Mr Tunnell

Met.O. 764

The Marine Observer

A quarterly journal of Maritime Meteorology

Volume XXXV No. 210

October 1965

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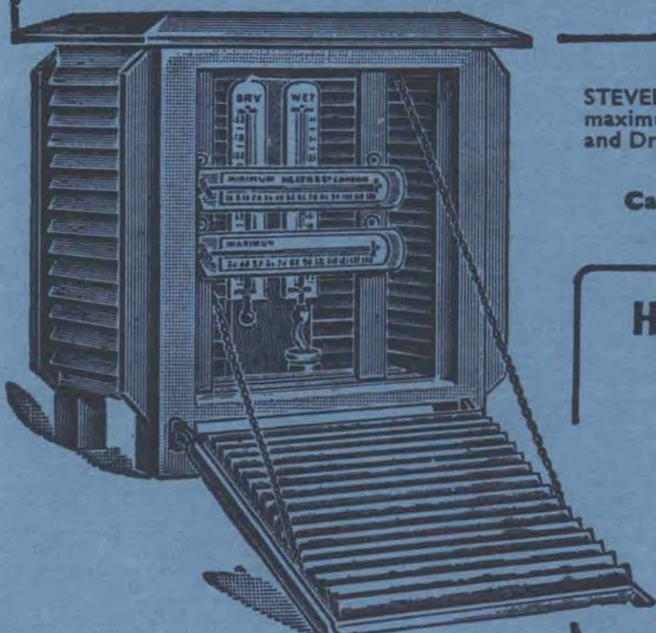
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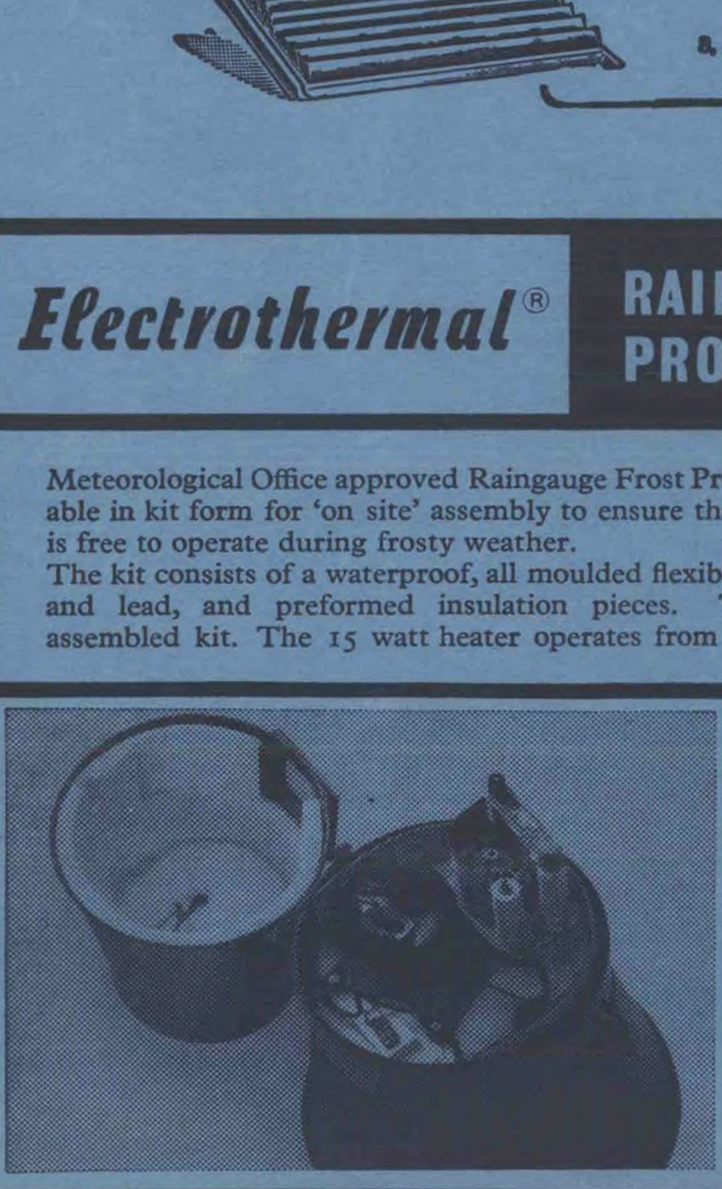

Met.O. 764

THE MARINE OBSERVER

A QUARTERLY JOURNAL OF MARITIME METEOROLOGY PREPARED BY THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE

VOL. XXXV **No. 210** **OCTOBER 1965**

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Editorial

"Under Heaven, here is neither lead nor lee!
"Must we sing for evermore
"On the windless, glassy floor?
"Take back your golden fiddles and we'll beat to open sea!"

Thus did the souls of Kipling's mariners, in the days when the Scriptures had been fulfilled and "there was no more sea", petition their Master to release them from their celestial commitments and allow them to return to their own more familiar calling.

Eternity is not to be measured in days or years but "in the smoke of Judgement Day" at the beginning of the poem those same mariners had called for a "plague upon the hurricane that made us furl and flee . . . Our bones we'll leave the barracout, and God may sink the sea". But on their own confession they plucked unhandily at their harps with their rough tarred thumbs, the Heavenly tunes were not to their liking, could they not, at least, "lift a Deepsea Chantey such as seamen use at sea?" and finally they asked to go back. And now Kipling tells us that the borders of the sea are established unto all eternity:

"Sun, Wind and Cloud shall fail not from the face of it
"Stinging, ringing spindrift, nor the fulmar flying free
"And the ships shall go abroad
"To the glory of the Lord
"Who heard the silly sailor-folk and gave them back their sea".

History in one form or another is undoubtedly being made almost every day of the week nowadays but if nothing else had happened in 1965, the year would be remembered as a year of centenaries or half centenaries, marking many of the achievements and disasters of mankind. Thinking at random we can mention the 750th anniversary of the sealing of *Magna Carta*; the seventh centenary of the calling of Simon de Monfort's parliament, the forerunner of our present system; the third centenary of the Great Plague; the first centenary of the foundation of the Salvation Army and of the publication of *Alice in Wonderland* and the 50th anniversary of the death of Victor Trumper and of W. G. Grace who, coming from opposite sides of the world became almost legendary figures in the history of cricket.

The world of shipping marks the year 1965 as being the 150th anniversary of the first appearance of a steam vessel on the River Thames; the centenaries of the foundation of the firm of Messrs. A. Holt & Co. and of the Royal Alfred Merchant Seamen's Society and the 50th anniversary of the torpedoing of the *Lusitania.* For us in the Meteorological Office too, the year has brought the centenary of the end of the first phase of our career for it was in 1865 that our first Superintendent, Admiral FitzRoy, died and a committee composed of Fellows of the Royal Society was set up to reorganize the office under Dr. Scott as Secretary and Captain Henry Toynbee as Marine Superintendent. This marked the end of the direct control of the Meteorological Office by seamen and the advent of the professional meteorologist.

In the plethora of centenaries and half centenaries occurring this year, the literary world has celebrated the 100th anniversary of the birth of Rudyard Kipling from whose *Last Chantey* we have quoted above. In this age of change it is difficult to assess with detachment the writings of a man who has been held to glorify war, who has been branded imperialist, jingoist and even fascist. Perhaps the last named label springs solely from the fact that the Hindu Swastika, signifying Light, Life and Glory was not removed from his works when it was adopted by a western oligarchy and to western eyes became the symbol only of Death, Darkness and Dishonour. One hopes that the issues which, since the war, have seemed so important will one day lose their edge and then there will remain only the good stories for posterity.

But detached from all complicity in an outworn philosophy as they are, Kipling's prose and poetry about the sea cannot but live; for the sea is ageless and recognizes no social, political or ideological barriers.

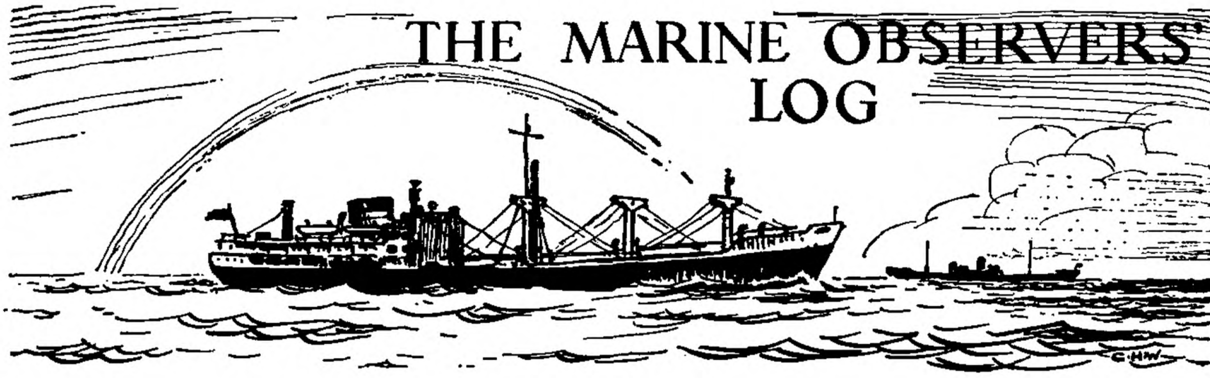
The sea would seem a very unlikely mistress to be wooed by a man born at Bombay into the British way of life which had been carried to India in Victorian times, the son of a Professor of Architectural Sculpture in the University of Bombay and the grandson, on both sides, of a Wesleyan Minister. Moreover, after 11 years at school in England, the young Kipling went back to India on the staff of the *Lahore Civil and Military Gazette*, subsequently going to the *Allahabad Pioneer* and his stories and poetry of those days naturally turn on subjects which were close at hand. In those days too he gathered material which would last him for many years after he left India.

The same meticulous accuracy and attention to detail which he used in his sketches of the British in India, the Army and the native population, he put also into his stories and poetry of the sea. It has been said that there has never been a better account of the deepsea cod fisheries than *Captains Courageous* and yet Kipling picked up all the material from browsing, talking and helping around the wharves at Boston, U.S.A. Certainly no marine engineer would quarrel with the technical details of *MacAndrew's Hymn* whilst the details of seamanship, rigging and natural phenomena which appear in most, if not all of his many sea poems are flawless. Yet he was never at sea except on rare occasions as a passenger. One of the *Jungle Books* contains a story called *The White Seal* and this might start many a ship's officer, as it did the writer of this Editorial, off to an interest in sea mammals and oceanography, a science which is so inextricably linked with meteorology.

Had Kipling chosen to adopt the sea as his profession instead of becoming a journalist, he would undoubtedly have become a most zealous and loyal voluntary marine observer.

Perhaps in the *Last Chantey* he was foreseeing the ultimate result of that drift from the sea which has become so marked of recent years and which is causing so much apprehension amongst those who have the future of the country at heart. This drift is shown not only by the decreasing number of young men going to sea and the increasing number coming ashore before they have finished their apprenticeship, but most significantly, by the steady decrease in the numbers presenting themselves for examination; in 1964 the number of candidates for Master was the lowest for 10 years. Perhaps we who came ashore ourselves should not be over dogmatic on this subject but, at least, we had spent half our working lives at sea and conditions have improved immeasurably since we took this step. Today it is problematical whether salaries, personal comfort and independence are any better ashore than afloat and coming ashore often means leaving adventure, romance, challenge and that indefinable Something which Kipling portrayed so well and which, in the end, his seamen asked might be returned to them. Ashore, never again will one be, in his words, "down, hull down on the Long Trail—the trail that is always new".

