marine belge — 5e Bureau

Fisheries Notice No. 16.

MINISTRY OF AGRICULTURE AND FISHERIES.

DRIFT BOTTLES.

In connection with researches upon the life habits of the important food fish in the sea, and upon the variations in abundance of these fish from year to year as indicated by the success or otherwise of the fisheries, it is necessary that as much as possible should be known about the actual waters in which the fish live, and particularly about the movements of these waters.

The study of currents is indeed of primary importance in fishery research. Most fish have eggs and larvae which float freely in the water and are carried passively by the currents; the fate of the baby fish depends very largely upon where they are drifted. It is possible that the big variations in abundance which occur in most fisheries may be linked up with changes in the normal course of the currents which affect the normal distribution of the fry. In their migrations for feeding or spawning, the larger fish are apparently guided by the currents; most fish move up-current towards their spawning places, from which the eggs and larvae are distributed down-current.

Direct researches on the water movements in shallow seas are carried out almost entirely by two methods. In some cases use is made of special instruments called current-meters. These are very similar to the apparatus employed to measure the rate and direction of wind. The other method is the employment of suitable bottles called "drift bottles," which are thrown into the sea in large numbers. It is the purpose of this Notice to describe the various types of drift bottles used by the Ministry in its researches, and to indicate shortly some of the results which have been obtained.

A further Notice will deal with the current-meter investigations.

The success of the drift bottle investigations depends entirely upon the co-operation of fishermen and others, and one object of this Notice is to interest such helpers in the researches, and to afford them all necessary information regarding the simple procedure involved.

Bottles have in the past frequently been used for conveying messages from vessels which have met with disaster on the high seas, but in these days most "bottle-post" papers or cards will prove to be documents originating from some research institution whose concern it is to carry out investigations of the currents either in the great oceans or in

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the shallower seas. In these cases the bottles will generally be made of glass, which permits some boldly printed instructions inside to be read, and will be ballasted and well sealed. In the past a considerable amount of real knowledge has been gained from a consideration of the movements of derelict vessels, of icebergs, and of flotsam of various kinds, and it is known that the wind exerts powerful influence on the movements of floating objects whereof a considerable portion is above sea-level.

Drifts of Derelict Shipping.

In the interests of navigation it is, of course, desirable that all large drifting objects such as abandoned ships should be destroyed. Steps are taken to secure that derelicts likely to prove a menace are broken up as soon as possible—by dynamiting or other method. Nevertheless, some craft, such as timber laden vessels, are not easy to sink or disperse, and may float for a long period, during the course of which they may perform striking journeys. A large object such as an abandoned ship, carried hither and thither by currents and winds, may be frequently seen and reported, and it may consequently be possible to chart its wanderings over large stretches of ocean. On the North Atlantic Pilot Chart for March, 1895, issued by the United States Hydrographic Office, the track of the derelict "Fannie E. Wolston" is shown. She was reported 46 times in the course of her prolonged wanderings, which occupied three years and six days, and covered 8,995 miles. Unfortunately such objects as the drift bottles commonly used have not this advantage of being sighted and reported, so that only under very exceptional circumstances can points on their tracks, intermediate between their starting and finishing positions, be ascertained.

Perhaps more striking is another North Atlantic drift—that of the American schooner "W. L. White," which was wrecked in March, 1888, off Baltimore. Two of her three masts remained standing during her early drift, so that she was carried along not only by current but under the influence of wind. She drifted quickly towards Newfoundland, in the neighbourhood of which she was sighted in May. She had then no mast standing, and was floating almost awash. That she did float was due to her cargo of timber. From the Newfoundland region her travels were determined by the current, since she had little exposed surface to "catch the wind." She was often sighted owing to her track lying in the liner route, and her wanderings could be readily charted. She is said to have been secured off the Hebrides in January, 1889, after having drifted for 317 days, and having travelled about 5,200 sea miles.

An astonishing drift was that of the American schooner "Fred Taylor," which was cut in two by the German liner "Trave" in July, 1892, at a spot some 260 miles southerly of east from New York. Each part performed completely different wanderings. The after part travelled towards the north and the forward part towards the south-west. Both parts drifted some 200 miles in their respective directions. The explanation of this strange occurrence is that the after part floated well out of the water and was driven along by the wind towards the north, whereas the forward part, which floated deep in the water, was carried south by the current—a striking illustration of the fact that a floating object must ride very low in the water before it can be taken as a reliable indicator of current.

Drifts of Objects Other than Derelict Vessels.

Interesting and illuminating journeys have been accomplished by many passively floating objects other than derelict ships, and, owing to the small freeboard of such objects as floating baulks of waterlogged timber, much of real value has been learnt regarding the movement of the surface waters of the great oceans. In December, 1887, an enormous lumber raft consisting of 27,000 tree-trunks was being towed from the Bay of Fundy towards New York, when bad weather was encountered and the raft was broken up. The large logs floated away towards the east. By the following June many were near the Azores, and three months later numbers of them were encountered to the north of Madeira.

Floating wood, which must have come from the West Indies, has, from time to time, been found stranded on the Faröes, and mahogany trees have been found washed ashore on the south point of Greenland. In the West Indies grows a climbing shrub remarkable for its large pods, and these fruits are known to the inhabitants of the Faröes, where they are frequently found on the coast, as "goblins' kidneys." Instances of tropical plants washed up on the Norwegian coasts are many, and their occurrence points to the existence of a general drift of surface water right across the North Atlantic Ocean in a north-easterly direction. From the wreck on Cape Lopez (Gulf of Guinea) in 1882 of a vessel laden with barrels of palm oil, one barrel bearing an unmistakable distinguishing mark was washed up at Hammerfest in Norway after an estimated drift of 11,000 sea miles. Siberian timber frequently drifts across the Polar basin to the north of Spitzbergen, or to the East Greenland coast, and when wreckage belonging to the "Jeanette," which foundered in the Arctic Sea, was found in the North Atlantic, Nansen concluded that a current must run from the polar basin between Greenland and Spitzbergen into the Atlantic Ocean. On this supposition

he planned that famous expedition when he deliberately froze up his specially constructed ship, "The Fram," in the pack ice off the New Siberian Islands. In the course of about two years, the vessel drifted to Franz Josef Land at an average rate of about one mile a day—so proving the correctness of the inference made from the drift of wreckage. It would be possible to multiply instances where the drift of wreckage, of plants of known origin, etc., have yielded information as to the existence of surface currents.

The movements of icebergs are very reliable indications of currents, owing to the little effect of wind force in influencing their wanderings. This is due to the great bulk of ice which is below sea level in a floating berg. Many floating icebergs are often to be found in the waters to the south-east of Newfoundland. These, having come from the Arctic regions, indicate the existence of a south-going current in the waters north of Newfoundland. Many of the bergs make very great journeys before they finally disappear, the remains of an iceberg being noticed on one occasion just west of Mull Island ($56\frac{1}{2}°$ N., $6\frac{1}{2}°$ W.).

The astonishing story of the life history of the common eel supplies information concerning the water movements of the North Atlantic Ocean. The small wriggling elvers which occur in such vast numbers in the coastal waters of south-west England, and ascend the rivers in millions in the Spring, are miniature eels resulting from the spawning of their parents some $2\frac{1}{2}$ years earlier in the greatest depths of the Atlantic. Their occurrence in our rivers points to the existence of a great current which carries the eel-larvae from south-west to north-east across the North Atlantic.

Long Bottle-Drifts.

