# A NEW AUTOMATIC CURRENT FLOAT

## An improvised self-anchoring, self-signalling, and self-timing drifting buoy suggested for use in estuarine and coastwise effluent dispersal investigations, etc.

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Just before the outbreak of World War II experiments were in train with a deep-riding buoy which, after floating freely for a time away from a chosen liberation point, would anchor itself, would hoist a flag to indicate that it had done so, and would register the exact time at which its travel had ceased (1).

The large number of things which could be done with such a device was so obvious that in addition to the published description being reprinted at Monaco (2) it was in process of being copied also into the Marine Observer when war came.

In recent years further work on the float has been undertaken in order to overcome the two chief defects of the pre-war version.

These were:

(a) that, although the time occupied by the free drift was learnt exactly after its completion, only a rough guess of travel time could be made in advance.

(b) that, with the very simple materials used, the attachment of enough fixed ballast to ensure that the buoys started their drift floating with negligible freeboard, meant that they usually towed under on anchoring and so were recoverable only during the brief duration of slack water.

The buoy finally constructed and used experimentally, is described and diagrammatically figured below. To ensure that the new buoy shall remain well proud above water after anchoring itself requires that it has to take on very considerable buoyancy at that time. If of adequate lift, the buoy will, when set adrift, have to carry considerable ballast to weigh it down enough to project little above the water surface. The buoys have to ride deep in the water, of course, to escape direct windage, and they need to be somewhat massive to permit the attachment of underwater drogues (if desired) above the heavy hanging ballast when interest attaches to tracing water movements well below surface.

It follows that if things are to be kept simple, there must be some special way of dropping anchor which will not only deal effectively with heavily-strained wires, but which will (and this is the most important thing) be quite indifferent to weather conditions.

It is quite imperative that no anchor-dropping device be used which goes off quicker in rough water than in smooth. No easy use of soluble plugs suggested itself which could cater both for the holding-up of heavy weights to start with, and the certain dropping of them after the lapse of a pre-set period completely unaffected by weather conditions.

Numerous things were tried in the course of long-continued experiments including various sorts of corrodible metal, different ways of letting acids eat through metal plates and tubes, the pulling of a body through viscous restrainers — and many more. Nothing was found, however, which could provide both a completely reliable timing independent of weather conditions and a sure release of heavy weights.

Recourse was had, therefore, to a device which, if used carelessly, would involve a certain element of danger, but which, used with circumspection and under proper control, would be quite safe enough. The decision was made to employ (as the perishing link) a bottle which would shatter after the lapse of a desired time. This imposes a few minor difficulties deemed quite acceptable as no more than a small price to pay for the possession of a currents-indicating float usable under the roughest water conditions encounterable. It was recognized as quite imperative to work out an arrangement ensuring that the bottle would be safely boxed-in before shattering could occur, and to make it impossible for an unexploded bottle to be uncovered except at considerable trouble.

It should be remarked at this stage that the « etc. » in the title of this article was inserted because the observations made for studies of effluent dispersal will often serve very well for other researches also.

We may make passing reference here to the fact that studies of plankton distributions and of varying concentrations of fish eggs and larvae could well be carried out by using a simple modification (for open sea use — see later) of the device we shall describe below.

In that connection it may be recalled that when fisheries research began to get into its stride again after the war, there arose a very strong belief that « float-following » would pay the best dividends in distribution studies concerned with floating eggs and larvae - but little has so far been done in the matter.

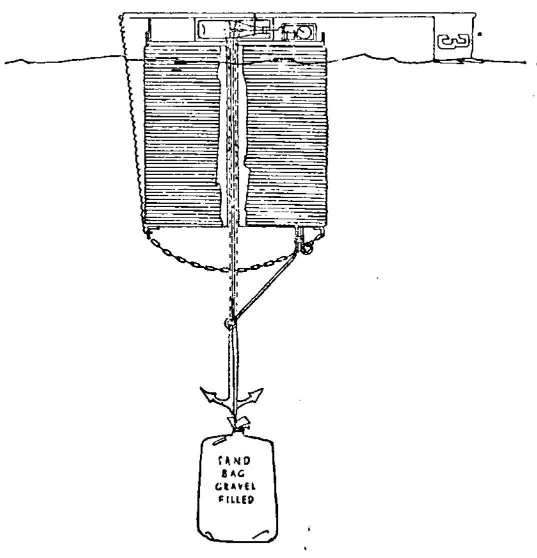


*Fig.* 1.

The automatic float as set adrift.

