 20° (**9**).

Before presenting sample records taken with the new "Vertical Log" current-meter, we may comment on a few other features of it.

VARIOUS ADDITIONAL FEATURES AND USES OF THE INSTRUMENT

It is to be realised that in the case of certain places of observation, the work would become simplified exceedingly. Used hung from a bridge over a river, sometimes only one counter would be necessary and no attention needed for as much as a week unless desired. Used in harbours and estuaries, sometimes only two counters would be necessary, and experience would dictate approximately at what times the instrument would have to be visited to change the counter — or to read it if the same one were to be left in for the new direction of stream. In such places as harbours and rivers with much shipping, the instrument's ability to withstand, without damage, collision with a variety of floating objects, would be a very useful quality.

It is a feature of the instrument that it cannot stop working without the fact being soon noticed — as the counters are visible. As regards the amount of attention the instrument needs, it is to be recalled that ordinary log-ship observations are a routine matter on German, Swedish and Finnish lightvessels and that on German North Sea lightships they are carried out six times a day.

The "wear and tear" which the new instrument should suffer can hardly turn out to be other than negligible, and if a few spares (not bulky to stow) were supplied, there should be no cause for any stoppage of work for well over a year — perhaps for much longer. There is nothing to go wrong but what can easily be set right on shipboard by seamen. Then again, one has no anxiety through fear of loss, if the instrument is properly rigged and the ropes renewed from time to time. If desired, one can turn all the counters to zero for new observations — by holding them in an obvious manner against the spindle of a high-speed emery-wheel such as is to be found in the Engine Room of most vessels. In any future instruments the cups could be heavily galvanised and a master-counter fitted if desired to total up the revolutions of the various counters used.

The instrument could conveniently be used from piers or beacon lights and in such cases a dumb compass could be painted on a board fastened to the ground. Used from piers even much extra weight would not matter, and the instrument could therefore be better corrected against any effects of canting than when used on shipboard. Observations of long duration very close inshore are scanty indeed and would be very useful. Apropos the question of canting, it will have been realised by the reader that the very simple method of suspension employed (rope beckets on a greased round pole) effectively provides that the spindle always aligns itself with the transmitting rope when the latter is not vertical.

The main feature of the instrument is of course its employment of rope transmission from cups to recorder. This feature in conjunction with the great strength of the cups is confidently expected to endow it with all-weather qualities not otherwise attainable. The use of rope is expected to reduce any over-registration during lively weather to a minimum — particularly as six cups spaced round the circle are employed. It is expected that any undesirable effects on registration due to lifting and diving on the part of the ship, will better counteract each other than in the case of an instrument like the Drift-Indicator, which will turn bodily as these and other opposite motions of the ship succeed each other. Clearly, with some instruments, if the ship rode so many fathoms towards her anchor and then an equal distance from it, the revolutions involved would be additive. With the Vertical Log perhaps only half (or less) as many undesired revolutions would be recorded, and since it turns much more slowly than other instruments, such errors would probably tend to be kept to small proportions. It is necessary to pay serious attention to the matter just considered — the question of faulty registration during very bad weather, and we propose to take as early an opportunity as possible to investigate it. It is intended to do continuous runs with a deep-riding log-ship over several hours at least (this from a lightship during heavy weather) and to note whether the instrument's showings tally with the information derived from the log-ship runs.

CALIBRATION TESTS AND SAMPLE RECORDS.

The first (and at the time of writing only existing) Vertical Log was tried out and calibrated from the research vessel *George Bligh* in April 1935. The calibrating was done in Corton Roads on 12th, 17th and 18th April. The method was to note the number of revolutions made during the time taken for a measured length of line to be pulled out by the log-ship figured in the illustration (Fig. 6) and described above. The line used was a properly seasoned one, and had been carefully measured several times by walking it (under the strain experienced in actual use) along a surveyor's chain stretched along the ship's deck. Three observers co-operated in the tests, and a good stop-watch and stop-clock were used. Something approaching fifty runs were made in all. The speed of stream varied from just under one-third to just above 2 1/3 knots. It was not possible to work in any speed of stream outside this range on the cruise concerned. It suffices here to say that, over the range of speed experienced, the instrument registered with very satisfactory uniformity. The accepted factor was :

$$270 \text{ revolutions} = 1 \text{ sea-mile.}$$

There seemed a tendency for the instrument to make one or two more revolutions per log-ship run at the highest speed met with, but to get proper evidence of this one ought to run a much longer line away so that it would not be necessary to estimate half-revolutions as we had to do using the line available. If it does turn out to be the case that the instrument as here described over-registers at high speeds as compared with low to a degree demanding correction, we anticipate no great difficulty. On this point, however, we may remark that in the course of log-ship observations at the Varne Lightvessel stretching over twelve weeks in each of two winters, the highest stream rate measured was 2.6 knots (134 cm./sec.). We propose to work the instrument in the River Humber in a 5-knot stream, and if some form of governor seems necessary, we shall try various devices. We have simple ones in mind of a type (as is necessary) which would add nothing material to the cost of the apparatus.