Many bottles have, from time to time, been set adrift in the great oceans containing papers asking that their finders shall write and say where the bottles were found. Often the bottles have been put out in pursuance of a definite piece of research, but it is not always possible to learn whether they were ballasted carefully to escape being blown about by the wind. Floating bottles put out in Franz Joseph's Fiord in East Greenland have been picked up off the north-western coast of Ireland and the Hebrides after completing their long journeys at an overall speed of some 10 miles a day. Many results published by the United States Hydrographic Office on their Pilot Charts give interesting information concerning journeys performed by drift bottles put out at various places in the North Atlantic and in other oceans. Bottles put out off Cape Hatteras (U.S.A.) have been found on the shores of Ireland after having drifted at an overall speed of $4\frac{3}{4}$ miles a day across the intervening 2,800 miles or so of ocean. One

bottle thrown out from the Peary Arctic Club's steamer "Roosevelt" in Davis Strait was recovered on the south coast of Ireland after having drifted some 2,800 miles at an overall speed of about 15 miles a day. Others put out to the north-eastward of Newfoundland were recovered on Icelandic shores after having journeyed some 2,000 miles in about 250 days. One bottle set adrift off the Coast of Labrador was recovered some 450 days afterwards about 3 miles from Cape North (Norway), after drifting about 3,000 miles at an overall speed of $6\frac{1}{3}$ miles a day. A bottle thrown out off the Portuguese coast was carried by the equatorial drift to Cuba—a distance of about 4,670 miles—in 626 days at the rate of $7\frac{2}{5}$ miles a day. Bottles set adrift near Nantucket Shoals (U.S.A.) have been recovered in Argyllshire after the lapse of about 500 days. Their journey was 2,587 miles, and their overall speed about $5\frac{1}{10}$ miles a day. Other bottles have stranded in Cornwall after travelling from Cape Cod at about $4\frac{1}{2}$ miles a day. Occasionally several bottles put out at the same time and place have been retrieved quite near to each other after a long drift. Thus, three bottles put out together about 600 miles north-east of Newfoundland were recovered within a short distance of each other and in the same week stranded in the Hebrides and Orkneys.

Since to the south of the great continents of the southern hemisphere there is an unobstructed waterway all round the earth, it might reasonably be expected that if drift bottles were put out at positions in southern latitudes about as far south as the extremities of the great continents, journeys of much greater extent than any yet cited could be accomplished. One bottle set adrift to the south of Cape Horn journeyed to Victoria in Australia at an overall speed of 9 sea miles a day. There is good reason to suppose that one bottle put out long ago actually did travel round the earth on a path varying in latitude from about 47° S. to 33° S. This bottle, which had been put out from a German barque about halfway between Kerguelen and Tasmania, was recovered 2,447 days afterwards at Bunbury in Western Australia, and it is reasonable to suppose that it must have travelled some 16,600 miles at an overall daily speed of about $6\frac{4}{5}$ sea miles.

Different Types of Drift Bottles.

(a) *Simple Surface-Floating Bottles.*—It is not possible to say who first made use of drift bottles in studying marine currents, nor can it be stated definitely how long the method has been in use. Really large-scale experiments are, however, of comparatively recent date, since they have been made only in connection with fishery research work, and this, in the form of systematic international researches, dates back no further than the beginning of the present century. An ordinary drift

bottle, as now commonly used, is a ballasted buoyant bottle containing a questionnaire paper or postcard, and is thrown into the sea at a chosen place duly recorded. The bottle floats along on the surface of the water until such time as it is cast ashore on a beach, unless, as happens very rarely, it is retrieved in the open sea—by drift net for instance. Whoever finds it is requested by the directions printed on the paper or card to send to a given address the information required by the persons who set the bottle adrift. In present-day experiments carried out by the Ministry of Agriculture and Fisheries the commonly used floating drift-bottles contain a red "Break the Bottle" slip, a postcard, and an instruction slip, particulars of which are as follows:—

(1) *The Red "Break the Bottle" Slip.*

This slip, which is about 5½ x 4 inches in size, bears printed directions easily legible through the glass of the bottle. In plain, black letters, the words:—"Break the Bottle" appear in five languages, and in the centre of the red slip the identification number of the bottle. An intimation that a reward awaits the finder is also discernible through the glass. This, usually one English shilling, is paid to such finders as return properly filled in cards.

(2) *The Postcard.*

The postcard, which it is intended that the finder shall fill in and return, is shown on pp. 7 and 8.

It will be seen that, in the case of the English drift bottle experiments, no postage stamp need be affixed by the finder when posting the card to the Ministry from places in Great Britain.

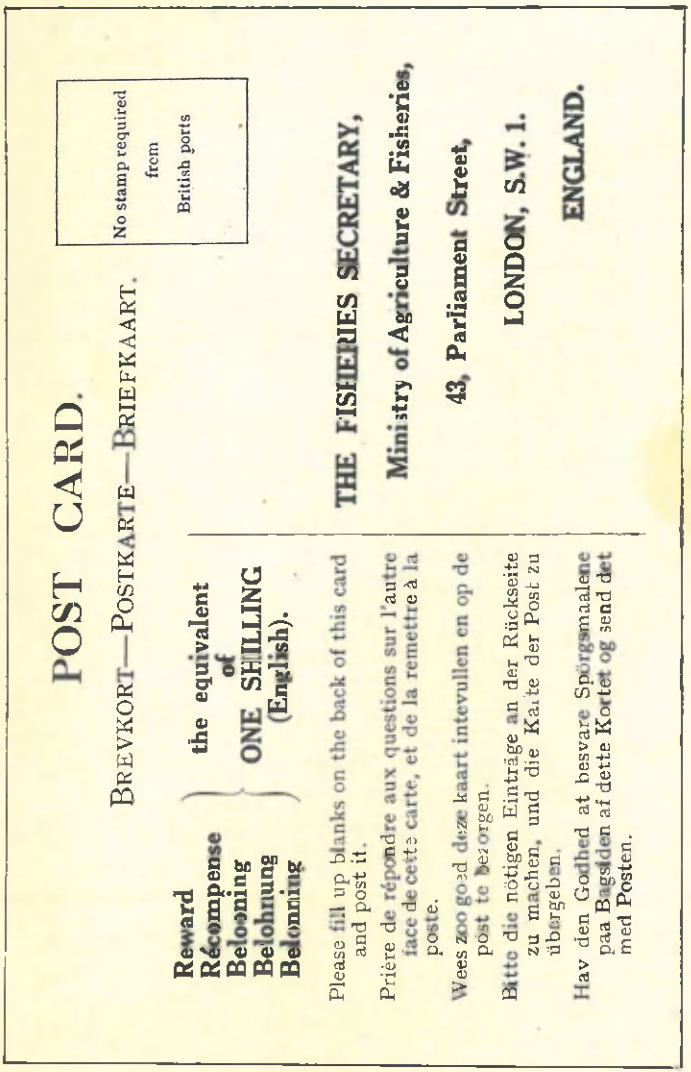
Where drift bottles of kinds other than the common surface floaters are used, the postcards enclosed contain questions designed to secure other necessary information.

(3) *The Instruction Slip.*

A slip, printed in five languages, is enclosed in each bottle, asking the finder to enter the required information in block letters, and further asking him, where possible, to give either the latitude and longitude of the place of recovery, or its distance from some well-known town.