The union of interest in the employment of common methods between the men who have to study the drift of pollutants, the dispersal of effluents, the transport by currents of shellfish spat, the changing distributions of plankton, etc., has become a good deal more obvious of late years. This is so largely because of the results obtained by Tully Inlet (3) in Canada from his studies carried out in Alberni, and of those arrived at by Pritchard and his co-workers of the Chesapeake Bay Institute (4) (5). Whether pollutant drift or spat dispersal be the prime object of estuarine or longshore studies, many findings and methods apply interchangeably.

What Pritchard has to tell of the hydrographical regimen of certain estuaries is of great importance indeed since, when discussing the difference in depth of the level of « no net motion » as between the two sides of a river in its seaward reaches, he is able to show very good agreement between expectation and fact regarding the settlement of oyster spat landwards of its place of extrusion. His clear delineation of the interface depth between the seawards-flowing and the landwards-flowing layers of water, and of how the situation varies with tidal state, shows adequately enough how much needs doing by those who are charged effluent dispersal investigations.

Since, dependent upon its density, an effluent will be carried towards or away from the sea (initially at any rate), there is a very real call for a simple way of finding out how the water moves at all depths — a way which will produce solid information requiring no interpretation but bearing directly upon the problems at issue. The dispersal of pollutants and that of such animate things as concern the fisheries researcher, are not the whole story by any means. Quite apart from the question of those silt movements which, on a big scale in a dock-lined river are of immense importance financially, there is that other consideration of silt transports being increasingly urged these days in a fisheries connection. It has been argued that, consequent upon man's activities in bringing about such a large measure of deforestation and in loosening soil generally on a very large scale, there has been a deleterious silting-up in many areas of bottom which had earlier supported goodly stocks of fish and other important edibles (6).

What has been said amounts to a demonstration of need for some means of tracing all-depth water movements in rivers, within estuaries, and along coasts, in a direct way which will produce the maximum of hard-fact information for the minimum effort. One mav expect great things from the new Canadian technique of studying the ionic ratios in sea water in the vicinity of estuaries by using the flame spectograph (7). Already characteristic variations in the K/Na ratio have been found in each of several estuaries, and it is hoped that the research may lead to a means of tracing the course of a river in the sea, even in the presence of subsequent dilution. It would seem to the present writer, however, that the method would suffer from a serious limitation in requiring much use of boats for the taking of water samples. If it has this requirement then there would presumably be weather limitations. It is worth mentioning also that a major activity proposed by Finland in connection with the forthcoming Geophysical Year, will be the study of determinations of trace metals in sea water in order to follow the contributions from rivers into the sea.

So far as coastwise water movements are concerned, it probably remains true to this day that the best example of learning a lot in a little time is that afforded by the work of Br. Schultz carried out off the Flemish coast during the German occupation of the first World War (8). Following W. Krüger he made use of what were in effect large waterlogged rafts fitted with flagged masts. These were set adrift at chosen places and were « fixed » throughout the whole time of drifting (so long as they could be seen from land), by Artillery Officers ashore taking sights from the opposite ends of long and carefully-measured base-lines. Thorade also gives a description of the method which served usually for offshore distances of 15 km. and exceptionally up to 22 km. (9).

## THE NEW FLOAT

The sort of thing which it would be proposed to do with the new float can best be conveyed by imagining a special problem of which many variants will readily suggest themselves. Suppose a pleasant seaside holiday resort to be situated not far from an estuary which has recently become unpleasantly dirty due to the setting-up of large industrial works along the banks of its river. The time comes when highly-undesirable effluents are poured into the sea, and an assertion is made on behalf of the watering place that its amenities are being seriously impaired by reason of the occasional drift of nauseous water on to its beaches. There is a denial from the river authorities and the matter goes to law.

What could be done to provide really convincing evidence which would leave nothing in doubt ?

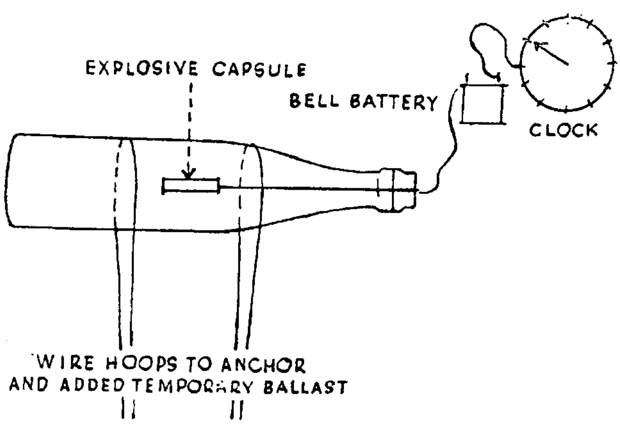


*Fig.* 2.
Showing the bottle breaking arrangements used in the automatic float.

