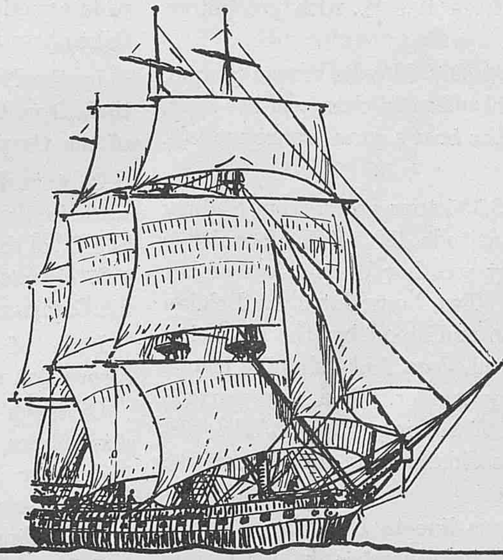
M.O. 262

FOR OFFICIAL USE



VOL. XII, No. 118. THE MARINE OBSERVER. APRIL 1935.

TABLE OF PRINCIPAL CONTENTS

SOME RECENT AWARDS AND PROMOTIONS.

"No observations taken. Standing by to render assistance to distressed S.S. *Usworth*."

That is what Captain BISSET and his officers write about the work of *Ascania* on Friday, December 14th, 1934. Their entries show that at midnight the ship was in Latitude 49° 29′ N. and Longitude 34° 02 W., and there was a fresh gale from W.S.W. with precipitous sea and heavy long swell.

The work done by *Ascania* earned that ship Lloyd's bronze plaque, Lieutenant E. R. J. POLLITT, R.N.R., 3rd officer in charge of her boat, Lloyd's much coveted silver medal, and the boat's crew bronze medals. Great-hearted lads, these !

Usworth, of Newcastle, a steamer of 3,535 tons gross, from Sydney C.B. to Queenstown, was disabled in Latitude 48° 35′ N., Longitude 36° 10′ W. on December 11th in heavy weather by the loss of her rudder, and made W/T distress signals. Two hours later the Belgian steamer *Jean Jadot* arrived on the scene and stood by, the sea being very heavy. Later a tow rope was passed, *Jean Jadot* shaping course for Fayal, and *Usworth* rigged a jury rudder. The tow parted; *Usworth* signalled she was in danger of sinking; *Jean Jadot* discharged oil to windward of *Usworth*, as did *Ascania*, arriving on the scene about 8 a.m.

Attempts by both these ships to pass a line to *Usworth* by rocket having failed, at 1 p.m. *Jean Jadot* sent away her boat, which having taken 14 men out of *Usworth* capsized and Mr. P. LAMBERT, 4th Officer, and Donkeyman DE JOUGH, with 12 of the crew of *Usworth* were drowned. Captain BISSET having manœuvred *Ascania* into a suitable position now sent away his boat which had a very difficult pull, but Mr. POLLITT and his men succeeded in closing *Usworth*, when three of her crew jumped too soon and were lost. Later they got the boat alongside and the remainder of *Usworth's* crew jumped into her, Seaman CAMPBELL of *Ascania* sustaining a broken leg.

The boat was pulled clear and *Ascania* manœuvred to pick her up, the men were hoisted in, and the boat abandoned.

Lloyd's bronze plaque was awarded to *Jean Jadot* and bronze medals to members of her boat's crew, those of Mr. LAMBERT and Donkeyman DE JOUGH being posthumous.

Mr. ALFRED WIESEN, 2nd officer of the Hamburg-Amerika *New York*, was also awarded Lloyd's silver medal and promoted to First Officer, bronze medals were awarded to the *New York's* boat's crew and the bronze plaque to the ship, for the rescue of the crew of the disabled Norwegian S.S. *Sisto* on December 19th, 1934, in the vicinity of Latitude 49° 06′ N., Longitude 23° 27′ W.

On this occasion Captain KRUSE listed *New York* to lower his boats while the Cunard *Aurania* spread oil on the sea; the boats, after a strenuous pull, closed *Sisto*, lines were passed and the crew hauled into the boat.

Captain KRUSE then placed *New York* in position, and after a critical time the rescued crew and the boat's crew were got on board through the pilot's entrance, and the life boat was cut adrift.

International work indeed in sea service !

Sir EDGAR T. BRITTEN has recently been appointed Commodore of the Cunard-White Star Line, the first officer to have this high distinction of the recently combined fleets of the old Cunard and White Star Lines. To be Commodore of either of which was formerly considered a great distinction in the British Merchant Navy. It has been made known that Captain R. B. IRVING is to be the first Captain of the new Cunard-White Star *Queen Mary*, launched and named by HER MAJESTY THE QUEEN, also that Captain A. L. OWENS is to be the first Captain of the new Orient *Orion*, which ship has the distinction of being launched at Barrow-in-Furness from Melbourne in Australia by H.R.H. THE DUKE OF GLOUCESTER.

Captain R. G. LATTA, late of *Empress of Britain*, recently retired from service afloat, has been appointed General Superintendent of the Canadian-Pacific Line at Montreal, in which appointment his wide experience of seafarers and ships and their management cannot fail to help the Merchant Navy.

In the New Year promotions of the Royal Navy Reserve out of three from Commander to Captain, two officers promoted are members of the Corps of Voluntary Marine Observers.

Captain R. L. F. HUBBARD of the Orient Line, who first did this work in the Barque *Lock Katrine* in 1908, and Captain H. L. UPTON, D.S.C., of the New Zealand Shipping Company, who first did this work in S.S. *Rimutaka* in 1906, and who is best known as the Commander of his Company's sea-going officers' training ships.

Both of these officers have been almost continuous in their association with this work.

Of seven promotions from Lieutenant Commander to Commander six officers promoted are or have been members of the Corps of Voluntary Marine Observers. Commander B. K. BERRY was for a short time on the list in S.S. *Somme*, Commander L. W. LEASK when commanding S.S. *Matiana* in 1924, and now he commands *Mulbera*, a Selected Ship. Commander E. R. TAYLOR has been an observing officer constantly from 1923 when he commenced in *Berengaria* until the end of 1933, and has acted for much of that time as principal observing officer of his ship. Commander S. McI. W. EASTERBROOK first did the work in 1921 when he was 3rd officer of S.S. *Clan Ross* and continued it in other ships, last when in S.S. *Clan Macphee* in 1933. Commander R. W. JONES commenced when 4th officer in S.S. *Corsican* and continued regularly, last in *Minnedosa* in 1922. Commander J. S. METCALF, D.S.C., commenced when 4th officer of *Orvieto* and continued last in *Orama* in 1926.

With an Observing Fleet limited to less than one in ten of the ships of the British Merchant Fleet there are many officers of the Merchant Navy, both those who are R.N.R. Officers and who are not, who cannot be members of the Corps of Marine Observers—the Captains and observing officers of regular observing ships for the time being.

Ships are accepted as regular observing ships, from amongst those whose commanders and officers will volunteer to do the work, which are most suitable for this work, and which in their trades cover with suitable distribution the Oceans.

This voluntary work is organized and conducted to carry out the provisions of the Merchant Shipping Act as specified in Article 35 of the Safety Convention, and no other consideration is given in the assembly of the observing fleet list, together with the Corps of voluntary marine observers, than that of maintaining the best world wide Marine Meteorological service.

An excellent award made by the Meteorological Committee which appeared in the 1933 list probably passed with little notice except by the receiver and his shipmates; it should be regarded as a distinction, for it was made to the only fisherman who has earned such an award for many years, and the first in a trawler.

Skipper A. HATTON in the Steam Trawler *St. Minver* did fine work in Arctic and Northern Waters when he earned that award, and he is continuing after a spell ashore in the Steam Trawler *St. Keverne*.

The officers of foreign-going ships of the British Merchant fleet seldom came in close connection with deep sea fishermen before 1914; since then many of us have worked with the fishermen in their Trawlers and Drifters and have come to better know their sterling qualities.

Those who know the life and work of the skippers and crews of the Trawlers, especially of those who fish in the Arctic, will understand the devotion required to do what Skipper HATTON is doing in carrying on the work under such conditions. Captain H. J. DORLING, D.S.O., R.N., better known as "Taffrail," has recently with the pen of a ready writer given a true-to-life account of these men and their work in his "Seventy North."

Wireless Weather Telegraphy.

During the time since May 1st, 1930—when the International Ships Wireless Weather Code and the Schedule for communication for British Selected Ships in all parts of the world was brought into use—until the system was well established no great encouragement was given to British Ships other than Selected Ships, to make routine reports. Since the Selected Ship system has taken hold and British Selected Ships have been so regular in carrying out the routine of reporting weather, all British ships fitted with W/T have been asked in these pages to make routine W/T weather reports when and where there are not Selected Ships to perform the service.

The pamphlet M.O. 329 containing the decode has been revised and the 3rd edition which was published recently, as well as including a description of the system, gives notes for the guidance of Masters of British ships for carrying out this service.

Further steps have been taken to make this generally known throughout the British Merchant Navy. We are indebted to the Chamber of Shipping of the United Kingdom for bringing to notice of owners the desirability of this service being encouraged and this little pamphlet being on board all British ships fitted with W/T. We are indebted to the Mercantile Marine Service Association, The Imperial Merchant Service Guild, and the Officers (Merchant Navy) Federation for the assistance they have given in making known these desires throughout the Merchant Service.

Some officers have asked, "what should be done when reports are asked for ashore of observations made at other than the four International observation hours?"

Just as when another ship asks for information of weather observed at other times than those appointed for routine reports, unless inconvenient the information desired is sent, so too should weather reports desired for some local purpose ashore also be sent.

In the case of aircraft, reports between routine times may be very desirable on account of their great speed.

Here is an example of a report from a British Selected Ship to a German airship which was made between her routine reports on June 11th, 1934 in the Atlantic.

From G.L.Q.R. to D.E.N.N.E. Weather 20105 27805 06303 13875 38578 63505 56105.

As a general rule as far as possible, whether other weather reports are made or not, routine W/T weather reports should be sent at the scheduled times twice daily by Selected Ships and ships carrying out the service, where there are not Selected Ships. It is desirable that there should be synchronised observations made over the oceans for the information of shipping and the Meteorological Services. As the principles of modern weather forecasting become more generally known amongst seamen the reasons for this will become clearer.

A Handbook for Seamen.

When I got command of a ship in 1913 I desired some book which would give me without too much scientific or technical detail information of weather, currents and ice with which to improve my knowledge and so navigate my ship to better advantage.

In my intercourse with the officers of the Merchant Navy since coming to the Meteorological Office towards the end of 1919, many have told me of their similar desire, and a number of sea officers have asked that a handbook for seamen should be published. Article 35 of the Convention of Safety of Life at Sea has made it still more desirable that the navigating officers of the Merchant Navy should have a book of some practical guidance in the application of meteorology to navigation.

The Honourable Company of Master Mariners requested that a general manual on Marine Meteorology for Seamen should be published, for they said the demand for such a book would be increased by the fact that the Board of Trade have recently recognised the value of this subject by including it in a more practical form in the examinations for Masters and Mates. A book intended mainly for the great majority of the navigating officers of the Merchant Navy who do not receive information regularly through the medium of THE MARINE OBSERVER will be published before this number appears entitled A HANDBOOK OF WEATHER, CURRENTS AND ICE FOR SEAMEN, which it is hoped will be of some assistance.

The Survey of the Currents of the Oceans.

The recharting of the currents of the Indian Ocean and the construction of the new atlas is now nearly complete. Since 1929 a great deal that is new has been learned of the currents of the Indian Ocean by this work. We hope soon to commence the recharting of the currents of the South Pacific. In 1928 we made a preliminary investigation of the currents along the routes from Panama to Australasian ports and in compiling the chapter on currents in the Handbook for Seamen it has become still more evident that the recharting of the currents of the Pacific is most desirable for there is at present a great lack of reliable information.

There are now sufficient observations of the set and drift of currents accumulated since 1910 along the main trade routes traversing the South Pacific, but more data are desired in less traversed parts of this ocean.

Shipowners, Marine Superintendents and the Captains of British ships which have navigated the South Pacific and which have not been observing ships since 1910 and so have not returned observations of current to the Meteorological Office since then can now assist us.

It is desired that reliable observations of set and drift of current since 1910 made in the remote parts of the South Pacific and logged in the ship's log book which have not previously been returned, should be made available for the purpose of this survey.

It is requested that those who can help in this matter will communicate with Commander M. CRESSWELL, R.N.R., Port Meteorological Officer, Liverpool, or Commander C. H. WILLIAMS, R.N.R., Port Meteorological Officer, King George V Dock, London, who will examine the entries and have them copied as desirable.

It is intended to chart the currents in the South Pacific and to publish sectional charts as usual in THE MARINE OBSERVER, from which to construct an atlas, in the following order:—

Charting	1935—The routes Australasian Ports to Cape Horn,	Publication	1936.
,,	1936—The routes Panama and Islands to Cape Horn,	,,	1937.
,,	1937—The routes Australasian Ports to Panama,	,,	1938.
,,	1938—The regions not covered by the above,	,,	1939.

The work done in the preliminary investigation of 1928 gives us confidence in tackling this much needed investigation.

MARINE SUPERINTENDENT.

23rd January, 1935.

April, May and June.

It is hoped that these pages will be filled each quarter with a selection of the contributions of Mariners in manuscript, or remarks from the Logs and Records of regular Marine Observers.
Responsibility for statements rests with the Contributor.

PHOSPHORESCENCE.

Equatorial Atlantic Ocean.

THE following is an extract from the Meteorological Record of S.S. *Themistocles*, Captain C. WOOD, D.S.C., Liverpool to Cape Town, observer Mr. C. J. SHANSUN, 3rd Officer.

11th June, 1934, at about 21.00 vessel entered an area of unusually phosphorescent sea water. Sea began to exhibit a generally mottled appearance with many planet-like balls of more intense brightness. Next appeared several broad lines of localised phosphorescence, some twenty fathoms in breadth, trending S.E.—N.W. for several miles, at least. These were clearly delineated and rather broken, for instance, by passage of vessels at right angles through them. Beyond these, the ship entered a huge patch of glowing water which had, for some time, been lighting up the horizon. It recalled the effect of near-by town lights obscured by mist; a closer view suggested the impression of wavelets forming under the quickly freshening breeze, each lighted with a submerged electric lamp. There, too, the phosphorescent balls were larger, brighter and more numerous; but, in addition, a myriad glowing *points* gave the appearance of luminous water. This area was well defined by edges curving as to enclose, roughly, a circle, the diameter steamed through being about 5 miles in extent. Thereafter. phosphorescence faded to normal in some seven miles' steaming. Vessel at this time practically in centre of west-going Equatorial Current.

Position of ship, between Latitude 1° 02′ S., Longitude 8° 40′ W., and Latitude 1° 19′ S., Longitude 8° 27′ W.

STATICS.

Western North Atlantic Ocean.

THE following is an extract from the Meteorological Record of S.S. *Montcalm*, Captain W. B. COYLE, R.D., R.N.R., Montreal to Southampton, observer Mr. D. S. PARSONS, 4th officer.

May 8th, 1934. On the night of the 7th-8th May, the Wireless Operators reported very pronounced atmospherics off Cape Race and though the ship was stopped only 45 miles south of the wireless station our signals could scarcely be heard by the land station after having been transmitted on full power by the ship. It was found to be impossible to read figures in morse code and spelling had to be resorted to. Each word had to be transmitted four times before complete reception could be achieved. Atmospherics have continued throughout the whole eastbound voyage though not so badly as on the occasion referred to above.

THUNDERSTORM.

North Pacific.

THE following is an extract from the Meteorological Log of S.S. *Aorangi*, Captain J. F. SPRING-BROWN, Victoria to Honolulu, observer Mr. L. P. BOURKE, 3rd officer.

April 1st, 1934, experienced a sharp thunderstorm, lasting for two hours. At the height of the storm at 6.5 p.m. the foremost starboard guy on the forward funnel was struck by lightning. The blinding flash was accompanied by a terrific report and torrential rain. A strong smell of burning was evident for several minutes. The only damage sustained was the destruction of the serving over the splice at the top of the guy, only a few partially burnt turns remaining.

The report disturbed persons three decks below, and caused some consternation among passengers. One lady was so upset, that she was given stimulant. After the third cocktail, she remarked that the storm wasn't so bad after all!

Position of ship, Latitude 31° N., Longitude 149° W.

THUNDERSTORM.

Indian Ocean.

THE following is an extract from the Meteorological Record of S.S. *Ranchi*, Commander A. H. HIGNETT, R.D., R.N.R., Yokohama to London *via* Suez, observer Mr. R. E. BALDWIN WISEMAN, 4th officer.

On April 18th, 1934, at 2.10 a.m., ship's time, the ship encountered a thunderstorm of extreme violence. The sky had been overcast with A-Cu, Cu. 4/10 and Cu-Nb. 6/10, the weather squally. Wind W.S.W., force 6, Barometer 29.97 in., temperature 80°F., and with vivid lightning in the western sky.

Before the commencement of the storm the temperature fell 5° and the wind decreased to force 2 and became variable, then suddenly freshened and again blew from W.S.W., force 6, accompanied by torrential rain, and vivid lightning and thunder. Between 02.35 and 03.10, ship's time, the wind veered to N.W., and at 03.25 the rain ceased. But at 03.45 the rain again commenced with extreme severity, the wind backing to W.S.W., force 5 to 6, and vivid lightning was observed all round the horizon.

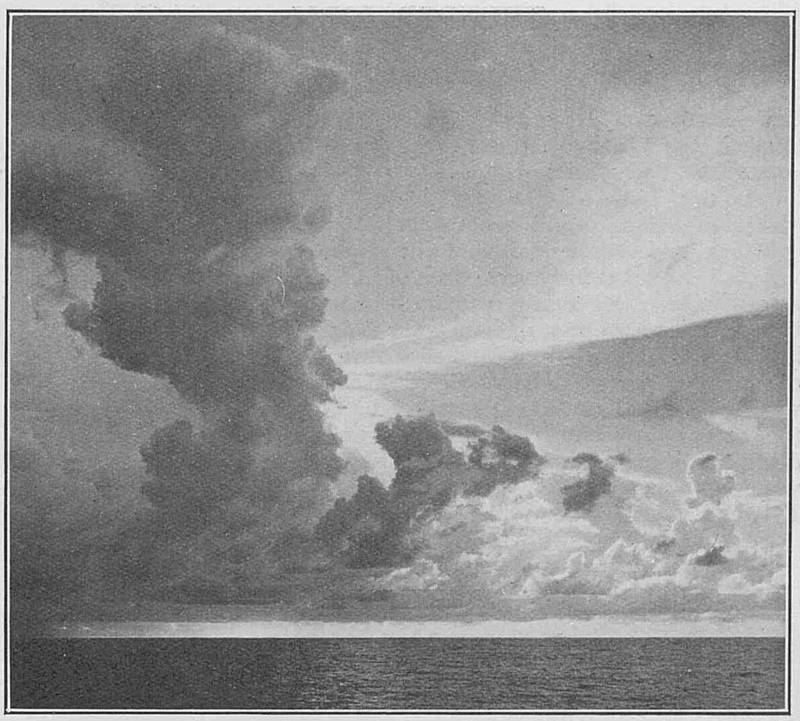
At 04.05, ship's time, during a particularly vivid flash of lightning a ball of fire exploded with a loud report between the bridge and foremast, and travelling in a downward direction struck the sea with a hissing sound about 30 yards from the ship to starboard. The track of the fireball from the time it exploded until it struck the water resembled that of a distress rocket. This phenomenon was observed by the Commander, Second Officer, Cadet of the Watch and myself. The 3rd Wireless Operator, who was on watch in the wireless room, reported that the condenser flashed a large spark, leading him to believe that his instrument had been burnt out, but this was not the case. At 04.39, ship's new time (clocks having been put back 28 minutes at 04.30), the storm passed away to the eastward, but until the ship's arrival off Colombo at noon on the same day, heavy thunder squalls of wind and rain were experienced.

The coast of Ceylon was completely obscured by rain until the ship was off Barberyn Lt. Hs. at 11.00. At the commencement of the storm the ship was within the charted range of Dondra Head light, course 270°, speed 15½ knots, but this light not being seen owing to the heavy rain, the ship was hauled to seaward. After the worst of the storm was over, the wind blew steadily from W.S.W., force 6 to 7, until the ship's arrival at Colombo.

THUNDERSTORM.

South African Waters.

The following is an extract from the Meteorological Log of R.R.S. *Discovery II*, Captain A. L. Nelson, South Georgia to Durban, observer Mr. L. C. Hill.



Towering Cumulus bearing S.E.

Towering Cumulus bearing West.

21st May, 1934, at 15.30, heavy towering cumulus clouds were observed to be forming on the western horizon. They were very chaotic thunder clouds, and a photograph was taken at this time by Mr. Saunders, A.R.P.S. Mr. Saunders also took a photograph of towering cumulus clouds on a S.E. bearing. From 16.15-17.00 a very violent thunderstorm took place with torrential rain and extraordinarily vivid lightning. Towards the end of this storm the sun showed faintly through a grey stratus sky. It was still raining heavily, but Mr. Saunders managed to photograph the sun showing through this stratus veil with a wisp of cumulus beside.

Position of ship, Latitude 31° 39′ S., Longitude 32° 27′ E.

THUNDERSTORM.

Caribbean Sea.

THE following is an extract from the Meteorological Log of S.S. *Hertford*, Captain E. R. KEMP, Colon to Curacao, observer Mr. H. K. COCKERILL, 2nd officer.

June 3rd, 1934, at 2.15 a.m. A.T.S., sky became rapidly overcast with heavy Cu-Nb. and nimbus cloud, torrential rain with sustained lightning, and thunder, commencing soon afterwards.

At 2.35 a particularly vivid flash of forked lightning, which appeared to originate in the zenith, split up into several "tails," one of which travelled down to approximately the height of the ship's main aerial, leaving a trail which remained visible for about two seconds. Upon examination immediately afterwards the card in the standard compass was found to be considerably agitated and swinging 20° either side of the course. Within two minutes, however, the card had settled down again, but a compass error being obtained shortly afterwards, it was found that the deviation for the ship's head had increased from 1° to $2\frac{1}{2}$° E. Two hours later the deviation had returned to normal.

Position of ship, Latitude 10° 10′ N., Longitude 78° 06′ W.

IRIDESCENT CLOUD.

Madras.

THE following is an extract from the Meteorological Record of S.S. *Clan Macalister*, Captain F. J. STENSON, R.D., R.N.R., Cocanada to Madras, observer Mr. H. DUNCAN, 3rd officer.

26th May, 1934, entering Madras harbour at sunset, the sun set behind a bank of dark cumulus cloud, extending to strato-cumulus, and the diffracted rays on the outer edges of this cloud produced a curiously beautiful mother-of-pearl effect. The fringes of the cloud appeared deep orange in colour, shading off through the various colours of the spectrum both inwards and outwards.

The effect was of a cloud whose upper edges were bounded by a double spectrum.

LUNAR RAINBOW.

North Atlantic Ocean.

THE following is an extract from the Meteorological Record of S.S. *Inanda*, Captain WILLIS GIBBINS, Antigua, B.W.I., to London, observer, Mr. W. S. EUSTACE, 3rd officer.

June 27th, 1934, 23,30 A.T.S., observed lunar rainbow against a background of watery-looking stratus cloud. The colours distinctly visible were red outside, yellow in the middle and green on the inside and lower edge. Altitude of vertex of bow 14° 45′ and the points where it appeared to touch the sea bore N.13° E. and N.50° W. True—the moon's altitude being 26° 45′ bearing S. 18° E. True. As the Cu-Nb. cloud passed, fragments of a white secondary bow could be seen. There was no rain in vicinity of bow, but at 23.50 A.T.S. a heavy shower moved rapidly from the eastward and phenomenon disappeared.

Wind W., force 1. Cloud, St., St-Cu and Cu-Nb 7/10. Slight sea and confused swell. Barometer 30.37 in. Dry bulb 73°, wet bulb 71°, sea 71°.

Position of ship, Latitude 34° 47′ N., Longitude 36° 56′ W.

THE following is an extract from the Meteorological Record of S.S. *Mahronda*, Captain R. G. HANNA, Calcutta to United States of America, observer Mr. J. B. LEIGH, 3rd officer.

On June 29th, 1934, during the evening watch at 11.08 p.m. A.T.S. a bright and unusual lunar rainbow was observed. This rainbow first appeared as a very bright semi-bow extending from the Western horizon to the vertex, which obtained an altitude of about 50°. This lasted for a minute, after which the phenomenon extended across the entire sky to the Northern horizon, increasing in brightness until a sheet of nimbus cloud and a heavy rain shower obliterated the entire bow.

The predominating colour in this phenomenon which was considerably brighter at the vertex and on its western half was a greyish white, bordered by a broad band of a faint yellow green on its outer edge. The colours of the inside edge were too faint to define.

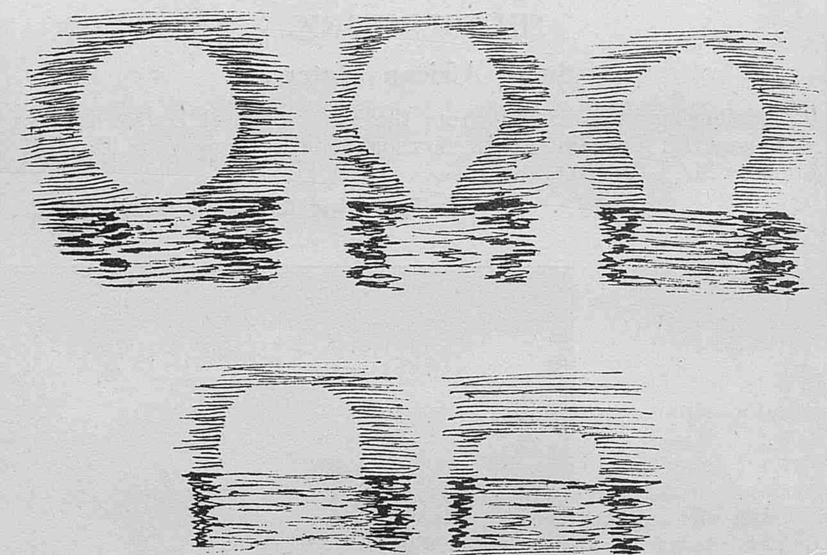
The extremities of the bow which bore West and North (True) respectively, extended to the sea surface on either bow, and was visible at a distance of about 7 miles. The phenomenon only lasted for a matter of $2\frac{1}{2}$ minutes. The altitude of the moon was about 40° and was bearing S.E.

Position of ship at 0133 G.M.T., 30th June, Latitude 41° 47′ N., Longitude 31° 29′ W., Course 277°.

ABNORMAL REFRACTION.

Gulf of Aden.

THE following is an extract from the Meteorological Record of M.V. *Clydebank*, Captain G. SUTHERLAND, Colombo to Aden, observer Mr. F. SHAW, 2nd Officer.



10th May, 1934, at sunset. Abnormal refraction caused the sun to assume the shapes shown in the sketches.

Barometer 1009 mb., Temperature, air 86°, sea 84°. Wind N.E., force 2. Sky cloudless. Visibility excellent. Position of ship, Latitude 12° 40′ N., Longitude 46° 13′ E.

ABNORMAL REFRACTION.

Straits of Juan de Fuca.

THE following is an extract from the Meteorological Log of S.S. *Ixion*, Captain C. J. WATSON, Yokohama to Victoria, observer Mr. H. H. SANDERSON.

13th May, 1934, approaching Straits of Juan de Fuca, Lennard Island. Light 115 ft. high was observed at 9.13 p.m., bearing 012°; and at 9.25 p.m. C. Beale Light, 178 ft. high, was observed bearing 066°. A cross bearing of the two lights placed the vessel $33\frac{1}{2}$ miles off Lennard Island and $35\frac{1}{4}$ miles off C. Beale. This position was subsequently found to be correct. Swiftsure L.V. 65 ft. high was observed at 9.58 p.m. bearing 090°, distant 34 miles, and at 10.15 p.m. Tatoosh Id. light, 155 ft. high was observed bearing 108° a distance of $41\frac{1}{2}$ miles. This condition of the atmosphere had the effect of magnifying the lights, as even lights of low power appeared brilliantly. The lights presumably of houses in the vicinity of C. Beale appeared distinctly, giving the impression that the vessel was passing close to the land, although, at the time, the nearest land was over 20 miles away. Swiftsure light vessel was passed at 0.42 a.m., 14th May. At 1.00 a.m. a strong hot wind of force 7 sprang up suddenly from south and continued until the vessel passed C. Flattery when it became calm. Slight mirage effects were observed at daybreak; conditions returning to normal towards sunrise.

10.00 p.m., 13th May. Air temperature 62°, wet bulb 55°. Sea 57.5°, density 1022. Barometer 1013.8 mb. Wind E'ly, force 1 to 2. Sky cloudless, except for line of cirrus over the land.

ABNORMAL REFRACTION.

Bay of Bengal.

The following is an extract from the Meteorological Record of S.S. *City of Roubaix*, Captain W. Gray, Savannah, U.S.A. to Los Angeles, observer, Mr. J. H. Owen, 3rd officer.

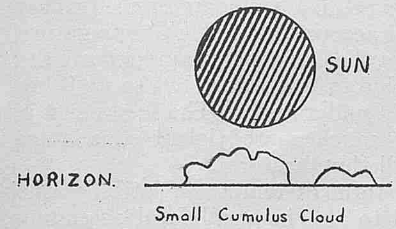


Figure 1.—Sun before reaching horizon appearing normal size.

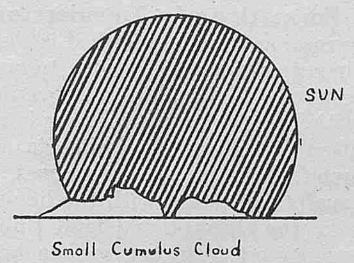


Figure 2.—Sun after reaching and partly obscured by horizon seems to have expanded twice its normal size.

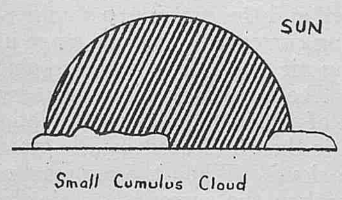


Figure 3.—The sun about half way in setting, still retained its abnormal size and it appeared to retain its abnormal size until completely set.

May 28th, 1934, 6.24 p.m. A.T.S. Sun's true bearing N. 68° W., whilst waiting for sun's lower limb to touch horizon before taking amplitude, I observed the sun to be expanding and before it went out of sight, it had expanded, or appeared so to me, twice its natural size; *see* diagrams.

Position of ship, Latitude 12° 39′ N., Longitude 92° 45′ W. (approx.).

METEORS.

Mediterranean.

The following is an extract from the Meteorological Record of M.V. *Clydebank*, Captain G. Sutherland, Port Said to Algiers, observer Mr. E. Needham, 3rd officer.

20th May, 1934, 2211 G.M.T. A very bright meteor was observed commencing at an altitude of approximately 18° and travelling in a southerly direction. Passing midway between θ Centauri and ι Centauri it illuminated the southern sky and horizon, finally disappearing at an altitude of about 5°. The meteor was of a bright greenish colour and left a faint trail of white light in its wake. Its magnitude was about twice that of Venus and it was visible for a period of about three seconds.

Position of ship, Latitude 35° 10′ N., longitude 17° 44′ E.

North Pacific.

The following is an extract from the Meteorological Record of S.S. *City of Roubaix*, Captain W. Gray, San Francisco to Manila, observer Mr. J. H. Owen, 3rd officer.

June 11th, 1934, 11.30 p.m. ships time, 12d. 9h. 08m. G.M.T., observed a very brilliant meteor magnitude 2.0, bearing south, about 45° to southward of Antares, seen through gap in stratus clouds. Just before disappearing under cloud the meteor itself kept very brilliant, but in space between clouds, the colours changed from white to blue, and then green. Duration of visibility, 2 seconds.

Position of ship, Latitude 34° 51′ N., Longitude 147° 48′ W.

THUNDERSTORMS AT SEA.

Prepared in the Marine Division by E. W. Barlow, B.Sc.

The formation of a thunderstorm depends upon a temporary instability of the air in the neighbourhood concerned. This instability may arise in two ways. The air near the earth's surface may be too warm in relation to that above it, or warm and cold air currents may converge in a certain place. The development of any thunderstorm is the process of change from an unstable condition of the air in a local region to a more stable condition, and an essential part of this process is the rising or uplifting of warm air. In a later paragraph a brief outline of this process will be given but it must be understood that a thunderstorm is a phenomenon much too complex to be explained fully in a simple manner.

In favourable circumstances thunder may be heard from a distance of 10 or 12 miles but the average distance is less than this. Lightning, especially at night, may be seen from a much greater distance. Everyone knows that a thunderstorm is a more or less local phenomenon but it is not generally realised that a very great number of thunderstorms occur daily, taking the earth as a whole. From the available data Dr. C. E. P. Brooks has calculated that the whole earth experiences an average of 44,000 thunderstorms daily or sixteen million per annum. It follows that an average of 100 lightning flashes occur over the earth in every second of time.

Types of Thunderstorms observed at Sea. As stated above, there are two main kinds of thunderstorms, those due to convection and those due to convergence. For the convection thunderstorm the existence of air that is too warm in relation to that above it is necessary, but this condition may occur from three different causes. We may therefore say that there are four different types of thunderstorm and these will now be described, together with remarks on their occurrence at sea.

The first type is the well-known " heat thunderstorm " of summer afternoons experienced in the British Isles and all countries situated in temperate latitudes. The ground becomes hotter as the day advances and the lower layers of air become overheated by contact with it. This type of thunderstorm does not originate at sea, since the effect of solar heating on the sea surface is slight, even on the warmest days. Such thunderstorms may however be experienced near the coast or in narrow waters and enclosed seas, such as the English Channel and the Mediterranean, and in the great river estuaries, such as that of the St. Lawrence.

The second type has no short name. It is produced by the inflow of a current of cold air above the unchanged warmer air nearer the surface of land or sea. If the cold current be sufficiently cold the requisite condition for the formation of a thunderstorm will exist, and such storms may originate over the sea as well as over the land. For example, if a thunderstorm occurs in the North Atlantic Ocean, which is not associated with a depression and is therefore not of the line-squall type, it is probably caused by a cold inflow in the upper air, particularly in summer. A similar effect may, however, be produced by the air at a moderate height cooling more rapidly at night than that near the sea surface.