It is essential that the drift bottles should be very well sealed or corked. In the case of experiments now carried out by the Ministry, specially made bottles permitting easy and efficient sealing are used. The bottles are all carefully ballasted with sand or fine shingle so that they float vertically

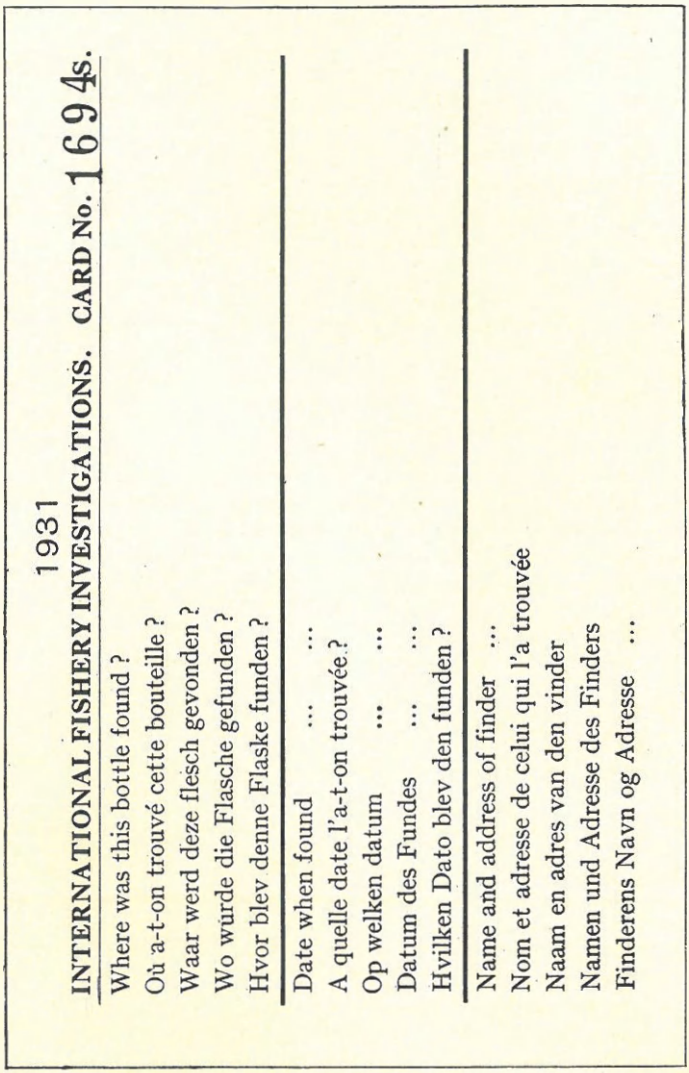
in the water with the tops of their necks just awash. They thus escape, as far as possible, the effect of wind influence. Still further to reduce to a minimum the degree to which the



Surface Drift Bottle Postcard.—1. *Front.*

bottles might follow the movements of the actual surface skin of water, which is much under the influence of the wind, bottles as long and thin as possible are now used by the

Ministry. These bottles, which bear the letters "M. A. F.", are about $10\frac{1}{2}$ inches long, $2\frac{3}{4}$ inches wide at the widest part, weigh about 1 lb., are of 16 ounces internal capacity, and can



Surface Drift Bottle Postcard.—2. Back.

float as desired when containing a ballast of about 7 ozs. weight. Such a bottle made up ready for use, so as to float with the top of the neck just awash, is shown in Figure 1 (p. 11).

In some future experiments it is possible that water may be used in the bottles as ballast instead of sand or shingle. If this method of ballasting is adopted, the postcards will probably be enclosed in small water-tight tubes, or a special type of postcard, which will take no harm from long immersion in water, will be used. To make sure that such a bottle containing water will, when lying stranded on a beach, attract the eye of anyone glancing at it, a few long strips of brightly coloured celluloid will be enclosed, and the water ballast will probably be slightly coloured.

(b) *Drag-Fitted Bottles.*

The simplest and best known type of drift bottle such as has just been described, necessarily reflects the movements of the surface layer of water a foot or so deep. Under the influence of a strong wind, such bottles move away quickly down wind. In an area like the English Channel, where strong tidal streams exist, a surface layer of water some fathoms thick may be moving throughout at the same speed at times of no wind. When there is much wind, however, it is easy to picture a simple floating bottle out-distancing an object which rides much deeper in the water if wind and stream are in the same direction, but being out-distanced by the deeper riding object when wind opposes stream.

It is often desired to learn something of the effect of wind in influencing the water movements and, to this end, experiments have been carried out to decide in what manner the journeys performed by simple surface-floating bottles differ from those accomplished by deeper-riding bottles put out at the same time and place. Such experiments have been carried out by the Ministry in the North Sea and English Channel, and the " deeper-riding bottles " have generally been buoyant bottles from which some sort of drag is hung. Examples of the various types of deep-riding bottles which have been used in the Ministry's experiments are pictured in Figures 2 and 3 (pp. 12 and 13).

In three cases the deep-riding bottles have been bottles from which strangely shaped metal drags hang. These drags are made from pieces of galvanised sheet about 5 inches square, cut into at the middle of opposite sides, and bent so that about half the available surface is horizontal and about half vertical. The galvanised sheet is of 24 gauge, and a drag of this kind weighs about 4 ounces. Drag-fitted bottles of all the types shown have been used, and usually the chief concern has been to make satisfactory attachments of the suspending wires to the bottles. At first ordinary bottles were braced round with wire as shown in Fig. 2a to afford a loop for attachment of the suspending wire, but the bracing wire had to be thinner than desirable in order that it could be manipulated satisfactorily. Later, a bottle specially made with a pierced bulge at the

bottom was used as shown in Fig. 2b, but of late the drag wire has been fitted to the bottles as shown in the left-hand part of Fig. 3. In this latest type the drag-fitted bottles are made up as follows:—a disc of monel metal which has a central hole just big enough to pass over the neck of the bottle, and having punched in it several holes to take the wire, is "threaded" on to the neck of the bottle. It is secured there by screwing tight home on to the bottle neck a specially made bell-shaped screw-on cap, also of monel metal. The water-tight sealing is effected (as in the case of the simple surface-bottle earlier described) by placing a rubber pad inside the screw-on cap before fitting it. The caps are screwed tight home by judicious use of gas-pipe pliers. A securely-sealed bottle, fitted with a conveniently pierced collar, is thus obtained, and the attachment of the wire is easy. The free end of the wire (which is cut to a chosen length—usually one fathom) is twisted through the hole provided in the metal drag as shown in the picture. As now made, the apparatus when thrown in the sea floats awash; the weight of the drag is chosen to effect this, or, if the bottles are very light, a suitable amount of sand is placed in each before making up.

It will be obvious that, in order to obtain reliable information from drag-fitted bottles of the kind just described, it will be necessary to learn whether the postcard bottles actually strand at the places from whence the postcards are sent back, *complete with fittings exactly as when set adrift*, since, if for any reason the drags become detached during the course of the journeys, the bottles will no longer float awash, but will have so much freeboard that they will be blown along by the wind to a much greater degree than they will be borne along by the currents proper. Hence, in the case of a bottle which is known to have performed a considerable part of its journey without its drag, the postcard, when received, would convey information which could not be of much use. Questionnaire postcards, asking the finders to state whether the bottles when found had wires and drags attached, have been used, but with less satisfaction than might have been expected, as a bottle, found without its drag, might have gone ashore complete at the place where found and have lost its drag as a result of the action of the breakers. It is obvious that the employment of these drag-fitted bottles involves many difficulties.

Another method is that pictured on the right-hand side of Fig. 3 (p. 13). Here, instead of using a metal drag, a second bottle (itself too heavily ballasted to float) is suspended by wires from the upper floating bottle. Though coupled-bottle systems have been used by workers of several nations for a considerable time past, those used by the Ministry in English experiments have several interesting features designed to enable the investigators to obtain results of particularly