It is well to remark that the cups were seen to be rotating when it was difficult to distinguish any movement on the part of match-sticks thrown over the side of the ship.

Testing registration at low speeds is not simple if one prefers (as we do) to calibrate under the conditions of actual use. On the occasions in question, very low speeds were met with only when the ship was on the point of swinging, and then there came a time when the log-ship would not float away from the vessel although the cups were rotating. This touches on an interesting question — what is it that a current-meter of the EKMAN type records under such circumstances? Only if the ship were anchored astern as well would the true set at what would otherwise be swinging time be recorded. As it is, from a ship riding to a bow anchor only, one must get a record of a resultant motion compounding several effects easy to appreciate, and there may be no record of there ever having been a set from the precise direction it *was* from at swinging time.

With an apparatus demanding the visual observation of direction, one is perhaps, despite the extra trouble, in somewhat better case, though usually the water movements effected at swinging time will be of little importance. In this connection one may remark that it would be interesting to know what amount of spread of the balls dropped by an EKMAN-type meter is referable to swinging of the meter as the ship lifts and dives in rough weather. We can hardly expect to learn this as the Drift-Indicator is the only one (so it is thought) which has been used in really heavy weather, and that remains down for too long for the effect to be discoverable. The point here is that, for all we know, and despite the alleged difficulties of estimating the direction of a log-ship reliably, we may get just as good direction recording with the Vertical Log apparatus as with the Drift-Indicator — particularly at times of heavy weather.

Three further remarks only are necessary here. If when working the Vertical Log, the long-line leads out over the dividing line between two direction sectors, it is well to leave in registration the counter relating to the sector from which the line shows signs of being about to pass; some such convention as this is desirable. If it happens to be raining when the apparatus is in use, it is convenient to drape a piece of waterproofed material over the recording box; up to the present we have preferred not to fit the box with a lid. An observer can easily know which counter is in use by noting which is absent from the box or rack in which the whole set is kept.

Clearly, although the counters will usually be read each day or half-day so that, in the event of any mishap, the minimum of time will be wasted, one can choose for what periods of time one works up the records. If suitable, one can neglect readings relating to shorter periods than a week, or can choose 3-day periods for comparison with Drift-Indicator records.

THE PRICE OF THE INSTRUMENT.

The makers (Messrs. ELLIOTT & GARROOD, Beccles, Suffolk, England) expect that, when a number of these instruments has been made, the price (allowing for ten five-figure counters) will be £12 within a very little. No provision is made in that estimate for any direction-indicating accessories since they can best be "home-made" for a few shillings to suit the tastes of the person who intends using the instrument.

SAMPLE RESULTS.

Overleaf are given the results from nine observations made with the Vertical Log. The first three were carried out from the research vessel *George Bligh*, and the others from lightvessels. These latter were made as the result of a cruise undertaken in the research vessel *Onaway* to ascertain whether it would be possible to rig and employ the instrument under the various conditions which would be imposed by the facts that all lightships are by no means the same as regards shape of rail, and that some have a poop.

To achieve compactness in the table, symbols are employed, and to convey an idea as to the state of the tides on the occasions concerned, the time of Dover H. W. is given in each case — Dover H. W. at F. & C. being at 11.20 G.M.T.

In most cases the observation lasted for a whole lunar day of 24 hours 50 minutes, and on nearly all occasions the counters were read after 12 hours 25 minutes as well. In the results set down below, the small letter *a* heads columns giving the data (water movement in sea-miles) for the first half-days; under *b* are entered those for the second half-days and under $a + b$ are given the data for the entire periods of 24 hours 50 minutes. Resultants have not been computed as they were in the case of the results given in the earlier article above referred to, nor is any information as to weather conditions set down in the present paper.

A — relates to an observation lasting for half a lunar day carried out from the research vessel *George Bligh* on 18th June 1935. The position was 54°20' N. - 0°37' E. (Flamborough Head is at 54°07' N. - 0°05' W.) and the time of Dover H.W. was 1200 G.M.T.

B — an observation lasting 24 hours 50 minutes from the *George Bligh* anchored in Hawke Roads in the Humber estuary. The dates concerned were 5th and 6th July 1935, and Dover H.W. was at 1400 G.M.T.