The third type may be called the thunderstorm of general convection, to distinguish it from the thunderstorm of local convection which forms the first type given above. Convection on a large scale occurs in tropical latitudes, forming an essential part of the general circulation, since the effect of solar heating of the earth is greatest in equatorial regions. Thunderstorms over land and sea are more frequent here than in any other part of the world, and being less dependent on the local heating of the ground, the thunderstorm of general convection may originate over the sea as well as over the land. The thunderstorm of the Doldrums is an example but it must be clearly stated that by no means all Doldrum squalls are accompanied by thunder and lightning; there are probably more Doldrum squalls without a thunderstorm than with it. A description of a squall without thunder or lightning in the Doldrums of the North Atlantic Ocean will be found in Marine Observer, Volume IV, 1927, July, page 127, recorded by S.S. *Windsor Castle*. In Volume V, 1928, January, page 5, there is an account by S.S. *Wangaratta* of a squall in the Doldrums of the Indian Ocean, accompanied by vivid lightning.

One special case of thunderstorms occurring within the tropics may be mentioned here; the West African tornadoes. The West African tornado is a thunderstorm of land origin but it is experienced at sea in the neighbourhood. The name tornado is given to the squall, sometimes very violent, which blows outwards from the front of the storm at about the time the rain commences. The following description of the West African tornadoes is taken from the Admiralty Pilot, Africa, Part I. "They are of short duration, usually blow offshore and are generally most frequent at the commencement and termination of the rainy season. Their approach is generally indicated by a well-defined and regular arch of dark clouds, from which thunder and lightning constantly proceed; a dense white cloud in the centre of the arch foretells a powerful blast. During the lull which follows a tornado, and while the wind is resuming its usual moderate force (a period sometimes of three hours) a perpendicular stream of rain descends and is attended by rapid peals of crashing thunder, with scarcely an interval between them, and by vivid forked lightning, which seems to proceed from all quarters at once."

The fourth type of thunderstorm is that due to convergence of cold and warm air at the trough or squall line of a travelling depression in temperate latitudes, or as it is now generally referred to by meteorologists, the cold front of the depression. In the northern hemisphere the colder air comes from a north-westerly direction and meets the warmer air which has come from a south-westerly direction. There is a sudden replacement of warm air by colder air and the advancing cold air pushes itself wedge-wise under the warmer air causing the latter to rise up an oblique plane. This ascent is sufficient to cause cloud and rain and if the upper air conditions are suitable a thunderstorm will occur. Line-squalls, with or without thunderstorms, may thus occur simultaneously along a line sometimes 300 or 400 miles in length, which travels at the rate at which the depression moves. A fuller description of the phenomena of a line-squall will be found in the article on Squalls at Sea, published in THE MARINE OBSERVER, Volume VII, 1930, January, page 10. Thunderstorms occurring in connection with a depression in the North Atlantic Ocean are of this type. Several instances have been published in THE MARINE OBSERVER; a good example is that recorded by S.S. *Hertford*, Volume VII, 1930, January, page 4. In the case of the line-squall recorded by S.S. *Clan Keith* at Durban, Volume X, 1933, page 3, a very severe thunderstorm followed about two hours after the squall.

The pamperos of the Argentine and Uruguay, frequently experienced at sea off those coasts, are line-squalls and are frequently accompanied by thunderstorms. Being in the southern hemisphere, the colder air comes from the S.W. Descriptions of pamperos will be found in Volume IX, 1932, July, page 128, recorded by S.S. *Navasota*, and in Volume X, 1933, page 4, recorded by H.M.S. *Eagle*, with a chart showing the fall of temperature and a photograph of one of the lightning flashes. A case of a pampero without thunder or lightning will be found in Volume III, 1926, May, page 70.

As stated in the article on Squalls at Sea, referred to above, varieties of line-squall may occur which are not associated with a depression. The sumatras of the Malacca Strait are line-squalls which come from the south-west and are more commonly experienced between April and October, the season of the S.W. Monsoon. The following description is taken from the Admiralty Pilot, Malacca Strait: "They generally blow during the first part of the night, are sometimes sudden and severe, and accompanied by thunder, lightning and rain; they are more frequently met with on the north coast of Sumatra, and on the Malay coast between Klang Strait and Tanjong Bulus. Here they often blow for six or eight hours at a time as a strong or moderate gale. Their characteristic is that of an arch squall." Observations of Sumatras by s.s. *Mongolia* and H.M.S. *Iroquois* were published in Volume VI, 1929, April, page 76, and August, page 173. Of the twenty-one sumatras observed in July to September, 1928, by H.M.S. *Iroquois* it was recorded that the strongest storms reached their maxima at 11.30 p.m. and 5.30 a.m., the latter being the most violent.

Tropical Cyclones. On looking through the numerous accounts of tropical cyclones which have been published in THE MARINE OBSERVER, it is at once evident that neither thunder nor lightning are recorded in the majority of cases. There is no sudden replacement of warm air by cooler air at the centre of a tropical cyclone and thunderstorms do not occur there. Lightning is, however, sometimes observed in the outer regions of a cyclone, especially in the case of the West Indian hurricanes. S.S. *Surrey* observed lightning with occasional heavy rain squalls before the onset of a cyclone in the South Indian Ocean, Volume I, 1924, March, page 37. H.M.S. *Herald* observed lightning just before a small tropical cyclone was encountered on the voyage from Colombo to Singapore, Volume II, 1925, March, page 38. S.S. *Scalaria* experienced a severe cyclone in the North Pacific Ocean, with intense lightning in its early stages, Volume V, 1928, February, page 29. In the case of the West Indian hurricane recorded by C.S. *Henry Holmes* in Volume VI, 1929, September, page 192, a thunderstorm occurred several hours after the hurricane had moderated.

Formation of a Thunderstorm. The type of thunderstorm whose formation is here described is the convectional thunderstorm, in which air near the surface begins to rise on account of its high temperature relative to the colder air above it. In the line-squall thunderstorm the initial rise of the warmer air is not due to this cause, but to its being lifted by colder air pushing its way in underneath. The final effect is much the same in both cases, but much more violent squalls are usually associated with the line-squall thunderstorm.

In the convectional land thunderstorm of temperate latitudes the warmer air near the surface begins to rise in small local ascending currents through the cooler air above. As the day advances and the ground gets hotter the ascending currents become larger and tend to coalesce. Finally, one big current comes into being, into which small ascending currents in the neighbourhood will be drawn like air into a chimney. This column of air continues to rise so long as it is surrounded by air cooler than itself and the centre of a thunder-cloud is a region of very violent ascending currents. At some stage in the ascent the temperature of the rising air will fall to its dewpoint and cloud is formed by condensation. The ascending currents carry large quantities of water vapour, most of which falls sooner or later as rain or hail. The top of the column is then indicated by the great dome or cauliflower-shaped head of the cloud. When the air reaches the point where it is no longer warmer than the surrounding air the ascending motion ceases and the air, together with the cloud particles contained in it, spreads out sideways, giving rise to the anvil shape frequently shown by the tops of thunder-clouds and also to the cloud known as "false cirrus."

The rain falling from the thunder-cloud is cold, owing to its height of origin, and as it falls it draws air down with it. This air is cold, having been mixed with cold rain and hail, and in those parts of the cloud away from the main ascending current forms a definite downward current of cold air. This downward current gives rise to the gusts of cool wind which are experienced blowing out from the front of the thunderstorm as it approaches. When the storm is fully developed the indraught of warm air is also from the front of the storm and the storm lasts as long as there is warm air available to maintain it.

The energy associated with a thunderstorm is stupendous. It is derived from two main sources. In the first place, a great deal of energy is released by the ascension of warm air. Secondly, energy in the form of heat is set free by the condensation of water vapour to raindrops. The electrical phenomenon of a thunderstorm is only a by-product of this energy but Dr. SIMPSON calculated that a single lightning flash would keep every electrical undertaking in London and the Home Counties supplied with power for eight minutes, on the basis of the amount of power used in this region in the year 1924.

The production of lightning discharges in or from the thunder-cloud depends on the fact that any raindrop having a larger diameter than a quarter of an inch is unstable and almost immediately breaks up into several smaller drops. Every time a drop of water breaks up it can be proved that electricity is separated, the water becoming positively charged and the surrounding air negatively charged. The negatively charged air is carried by the general ascent of air into the upper part of the cloud. The greatest amount of positively charged water is in the lower part of the cloud. Hence, in time, the accumulation of separated electricity becomes so great that strong electrical forces are set up, either between different parts of the cloud or between the cloud and the ground. Finally, the intervening air can no longer support the strain and a discharge takes place in the cloud or to the ground, as the case may be. This discharge constitutes the lightning flash, which temporarily relieves the situation, but the electrical force rapidly rises again, producing another flash, and so on.

The formation of hail is a difficult subject. A hailstone is not a frozen raindrop and is originally formed as soft hail by the direct condensation of water vapour to ice. Only very small hailstones can form unless they have been prevented from falling by the strength of the ascending air currents. Most hailstones have actually been blown upwards and an alternate fall and rise may proceed for some time. During this process the hailstone grows, for all water drops which it encounters immediately freeze on its surface.

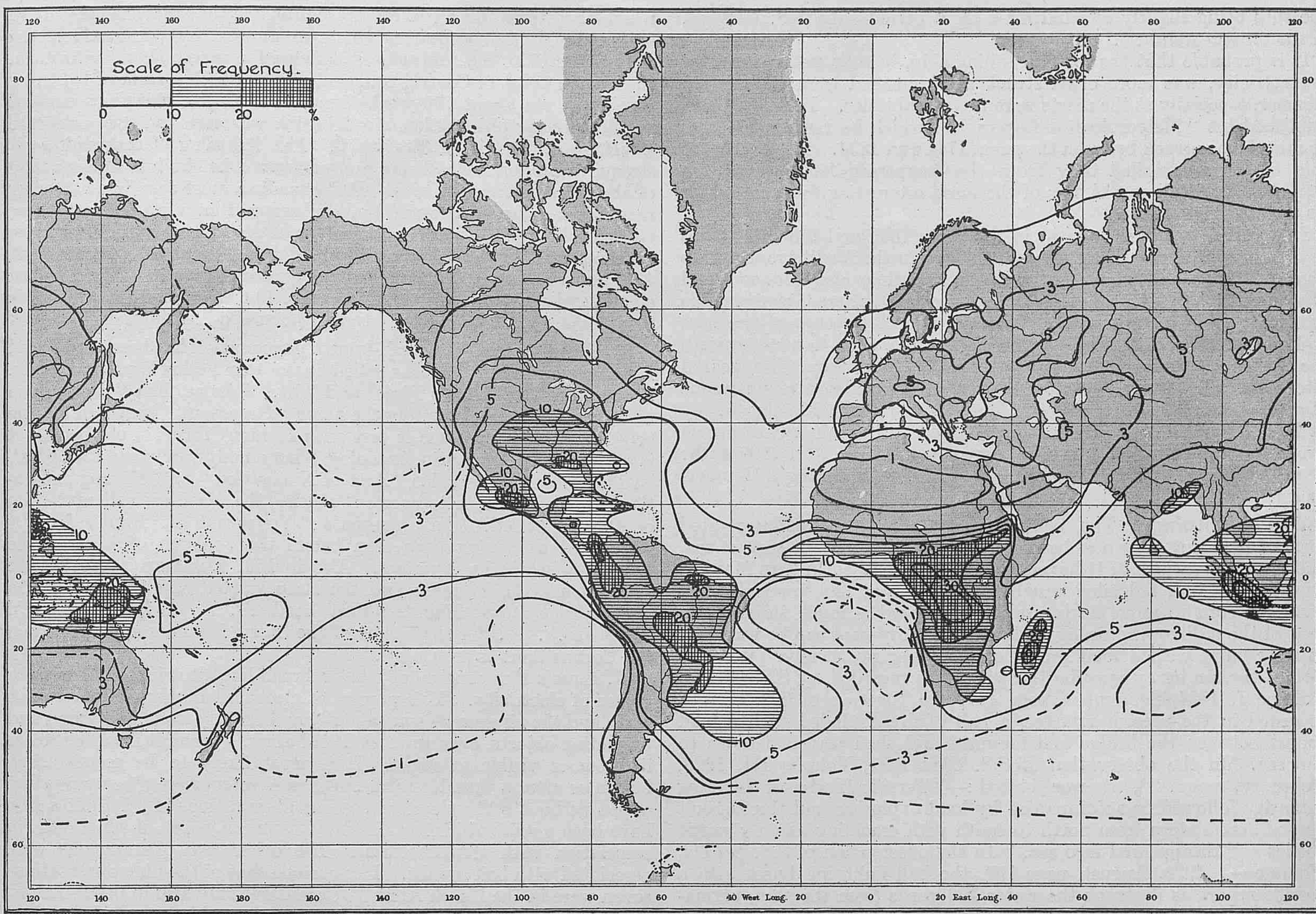


Chart showing percentage of days with thunder heard during the year.

Frequency of Thunderstorms at Sea. Exact information about the frequency of thunderstorms at sea is not at present available. When the data from the older logs in the Marine Division have been extracted there will be plenty of material for making such an investigation. The only part of the oceans for which weather data have so far been fully published is the China Sea, for the period 1855 to 1917. On the charts of this sea, published on the backs of the MONTHLY METEOROLOGICAL CHARTS OF THE EAST INDIAN SEAS, 1918 edition, will be found the percentage frequency of various weather phenomena, including thunderstorms, given for each five degrees square, for all months of the year except January. A memoir by Dr. C. E. P. Brooks, " The Distribution of Thunderstorms over the Globe ", was published in GEOGRAPHICAL MEMOIRS, No. 24, Meteorological Office, 1925. This includes the oceans as well as the land areas but the data for the Atlantic and Indian oceans is derived only from the observations of foreign ships, mainly German. For the Pacific Ocean a small number of island stations were used. The map of frequency of thunderstorms for the whole year is shown in the chart above where it has been redrawn on a Mercator projection.

On account of the insufficiency of marine observations available for this map, too much reliance must not be placed on the smaller details shown for the oceans. We may however, obtain a good deal of information from it in broad outline, especially as some of our previous ideas are confirmed by the map.

Thunderstorms at sea are in general less frequent than those over the land in similar latitudes. The frequency of thunderstorms at sea decreases with increasing latitude in either hemisphere and there are also regions of minimum thunderstorm occurrence centred over the five great anticyclonic regions of the oceans in about Latitude 30° N. and S. In Arctic and Antarctic regions thunderstorms are very rare and the observations of Arctic expeditions have shown that on the average only one thunderstorm occurs every ten years in any place in the Arctic regions. It will be seen from the map that there are three main regions of the world where thunderstorms are most frequent, in North and South America, Africa, and the East Indies. The American and African regions extend over the sea in places, notably in the South Atlantic Ocean, including the Pampero region, parts of the Gulf of Mexico and Caribbean Sea, the North Atlantic Ocean off the West Coast of Africa, including the tornado region, and round the coasts of Madagascar. The East Indian region, on the other hand, covers more sea than land. Java, with a frequency of days of thunder of 61 per cent. for the whole year, is probably the most thundery region of the earth.

In all oceans thunderstorms appear to be more frequent in the summer half-year than in the winter half-year. So far as the information goes thunderstorms are most frequent at sea between the hours of midnight and 4 a.m., twelve hours before the maximum period on land, which is between noon and 4 p.m.

Ships Struck by Lightning. Five instances of ships having been struck by lightning and damaged have been published in THE MARINE OBSERVER. These ships were the S.S. *Royal Transport* on February 16th, 1924, off Palma Island; the S.S. *Romney* on January 18th, 1925, off the Brazilian Coast; the S.S. *Clan Macnaughton* on November 10th, 1927, in the Malacca Strait; the S.S. *Araguaya* on December 26th, 1927, in the North Atlantic Ocean; and the S.S. *Essequibo* on July 3rd, 1930, in the North Atlantic Ocean. It is an interesting fact that in every case the foremast was struck and was damaged to a greater or less extent. It is perhaps not wise to generalise on five cases, but it does appear that the foremast is the most vulnerable part of the modern steamer in a thunderstorm. There is no obvious reason for this, unless it be connected with the forward motion of the ship. In the cases of the *Royal Transport*, *Araguaya*, and *Essequibo* it was also stated that the compasses were affected. Three other cases of ships being apparently struck, in one case definitely on the foremast, without material damage, have been also published, the compasses in one ship being slightly affected for a short period only (S.S. *Hertford*, in the present number).

It is probable that the wooden sailing ship, being a poor conductor of electricity, was more often struck and damaged than the modern steamer, especially as the masts were in general taller. In 1855 ARAGO published his "Meteorological Essays" in which he records 71 cases of ships being struck between the years 1741 and 1834. He states that this list was compiled only from the temperate latitudes of the Northern Hemisphere. A few of the more interesting facts stated by ARAGO are given here.

In a period of fifteen months in the years 1829 and 1830, five ships of the Royal Navy were struck by lightning in the Mediterranean, the *Ocean*, *Melville* and *Gloucester*, ships of the line, also *Mosquito* and *Madagascar*. The masts of all these vessels suffered considerable damage. In 1811, near Cape Finisterre, the *Glory*, ship of the line, had all her masts split during a thunderstorm. On a date not stated, the *Resistance* and the *Lynx*, accompanying a convoy, disappeared altogether after some lightning strokes. ARAGO also gives instances of serious casualties, with loss of life and injury. Thus in the *Sultan*, at Port Mahon in 1805, five men were killed by lightning, two thrown overboard and drowned, and three were severely hurt. In 1809 in the Bay of Rosas, nine men were killed on the *Repulse* during a thunderstorm.

Ball Lightning. The comparatively rare but well-accredited form of lightning known as ball or globe lightning may be seen at sea, and six observations of it have so far been published in THE MARINE OBSERVER. Ball lightning usually falls more or less vertically but has been seen to move horizontally. Its speed is much slower than that of the ordinary lightning flash and the movement can be watched. It may burst with a loud report or disappear noiselessly. When it strikes the sea spray may be thrown up, as recorded by S.S. *Orvieto*, Volume I, 1924, September, page 117. In the case of S.S. *Ranchi*, recorded in the present number, a ball of fire exploded with a loud report between the bridge and foremast and then travelled down to the sea. In the observation of S.S. *Clan Ross*, Volume III, 1926, February, page 22, it was stated :—"Terrific flash of blinding intensity followed or accompanied by loud explosion and thunderbolt passed across stern from north to south with crackling like a gigantic rocket and disappeared into sea." In the observation of S.S. *Sai On*, Volume V, 1928, August, page 157, the ball lightning burst with a terrific report as it struck the water 100 yards from the ship, permanently affecting the compasses. Ball lightning burst just in front of S.S. *Redstart*, without damaging the ship, but part of the ship was covered with sparks, Volume II, 1925, August, page 129.

In some cases marine observers have used the word "thunderbolt." It is now known there is no such thing as a thunderbolt in the sense of anything solid falling from a thunderstorm. On land lightning may fuse metal or other objects that it strikes and this accounts for many alleged thunderbolts. The word has also been used in cases of ball lightning. Ball lightning is sometimes called a "fireball" but this is apt to cause confusion with the kind of meteor known by this name.

Unusual Phenomena. A few cases of unusual phenomena associated with thunderstorms have been published in THE MARINE OBSERVER. Thus S.S. *Elpenor* in the East Indies on the night of June 19th, 1927, recorded flashes of dull red lightning occurring once a minute during sixteen minutes. S.S. *Inkum* in the West Indies, on the evening of August 18th, 1927, observed a thin streak of lightning, not very bright, pass upwards rather slowly until it was overhead, when it scattered like a rocket. It is probable that this flash was more or less horizontal, appearing to move upward by perspective. On July 26th, 1929, S.S. *Salvador* experienced a severe thunderstorm on the Pacific Coast of Central America, during which a flash of lightning struck the sea about 100 yards from the ship. In this very unusual and interesting observation the lightning was seen to have a definite structure as shown in FIGURE 2. The lightning "appeared as a stream of molten metal being poured from a height into the sea and of about one to two feet wide. It first made a most peculiar shattering noise (as a china plate would make if dropped on a stone floor), then, as it broke up the noise changed to a sizzling sound . . . . On breaking up it appeared as a disjointed spinal column (Sketches 2, 3, 4, 5) and the sea as if water was being poured into it. The flash, of course, only lasted a matter of seconds, but the above description is how it appeared to the pilot, others who saw it, and myself."

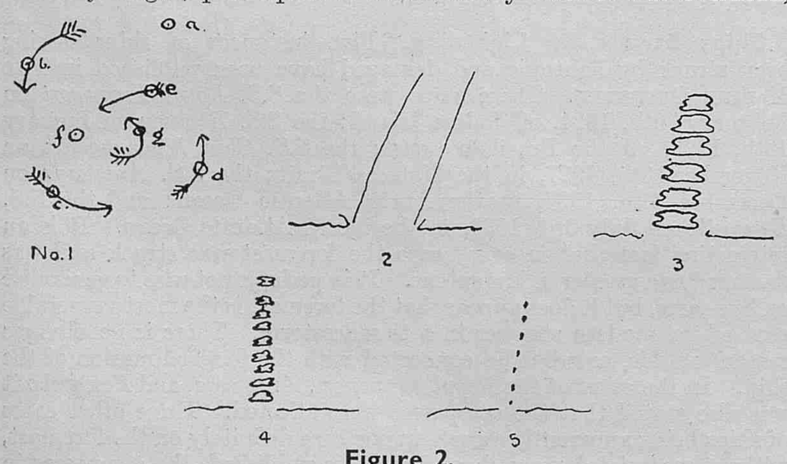


Figure 2.

St. Elmo's Fire. This well-known phenomenon has been recognised from long antiquity. It was called Castor and Pollux by the ancients. The names "St. Elmo's Fire" and "St. Nicholas' Fire" were given to it by seamen and probably the name "Corposant" is also of marine origin. This latter name is met with in many forms in old books; it is derived from the Latin, meaning "holy body" or "saint's body." In 1561 EDEN wrote in his "Arte of Nauigation" of "Shining exhalations that appeare in tempests : whiche the Mariners call sant-elmo or Corpus Sancti." In Dampier's "Voyages" St. Elmo's Fire is mentioned as having been seen before the typhoon of 1687 in the China Sea which he describes. Also in 1697 DAMPIER wrote "After four a clock the Thunder and the Rain started and then we saw a Corpus Sant at our Main-top-Mast head . . . . This sight rejoic'd our Men . . . . for the height of the Storm is commonly over when the Corpus Sant is seen aloft."

St. Elmo's Fire consists of jets or brush-like electrical discharges or globes of electricity. This process of electrical discharge between the earth and the air goes on continuously and silently from all pointed and projecting objects, even from blades of grass. When it is more intense it becomes visible at night. It is most likely to be seen during, before or after a thunderstorm but is said to occur in stormy weather at sea without a thunderstorm. Nine observations of St. Elmo's Fire have been published in THE MARINE OBSERVER, seven of which were in association with thunderstorms. The other two observations were associated with hail squalls. It is curious that of the nine observations seven were in the North Atlantic Ocean and only two in other oceans, the South Atlantic and the North Pacific, but this is probably only a coincidence. Most of these observations were made during or just after the thunderstorm but S.S. *Rotorua* stated that "Numerous globules of bright light resembling large rain drops appeared along the entire length of the aerial. Phenomenon lasted for half an hour and was succeeded by vivid lightning and thunder," Volume XII, 1935, page 7. Observations made on land by TRABERT suggest that the character of St. Elmo's Fire differs according to whether the electricity being discharged is positive or negative, the positive electricity giving the more usual forms, while the negative electrical discharge completely envelops an object like a mast in fire. No complete study of the various forms of this phenomenon has yet been made and the following interesting observations may help in this respect. S.S. *Empress of Asia* records in Volume IV, 1927, January, page 5, that "Just before a heavy hail squall the wireless aerial was lighted up to the thickness of a 'hawser', also a light on each truck and one on the wireless aerial insulator at the foremast were very prominent." In S.S. *Inanda* blue-green lights were spaced about two feet apart along the aerial, Volume XII, 1935, page 7. A particularly interesting observation is that of S.S. *Baronesa*, Volume IX, 1932, May, page 92 : "aerial and fore truck brilliantly lit up with corposants which lasted five minutes, then a flash of lightning in the zenith cleared the corposants from the truck, and left the aerial lit up in equal patches of light and dark, each about six feet long. This lasted for nearly a minute." This was perhaps a positive discharge, changed by the lightning flash to a negative one. S.S. *Minnewaska*, Volume VIII, 1931, October, page 207, recorded that "During the storm the ship's aerial became prettily decorated with a display of St. Elmo's Fires, each about the size of a golf ball. These perched along the aerial (318 ft.) at equidistance of about three feet and would appear and disappear simultaneously at each brilliant flash of lightning." The amount of light given by the Fires seems to vary considerably. Sometimes the jets or globes are compared with first magnitude stars. In the case of the *Empress of Asia*, referred to above, "the light cast at this time lighted up the ship with much brilliance."

WIRELESS COMMUNICATION.

E. F. Greenland, Officer in Charge, Burnham Radio.

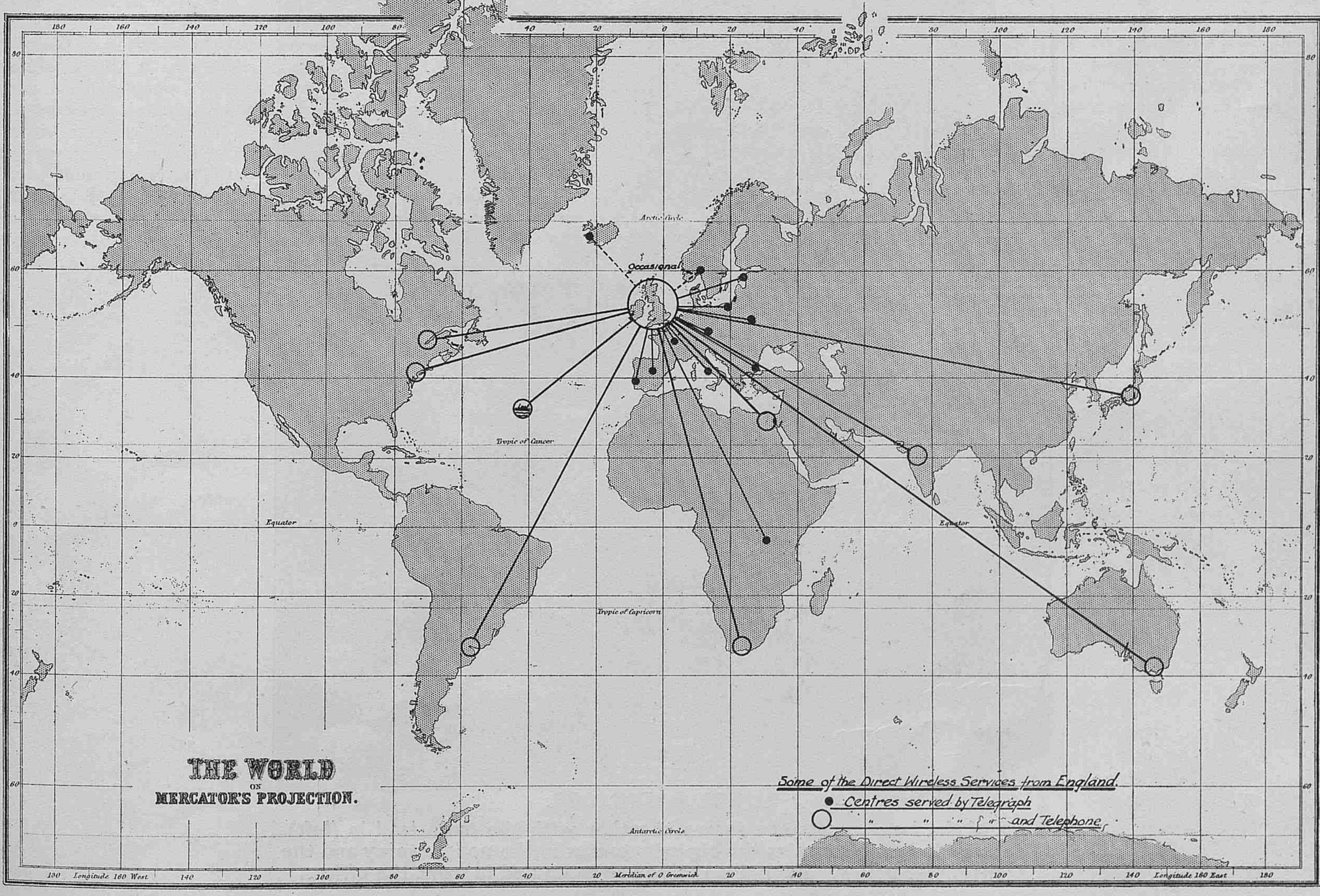
Although wireless communication was introduced at the outset in the service of ships, its development since that time has rapidly covered many varied fields. It has been applied very largely in telegraph communications over long and short distances supplementing earlier existing lines and providing communications where lines would be impracticable or uneconomic. The interconnection of telephone systems throughout the world, bringing over 90 per cent. of the world's telephone subscribers within reach of one another, has been one of the outstanding developments side by side with the distribution of information and entertainment by means of telephonic broadcasting. Explorers have taken advantage of its adaptability to maintain touch with their bases and with the outside world. Remote districts and islands have been provided with immediate and direct contact with the world and its happenings. Army communications have been to some extent revolutionized. The maintenance of law and order has benefited by its suitability for police services. Trains have been provided with telephonic facilities while travelling long distances and aircraft can maintain communication with the ground while in flight. Lifeboats in their stormy travels have found it useful and even individual persons moving freely in varying surroundings have been able to maintain continuous touch by portable apparatus with fixed points at some distance. No aerodrome is complete without wireless means of communication with aircraft in its vicinity, of fixing their positions while in flight and of guiding them to land. Recent developments have included the rapid transmission of pictures incorporating fine detail, and have opened up an early prospect of commercial television including combined sound and vision transmission. Radio beacons for sea and air navigation are now common practice rendering fog and darkness less troublesome than in the past. Application of the principles of wireless has been made to prevent collisions at sea, and to take soundings, while the interest evoked by the peculiarities of wireless working has led to advancement in the study of the upper atmosphere.

Altogether the field over which the effect of wireless has made itself felt is extremely wide and the increase in wireless knowledge even of the ordinary individual has been marked. Broadcasting is no doubt largely responsible for this last and for making such matters as valves, wavelengths and their peculiarities and many other wireless terms and principles more or less common knowledge.

Side by side with all the developments in other fields of wireless activity its application to the needs of mobile working and of shipping in particular has received a full share of attention and has benefited from progress elsewhere. While looking briefly at what has been done in other fields it is interesting to study in more detail the wide application to shipping which has developed from its first tentative trial in this service.

Most countries now employ wireless in one form or another and a glance at some of the British wireless services can be taken as representative of the most advanced present day application. Cables and telegraph lines have long been regarded as the normal method of passing telegrams but actually quite a large percentage of the many thousands which pass to and fro every day are sent over wireless circuits. The Chart shews diagrammatically some of the main routes, between this country and others, over which telegrams regularly pass by wireless.

All the chief business areas of the world are connected direct with London by wireless and these areas in turn are connected to others by their local distributing circuits. In many cases, as the diagram shews, direct telephone circuits are also in operation allowing people to speak together, although separated by many thousands of miles, with ease and distinctness equal to many conversations within a single township.

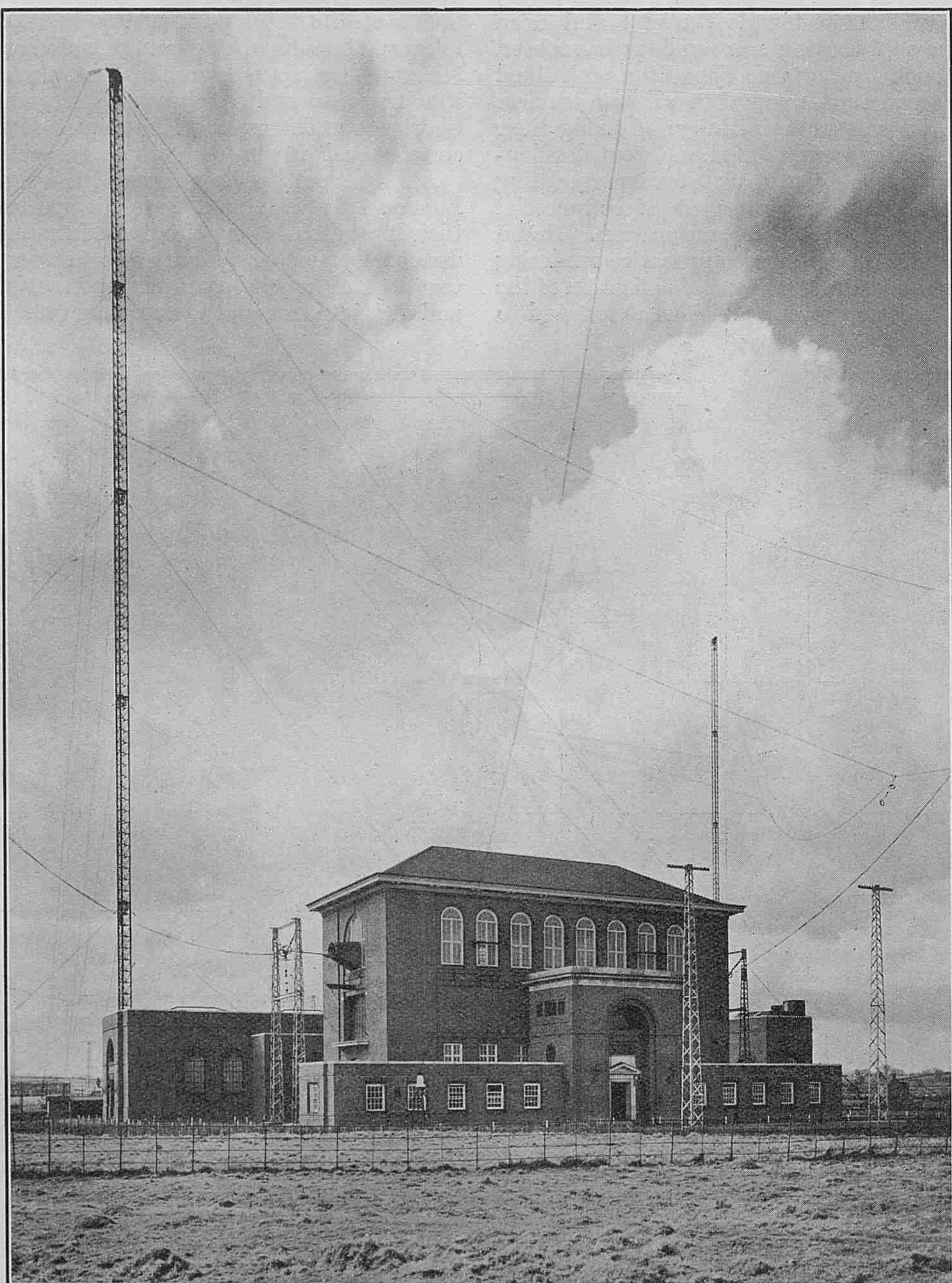


Broadcasting, although originally a local service, is now being distributed to an appreciable extent to world wide ranges by means of short wave wireless, but considerably in advance of this telegraphic broadcasts of press news and other information have been regularly disseminated by long wave stations of very high power and by short waves.