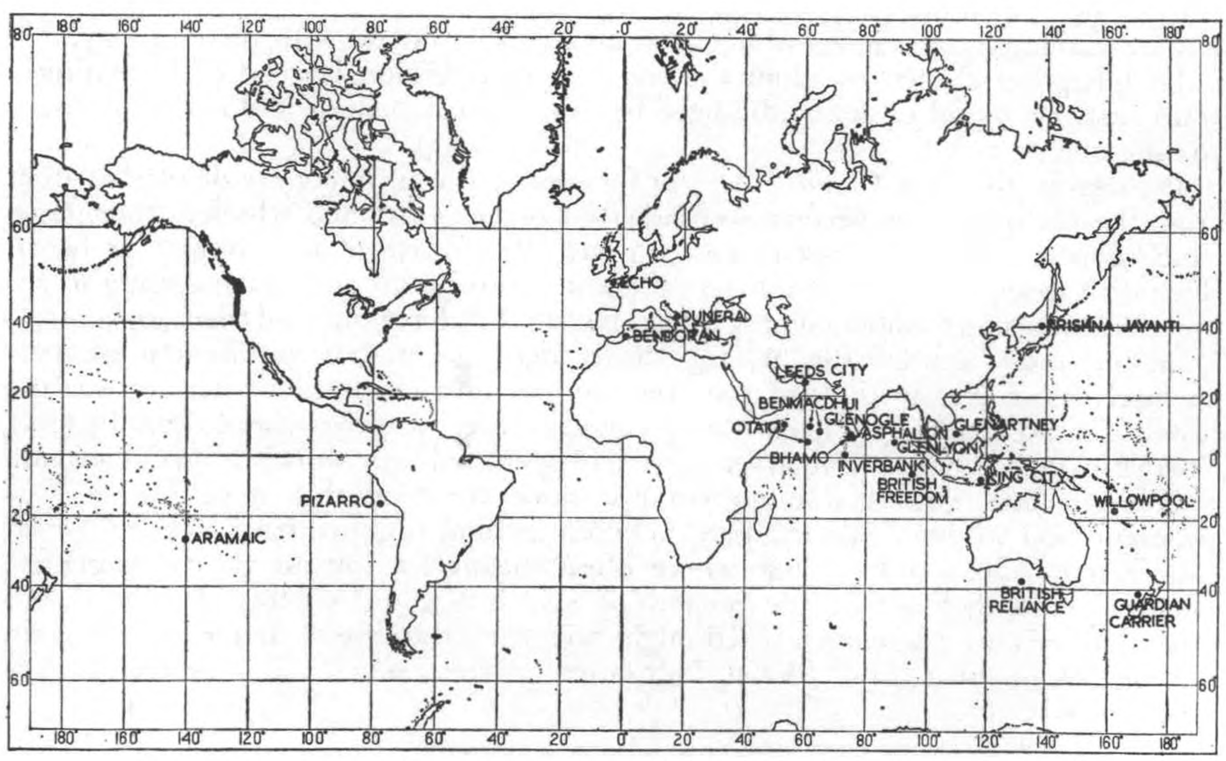
L. B. P



October, November, December

The Marine Observers' Log is a quarterly selection of observations of interest and value. The observations are derived from the logbooks of marine observers and from individual manuscripts. Responsibility for each observation rests with the contributor.

It sometimes happens that we are unable to offer an explanation for phenomena reported. In such cases we shall be very glad to hear from any reader who can put forward an authoritative or a possible explanation, which could be published in this journal. We should also be glad to hear from any reader who has witnessed a similar phenomenon in the past, but which has not previously been communicated to us.



Positions of ships whose reports appear in "The Marine Observers' Log".

TROPICAL STORM

Bay of Bengal

m.v. *Glenlyon*. Captain W. K. Hole. Suez to Singapore. Observers, all officers.

20th December 1964. Radio reports received on the 19th indicated a tropical storm off N.W. Sumatra, moving W slowly, or almost stationary, which on the forecast, would pass 60 miles S of the ship's course. At this time we were experiencing NE monsoon winds of force 4 and a moderate ENE swell. There were occasional heavy showers. Our course was 088°(T) at 20½ kt in lat. 6°N, 86°E.

During the morning of the 20th the wind began to increase from NNE and by 1200 LMT (0542 GMT) it reached a maximum of force 11. There was torrential rain and visibility was reduced to less than half a mile. Swell from NE and later from NNE was very heavy and there were mountainous seas blown white by the wind. Conditions were so bad that we were forced to reduce speed to 10 kt.

We entered the storm centre at 1550 LMT (0932 GMT) in lat. 6°N, long. 90½°E, the seas being short and choppy. There was a moderate E'ly swell. The cloud height rose noticeably and the rain ceased. The radar PPI showed a very 'open' storm centre with a well defined rain belt (see Fig. 1). Flocks of small, brown coloured

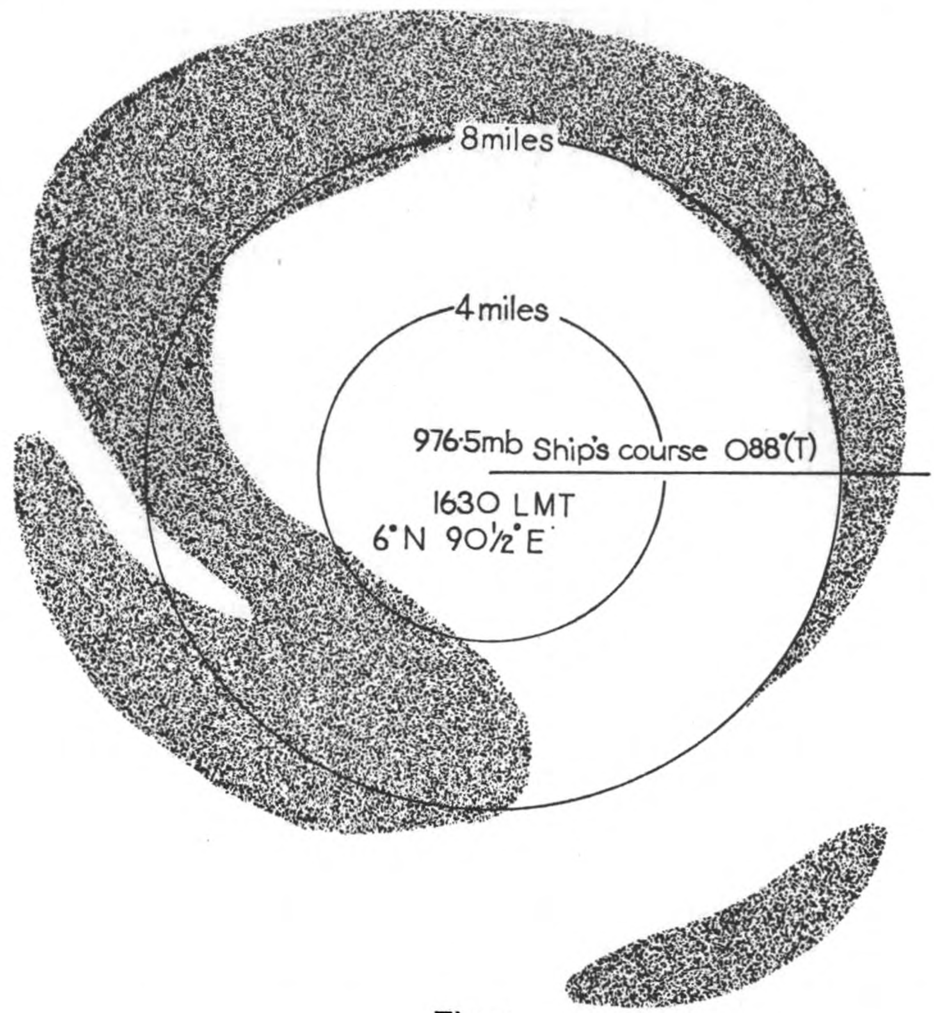


Fig. 1

seagulls, with black heads and small webbed feet were seen, trying with difficulty to land on the ship, all looking as if they had been fighting the storm for a long time.

On leaving the centre at 1640 LMT (1022 GMT), the wind immediately blew from the S, force 7 and by 1800 LMT (1142 GMT) it was SSE force 9. There were high to moderate seas. A moderate E'ly swell was still present, but increasing swell from the S soon began to come in. Heavy rain was experienced again for an hour, giving way later to scattered showers. By midnight the wind had become SE'ly and decreased to force 5. It did not return to the usual monsoon direction and force until noon on the 22nd.

The lowest barometer reading was 976·5 mb in the vicinity of the centre (see Fig. 2, the ship's barograph trace).

This storm appeared to us to be moving in a WNW direction and was later to cause havoc on the coasts of E. Ceylon and S.E. India on Christmas Day.

Note. This observation was referred to the India Meteorological Department whose comment was as follows:

"The severe cyclonic storm, named Rameswaram Cyclone, of December 1964, which caused

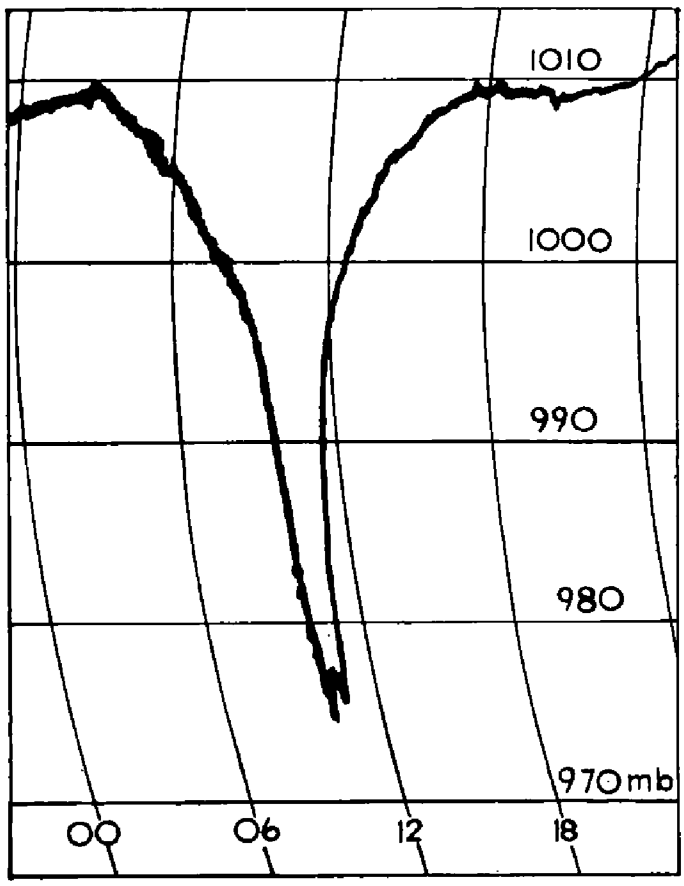


Fig. 2

considerable devastation on Rameswaram Island in the Palk Strait on the night of 22nd–23rd December 1964 originated as a depression in the South Andaman Sea on 17th December, centred near lat. 5°N and long. 93°E. It remained nearly stationary for the next two days but intensified into a deep depression by the 19th. Moving slightly w'wards, it further intensified into a severe cyclonic storm which lay centred, at 0300 GMT on the 20th, near lat. 5°N and long. 91°E. The severe cyclonic storm then took a WNW'ly course and at 0300 GMT on the 22nd was centred near lat. 7°N and long. 84°E. Thereafter it moved rapidly NW and was centred near lat. 9°N and long. 82°E at 1200 GMT on the 22nd. The storm then took a WNW'ly course and, moving across the Palk Strait, crossed the south Madras coast near Tondi on the afternoon of the 23rd. Thereafter it gradually weakened and, moving across the Peninsula, emerged into the Arabian Sea off the Kerala coast, where it lay as a depression on the morning of the 24th. Continuing to move towards the WNW, it weakened further and became unimportant by the 27th. The track of the cyclonic storm is shown in Fig. 3.