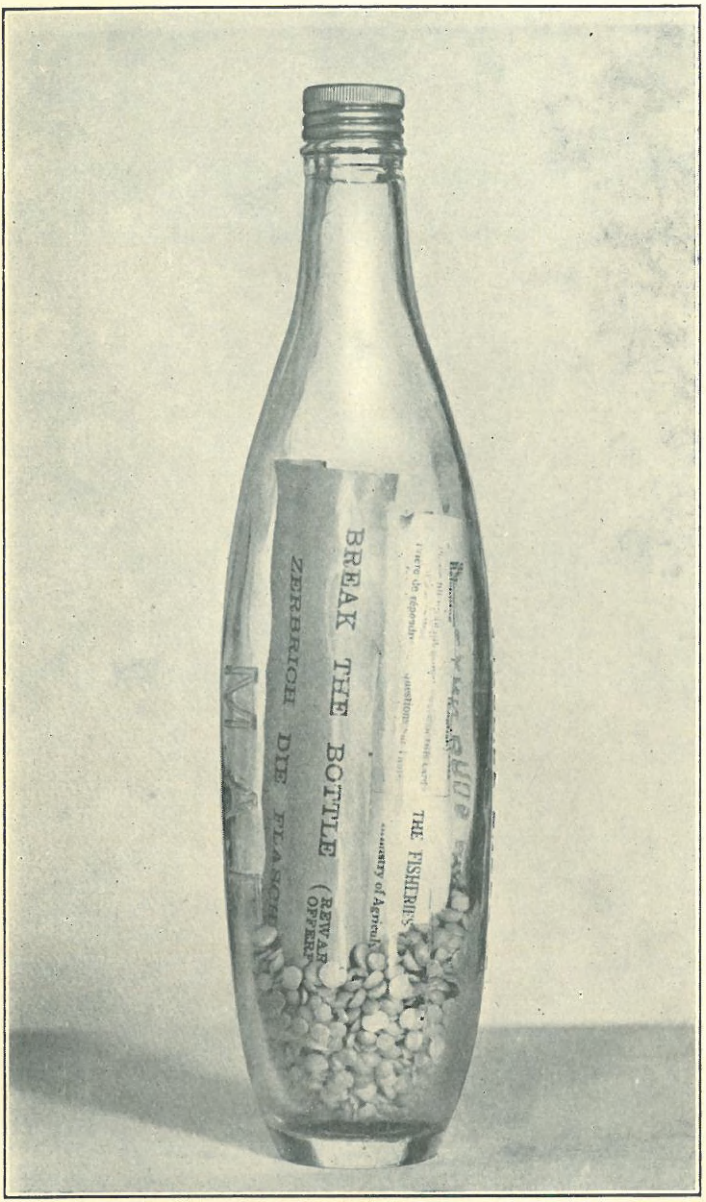
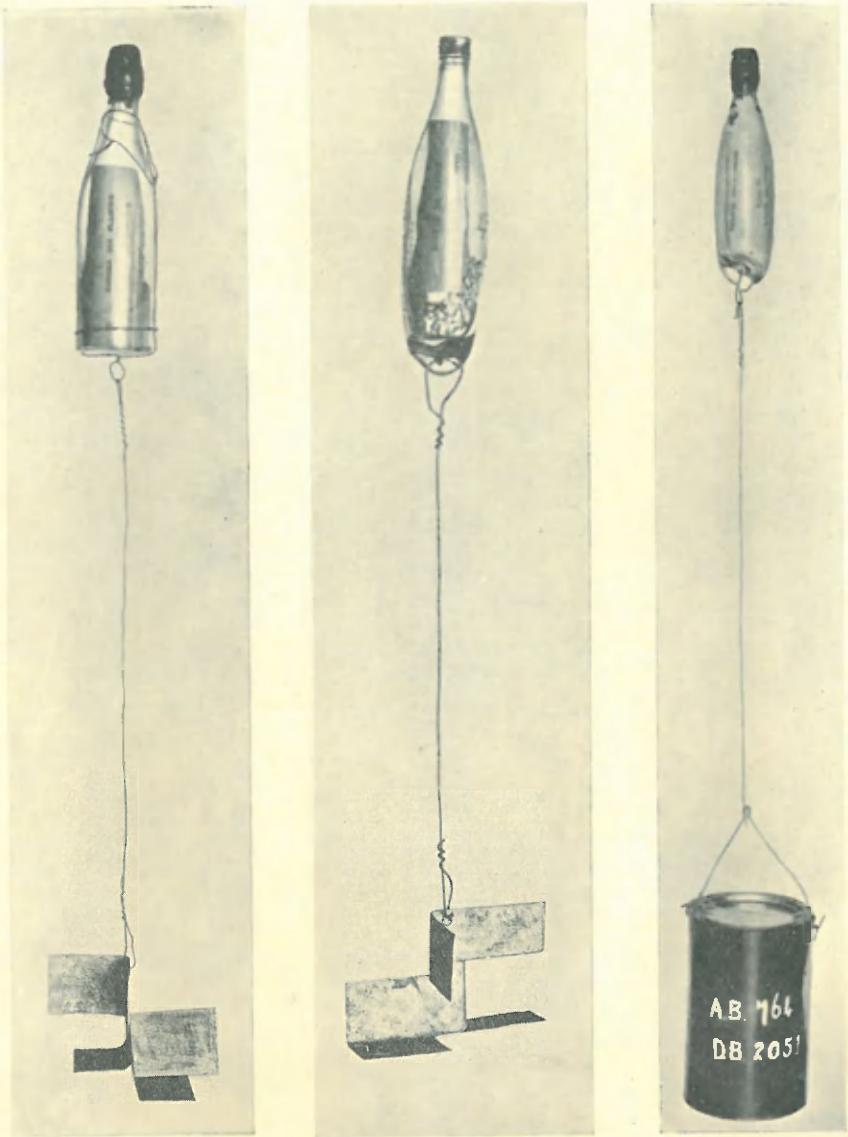


FIG. 1.—Surface Drift Bottle.



a. b. c.

FIG. 2.—Illustrating various types of drag-fitted drift bottles.

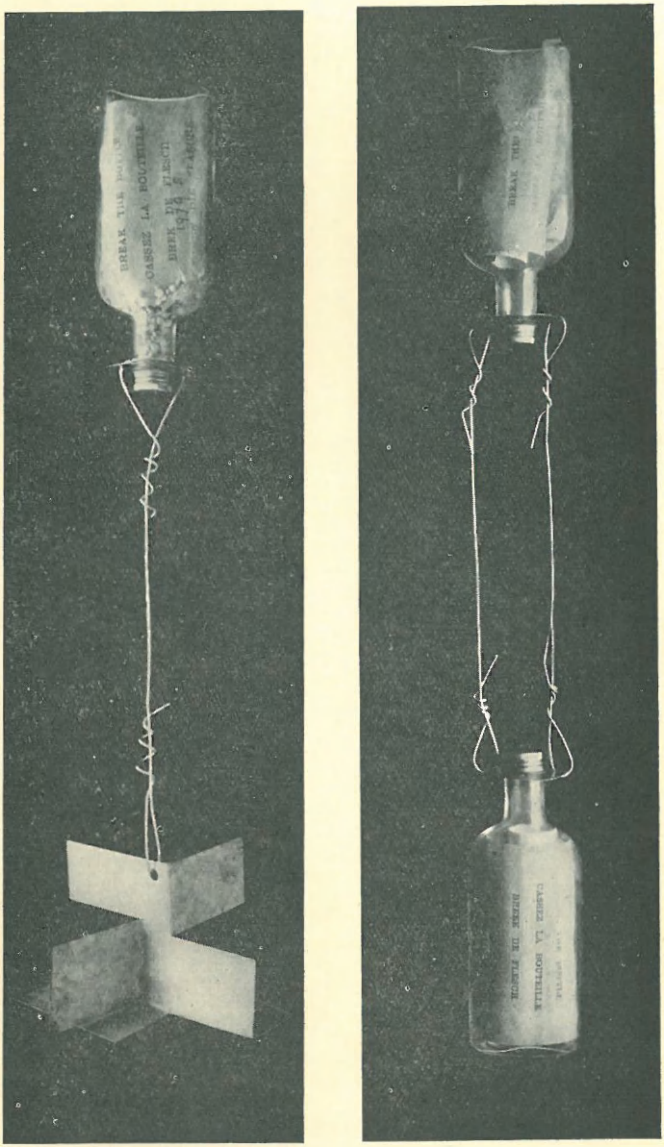


FIG. 3.—Illustrating improved types of drag-fitted drift bottles.