Rugby. These telegraph broadcasts serve both land and sea areas, and from England they are transmitted mostly by the well-known Rugby Station—a high powered station working on a very long wavelength of 18,750 metres—with which short wave transmissions as well are associated from time to time. The broadcast messages from the Rugby station include the CQ broadcast of British Official news, and the copyright Shipress news messages, both of which convey daily to ships near and far items of news collected from all parts of the world. This news can reach even the most distant ships almost as soon as it is in the hands of people on shore in their morning and evening newspapers. The same transmitter also sends, twice daily, time signals, and a series of private messages for ships otherwise out of direct touch with England, as well as meteorological messages which will be referred to later.

Although these messages are sent by the Rugby transmitter, the 840 ft. masts of which are very familiar to railway passengers travelling through Rugby on the main line from Euston, none of the telegraph forms on which they are written goes to the Rugby station itself. The Rugby transmitter is, instead, connected by a long telegraph line to London, a line which in the old days used to be carried on the heavily loaded telegraph poles which motorists follow when travelling through St. Albans, Dunstable, Fenny Stratford, and northwards along the Watling Street. Nowadays this line is underground and forms part of one of the multiline underground cables, many of which have been laid in the last few years. These give greater security in stormy weather, but the importance of Rugby is such that additional reserve lines following other routes are provided to give a maximum of security.

The line itself terminates in London in the large Post Office building not far from St. Paul's and is led into one of the big operating rooms in the Central Telegraph Office. Here a staff of selected telegraphists, who take a great pride in their world-wide service, handle the actual messages and control the signals which are sent out from Rugby. Actually the signals sent out by Rugby are transmitted either by an automatic sender or a small morse key. It is interesting to realise



RUGBY RADIO GBR.

Two of the large masts are shown together with the main lead in (left). The large building contains the big inductances in the upper storey and the transmitter below. Behind is the power room and in front the offices.

that a slight pressure on this relatively insignificant key immediately releases several hundred kilowatts of energy from the aerials 90 miles away, in the form of a signal which is heard almost instantaneously by listeners many thousands of miles away, and, incidentally, by the telegraphist pressing the key, who has his signals intercepted on a local receiving set and listens to them in a small loud speaker to ensure their correctness.

Many visitors to this operating room are interested to see the large part which automatic transmission plays in the signalling of Rugby and other messages, but a little thought will show that almost continuous signalling for many hours on end to a pre-arranged programme is a tiresome job. Many of the messages, including long press messages, are available some time in advance and the typewriter keyboard has been made to operate machines which transfer the letters picked out on it to continuous paper ribbon or "slip," not actually as printed letters, but in the form of small holes about $\frac{1}{16}$-in. diameter grouped to correspond to the morse characters of the letter selected. These small perforations run almost continuously along the "slip," which for a press message may be several yards in length. When the transmission time arrives the "slip" is fed into a small machine—a wheatstone transmitter—under a small wheel driven by an electric motor. This wheel draws the slip along and small contacts are closed or opened as the various holes pass under the wheel. These contacts operate relays, which in their turn energize the line to Rugby and the Rugby transmitter and aerials. By this method of transmission steady signals of regular speed are sent. It is a "hand" which does not tire, and not only can it send at the normal speeds of hand sending, but on heavily loaded circuits where high speed automatic reception is possible it can accelerate to ten or fifteen times that speed without any deterioration in its perfect signals. These high speeds, of course, are rarely utilized on Rugby as most of Rugby's listeners are receiving aurally and have to write or type the messages received, often under very adverse receiving conditions. On many wireless services, however, such speeds are standard practice and are in fact very necessary to clear the heavy loads of messages which come to hand at times, especially during office business hours.

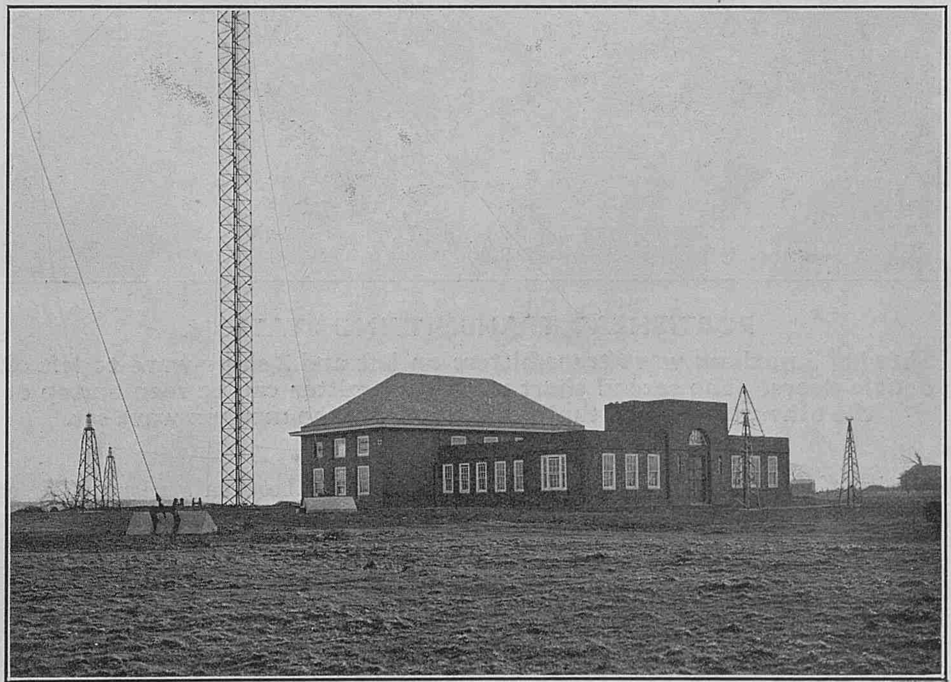
One of the reasons for not sending the actual messages to a wireless station to be transmitted is that with many services, though not as it happens with Rugby's, the sending side is only one half of the service, the other being the receiving side. To send messages from one station and receive messages in the reverse direction at another would mean a disjointed service, or, if the receivers and transmitters were at the same station, would generally involve shutting down sending while reception was in progress. Such a course would waste much of the time of both transmitting and receiving equipment, and in modern services between fixed points the arrangement is adopted of having transmitting stations and receiving stations well separated. These are connected by lines and relays to a further separate traffic centre, which can then be brought into the heart of a business community where it is best placed for collecting and distributing messages.

In busy stations, working only with ships, a modification of this arrangement is adopted. These usually have the transmitters and receivers at different places, but the transmitting control keys—morse keys—are situated, together with the traffic centre, in the receiving station, a key being placed at each receiver so that an operator at a receiver can also send. This is necessary on account of the continual searching for ship's calls carried out on receivers, to admit of quick response once a call is picked up. The messages in these cases are handled on forms, and are exchanged over an ordinary telegraph line with the inland and foreign telegraph systems.

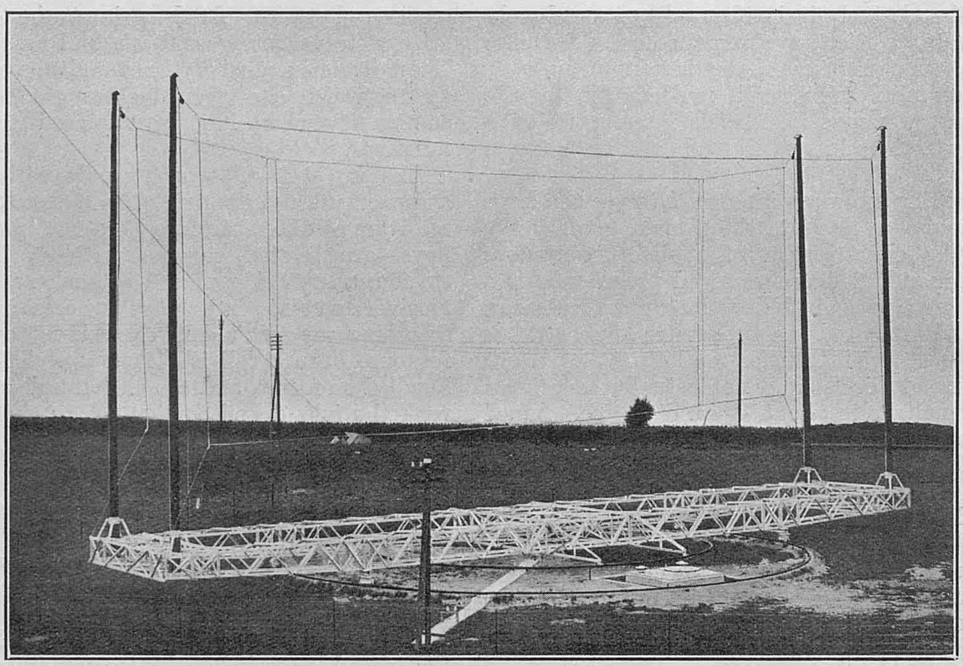
Coast Stations. The smaller coast stations, which are not heavily loaded with messages, have transmitters and receivers in the same station, and this system provides capacity for quite a large amount of traffic and avoids the added difficulties and expense of separate stations. Stations of this type, or at any rate the main features, are somewhat similar to those on many ships, though usually larger. Busy stations, which may handle up to 1,000 telegrams on some days, are, however, not very numerous, and a description of Burnham-Portishead, a station of this type, may be of interest.

Burnham–Portishead. This station, which replaced the old Devizes (Wiltshire) station about ten years ago, is in Somerset, not very far from Bristol. The Portishead station where the transmitters are installed is only about 5 or 6 miles from Clifton Suspension Bridge and situated on the high ground close alongside the Bristol Channel. Originally constructed with four 250-ft. masts and three medium wave transmitters, the station's equipment has in recent years been increased by the addition of three short wave transmitters and a number of short wave directive and ordinary aerials. The transmitters are rated at 12 k.w. (1) and 6 k.w. (2) in the case of the medium wave side and 6 k.w. in the recent short wave sets. The waves employed are of the order of 2,000 to 2,400 metres and 36, 26 and 18 metres. More recently still a service on 600 metres has been provided. All these are for wireless telegraph service, but a small coastal telephone service transmitter has just been installed for working with small craft on about 100–150 metres.

Although the old Devizes station was equipped with its own generating plant, the Portishead station is provided with power from the public supply system, one of the generating stations on this system being in

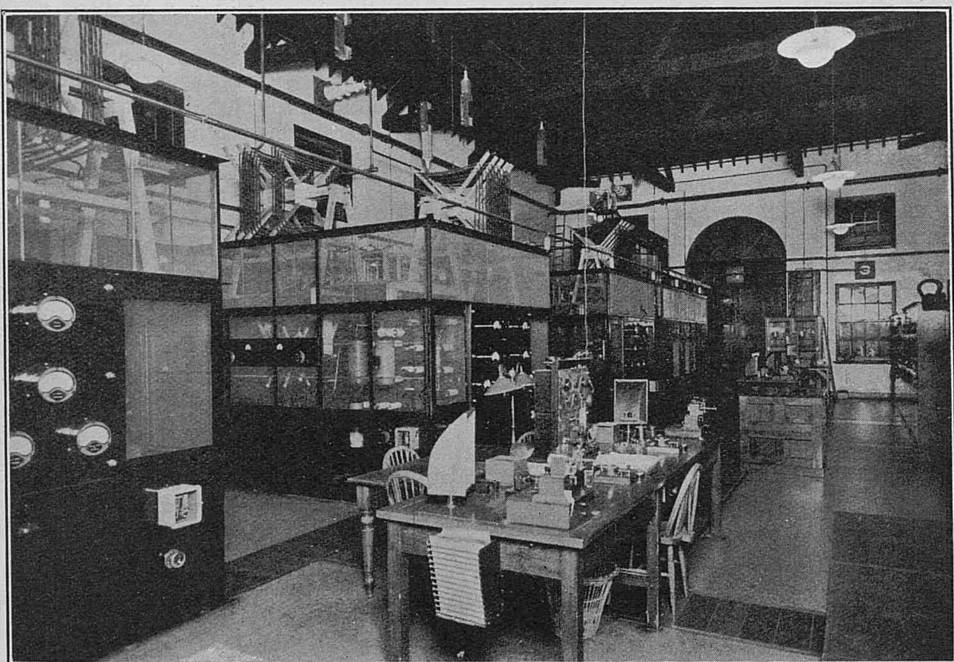


PORTISHEAD TRANSMITTING STATION.
Transmitter room at rear.



PORTISHEAD TRANSMITTING STATION.

Rotating beam aerial 17.81m. This may be rotated to the required position by the receiving operator at Burnham Radio who has a similar array for reception on this wave.



PORTISHEAD TRANSMITTING STATION.

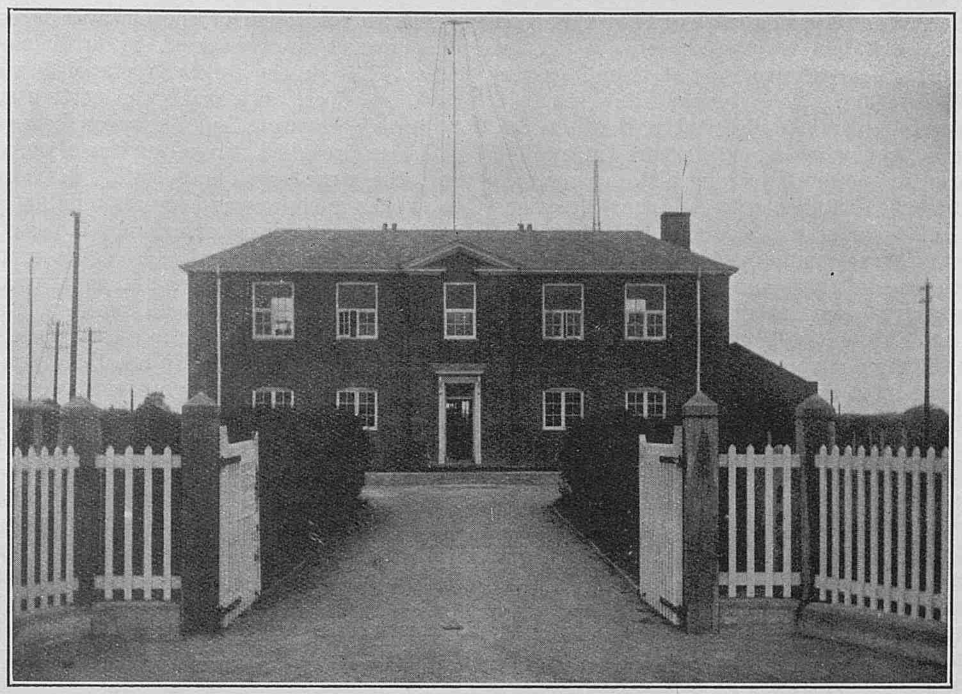
Shewing 3 medium wave transmitters on left and 2 short wave to left of double doors. The second short wave transmitter can be seen on top of the other, behind the tuning inductance of the medium wave set.

close proximity. The transformation of this power into suitable form for the transmitters is carried out in the station's own power and battery rooms. Its further transformation into radio signals involves the use of many valves of all sizes from large silica transmitting valves, cooled by motor blowers, to quite small valves of the ordinary receiving types. Reserve valve room, office, workshop, and stores complete a compact and efficient station of a thoroughly modern type throughout.

Several telegraph and telephone lines connect this station with Burnham, the complementary receiving station situated between Burnham-on-Sea and Highbridge, about 25 miles away. These lines are utilized for controlling the transmitters and for necessary arrangements between stations. For emergency use lines following other overhead and underground routes may be utilized.

At Burnham are the morse keys for transmitting signals from Portishead, receiving equipment for incoming messages, the message handling organization and the larger part of the combined staff—namely the wireless operating personnel.

The wireless operators at Burnham, as at other British coast stations are skilled telegraphists drawn from the staff of the Post Office telegraph services. It is this personnel which makes immediate contact with the sea-going operator, the two constituting the link through which the service is provided. On land, however, as at sea, skill in telegraphy is only the first step towards full operating efficiency



BURNHAM RADIO.
The operating room extends across the whole of the upper storey.

BURNHAM RADIO.
View of operating room showing medium wave (GKU) receivers in foreground.

and the gap between the two covers a long period of operating experience in all its phases. One of the most important lessons to be learned is that of appreciating the other fellow's difficulties. At sea the "Old Man" may be hard to please and require 101 things to be done while the shore operator is becoming caustic at the lack of attention having an important message on hand. On shore there may be several ships waiting at a busy period, when everyone is hard at it and trying to give the more distant man a chance in case he fades out and can't clear his message, while the ship operator threatens to offer his traffic to a foreign station. A good example however of the basic co-operation and good fellowship which exist in the mobile service is the patience and forbearance with which both sides treat the "Young hand" at the game.

Given experienced operating staff another important factor in furnishing a good service is that of equipment. All English stations are now provided with modern equipment and the Burnham station incorporates the latest patterns of Post Office and commercial receivers. The medium-wave service is handled by three large receivers covering the 2,000-2,500 metre wave bands, and a receiver for the 600-800 metre range. These are provided with facilities for all round reception or for reception only in a certain sector if required to cut out jamming and interference. This directional reception in a certain sector cuts out also, of course, signals in other sectors. Another receiver is available for the small craft coastal telephone service, which is provided to enable small craft not carrying wireless telegraph operators to exchange telegrams with the shore. Out of a total of 14 receivers on the station the remaining 9 are installed for the short-wave service which has grown so rapidly in the last few years that it now carries more than half the load of the station. These are associated with a dozen or more short-wave receiving aerials directive and otherwise. The directive types present a somewhat novel feature in mobile working as previously their use was confined to long distance services between fixed points. Judicious arrangements of the directions in which they face, and the angles or sectors covered has permitted of their successful employment to serve the main shipping routes of the world. By their use, at both transmitting and receiving stations it has been possible to compensate to some extent for the power and equipment limitations which are automatically imposed on ships' sets. Their effectiveness is found in the regular and usually daily communication with short-wave ships in the most distant parts of the world.

While these receivers are in constant use in the hands of the staff, exchanging messages with ships, the acceptance and clearance of these messages from and to land destinations is in constant progress. This takes place over a direct line to the Central Telegraph Office in London from which lines radiate in all directions to other smaller centres and to the offices of many business firms. The messages are sent along this line by Teleprinter, which involves an operator typing at one end on a special machine, a continuous typed slip appearing at the other. Both London and Burnham may type at the same time, and messages be passed simultaneously in both directions. This frequently occurs at busy periods, chiefly during the afternoon and early evening when the message load is found to have marked peaks much in excess of the loads at other times. A staff of about 30 all told is employed at this station and during peak seasonal rushes as many as half may be required on duty together at certain times of the day.

As is natural in a station such as this all types of ships are in contact, small trawlers, fast transatlantic liners, distant fishing vessels off Greenland, holiday cruising vessels in the Mediterranean, whalers and explorers in the Antarctic, far off cargo vessels in the China seas, Australian vessels east and west, South African and South American liners, world cruising vessels and H.M. ships on their various stations. Here are all the waters of the world at the touch of a key and here can be seen the struggle to clear a far-off ship's single message while a near-in liner clears 30.

Wavelengths. In the earlier days before the advent of short wave the North Atlantic carried many passengers and many messages. Burnham and other European medium-wave stations vied with one another for traffic, working cheek by jowl in the limited wave band available. Much interference arose from the heavy signalling and ship and shore operator alike on this and the 600 metre service acquired a skill in reading through interference which has stood them in good stead in the increasing severity of interference on short wave. On the longer waves, working ranges were definitely limited and so of course were interference ranges. On short wave, working ranges are world wide as are also, unfortunately, interference ranges with the result that ships for instance off Australia and working to America may cause serious interference at Burnham. It is in these cases that directional short-wave aerials show additional advantages more especially as the larger part of the messages comes from outside the range of the medium-wave service.

Nevertheless, the medium wave service has a number of valuable features not found in short wave work. For instance, the medium wave ranges are steady, slightly shorter by day than by night, and their reliable effectiveness is known. They suffer of course some reduction in effectiveness in times of heavy thunderstorms and atmospheric disturbance.

The direct range of short waves is comparatively very short, but long ranges are obtained by utilizing partially upward radiation reflected from the upper layers of the atmosphere. These reflected rays, however, only reach the earth's surface again in a number of "jumps" covering isolated areas between which no signal is heard. The areas reached depend on the time of day, the season of the year and the wavelength employed. It is in consequence impracticable to exchange short wave signals reliably at the nearer distances, and a matter of complex arrangement to secure communication regularly at the longer distances. The effect of these different characteristics of long (including medium) and short waves is seen in the development of the Burnham-Portishead medium wave service up to ranges of about 1,500 miles, and the short wave service beyond; and in the development of the Rugby broadcast long wave service supplemented by short wave to improve security of reception in the most distant receiving areas.

For broadcast messages which require to be received in all directions over a wide area the long or medium wave proves most effective, the longer waves with high power being utilized for covering very large areas. For broadcasting messages over areas such as the continent of Europe medium waves have proved very satisfactory, and for some years British fixed service stations have been regularly engaged in distributing telegraph broadcasts of financial and other news items to most European countries on waves of the order 3,000–6,000 metres. Similarly in the service of ships medium waves of a slightly lower order (2,000–2,400) have been widely employed for broadcasting traffic lists, and especially more recently for the development of the ships' meterological service. In this service advantage is taken of the facts that many ships themselves transmit on these waves and that nearly all ships are equipped for receiving them, to organize broadcast distribution over a wide area. In making their daily reports, for example, to Portishead, the selected ships themselves act as broadcasting stations, giving other ships in their vicinity an opportunity to build up at once their own weather reports for the area in which they happen to be. Although the information collected by Burnham is transmitted immediately to the Meteorological Office and utilized in building up the comprehensive reports for shipping which are broadcast twice daily from Rugby, appreciable time is required for the study of the quantity of data received from the numerous ship and other reporting stations, and for the final compiling of these comprehensive reports. During this period, however, ships which have been able to intercept the reporting ships' messages have already received the information relating to their areas and are in a position to take full advantage of much earlier knowledge of the weather conditions likely to be encountered.

In the organization of this ships' reporting system the insistence on strict adherence to regular reporting and signalling procedure by Burnham-Portishead is occasionally remarked upon. To operators, however, the benefits of a regular procedure well understood by all and the elimination of unnecessary signalling, with consequent saving of time and reduction of interference, need no emphasis. Moreover, everybody directly concerned in the service realizes the advantages of an organized sequence of reporting, so that to intercepting ships and to land stations the series of reports builds itself up as received into a complete report in a systematic order of areas. This greatly facilitates interpretation by the various interested persons under whose scrutiny it regularly passes.

The splendid response by ships, and the enthusiasm with which this service has been developed, afford evidence, if any were necessary, of the value attaching to what is of course a purely voluntary service.

January, 1935.

NOTES ON THE HISTORY AND DEVELOPMENT OF NAVIGATION

II—Instruments and Methods.

Having briefly traced the history of exploration by intrepid navigators, through which all regions of the world were discovered and present day conditions made possible, a short description is now given of the means, equipment and methods used, whereby the knowledge and skill of navigation progressed through the ages.

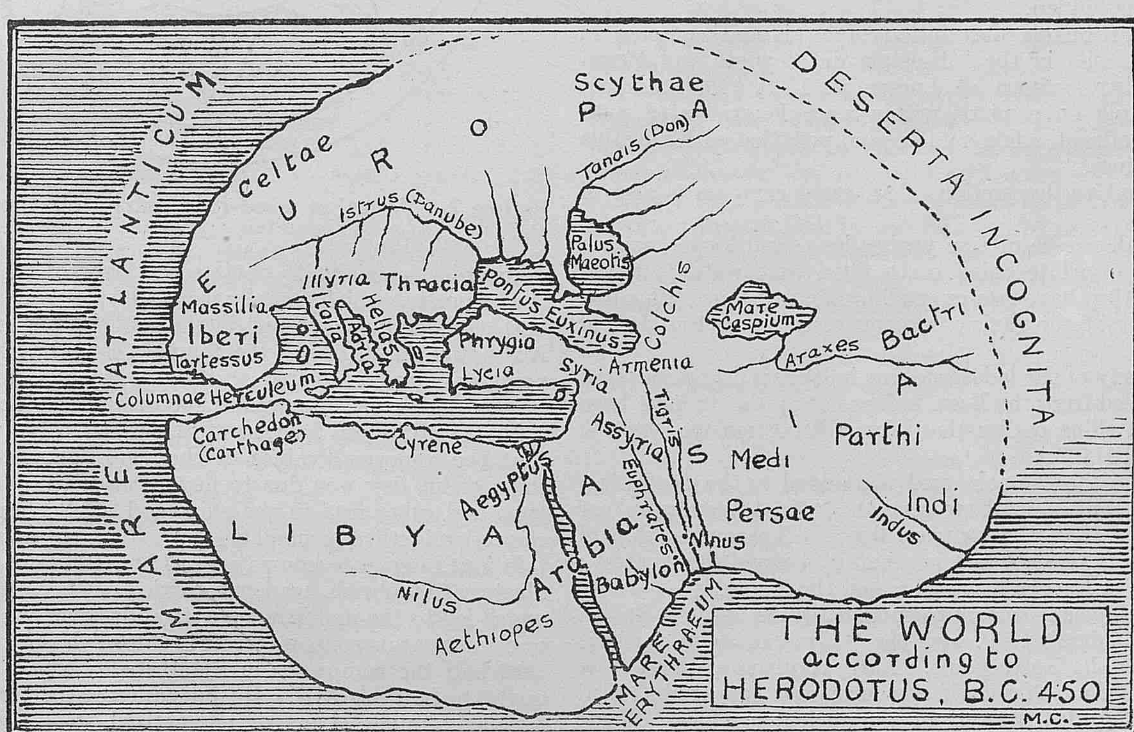
The earliest definite idea formed of the Earth by people emerging from a primeval condition seems to have been that of a flat circular disc, surrounded on all sides by water, and covered by the heavens as with a canopy, in the centre of which their own land was supposed to be situated. Babylonian and Egyptian tablets have been found which show that those ancient nations had similar ideas, several thousands of years B.C.

HERODOTUS, the renowned Greek historian (born 484 B.C.), voyaged extensively over an area of 1,700 miles from East to West, and recorded in his "History" a complete representation of all that was known of the Earth's surface in his day.

Before the introduction of the Mariner's Compass, the only practical means, among Western nations, of navigating ships was to keep within sight of land; or to steer for short distances out of sight of land, by reference to the sun or stars, more particularly the North star. This mode of procedure must have failed in cloudy weather, and even on short voyages in the Mediterranean the early navigators must have often been hopelessly bewildered as to their position.

In Eastern waters, however, long voyages out of sight of land were possible, owing to the steadiness in direction of the monsoons, which enabled vessels in those localities to undertake voyages in opposite directions at different seasons of the year.

It will be convenient to group the following notes under simple headings, the first being "Winds," as it was wind power which originally made voyages possible.



Winds and Wind-rose.

Arab navigators called the seasonal winds of the Indian Ocean "Mausin" (season), which word has degenerated into "Monsoon." Traces of the Arab type are found in India, showing that they formed colonies there in early times.

The idea of naming the principal winds and arranging them in the form of a "Wind-rose" is of very ancient origin. The Babylonians used an eight-part wind-rose, and the Greeks in the second century B.C., erected a temple at Athens known as the Tower of the Winds, which was octagonal in shape and carried on its faces the name of the winds, and sculptured figures to represent the general character of the eight selected winds in Greek mythology.

Venetian and Genoese charts of the early 14th Century have wind-roses drawn upon them with the initials of the eight principal winds, as shown in FIGURE 2. A cross was used to mark the East point, and the North was indicated on some of the oldest wind-roses with a broad-arrow-head or a spear, as well as the letter T for Tramontano, and gradually developed by a combination of these, about 1492, into a "fleur de lis."

The Trade Winds were unknown to the ancients, and even to seamen up to the time of Columbus, but subsequent to that epoch, European navigation extending rapidly in the Atlantic and Indian Oceans, the phenomenon was generally observed and utilized by navigators to their great benefit. It does not seem, however, that any attempt to explain the theory was made before the time of GALILEO (1596), who appears to have had a true, though obscure, perception that the rotary motion of the earth must be somewhat concerned in the production of trade-

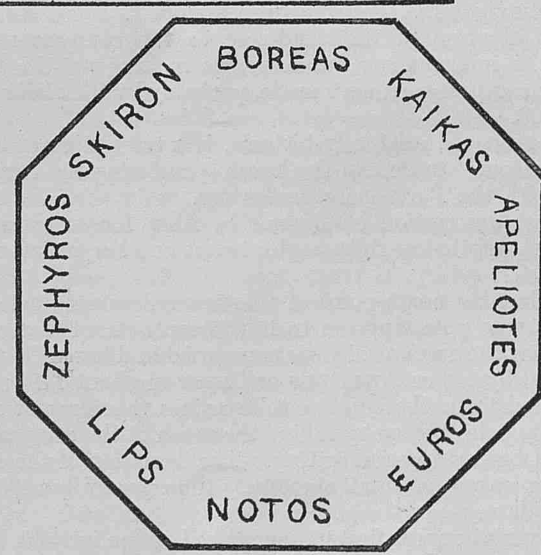


Figure 1. The wind-rose of Aristotle, with directions as shown by the sculptured figures on the Tower of the Winds at Athens, erected in the second century B.C.

winds, but he singularly omitted to consider the operation of solar heat. A more complete explanation was recorded by GEORGE HADLEY in 1735.

As seamen extended their voyages of discovery and trade over the various seas and oceans, their practical observations of winds were noted, handed down and recorded, and finally used in the shaping of routes for the improvement of navigation; and from old books of the period it can be seen that by the end of the 17th Century some general idea of the principal prevailing and seasonal winds of the oceans had been obtained; as, for example, the descriptions of winds and the passages depending upon them in Dampier's "Voyages." As will be mentioned later, wind charts of the world for navigators were not produced until about 1840.

Compass.

The directive property of the magnet seems to have been unknown in Europe until the 12th Century, but some authorities claim that it was known in China at a very remote period, and it has been asserted that MARCO POLO introduced the compass into Italy from the East in 1260.

The Arab geographer, EDRISI, who lived about A.D. 1100, writes of a needle carried on board ship which, being placed on a pivot and allowed to take its own position of repose, shows mariners their course when the polar star is hidden.

The earliest unquestionable description of a pivoted compass in Europe, is that contained in the "Epistola de Magnete" of PEREGOINUS DE MARICOURT, written at Lucera in 1269. The compass is described as moving on a pivot within a circle graduated with 90 degrees to each quadrant, a fiducial line, and provided with movable sights for taking bearings.

The following primitive description of an early compass is also of interest:—

> "A magneticall needle of sixe ynches long, and longer upon a pinne in a dish of white china earth filled with water; in the bottom whereof they have two crosse lines, for the foure principall windes; the rest of the divisions being reserved to the skill of their Pilots."

Whether the property of the lodestone was independently discovered in Europe or introduced from the East, it does not appear to have been utilized in European ships earlier than about 1300, and was not in general use until about 1400.

When and by whom the compass card was added to the needle is a matter of conjecture, but as we have seen the "Rosa Ventorum" or Wind-rose is far older than the compass itself. The combination of card, needles and cap in this country is generally termed the "card"; but on the continent of Europe it is still called the "rose."

The cross to indicate the East point continued to be used on British compasss cards until about 1700, and the "lily" or fleur de lis is still universal to mark the North point. Early compass cards used by the Italians about 1380 had a design in star form, and came to be called the "star," a surviving idea possibly of the ancient use made of the pole star by navigators. *See* wind-rose, Figure 2.

After the adoption of the wind-rose to the compass needle, the naming of the intermediate sub-divisions making up the thirty-two points of the compass card were made, probably by Flemish navigators, in about 1400.

The term binnacle, originally bittacle, is a corruption of the Portuguese "Abitacolo," to denote the housing enclosing the compass, and originated with the Portuguese navigators.

The earliest description of gimbals or rings for suspension of the compass bowl, pivoted at right angles to one another, is first mentioned in about 1604.

The fact that the north point of a compass does not, in most places, point to the true pole, appears to have been noticed at a very early date; but that the amount of variation varied in different localities was first observed by either COLUMBUS or CABOT in about 1490; and later we find it used to be the practice to ascertain this error at sea from a bearing of the pole star, or by taking the mean of the compass bearings of the sun at both rising and setting. The deviation of the compass in wooden ships was of too small a quantity to be generally noticed until a much later date.

Magnetic variation was first measured at London in 1580, the change of the variation year by year at the same position being noted by GELLIBRAND in 1635. Reliable variation charts as now used were not produced until comparatively recent times, the first being one by EDMUND HALLEY in 1700.

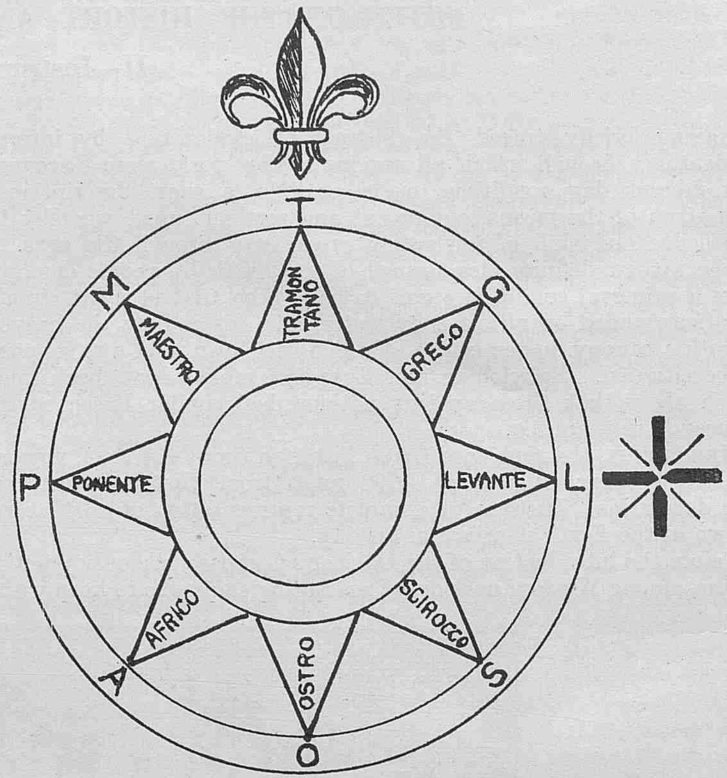


Figure 2. Venetian wind-rose, early fourteenth century.