"The storm caused fairly widespread rainfall in the Bay Islands and southern parts of the India Peninsula. Madurai in the Madras State recorded 23 cm of rain on 24th December. The cyclonic winds and tidal waves associated with the storm ravaged Dhanushkodi and other places in Rameswaram Island, the death roll being estimated at over 900 including all the passengers in an entire train that was swept off in the raging waters on the night of 22nd–23rd. The railway bridge between Mandapam and Pamban was also washed off by the tidal waters and the communication between Dhanushkodi and the mainland was completely cut off.

"An officer of this service who toured the affected area soon after the cyclone disaster collected valuable meteorological information. The eye of the storm moved through Dhanushkodi, Rameswaram and Pamban and its diameter was estimated to be about 10 miles E–W and 15–20 miles N–S. The wind speed over the land was 70–80 kt with isolated peaks of 100 kt. The tidal wave which came ahead of the cyclonic storm was 15–20 ft high. The lowest pressure of 987 mb was recorded by the barograph at Pamban when the centre of the storm was at some place slightly N.

"This cyclonic storm presented some unusual features. Hardly has any severe cyclonic storm originated in the South Andaman Sea at such a low latitude during the last 70 years. Another noteworthy feature of the storm was its rapid movement from 21st onwards. The

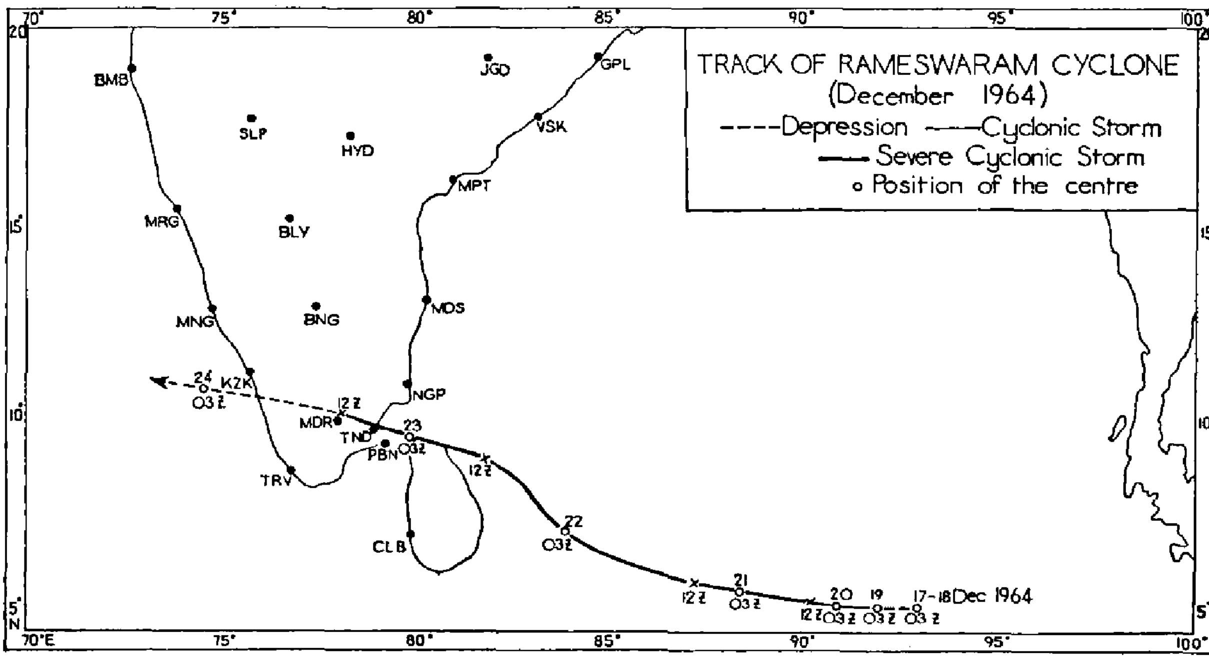


Fig. 3

changes in the course of the storm from WNW to NW on the morning of the 22nd and again from NW to WNW on the evening of the same day was yet another feature."

EXCEPTIONALLY HEAVY SQUALL
off Algerian coast

s.s. *Bendoran*. Captain J. Cringle. Aden to Liverpool. Observer, Mr. J. Hamilton, 1st Officer.

23rd October 1964. At 0630 GMT the vessel passed through a squall of the utmost violence which lasted for about 10 min. The wind increased to force 10 from a N'ly direction and it was accompanied by rain which was so heavy that it reduced the visibility to about 40 ft. This was the heaviest rain ever seen by the observer. A thunderstorm had been experienced at 0600. Air temp. 64°F.

Position of ship: 37° 00'N, 1° 12'E.

Note. Reference to the Meteorological Office synoptic chart for 0600 GMT shows that a slow moving depression was centred at that time near 38°N, 3½°E, with a trough extending from the centre towards southern Spain. The trough was a thundery one and lightning had been reported from places as far apart as Gibraltar and Algiers.

s.s. *Bendoran* was in the vicinity of the trough line where she was particularly liable to encounter severe storms. The convergence of air in the trough probably intensified the existing instability and added to the heaviness of the rain.

HEAVY HAIL
Australian Bight

m.v. *British Reliance*. Captain S. C. Davies. Kwinana to Sydney. Observer, Mr. D. McCallum, 3rd Officer.

28th October 1964. At 1330 GMT a shower of hail began to fall which lasted for 20 min. So heavy was the fall that when it gave way to rain there was a covering of slush half an inch deep on the decks. The air temp. after the hail was 46°F, compared with 51° at 1200 and 50° at 1500 GMT. Wind, WNW force 7–8.

Position of ship: 37° 26'S, 132° 06'E.

Note. The synoptic weather chart issued by the Australian Bureau of Meteorology shows that the centre of a rather active depression, moving E, had passed some 500 miles to the S of the vessel on the evening of the 28th. The heavy hail storm appears to have occurred at the passage of an associated cold front which extended NNW'wards from the centre.

HEAVY STATIC CHARGE

Adriatic Sea

m.v. *Dunera.* Captain R. Baker. Venice to Piraeus. Observer, Mr. W. C. G. Sturgess, Senior Radio Officer.

4th December 1964. At 1945 GMT the aerial discharge indicator in the W/T room began to glow. The aerial voltage to earth was 650 V DC (aerial negative) with a maximum current of 10 mA. There was a shower of sleet at the time. Wind, NW'ly force 5.

Position of ship at 1800: 42° 12'N, 17° 00'E.

Note. The synoptic chart for 1800 GMT, prepared by the Meteorological Office, shows that the vessel was passing through a trough of low pressure which lay approximately WNW–ENE across the Adriatic Sea. Cb cloud was occurring over quite a wide area and a few thunderstorms were reported. There is often an unstable large positive charge at the base of a thundercloud before lightning occurs and a particularly heavily charged cloud was apparently overhead at the time.

EXCEPTIONAL VISIBILITY

English Channel

m.v. *Echo.* Captain J. L. Jenkins. Observer, Mr. A. Sims, 2nd Officer.

11th October 1964. At 0000 GMT when the vessel was 12 miles SW of Portland Bill, the loom of lights at Start Point (37 n. miles distant), the Casquets (43 n. miles) and St. Catherine's Point (56 n. miles) was plainly visible.

Wind, WSW force 4. Air temp. 53°F, Sea 57°. Cloud cover 6/8.

Position of ship: 50° 12'N, 2° 12'W.

Note. m.v. *Echo* was on the E side of a shallow, rounded, trough of low pressure which extended S'wards to the Channel from a depression centred over N. Wales. At 0000 GMT on the 11th. Cb cloud was reported from a number of places on the Channel coasts. The convection associated with the formation of cloud of this type must have carried aloft any atmospheric impurity near the surface, causing the visibility to be extremely good.

CALM PATCHES

South Pacific Ocean

m.v. *Aramaic.* Captain D. Aberdeen. Balboa to Auckland. Observers, Mr. D. M. Cole, 3rd Officer and Mr. F. Kirk, Senior Radio Officer.

23rd October 1964 at 2000 GMT. Three circular patches of completely calm water were observed, each approx. 15 ft in diameter and extending evenly spaced, in a straight line for about 300 ft. The patches remained undisturbed from first sighting to final disappearance from view, a period of approx. 7 min. There was no indication that oil slicks were responsible for the calm appearance. Wind, SW force 3. Sea slight with long heavy SW swell.

Position of ship: 26° 20'S, 138° 43'W.

DISCOLOURED WATER

North Arabian Sea

m.v. *Leeds City.* Captain J. H. Thornhill. Mina al Ahmadi to Bombay.

15th November 1964. Streaks of a bright red substance, having a 'textured' appearance were seen lying in lines down-wind. The streaks extended over a distance of at least ½ mile and had a width of about 100 yd. They lay on, or near, the surface of the sea, and bore a strong resemblance to paint or powder freshly poured on to the water in considerable quantity. Wind, N'E force 1. Sea temp. 77°F.

Position of ship: 23° 50'N, 61° 15'E.

Note. Dr. T. J. Hart, of the National Institute of Oceanography, comments:

"The description fits a dinoflagellate bloom, most probably of a species of *Goniaulax* but the very much larger *Noctiluca* has been sampled in that area."

West Pacific Ocean

m.v. *Willowpool*. Captain F. D. Lloyd. Niihama to Noumea. Observers, Mr. C. B. Tingle, Chief Officer, Mr. T. F. Jones, 2nd Officer and Mr. R. H. Taylor, 3rd Officer.

19th December 1964. From 0130 to 0430 GMT the vessel passed through numerous patches of discoloured water, the substance discolouring the sea being of a light brown colour. It was lying in streaks in the same direction as the wind and was not broken-up. Some of the substance was lying on the surface and some a little beneath it. Sea temp. 83°F. Wind, SE'ly force 3.

Position of ship: 17° 43'S, 161° 57'E.

Note. Dr. T. J. Hart, of the National Institute of Oceanography, comments:

"They sound like *Trichodesmium* blooms, encountered over a very large area both to the NW and SE of the New Hebrides. We have had previous similar reports slightly farther W, in the Coral Sea. Samples from that area have not yet been available however."

off coast of Peru

s.s. *Pizarro*. Captain A. Lang. Callao to Matarani. Observers, Mr. A. S. Adams, 2nd Officer and Mr. A. M. Shaw, 3rd Officer.

29th November 1964. Large isolated patches of a rust coloured substance were seen in the water, stretching for approx. 20 miles along the ship's course line (113°T). They were roughly half a mile long and 100 ft wide and were lying in a S'E–N'W direction. A sample of the discoloured water was taken and a few drops of Formaldehyde added as a preservative. Sea temp. 72°F.

Position of ship: 16° 21'S, 73° 46'W.

Note. Dr. T. J. Hart, of the National Institute of Oceanography, comments:

"I received the sample direct from the Port Meteorological Office, Liverpool. It contained a rich mixed bloom of coastal planktonic diatoms similar to the generally rich flora usually encountered thereabouts but much heavier—not less than 2,300,000 cells/litre. The dominant species were: *Leptocylindrus minimus*, *Cerataulina pelagica*, *Bacteriastrum hyalinum* and *Chaetoceros costatum*. The sample was in a very good state of preservation and I have used the data from it in a paper written for Barnes' volume prepared in compliment to Marshall and Orr with due acknowledgement to the collectors and to the Meteorological Office."

New Zealand waters

m.v. *Guardian Carrier*. Captain C. G. Couldrey.

10th October 1964. At 1225 when proceeding S'ward in a position 2 miles W of Kahurangi Light, the ship passed close to and on one occasion through, patches of 'red tide'. There were several patches scattered over approx. 2 miles N and S and others visible to seaward.