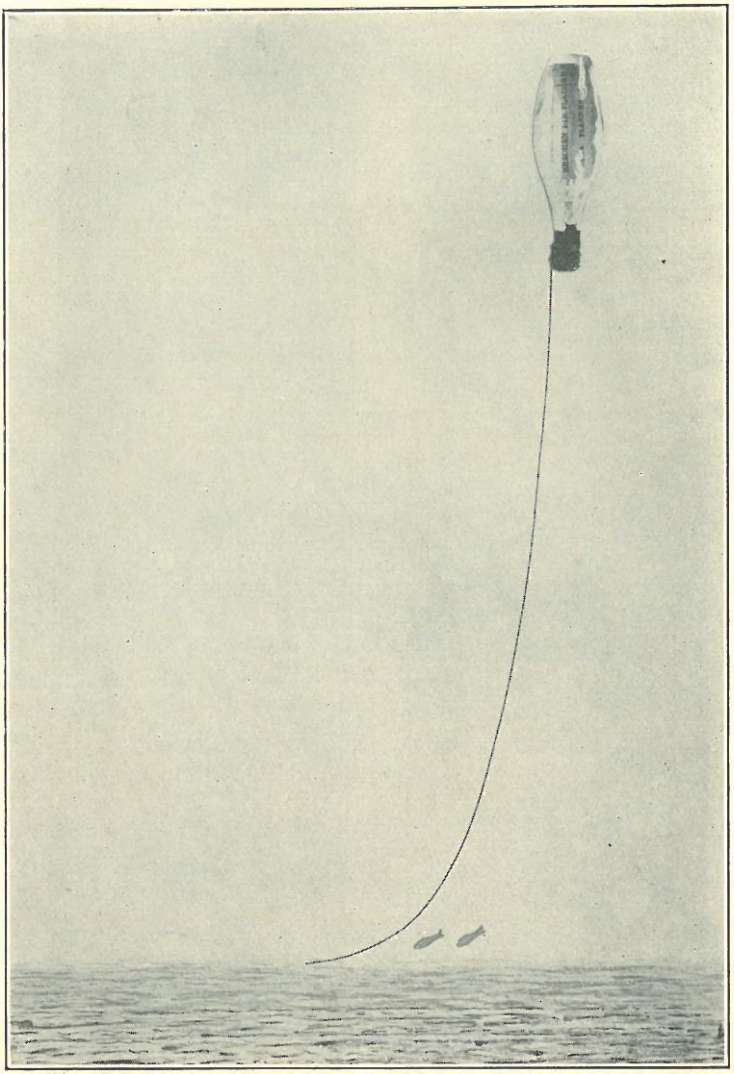


FIG. 4.—Bottom Trailing Bottle.

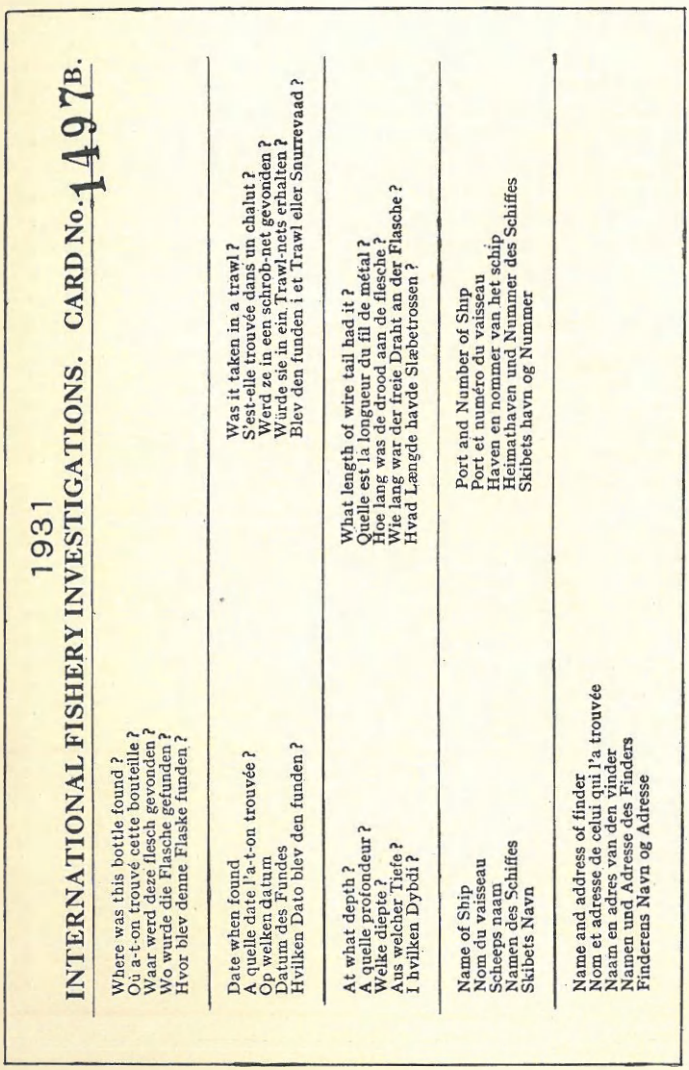
good value. Firstly, as will be seen from the picture, the coupled-bottle systems are made up in as strong a manner as possible. The attachments to the bottles are made by means of the monel metal pierced discs and belled-out screw caps as already described. Two wires (of gauge 14) are used to ensure as far as possible that the bottles shall not come adrift. It is hardly necessary to say that the bottom bottle is so ballasted (with sand) as to secure that the apparatus will float just awash when thrown into the sea. Actually the bottom bottle is made sufficiently heavy to secure that it shall ride up as little as possible when the immediate surface layer of water is moving at a speed differing from that of the layer below in which the lower bottle resides. In the English experiments a postcard is placed in both bottles, in the hope that both cards will be sent back from the same place and by he same finder—thus establishing that the apparatus, when it went ashore (or even, in rare cases, when retrieved at sea), was complete as when originally sent adrift. This has happened in a number of cases in the course of experiments recently made. It should be explained that Fig. 2c (p. 12) shows an arrangement whereby a drag of extra large size might be used. Brightly coloured toffee-tins (nine inches high and six inches in diameter) were hung from buoyant bottles of the type referred to earlier as having a hole provided for the attachment of wires. Each of the heavy toffee-tins had a buoyant bottle with pressure-resisting sealing securely enclosed in it. This "imprisoned" bottle served two purposes; it buoyed up the heavy tin enough to ensure that the whole apparatus floated just awash, and it carried a second postcard so that the investigators might learn whether the apparatus was later recovered entire. Not much success attended experiments with these "toffee-tin bottles," as the tins perished too soon. Much was learnt, however, about the effect of the wind in blowing along bottles with high freeboard, as both bottles in this apparatus must have had after they had become quite free of all attachments and restraints consequent upon the breaking up of the apparatus.

(c) *Bottom Trailing Bottles.*

A third type of bottle, variously referred to as "bottom bottles," "bottom trailers," "bottom trailing bottles," or (after their inventor) "Bidder-type bottles," may now be described. If a bottle is weighted so that when properly sealed with a pressure-resisting sealing it is a little heavier than the volume of water it would displace, the bottle will sink slowly to the bottom on being placed in a tank of water. If this weighting of the bottle is suitably adjusted it will, on being thrown into the sea, sink to the bottom and be light enough to roll along on the sea floor if the water there