It would avail little to have recourse to current-meters unless they could be used at many points and unless the weather stayed calm. Their registrations would tell only how fast and towards what directions water passed certain points, whereas we would want to know the *reach* of the travel in a certain time. The use of current-meters would call for a good deal of boat attendance, and there would be an absence of information relating to those times of really wild weather which might well matter most.

If one of the floats described below were set adrift from the pier head of the estuary half-an-hour before local high-water and were timed to float for exactly one hour before it anchored itself, and if a similar liberation were made each subsequent hour until thirteen floats had been set adrift, then, when all had anchored themselves after each had travelled for its hour, there would be a completely factual result for all eyes to see. The positions of anchoring could easily be « fixed »; the liberations could be repeated for all tidal states and for all weathers (recovery could wait at times of gales), and the drift times could be varied at will.

It is thought that solid proof or disproof would soon be forthcoming and that the clear evidence would render argument unnecessary. What could be done inside estuaries and in rivers will suggest itself. The attachment of drogues at different depths would be possible in view of the heavy hanging ballast, and it should be possible quite quickly to build up a body of information relating directly to the water movements at depths where effluents or shellfish spat were known to be « floating ». The nature of the new float can be made out from the accompanying diagrams.

The main component is an ordinary galvanized hot-water cistern of the following dimensions (in inches): 21 × 15 × 14. The weight of this is about 50 lb., and its buoyancy in ordinary sea water is about 100 lb., allowing for extra iron welded on. Through the tank between the centres of its two smallest sides, is welded a 1 in. pipe (also galvanized) the presence of which leaves the tank watertight.

Near each edge of both the hole-pierced sides there is a length of galvanized angle iron welded on. These, punched with holes, are to permit attachments to be made easily. On what is to be the top of the tank a slab of wood is spiked in place, and a hole is made in it above the orifice of the pipe. At the bottom of the tank a short length of chain is slung from side to side as shown. A rough box is built on to the wooden slab atop the tank, and in this is laid a bottle which has something of a waist — such as have various bottles used for the marketing of soft drinks. This bottle is filled with water, and inside it is placed one of those common-enough little demolition charge detonators resembling 1 in. of common pencil in size. Its thin covered twin cable is led out through a rubber cork which has been bored, cut in two lengthwise, and fastened into the bottle neck again by screwing on a metal cap itself punched with a suitable hole.

The other end of the thin twin cable is led through a similar cork into a watertight canister containing a cheap glassless clock of alarm clock type and a common bell battery. It is arranged that, when prepared for use, an open circuit is made which will be closed one hour after launching time.

Of course, water being so little compressible, the bottle shatters when the detonator fires, and it is consequently provided that the lid of the rough box which houses the bottle will always be secured down in a very sure fashion.

During use of the floats in systematic investigations conducted by responsible persons who own them, the box lids can best be padlocked down. This is not only an ordinary safety precaution but makes re-use of the floats easier. If it were intended to use the floats for open-sea experiments (see below) with the chance that one might come into the hands of meddlers prior to anchoring, it would be best to nail the lids down very thoroughly in addition to affixing a suitable warning notice.

Up the iron pipe passes a double loop of slender but very strong stranded wire cable such as is used in Oceanography for water bottle lowerings. A double loop of the wire passes round the bottle — the loops being preferably held apart by a small wooden « tipcat » to minimise the chance of a solid piece of bottle left after the explosion holding up the wire. The wire projects a foot or two below the hole at the bottom of the tank, and on this loop is taken the weight of the anchor throughout the time of drifting. It is convenient to use an anchor which is not too heavy to be weighed by hand on a slender rope (2 in. manilla or thereabouts), and, since such an anchor would not have sufficient weight to cause the tank to float with negligible freeboard, an auxiliary ballast is provided in the form of a sack of gravel destined to be jettisoned and left at the bottom of the sea. Practice reveals what size of measuring-can filled with gravel suits in this connection. The line which, when the float is anchored, will run all the way between it and the ground, is, of course, bent on to the anchor at one end. At the other it carries a ring which, after the explosion and the anchoring, finds itself free to move along the loop of chain which hangs beneath the tank. To prepare the float for use, the anchor line is doubled on itself and wound around the tank to remain held on by a weak whipping (or whippings) as common sense suggests, until, after the bottle shatters, the weight of the anchor tears the rope loose and unwinds it from the tank as it (the anchor) descends in the water casting the sack of gravel loose in the process.