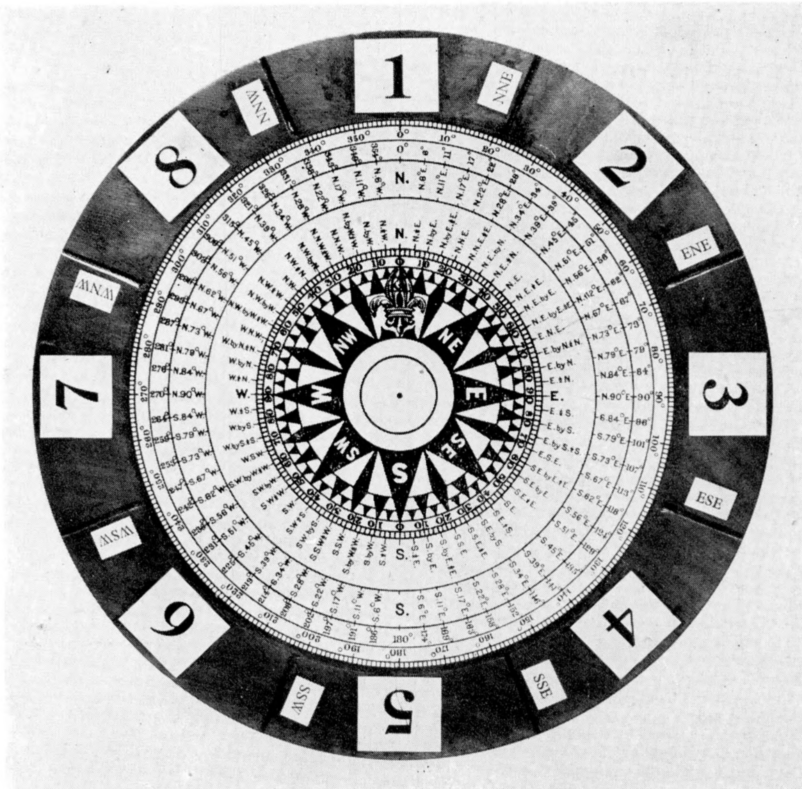

Fig. 7

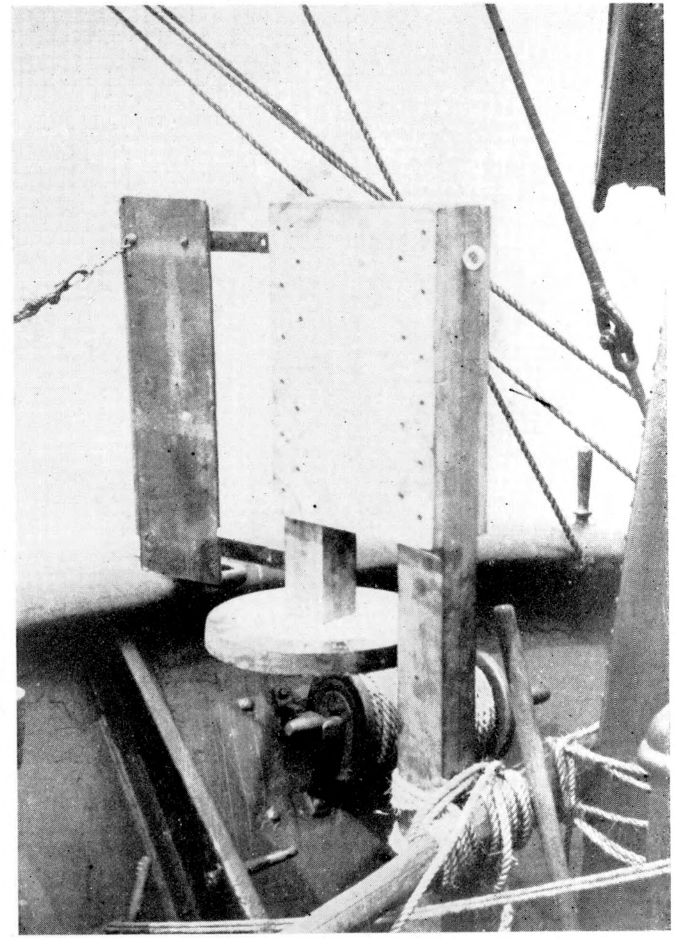

Fig. 8.