The largest patch would be 100 yd long by 50 yd wide, irregularly shaped and showing a dull red. After the ship passed through a patch, the colour astern had not altered, indicating the organisms were not surface only but also to or below the propeller depth.

Also from September onward, during the period of whitebait run, there have been a number of the small light porpoises about the entrance to Westport. On one occasion I counted 11 round the Bar and this year I conclude there are 20 or more from 2 miles off to the entrance apparently feeding on whitebait.

I have previously seen four outside Raglan Harbour, 1 mile outside the Bar, also during the whitebait season.

When passing through the red tide shoals special notice was taken, even with binoculars, to determine whether anything such as small Britt or anything visible individually could be detected, but discolouration was all that could be noticed. It appeared more like red dye rather than visible organisms. I would say the appearance was exactly comparable to the patches seen near The Brothers and from which samples were taken by scientists in the m.v. *Viti*.

Position of ship: 40° 52′S, 172° 05′E.

Note. Dr. D. E. Hurley, of the New Zealand Oceanographic Institute, comments:

"Several organisms are reported to cause red discolouration in sea water in New Zealand waters.

"The most easily recognized is the red shrimp-like *Munida gregaria* which is known locally as 'whale-feed'. This occurs annually in spring and summer off the South Island, particularly along the east coast near Dunedin, in some years in vast shoals.

"Two Protozoans are also known to cause red discolouration. *Gymnodinium sanguineum* Mirasaka has been recorded on three occasions from the Marlborough Sounds, but, as yet, not from anywhere else in New Zealand waters.

"*Cyclotrichium meunieri* Powers is more common and is frequently noted during summer in Wellington Harbour, Marlborough Sounds and Cook Strait.

"The bloom taken by m.v. *Viti* from near The Brothers, referred to in Captain Couldrey's letter, was attributed to a species of *Synchaeta* predominately *S. baltica*. These are rotifers, microscopic multi-celled cells animals which were known to the early naturalists as 'wheel-animalcules'. Species of this genus typically have a red colour in the ganglion and eyespot.

"Apart from *Munida*, which grows up to about 2 inches in length, microscopic examination is necessary to identify these animals and it is not always easy to preserve them satisfactorily with common preservatives.

"It is of interest that, on 22nd October 1963, the dredge *Eileen Ward* reported passing through large areas of reddish-brown waters outside the Westport Harbour entrance in an otherwise clear sea."

ACTIVE VOLCANO

Sangeang Island

m.v. *King City*. Captain C. E. Exton. Mackay to Singapore. Observers, The Master, Mr. J. J. Birrell, 2nd Officer and Mr. M. Sullivan, 3rd Officer.

14th November 1964. When Sangeang Island was passed in darkness between 1400 and 1700 GMT, the volcano on it was seen to be active. Lava could be seen distinctly on the mountain side at a distance of 22 miles from the base of the Island.

Position of ship: 8° 10′S, 119° 00′E.

ECHO SOUNDINGS

One-and-a-half-degree Channel

m.v. *Inverbank*. Captain G. D. Scott.

The following comment appeared in the vessel's meteorological logbook: "We were very interested in the article on echo soundings* in *The Marine Observer*, giving the experiences of m.v. *British Vision*, especially as we ourselves were on this run from India to the east and south coasts of Africa. We first experienced this form of echo in the One-and-a-half-degree Channel on the way to Africa and made all the necessary arrangements to send particulars to the Admiralty, but, when off Mombasa we had the same thing occurring, we came to the conclusion that it must be due to double echoes, although the depths were not always consistent. At least we now know why it occurs, and will probably not get a fright again. The actual depth shown on the charts at the time were in each case over 1,000 fm."

Position of One-and-a-half-degree Channel (mean): 1° 20′N, 73° 20′E.

WHITE WHALE

Indian Ocean

s.s. *Benmacdhui*. Captain Wm. C. Watson. Aden to the Far East. Observers, the Master and Mr. G. M. McCrone, 2nd Officer.

16th October 1964. Three whales were observed on the surface at a distance of

* m.v. *British Vision*. Marine Observers' Log, echo sounding. *Mar. Obs., London*, **34**, 1964, p. 176.

about 2 cables from the ship at 1000 GMT. The leading and largest one appeared to be almost pure white in colour while the two smaller ones were a very pale brown. They were visible for about 5 min before diving on coming in contact with the ship's wash. Shortly afterwards another three were sighted about ½ mile away. With them was a shoal of smallish fish creating a great disturbance on the sea surface and sometimes jumping about 2 ft into the air.

Position of ship: 9° 52'N, 61° 35'E.

SWALLOWS

Indian Ocean

m.v. *Otaio*. Captain K. Barnett. Aden to Fremantle. Observers, all the ship's company.

25th and 26th October 1964. During the morning of the 25th swallows, estimated at about 30 in number, arrived at the ship. They appeared to be quite fearless, flying very close to the decks and into spaces such as the fo'c'sle head, wheel house and through accommodation windows—one even landing on the lecturer's desk in the schoolroom. Some were tame enough to be approached and stroked, but none accepted any food. The visitors stayed with the ship all day and throughout the next day, finally disappearing about sunset. During the night, although the weather was fine and clear with a nearly full moon no birds were seen or heard, but at day-break on the 26th they were there in strength. On the 25th, the wind early was light and variable; during the day it gradually veered from NW force 3 to NE force 3. On the 26th it was mainly WNW'ly force 3.

Position of ship at first sighting on the 25th: 10° 45'N, 53° 03'E.

Position of ship at first sighting on the 26th: 5° 03'N, 61° 00'E.

DRAGONFLIES

South China Sea

m.v. *Glenartney*. Captain R. G. Rippon. Penang to Hong Kong.

9th November 1964. Throughout the day the vessel was invaded by large numbers of dragonflies. They appeared to be all of the same species, having greenish wings and brown bodies, and wing span varying from 3 in to 6 in. At the time the vessel was approx. 100 miles from the nearest land, the Islands of N. and S. Natuna.

Position of ship at noon GMT: 8° 06'N, 109° 00'E.

PHOSPHORESCENCE

Arabian Sea

m.v. *Bhamo*. Captain J. C. Gibson. Aden to Rangoon.

8th October 1964.

1615 GMT: Radar switched on and left running.

1622: Observed numerous patches of upwelling subsurface water breaking into vivid luminosity and mushrooming out into patches of from 50–100 ft in diameter, all round the vessel. Only very faint phosphorescence had been observed before this time.

1637: Patches of phosphorescence now fewer and seen only occasionally.

1640: The rain which began at 1607 now ceased.

1645: Radar switched off.

1705–1710: Once again frequent upwelling luminous patches were seen. During this time experiments were carried out using the Aldis lamp. The lamp was switched on and directed over a large area; it was then turned off, when it was found that the whole area on which the beam had been directed was glowing with vivid light. This lasted for about 5 sec before gradually fading. All the phosphorescence seen was white in colour. Sea temp. 82°F. Wind, WNW force 4. Sea, moderate.

Position of ship: 7° 17'N, 74° 25'E.

Indian Ocean

m.v. *Asphalion*. Captain J. T. Knox. Belawan to Trincomalee. Observers, Mr. R. G. Pritchard, 3rd Officer and Mr. A. Chapman, Officer Cadet.

29th October 1964. Between 1600–1700 GMT on the night of the 29th when approx. 140 miles SSE of Minicoy Island, several faint flashes of phosphorescence were observed in the water. Recalling the report sent in by m.v. *Achilles** I directed the Aldis lamp on to the sea surface, with the result that phosphorescence immediately appeared in the illuminated area. The longer the light was directed at any one spot the greater became the intensity of the phosphorescence. When the light was switched off the afterglow persisted for up to 10 sec until it was lost to sight astern. The phosphorescence took the form of a 'billowing cloud' of green light in which several golden coloured spots were seen. From the bridge (ht 50 ft) the spots appeared to be the size of a penny.

A water sample was obtained in the sea temperature bucket, and on this being poured out a point of intense blue light was seen on the side of the bucket. This was produced by an organism no bigger than a pin head. When brought into the light it lost its luminosity, but on being returned to the darkness it immediately regained it and remained luminous for several minutes though with decreasing intensity until it completely faded out.

I wonder if this was one of the gold coloured spots seen in the beam of the Aldis lamp—perhaps magnified by the water, and if such were the case, why it gave off a blue light when out of the water? Also, could the cloud of green light be caused by organisms attracted to the surface by the light? This may explain why the light grew more intense the longer the lamp was directed upon one area of the water. Weather: O'cast. No moon. Wind, force 3. Sea, slight. Sea temp. 80°F.

Position of ship: 7° 22'N, 75° 12'E.

m.v. *Glenogle*. Captain W. J. Moore, D.S.C., R.D., R.N.R. Suez to Singapore. Observers, Mr. A. J. Dyne, 2nd Officer and Mr. J. V. White, Midshipman.

13th November 1964. At 2105 GMT patches of phosphorescence were seen, which took the form of isolated patches of milky white light about forty feet across. They had a dull glow about them as if they were in fact below the sea surface.

Remembering your requests in *The Marine Observer*, we now started using the Aldis Lamp on the water. It may be important to note that ours is the Aldis Long-range Mk X. This type has a sleeve over the bulb which is retracted by the action of the trigger. The beam of light is either 'on' or 'off', unlike the more usual reflector type where the light is 'on' all the time. For this reason the times given for the light being on are quite accurate.

For a trial the light was directed on to existing patches of phosphorescence and it was found to activate them to a startling degree. The glow thus produced lasted for some time but did fade away after a time. The experiment was then tried of shining the light on a normal part of the sea, outside the bow wave, about 50 ft from the ship's side and forward of all the ship's lights. Once again a milky white glow was produced. In this glow there were seen small reddish or pinkish dots of light, about the size of small Christmas tree fairy lights. It was found that by shining the light on one spot for 2 sec, the glow lasted for 20 sec after the light was put out. With the lamp on for 5 sec, the after glow lasted for 22 sec: with exposure to the light for 10 sec the after glow lasted about 20 sec. This last experiment (10 sec

* m.v. *Achilles*. Marine Observers' Log, phosphorescence. *Mar. Obs., London*, **34**, 1964, p. 122.

illumination) was not very successful as the ship was well past the patch of light and it wasn't easy to tell when exactly the fade-out was complete.

It was then found that by flashing the Aldis beam at a point about 40 ft from the ship's side for only about ¼ or ½ a sec a startling effect resulted. After the light went out the phosphorescence seemed to bloom in the water. A patch about 10 ft across would activate a patch about 60 ft across, in a sort of chain reaction. This happened quite rapidly but could still be followed. It seemed to mushroom up and out like an atomic cloud, exhibiting that curdled milk effect, rather like the side of a well-developed Cu cloud. Once again the pinkish dots were seen.

At 2120 it was found that with the light on for 2 or 5 sec the after glow continued for 10 to 12 sec. It was then tried shining the light over a wide area of the sea with a sweeping motion of the beam. The effect was like spraying white paint on to a blackboard. The whole surface of the sea became white and the glow was enough to light up the side of the ship.

The effect of shining the Aldis on the water was noticed to be getting steadily less until at 2135 it was found that a beam of light switched on for 2 sec left an after glow lasting only 2 or 3 sec. The wind had by now freshened from the NW to force 3 or 4 and small wavelets were seen with breaking crests. Although the 'glowing' was becoming less, the last natural glow having been seen about 2130, there seemed to be more of the pinkish dots than before, about double the number there was at 2105.

At 2136 GMT the engines were shut down to effect repairs and by 2145 the ship was virtually stopped in the water. It should be noted however that although the main engines were stopped the generators were still running and there was still a fair amount of vibration aboard the ship.