In order, partially to obviate the error of the compass (variation), the magnets, which usually consisted of two steel wires joined at both ends and opened out in the middle, were not placed under the North and South line of the compass card, but with the ends about a point eastward of North and westward of South; the variation in London when first observed in 1580 being about eleven degrees East.

In 1814, Captain MATTHEW FLINDERS, R.N., was the first to show that the abnormal values of the variation observed in the wooden ships of his day was due to deviation of the compass caused by the guns and other iron in the ship, and his "Flinders" bar method of correction is still in general use.

It is of interest to know that in 1820, PETER BARLOW, Mathematical Master at Woolwich Academy, carried out investigations on magnetism which led to the important practical discovery of a means of rectifying or compensating compass errors in ships. He reported to the Admiralty that half the compasses in the British Navy were mere lumber and ought to be destroyed. He introduced a pattern having four or five parallel straight strips of magnetized steel fixed under a card; a form which remained the standard Admiralty type until 1876, when LORD KELVIN greatly improved the compass by the introduction of short needles and slow periods of vibration, which enabled the principle of Sir G. B. AIRY in 1837 to be accurately carried out.

Tides and Currents.

The ancient Greeks and Romans lived on the shores of a tideless sea, and until the Romans ventured outside, no reference is made to tides in their writings. Later, STRABO, a Greek, in his famous "Geography," A.D. 17, gives a clear account of the tides on the Atlantic coast of Spain, and connected them correctly with the motion of the moon. He also gave the laws of the tides and diurnal inequality in the Indian Ocean as observed by SELEUCUS, the Babylonian.

A knowledge of the times and heights of high and low water and the directions of the Tidal Streams are of vital importance to navigation, but very little was really known about the subject until NEWTON and LAPLACE in 1687 laid the foundation of the theory of the tides.

FLAMSTEED, the first astronomical observer at Greenwich, in 1683 produced a table giving the times of each high tide at London Bridge on every day in the year; and for a long subsequent period, empirical tide tables for a few places in England were published by private individuals; until in 1832 the researches of Dr. W. WHEWELL and Sir J. W. LUBBOCK enabled official tide tables to be issued by the British Admiralty, and these have steadily advanced in detail and accuracy.

The discovery of the great ocean currents was probably commenced by COLUMBUS, who observed and described the Equatorial Current of the North Atlantic Ocean, in the course of his voyages to America, 1498–1500. ANGHIERA, the geographer and friend of COLUMBUS, successfully traced the deflection of the water, of the Atlantic on their whole course from the Equatorial Current to the neighbourhood of Newfoundland, from the combined observations of COLUMBUS, and JUAN PONCE DE LEOM, who discovered Florida in 1513, and was therefore the first to encounter the full force of the Gulf Stream.

Sir FRANCIS DRAKE in the latter half of the sixteenth century was well acquainted with the rapid motion of the Gulf Stream; and BARON VON HUMBOLDT, the celebrated naturalist and traveller (1769–1859), collected information and wrote of the many effects of the Gulf Stream noticed on the shores of Europe.

The monsoonal currents of the Arabian Sea and Bay of Bengal must have been known to local navigators in very remote times, but of this we have no definite knowledge. The early Portuguese sailing to India, named the most southerly point of Africa, "Cape Agulhas," on account of the saw-edged reefs and sharp sunken rocks which ran out to seaward of the cape (Agulha being the Portuguese word for needle). The Agulhas Current running along the coast in the vicinity of the cape thus derived its name. They must also have experienced the Mozambique Current, and we may therefore attribute the discovery of these currents to Portuguese navigators.

BARON VON HUMBOLDT, previously mentioned, first fully described the cold northerly current on the West Coast of South America, now called the Humboldt Current, but it was known to the Spaniards and others at a much earlier period. The Spaniards of the sixteenth century probably recognized the North Equatorial Current of the Pacific Ocean, when their "Manila Ships" voyaged regularly from Acapulco.

Captain DAMPIER in his "Voyages," published in 1729, was the pioneer to render real assistance to navigators with regard to information on Currents. He described his own experiences, and for the North Atlantic Ocean he gave an account of the relative strengths of the Equatorial Currents at various places in the Caribbean Sea, and he also knew of the easterly counter-current, and the Guinea Current. He stated that on the coasts of India the currents set with the Monsoon prevailing according to the season, and he was familiar with the Agulhas Current. He found that on the west coast of South America the current set northerly from Latitude 30° S. to the Equator, and even to Latitude 3° N—4° N.

Thus navigators in their voyages of discovery and trade gradually accumulated knowledge of all the principal ocean currents, and in 1770 the first current chart was published, being one of the Gulf Stream, by Dr. BENJAMIN FRANKLIN, an American. When HUMBOLDT started on his voyage to South America in 1799 he was aware of the complete general circulation of the North Atlantic Ocean as we know it to-day.

It was the introduction of chronometers and of celestial observations for the determination of longitude at sea, which made the computation of set and drift of current experienced by a ship possible. Chronometers came into general use in about 1780, and in 1832 a book was published, entitled "An Investigation of the Currents of the Atlantic Ocean, and of those which prevail between the Indian Ocean and the Atlantic." The author was Major JAMES RENNEL, F.R.S., and he not only gave a very good account of ocean currents, but included a set of large current charts, on which thousands of actual current observations were plotted.

In 1845 and succeeding years, Lieutenant M. F. MAURY of the U.S. Navy produced his well-known Wind and Current Charts. These were the first to be distributed to navigators on an extended scale, in return for the provision of observations to a state service.

Admiralty Current Charts were first published at the end of the nineteenth century, the work being carried out in the Marine Division of the Meteorological Office; and in 1924 was begun the publication of THE MARINE OBSERVER Charts and new style of Atlas, now so familar to the modern navigator.

Soundings.

From the earliest times navigators have ascertained the depth of the sea in shallow water by means of a weighted line, and the lead line, marked in fathoms, is of considerable antiquity.

It is mentioned in the narrative that MAGELLAN during the first voyage round the world attempted to sound the open ocean in the Pacific, and not having reached bottom at 200 fathoms he naïvely concluded that he had crossed the deepest part of the ocean.

Lord KELVIN invented what became known as the "patent sounding machine" in 1870, using a thin stranded wire instead of line; and the recording of depth by means of the discolouration of chemical tubes, or the automatic record of the position of a piston forced upwards in a tube by increased pressure.

Log.

Even at the time of the voyages of COLUMBUS the rate of progress of the ship was usually guessed or estimated, although one of the earliest methods of actual measurement of a ship's speed was what was known as the "Dutchman's log"; which consisted in throwing overboard from the bows something which would float and noting the interval between its apparently drifting past two observers standing on the deck at a known distance apart. No other method is mentioned until 1577, when a line was attached to a small log of wood, which was thrown overboard, and the length of line which was dragged astern in a certain interval of time was measured. This interval of time was, we read, generally obtained by the repetition of certain sentences, which were repeated twice if the ship was only moving slowly.

From this rough method was finally produced the logship, used in conjunction with a sand glass, and so familiar to those who spent their early days in sailing ships.

In 1578 we find in BOURNE'S "Inventions and Devices" the description of a patent log, the invention of one HUMPHRAY COLE, the idea being to register the ship's speed by means of a "little small close boat," with a wheelor wheels, and an axle-tree to turn clockwork in the little boat; with dials and pointers indicating fathoms, leagues, scores of leagues and hundreds of leagues.

About 1668 Dr. HOOKE introduced an instrument depending upon a vane or rotator, and he was followed by several others who produced various devices for ascertaining the speed of ships, but nothing really practical until 1802, when EDWARD MASSEY invented the screw or rotatory log, which came into general use in 1836. This was superseded in 1878 by WALKER'S log, which had the great advantage of carrying its mechanism on deck, thus making readings available without hauling in the rotator.

Keeping the reckoning.

As ships commenced to make regular long voyages a record by navigators of the way of their ship was for many years recorded in chalk on a wooden board (log board), which folded like a book, and from which each day a position for the ship was deduced (ded. reckoning) or from which the more careful calculated the day's work, and made abstracts into what was termed the "Journal."

The log board eventually developed into the log slate, and later the log book was devised and arranged with columns by Captain JOHN DAVIS in about 1600.

Astronomy.

There can be no doubt that astronomical observations of a certain description began in the very earliest ages in connection with ancient religions, and the foretelling of events by astrology which invariably accompanied the worship of peoples during the progress of ancient civilizations. The earliest observations must have been those of the sun and moon, followed by the stars and planets, which would lead to the registration of the different appearances presented by the heavens in the course of a year. To this would be added solar, and lunar eclipses and comets. It is known that the solar zodiac was devised at a very early date. Astronomy was greatly developed by the Greeks from about 400 B.C. until the fall of the Grecian Empire. ERASTOSTHENES in about 240 B.C. first used parallel lines to indicate latitude and longitude and constructed charts on mathematical principles. He considered the world to be a sphere revolving with its surrounding atmosphere on one and the same axis.

HIPPARCHUS, 160–125 B.C., was the greatest of all Greeks in the study of astronomy. He discovered the precession of the equinoxes, used right ascensions and declinations, and referred terrestial positions in terms of latitude and longitude. He employed processes analogous to those of plane and spherical trigonometry, for which he constructed a table of Chords. He catalogued a long list of stars, giving their right ascension and declination, determined the length of a year to reasonable exactness and discovered much information regarding the sun and moon, even to calculating eclipses.

After HIPPARCHUS there was no astronomer of eminence until

PTOLEMY of Alexandria, A.D. 130–150. He enlarged upon the works of HIPPARCHUS, discovered refraction, and extended the stereographic projection of the sphere of HIPPARCHUS; but as was found out centuries afterwards he much under-estimated the size of the earth.

The Alexandrian school was destroyed by the Saracens in A.D. 640, but at Baghdad, in 762, translations of the writings of the Greek astronomers were begun, and with nearly the same theory as PTOLEMY, a career of four centuries of observation commenced, during which many astronomical elements, and in particular the obliquity of the ecliptic and the precession of the equinoxes, were more accurately determined.

AL BATANI, A.D. 880, was the first who made use of sines (instead of chords) and versed sines. He also corrected the value of precession, the solar eccentricity, and the obliquity of the ecliptic, and produced several astronomical tables.

In Persia and in China also astronomy made great progress, until about the fifteenth century, when its study declined throughout the East, leaving little besides Astrology. FREDERICK II, Emperor of Germany, caused the translation of the "Almagest" of PTOLEMY to be made in about 1230, and so Astronomy was again introduced into Europe and rapidly developed; extensive trigonometrical tables and almanacs being finally produced in about 1450 by JOHN MÜLLER.

It will thus be seen that, at the period when long ocean voyages were commenced by COLUMBUS and others, these navigators were equipped with at least tables of the sun's declination, and so able to obtain a rough latitude by observation of the meridian altitude of the sun. When long voyages had become comparatively common, thirty-eight years after the discovery of America, GEMMA FRISIUS produced his famous work upon astronomy and cosmogony, with the use of globes. This book comprised much valuable information to seamen of that day, and was translated into several languages. The Astronomical system adopted was still that of PTOLEMY, and the following are some of the points of interest to navigators. It contained a good description of the sphere and its circles: the obliquity of the ecliptic is given as 23° 30′. The distance between the meridians is measured on the equator, allowing 15° to an hour of time, and latitude is measured from the equator, not from the ecliptic. The use of globes is thoroughly explained. Rules for finding the course and distance are given correctly except that GEMMA treats difference of longitude as departure. A table of latitudes and longitudes of known places is given, but the positions, even the latitudes, are much in error.

TYCHO BRAHE, the Danish Astronomer, in 1603 published a list giving the places of 777 fixed stars; and he also treated of the motions of the sun and moon, and constructed a table of refractions.

The final result to navigators from the work of Astronomers was the Nautical Almanac, first published for the use of Seamen in 1767; the preparation of tables for this great work being one of the chief duties of the Royal Observatory at Greenwich. Various useful rules and tables were appended to early volumes of the Nautical Almanac. Thus, that for 1771 contained a method and table for determining the latitude by two altitudes and the elapsed time. In 1772 three special tables are given for clearing the lunar distance. In 1773 a new table of equations of equal altitudes was included, and in 1797 and 1800 tables were added for rendering the calculations for double altitudes easier.

Geometry.

As the practice of navigation largely depends upon Geometry and Mathematics, the great Mathematicians of ancient times played an important part in the foundation work of the science. The names of some early Greek compilers of "Elements" are handed down; the first being HIPPOCRATES of Chios (5th century B.C.), then THAUDUIS, from whose text-book EUCLID probably received his early geometrical training at Athens. We know little of the circumstances of the life of EUCLID, except that he founded and taught at a school in Alexandria, during the reign of PTOLEMY I, who reigned from B.C. 306 to 283. His works live after him (as every school boy knows) for it is safe to say that no other scientific text-book in the world has remained in use practically unchanged for more than 2,000 years.

The story is told of EUCLID's reply to King PTOLEMY, when asked whether there was any shorter way in geometry than that of the "Elements"—"There is no royal road to geometry."

But then EUCLID could hardly have foreseen logarithms, the slide rule and other devices of a later age!

Logarithms were invented by JOHN NAPIER, a Scottish mathematician, in 1614, and EDWARD GUNTER, in 1620, published tables, and so made the application of this important discovery available to navigators.

Charts.

The use of globes was fairly general with the early navigators, and great circle sailing was known of as early as 1495, when CABOT projected a voyage across the North Atlantic on the arc of a great circle.

Captain JOHN DAVIS, the celebrated navigator, in 1594 published "The Seamen's Secrets," a black letter pamphlet of eighty pages, in which he proposes to give all that is necessary for seamen—not for scholars on shore. He rendered great circle sailing more practicable by dividing a long distance into several short "rhumb lines."

Marine charts worthy of the name were first issued by the Portuguese at the time of "Henry the Navigator." The first step towards a knowledge of the British coasts was by an almanac with a Chart of the coasting part of England, printed on vellum by WYNKEN DE WORDE in 1520, and bound in a small portable volume.

GERARD MERCATOR, a native of Flanders, who applied himself with great industry to the sciences of geography and mathematics, constructed charts showing the meridians of longitude as equidistant parallel lines, and the parallels of latitude as straight lines at right angles to the meridians; but he did not discover the distance which ought to separate these parallels. The credit of first investigating the principles of that projection, and applying them for the purposes of navigation, appears to be due to EDWARD WRIGHT, who explained them in a treatise published in 1599.

WRIGHT's great discovery was of a correct and uniform method of dividing the meridianal line in the proportion of the secants of the latitude, and in the edition of his work published in 1610 his calculations are for every minute of arc. He produced a Chart of the world, upon which both Capes and the recent discoveries in the East Indies and America are laid down correctly, as far as his knowledge of latitudes and longitudes would admit. Just the northern extremity of Australia is shown.

This great improvement in the principle of constructing charts was adopted slowly by seamen, who, putting it as they supposed to a practical test, found good reason to be disappointed. The positions of most places in the world had been originally laid down erroneously by very rough courses and estimated distances upon a plane chart, and from this they were transferred to the "Mercator"; so that errors in courses and distances really due to errors in positions were for some time wrongly attributed to the new and accurate form of Navigating Chart. All old charts and even those up to comparatively recent times had a confusion of course lines drawn upon them, and although parallel rulers were invented by MORDENTE in 1584, they did not come into general use at sea until much later.

In 1620 middle latitude sailing was invented. Until well into the 17th century seamen generally employed small collections of Dutch charts, known as "Waggoners," from Waghenair, the name of a celebrated Dutch hydrographer in 1584. In 1671 appeared the "English Pilot," by JOHN SELLER, which consisted of a collection of sketches of the coasts of England, the North Sea, France and Spain, together with sailing directions.

The British Navy and Merchant Service were for many years onwards supplied with constantly improving charts by private enterprise. In 1595 ALEXANDER DALRYMPLE, the hydrographer of the East India Company, was appointed as the first hydrographer of the Navy. This post has since been occupied by a succession of distinguished Naval Officers, under whom have grown up a large school of Nautical Surveyors, the results of whose work are now published in the Admiralty Charts.

To mention something of charts other than Navigating charts we must go back to the days of the East India Company, who in order that the Captains of their ships should be supplied with the best information as to their routes had some thousands of their log books carefully gone through by some of their officers, who noted every relevant fact, and by means of combining the data thus collected they produced a corpus of information as to wind, weather, currents, tides and other phenomena; making clear many points which had previously caused difficulties and dangers to the Mariner. This work was continued by HORSBURGH, who collected further data from the log-books of the British Navy. His work was improved upon by Lieutenant MAURY, of the United States Navy, who from 1834 to 1856 published Charts, also books, which proved of great value to the Navigators of his day.

Instruments for angular measurement. The Cross-Staff was an instrument known to Astronomers at a very early period, but was not used at sea, at any rate in European ships, until about 1450. It consisted of two wood battens, the staff about 36 inches long and the cross 26 inches. The cross was made to slide along the staff at right angles to it. The staff was graduated by describing the angles on a table and laying the instrument upon it.

attempts at improvements on the cross-staff and astrolabe will be of interest.

TYCHO BRAHE, the Danish astronomer, originally introduced a Sextant in about 1590. It had two sights, one on a fixed, the other on a movable radius, which the observer pointed to the two objects of which the angular distance was to be measured.

In a black letter pamphlet published by the celebrated navigator,

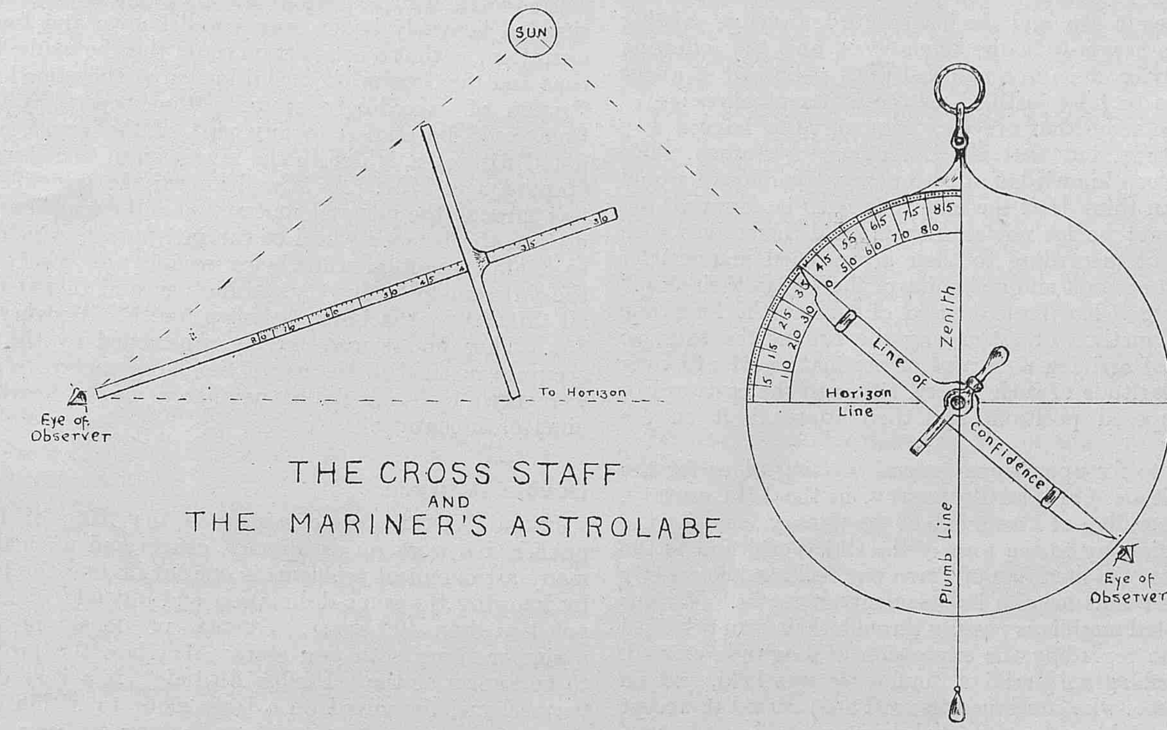


Figure 3.

To observe a meridian altitude of the sun with the cross-staff, a bearing by compass was taken to ascertain when it was near the meridian; then the end of the staff was held close to the observer's eye, and the cross moved until one end apparently touched the horizon, and the other the sun's centre. This was continued until the sun dipped, when the meridian altitude was read off.

The Astrolabe was also used by navigators, but it seems that they generally preferred the cross-staff. The Astrolabe was also an ancient instrument, being devised by the Greek Astronomers of old. In the 15th, 16th and even 17th centuries large specimens were among the chief observatory instruments in Europe.

The Mariner's Astrolabe was adapted from that of the Astronomers by MARTIN BEHAIM, a German navigator, in about 1466, and consisted of a circular brass plate, about $\frac{1}{4}$ inch in thickness and from six inches to one foot in diameter. The face was divided into quadrants, and the upper left hand one was graduated in degrees. A movable arm, pivoted at the centre was provided with sight vanes, and the whole instrument was suspended by means of a ring. The horizontal position of the horizon line was obtained by means of a plumb line attached to the suspending ring.

To take an observation at sea, three persons were necessary, one to hold the instrument by the ring passed over his thumb, the second to observe the sun along the sights on the movable arm, and the third to read off the altitude.

On shore, doubtless, with the Astrolabe suspended from some fixed object, a fairly accurate altitude could be taken, but it is obvious that at sea, and especially in a small vessel, any observation must have been very unreliable when taken by an instrument in which the perpendicular and consequently the horizon line was ascertained by means of a plumb line.

However, as can be seen, all later quadrants and sextants were devised from the circular astrolabe, first by taking a quadrant only and suspending it at its apex by a ring with a plumb line to hang across the arc and two sights fixed on one side. From that stage the arm pivoted from the apex naturally followed.

The Sextant, in its present familiar form, was invented by JOHN HADLEY in 1731, but a description of a few of the several earlier

Captain JOHN DAVIS, in 1594, he described a modification of the cross-staff, using which the observer stands with his back to the sun, looking at the horizon through a sight on the end of the staff, while the shadow of the top of a movable projection falls on the sights; this, known as the back-staff, was an improvement on the cross-staff and remained in common use until about 1745.

On May 31st, 1731, JOHN HADLEY, described an "Octant" employing double reflection, and a fortnight later he exhibited the instrument, which was tried by the Admiralty in August, 1732, on board the yacht *Chatham*, and found to be satisfactory. It did not, however, supersede the older instruments for some twenty years. The arc of HADLEY'S octant was only 45°, but being an instrument of double reflection, the angles of incidence and reflection were changed by a movement of the index bar, and it measured up to 90° of arc, and was graduated accordingly.

In 1757, Captain CAMPBELL, Royal Navy, one of the first navigators to use HADLEY'S instrument assiduously, proposed to enlarge it so as to measure angles up to 120°, in which form as a Sextant it is now generally employed.

In 1610, GALILEO, the Italian astronomer, constructed a reliable telescope, although the instrument was originally invented by the Dutch. PIERRE VERNIER produced the device which bears his name, in 1631; and about the same time JOHANN HEVELUIS, a German astronomer, invented the tangent screw, to give slow and steady motion to the index when near the desired position. All these practical improvements were added to the Sextant shortly after its production by HADLEY.

Latitudes.

As we have mentioned, at an early period simple practical astronomical means of finding the latitude at sea were known and in use, but RICHARD NORWOOD, a seaman and clever mathematician, in 1637 removed one of the greatest stumbling-blocks in the way of correct navigation, by ascertaining the true length of a degree or nautical mile. Using a sextant of more than 5 feet radius he carefully obtained the exact latitude of positions in London and York, and found the difference of latitude to be 2° 28′. He then measured the distance with a chain, taking horizontal angles of all windings, and made a special table for correcting elevations and depressions. Where he was unable to measure with the chain, he paced. His conclusion was that a degree contained 122,392 yards: this gives 2,040 yards to a nautical mile—only about 12 yards too much.

Longitude.

For centuries after the time of the voyages of the discoverers, the mystery of finding the longitude at sea proved unfathomable, owing to the crude appliances in use, and the inaccurate knowledge existing of the positions of the heavenly bodies themselves, and the following quaintly expressed advice given in a nautical work published in about 1660, would appear to be fully justified, as the writer observes:—

> "Now there be some that are very inquisitive to have a way to get the longitude, but that is too tedious for seamen, since it requireth the deep knowledge of astronomy, wherefore I would not have any man think that the longitude is to be found at sea by any instrument; so let not seamen trouble themselves with any such rule, but (according to their accustomed manner) let them keep perfect account and reckoning of the way of their ship."

At that time no method had been devised of finding the longitude except by the rough method of estimating the run of the ship, so that the only means of arriving at a port of destination was to steer so as to get into the latitude of such a port, either to the eastward or westward of its supposed position, and then approach it on the parallel its latitude.

It being necessary to fix upon some general starting place for the measurement of longitude, Cardinal RICHELIEU, in the 17th century, proposed to use the meridian of Ferro, one of the Canary Isles, for the purpose, as this meridian lay to the west of the Old World and to the east of the New. Later, the meridian of Ferro was reckoned as exactly 20° West of Paris, and thus lost its independent character. Various countries having adopted meridians passing through their own principal towns, much confusion regarding the expression of longitude existed, until in 1884 the Washington Meridian Conference was held, and all countries (except France, who continued to use Paris) agreed to accept the meridian of Greenwich as the universal prime meridian.

The celebrated problem of finding longitude by measurement of "lunar distances" occupied the attention of astronomers and seamen for several centuries. The cross-staff was used at night, and by its means the angle between the moon and a fixed star was measured. PHILIP III of Spain, in 1598, offered a reward of 1,000 crowns for the discovery of a method of finding longitude at sea, but nothing practical emerged, owing to the lunar tables then in use being quite useless, the instruments not sufficiently accurate, and the calculated positions of the stars erroneous. Principally to meet the exigencies of navigation, Greenwich Observatory was established in 1675, and JOHN FLAMSTEED was appointed "Astronomical Observer," upon a salary of £100 a year, for which also he was to instruct two boys from Christ's Hospital. TYCHO BRAHE's catalogue of 777 stars, formed in about 1590, was his only guide. Before his death in 1719, FLAMSTEED had obtained the right ascensions and declinations of nearly 3,000 stars, which were later published in the "British catalogue" of 1723.

So important had navigation become to England that in the year 1714 a body was constituted known as the "Commissioners for the discovery of longitude at sea," with power to grant annually sums not exceeding £2,000 to assist experiments and reward discoveries. For a method of determining the longitude within 60 geographical miles, the sum of £10,000 was offered; within 40 miles, £15,000, and within 30 miles, £20,000. The Board continued to exist until 1828, when the longitude problem had been solved, and voyages of discovery were nearly over. During the period from 1737 to 1815 the Commissioners disbursed in all £101,000, no small contribution to the assistance of world navigation by British interests.

Even after the introduction of the sextant, the complicated calculation of clearing the lunar distance made the finding of longitude one of considerable difficulty; the principal reason being that a very small error in measuring the lunar distance produces a large error in the resulting longitude, as the moon passes the stars lying in her course at a mean rate of only 33″ in one minute of time, her motion in regard to the sun being less than this.

To ascertain local time at sea by altitude observations of suitably situated heavenly bodies was a well known and frequently practised operation, so that a comparison could thus be made between such local time and the Greenwich time if known at the same instant. The introduction of exceedingly accurate timekeepers by which Greenwich time could be carried to any part of the world, and the longitude found with ease, is due to the invention of the Chronometer by JOHN HARRISON in 1761. As is well known the principle of compensation was through the unequal contraction and expansion of the two metals used n the balance wheel of the instrument, which was also devised to retain its motion while being wound up. Early tests at sea with the chronometer were very satisfactory, and HARRISON was granted in all £20,000 by the Commissioners for the discovery of Longitude at Sea. Thus lunars were largely superseded by the more simple and accurate method of the use of the chronometer, to check which they were used by some skilled navigators up to nearly the end of the nineteenth century.

Double Altitude.

PEDRO NUNEZ, cosmographer to the King of Portugal, in 1537 published a work on astronomy, charts and navigation; and among many astronomical problems is one for finding the latitude at a place by knowing the sun's declination and altitude when on two bearings not less than 40° apart. GEMMA, previously mentioned, later did a similar thing with two stars; therefore the problem which came to be known as the "Double Altitude" is a very old one. It could be mechanically solved on a large globe to within a degree.

The means of finding both latitude and longitude at the same time was introduced by Captain SUMNER of the U.S.A. Mercantile Marine in 1847, although the method was practised in the British Navy, in a modified form, at a much earlier date. The publication of azimuth tables in 1866 greatly simplified the calculation, and of comparatively recent years SUMNER's method received a very important and valuable development under the name of the "New Navigation," originally proposed by MARC ST. HILAIRE.

Conclusion.

Having briefly traced the development of the science of Navigation up to the end of the nineteenth century, it is not intended in these notes to describe the equipment and aids of the navigators of to-day, which are only too familiar to the readers of this article.

As can be seen, the rise of modern navigation may be fairly dated from the invention of the sextant in 1731, and the chronometer in 1735; and it was a curious coincidence that these two invaluable instruments were invented at so nearly the same time.

It is of interest to conclude with a list of what must have been the appliances possessed by COLUMBUS and other great navigators in his day—A compass, a cross-staff and possibly an astrolabe, a fairly good table of the sun's declination, a rough correction for the altitude of the pole star, a globe or occasionally a very incorrect chart, and a sounding line. Yet with such implements in the hands of our ancestors, who bravely sailed their tiny ships, the world of to-day was opened up and mankind brought to his present stage of development.

THE HISTORY AND DEVELOPMENT OF ORGANISED MARINE METEOROLOGY.

II—Middle Period.

The Committee appointed in 1865 to examine the work of the Meteorological Department of the Board of Trade under the direction of Admiral FitzRoy, went very fully into the work already accomplished and made recommendations for the future structure of the department.

They stressed the fact that already the Department had digressed very considerably from the original purpose for which it was founded. It is pointed out in their Report, that in the opinions expressed by the Royal Society, which were adopted by the Government when the Department was founded, "It will be observed that the great object steadily kept in view was the collection and subsequent discussion of facts and observations, too numerous to be collected and discussed by private persons. The publication in a form available to seamen of such results as might be immediately useful to them, would be a collateral duty, naturally arising out of the primary functions of the office. There is no indication that it was part of the functions of the Department as originally instituted, to publish undiscussed observations on the one hand, or to speculate on the theory of Meteorology on the other. Still less can it be considered to have been a part of those functions to attempt the prognostication of weather."

Already 550,000 sets of observations had been collected. Probably the number of observations would have been even greater if FitzRoy had not allowed his attention to be diverted to the prognostication of weather. As it was, faced with an accumulation of observations and a divided office to deal with them, he had drastically reduced the number of observing ships. The Committee expressed the view "that it would be a subject of legitimate regret if these observations were not turned to fullest account, and if the further contribution of such similar data as may yet be needed in order to fulfil the desiderata of the Royal Society, were declined or discouraged."

With regard to weather forecasting, the Committee felt that too little was known of the sequence of weather over the British Isles to make the daily forecasts anything more than mere guess-work and they recommended the discontinuance of their publication until further knowledge of weather changes had been obtained by the study of the records of seven stations equipped with self-recording instruments. The storm warning service, however, they considered had sufficiently proved its utility to justify its continuance. Consequently, the issue of forecasts to the public was stopped and not resumed again until 1879, but the storm warning services to shipping were maintained except for a short break during 1867 and 1868.

As a result of the Committee's recommendations, the Meteorological Office came into being as a separate department in 1867, administered by a Committee consisting of representatives from the Royal Society, Admiralty and British Association. It is evident from the correspondence between the Board of Trade and the Royal Society, that the Royal Society realised the difficulty they would encounter in obtaining observations over the seas, owing to their inability to keep in touch with shipping and the personnel of the Mercantile Marine, and in the first instance, they expressed the view that the work of collection of observations over the sea should be continued by the Board of Trade, in accordance with the Committee of Enquiry's recommendation. There were, of course, objections to the splitting up of the work among various departments, and a more satisfactory solution was found by the creation of the post of a Marine Superintendent of the newly formed Meteorological Office, who was to be responsible to the Meteorological Committee for the sea side of the work.

The success of this organisation of the Marine Department of the Meteorological Office was undoubtedly due to the fact that such a high-placed merchant service officer of such great outstanding ability in his own profession, as Captain Henry Toynbee, was available and ready to take up the appointment as first Marine Superintendent.

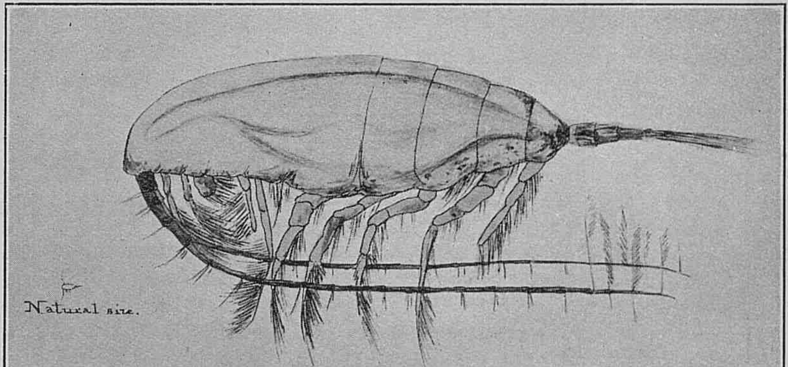
Henry Toynbee, who was the son of a Lincolnshire gentleman farmer, first went to sea as midshipman in the East India Company's *Dunvegan Castle*. He eventually joined Messrs. T. & W. Smith, whose ships were among the famous "Blackwall Frigates" which form the connecting link between the old East India Company and the Orient, and P. & O. Lines of to-day.