VERTICAL LOG CURRENT–METER — ENREGISTREUR DE COURANT A LOCH VERTICAL

Direction–indicating Accessory — *Accessoire indicateur de direction*

Directions (magnetic) towards which the streams ran / Direction magnétique dans laquelle porte le courant	A	B			C	D			E	F			G			H			J		
	a	a	b	a + b	a	a	b	a + b	a + b	a	b	a + b	a	b	a + b	a	b	a + b	a	b	a + b
Between / entre NNW. & NNE.	Nil.	6.4	3.1	9.5	Nil.	Nil.	0.1	0.1	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	0.2	0.2
" NNE. & ENE.	Nil.	0.1	0.0	0.1	0.7	10.3	11.5	21.7	21.3	6.1	9.0	15.1	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	0.1	0.1
" ENE. & ESE.	Nil.	0.2	0.2	0.4	0.5	Nil.	Nil.	Nil.	0.2	Nil.	Nil.	Nil.	4.2	Nil.	4.2	2.0	4.3	6.3	Nil.	0.1	0.1
" ESE. & SSE.	Nil.	12.6	13.0	25.7	11.5	Nil.	0.1	0.1	0.6	Nil.	Nil.	Nil.	Nil.	5.0	5.1	3.8	1.6	5.4	4.2	3.6	7.7
" SSE. & SSW.	5.0	Nil.	Nil.	Nil.	Nil.	3.9	12.4	16.3	9.5	Nil.	Nil.	Nil.	0.1	0.5	0.6	0.5	0.2	0.6	Nil.	0.2	0.2
" SSW. & WSW.	0.5	Nil.	Nil.	Nil.	Nil.	6.4	Nil.	6.4	12.3	9.5	8.2	17.7	2.0	4.9	6.9	0.4	1.2	1.6	Nil.	Nil.	Nil.
" WSW. & WNW.	0.4	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	3.8	Nil.	3.8	5.9	5.5	11.3	0.4	Nil.	0.4
" WNW. & NNW.	6.4	Nil.	1.7	1.7	4.4	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	Nil.	1.1	2.2	3.3
All Directions / Toutes Directions	12.3	19.3	18.0	37.4	17.1	20.6	24.1	44.6	43.9	15.6	17.2	32.8	10.1	10.4	20.6	12.6	12.8	25.2	5.7	6.4	12.0

VERTICAL LOG CURRENT-METER

Table of results

ENREGISTREUR DE COURANT A LOCH VERTICAL

Tableau des résultats

C — a repeat of *B* for half a lunar day commenced some ten hours afterwards.

D — an observation lasting a whole lunar day from the Brake lightvessel (51°16' N. - 1°27' E.) on 16th/17th July 1935. Dover H.W. was at 2330 G.M.T.

E — an observation from the North Goodwin lightvessel (51°20' N. - 1°34' E.) on 17th/18th July 1935. Dover H.W. was at 2400 G.M.T. In this case the counters were not read after 12 hours 25 minutes.

F — an observation from the South Goodwin lightvessel (51°09' N. - 1°28' E.) on 21st/22nd July 1935. Dover H.W. was at 1500 G.M.T.

G — an observation from the Royal Sovereign lightvessel (50°43' N. - 0°27' E.) on 23rd/24th July 1935. Dover H.W. was at 1630 G.M.T.

H — an observation from the Owers lightvessel (50°37' N. - 0°41' W.) on 25th/26th July 1935. Dover H.W. was at 1900 G.M.T.

J — an observation from the Warner lightvessel (50°44' N. - 1°04' W.) on 26th/27th July 1935. Dover H.W. was at 2020 G.M.T.

It is to be mentioned in this case that the spacing of the direction sectors is not such as to reveal the streams associated with the double tides properly. It is to be mentioned also that at this position, the surface water is often moving in a different direction from the water a fathom or two beneath. Ideally therefore, our direction-indicating drag should have been arranged to plumb the same depth as the cups.

NOTE CONCERNING LATER MODIFICATIONS, etc.

Four days have recently been occupied carrying out a thorough test of the instrument from the research vessel *George Bligh*. The ship was anchored in Hawke Roads in the Humber estuary, and the effects of using six different substitutes for the cylindrical steel weight below the cups were investigated under all strengths of stream experienced. With one arrangement it was found possible to obtain extremely satisfactory indications over a range of speeds from below 1 to slightly over 3½ knots.

The tendency to over-register at the greater speeds was finally corrected by using in place of the steel rod weight, a length of chain (steering-gear chain) weighing 50 lbs. (22.7 kg.), to the free end of which was shackled a small 3-bladed propeller weighing about 10 lbs. (4.5 kg.). The type of propeller chosen was such as would oppose the cups when the chain was carried far enough out of the vertical for it (the propeller) to be urged to rotate.

The lightvessel results given in this paper were obtained with the aid of a very simple and convenient direction-indicating accessory. The line coming inboard from the bucket-drag was attached to the top of a light "gate" swinging on a vertical axis directly above the centre of the dumb compass (Fig. 8). The top of this "gate" was about 7 feet (2.1 m.) above deck level and the bottom only just free of the wooden compass. In this way it was easy to see what counter was required. The inboard end of the drag-line hooked into an eye carried on the gate, so that when necessary the line could be passed round any obstructions.

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