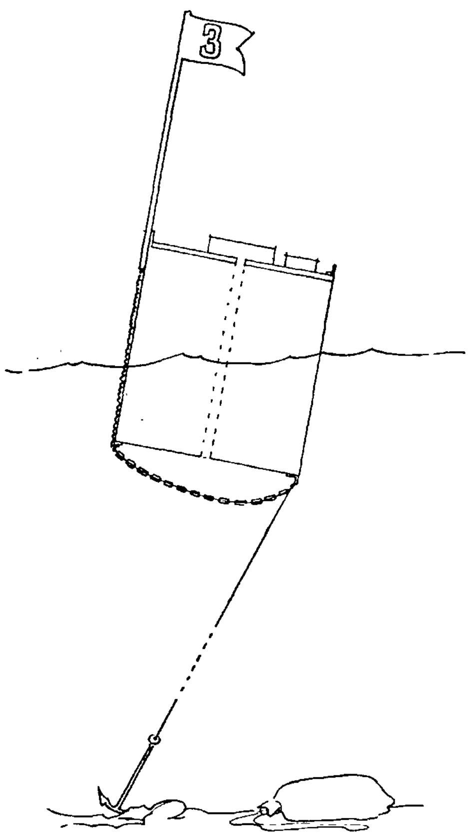


*Fig.* 3.
The automatic float after self-anchoring.
(The anchor line attachment would be made to a ring sliding on the slung chain).

Across the top of the bank there is a flagstaff made from a broom handle. It carries a small banner at one end of individual colouring or numbering; at the other end it is pivoted to present a small-length projection beyond the tank. This heel is spring-loaded as shown — the spring being in strong tension whilst the mast lies horizontal across the top of the tank during the drift. The stick is held down by a loop of line which passes through a slit in the top of the bottle housing and round the bottle neck. Clearly, when the bottle shatters, the lift of the mast will help considerably to pull apart any large pieces of bottle which might remain.

It is thought that no further description is necessary.

When investigations with the floats were pending the fact would be publicised and a warning given that the floats should be left alone. At the time of the writer's experiments a suitable leaflet was placed in a glass jam jar with a screw-on watertight lid, and the jar tied on to the float after enclosing it in one of those little nets used for securing glass floats to trawl headlines. The bottle box lid carried a marking *Danger: Read paper in jam jar.* This was all to guard against possible trouble if the float was lost in a fog and retrieved by some curious person before it had « gone off » and anchored. Finders were adjured to cut the thin electrical cable before they did any dismantling.

*Some possible modifications for use in the open sea.*

The float described could be modified for use in deep water very easily so far as the anchoring is concerned. In place of the rope which is used in shallow water to permit weighing by hand, an adequate length of thin stranded wire cable (water bottle wire) would be used. This would be wound on to a spool hung beneath the buoy and so would be a simpler thing by far than the arrangement with the rope, which latter, by the way, causes the tank to perform extraordinary evolutions as it unrolls when the anchor drops.

A clock would not need to be used with the open sea version of the float, but everything possible would have to be done to the end that nobody retrieving a float from the sea before it had anchored, would be likely to prise the bottle box open and so run some risk of hurt. One could use in the bottles small demolition detonators of a purely mechanical type (like a few inches of common lead pencil in size) having nominal « go-off » times of specified numbers of days. On anchoring after explosion, the descent of the anchor would stop the method of timing used and it would be learnt for how many days the float had drifted. This would be accomplished by a means not so far employed but thought of by the writer as, « Zebra Registration ». A strong spring in extension would pull a ball or other shape through a closed vessel filled with a thick semi-solid, and, in so doing, would draw a strip of ordinary daylight-sensitive photographic paper slowly under a slit. It is easily seen that if the paper movement were stopped at anchoring time, subsequent fixing would provide a striped record interpretable in numbers of days and nights.

*Acknowledgment.*

I am indebted to my former colleague, Mr. J.B. Rogers, for much help during the development of the float, and to Mr. W. Jackson Burton for drawing the diagrams from my rough sketches.

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## ADDENDUM

In an article on Beach Pollution which appeared in « Lancet » of 10 April 1954, reference is made to « a notable paper » by B. Moore (J. Hyg. Cambr. 1954, 52, 71) which, judging from the citations made' deals with just such problems connected with sever outflows into the sea as we suggest could be elucidated by use of the automatic float described above.