His first command was the *Ellenborough* and he subsequently commanded the *Gloriana* and the *Marlborough*. His last command was, however, his most famous, namely, that of the *Hotspur*. Lubbock, in the "Blackwall Frigates," says: "The *Hotspur*, which followed the *Blenheim* off the stocks, was one of the most popular passenger ships trading to Calcutta, and this was in great part due to her commander, Captain Toynbee."

The command of a Blackwaller was considered to be the highest position a man could attain in his sea career. It was frequently worth as much as £5,000 a year to the holder, and he was allowed to use the title "Commander." Strict disciplinarians, these old Blackwall Captains maintained rigidly the dignity of their position both afloat and ashore. The side was always piped when the Commander came aboard, and he was never seen on deck off his poop; while he wore his starched stock and tight-buttoned frock coat even in the tropics. They maintained a similar dignity ashore. It was no uncommon sight to see Captain and Mrs. Toynbee, driving in some state along the "Course" at Calcutta, "with one of his 'mids' seated on the front seat like a diminutive aide-de-camp."

Toynbee was recognised as one of the foremost navigators of his day and contributed many papers on navigational subjects to the *Nautical Magazine*. In the course of his navigational work he came into contact with Admiral Smyth, R.N., whose daughter he married in 1854. Mrs. Toynbee was a great lover of the sea and an excellent sailor; she accompanied her husband on his voyages and contributed by her water-colour sketches to the excellence of Toynbee's Meteorological Logs.

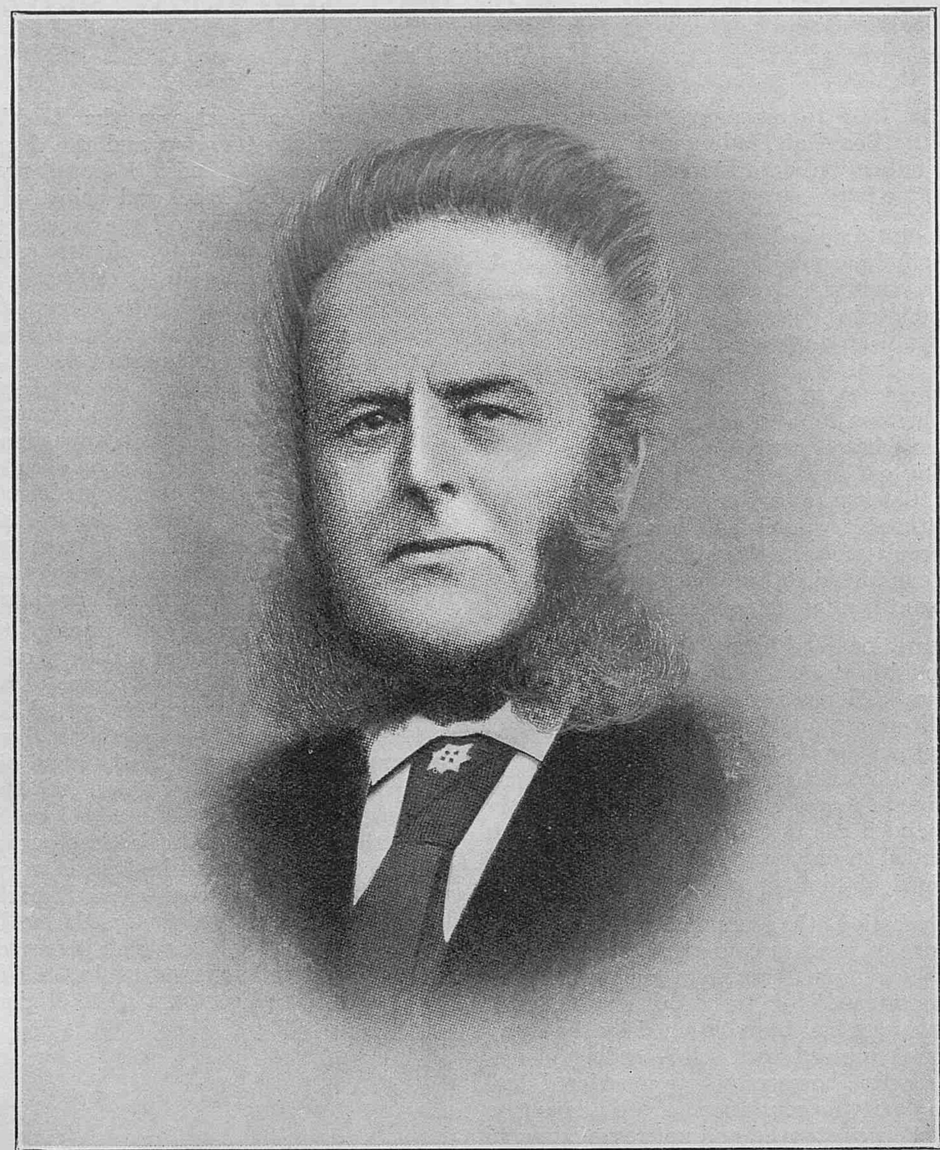
Toynbee was an enthusiastic observer. He co-operated first with Maury of U.S.A. whom he held in very great esteem and after 1855 with the British Meteorological Department, and his Meteorological Logs are still preserved in the Marine Division as models of a really excellently kept log. A sketch is reproduced from the meteorological log kept by Captain Toynbee in the *Gloriana*, and shows an original drawing by Mrs. Toynbee. The original was beautifully coloured.



This interest in Marine Meteorology was very clearly evidenced by his acceptance of the post of Marine Superintendent of the Meteorological Office at a salary which was purely nominal compared with that he could command at sea.

Toynbee's first task on assuming office in 1867 was to re-establish the work of observing at sea which FitzRoy had allowed to lapse. This was not an easy matter, for the keeping of a meteorological log at sea had not been carried on a sufficient number of years (only since 1855) to become an established tradition and it was probably only his personal position in his own profession that enabled him successfully to re-establish the interest of seamen in the work of observing at sea.

His second task was to deal with the observations already received in the Meteorological Office. With the small staff allocated to him for the work, he did not find it possible to extract completely all the information from the logs. Impressed with the necessity of making some early return to seamen for the work they were doing, he made it a rule to carry out as far as possible investigations which had a direct bearing on navigation and which answered questions constantly being asked by seamen themselves. Thus, the "Charts and Remarks of



The Master of the *Hotspur*.

Captain Henry Toynbee,

Marine Superintendent of the Meteorological Office, 1867–88.

Meteorological Data for Square 3," published in 1873, and "Charts and Remarks of Meteorological Data for the Nine Ten Degree Squares (Latitude 20° N.—10° S., Longitude 10°—40° W.)," published in 1876, aimed at determining the best route for crossing the Equator, the position of the Doldrums, and in obtaining some clue as to the place of origin of West Indian hurricanes, all problems of vital interest to the sailing ship master.

The Committee of Enquiry of 1865 had recommended a new method of dealing with the observations received, by means of a card on which was extracted each set of observations, the reference to the log, latitude and longitude being given. It was thought that these cards would facilitate the grouping of the observations and allow their being used for various investigations without re-copying. On being put into practice, however, it was found that the process of copying each set of observations on to separate cards was a long one and in addition the cards became difficult to handle as their numbers increased. This system was therefore replaced by Toynbee's system of "data-books." Each book contained the observations for one month in a ten-degree square which was divided up into a hundred sub-squares of 1° of Latitude by 1° of Longitude.

The data book was a distinct advance on previous methods since it allowed the observations to be computed in an area of 1° square or combined into larger areas as the occasion warranted, and also enabled the same observations to be used again and again without labour of re-copying. Using this system of data extraction, a considerable output of atlases and publications was achieved under the supervision of Toynbee.

Space does not permit of a review of the publications issued, but Figure 3, taken from the "Charts of Nine 10° Squares," illustrates the progress made in clarifying the diagrammatic representation of information for seamen.

Many of the results of the investigations Toynbee undertook have found a permanent place in the sailing directions and pilots, which was the most appropriate place for them. By that means information was conveyed, not only to the few who observe for the Meteorological Office, but was desseminated to all seamen, and at the same time indicates the reliance placed upon his work.

In 1874 another conference of the maritime nations who had attended the Brussels Conference in 1853 was called. It had been felt by some nations that the form of the Abstract Log adopted at Brussels was no longer appropriate and that the experience of twenty years' work in marine meteorology would suggest better methods of co-operation in the discussion of observations over the oceans. The conference met in London, and with regard to the form of the Meteoro-

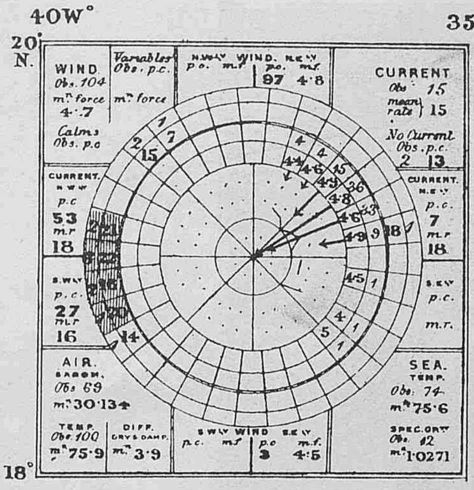


Figure 3.

logical Log its conclusions may perhaps best be stated by a quotation from the Annual Report of the Meteorological Committee for 1874. "As regards its results, it is remarkable to find that, although the first promoters of the Conference had urged as the principal ground for its being convened that the regulations for filling the log adopted at Brussels had been too stringent, the members, when assembled, passed by a large majority rules hardly differing in any important particulars from those emanating from the Brussels meeting; the only deviations, in fact, being a demand for increased information, viz., the entry of 'Course and Distance by Log every four hours,' in order to facilitate a closer approximation to the true position of the ship from time to time than was previously possible, and a request that the wind should be given for the actual time of observation, and not estimated for a number of hours previously.

"In fact, the Committee cannot but feel that the practical experience of the Office carried on under their superintendence was highly honoured by the fact that the Draft Log and the Instructions for Observers, prepared by their own Marine Superintendent, Captain Toynbee, were, by the resolution of the Conference, appended to the Report of its proceedings. It should here be remarked that the Log and Instructions just referred to are almost identical with the modified form of the Brussels Log adopted by Admiral FitzRoy at the first institution of the Meteorological Department; in fact, the office may almost say that its practice has been unaltered from the first, and is now handed on for general adoption."

With regard to the discussion of the observations, it was agreed that every Institute should publish its results in such a manner that the observations could be incorporated with those of other institutes, that is, by preserving the number of observations on which means were based.

They further emphasized that the seaman requires the results of experience alone and the assurance that his observations have been turned to use. Only when these have been given should the theorist point out why certain routes are best.

The Conference agreed that observations should be available for exchange between different institutes, but only on the condition that payment should be made for the work entailed in copying the observations.

As expressed above by the Meteorological Committee, the result of the Conference was a tribute to the personal prestige and experience of Captain Toynbee, who attended the Conference as the representative of the Board of Trade.

The application of marine observations to the advancement of knowledge of synoptic meteorology was not forgotten and a series of weather charts made by international co-operation, "The Synchronous Weather Charts of the North Atlantic, 1st August, 1882, to 3rd September, 1883, and Toynbee's own contribution in the "Meteorology of the North Atlantic," were the basis from which the later discussions of weather systems and their movements by Abercromby and others was developed.

Toynbee retired in 1888. His lovable disposition, genial and breezy manner endeared him to all observers, although he was always a strict disciplinarian and retained to the end that brusqueness characteristic of the master of sail.

He was succeeded by navigating-Lieutenant C. W. Baillie, R.N., who had been his assistant in the Marine Division since 1879. Baillie carried on the work on much the same lines as Toynbee, many of the publications issued during his term of office being the completed work of investigations started by Toynbee.

Early in the 'nineties the method of plotting observations on charts instead of extracting them into data books was adopted for some investigations, in particular for the Current Charts of the Atlantic, Pacific and Indian Oceans. This method, while perhaps facilitating the work at the time, has barred any revision of the work by the addition of subsequent observations without first re-extracting all the original observations.

Baillie's name will, however, be remembered for the diagrammatic form he devised to show the percentage frequency of both wind direction and force which was first used in 1892, in the meteorological charts of the Red Sea. The Baillie Wind Rose, which gives the percentage frequency of force, either light, moderate or gale from each two points of the compass, has proved so satisfactory that it remains the standard diagrammatic form for showing wind frequency in use to-day.

Navigating Lieutenant Baillie died in 1899 and was succeeded by Captain Campbell Hepworth of S.S. *Aorangi*, an excellent observer for the Meteorological Office of thirty years' standing. He came into office impressed as an observer with the necessity of presenting to observers at sea the results of their observations in a more general and more convenient form than the atlases published hitherto.

To satisfy what he felt was an immediate demand, more especially as the United States of America were issuing Pilot Charts indiscriminately to all nationals who cared to apply for them, Hepworth compiled a Meteorological Chart of the North Atlantic from all available sources and in 1901 the monthly Meteorological Chart of the North Atlantic was first issued month by month. The face of the Chart presented the mean or average meteorological conditions for the month, while the back served as a means of communication, between the Marine Superintendent and the observers afloat, for the issue of notices and instructions, and notes upon any particularly interesting phenomena reported. It also provided for the dissemination of the latest information concerning ice, derelicts, etc.

In conjunction with these charts of the North Atlantic the number of observing ships was increased in that ocean with a view to obtaining as much information as possible, about ice in particular, for dissemination by the charts. This was done by the introduction of a form whereby observations were taken at 8 a.m. and 8 p.m., using the ship's instruments. These forms provided a wealth of observations which, if not of sufficiently high standard for inclusion in the computation of means, were yet of sufficient reliability for the investigation of immediate phenomena.

By 1906, Hepworth had been able to have completely extracted into data books all the information available in logs received in the Meteorological Office since 1855 in the Indian Ocean. The construction of monthly Meteorological Charts for that ocean from the averages thus obtained was proceeded with and in May, 1906, the first Monthly Meteorological Chart of the Indian Ocean was issued. Figure 4 is a specimen of these charts and illustrates what progress towards simplicity and clarity of presentation had been achieved.

With regard to the collection of observations a fairly regular stream of logs continued to flow in to the Office year by year; but it is noticeable that as steam superseded sail, the logs tended to become more perfunctory and less detailed than in the old sailing ship days.

The invention of wireless telegraphy as a means of communication and its gradual adoption at sea offered a new means of obtaining information of weather over the ocean for the improvement of the Forecast Service. The necessity for the organisation of such a scheme was included in the recommendations of a Committee which investigated the administration of the Office in 1904, and upon whose report the Office was reorganised under a Committee appointed by H.M. Treasury, and not, as heretofore, by the Royal Society. In 1906,

The Master of the *Aorangi*.

Captain M. W. Campbell Hepworth, C.B., R.D., R.N.R.

Marine Superintendent of the Meteorological Office, 1899–1919.

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by the courtesy of the Lords Commissioners of the Admiralty, an arrangement was made whereby H.M. Ships sent observations of weather to the Meteorological Office by W/T. This was helpful, although the distribution of the reports was necessarily limited, but at that time the financial resources of the Office would not permit of the introduction of reports from the Mercantile Marine. But in 1908, the Marconi Company offered to accept the messages at 6d. per word, waiving their minimum charge of 6s. 6d. per message, and after a preliminary trial commencing in January, 1909, a service whereby a number of trans-Atlantic liners already co-operating with the Office, transmitted their weather observations in code to London by W/T was inaugurated. These ships were not specially equipped with tested instruments, and many of them used the ship's instruments. While the resulting observations to the westward undoubtedly materially assisted the forecaster ashore, the difficulty of obtaining reliable errors for the ships' barometers was very apparent when the observations were charted, and diminished to some extent their value. At that time few of the reports came to hand early. Nevertheless, their loss was a considerable handicap when the outbreak of war in 1914 made it impossible for any further messages to be sent.

The loss of the *Titanic* on her maiden voyage after collision with an iceberg on 14th April, 1912, aroused public opinion to the danger to shipping on the North Atlantic trade routes, of ice off the banks. The United States despatched two cruisers to patrol the ice zone for the rest of the 1912 season. In 1913, the British Government in conjunction with the principal Steamship Lines trading between Europe and North America despatched the *Scotia* to watch the break up and movement of ice in the North Atlantic, and to carry out scientific investigations as to the set and velocity of currents affecting the ice and the direction and rate of the ice drift.

The same year, an International Conference on Safety of Life at Sea was called. Captain Hepworth was a member of the Committee of Safety of Navigation which dealt with ice dangers, derelicts, weather signals, ocean routes, etc. As a result of this conference, the establishment of an international service of ice observations, ice patrol and ocean derelict destruction, manned by the United States

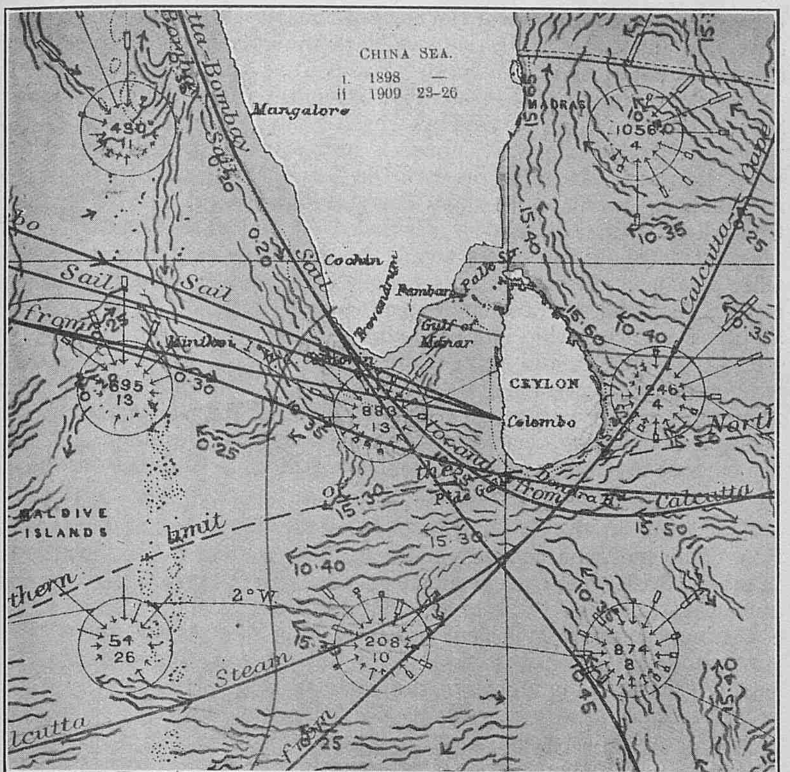


Figure 4.

was inaugurated, the expense of maintaining this service being defrayed by the contracting countries in a fixed proportion.

The work of investigation and preparation in connection with this very necessary and important conference occupied a considerable amount of time of the Marine Division of the Meteorological Office and necessarily adversely affected the continued extraction and compilation of weather observations.

The years of the War necessarily form a blank in the continuity of marine observations. The majority of observing ships were on duties which made it impossible to record observations; and where the exigencies of service allowed of the observations being taken, the conditions of war did not permit the logging of the ship's position, while many went forth to return to port no more. One important investigation was undertaken early in the War by the Marine Division, namely the preparation of data for the construction of charts for the Mediterranean (issued after the War as M.O. 224, "Monthly Meteorological Charts of the Mediterranean") which were compiled by Colonel H. G. Lyons, Sc.D., F.R.S., R.E., for the requirements of the Forces operating in this region. The staff of the Division was depleted by all the junior members who were fit being on active service.

The period from 1900 to the end of the War may be regarded as one in which the interests of the Marine Meteorological service were widening in their scope. The output of atlases and publications decreased, but the publication of periodical charts provided information to a far greater number of officers in the Mercantile Marine, and if results are not so apparent during this time it is because marine meteorology was slowly adapting itself to the different conditions imposed by the dominance of steam.

CURRENTS IN THE CHINA SEAS AND EAST INDIAN ARCHIPELAGO.

Prepared in the Marine Division by E. W. Barlow, B.Sc.

I—Meteorological Conditions which affect the Currents, with Summary of Current Information previous to the present Charting.

The winds of this region comprise two quite separate monsoon systems, that of the China Seas and that of the East Indian Archipelago.

Pressure and Winds of the China Seas. The great alternations of mean atmospheric pressure over the Asiatic continent between summer and winter, which give rise to the monsoons of the Indian Ocean, similarly influence the winds of the China Seas and of the North Pacific Ocean to about longitude 150° E. The monsoonal system of the China Seas extends from about latitude 30° N. to the equator between Sumatra and Borneo (Carimata Strait). Over the whole of this area the N.E. Monsoon blows from November to March and the S.W. Monsoon from June to August. The N.E. Monsoon is much the stronger and steadier, interruptions being rare, while the S.W. Monsoon is more irregular, especially in the northern part of the region, and often weak. When at its height, in December and January, the N.E. Monsoon is continuous with the N.E. Trade Wind of the North Pacific Ocean. During June, July and August, when the S.W. Monsoon is at its strongest, a small frequency of north-easterly winds still occurs, notably in the nothern part of the region. Land and sea breezes in the vicinity of the coasts of the China Seas are experienced more frequently during the prevalence of the S.W. Monsoon.

The relative strengths of the monsoons are thus reversed from those of the Indian Ocean, where the S.W. Monsoon is the stronger. This fact is readily explained by the charts of mean atmospheric pressure, which show that the steepest pressure gradient lies over the North Indian Ocean in summer, while in the China Seas the steepest pressure gradient occurs in winter.

An account of the typhoons of the China Seas will be found in Marine Observer, Volume VIII, 1931, page 13. These winds only affect the currents temporarily.

Winds of the East Indian Archipelago. These monsoons form part of the wind system which prevails in the Indian Ocean north-west of Australia, described in Marine Observer, Volume XI, 1934, page 68. The S.E. wind may be regarded either as a trade wind or a monsoon. The S.E. Monsoon in the East Indian Archipelago persists from April to September, the N.W. Monsoon being experienced from October to March. Neither monsoon is very strong, but the S.E. Monsoon is the steadier in direction, especially during July and August, when it becomes continuous with the S.E. Trade Wind of the South Pacific Ocean. The N.W. Monsoon is less steady in this region than in the open waters of the equatorial Indian Ocean, and in the East Indian Archipelago blows with diminishing force as lower latitudes are reached. South of latitude 4° N. it blows fitfully and comes in squalls, alternated by calms, variable winds and rains, the weather more resembling that of the Doldrums than that of a monsoon region.

Currents of the Region. For the purpose of giving a summary of the information on currents available previous to the present charting, the region will be divided into three parts :—

(i) The part of the North Pacific Ocean bounded on the west by the Philippine Islands and Formosa and on the east by longitude 140° E., the limit to which the charts extend.
(ii) The East Indian Archipelago.
(iii) The China Sea, Formosa Channel and the Eastern Sea, as far as latitude 30° N.

With the exception of the first part, there is comparatively little open deep water in these areas. The great length of coastline, the multiplicity of islands and reefs, particularly in the Eastern Archipelago, and the fact that the whole of the Gulf of Siam, the southern part of the China Sea, and most of the Eastern and Java Seas are within the 100-fathom line, make it inevitable that a large part of the currents of the whole region are local, coastal or subjected to tidal influences. The summary given in the present article will therefore deal only with the previous knowledge of the general current circulation. A great deal of information about the local currents is to be found in the sailing directions and has been included in Admiral Somerville's "Ocean Passages of the World."

Currents of the North Pacific Ocean, West of Longitude 140° E. The main body of the westward-flowing North Equatorial Current of the Pacific Ocean passes between latitude 8° N. and 20° N., through the Mariana or Ladrone Islands in longitude 145° E., towards the east coast of the Philippine Islands. The speed of this current is from 10 to 40 miles a day. At the Philippine Islands the North Equatorial Current turns north-westerly, northerly and north-easterly past Formosa, the Liu Kiu chain of islands and the south-eastern side of the islands of Japan. Through this part of its course it flows as a warm stream of a distinctly deep blue or sometimes black colour and is known as the Kuro Siwo (Black Current) or Japan Current. The colder water on either side is of a pale green colour. As stated in Admiral SOMERVILLE's "Ocean Passages of the World," the correct transliteration of the Japanese words is "Kuro Shio," but the spelling "Siwo" was given in the nineteenth century before a standard system of the spelling of Japanese had been adopted. As "Siwo" has been used in all Admiralty charts and publications, as well as in other books, since about 1840, it is not possible to alter it now without causing confusion.

The Kuro Siwo is the Gulf Stream of the Pacific Ocean. Its mean temperature is about 80° F., from 5° to 15° F. warmer than the water on either side of it. The north-western edge is sometimes strongly marked; the south-eastern edge is less definite. Hot and cold belts, differing in temperature from 4° to 6° F., may alternate within the warm current.

Off the north-east of Luzon the speed of the Kuro Siwo averages 10 to 35 miles a day, eastward of Formosa 10 to 50 miles a day, and north-eastward of Formosa 10 to 60 miles a day. Close to the south-east coast of Formosa it may attain a speed of from 3½ to 4½ knots.

It is probable that the Kuro Siwo is of considerable depth and that the deeper water always follows its usual course, but the surface water to the depth of several feet often flows in a different direction. Its limits and surface direction are considerably influenced by the monsoons and prevailing winds and by the drift currents these produce. Its rate is probably less affected. Although the Kuro Siwo is well within the region of the N.E. Monsoon, between the Philippine Islands and Japan, the main body of the current sets to the north-east against the wind, while only a few miles westward, in the region north of Formosa, the N.E. Monsoon drift current is setting southward along the Chinese coast.

A branch of the Kuro Siwo passes up the west coast of Formosa and rounding the northern end of the island rejoins the main current.

Between Latitude 3° N. and the northern coast of New Guinea, the northern part of the South Equatorial Current also flows westward towards the island of Halmahera (Gilolo), in the Molucca group.

Between the North and South Equatorial Currents, the Counter-Equatorial Current flows eastwards throughout the year, but is probably stronger from May to October than during the remainder of the year. It varies in strength from a half to two knots. The Counter-Equatorial Current is usually found between Latitudes 4° N. and 9° N., and generally within the limits of 5° N. and 8° N., but is subject to some change of latitude as the sun moves northward and southward throughout the year. It has been met with almost down to the equator. Its average speed is from 10 to 40 miles a day. The Counter-Equatorial Current of the Pacific Ocean is more definite and more permanent than those of the Atlantic or Indian Oceans, being less affected by seasonal causes.

The Counter-Equatorial Current originates in about longitude 130° E. The northern portion of the South Equatorial Current, above referred to, is deflected northwards and eastwards in this longitude, passing into the Counter-Equatorial Current. While the main body of the North Equatorial Current is deflected northwards at the Philippine Islands to form the Kuro Siwo, a portion is deflected southwards off Mindanao, and this also turns eastward into the Counter-Equatorial Current.

Currents of the East Indian Archipelago. A small part of the South Equatorial Current passes through the Torres Strait at all times of the year. The currents of the East Indian Archipelago are mainly wind drifts, generally flowing westward or north-westward during the period of the S.E. Monsoon and easterly or south-easterly during the rest of the year. The average rate of the currents in the Java Sea is 11 miles per day during the S.E. Monsoon and 15 miles per day during the N.W. Monsoon, but they are irregular both in force and direction.

During the S.E. Monsoon the current sets to the north-west along the western coast of New Guinea, and between the Kei and Aru Islands, and thence westward along the south coast of Serang. The strength varies with that of the wind and is greatest along the coast of New Guinea, where it may reach 1 or 1½ knots. At the same time an easterly current sets along the northward of the Sermata Islands, between Timor and the Tanimbar group. The westerly current continues along the south coasts of Celebes and Borneo and then turns northward through the wide Carimata Strait between Borneo and Sumatra. It flows between the Anamba and Natuna Islands and so passes into the north-easterly S.W. Monsoon drift of the China Sea.

During the N.W. Monsoon the surface drift of the N.E. Monsoon in the China Sea passes southward through the Carimata Strait and into the waters of the East Indian Archipelago.

There are passages between the islands where southerly currents flow on the average throughout the year. Through Sunda Strait, between Sumatra and Java, the current runs south-westward from the Java Sea and turns south-eastward into the current setting eastward along the south shores of Sumatra and Java. There is a constant southerly current, of considerable strength, through the Macassar Strait, between Borneo and Celebes. This current flows south-westward during the S.E. Monsoon and south-eastward during the N.W. Monsoon. It interferes with the flow of the drift currents of the neighbouring parts of the Java Sea; the excess of water flows out through the Sunda Strait, as mentioned above.

In the shallow Carimata Strait the currents are affected by the tidal streams. When the monsoon is light and the tidal stream is against the wind, there is little or no current, or the tidal stream may at times overcome the monsoon current.

In the Sulu Sea, the current during the N.E. Monsoon sets south-westward, varying in strength with the force of the wind. In the early months of this monsoon when the wind blows strongest, the current strength is one knot, decreasing to about half a knot in May. In June the current reverses, setting in northerly and easterly directions under the influence of the S.W. Monsoon.

Currents of the China Sea, Formosa Channel and Eastern Sea. The monsoon currents of the China Sea are very variable, both in set and drift. The currents during the N.E. Monsoon are stronger and more constant than those of the S.W. Monsoon.

During the N.E. Monsoon period (October to April) the current runs generally south-westward, beginning at the Korea Strait and setting thence to the mouth of the Yangtze River. It flows down the coast of China, nearly parallel to the coast, and through the western side of Formosa Channel. It then continues through the western part of the China Sea and passes through the Carimata Strait into the waters of the East Indian Archipelago. The speed of this current depends on the strength of the wind; when the monsoon is weak there is often little or no current in the China Sea. At the beginning of its course the speed of the monsoon current is from 5 to 30 miles a day. Its rate off the coast of China is from 10 to 50 miles a day, increasing to 60 or 65 miles a day in the southern end of Formosa Channel. In the open waters of the China Sea it is reduced to 45 miles a day, but on rounding the coast of Annam it increases from 60 to 65 miles a day. In the Carimata Strait it is usually about 40 miles a day. The strength of the current may be much increased by a typhoon or gale.

In the central part of the China Sea, to the westward of the great number of reefs lying between Latitudes 7° N. and 12° N., Longitude 108° E. to 115° E., there is usually little current, even when the N.E. Monsoon is at its height. In the northern part of this region there is invariably a current setting northwards against the wind, generally strongest when the wind blows hardest. In the eastern part of the Sea, towards the coasts of Borneo, Palawan and Luzon, the currents are generally weak.

Between the south end of Formosa and the north end of Luzon, the general direction of the current through the Bashi and Balintang Channels (Luzon Strait) is westerly during the N.E. Monsoon. Part of the North Equatorial Current passes through these channels and joins the monsoon current of the China Sea, setting south-westward at a rate of from 10 to 50 miles a day.

Late in April or early in May the currents of the southern and middle parts of the China Sea begin to set to the northward. During the strength of the S.W. Monsoon the current flows in a north-easterly direction, but is not constant, and should the wind be moderate or light, it is liable to set in various directions. After the strength of the monsoon has abated currents running to the southward may sometimes be found. Up the coast of China the speed of the current varies and may reach 30 miles a day. Off the western coast of Formosa the speed is from 5 to 40 miles a day and near the land off the north-west coast of the island may reach 50 miles a day. This is due to the branch of the Kuro Siwo, previously mentioned, flowing up the west coast of Formosa and strengthening the monsoon current during this season.

The monsoon currents of the China Sea set across the opening of the Gulf of Siam. The currents in the centre of the Gulf are generally weak and variable. In the N.E. Monsoon period there is frequently a strong westerly set in the head of the Gulf.

In certain parts of the above account, what appears to be the general opinion has been given. Some of the statements made with regard to the currents in this area have been found more or less inconsistent. The most doubtful points are the relative strengths of the Kuro Siwo in the two monsoon periods and the relative strengths of the N.W. Monsoon and S.E. Monsoon drift currents of the Eastern Archipelago. It is hoped that the present charting of the currents will afford further information on these points.

ICE IN THE WESTERN NORTH ATLANTIC.

1934.

Prepared in the Marine Division by Commander J. Hennessy, R.D., R.N.R.

The following monthly summary of ice conditions in the Western North Atlantic during the 1934 season is compiled from ice reports returned from those ships of the Voluntary Observing Fleet traversing the trans-North Atlantic Routes, from bulletins issued by the International Ice Patrol Service, and from other sources.

January.—Between the 11th and 29th of the month extensive ice fields and one moderate sized berg was reported on and in the vicinity of the Grand Banks north of the Virgin Rocks, between the east coast of Newfoundland and Longitude 47° E.

February.—A large field of ice and a few growlers were observed on the north-eastern side of the Grand Banks, north of the 46th parallel between the 1st and 15th of the month. Between the 11th and 17th large areas of brash and slob ice were reported off the Nova Scotia coast, extending from Halifax eastward to the 60th meridian.

March.—Between the 5th and 13th of the month some large fields of ice and a few bergs were reported to the eastward of the northern edge of the Grand Banks between Latitude 47° and 49° N. and Longitude 47° and 48° W. On the 12th of the month a large berg was also sighted in Latitude 50° 23′ N., Longitude 45° 11′ W. The southernmost ice reported during the month was a field of heavy ice situated near the western edge of the Grand Banks in Latitute 46° N., between Longitude 55° and 56° W.

April.—Ice conditions on the south-west coast of Greenland were reported by the Danish Meteorological Institute as follows:—April 6th: "Free of ice 75 miles off Cape Farewell, Bergs in Longitude 38° W. Julianehaab Bay free of ice." April 20th: "Between Cape Farewell and Arsuk no storis or icebergs sighted."

The Canadian Signal Service reported the following ice conditions within the River and Gulf of St. Lawrence on the 20th: "Montreal to Cape Rozier no ice in sight, 20 miles eastward to 35 miles south of Heathpoint, Anticosta, and Magdalen Islands, heavy closed packed ice everywhere. St. Paul's, light open ice everywhere. Within Belle Isle Strait, heavy open ice everywhere."

On April 26th, the opening of navigation within the St. Lawrence was marked by the arrival at Montreal of the Greek steamer *Hadiotis.* The captain received the gold mounted walking stick which is presented each year to the commander of the first vessel from overseas to dock at the port.

The United States Coast Guard cutters *General Greene*, *Pontchartrain* and *Mendota* were detailed for ice partol duties on and in the vicinity of the Newfoundland Banks. The *General Greene* sailed from Boston on April 2nd to commence the service.

Throughout the month numerous bergs and growlers were reported on and in the vicinity of the Grand Banks, between the 43rd and 50th parallel and the east coast of Newfoundland and Longitude 47° W. On April 24th the M.V. *Georgic* sighted 20 bergs and numerous growlers when crossing the Grand Banks from west to east. The southernmost ice reported during the month was a growler observed on the 15th in Latitude 43° 26′ N., Longitude 49° 21′ W.