exhibits any movement. If many such bottles were thrown out at a chosen place, with postcards (of the usual drift-bottle type) placed in them, it might be expected if the waters concerned were trawled or seined that some of the postcards would be returned, owing to bottles being taken in fishing nets. As a matter of fact, however, no matter how lightly the bottles press on the sea bottom, the friction must be so considerable as to prevent them from being urged along at a speed anything like that of the moving water. Objects other than bottles might be expected to travel better if there was no objection to their being *rolled* along the sea floor by the bottom current. In certain early experiments cocoanuts were used. Each empty nut had a metal numbered identification tally attached to it, but no great success seems to have been achieved. The real step forward came when Dr. G. P. Bidder invented the bottom trailing bottle as now used. The arrangement consists of a bottle (containing a postcard as usual) which, before being fitted with a pressure-resisting sealing, has been weighted *in the neck* by means of a cotton wool padding in which lead shot are enclosed, and which, after sealing, has had a yard or so of copper wire attached to its neck. The bottle without the copper wire would just float neck-downwards; with the copper wire attached, it will just sink neck-downwards in the sea-water to which it is adjusted. The copper wire is so fitted that, whilst one end is securely fastened to the bottle neck, it is possible to straighten out a yard or so in line with the length of the bottle so as to make a tail. On throwing such an apparatus into the sea, it sinks gently to the bottom, but, when the tip of the wire touches the sea floor, the descent is arrested, and the bottle remains lightly poised on its wire tail. It can then be much more easily moved along by the currents at the sea bottom, for there is only the friction of the tip of the wire to offer resistance. In a word, the bottle dances lightly along on the tip of its tail. These bottom-bottles can, of course, be usefully employed only in areas where intensive trawl or seine fishing is prosecuted, since recovery depends almost entirely upon fishing nets. The bottles move so slowly that years of waiting might be necessary for any recoveries from strandings in the case of liberations made in the open sea far from coasts, and in areas where no fishing with ground nets is carried on. In the North Sea the method has been used extensively, and, thanks to the high intensity of trawling there, a very fair percentage of the bottles have been caught by trawlers (25 per cent.), and much has consequently been learnt about the bottom water movements. In the case of these bottom-bottles, the questions on the postcards are designed to procure information on several important points which do not apply to the simple surface floaters. It is necessary to know what length of copper wire

tail the bottle had when recovered, since, if the bottle had *stranded*, this information would probably establish whether it had been afloat for part of its journey. It is also necessary to ask whether it was recovered in a trawl in order to ascertain that the bottle was not (as some of them occasionally are) recovered floating at sea. This can happen with a bottle whose entire copper wire tail is lost, though the loss only rarely happens. The question side of the postcard enclosed in bottom trailing bottles is as follows:—



The address side of these cards is the same as that of the cards used in the ordinary floating bottles.

A picture of a bottom trailing bottle is shown in Figure 4 (p. 14). It is shown as it would be seen by a diver on the sea bottom.

The bottle pictured is an ordinary soda water bottle. Those used for bottom trailers have usually been of the type known in the trade as "10 oz. Flat Bottom, Crown Mouth, Sodas," and have generally been obtained of the same external volume by having them made all from the same mould. This precaution has enabled investigators who later use the bottles as bottom trailers to achieve the correct weight adjustment much more easily. Such a bottle as that shown in Fig. 4 is about 9 inches long.

When these bottom trailers are packed for transport, the copper wire tails are loosely coiled round the bottle necks, and the bottles are packed in straw in wooden boxes. When the time comes to liberate them, as each bottle is removed from the straw, the tail is very carefully straightened out by *uncoiling* the wire and not merely by pulling it straight; the latter practice cannot fail to produce some kink which will prove a source of weakness and so eventually render the bottle useless when the tail breaks off in consequence of the strain.

(d) *Short-Period Floating Bottles.*

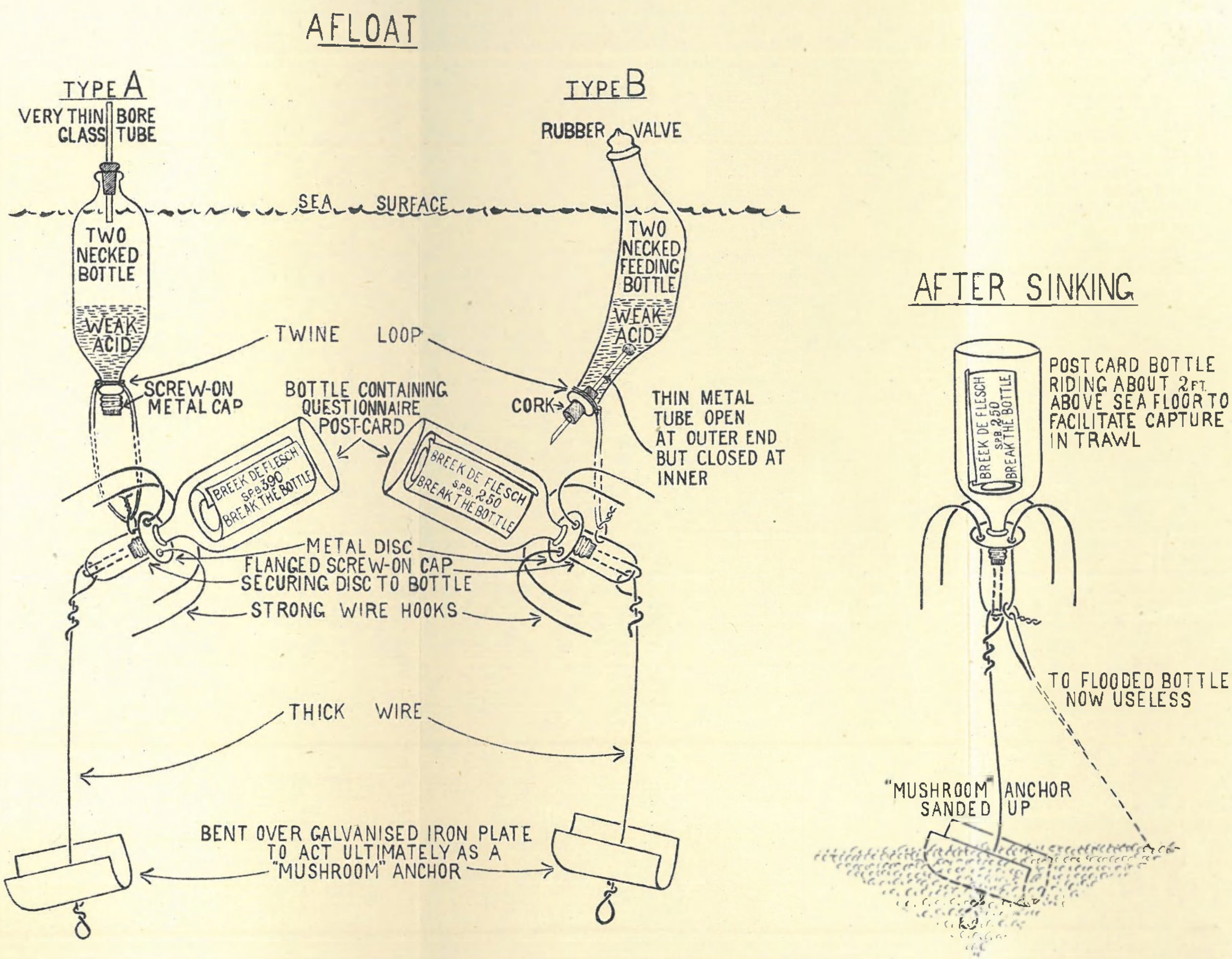
There is another type of drift bottle of such a special nature that, when experiments were started with it, the Ministry (by whom alone such bottles have been used) found it necessary to issue a special leaflet so that the interest of fishermen and others upon whose co-operation the success of the experiments would largely depend might be aroused. For a full account of these bottles the leaflet concerned should be consulted.* It is the practice of the Ministry to send a copy to fishermen who, having taken such bottles in their nets, have returned the filled-in postcards. Full details as to the history of the bottles of this type are also supplied to the finders.†

A reproduction of the illustration from the "Leaflet for the Information of Finders" faces this page.

It will suffice here to remark that the main use of this complicated looking drift-bottle apparatus is indicated when it is stated that by means of it something may be learnt of the actual routes followed by ordinary surface-floating bottles along with which it is sent adrift. The apparatus just pictured will float in company with ordinary drift bottles for a part of their journey only, and will then sink to leave anchored on the sea floor a postcard bottle whose recovery in

* Leaflet 3495–4/30—a copy of which can be obtained from the Ministry.

† A copy of the form concerned can be obtained from the Ministry on asking for :— Form (*2426) – 4/30.