It was now found that only the faintest glow could be produced in the water with the aid of the Aldis lamp. It was found that by shining the beam vertically downward there was no effect at all. By shining it at about 30° to the vertical there were a few dots of light, pinkish as before. By shining the beam at about 45° to 60° to the vertical there were many dots to be seen, some pinkish, some white. They had a very real motion of their own and seemed to swim about on the surface in a rapid but aimless way.

At 2200 no glow at all could be produced although the dots were still to be seen when the light was on. It may be of interest that they were not evenly distributed. In one place there were only a few, while maybe 50 ft away there would be quite a lot, say 20 or 30 in the light of the beam.

No more phosphorescence was seen after 2247 and the use of the Aldis lamp was discontinued.

The night was very dark, there being no moon at all. Sea temp. 80·6°F.

Position of ship at 2105: 7° 28'N, 75° 00'E.

Note. Dr. R. H. Kay, of the University Laboratory of Physiology, Oxford, writes:

"These most detailed and valuable observations are selected as showing conclusively an excitatory effect of light on the bioluminescence of some marine creatures. It will be noticed that all three observations were made between 8th October and 13th November 1964 and in the same sea area. The most striking excitatory effects of light so far reported have in fact all been from the Indian Ocean (e.g. see also m.v. *Achilles*' report mentioned above). We must await more reports of positive and/or negative effects of the Aldis lamp from this and other sea areas before we can determine whether or not this very striking excitatory effect is in fact confined to particular sea areas among those actually covered by the reporting ships.

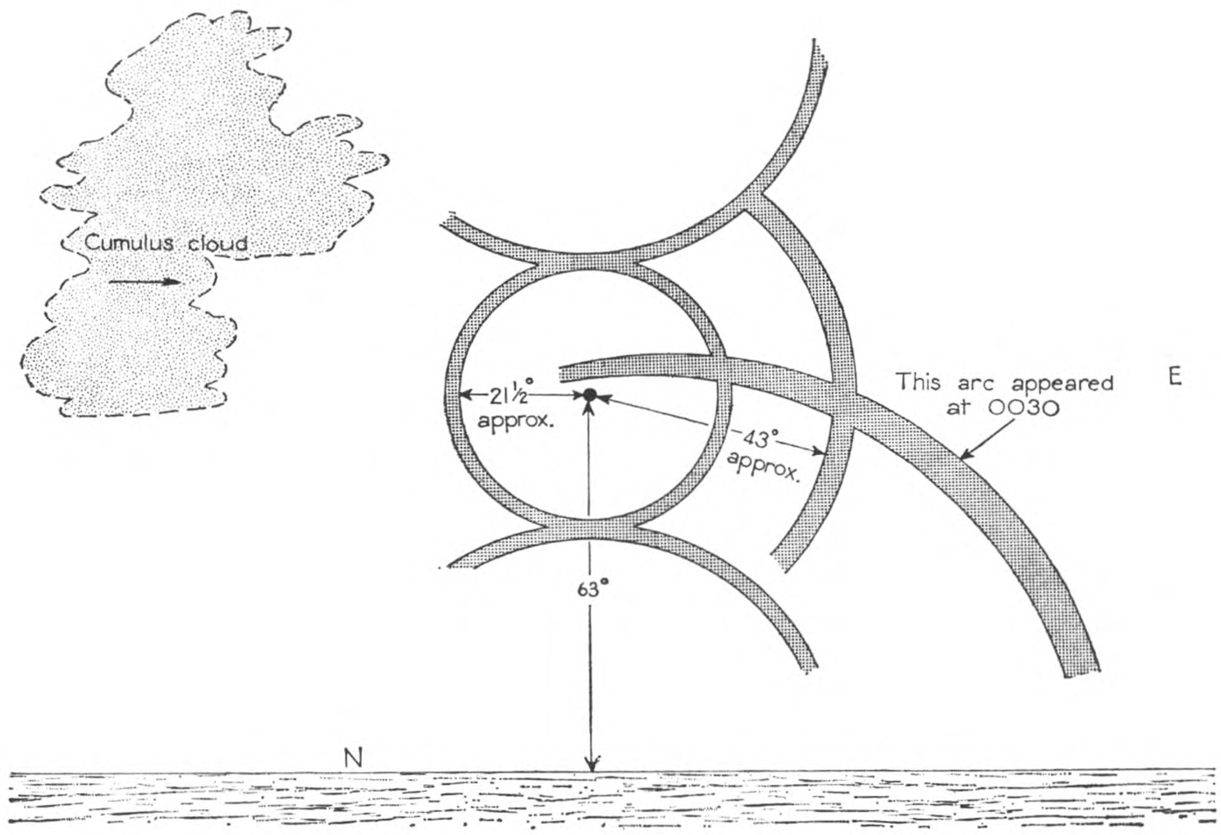
"The many observations now coming in are being transferred to punched cards for analysis: the detail in the three examples above is indeed a model for all observers to copy."

LUNAR HALO COMPLEX

Indian Ocean

m.v. *British Freedom.* Captain C. K. Temple. Noumea to Persian Gulf.

23rd October 1964. Between 0015 and 0040 SMT, the lunar halo complex shown in the accompanying diagram was seen.



The arc which appeared at 0030 did not have a uniform width; it gradually broadened towards the horizon. The sky was completely covered with Cs.

Position of ship: 5° 18′S, 98° 07′E.

LUNAR HALO—PROGRESSIVE REDUCTION IN SIZE

North Pacific Ocean

m.v. *Krishna Jayanti*. Captain N. S. Rajagopal. Aioi (Japan) to San Diego. Observers, Mr. M. M. Varavadekar, 2nd Officer, Mr. K. Guha, 3rd Officer and Mr. M. K. Udeshi, Purser.

14th December 1964. A colourless halo was seen round the moon which had an altitude of 58° at 0630 GMT. At 0645 the halo was brightest and at this time its radius was 29°02′. Between 0700 and 0900 the radius progressively contracted, finally reaching a value of 24° 30′. There was no further reduction in size and the halo was not seen after 0930. The sky was covered with 6/8 Cs, and patches of Sc were also present in the vicinity of, and overlapping the halo. Some Ac was seen, but in a different part of the sky.

Position of ship: 40° 18′N, 138° 42′W.

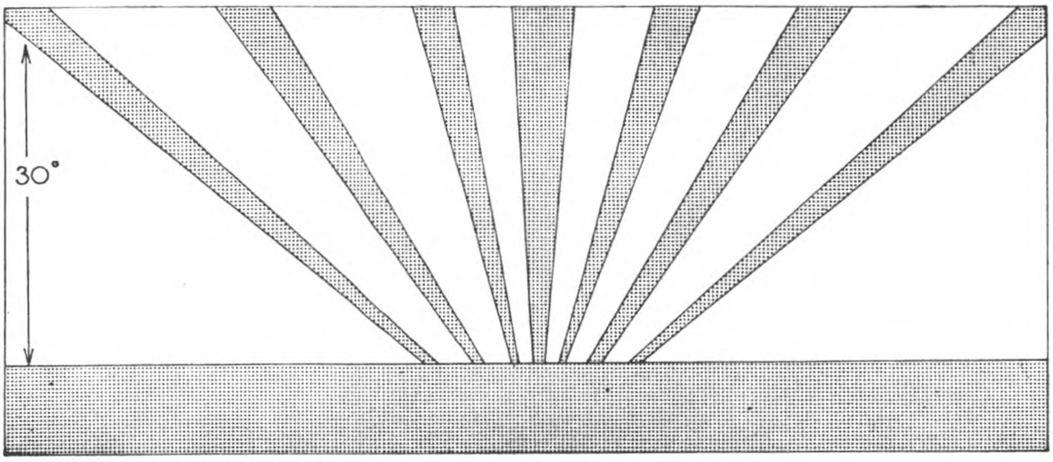
Note. We are glad to have this interesting report from m.v. *Krishna Jayanti*, which is an Indian Selected Ship.

CREPUSCULAR RAYS

South Arabian Sea

s.s. *Benmacdhui*. Captain Wm. C. Watson. Far East to Aden. Observer, Mr. R. Arkless, 3rd Officer.

8th December 1964. At 1325 GMT, which was 10 min after sunset, there appeared rays of light extending in a fan-shape from a point on the E horizon. They disappeared after about 10 min and similar rays were seen coming from the W horizon in the direction where the sun had set. These also faded out after 10 min. Considerable Cb cloud was present around the horizon, but the sky was mainly clear. The general impression is seen in the sketch.



Air temp. 80°F. Wind, ENE force 2. Visibility excellent.
Position of ship: 8° 57′N, 67° 23′E.

Note. Crepuscular rays are caused by clouds or mountains, often beyond the horizon, which cut off the sun's rays and cast shadows on particles suspended in the high atmosphere. Sometimes the clouds or mountains are a very long way from the observer—possibly as much as several hundred miles. The 'fanning-out' of the rays is due to the effects of perspective; actually the rays are parallel to each other, but they appear to converge in the distance. If the convergence occurs 180° away from the sun, the rays apparently meet at the 'Anti-Solar point'.

AURORA

Below are listed briefly reports of aurora made in Selected Ships and Ocean Weather Ships during October–December 1964 (with a few for earlier months received too late for the last issue). These reports have been forwarded to the Balfour Stewart Auroral Laboratory at Edinburgh from the Meteorological Office (Met.O.1) and the Ocean Weather Ship Base at Greenock. Data are entered on charts and are interchanged with data collected at the two other World Data Centres in Moscow and New York. Hourly synoptic maps are being prepared to show all auroral activity reported by observers in both hemispheres during the International Years of the Quiet Sun (1964–65).

We are always pleased to see new names in the list and we acknowledge reports from the trawler *Stella Leonis*, s.s. *Cairndhu*, s.s. *Aden* and m.v. *Athelduke* (via the Canadian Meteorological Branch). Sketches by Mr. Keegan of m.v. *Athelduke* and the observer in m.v. *Manchester Trader* were very helpful accompaniments to narrative reports. We feel that we should comment again on the excellence of the reports received. They are interesting to read and make easy the task of reducing the data to chartable size. To the observers on the ships listed and to others involved in sending the reports to Edinburgh, we send grateful thanks and hope for your continued co-operation.

Many reports for the three months are from the auroral zone (i.e. 67°–70° geomagnetic latitude) which is to be expected during the period of minimum solar activity, with occasional sightings further south in the main shipping routes when periods of greater solar activity occurred, e.g. end–September and early October.

The 1965 noctilucent cloud season (May–August in the northern hemisphere) will be over when these notes are published, but we hope that reports of the clouds may yet come from ships. Occurrences have been so far less frequent than during 1964, but a magnificent display of the clouds was recorded and photographed on 4th–5th July. In central Scotland the clouds were seen extending to the southern horizon. The clouds were recorded and photographed for the first time in the southern hemisphere in January 1965 by Mr. Fogle of Alaska who was observing in southern Chile. Cloud data are being collected at a network of stations in U.S.S.R., U.S.A. and Europe in much the same way as for aurora, and it is hoped that there will be similar interchange of information.

Noctilucent clouds have been found to occur most frequently at the time of sunspot minimum. Recent investigations have shown that they almost certainly consist of ice crystals that have formed on a nucleus of meteoric dust. It may be therefore that the temperature at a height of 80 km reaches a minimum at the time of sunspot minimum, since condensation to ice would then be most likely. So, our two subjects of study, aurora and noctilucent clouds, conveniently occur most frequently out of phase with each other, aurora at sunspot maximum, noctilucent cloud at minimum.