May.—On the 24th the Danish Meteorological Institute reported: "Free of ice 20 miles off Cape Farewell, Bergs in Longitude 42° W., Julianehaab Bay free of ice."

The Gulf of St. Lawrence was reported clear of ice with the exception of Belle Isle Strait where, towards the end of the month, several bergs and heavy open ice were reported.

In the western North Atlantic numerous bergs and growlers were reported throughout the month between the 42nd and 53rd parallels and the 41st and 53rd meridians. The bergs were especially numerous on and in the vicinity of the eastern edge of the Grand Banks. The southernmost ice reported during the month was a small berg observed on the 27th in Latitude 42° 17′ N., Longitude 50° 56′ W.

June.—The Danish Meteorological Institute reported on the 2nd: "Free of ice 30 miles off Cape Farewell, Julianehaab Bay ice edge, 30 miles off shore." On the 12th: "Free of ice 30 miles off Cape Farewell."

On June 12th, in Davis Strait, a huge berg approximately 7 miles in length, was reported in Latitude 62° 53′ N., Longtitude 60° 45′ W., bordering an extensive ice field which stretched to the north and east as far as the eye could see.

Belle Isle Strait opened to navigation on the 17th and from that date to the end of the month numerous bergs and growlers were reported, both within the straits, and on the tracks eastward to the 51st meridian.

On and in the vicinity of the Grand Banks bergs were reported during the month between the 43rd and 51st parallels and the 43rd and 53rd meridians. Reports which were far more numerous during the first half than during the second half of the month chiefly referred to ice observed north of the 47th parallel.

On June 2nd a small growler measuring about 20′ by 8′ by 3′ above water was observed by the Norwegian M.V. *Beaulieu* in Latitude 30° 50′ N., Longitude 45° 06′ W., a phenomenal position in which to sight ice, but other than this the southernmost ice reported during the month was a berg observed on June 6th in Latitude 43° 47′ N., Longitude 45° 04′ W.

There being no ice likely to cause menace to ships bound to or from United States ports the International Ice Patrol service was discontinued for the season on June 29th. Altogether about 600 bergs were sighted on or in the vicinity of the Grand Banks during this patrol season. The greatest number of bergs sighted during any one season was the 1,351 bergs observed in 1929.

July.—On the 13th, 25 bergs and scattered patches of ice were reported in the vicinity of Cape Farewell. On the west coast of Greenland, between Disko Island and Duck Island, great numbers of bergs were observed on the 14th.

Throughout the month ships navigating the Straits of Belle Isle reported several bergs within Belle Isle Strait and eastward on both sides of the tracks to the 52nd meridian.

North of the Virgin Rocks on and in the vicinity of the Grand Banks between the east coast of Newfoundland and Longitude 46° E. bergs were observed throughout the month, but south of the Virgin Rocks the only report of ice received was a berg sighted on the 3rd in Latitude 45° 46′ N., Long. 45° 48′ W.

August.—Several large bergs were sighted off Cape Farewell on the 18th and 22nd.

No ice was reported within the Belle Isle Strait during the month but on the tracks east of Belle Isle a few bergs were observed during the first half of the month, after which, with the exception of a berg sighted in Latitude 52° 10′ N., Longitude 50° 55′ W. on the 20th the Belle Isle tracks were free from ice.

On and in the vicinity of the Grand Banks only three reports of ice were received during the month the southernmost of which was observed on the 21st in Latitude 47° 47′ N., Longitude 49° 32′ W.

September.—The only ice reported during the month were a few scattered bergs in the entrance to Belle Isle and on the track eastward to the 50th meridian.

October.—Two small bergs were reported on the 2nd in the entrance to Belle Isle Strait.

On October 3rd, S.S. *Rhexenor* reported a small growler about 4 feet in height and 20 feet in length in Latitude 36° 52′ N., Longitude 29° 13′ W. On the 4th, S.S. *Imperial Valley* reported a growler about 3 feet in height and 15 feet in length in Latitude 35° 15′ N., Longitude 29° 26′ W. These are both phenomenal positions in which to observe ice.

November.—The only ice reported during the month was a large berg on the northern track in Latitude 52° 35′ N., Longitude 52° 54′ W.

December.—No ice was reported in the Western North Atlantic during the month.

Within the Gulf of St. Lawrence ocean navigation closed for the season with the departure of the S.S. *August* from Montreal on December 8th.

On December 21st the Canadian Signal service reported the following ice conditions within the river and Gulf of St. Lawrence. "Montreal to Three Rivers frozen solid. Eastward to Saguenay River, light open ice everywhere, Eastward to west end of Anticosti heavy open and close packed ice everywhere. Some points eastward to Cape Ray and St. Pauls Island, no ice in sight.

The chart shows the monthly limits within which reports of ice have been received by the Meteorological Office during the year 1934, also the monthly limits reached by ice over the period 1901–1933.

The International Ice Patrol which is administered by the United States Coast Guard Service has now completed its 20th year, during which period not a life has been lost as a result of the ice menace to shipping in the Western North Atlantic.

During the ice season a cutter is always cruising on or in the vicinity of the Grand Banks locating the ice, determining its set and warning and advising approaching shipping. In addition, the patrol cutter renders assistance to vessels in distress, gives medical aid to crews of passing vessels if required, and removes obstructions to navigation.

The Patrol also obtains observations for the furtherance of oceanographic and meteorological research in the region of the Grand Bank. Surveys are also made of current and ice conditions in the Davis Strait, and with the accumulated data obtained by the Coast Guard Cutters since 1914 much has been learned of the movement and distribution of ice from its source to place of disintegration.

North Atlantic Lane Routes.

The suggestion that all ships engaged in the Trans-North Atlantic trade should follow separate routes when eastbound to those used when westbound, was first made by Commander F. M. Maury, U.S.N., in 1855, but it was not until 1875 that his suggestion was adopted. The Cunard Company then laid down specified routes which all their ships were ordered to follow.

On the recommendation of the United States Hydrographic Office these routes were amended in 1891, and seven years later the Trans-North Atlantic Conference was formed consisting of the principal International Shipping Companies engaged in the Trans-North Atlantic trade. The conference, working in conjunction with the United States Coast Guard, revise the tracks from time to time in accordance with Article 39 of the International Convention for the Safety of Life at Sea, 1929.

The tracks are shown on Admiralty Route Chart which is published in two sections.

Chart No. 2058 b showing lane routes south of Ireland and English Channel.

Chart No. 2058 c showing lane routes north of Ireland.

The section of the routes running through the ice region in operation for the month are shown on the ice chart published with each quarterly number and monthly supplement of The Marine Observer.

The particulars of the routes which were last revised in March, 1931, are as follows :—

United States.

Track "A" (Extra Southern).

Westbound.

Will only be brought into operation when necessity arises.

Steer from Fastnet or Bishop Rock on Great Circle course, but nothing South, **to cross the meridian of 47° 00′ W in Latitude 40° 30′ North** thence by either rhumb line or Great Circle to Boston Light Vessel or to a position South of Nantucket Light Vessel.

Eastbound.

Will only be brought into operation when necessity arises.

From the position of 70° 00′ West and 40° 10′ North, or from Boston, steer by rhumb line **to cross the meridian of 47°00′ West in Latitude 39°30′ North,** and from this last position nothing North of the Great Circle to Fastnet or Bishop Rock.

Track "B" (Southern).

Westbound.

From April 11th to June 30th (both days inclusive). Except when ice conditions necessitate the use of "A" Track.

Steer from Fastnet or Bishop Rock on Great Circle course, but nothing South, **to cross the meridian of 47° 00′ West in Latitude 41° 30′ North**, thence by either rhumb line or Great Circle to Boston Light Vessel, or to a position South of Nantucket Light Vessel.

Eastbound.

From April 11th to June 30th (both days inclusive). Except when ice conditions necessitate the use of A Track.

From the position of 70° 00′ West in 40° 10′ North, or from Boston, steer by rhumb line, **to cross the meridian of 47° 00′ West in Latitude 40° 30′ North**, and from this last position nothing North of the Great Circle to Fastnet or Bishop Rock.

Track C (Northern).

Westbound.

From July 1st to April 10th (both days inclusive). Except when ice conditions necessitate the use of B track.

Steer from Fastnet or Bishop Rock on Great Circle course, but nothing South, **to cross the meridian of 50° 00′ West in Latitude 43° 00′ North,** thence by either rhumb line or Great Circle to Boston Light Vessel, or to a position South of Nantucket Light Vessel.

Eastbound.

From July 1st to April 10th (both days inclusive). Except when ice conditions necessitate the use of B Track.

From the position of 70° 00′ West in 40° 10′ North, or from Boston, steer by rhumb line, **to cross the meridian of 50° 00′ West in Latitude 42° 00′ North,** and from this last position nothing North of the Great Circle to Fastnet or Bishop Rock.

General Instructions.

Vessels bound to or from United States ports **calling at Halifax** have the option of following either the Canadian or United States Seasonal Tracks to or from that port, passing 40 miles South of Sable Island Westbound and 60 miles South of Sable Island Eastbound when proceeding on U.S. Tracks and Canadian Track "D." When proceeding on Canadian Tracks "E" or "F" via Halifax, ships pass North of Sable Island both Westbound and Eastbound.

(Note.—General Instructions Canadian Tracks for vessels bound to or from the North of Ireland.)

Vessels bound direct to Portland (Marine) may follow the Canadian Seasonal Tracks.

When courses are changed at the iutersections of meridians any time before or after noon Commanders must note in their logs both distances to and from the meridians that the ship has sailed from noon to noon, and not the distance from the position at noon the day before to the position at noon the day after the meridian is crossed.

The date on which Tracks change is to apply to the meridian of the Fastnet for Westbound steamers and the meridian of 70° 00′ West for Eastbound vessels.

Communications on General Track matters between the British Lines will pass through the Cunard Line. The Holland America Line will communicate with the Continental Lines, excepting that, during the Ice Season, the Cunard Line will communicate direct with all Lines.

With regard to proposals for any changes in Tracks, owing to prevalence of ice, the Cunard–White Star Line in Liverpool will decide dates on which changes are to become operative, advising Lines by telegraph. Lines undertake to give immediate instructions to their steamers in accordance with such advices.

Canada.

Track "D."

From 15th February to 10th April (both days inclusive).

Westbound.

Steer from Fastnet, Inishtrahull, or Bishop Rock on Great Circle course **to cross the meridian of 50° West in Latitude 43° North,** thence to Halifax or other Port, passing not less than 40 miles south of Sable Island.

Eastbound.

Steer from Halifax or other port to pass 60 miles south of Sable Island **to cross the meridian of 50° West in Latitude 42° North,** thence on the Great Circle course to Fastnet, Inishtrahull, or Bishop Rock.

Track "E."

From 11th April to 15th May or until the Cape Race Route clear of ice, and December 1st to February 14th.

Westbound.

Steer from Fastnet, Inishtrahull, or Bishop Rock on the Great Circle course **to the meridian of 50° West in 45° 55′ North,** thence to Halifax or the Gulf of St. Lawrence.

(NOTE :—The Donaldson Line reserve the right to cross Longitude 45° West in Latitude 45° north on this track.)

Eastbound.

Steer from Halifax or the Gulf of St. Lawrence **to cross the meridian of 50° West in Latitude 45° 25′ North** thence on the Great Circle course to the Fastnet, Inishtrahull or Bishop Rock.

Track "F."

From 16th May to the opening of Belle Isle Route and to November 30th when not using the Belle Isle route.

Westbound.

Steer from Fastnet, Inishtrahull, or Bishop Rock, on a course 10 miles North of the Great Circle track until approaching Cape Race, then steer a course to pass 10 miles South of Cape Race, thence to Halifax or the Gulf of St. Lawrence.

Eastbound.

Steer from Halifax or the Gulf of St. Lawrence to a position 25 miles South of Cape Race thence on a course 10 miles south of the Great Circle track until approaching Fastnet, Inishtrahull, or Bishop Rock.

Track "G."

Belle Isle route.—From the opening of the Straits of Belle Isle to November 14th.

Westbound.

Steer from Fastnet, Inishtrahull, or Bishop Rock, on a course 10 miles north of the Great Circle track until approaching Belle Isle.

Eastbound.

Steer from Belle Isle on a course 10 miles South of the Great Circle track until approaching Fastnet, Inishtrahull, or Bishop Rock.

General Instructions.

Vessels bound to or from U.S. ports **from or to the north of Ireland** have the option of following either the U.S. or the Canadian Seasonal Tracks D, E and F, remaining on track F during the operative dates of Track G.

On tracks " E " and " F " vessels passing 40 miles south of Sable Island westbound thence to position south of Nantucket and Eastbound from position 40° 10′ North in 70° 00′ West to position 60 miles south of Sable Island.

On track " D " westbound proceeding by rhumb line from position 43° 00′ North in 50° 00′ West to position south of Nantucket and eastbound from position 40° 10′ North in 70° 00′ West to position 42° 00′ North in 50° 00′ West.

Commanders on encountering ice have permission to deviate from these tracks and after the end of October to leave the Belle Isle for the more southerly route at their discretion according to weather conditions. Should vessels on Track " C " bound to or from United States be deviated to Track " B " on account of ice, Canadian vessels will remain on Track " D " for the period prescribed but will have the above option of deviating as necessary in the vicinity of ice areas.

The Lines have the option of continuing the use of the Belle Isle route after November 14th should they wish to do so.

SOUTHERN ICE REPORTS

During the year 1934.

April.

Year.	Day.	Position of Ice. Latitude.	Longitude.	Description.	Remarks.	Name of Ship reporting.
1934	1	From 60° 51′ S. To Signy Island.	46° 20′ W.	Numerous bergs	...	R.R.S. *Discovery II*.
	2	Laurie Island.		Surrounded by heavy loose pack ice	...	do.
	3	South Orkneys.		Apparently surrounded with bergs, mostly aground.	...	do.
	4	60° 18′ S.	44° 58′ W.	Berg	Medium sized tabular within 1 mile of track	do.
		60° 17′ S.	44° 52′ W.	Berg	Small and irregular and within 3 miles of track	do.
	5	From 59° 10′ S. To 58° 51′ S.	44° 25′ W. 44° 25′ W.	4 bergs	3 irregular and one small tabular all within 2 miles of track	do.
		58° 39′ S.	44° 25′ W.	1 berg and 1 growler	Small and irregular berg	do.
		58° 29′ S.	44° 24′ W.	1 berg	Dark bottle green with the appearance of having overturned	do.
		58° 24′ S.	44° 24′ W.	1 berg	Shape irregular. Height 300 ft. by sextant angles	do.
		58° 20′ S.	44° 24′ W.	1 berg	Irregular and within 2 miles of track	
	9	52° 47′ S.	39° 18′ W.	1 berg	Small and irregular	do.
	20	54° 06′ S.	36° 16′ W.	2 small bergs and growler	Within 2 miles of track	do.
	21	From 53° 37′ S. To 53° 52′ S.	34° 11′ W. 33° 06′ W.	6 bergs and 3 small growlers	Within 5 miles of track. All small and irregular	do.
	21	From 53° 52′ S. To 53° 48′ S.	33° 06′ W. 32° 15′ W.	18 bergs and several growlers	Mostly small and irregular. Only one medium sized tabular	do.
		From 53° 48′ S. To 53° 45′ S.	32° 15′ W. 31° 09′ W.	9 bergs	Mostly small and irregular	do.
		From 53° 45′ S. To 53° 42′ S.	31° 09′ W. 30° 05′ W.	4 bergs	Small and irregular and within 2 miles of track	do.
	22	From 53° 38′ S. To 53° 35′ S.	28° 41′ W. 27° 42′ W.	6 bergs and 1 growler	This growler was a complete bottle green colour	do.
		From 53° 35′ S. To 53° 35′ S.	27° 42′ W. 26° 49′ W.	8 bergs	All within 3 miles of track. 3 medium tabular. Remainder irregular.	do.
		From 53° 35′ S. To 53° 40′ S.	26° 49′ W. 25° 49′ W.	13 bergs	Within 10 miles of track. Several small tabular	do.
	24	56° 11′ S.	22° 44′ W.	1 morainic berg	3 miles distant. This berg had a definite morainic deposit	do.
		56° 21′ S.	22° 41′ W.	2 bergs	Both irregular and within 2 miles of track	do.
		From 56° 21′ S. To 56° 34′ S.	22° 40′ W. 22° 40′ W.	3 bergs	All small and irregular and within 3 miles of track	do.
		From 56° 34′ S. To 56° 53′ S.	22° 40′ W. 22° 39′ W.	3 bergs	All small and irregular	do.
	25	57° 33′ S.	22° 30′ W.	1 berg	Irregular and about 1 mile distant	do.
		From 57° 41′ S. To 57° 48′ S.	22° 25′ W. 22° 18′ W.	15 bergs	3 small tabular. Remainder irregular	do.
		From 57° 48′ S. To 58° 33′ S.	22° 18′ W. 23° 47′ W.	7 bergs	All small and about 1 mile distant	do.
	26	59° 56′ S.	22° 37′ W.	3 bergs	Only one small tabular about 1 mile distant	do.
		From 60° 08′ S. To 60° 25′ S.	22° 20′ W. 22° 07′ W.	5 bergs	All small and within 3 miles of track	do.
		60° 38′ S.	22° 01′ W.	1 berg	Irregular and pinnacled. 165 ft. high by sextant angles	do.
		From 61° 00′ S. To 61° 19′ S.	21° 50′ W. 21° 39′ W.	6 bergs	Only one tabular. Remainder irregular and about 2 miles distant.	do.
	27	From 60° 31′ S. To 60° 24′ S.	18° 48′ W. 16° 06′ W.	6 bergs	Small and irregular	do.
		From 60° 24′ S. To 60° 19′ S.	16° 06′ W. 14° 14′ W.	4 bergs	Small and irregular	do.
	28	From 60° 18′ S. To 60° 10′ S.	13° 55′ W. 11° 30′ W.	6 bergs	One small tabular. Remainder irregular	do.
		From 60° 10′ S. To 60° 07′ S.	11° 30′ W. 9° 15′ W.	9 bergs. Several growlers	...	do.
	29	From 60° 03′ S. To 59° 57′ S.	7° 42′ W. 5° 42′ W.	4 bergs and 1 growler	Small and irregular	do.
		From 59° 57′ S. To 59° 51′ S.	5° 42′ W. 2° 21′ W.	4 bergs and 1 growler	Small and irregular	do.
	30	From 59° 44′ S. To 59° 44′ S.	2° 22′ W. 1° 35′ W.	2 bergs and 1 growler	...	do.
		59° 32′ S.	1° 46′ E.	4 bergs	One small tabular. Remainder irregular	do.
		From 59° 32′ S. To 59° 25′ S.	1° 46′ E. 3° 56′ E.	6 bergs and 1 grower	All small and weathered	do.

May.

Year.	Day.	Latitude.	Longitude.	Description.	Remarks.	Name of Ship reporting.
1934	1	From 59° 25′ S. To 59° 18′ S.	3° 59′ E. 6° 24′ E.	3 bergs	One tabular. Remainder irregular	R.R.S. *Discovery II*.
		From 59° 18′ S. To 59° 15′ S.	6° 24′ E. 7° 34′ E.	6 bergs and 1 growler	...	do.
		From 59° 15′ S. To 59° 08′ S.	7° 34′ E. 10° 01′ E.	8 bergs and several growlers	...	do.
	2	59° 05′ S.	11° 03′ E.	Several growlers	...	do.
		From 59° 05′ S. To 58° 58′ S.	11° 03′ E. 13° 32′ E.	11 bergs and 2 growlers	All weathered and of no great size	do.
		From 58° 58′ S. To 58° 48′ S.	13° 32′ E. 15° 47′ E.	14 bergs	All small and weathered. One had an almost straight morainic line just clear of the top.	do.
		58° 46′ S.	16° 11′ E.	1 berg	Small and pinnacled	do.
	3	58° 53′ S.	17° 05′ E.	2 bergy bits	...	do.
		From 59° 39′ S. To 59° 57′ S.	18° 31′ E. 19° 04′ E.	11 bergs and 4 growlers	All small and weathered	do.
		From 59° 57′ S. To 60° 13′ S.	19° 04′ E. 19° 37′ E.	11 bergs and several bergy bits	One of these bergs was remarkable for its deep green, bottle colour.	do.
	4	60° 50′ S.	21° 36′ E.	1 berg	Small and irregular	do.
	5	61° 38′ S.	25° 17′ E.	1 berg	Small and pinnacled	do.
		62° 00′ S.	27° 02′ E.	1 berg	Small and pinnacled	do.
	6	62° 42′ S.	30° 44′ E.	1 berg	Small and irregular	do.
		63° 37′ S.	35° 50′ E.	1 berg	Small and irregular	do.
	8	65° 03′ S.	42° 50′ E.	1 growler	At this time strong ice blink was observed to southward	do.
		64° 37′ S.	45° 23′ E.	1 growler and slush ice	...	do.
	9	From 64° 01′ S. To 63° 47′ S.	44° 08′ E. 44° 08′ E.	Slush ice	A continuous expanse of slush ice	do.
	11	58° 31′ S.	44° 44′ E.	2 bergs	Small and irregular	do.
		57° 46′ S.	44° 40′ E.	1 berg	Small and irregular	do.
		57° 18′ S.	44° 42′ E.	1 growler	...	do.
		57° 09′ S.	44° 43′ E.	1 berg and several growlers	Small and irregular NOTE.—All the icebergs seen on this voyage were small and weathered and at no time exceeded 1 cable in length.	do.
	26	56° 00′ S.	97° 00′ W.	Small berg	Sighted about 6 miles off	S.S. *Port Wellington*.

Reports of Ice previous to April, May and June, 1934, will be found in the Marine Observer Volume XI, No. 114, p. 69.

WIRELESS WEATHER SIGNALS.

I.—SHIPS' WIRELESS WEATHER SIGNALS.

A full description of the world wide system of voluntary "Selected Ships" routine weather reports with instructions was given on pp. 30–41 of the January number of this volume of THE MARINE OBSERVER.

The list which follows contains the latest information of stations to which "A Selected Ships" should report in accordance with those instructions, and stations detailed to intercept or receive reports from "B Selected Ships" also in accordance with those instructions.

To decode these reports, and for information of the system of communication of "Selected Ships", all concerned are referred to the PAMPHLET, M.O. 329, concerning which special notice to the masters of British ships will be found on p. 33, paragraph (27), and p. 34, paragraph (34) of the January 1935 number of THE MARINE OBSERVER.

WIRELESS STATIONS DETAILED TO RECEIVE ROUTINE CODED WEATHER REPORTS FROM "A SELECTED SHIPS."

Request for Information.

THE ATTENTION OF METEOROLOGICAL SERVICES IS INVITED TO THE INVITATION GIVEN ON PAGE 30 OF VOL. XII NO. 117, JANUARY 1935 MARINE OBSERVER.

Ocean.	Station.	Position.	Call Sign.	Frequency and Wave Length.		Area and limits covered by Station.	Telegraphic address of Meteorological Centre.	Information required—Limit of Groups.	Notes.
				For Station to call up "Selected Ships."	For "Selected Ships" to report to Station.				
North Atlantic and North Sea.	Portishead.	Lat. 51° 28′ 41″ N. Long. 2° 47′ 30″ W.	GKU.	149 kc/s. (2013 metres).	143 kc/s. (2100 metres).	North Sea and Eastern North Atlantic East of Longitude 40° W. and North of Latitude 38° N., but not within 300 miles of station. (*see* Chart of the World.)	Weather London.	Weather only, up to seven groups, preferably No. 3 Supplementary Groups.	Control system. "Selected Ships" chosen to report in given order notified by station daily at 2230, 0330, and 1030 G.M.T. Roll call thus—Weather London—call sign of chosen "Selected Ships" to report through GKU at schedule times on 2100 m.
	Chatham Mass.,	Lat. 41° 43′ N. Long. 70° 47′ W.	WCC.		142·9kc/s. (2098 metres).	North Atlantic West of Longitude 40° W.	Observer Washington	Weather only. First four groups of observations taken at 0000 and 1200 G.M.T. only required.	No control. All British "A Selected Ships" within area to address their 0000 and 1200 G.M.T. observations to Observer Washington and their 1800 G.M.T. observations to CQ in accordance with schedule.
	Sayville N.Y.	Lat. 40° 45′ N. Long. 73° 06′ W.	WSL.						
	Thomaston.	Lat. 44° 01′ N. Long. 69° 13′ W.	WAG.						
	Jupiter.	Lat. 26° 42′ N. Long. 80° 02′ W.	WMR.						
	Palm Beach.	Lat. 26° 42′ N. Long. 80° 02′ W.	WOE.						
Mediterranean and Red Sea.									
South Atlantic.	Slangkop (Cape Town)	Lat. 34° 08′ 46″ S. Long. 18° 19′ 18″E.	ZSC	—	143 kc/s. (2100 metres).	South Atlantic Westward of 25° E. and within a range of about 2,000 miles of station.	Met.	Weather only. Four universal groups and first group of No. 6 Supplementary groups.	No control. Only 0600 G.M.T. observation required. All British "A Selected Ships" within area should report, commencing at 0618 G.M.T.

WIRELESS STATIONS DETAILED TO RECEIVE ROUTINE CODED WEATHER REPORTS FROM "A SELECTED SHIPS."

(Continued.)

Ocean.	Station.	Position.	Call Sign.	Frequency and Wave Length. For Station to call up "Selected Ships."	Frequency and Wave Length. For "Selected Ships" to report to Station.	Area and limits covered by Station.	Telegraphic address of Meteorological Centre.	Information required—Limit of Groups.	Notes.
Indian Ocean.	Jacobs (Durban).	Lat. 29° 55′ 40″ S. Long. 30° 58′ 50″E.	ZSD	—	143 kc/s. (2100 metres).	Indian Ocean S. of 20° S. and Eastward of 25° E. and within a range of about 2,000 miles of station.	Met.	Weather only. Four universal groups and first group of No. 6 Supplementary groups.	No control. Only 0600 G.M.T. observations required. All British "A Selected Ships" within area should report, commencing at 0618 G.M.T.
	Bombay.	Lat. 19° 04′ 55″ N. Long. 72° 49′ 54″E.	VWB	—	143 kc/s. (2100 metres).	Arabian Sea N. of line C. Comorin to Ras Fartak.	Weather.	Weather only. No. 6 Supplementary groups.	All British "A Selected Ships" are requested, when convenient, to report 0000 G.M.T. observations commencing at 0018 G.M.T. in addition to schedule times.
	Madras.	Lat. 12° 59′ 17″ N. Long. 80° 10′ 56″E.	VWM	—	143 kc/s. (2100 metres).	Bay of Bengal N. of line C. Comorin to Achin Head.	Weather.	Weather only. No. 6 Supplementary groups.	All British "A Selected Ships" are requested, when convenient, to report 1200 G.M.T. observations commencing at 1218 G.M.T. in addition to schedule times.
	Colombo.	Lat. 6° 55′ 14″ N. Long. 79° 52′ 46″E.	VPB	130 kc/s. (2300 metres).	143 kc/s. (2100 metres).	Indian Ocean South of a line Ras Fartak, C. Comorin and Achin Head, and within a range of about 1500 miles.	Weather.	Weather only. No. 6 Supplementary groups preferred.	No control—all British "A Selected Ships" within area should report in accordance with Schedule.
	Mombasa.	Lat. 4° 03′ 11″ S. Long. 39° 39′ 49″E.	VPQ	—	125 kc/s. (2400 metres).	From Ras Hafun to Lat. 20° S. when westward of the Colombo area.	Weather Nairobi	Weather only. No. 6 Supplementary groups.	No control—all British "A Selected Ships" within area should report 0600 G.M.T. observations.
	Perth.	Lat. 32° 01′ 51″ S. Long.115° 49′31″E.	VIP	125 kc/s. (2400 metres).	143 kc/s. (2100 metres).	Indian Ocean and Southern Ocean between Long. 105° and 135° E.; but not within 100 miles of the coast.	Weather.	Weather only. No. 6 Supplementary groups.	No control—all British "A Selected Ships" within area should report in accordance with Schedule. Reports not required for observation times not starred on Chart, p. 32, of the January 1935 number.
North Pacific and China Sea.	Cape d'Aguilar, Hong Kong.	Lat. 22° 12′ 39″ N. Long.114°15′11″E.	VPS.	8330kc/s. (36 metres) or 500 kc/s. (600 metres).	143kc/s.* (2100 metres).	China Sea and North Pacific to about 1,500 miles from station.	Royal Observatory	Weather only, preferably No. 6 Supplementary Groups.	No control—all British "A Selected Ships" within area should report in accordance with Schedule. *Alternatively see particulars on p. 78 and use wave length and times for "B Selected Ships."
South Pacific.	Sydney.	Lat. 33° 46′ 00″ S. Long.151° 03′09″E.	VIS	125 kc/s. (2400 metres).	143 kc/s. (2100 metres).	S. Pacific Coral and Tasman Seas and Southern Ocean between Long. 135° and 160° E.; but not within 100 miles of the coast.	Weather.	Weather only. No. 6 Supplementary groups.	No control—all British "A Selected Ships" within area should report in accordance with Schedule. Reports not required for observation times not starred on Chart, p. 32, of the January 1935 number.
	New Zealand.	—	—	—	—	—	Weather Wellington.	Weather only, four universal groups.	The Meteorological Office Wellington, will be glad to receive routine reports from British Selected Ships within range of New Zealand W/T Stations through the normal commercial channels.

WIRELESS STATIONS DETAILED TO INTERCEPT ROUTINE CODED WEATHER REPORTS FROM "B SELECTED SHIPS."

In cases where routine weather reports made to CQ might not be received by the appropriate station within range, indicated in this list, they should be made to that station by call sign, but so that they may be readily intercepted by all ships. 600 m. is used throughout.

Ocean.	Station.	Position.	Call Sign.	Telegraphic address of Meteorological Centre desiring information.	Information desired.	Notes.
North Atlantic.						
South Atlantic.	Salinas	Lat. 0° 37′ 00″ S. Long. 47° 23′ 00″ W.	**PPL.**	Meteoro Rio	Weather only, including supplementary groups.	
	S. Luiz	Lat. 2° 31′ 28″ S. Long. 44° 16′ 30″ W.	**PXM.**			
	Fortaleza	Lat. 3° 42′ 49″ S. Long. 38° 30′ 56″ W.	**PPC.**			
	Natal	Lat. 5° 46′ 30″ S. Long. 35° 16′ 20″ W.	**PXN.**			
	Olinda	Lat. 8° 00′ 55″ S. Long. 34° 50′ 40″ W.	**PPO.**			
	Amaralina	Lat. 13° 00′ 50″ S. Long. 38° 28′ 27″ W.	**PPA.**			
	Abrolhos	Lat. 17° 57′ 35″ S. Long. 38° 42′ 00″ W.	**PXH.**			
	Victoria	Lat. 20° 18′ 52″ S. Long. 40° 19′ 06″ W.	**PPT.**			
	Rio	Lat. 22° 59′ 19″ S. Long. 43° 11′ 26″ W.	**PPR.**			
	Santos	Lat. 23° 59′ 22″ S. Long. 46° 18′ 18″ W.	**PPS.**			
	Florianopolis	Lat. 27° 35′ 22″ S. Long. 48° 34′ 17″ W.	**PPF.**			
	Juncçao	Lat. 32° 03′ 22″ S. Long. 52° 08′ 13″ W.	**PPJ.**			
Indian Ocean	Jacobs (Durban).	Lat. 29° 55′ 40″ S. Long. 30° 58′ 50″ E.	**ZSD**	Met.	Weather only, 4 universal groups and first group of No. 6 Supplementary groups.	
	Algoa Bay (Port Elizabeth).	Lat. 33° 57′ 16″ S. Long. 25° 35′ 30″ E.	**ZSQ**	Met.	Weather only, 4 universal groups and first group of No. 6 Supplementary groups.	
	Calcutta.	Lat. 22° 33′ 31″ N. Long. 88° 20′ 16″ E.	**VWC.**	Weather.	Weather only up to 6 groups, No. 6 Supplementary Groups preferred.	
	Rangoon.	Lat. 16° 45′ 57″ N. Long. 96° 11′ 51″ E.	**VTR.**			
	Madras.	Lat. 12° 59′ 17″ N. Long. 80° 10′ 56″ E.	**VWM.**			
	Bombay.	Lat. 19° 04′ 55″ N. Long. 72° 49′ 54″ E.	**VWB.**			
	Karachi.	Lat. 24° 51′ 05″ N. Long. 67° 02′ 32″ E.	**VWK.**			
	Matara.	Lat. 6° 01′ 07″ N. Long. 80° 35′ 39″ E.	**GZP.**			
	Mombasa.	Lat. 4° 03′ 11″ S. Long. 39° 39′ 49″ E.	**VPQ**	Weather Nairobi.		
	Dar-es-Salaam.	Lat. 6° 50′ 38″ S. Long. 39° 17′ 24″ E.	**ZBZ**	Weather Nairobi.		
	Mauritius.	Lat. 20° 23′ 41″ S. Long. 57° 35′ 25″ E.	**VRS.**	Observatory Mauritius.	Weather 4 universal groups and first of No. 6 Supplementary Groups.	
	Geraldton.	Lat. 28° 47′ 15″ S. Long. 114° 36′ 24″ E.	**VIN**	Weather.	Weather only, including No. 6 Supplementary Groups.	
	Esperance.	Lat. 33° 52′ 40″ S. Long. 121° 53′ 34″ E.	**VIE**			

WIRELESS STATIONS DETAILED TO INTERCEPT ROUTINE CODED WEATHER REPORTS FROM "B SELECTED SHIPS."

(*Continued.*)

In cases where routine weather reports made to CQ might not be received by the appropriate station within range, indicated in this list, they should be made to that station by call sign, but so that they may be readily intercepted by all ships. 600 m. is used throughout.