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Malby & Sons Photo-Lith.

a fishing net will furnish the investigator with information as to the departure course of the ordinary drift bottles, the end points of whose journeys he will later learn. The construction of the apparatus is as follows:—

A suitably buoyant bottle, empty except for a postcard, is provided with a pressure-resisting seal, and is then fitted with strong wire hooks and an anchoring device as shown in the picture. This bottle by itself could float, but it is not able to bear up all the wires, etc., attached to it. If thrown into the sea, it would be pulled down to the bottom, and then, by virtue of its own lightness, would ride up off the sea floor exactly as shown in that part of the picture under the heading "After Sinking." This is how the postcard bottle actually is when a net catches it. This part of the apparatus (that is, the part caught up by the net) is originally hung from a float of a kind designed to carry it along near the surface of the sea for a certain fixed length of time only. The idea is that this float, after a time fixed upon to suit the purposes in view, becomes flooded with water, sinks, and allows the postcard bottle to fall to the bottom of the sea and anchor itself there by means of the attachments provided.

After the whole apparatus has sunk, that part which had acted as the float no longer matters. The float in question is a two-necked bottle of one of the two kinds pictured (Type A and Type B).

In the float bottle some harmless, weak acid eats through a metal screw cap, or a metal tube as the case may be, and thus allows the air which it contains to be pushed out through the vent provided at the top; thereupon the whole apparatus sinks.

It is known where the bottle was sent adrift and for how long it was timed to float, so that, on learning the place of recovery, it is possible to determine how far, and in what direction, it had travelled in so many days.

It may be necessary from time to time to make slight alterations to this bottle apparatus; future bottles retaken in fishing nets may, therefore, differ somewhat from that pictured above, but the aims in view will be the same as those declared in the leaflet to which reference has been made.

It is not yet possible to claim that the timing of these bottles has been satisfactorily achieved, and as yet only very few experiments have been carried out with them. Still, much of value is learned, even though reliable information as to speed may not be obtained until much more experimenting has been done.

For a properly filled in postcard from one of these bottles it has been the practice in the early experiments to pay to the finder a reward of two shillings. The cards used in these bottles differ from those used in the bottom bottles (see

pages 16-18) in one or two details only. The identification numbers of the cards are followed by the letters S.P.B. (denoting "Short Period Bottle"), and the question about length of wire tail does not appear.

Some Results from Drift-Bottle Experiments Carried Out by the Ministry of Agriculture and Fisheries.

It remains now to give some account of the results of the Ministry's experiments with drift bottles. These experiments have been made, almost always, in connection with problems of fishery research. From the journeys performed by bottles in large scale and continued experiments, it is desired to gain general information concerning the most usual state of the currents. Smaller experiments carried out from time to time as occasion demands are usually concerned with investigating the dispersal of floating fish-eggs, fish-fry, or other small, passively-transported organisms from places where they have been found to occur in concentration, the inference being made from the travels of bottles thrown out in the areas in question.

In the North Sea many thousands of drift-bottles have been put out in pursuance of carefully prepared schemes, and though in this Notice English work alone is dealt with, it should be mentioned that many large and valuable experiments have been carried out by the Scottish Fishery Board, and that excellent researches have been made also by Belgian investigators and, to a lesser degree, by investigators from Holland.

Throughout a whole year commencing in September, 1920, the Ministry of Agriculture and Fisheries had 25 surface-floating bottles, and 25 bottom-trailing bottles put out each week from each of the following seven North Sea light-vessels:—Smith's Knoll, Outer Dowsing, Galloper, Swarte Bank, Sandettie, Noord Hinder and Doggersbank-Zuid. Of the 9,550 surface-bottles put out, 6,435 (67 $\frac{2}{5}$ per cent.) were ultimately recovered, whilst of the 9,525 bottom-trailing bottles put out 3,362 (35$\frac{1}{3}$ per cent.) were recovered. Of the total recoveries of bottom-bottles, two-thirds were re-taken by trawl.

In the case of the surface-bottles it was possible to construct charts showing the varied movements of the surface waters of the Southern North Sea with varying conditions of wind, and from the bottom-bottle results it was possible to gain a very good idea of the main bottom circulation of the Southern North Sea. In some cases surface-bottles have been known to travel across the southern part of the North Sea at an overall speed of no less than 10 miles a day. Perhaps a representative figure regarding the speed of the bottom-

bottles would be one mile a day, though in their case speed estimates are not easily made.

For purposes of illustration the results of certain experiments in the English Channel may be cited. In the summers of five different years surface-bottles have been put out at a position situated about half-way between Plymouth and Ushant. Quite commonly these bottles have been carried up Channel into the North Sea; many have at times crossed the North Sea, skirted the coasts of Jutland and Norway, and have finished up well over 1,200 miles from their starting points. One bottle travelled in 1924 over 1,450 miles at a rate of little less than 8 miles a day; it journeyed from the Western Channel to a point 70° N. latitude on the coast of Norway. The three charts given on pp. 22-24 illustrate the travels of surface bottles put out in the Western English Channel at the times indicated.

Though in the three different years the surface-bottles were put out at the same position, strandings resulted at very different places. This fact is explainable by the different wind conditions ruling in the respective years. It was found possible to work out, on the basis of the results from four experiments, a relationship between wind speed and the rate of travel of ordinary surface-bottles.

In the experiment of 1928, to which Chart 2 refers, other types of bottle were put out along with the surface-floating bottles of the usual kind. A number of bottles without any ballast, and also a number of drag-fitted bottles, were sent adrift. The travels of the light, unballasted, bottles were much more markedly dependent upon the wind than were those of the ordinary ballasted surface-bottles with no freeboard, whilst the drag-fitted bottles performed journeys which showed them to have been much better indicators of the water-movements proper, and to have been less influenced by wind than were the ordinary floaters.

Acknowledgment.

The blocks from which Figs. 2 and 3 and Charts 1, 2 and 3 were printed were originally prepared to illustrate an article published by an officer of the Ministry in the Journal of the Marine Biological Association of the United Kingdom, and the Ministry's thanks are here expressed to the Director of the Association for the loan of them.