Date (1964)	Ship	Geographic Position		Λ	Φ	I	Time (GMT)	Forms
5th Aug.	*Cairndhu*	53°28′N	51°05′W	020	64	+74	0300–0510	RA
2nd Sept.	*Manchester Trader*	49°40′N	65°25′W	360	61	+76	0030–0240	HA, RA, RR, P
6th ..	*Athelduke*	46°47′N	59°07′W	010	58	+74	0300–0430	RR, N
7th ..	*Aden*	St. Lawrence		360	61	+76	0530	RB, RR
29th ..	*Manchester Trader*	56°32′N	19°50′W	070	63	+72	2325–2345	RR, N
30th ..	*Stella Leonis* ..	61°54′N	50°30′W	030	65	+78	2250–2300	RB
	Manchester Trader	56°22′N	28°45′W	060	64	+72	2258–2304	RR, N
4th Oct.	*Cairngowan* ..	58°00′N	03°00′W	080	61	+71	0001–0300	N
	Cairndhu	57°20′N	34°54′W	050	66	+74	0200–dawn	RB, N
	Weather Surveyor	59°20′N	18°55′W	070	65	+72	2042–2345	HB, RA, N
5th ..	*Cairndhu*	58°28′N	25°30′W	060	65	+73	0115–0300, 0430	RA, N
	Manchester Trader	50°03′N	59°53′W	020	61	+75	0200–0245	HA, RR, P, N
	Weather Surveyor	59°05′N	19°20′W	070	65	+72	2245–2315	N
6th ..	*Weather Surveyor*	59°05′N	19°20′W	070	65	+72	0045	N
	Weather Surveyor	59°20′N	19°00′W	070	65	+72	2045–2345	N
7th ..	*Weather Surveyor*	59°20′N	18°50′W	070	65	+72	0145–0345	N
	Weather Surveyor	59°00′N	18°25′W	070	65	+72	2245–0145	N
8th ..	*Weather Surveyor*	59°05′N	18°50′W	070	65	+72	2045–2345	N
	Stella Leonis ..	60°48′N	49°00′W	030	71	+77	2200–2400	RB
10th ..	*Weather Surveyor*	59°20′N	19°10′W	070	65	+72	2300	N
12th ..	*Weather Surveyor*	59°05′N	18°00′W	070	65	+72	2105–2200, 2330–2345	RR, N N
13th ..	*Weather Surveyor*	59°05′N	18°20′W	070	65	+72	0345, 0545	N
14th ..	*Manchester Trader*	49°30′N	65°54′W	360	61	+76	0030–0330	HB, HA, RB, RA, N
	Weather Surveyor	59°00′N	19°00′W	070	65	+72	0045–0545	N
18th ..	*Weather Surveyor*	59°05′N	18°40′W	070	65	+72	0400	N
25th ..	*Laurentia*	50°00′N	61°06′W	010	61	+75	0900	HB
6th Nov.	*Weather Reporter*	59°00′N	18°43′W	070	65	+72	0100	N
15th ..	*Weather Monitor* ..	58°25′N	17°20′W	070	64	+72	2240–2248	RB
23rd ..	*Stella Leonis* ..	74°24′N	17°00′E	120	71	+79	1819–1925	RB
26th ..	*Weather Monitor* ..	58°55′N	18°30′W	070	65	+72	1900	N
27th ..	*Weather Monitor* ..	59°05′N	19°10′W	070	65	+72	2235–2400	N
28th ..	*Weather Monitor* ..	59°05′N	19°20′W	070	65	+72	0230	N
1st Dec.	*Weather Monitor* ..	59°05′N	19°00′W	070	65	+72	0001, 0200, 0400, 0800	N
7th ..	*Weather Monitor* ..	58°05′N	15°40′W	070	63	+72	2000	N
10th ..	*Weather Adviser* ..	59°08′N	18°47′W	070	65	+72	0250–0400	HA, N
30th ..	*Weather Adviser* ..	58°24′N	17°32′W	070	65	+72	2010–2020	RR, N

KEY: Λ = geomagnetic longitude; Φ = geomagnetic latitude; I = inclination; HA = homogeneous arc; HB = homogeneous band; RA = rayed arc; RB = rayed band; R(R) = ray(s); P = patch; V = veil; N = unidentified auroral form.

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The Climate and Weather of the North Sea

WITH SPECIAL REFERENCE TO THE REGION BETWEEN LATITUDES 53° AND 56°N, AND LONGITUDES 1° AND 3°E

By B. F. BULMER, M.A., B.SC.

Considering its importance to shipping it is surprising that so little has been written about the climate and weather of the North Sea. Recently, a new interest in this subject has been aroused by the enquiries of a number of oil companies who are currently engaged in prospecting for oil and gas under the sea bed. Such operations are liable to be more sensitive to adverse weather conditions than is ordinary navigation and it is desirable for the operators to have some idea of the frequency and severity of such conditions, especially as regards wind and waves. Some of those now operating in this area may be accustomed to the very different conditions of tropical or sub-tropical seas where extreme hazards may occur at rare intervals, but where the frequency of moderately rough conditions is much less. The following article is a brief review of some of the climatic conditions most nearly affecting shipping and other allied marine operations.

The very position of the North Sea largely accounts for the peculiarities of its climate and weather, situated as it is on the north-eastern fringe of the North Atlantic Ocean, and at the same time on the north-western fringe of the Eurasian land mass.

For most of the time, the Atlantic influence prevails and the climate resembles that of the north-eastern Atlantic. While under the Atlantic influence, the predominantly westerly winds are highly variable and often strong, while the temperatures are rather above the average for the latitude and, though frequently changing, do so over a fairly limited range. At other times, however, the continental influence asserts itself. Then, usually under the influence of persistent high pressure, the climate changes its character and conditions may remain almost static for weeks on end. Winds from some easterly direction are then liable to bring abnormally high temperatures in summer, and abnormally low ones in winter.

Thus the climate of the North Sea is a mixed one, having all the dynamic variability of the higher latitudes of the North Atlantic while being subject to more extreme temperatures on account of the intermittent influence of the nearby continent.

Travelling depressions largely dominate the weather of the North Sea. These move on a great variety of tracks, although the general trend of the majority is from south-west to north-east. Fig. 1 illustrates some of the principal tracks of depressions affecting the North Sea. In this diagram, arrows which have been placed on a circle of arbitrary diameter indicate the wind directions associated with depressions moving on various tracks. Whatever the size of the depression the winds will have similar directions relative to the centre.

The depressions may be of almost any size or intensity, but large depressions are more common than small ones. More often than not, a depression whose centre passes over the North Sea affects all parts of it, and not infrequently the whole of the North Sea is affected by a depression whose centre remains outside. For example, a depression moving north-east near the Faroe Islands may well have a circulation affecting the whole of the North Sea. Each depression which affects the North Sea brings its own anti-clockwise circulation of winds. As the depression centres are liable to pass either to the north or south of, or directly over, any position in the North Sea (to say nothing of the occasional passage to east or west), there is almost no limit to the different sequences of wind and weather which they may cause.

Accordingly, the most outstanding attribute of the weather in the North Sea may be said to be its high variability. Even in this it is not consistent, since long periods of highly variable weather are liable, suddenly, to give place to quiet anticyclonic spells which may sometimes persist for as much as a month at a time.

Although this means that the weather is largely unpredictable on a long-term basis, the fact that the area is practically surrounded by a close network of reporting stations makes it a comparatively favoured area for short-range forecasts, that is for forecasts for the next 24 hours. There is always a need, however, for more reports from shipping in the area in order to fill in gaps in the weather map. Because bad weather usually affects some parts of Britain, or the adjacent continent, before affecting the North Sea, warnings can usually be broadcast several hours before the danger becomes imminent. Vessels are advised to 'listen out' to the forecasts and warnings broadcast to shipping not only by the GPO and BBC but also by continental authorities. Details of the information provided, and of the frequencies and times of transmission are to found in the *Admiralty List of Radio Signals*, Vol. III. Arrangements have been made to broadcast special forecasts to the oil companies.

Climatological data, in the form of means, extremes, and frequencies are of little use for forecasting for any individual occasions in an area like this. Nevertheless, such data, by defining the field of variation and giving an idea of the limits and frequencies of the various elements, can serve a useful purpose in providing a background for the design of vessels and equipment, and for general operational

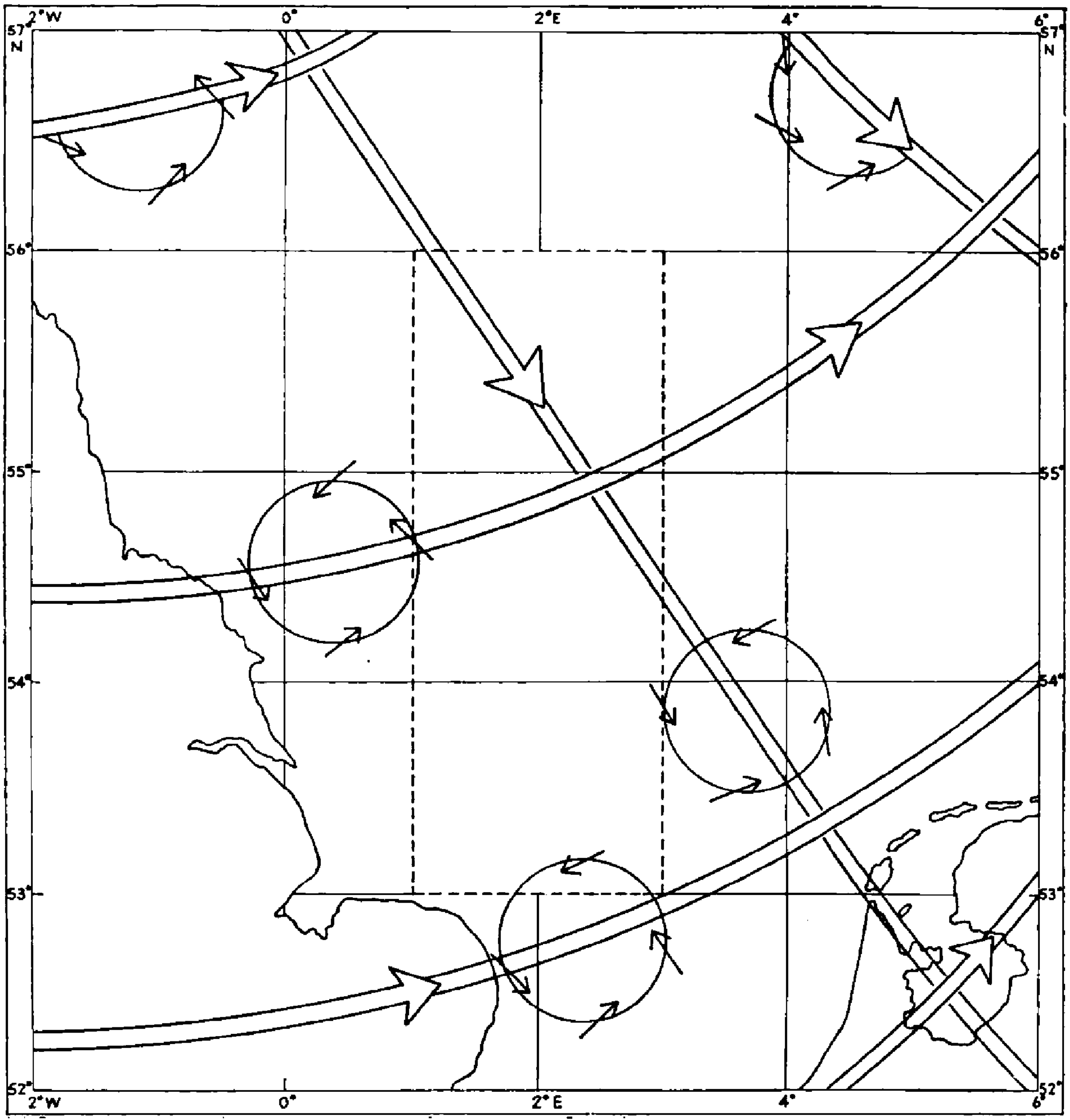

Fig. 1. Some of the more typical tracks of depressions affecting the central North Sea. (The arrows on the circles indicate the wind directions relative to the depression centres. The windfield of any depression may extend over the whole of the North Sea.)

planning, including the choice of the best times and seasons for carrying out particular tasks. As an example, even in a region where gales (force 8 and over) are liable to be encountered in any month, it is well worth knowing, when planning operations, that the chance of such a wind occurring in July is only 1/10th of that in January.