Ocean.	Station.	Position.	Call Sign.	Telegraphic address of Meteorological Centre desiring information.	Information desired.	Notes.
North Pacific and China Sea.	Cape d'Aguilar, Hong Kong.	Lat. 22° 12′ 39″ N. Long. 114° 15′ 11″E.	**VPS.**	Royal Observatory.	Weather only, preferably No. 6 Supplementary Groups.	
South Pacific.	Auckland.	Lat. 36° 50′ 37″ S. Long. 174° 46′ 08″E.	**ZLD.**	Weather Wellington.	Weather only, four universal groups.	The Meteorological Office, Wellington, will be glad to receive routine reports from British Selected Ships within range of New Zealand W/T Stations through the normal commercial channels.
	Wellington.	Lat. 41° 16′ 26″ S. Long. 174° 45′ 55″ E.	**ZLW.**			
	Awarua.	Lat. 46° 30′ 47″ S. Long. 168° 22′ 24″ E.	**ZLB.**			
	Chatham Island.	Lat. 43° 57′ 28″ S. Long. 176° 34′ 25″W.	**ZLC.**			
	Rarotonga.	Lat. 21° 11′ 52″ S. Long. 159° 48′ 52″W.	**ZKR.**			
	Apia.	Lat. 13° 50′ 17″ S. Long. 171° 49′ 42″W.	**ZMA.**			
	Thursday I.	Lat. 10° 35′ 14″ S. Long. 142° 12′ 43″ E.	**VII**	Weather.	Weather only, including No. 6 Supplementary Groups.	
	Townsville.	Lat. 19° 16′ 09″ S. Long. 146° 49′ 47″ E.	**VIT**			
	Brisbane.	Lat. 27° 25′ 34″ S. Long. 153° 07′ 19″ E.	**VIB**			
	Melbourne.	Lat. 37° 46′ 56″ S. Long. 144° 52′ 09″ E.	**VIM**			
	Adelaide.	Lat. 34° 51′ 14″ S. Long. 138° 31′ 55″ E.	**VIA**			

II.—WIRELESS WEATHER SIGNALS

Bulletins

It is necessary to make careful distinction between wireless weather reports and weather forecasts.

A wireless weather report is a statement, in plain language or code, of the observed conditions prevailing at a place at a given time.

A weather forecast is a statement, usually in plain language, of weather which may be expected at a place or over an area in the near future.

For forecasts issued to shipping by wireless it is usual to publish full descriptions giving abbreviated names of areas with prescribed limits and the length of period; if such published description is not given, the place, or area and the period to which the forecasts apply are included in the message.

BRITISH ISLES.

" WEATHER SHIPPING " BULLETIN.

C.W.

W/T Station, **Rugby.** Latitude 52° 21′ 59″ N. Longitude 1° 11′ 12″ W. Call Sign **G.B.R.**

Wavelength 18,750 metres C.W. (16 kc/s.).

Times of transmission 0910 G.M.T. and 2133 G.M.T.

The message issued at 0910 G.M.T. contains 0700 G.M.T. observations. The message issued at 2133 G.M.T. contains 1800 G.M.T. observations.

During the time of S.O.S. lookout, from 0915 to 0918 G.M.T. there will be a pause in the transmission of the signal.

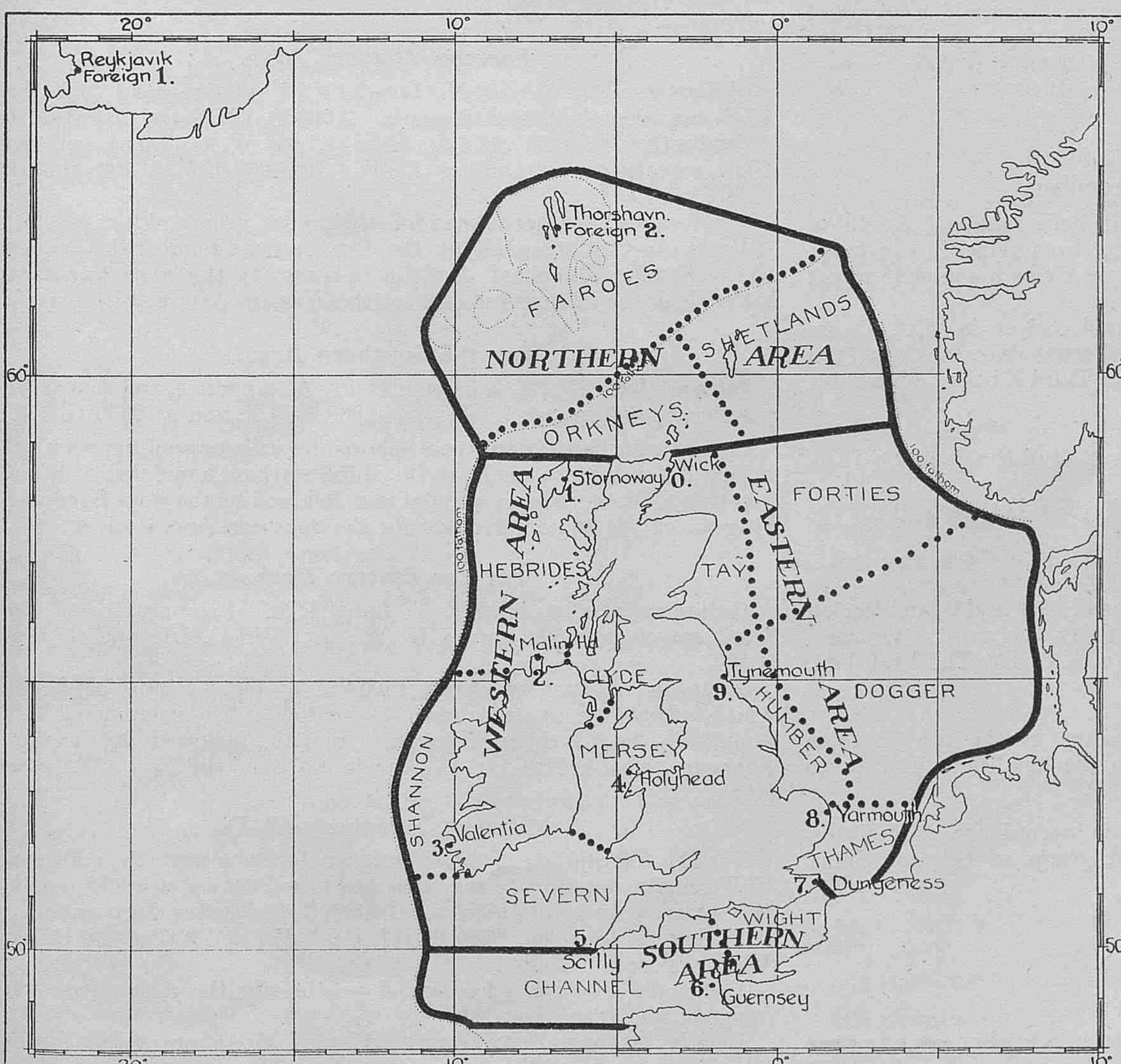
These messages are preceded by the words " Weather Shipping " and consist of seven parts. Part II is in code, the remaining parts in plain language.

Part I is a brief general statement which will generally provide information of the atmospheric pressure systems which influence the weather in the region dealt with by this Bulletin.

Part II is a weather report in code giving actual observations at ten British coast stations and two foreign stations.

For full information for decoding see next page, also the Pamphlet, M.O. 329, " DECODE FOR USE WITH THE INTERNATIONAL CODE FOR WIRELESS WEATHER MESSAGES FROM SHIPS, (Third Edition)," obtainable from H.M. Stationery Office, price 6d.

Chart showing Stations, Forecast Areas and Districts.



WESTERN AREA.

The sea and coasts eastward of the 100 fathom line from the latitude of Cape Wrath to Scilly.

DISTRICTS.

HEBRIDES—That part of Western which lies N. and W. of Bloody Foreland, Rathlin I. and Islay.

SHANNON—West coast of Ireland from Bloody Foreland to the Fastnet.

SEVERN—South coast of Ireland, Bristol Channel and approaches.

MERSEY—The Irish Sea and approaches.

CLYDE—The North Channel and approaches to Clyde.

SOUTHERN AREA.

The English Channel from S. Foreland to the 100 fathom line.

DISTRICTS.

CHANNEL—West of St. Albans.

WIGHT—East of St. Albans.

EASTERN AREA.

The North Sea southward of line Duncansby Head to Utsire to the Straits of Dover.

DISTRICTS.

THAMES—Thames estuary and its approaches.

HUMBER—East coast from Haisborough to Longstone.

TAY—East coast of Scotland, including Moray Firth.

FORTIES—Eastward to 100 fathom line and N. of Longstone to Naze.

DOGGER—Eastward to coast of Denmark and S. of line Longstone to Naze.

NORTHERN AREA.

Northward of latitude of Cape Wrath and of line Duncansby Head to Utsire, to the bank of soundings north of the Faroes in the west, and to north east extremity of the 100 fathom line in the east. Westward of the 100 fathom line to Bill Baileys Bank.

DISTRICTS.

ORKNEYS—Orkneys and north-westward to the 100 fathom line.

SHETLANDS—Shetlands and eastward to the 100 fathom line.

FAROES—That part of the Northern Area to the northward of the 100 fathom line.

Parts III, IV, V and VI are forecasts of wind and visibility for the 12 hours following the time of shore observations for the areas shown upon the Chart on p. 79.

Part VII commencing "Outlook" is a brief general statement of weather expected after the period of the forecasts.

NOTE.—In order to avoid ambiguity between the words Ireland and Iceland the latter word is always repeated whenever it occurs in Part I.

Explanation of Chart.

The numbers alongside the names of the stations indicate their code number (in the event of any station being substituted, the name of the substitute will be given in the message in place of this figure until such time as correction has been adequately made in Notices to Mariners and in THE MARINE OBSERVER).

The boundaries of the areas are defined by the plain black lines and the coast line.

These areas are sub-divided into districts, named after islands, rivers or banks within them, so that they may be readily memorised.

For instance the district in the neighbourhood of the Long Forties is termed "Forties."

The boundaries of these districts should only be taken as an approximate indication of their extent.

These districts are for the purpose of giving information of different weather within an area, without unduly lengthening the wording of a message. When similar weather is expected all over an area, these district names will not be used.

DESCRIPTION OF STATION REPORTS GIVEN IN PART II OF THE BULLETIN AND INSTRUCTIONS FOR DECODING.

These reports only contain an identifying number of the stations from which they originate, and just those elements which are most essential for the purpose of the mariner, viz., the true direction of the wind, and its force, the barometer and how it has recently changed, the visibility to seaward, and the weather.

The observations are made at fixed times, viz., 0700 G.M.T. and 1800 G.M.T.

Instructions for Decoding.

These reports are made by means of the code tables of the International Code for wireless weather messages from ships, in five figure groups which are paired, each pair of groups giving a complete report for a station.

To decode these stations' reports the tables given in M.O. 329 are required (DECODE FOR USE WITH THE INTERNATIONAL CODE FOR WIRELESS WEATHER MESSAGES FROM SHIPS (Third Edition), obtainable from H.M. Stationery Office, price 6d.).

The Key Letters of the International Ships Wireless Weather Telegraphy Code are fully described on page 38 of the January, 1935, number and in M.O. 329.

The following is a brief description of the Key Letters used for the station reports in this bulletin.

First Group of Pair :—I_NABBV meaning :—

I_N = Station. British stations from 1 to 9 and 0, and foreign stations 1 and 2, prefixed by the word "foreign" (*see* Chartlet), also page 27 of M.O. 329 (Third Edition).

A = Barometric tendency.

BB = Barometric pressure.

V = Visibility. Caution is necessary in the use of these visibility reports owing to the conditions of view to seaward at some stations.

Second Group of Pair is arranged, in accordance with International agreement, similar to the third group of Selected Ships' reports, *i.e.*

D D F w w

meaning :—

DD = Wind Direction.

F = Wind force.

w w = Weather.

In all cases when a figure cannot be given, a hyphen ▬ ▪ ▪ ▪ ▪ ▬ is given to preserve the order.

Sample Message.

(28th December, 1930.)

Call Sign :—*CQ CQ CQ GBR GBR GBR (repeated twice).*

Weather Shipping.

General Statement.—Deep depression north of Faroes moving slowly northeast stop Intense depression north-west of Ireland will probably move east-north-east.

Station Reports,

10877 20301 28856 09360 30868 20402 47935 17760 57996 18902 66117 16401 75127 20602 85106 18502 96977 16360 00898 18601 Foreign 12847 08102 22726 22660

Forecast.

Western Area. Hebrides wind moderate to strong south easterly or variable visibility moderate to good Shannon wind south westerly veering fresh to strong visibility good Clyde Mersey Severn southerly gale visibility moderate to good.

Southern Area. Southerly gale whole gale at times visibility moderate to good.

Eastern Area. Visibility moderate to good stop Forties wind southwest strong to gale backing and moderating then increasing remainder Eastern Area wind southerly increasing to gale whole gale in places.

Northern Area. Visibility moderate to good stop Faroes Orkneys wind southwest to west strong to gale then moderating and veering northwest Shetlands wind southwest strong to gale probably backing and moderating then increasing.

Outlook strong winds or gales.

I.C.W. and Spark.

Certain portions of the "Weather Shipping" Bulletin described above are broadcast by coast W/T stations on I.C.W. or spark as follows :—

For the Western Area.

Valentia. Lat. 51° 56′ N., Long. 10° 21′ W. (approx.), call sign **GCK,** wavelength 600 metres spark. At 0948 G.M.T. and 2048 G.M.T.

Seaforth. Lat. 53° 28′ N., Long. 3° 01′ W. (approx.), call sign **GLV,** wavelength 600 metres I.C.W. At 0930 G.M.T. and at 2030 G.M.T.

Commencing **Western Area** followed by ten groups of figures which indicate observations made at the five stations numbered 1 to 5 in the "Weather Shipping" Bulletin followed by the word **Forecast,** after which the 12-hour forecast for the Western Area will be given.

For the Southern Area.

Niton. Lat. 50° 35′ N., Long. 1° 17′ W. (approx.), call sign **GNI,** wavelength 600 metres I.C.W. At 0930 G.M.T. and at 2030 G.M.T.

Commencing **Southern Area** followed by six groups of figures which indicate observations made at the three stations numbered 5, 6 and 7 in the "Weather Shipping" Bulletin, followed by the word **Forecast,** after which the 12-hour forecast for the Southern Area is given.

For the Eastern Area.

Cullercoats. Lat. 55° 02′ N., Long. 1° 26′ W. (approx.), call sign **GCC,** wavelength 600 metres I.C.W. At 0948 G.M.T. and at 2048 G.M.T.

Commencing **Eastern Area,** followed by eight groups of figures which indicate observations made at the four stations numbered 7, 8, 9 and 0 in the "Weather Shipping" Bulletin, followed by the word **Forecast,** after which the 12-hour forecast for the Eastern Area is given.

Wireless Telephony (R/T).

For the information of small craft unable to receive the foregoing W/T signals, appropriate messages are broadcast by word of mouth, R/T from certain stations of the British Broadcasting Corporation.

During the forenoon, Parts I, III, IV, V, VI and VII of the British Weather Shipping Bulletin.

During the evening a forecast of weather for the regions near the coasts of the British Isles.

Details as to stations, wavelength and times are given in the "Radio Times" and the daily press.

WIRELESS GALE WARNINGS.

I.C.W. and spark.

Gale warnings are broadcast on a wave of 500 kc/s (600 m.), from the following W/T stations :—

Station.	*Call Sign.*	Lat. (approx.)	Long.	*Station.*	*Call Sign.*	Lat. (approx.).	Long.
Wick	**GKR**	58° 26′N.	3° 06′W.	**Lands End**	**GLD**	50° 07′N.	5° 40′W.
Humber	**GKZ**	53° 20′N.	0° 17′E.	**Valentia**	**GCK**	51° 56′N.	10° 21′W.
Niton	**GNI**	50° 35′N.	1° 17′W.	**Malin Head**	**GMH**	55° 22′N.	7° 20′W.

The warnings are broadcast from the station or stations appropriate to the area within which the gale is expected immediately upon receipt at the station, and also, when this time is outside the periods of single operator watch, at 18 minutes past the first hour, within the next such period. The date and time of origin is given in each warning.

Warnings are preceded by the W/T safety signal ▬ ▬ ▬ **(TTT)** repeated at short intervals ten times on full power. The warning is broadcast one minute later.

Example—" *Gale Warning Thursday* 1230 *G.M.T. Easterly Gale south of line Spurn head to Galway and in Dogger district.*"

Gale Warnings will only be broadcast when winds of gale force (force 8 of the Beaufort Scale) or above are expected; when a " whole gale " (force 10 or above) is expected this will be stated.

Wireless Telephony (R/T).

For the information of small craft unable to receive the foregoing **TTT** Gale Warning W/T signals, these messages are broadcast by word of mouth, R/T, from certain of the British Broadcasting Corporation's stations immediately after the Time Signals or with the routine weather messages.

III.—WIRELESS TIME SIGNALS.

C. W.

Rugby W/T Station, Lat. 52° 21′ 59″ N., Long. 1° 11′ 12″ W., call sign **GBR,** broadcasts Time Signals on a wavelength of 18,740 metres (C.W.) at 1000 and 1800 G.M.T. :—

System Used.—Modified rhythmic type as recommended by the International Time Commission of 1925, consisting of a series of 306 signals emitted in 300 seconds of Mean Time, the concluding signal being the exact hour.

In each series, Signals Nos. 1, 62, 123, 184, 245 and 306 are single dashes (▬) of 0·4 sec. duration and commence at the exact minute. Each dash is followed by 60 dots (•) of 0·1 sec. duration.

The commencement of successive signals, whether dot or dash, are equally spaced at intervals of 60/61 parts of one second of Mean Time, *i.e.* :—

G.M.T. h.	m.	s.	Signal.			
9 or 17	55	00	1st signal a dash (▬)	followed by 60 dots	(•••• etc.).	
,,	56	00	62nd	do.	do.	do.
,,	57	00	123rd	do.	do.	do.
,,	58	00	184th	do.	do.	do.
,,	59	00	245th	do.	do.	do.
10 or 18	00	00	306th signal, a dash (▬).			

This type of time signal will enable chronometer comparisons of extreme accuracy to be obtained, the method employed being to count the number of intervals from the first dash (▬) until coincidence occurs between one of the rhythmic signals and the beat of the chronometer. (There being two such coincidences, 29½ or 30½ seconds apart, every minute.)

It is not necessary actually to count the signals.

Write down :—

(1) The chronometer time of the tick (whole or half second) immediately preceding the *first* dash.

(2) The chronometer times of coincidences (seconds only need be written down).

The difference between these (the " Elapse Time ") increased by 0.5 sec. when it is not a whole number, gives the Rhythmic " Interval Number " from which the corresponding correction can be obtained.

Note.—An article entitled " Greenwich Time " describing how these signals are made, of great interest to navigators, will be found on pp. 159-167, Vol. V, No. 56.

SPECIAL SERVICE BY PAYMENT.

Additional Wireless Telegraphic and Land Line Services which are performed for shipping, with charges.

The following list indicates the information which may be obtained on request, at any time, night or day.

Weather Forecasts.

Special weather forecasts can be made at the Meteorological Office for a period of 24 hours for areas within the region contained between the parallels of 70° N. and 35° N. and between the meridians of 12° W. and the coast of the Continent of Europe.

Procedure for Ships at Sea.—Request weather forecast through the nearest coast W/T station in Great Britain or Ireland, specifying required date and area, and giving ship's name.

Charge.—7s. 6d.

Procedure for Shipowners and Masters of Ships in port about to sail.—Telephone to Meteorological Office (Telephone No. Holborn 3434, Extension 174) or send **reply paid** telegram to Weather, Phone, London (allowing 10 to 20 words as necessary for reply), requesting weather forecast and specifying date and area for which required, and address to which to be sent.

Charges—None, if the information is required immediately and the reply paid telegram covers the telegraphic charges.

If the information is required for a specified day in advance, or for a number of days, a registration fee of 6d. per week (minimum fee 6d.) in addition to cost of telegrams. In this case application for the forecasts may be made by letter.

Procedure for Salvage Officers and others requiring warning of gales or winds from specified directions, or particular kinds of weather.—Write to the Meteorological Office, London, stating the position or locality and the warnings required, with the period.

Charge.—2s. 6d. for each message, plus telegraphic charges.

Note.—For Home waters the Areas and Districts used in the British " Weather Shipping " Bulletin may be used with advantage to indicate the localities for which forecasts are required.

Weather Reports.

Information of the actual local weather conditions prevailing at any of the following stations may be obtained :—

Aberdeen.	Hoylake.	Southend.
*Bangor, Co. Down.	Inchkeith.	Spurn Head.
Barry Island.	Kildonan.	†St. Ann's Head.
Beachy Head.	Lizard.	St. Catherines Point.
*Broughness.	*Mumbles.	*Stornoway.
Cape Wrath.	Needles.	*Torr Head.
†Dover Pier.	*Rame Head.	†Tynemouth.
Dunnet Head.	†Portpatrick.	†Wick.
*Holyhead.	Prawle Point.	

*These stations cannot give information about barometric pressure.
†Reports from these stations include information as to the state of the sea.

Procedure for Ships at Sea.—Request through nearest W/T coast station in Great Britain or Ireland, specifying the name of the station for which observed weather conditions are required.

Charge.—7s. 6d.

GERMANY.

II.—WEATHER SHIPPING BULLETIN.

North Sea.

I.C.W.

Norddeich W/T station approximate Latitude 53° 36′ N., Longitude 7° 09′ E.

Call sign—**DAN.**

Wavelength—677 m. I.C.W.

Times of Transmission—1020 and 2130 G.M.T.

The message issued at 1020 is based on 0700 G.M.T. observations. The message issued at 2130 is based on 1800 G.M.T. observations.

The messages are preceded by the words "Seewetter Nordsee" and consist of two parts.

Part I is a weather report in code giving actual observations at the stations hereunder.

Station No.	*German Station.*	*Position.*	*Station No.*	*Foreign Station.*	*Position.*
0	Borkum Riff Lt.-V.	53° 46′ N., 6° 04′ E.	0	Helder ...	52° 58′ N., 4° 45′ E.
1	Heligoland ...	54° 11′ N., 7° 54′ E.	1	Hanstholm ...	57° 05′ N., 8° 35′ E.
2	Elbe Lt.-V. No. 1 ...	54° 01′ N., 8° 13′ E.	2	Krakenes ...	62° 02′ N., 4° 59′ E.
3	Amrum Bank Lt.-V.	54° 33′ N., 7° 53′ E.	3	Aberdeen ...	57° 10′ N., 2° 06′ W.

The foreign stations' observations are preceded by the word "Ausland" (Foreign). The Key and Code used is exactly the same as that used for the British "Weather Shipping" Bulletin see page 80.

Part II contains a brief statement of weather conditions followed by a forecast for the following 24 hours in German, covering the whole sea area off East and North Frisian coasts including Ostfriesland (between Borkum Riff Lt.-V., Elbe entrance and Heligoland) and Nordfriesland (Elbe entrance northward to Ellenbogen, Sylt).

Western, Middle and Eastern Baltic.

I.C.W.

Rügen W/T station, approximate Latitude 54° 35′ N., Longitude. 13° 37′ E.

Call sign—**DAS.**

Wavelength—636 m. I.C.W.

Times of transmission—1030 and 2150 G.M.T.

The message issued at 1030 G.M.T. is based on 0700 G.M.T. observations. The message issued at 2150 G.M.T. is based on 1800 G.M.T. observations.

The messages are preceded by the words "Seewetter Rügen" and consist of two parts.

Part I is a weather report in code giving actual observations at the stations hereunder.

Station No.	*German Station.*	*Position.*	*Station No.*	*Foreign Station.*	*Position.*
4	Bulk	54° 27′ N., 10° 12′ E.	4	Skagen ...	54° 42′ N., 10° 33′ E.
5	Fehmarnbelt Lt.-V.	54° 36′ N., 11° 09′ E.	5	Copenhagen ...	55° 42′ N., 12° 37′ E.
6	Aldergrund Lt.-V.	54° 50′ N., 14° 22′ E.	6	Visby	57° 39′ N., 18° 18′ E.
7	Arkona	54° 41′ N., 13° 26′ E.	7	Memel	55° 42′ N., 21° 10′ E.
8	Leba	54° 46′ N., 17° 33′ E.			
9	Brusterort... ...	54° 58′ N., 19° 59′ E.			

The foreign stations' observations are preceded by the word "Ausland" (Foreign).

Key and Code as above.

Part II contains a brief statement of weather conditions followed by a forecast for the following 24 hours in German.

WIRELESS GALE WARNINGS.

I.C.W.

Gale Warnings are broadcast in German, preceded by the word "Funksturm," giving the nature of the atmospheric distribution with direction and force of wind for the regions specified by the stations indicated below.

W/T Station	Call Sign.	Position. Latitude N.	Position. Longitude E.	Wavelength.	Time of Transmission.	Region.
Norddeich	**DAN**	53°36′	7°09′	600 m. I.C.W. 677 m. I.C.W.	On receipt 0520, 1020* 1630, 2130*	North Sea.
Rügen	**DAS**	54°35′	13°37′	600 m. I.C.W. 636 m. I.C.W.	On receipt 0530, 1030* 1650, 2150*	Baltic — Flensburgh to Memel.

* After Weather Bulletin.

IV.—WIRELESS ICE WARNINGS.

C.W. and I.C.W.

Norddeich W/T Station, call sign **DAN,** broadcasts, when necessary, except Sundays, information of ice conditions along the German coasts in the North Sea and Baltic in a local code.

The message is transmitted at 0950 G.M.T. on a wavelength of 2400m. C.W.

Rügen W/T Station, call sign **DAS,** broadcasts ice warnings similar to above at 1030 G.M.T. on a wavelength of 636 m. I.C.W.

SWEDEN.

II.—WEATHER SHIPPING BULLETIN.

North Sea and Baltic.

C.W.

Karlsborg W/T Station, approximate Latitude 58° 29′ N., Longitude 14° 29′ E.

Call sign—**SAJ.**

Wavelength—4267 m. C.W.

Times of transmission—1050 and 2230 G.M.T.

The message issued at 1050 is based on 0700 G.M.T. observations.

The message issued at 2230 is based on 1800 G.M.T. observations.

The messages are preceded by the words "Weather Report" and consist of five parts.

Part I is a weather report in code giving actual observations at the stations hereunder :—

List of Observation Stations.

Index Number.	*Station.*	*Position (approx.) Latitude N.*	*Longitude E.*
1	Kalmar	56°39′	16°22′
2	Bjurö klubb	64°28′	21°34′
3	Holmögadd	63°35′	20°45′
4	Bremö	62°13′	17°44′
5	Orskär	60°31′	18°22′
6	Sandhamn	59°17′	18°55′
7	Visby	57°39′	18°18′
8	Skanör	55°24′	12°49′
9	Kullen	56°18′	12°27′
0	Vinga	57°38′	11°36′
1	Hammershus	55°19′	14°47′
2	Hanstholm	57°07′	8°36′
3	Utsira	59°18′	4°53′
4	Krakenes	62°03′	4°59′

The key and code used is exactly the same as that used for the British "Weather Shipping" Bulletin, see page 80.

Part II, en clair (English).

A statement of weather conditions in N. and N.W. Europe and adjacent seas.

Part III, en clair (English).

Weather forecasts for 12 hours for the following areas :—

1 Eastern part of the North Sea (E. of Longitude 5° E.).
2 Sweden, West Coast (Skagerrak, Kattegat and the Sound).
3 Baltic (Southern Baltic; South Skane, Bleking and Oland; Northern Baltic; East Gotaland, Svealand and Gotland).
4 Gulf of Bothnia (Bothnia Sea; Bothnia Bay).

Part IV, en clair (English).

Gale warnings for areas 2, 3 and 4 (above), for particulars, see below.

WIRELESS GALE WARNINGS.

Baltic.

C.W.

Karlsborg W/T station broadcasts warnings, *en clair*, English, of gales for the areas given in Part III of the Weather Shipping Bulletin.

The warnings commence with the words "Gale Warnings" and are valid for the ensuing 24 hours. They form Part IV of the weather bulletins broadcast by **Karlsborg W/T** at 1050 and 2230 G.M.T., explained above.

IV.—WIRELESS ICE WARNINGS.

Swedish Ice Breaker.

C.W., I.C.W. and R/T.

The Swedish Government ice breakers broadcast information in **English** on a wavelength of 600 metres, giving their position, proposed area for ice breaking and rendering assistance during the ensuing 12 hours. Important local information for mariners will also be broadcast.

The messages are broadcast daily, during the time the vessels are employed on ice-breaking service.

The message will be repeated by wireless telephony on a wavelength of 600 metres R/T, in Swedish and English immediately after the transmission on I.C.W. The repetition will be preceded by the words "Fran svenska statens isbrytarfartyg" (from the Swedish State ice breaking vessel).

Ice breaker "Ymer," call sign **SBPN**, at 0800 and 1045 G.M.T. on weekdays and 1210 G.M.T. on Sundays and holidays.

Ice breaker "Atle," call sign **SBLN,** at 0815 and 1100 G.M.T. on weekdays and 1225 G.M.T. on Sundays and holidays.

NORWAY.

II.—WIRELESS GALE WARNINGS.

I.C.W. and R/T.

The following stations broadcast gale warnings for the coast of Norway.

Station.	Call Sign.	Position.		Wavelength.	Times of transmission G.M.T.	Region.
		Latitude N.	Longitude E.			
Flekkeroy	**LGY**	58°04′	8°00′	600m. C.W.	1025, 1620, 2120	S. of Kristiansand.
Utsira ...	**LGK**	59°18′	4°55′	600m. I.C.W.	1200, 1600 1800, 2100	Lindesnes to Hellisöy Lt. Ho.
Alesund ...	**LGA**	62°28′	6°10′	600m. I.C.W.	1150	Sonefjord to Rorvik.
Röst ... (1st Dec. to 1st Apr.)	**LGR**	67°30′	12°05′	600m. R/T	1200, 2030 (Sundays 2030)	Lofoten, Helgeland, Salten.
Tromsöy ...	**LMT**	69°39′	18°58′	1100m. C.W. 1100m. R/T	1025, 1145, 1545, 2015	Northern Norway, Rorvik to Grense Jakobselva.

DENMARK.

IV.—WIRELESS ICE WARNINGS.

Danish Waterways.

I.C.W.

The following W/T stations broadcast a summary of ice conditions in Danish waterways, *en clair* (English). Wavelength 600 metres, I.C.W.

Blaavand W/T station, approximate Latitude 55° 33′ N., Longitude 8° 05′ E., call sign **OXB,** at 0100 and 1300 G.M.T.

Copenhagen W/T station, approximate Latitude 55° 41′ N., Longitude 12° 37′ E., call sign **OXA** at 1100 and 2300 G.M.T.

LATVIA.

IV.—WIRELESS ICE WARNINGS.

Wireless Telephony (R/T).

The broadcasting station at Riga, Latitude 56° 57′ N., Longitude 24° 02′ E., call sign **YLZ,** broadcasts in winter, on a wavelength of 514.6 metres R/T, ice reports at 0650, 1035 and 2000 G.M.T. The reports contain information concerning ice and navigation conditions for the Latvian coast. They are broadcast in the Latvian, ENGLISH and German languages.

ESTONIA.

IV.—WIRELESS ICE WARNINGS.

C.W.

Tallinn W/T Station. approximate Latitude 58° 56′ N., Longitude 23° 32′ E., call sign **ESA** broadcasts, on the first appearance of ice, information of ice conditions in Estonian waters in a local code.

The message is transmitted at 0940 G.M.T. on a wavelength of 3508m. C.W.

FINLAND.

II.—WIRELESS GALE WARNINGS.

I.C.W. and R/T.

The following stations broadcast Gale Warnings when necessary *en clair*, in **English,** at the times and wavelengths given below, the message commencing with the International Safety Signal "TTT Gale Warning."

Station.	Call Sign.	Position.		Wavelength.	Times of Transmission G.M.T.
		Latitude N.	Longitude E.		
Viipuri (Viborg)	**OHP**	60°43′	28°45′	600m. I.C.W. 750m. R/T	1230 and 2030 1235 and 2035
Hango	**OHD**	59°50′	22°56′	600m. I.C.W.	1210 and 1755
	OFK	,,	,,	750m. R/T	1205 and 1750
Vaasa	**OHX**	63°07′	21°37′	600m. I.C.W. 750m. R/T	1225 and 1800 1220 and 1755

Example of message—"TTT Gale Warning. Southwest gale expected up to about next morning between Aland and Helsinki."

IV.—WIRELESS ICE WARNINGS.

C.W.

Helsingfors W/T Station, approximate Latitude 60° 09′ N., Longitude 25° 02′ E., call sign **OHA** broadcasts, when necessary, information of ice conditions for the coasts of Finland in a local code.

The messages are transmitted at 1030 and 1410 G.M.T. on a wavelength of 3750m. C.W.

HOLLAND.

II.—WIRELESS GALE WARNINGS.

North Sea.

I.C.W.

Scheveningen W/T Station, Latitude 52° 06′ N., Longitude 4° 16′ E. (approx.), call sign **PCH**, makes gale warnings on receipt and following the end of the next compulsory 3 minutes' silent period, both in Dutch and English, and also at 1230 and 2030 G.M.T. Wavelength used is 600 metres (I.C.W.).

The warning commences with the letters **"KNMI,"** and is transmitted first slowly and then repeated quickly.

IV.—WIRELESS ICE WARNINGS.

I.C.W.

Scheveningen W/T Station, call sign **PCH,** broadcasts, when necessary, information of ice conditions in certain Dutch harbours and approaches, daily as follows :—

At 1230 and 2030 G.M.T. after the Storm Warning (if issued). Wavelength 600 metres (I.C.W.).

The ice report is broadcast in a local code and will contain the ice conditions for the following harbours :—

Delfzijl (Ems).	Helder (Zuider Zee).
Harlingen (Zuider Zee).	Rotterdam (Waterway).
Amsterdam (North Sea Canal).	Dordrecht (North).
Zaandam (Voorzaan).	Dordrecht (Mallegat).

The report commences with the words "Ijsbericht, Ice report."

The broadcast of the ice reports will begin when navigation is closed to small steamers and seagoing motor vessels at any of the harbours mentioned in the list, and will cease when navigation is re-opened.

FRANCE.

II.—WIRELESS GALE WARNINGS.