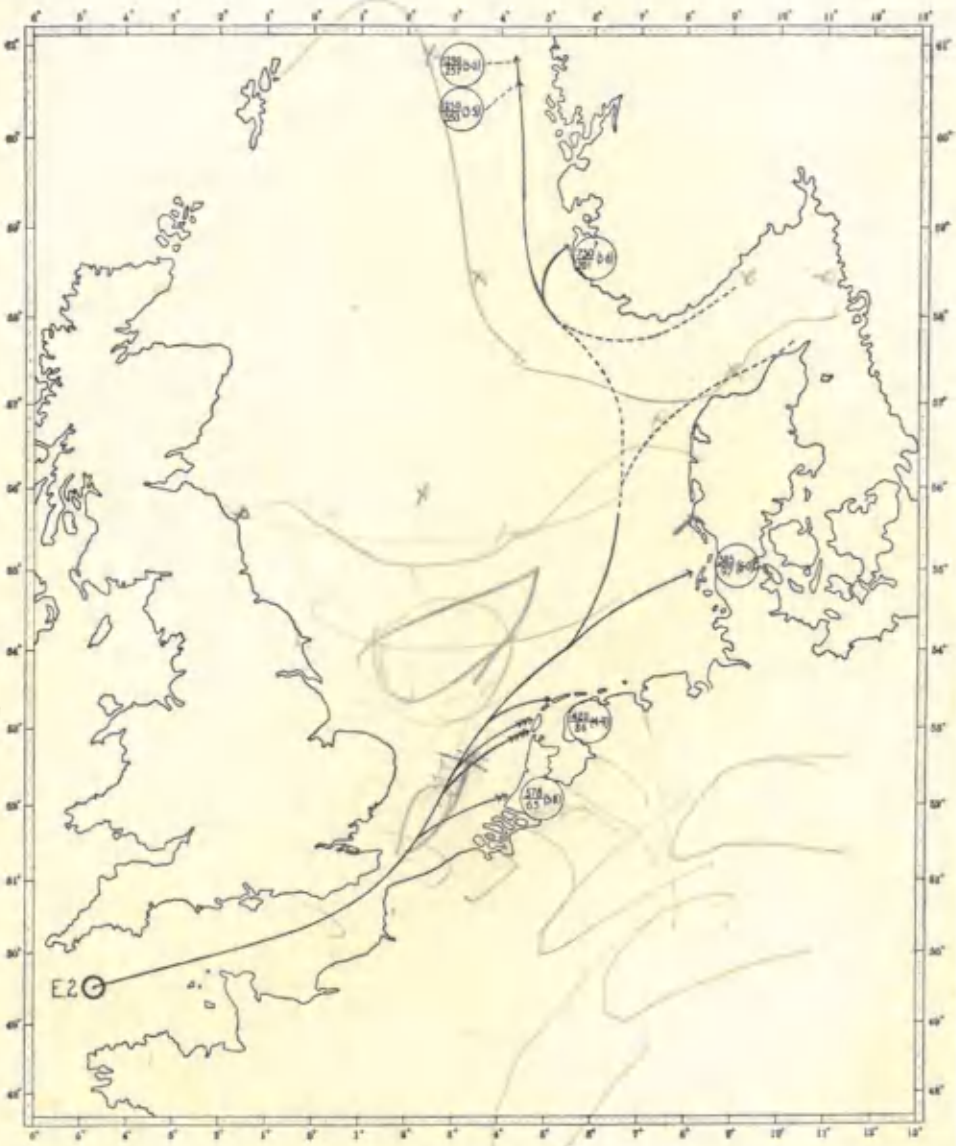

CHART 1.

Illustrating the journeys accomplished by simple surface floating bottles put out at International Station E2 on 2nd August, 1927. Where the arrows are multi-barbed, the number of barbs denotes the number of bottles recovered at the place indicated. The figures in the circles refer to the stranding places near by, and have the following signification:—

The numerator indicates chordal distance travelled in miles.
The denominator gives the time "out" (in days) of the fastest bottle.
The bracketed figures denote the corresponding speed in miles per day.

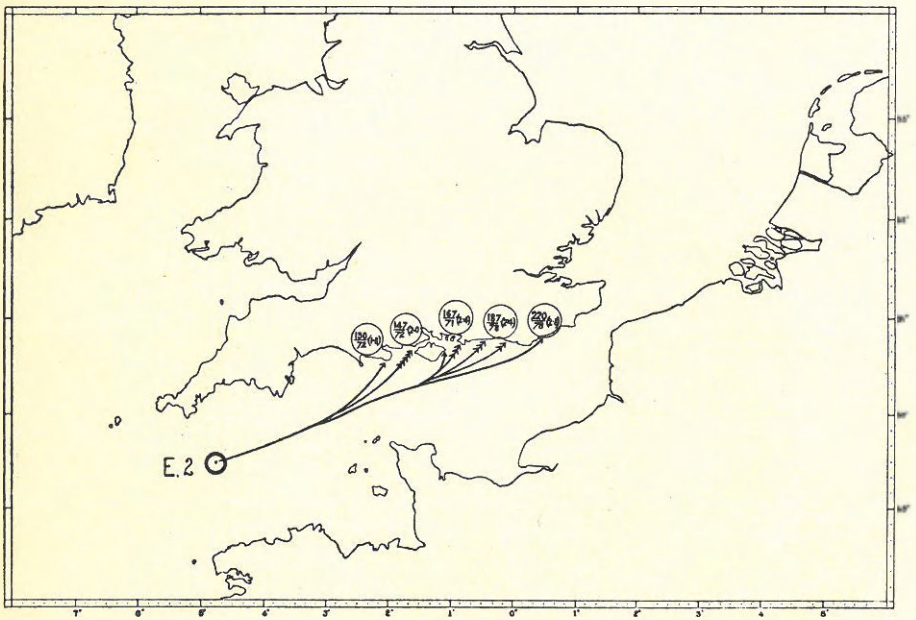

CHART 2.

Illustrating the journeys accomplished by simple surface floating bottles set adrift at International Station E2 on 10th August, 1928.

The figures in circles refer to the strandings near by, and have the same signification as on Chart 1—as also have the arrows.

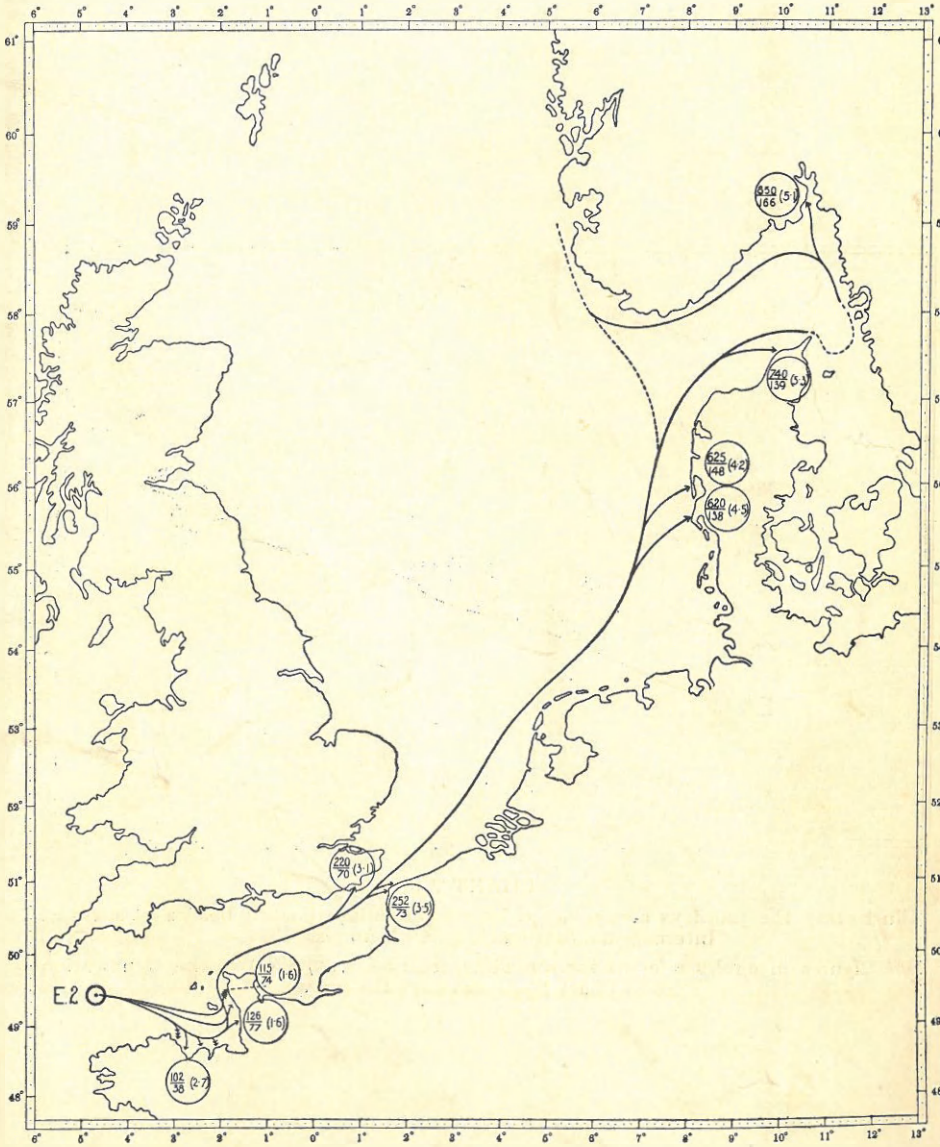

CHART 3.

Illustrating the journeys accomplished by simple surface floating bottles set adrift at International Station E2 on 30th July, 1929.

The figures in circles refer to the strandings near by, and have the same signification as on Chart 1—as also have the arrows.