Data for some of the climatological elements of most interest to shipping and allied interests for the west-central North Sea (between latitudes 53° and 56°N and between longitudes 01° and 03°E, which includes the western half of the Dogger Bank) are given in the following paragraphs.

Winds, Gales

The comparative frequency of winds from various directions, and of various strengths is set out in Table 1. This gives, for each month of the year, the percentage frequency of winds from eight points of the compass, and of calms. The winds from a given direction are divided into three categories of wind strength, namely I—light

Table 1. Wind direction and force in the west-central North Sea
(Percentage frequency of observations)

Month	N			NE			E			SE			S			SW			W			NW			Calm	Totals		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III		I	II	III
January ..	1	4	3	2	3	1	2	3	1	2	5	3	3	6	2	4	10	4	4	17	4	2	8	3	3	20	56	21
February ..	3	8	2	2	3	1	2	4	*	3	4	*	4	8	1	5	13	2	5	12	3	4	9	3	1	28	61	12
March ..	3	4	1	3	4	*	3	7	1	3	8	1	5	8	1	5	11	2	4	10	2	4	7	3	1	30	59	11
April ..	4	8	1	3	7	1	4	7	*	4	5	*	5	5	1	5	8	1	6	9	1	4	8	1	2	35	57	6
May ..	4	7	*	6	5	*	9	6	*	6	5	*	7	6	0	7	6	*	6	5	*	4	5	*	4	49	45	2
June ..	6	11	*	7	5	*	7	4	0	4	3	*	7	4	*	7	7	*	6	6	*	5	7	1	4	49	47	2
July ..	6	10	1	6	4	0	5	2	0	6	3	0	9	3	0	7	5	*	7	6	1	8	8	*	5	54	41	2
August ..	6	7	1	4	3	*	4	2	*	4	3	0	5	5	*	8	8	*	7	11	1	6	9	1	3	44	48	4
September ..	7	10	1	5	5	*	4	4	*	4	4	2	5	4	1	7	6	1	6	5	1	7	10	1	1	45	48	7
October ..	4	5	2	3	4	1	3	6	*	4	6	1	7	7	1	7	11	1	5	7	1	4	6	1	2	37	52	9
November ..	4	7	1	3	4	*	3	5	1	3	6	1	4	6	1	4	13	3	4	11	3	3	7	2	1	28	59	12
December ..	3	4	1	2	2	*	2	4	0	2	5	1	3	10	2	5	16	2	5	13	1	4	9	1	1	26	63	9

I = Beaufort force 1–3, II = force 4–7, III = force 8 and above.
* indicates less than ½ per cent.

winds (Beaufort forces 1 to 3, or 1 to 10 knots), II—moderate to strong winds (Beaufort forces 4 to 7, or 11 to 33 knots) and III—gales (Beaufort forces 8 and above, or 34 knots and over).

These figures show that, from October to April, inclusive, the wind is most frequently either south-westerly or westerly. In May the most frequent direction is easterly. In June and July it is northerly, in August westerly, and in September north-westerly.

For most of the year winds from the western half of the compass are more frequent than those from the eastern half.

In general the winds are rather evenly distributed around the compass, and the frequency of the most frequent wind does not greatly exceed that of the others.

The relative frequency of winds from different directions and of different strengths is most readily appreciated in diagrammatic form. Fig. 2 and Fig. 3 represent, by means of wind roses, the distribution of winds in the west-central North Sea in December and in June respectively. These two months may be taken, respectively, to typify the winter and summer conditions.

In the diagrams the length of each arrow is proportional to the total frequency of

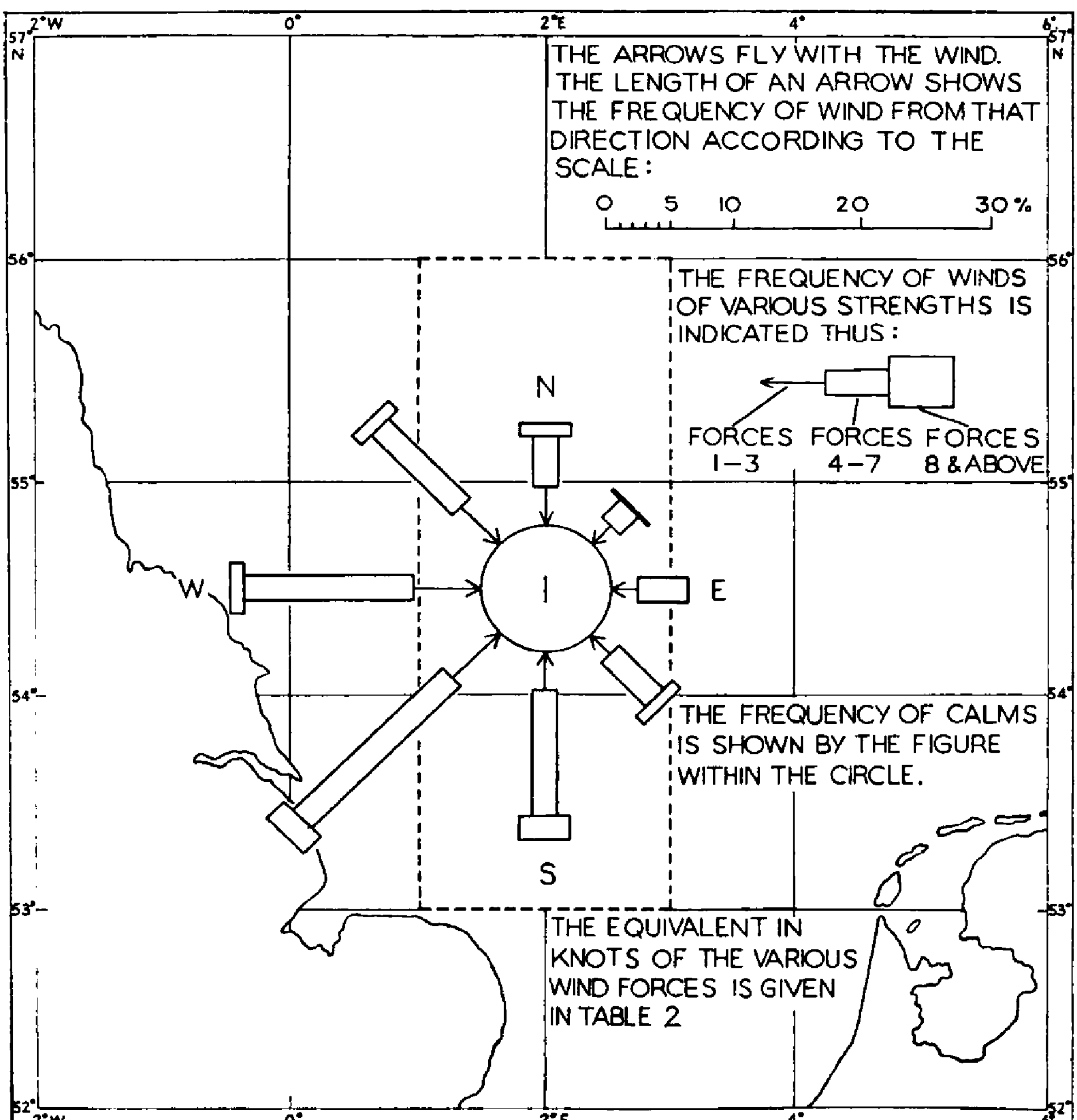

Fig. 2. Wind frequency in December.

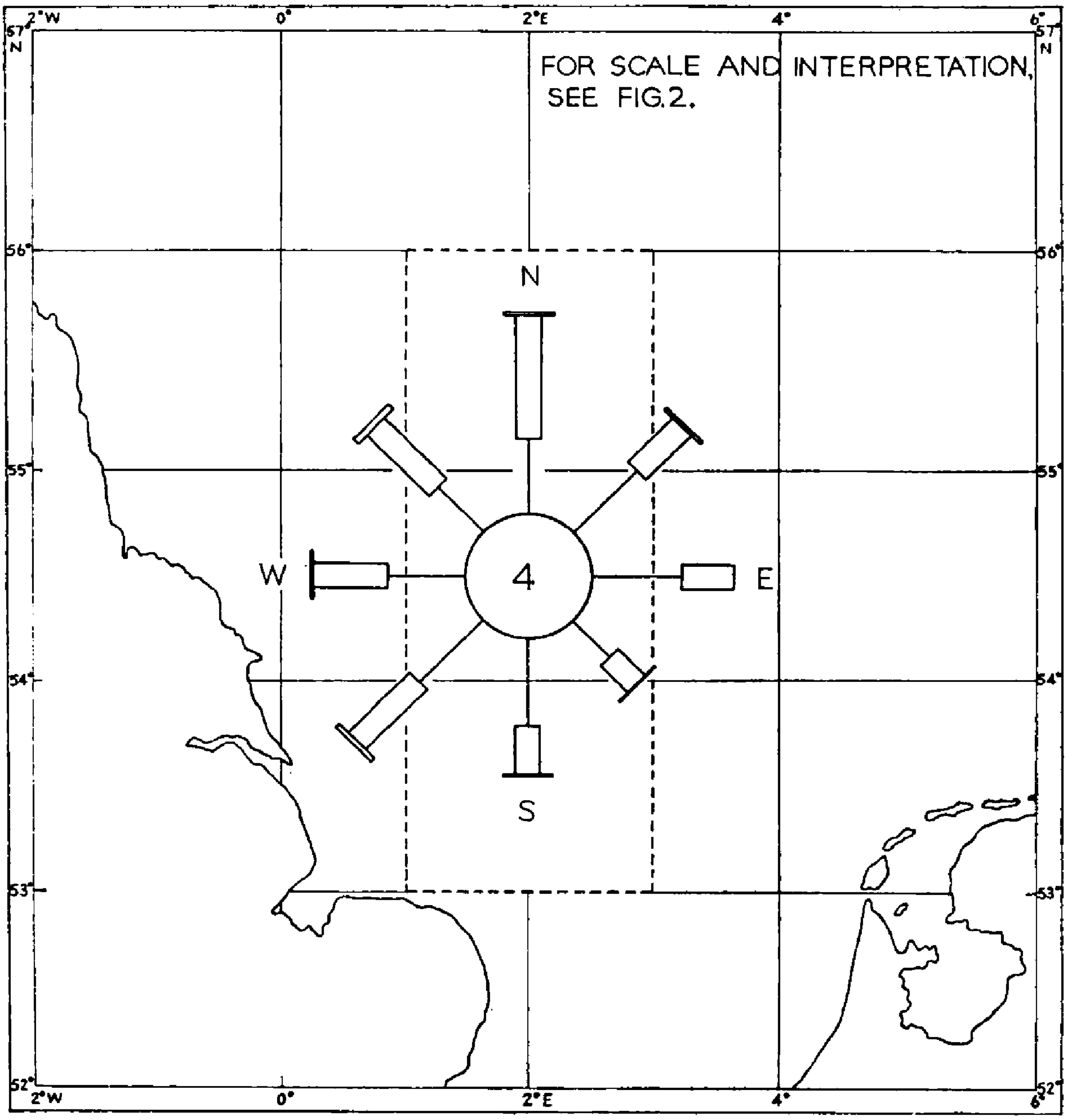

Fig. 3. Wind frequency in June.

winds from the direction indicated, while the sub-divisions of each arrow indicate the frequency of occurrence of the three categories of wind strength, namely light, moderate to strong, and gale as previously mentioned. The number in the centre of the rose indicates the percentage frequency of calms.