The following W/T stations broadcast gale warnings concerning the areas "Manche," "Bretagne," "Océan," and "Gascogne" :—

Cherbourg-Rouges Terres ... ... Approximate Latitude 49° 37′ N., Longitude 1° 36′ W., call sign **FUC.**

Brest-Mengam ... Approximate Latitude 48° 21′ N., Longitude 4° 35′ W., call sign **FUE.**

Lorient-Pen-Mané Approximate Latitude 47° 44′ N., Longitude 3° 21′ W., call sign **FUN.**

Rochefort-Soubise Approximate Latitude 45° 56′ N., Longitude 0° 59′ W., call sign **FES.**

The following W/T stations broadcast storm warnings concerning the areas "Roussillon," "Provence," "Rhône," and "Corse" :—

Toulon-Mourillon Approximate Latitude 43° 07′ N., Longitude 5° 55′ E., call sign **FUT.**

Ajaccio-Aspretto Approximate Latitude 41° 56′ N., Longitude 8° 46′ E., call sign **FUI.**

The W/T stations transmit the warning on the 600 metre wavelength as soon as it is received. The International Safety Signal ▬ ▬ ▬ **(TTT)** is first sent out, followed by D.E. and station call sign. This transmission commences towards the end of one of the international three-minute silent periods and the nature of the warning is sent immediately after the end of the silent period. The message is repeated after several minutes.

When the time of sending falls outside a single operator watch on board ship the message is repeated at the commencement of the succeeding watch.

C.W.

Eiffel Tower W/T Station, approximate Latitude 48° 51′ N., Longitude 2° 18′ E., call sign **FLE,** broadcasts wireless gale warnings on a wavelength of 7,200 m. C.W.

The warnings are broadcast if the forecasts indicate that the wind force is likely to exceed 7 on the Beaufort scale.

The signals refer to the following French coastal areas :—

Manche, Bretagne, Océan, Gascogne, Roussillon, Rhône, Provence, Corse.

The limits of the areas mentioned above are as follows :—

"Manche" ...	Belgian frontier to and including Carteret.
"Bretagne" ...	From and including Cherbourg to estuary of Loire.
"Océan" ...	From and including Lorient to the Gironde.
"Gascogne" ...	From and including Ile de Ré to Spanish frontier.
"Roussillon" ...	From Spanish frontier to and including Cette.
"Rhône" ...	From and including Cette to Camarat.
"Provence" ...	From and including Camarat to Italian frontier.
"Corse"... ...	All the coasts of Corsica.

Form of Message.

The warnings are sent *en clair* in French, and are valid for 24 hours from the time indicated in the message.

They commence with the name of the day of the week, the time from which the validity of the warning is reckoned, the name of area threatened followed by the word "Tempête" and the probable direction from which the gale may be expected.

Example.

"*Jeudi* 15 *heures Manche tempête, Nord-Ouest* (*N.W.*)."

Explanation.

From Tuesday until 1500 to-morrow a gale (Force 7 or over Beaufort) and from a direction between North and West will threaten all parts of the coast between the Belgian frontier and Carteret.

PORTUGAL.

II.—WIRELESS WEATHER BULLETINS.

Containing meteorological conditions at Madeira and Azores.

I.C.W. and R/T.

Monsanto W/T Station, approximate Latitude 38° 44′ N., Longitude 9° 11′ W., call sign **CTV,** broadcasts a meteorological report *en clair*, in Portuguese and English at 0000, 1130 and 2300 G.M.T. on a wavelength of 760 metres (I.C.W.) and at 1155 and 2325 G.M.T. on a wavelength of 760 metres (R/T), giving :—

Observations of wind and swell, also a forecast for the next 24 hours of wind and swell for the coast of Portugal. The coast is divided as follows :—

Zona Norte...	From River Minho to Cape Mondego.
Zona Centro	From Cape Mondego to Cape St. Vincent.
Zona Sul ...	Cape of Algarve (southern coast).

The messages are based upon observations of 0700 or 1800 G.M.T.

MOROCCO.

II.—WIRELESS GALE WARNINGS.

Spark.

Casablanca—Chetaba W/T Station, approximate Latitude 33° 37′ N., Longitude 7° 37′ W., call sign **CNP,** broadcasts gale warnings when necessary on 600 m. spark. They are broadcast *en clair* in French and repeated at the commencement of the following watch for single operators. The area affected is given in the message.

The message is preceded by the International Safety Signal **(TTT)** ▬ ▬ ▬

AZORES.

II.—WIRELESS WEATHER BULLETIN.

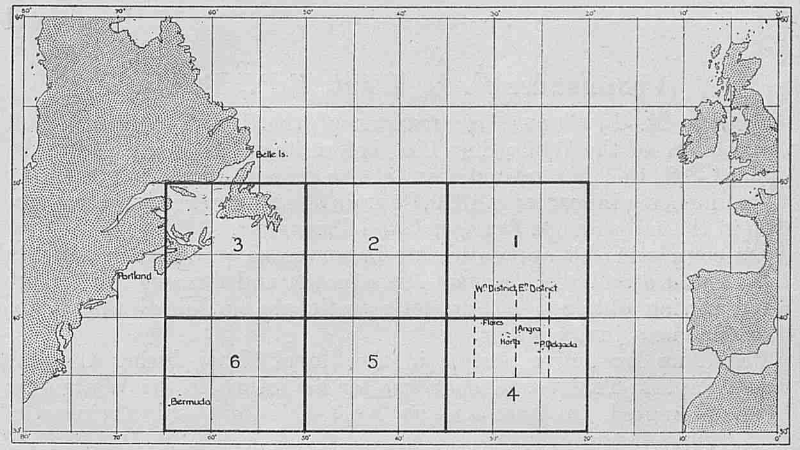
C.W. and Spark.

Horta W/T Station, Latitude 38° 32′ N., Longitude 28° 38′ W. (approx.), call signs :—

CTH, Wavelength 600 m. spark. Time of transmission 2000 G.M.T.
CTG, Wavelength 2400 m. C.W. Time of transmission 2030 G.M.T.

This weather bulletin is sent *en clair* in Portuguese and repeated in English, the time of observation upon which the forecasts are based being stated in the message.

The zones referred to are indicated in the chart below.



PERSONNEL.

The Marine Superintendent will be glad to receive information of distinctions gained and retirements, &c., of Marine Observers.

Commander J. G. P. Bisset, R.D., R.N.R.

Captain J. G. P. Bisset, commanding the Cunard/White Star S.S. *Ascania*, has been awarded the Liverpool Shipwreck and Humane Society's silver medal and illuminated certificate for the part he played in rescuing the crew of the British S.S. *Usworth* in the North Atlantic in December last.

A Bronze Plaque has also been awarded by Lloyd's to the ship.

Lieutenant E. J. R. Pollitt, R.N.R.

Lieutenant E. J. R. Pollitt, 3rd Officer, who was in charge of *Ascania's* lifeboat sent to the rescue of *Usworth's* crew, has been awarded Lloyd's silver medal, also the silver medal of the Liverpool Shipwreck and Humane Society, together with an illuminated certificate and inscribed barometer and clock.

Each member of *Ascania's* boat's crew was awarded Lloyd's bronze medal, together with the Liverpool shipwreck and Humane Society's silver medal and illuminated certificate.

Captain J. W. Binks.

Captain J. W. Binks, commander of the R.M.S. *Olympic*, has retired from active service afloat. Commencing his apprenticeship in sail at the age of 15, Captain Binks has served 45 years afloat and has commanded several vessels of the White Star (now Cunard/White Star) fleet, including the *Delphic, Atheric, Baltic, Adriatic, Doric, Calgaric, Laurentic, Georgic,* and *Olympic.*

Captain J. M. Draper.

Captain J. M. Draper, late master of the Elder Dempster R.M.S. *Appam*, has retired from active service afloat.

Captain Draper served his apprenticeship in the Barques *Valdivia* and *Borrowdale*, employed in the West Coast of South America trade. On obtaining his second mate's certificate he joined the Elder Dempster Line as fourth officer, and rising through the different grades was appointed to his first command in 1917, since when he has commanded a number of ships in the Elder Dempster Fleet.

Commander C. P. Freeman, R.D., R.N.R.

Captain C. P. Freeman, commander of the R.M.S. *Adriatic*, has retired after nearly 38 years' service with the White Star (now Cunard/ White Star) Line.

After serving his apprenticeship in sailing vessels owned by Messrs. Gracie, Beazley & Co. and Messrs. James Chambers & Co., Captain Freeman subsequently served in the ship *Belpore*, which was dismasted and lost off Cape Horn, and in the Barque *R. N. Calderon.*

On obtaining his master's certificate he joined the White Star Line and since rising to command has had in his charge a number of their ships, including the *Welshman, Corinthic, Doric, Cedric, Britannic, Georgic, Laurentic* and *Adriatic.*

Captain S. J. Furneaux.

Captain S. J. Furneaux, commander of the Furness Withy liner *Nova Scotia*, has retired after 39 years' service with the company.

At the age of 15 he was apprenticed to Messrs. J. & J. Rae & Co., of Liverpool, and served in their barque *Craignair*. In 1895 he joined the Furness Withy Line as 3rd officer, and seven years later was appointed to command, his first ship being the *London City*. Since then he has commanded several vessels in the Furness Withy Fleet and was for a while the Company's Marine Superintendent at Philadelphia.

Captain W. Keasley.

Captain W. Keasley has retired from the service of the Ellerman Hall Line after 44 years' service afloat, of which 30 years were spent in command.

He commenced his career in 1890 as an apprentice in sailing ships owned by Messrs. Shaw, Savill and Albion. On completing his apprenticeship he continued in sail, serving in the ships *Invercargill, Margaret Galbraith* and the barque *Lutterworth.*

On obtaining his master's certificate in 1897 he entered Messrs. Bucknall Bros'. employ as a 3rd officer and obtained his first command in 1904. After the war he was transferred from the Ellerman and Bucknall Line to the Ellerman Hall Line, with whom he continued to serve up to the time of his retirement.

Commander M. F. Murray, R.D., R.N.R.

Captain M. F. Murray, commander of the R.M.S. *Montrose*, has retired from the sea after 45 years' service afloat.

Commencing his career in 1892, he served his apprenticeship in Messrs. J. B. Walmsley's full rigged ship *Hartfield*, and later served as second mate of the barque *Invercol* and ship *British Empire.*

On leaving sail for steam he at first joined the White Star Line, but transferred to the Canadian Pacific Steam Ship Co. in 1903. He was promoted to master shortly after his return to the Company at the end of the Great War, and has since commanded the *Batsford, Bolingbroke, Holbrooke, Bothwell, Metagama, Montrose* and *Montclare.*

Captain E. W. Sutherland.

Captain E. W. Sutherland, of Messrs. Furness, Withy & Co., has retired from active service afloat after 48 years 'sea service.

After serving his apprenticeship in Messrs. H. Fernie & Sons' ship *Laomene*, he subsequently served as second mate and mate of the ships *Pythomene* and *Aristomene* belonging to the same owners.

On obtaining his master's certificate Captain Sutherland transferred to steam, joining the Johnston Line as third officer in 1899. When the Johnston Line was taken over by Messrs. Furness, Withy & Co., in 1916, Captain Sutherland, then in command, transferred to the new company, whom he continued to serve throughout his career.

Personnel : *continued*

Commander E. L. Trant, R.D., R.N.R.

Captain E. L. TRANT, commander of the R.M.S. *Majestic* and Commodore of the White Star Line before its recent merger with the Cunard S.S. Co., has retired from active service afloat.

Commencing his career in 1890, Captain TRANT served his apprenticeship in the sailing ships *Drumpark* and *Drummuir*.

On completing his apprenticeship he served as an officer in the ship *King Edward* and the steamers *Armathwaite* and *Beneroy* until 1898, when having obtained his master's certificate he joined the White Star Line as a junior officer.

Called up for active service in the Royal Navy during the war years, Captain TRANT was, shortly after his return to the White Star Line, promoted to command in 1919, his first ship being the *Cornishman.* Since then he has had charge of several ships of the White Star fleet, including the *Runic*, *Cedric*, *Ceramic*, *Adriatic*, *Megantic*, *Laurentic*, *Olympic* and *Majestic.*

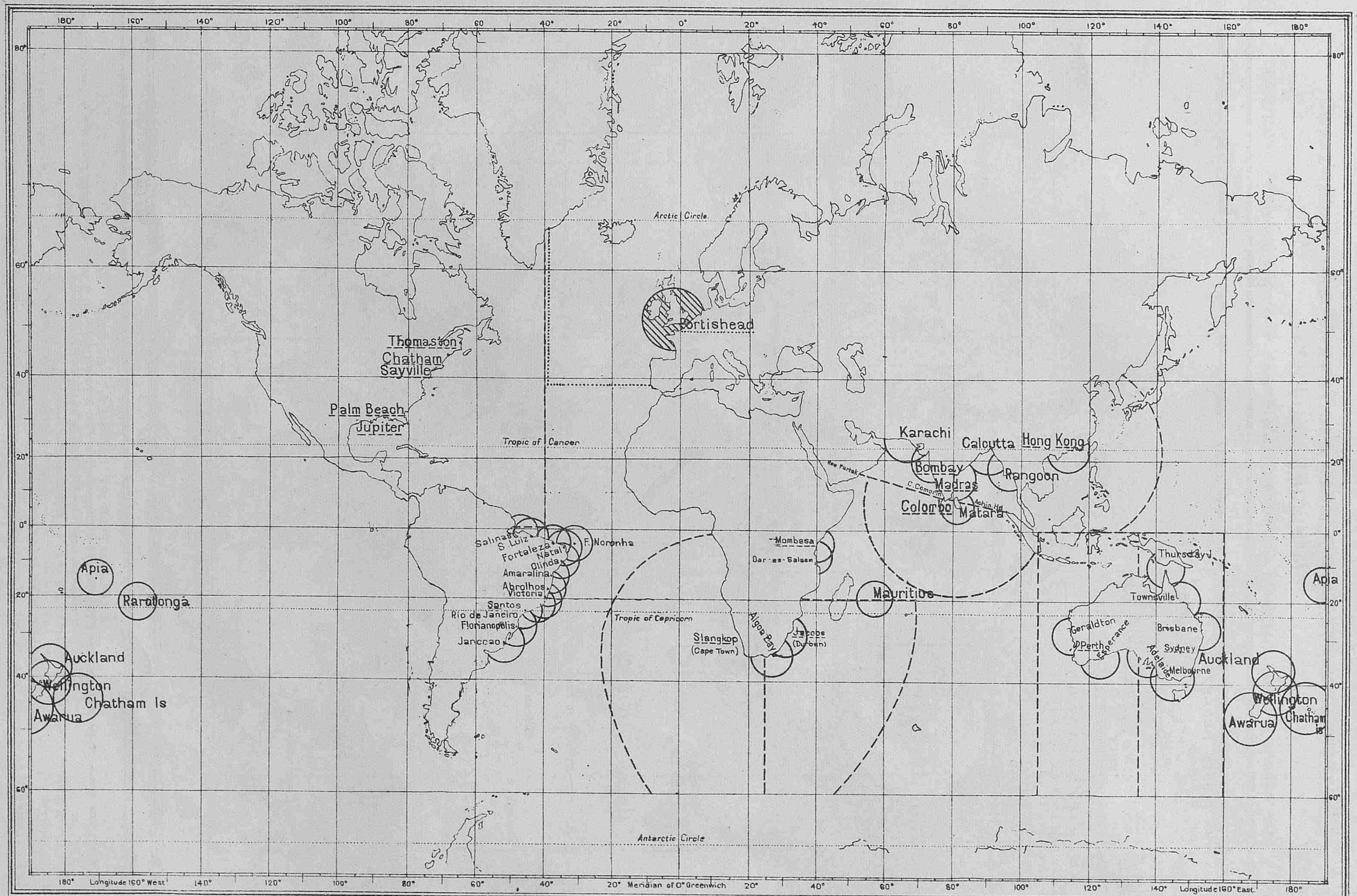
Captain J. Willits, R.D., R.N.R.

Captain J. WILLITS, commander of the S.S. *Clan Mackay*, has retired from active service afloat after 33 years' service with the Clan Line.

After serving his apprenticeship in the ship *Netherby* he sailed as an officer in that ship and in the ship *M. E. Watson* before joining the General Steam Navigation Company. In 1902 he joined the Clan Line, and for the past nine years has held command of the *Clan Lindsay* and *Clan Mackay.*

SHIPS' WIRELESS WEATHER SIGNALS.
CHART OF THE WORLD.

Stations for Reception of Routine Wireless Weather Reports from "Selected Ships".



The dotted line indicates the area in which British "A Selected Ships" report under control to Portishead

A pecked line indicates the reporting area round stations in other countries to which British "A Selected Ships" should report. The names of such stations being underlined with a pecked line

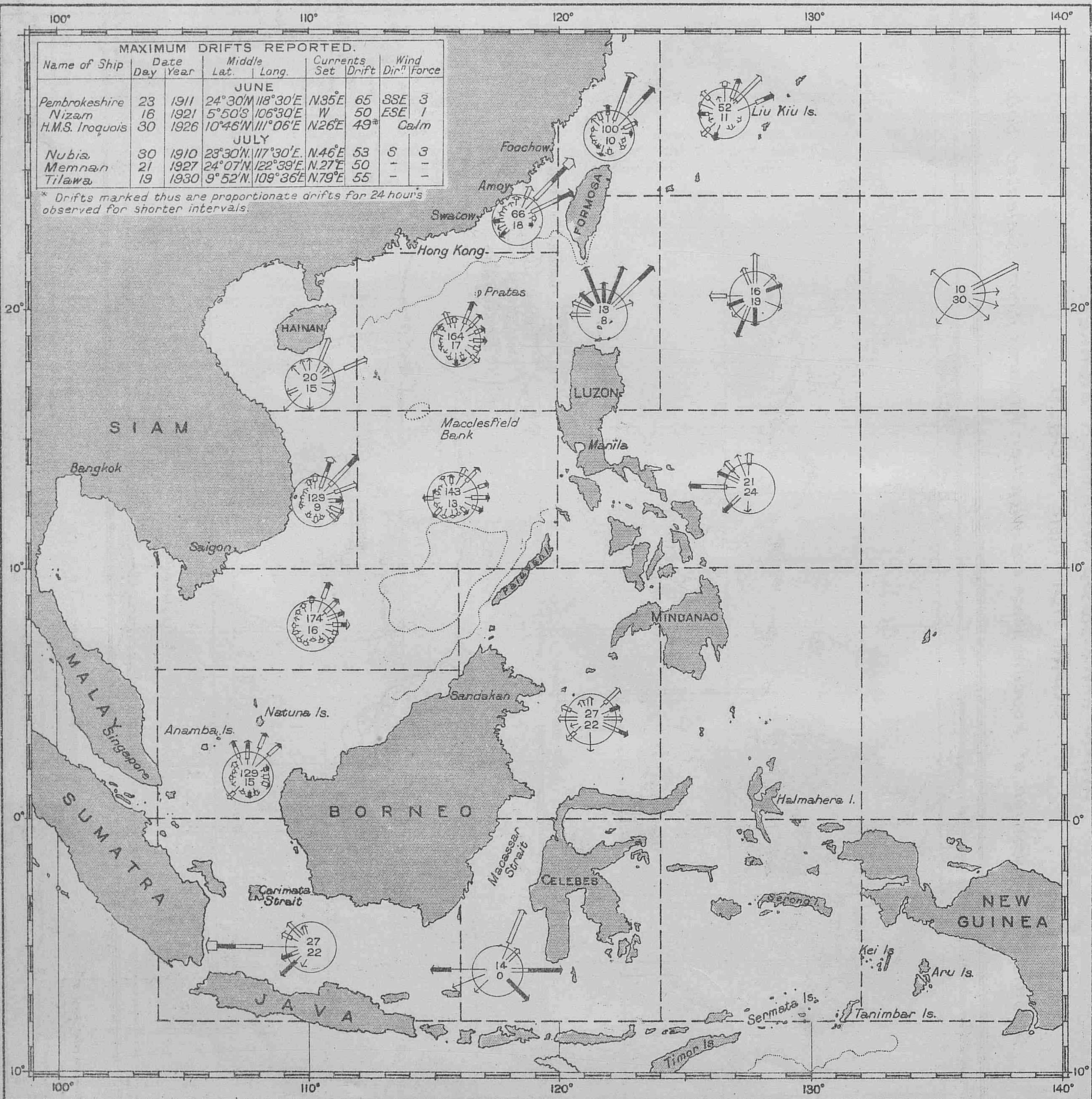
The small shaded areas round stations detailed to receive reports from "A Selected Ships" indicate where these ships should not report on account of congestion.

The full circles indicate the areas round islands and coast stations which are detailed to intercept "B Selected Ships" reports made to CQ on 600 metres

Currents in the China Seas and East Indian Archipelago.

MAY JUNE. and JULY.

Observations of ships regularly observing for the British Meteorological Office, 1910 - 1934.



MAXIMUM DRIFTS REPORTED.

Name of Ship	Date Day	Date Year	Middle Lat.	Middle Long.	Currents Set	Currents Drift	Wind Dirn.	Wind Force
JUNE								
Pembrokeshire	23	1911	24°30'N	118°30'E	N.35°E	65	SSE	3
Nizam	16	1921	5°50'S	106°30'E	W	50	ESE	1
H.M.S. Iroquois	30	1926	10°46'N	111°06'E	N.26°E	49*	Calm	
JULY								
Nubia	30	1910	23°30'N.	117°30'E.	N.46°E	53	S	3
Memnan	21	1927	24°07'N.	122°39'E.	N.27°E	50	–	–
Tilawa	19	1930	9°52'N.	109°36'E	N.79°E	55	–	–

* Drifts marked thus are proportionate drifts for 24 hours observed for shorter intervals.

EXPLANATION OF CURRENT ROSES.

The current roses are drawn from observations within the pecked lines. Arrows flow with the current, length represents frequency, thickness strength:–

6–12 miles per day, ⟶, 13–24 miles per day ⟹,
25–48 " " , ⟶, 49–72 " " ⟹,
73 miles per day and above ⟹

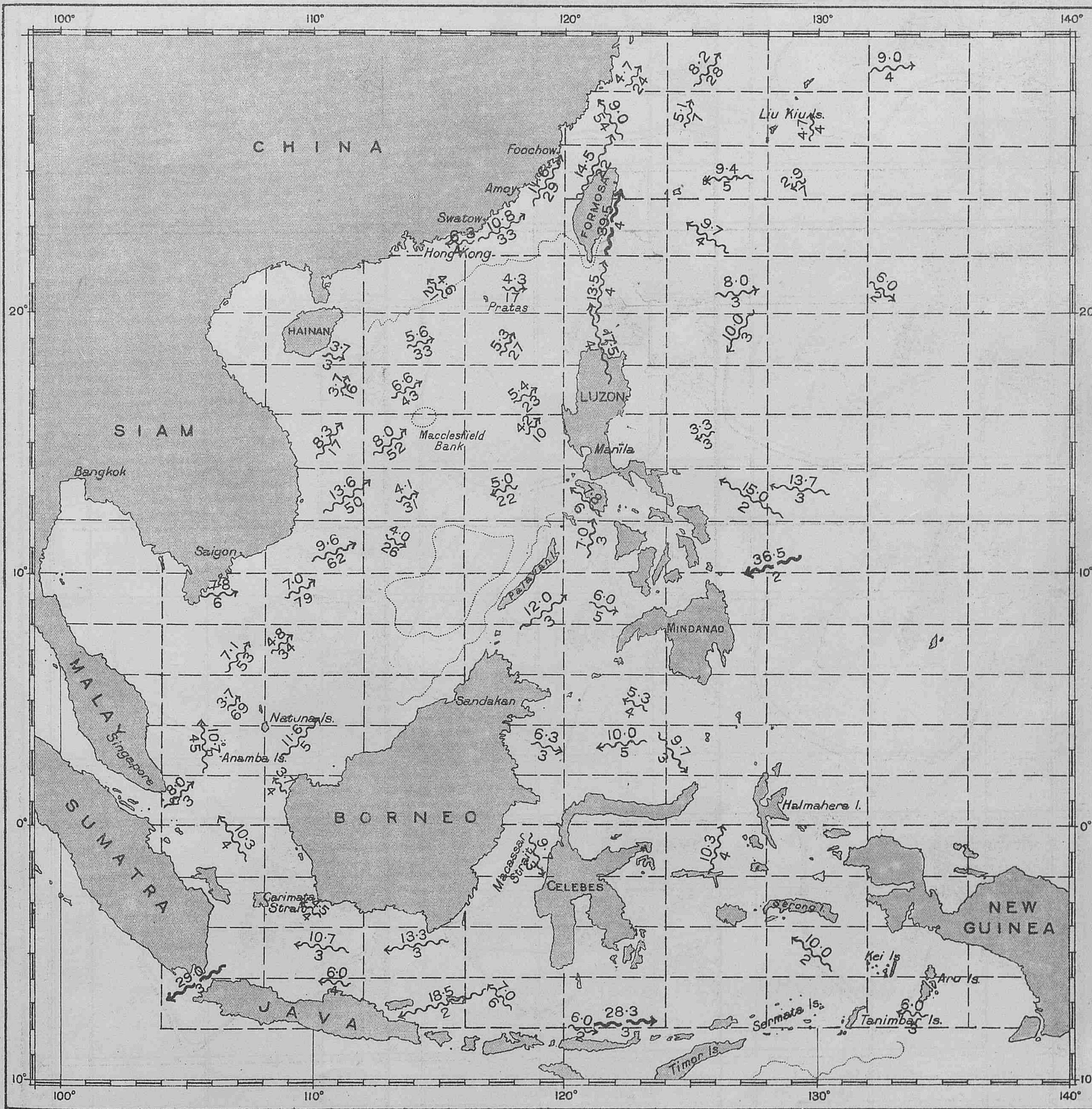
Distance from tail of arrow to circle represents 5% Scale 0 10 20 30 40 50%

The upper figure in centre of rose gives total number of observations, the lower figure the percentage frequency of currents less than 6 miles per day.

Currents in the China Seas and East Indian Archipelago.

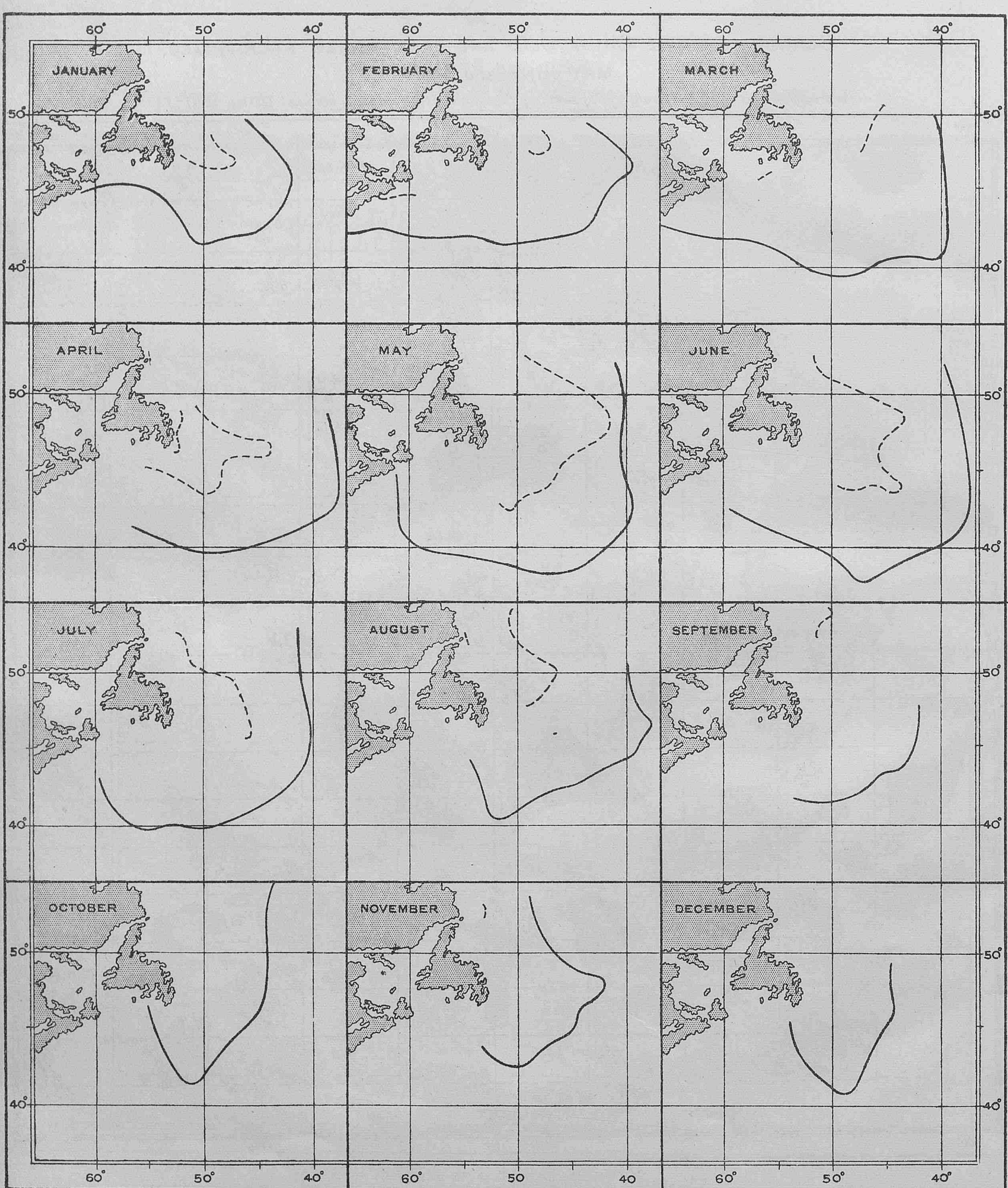
MAY JUNE. and JULY.

Observations of ships regularly observing for the British Meteorological Office, 1910–1934.



EXPLANATION OF CURRENT ARROWS.

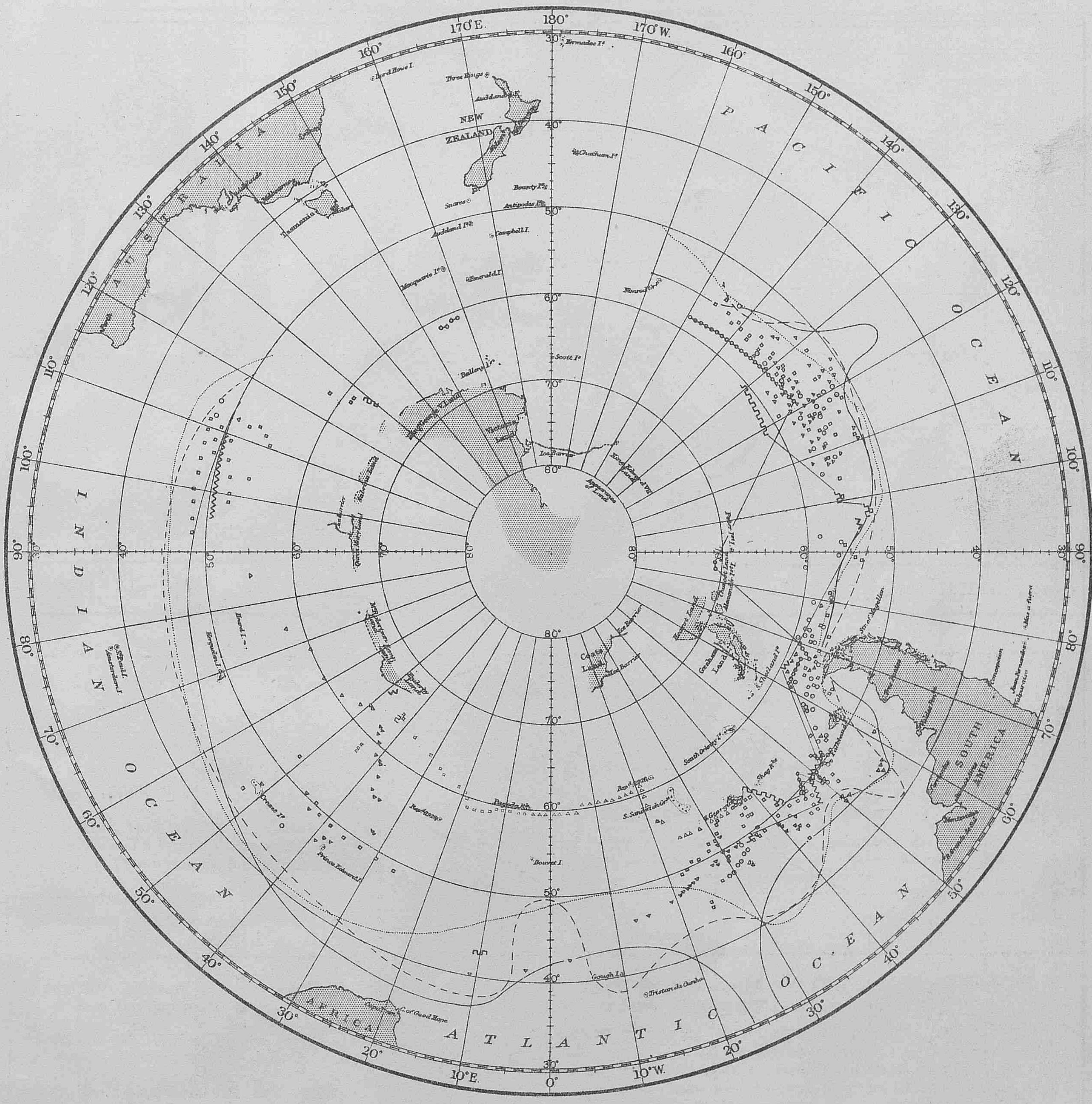
The arrows flow with the current and represent the resultant of currents observed within the pecked lines. The centre of each arrow lies in the mean position of observation. The figures above the arrows give the velocity of current in miles per day; the figures below the arrows the number of observations. In cases where the arrows drawn to scale are inconveniently long the symbol ⟿ *is substituted.*



LIMITS OF ICE, WESTERN NORTH ATLANTIC.

Limit from 1901 to 1934 shown thus ____________

Limit for 1934 shown thus - - - - - - - - - - - -



ICE CHART OF THE SOUTHERN HEMISPHERE,

APRIL MAY and JUNE.

EXPLANATION.

The symbols used to distinguish the ice of each of the three months are as follows:–

	Bergs, 1902-1934.	Position of northernmost pack ice actually observed 1885-1934.	Extreme limit of all ice, 1772-1934.
April	△	∿∿∿∿∿∿∿∿∿∿	————————
May	□	⊓⊓⊓⊓⊓⊓⊓⊓⊓⊓	— — — — — —
June	○	—o—o—o—o—o—	············

Note — The symbols for pack ice are joined by hair line where desirable.

The coast line of the Antarctic continent as shown on this chart is not completely corrected to accord with the latest survey information. It is intended in a later volume of The Marine Observer, after the Admiralty Ice chart of the Southern Hemisphere No. 1241 has been revised to again publish this chart in The Marine Observer with coast lines as complete as possible and to bring the ice information up to date annually.

H.M. Stationery Office Press Kingsway. W.C.2

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