On the average, the wind is calm on only about 1 per cent of the occasions in most of the winter months, but this frequency rises to a maximum of about 5 per cent in July.

The winds are strongest, on the average, in the winter months. From November to the end of March about 70 to 75 per cent of the winds are of force 4 and above (11 knots or more), while about 10 to 20 per cent of the winds are of gale force (force 8 and above or 34 knots and over).

The gales are most frequently from directions between south-west and north-west. In the summer the winds are lighter, on the average, and the percentage of light winds (forces 0 to 3 or 10 knots and under) rises from 25 to 30 in the winter months to about 50 or 60 from May to August. Gales in these months constitute only 2 to 4 per cent of the total observations.

Although hurricanes, as such, are not experienced, there is a risk of the wind reaching hurricane force (force 12 or 64 knots and above) on rare occasions in intense depressions.

The wind does not usually blow from the same direction for very long. Any given wind direction seldom persists for more than 2 to 3 days. In the most frequent weather situation wherein a succession of lows affects the area, the wind undergoes a regular cycle of changes which is roughly repeated with the passage of each successive depression. Thus, the most common sequence is a rhythmic backing and increasing of the wind as the depression approaches, and a subsequent veering and decreasing as the depression passes away, the whole cycle being repeated several times at intervals of about two days. Most commonly the wind backs from some westerly direction, to about south, ahead of the depression, and veers to about north-west behind it. This assumes that the centre passes well to the north of the vessel. In those cases where the centre, in its eastward movement, passes to the south of the vessel the latter will experience a continued backing of the wind through south, as the depression approaches, to east and north as it passes, and finally to north-west and west as it moves away. In this region the strongest winds are usually experienced with a falling barometer, in advance of the depression. When the barometer rises with the eastward passage of the centre, the wind usually moderates.

From time to time, high pressure becomes established over part of the adjacent continent and then the wind may blow from some easterly direction with little change for a prolonged period.

State of Sea

A knowledge of the wind is not only of importance in itself, but also because it gives an indication of the state of the sea. The maximum wave height which will be produced by a given wind can be calculated, and tables are available giving the maximum wave height, in deep water, for various wind speeds. While of great theoretical interest, such tables are of limited practical use because of the complications involved. The waves vary according to the duration of the wind, the 'fetch', which is the length of water over which the wind blows unimpeded without change of direction, the depth of water involved, and tidal effects, if any. So, for practical purposes, it is better to know what wave heights *have actually been recorded* in the region. The following table gives the average and maximum wave heights which have been recorded, with various wind strengths, in a part of the North Sea which embraces the present area.

Table 2. Average and maximum wave heights observed with winds of various strengths in the North Sea, south of latitude 56°N and west of longtitude 5°E

Wind Force (Beaufort Scale)	Equivalent Wind Speed (Knots)	Height of Waves	
		Average (Feet)	Maximum (Feet)
3	7–10	2·6	9·2
4	11–16	3·6	9·8
5	17–21	5·2	13·1
6	22–27	no observation	19·7
7	28–33	11·8	23·0
8	34–40	16·2	23·0

These figures represent a limited number of observations and do not cover wind speeds above 40 knots. Such winds certainly do occur, so that the liability for wave heights appreciably in excess of 23 feet should not be overlooked. Naturally with winds above 40 knots, vessels tend to take shelter. Consequently, in addition to the natural decrease in the frequency of occurrence of progressively higher winds, progressively fewer of these yield wave observations as the storm intensity mounts.

Thus there would seem to be a natural tendency for figures based on visual observations to underestimate the extreme maximum wave height. For the North Sea as a whole the maximum wave height that has been observed is 31 feet. For a given wind speed, in this area, winds with a northerly component tend to raise higher seas than do those with a southerly component. The highest seas recorded were associated with winds between west and north. Waves originating in deep water are liable to increase in height as they go into shallow water. Consequently in some situations the seas may be rougher over the shallow parts of the Dogger Bank than elsewhere.

An idea of the seasonal variation of the frequency of rough seas may be gained from the following table which gives, for each month, the percentage frequency of waves of 8 feet and over.

Table 3. Percentage of monthly observations in which wave height was 8 feet or over in the North Sea, south of latitude 56°N and west of longitude 5°E

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
18	14	11	5	3	2	2	4	6	12	21	18

This shows that rough seas are relatively frequent from October to March and comparatively infrequent from April to September.

Fog and Visibility

Fog (meaning visibility less than 1100 yards) is not particularly frequent in this area, but neither is good visibility (more than 10 miles). The average visibility here has been estimated as between 3 and 8 miles. In the southernmost parts of the North Sea most of the fog originates over the land and is most common in winter. This type of fog may drift for appreciable distances over the sea, but, in general, becomes less frequent with increasing distance from the coast. In the more northern parts of the North Sea, remote from land, the fog is mainly 'sea fog' produced by the chilling of moist air over relatively cold water. This type is most common in early summer when the sea is at its coldest relative to the overlying air.

In the region considered the frequency of fog in the various months of the year is given in the following table.

Table 4. Frequency of fog (visibility less than 1100 yards)
(percentage of observations)

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
2	4	4	2	5	7	3	1	2	2	1	2

Fog will be seen to be most frequent in June and least so from August through January.

Temperature

The average air temperature through the year is higher than might be expected from considerations of latitude. This is due to the predominance of mild south-westerlies of Atlantic origin. The mean air temperature over the west-central region is about 5°C (41°F) in January which is the coldest month, and rises to about 16°C (61°F) in July. The air temperature is very dependent upon wind direction, southerlies bringing relatively high temperatures, and northerlies low ones. Since the wind direction is very variable, so also is the air temperature. The range of air temperature is such that, in January, the temperature seldom falls below 1°C (34°F) nor exceeds 10°C (50°F). In July the corresponding probable range is from 12°C (54°F) to 19°C

(66°F). Although 90 per cent of the temperatures in these two months will lie between the limits stated, appreciably higher (and lower) values will occur from time to time.

The most extreme temperatures are experienced with easterly winds from the continent. South-easterly winds in late summer, coming from the heated continent, are liable to cause temperatures well above average, whereas in winter, easterlies which may come from Siberia and travel over continuous snow until they reach the North Sea are liable to produce temperatures below freezing. In January 1963 persistent cold easterlies reduced the air temperature below freezing-point even over the sea. At Hull −10°C (14°F) was recorded on the 26th January 1963. In this unusually cold spell, although there was no general freezing of the sea, ice formed in shallow water near the east coast. At King's Lynn the movement of shipping was halted and large ice floes threatened the safety of the Lynn Well lightship. Farther north, small harbours such as Whitby were almost covered with land-fast ice. During this period, the near freezing temperatures were accompanied by generally fresh winds, which at times reached gale force. This combination of strong winds and very low temperatures is, of course, highly unpleasant.

Apart from causing discomfort, the combination of strong winds with freezing temperatures can produce a still more serious effect. If the upper parts of a vessel or drilling rig are exposed to freezing temperatures, while in rough seas, spray will freeze on to them. If these conditions persist there is liable to be a gradual build-up of ice on these upper parts which, in extreme cases, might cause the vessel or rig to capsize. Most of the area now considered is rather too far south for this to be more than a slight risk even in winter, but in February 1956 a vessel in latitude 57°N, longitude 3°E reported ice forming on her fore part, due to spray freezing on contact; the ice gradually thickened until the shrouds, normally 3-inches thick, increased to 14 inches.

However, in spite of the hazards, the weather in this area can be relied upon in one respect—that is, to provide variety. It will probably be alternately praised for its mildness, and cursed for its inclemency. At least it will not be boring.

Acknowledgements

The principal sources of information used in this article are listed below:

1. London, Admiralty, Hydrographic Office. *North Sea Pilot*. London, Admiralty, vol. III, 12th edn., 1961; vol. IV, 11th edn., 1963.
2. London, Meteorological Office. *Weather in Home Waters and the North-eastern Atlantic*, vol. II, part 5—*North Sea*. London, HMSO, 1940.
3. London, Meteorological Office. *Monthly Meteorological Charts of the Atlantic Ocean*. London, HMSO, 1948, *reprinted* 1959.
4. m.v. *Marna*. Marine Observers' Log, ice. *Mar. Obs., London*, **27**, 1957, p. 6.
5. TUNNELL, G. A.; The Winter of 1962–63 and its Effect upon British Coastal Waters. *Mar. Obs., London*, **34**, 1964, p. 21.
6. Hamburg, Deutscher Wetterdienst. *Seewetteramt*, Einzelveroeffentlichungen, **17**, 1958.
7. Hamburg, Deutsches Hydrographisches Institut. *Nordsee-Handbuch*, No. 2008, 1964.
8. Washington, U.S. Naval Oceanographic Office. *Oceanographic Atlas of North Atlantic*. Washington, 1963.

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Testing Time for a Tanker

By H. J. S. CANHAM, M.R.I.N.A.

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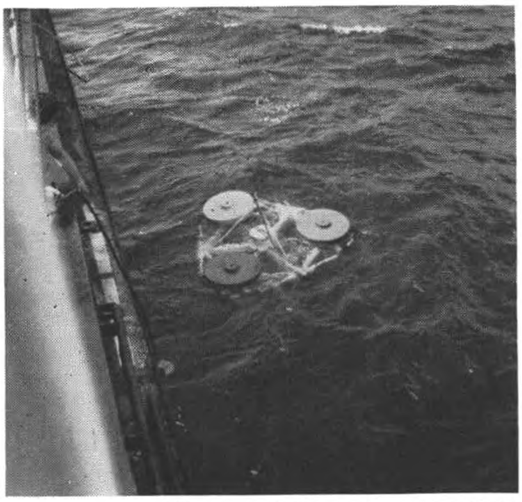
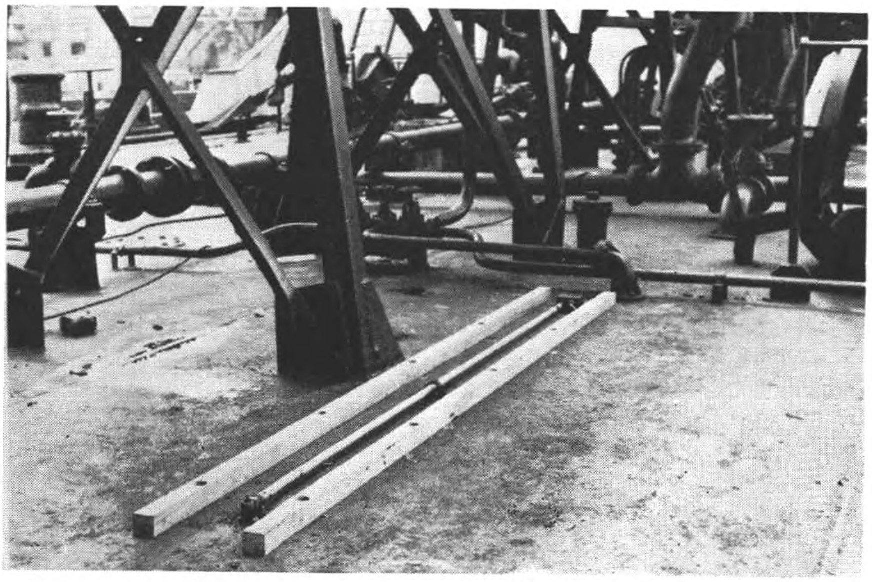
Towards the end of May 1964, the Shell tanker *Hemifusus*, 18,000 tons deadweight, arrived at Rotterdam to discharge a cargo of oil from Venezuela. 24 hours later she departed again in ballast for Curaçao—but this was the start of no ordinary voyage,

(*Opposite page 188*)



Photograph by courtesy of BSRA

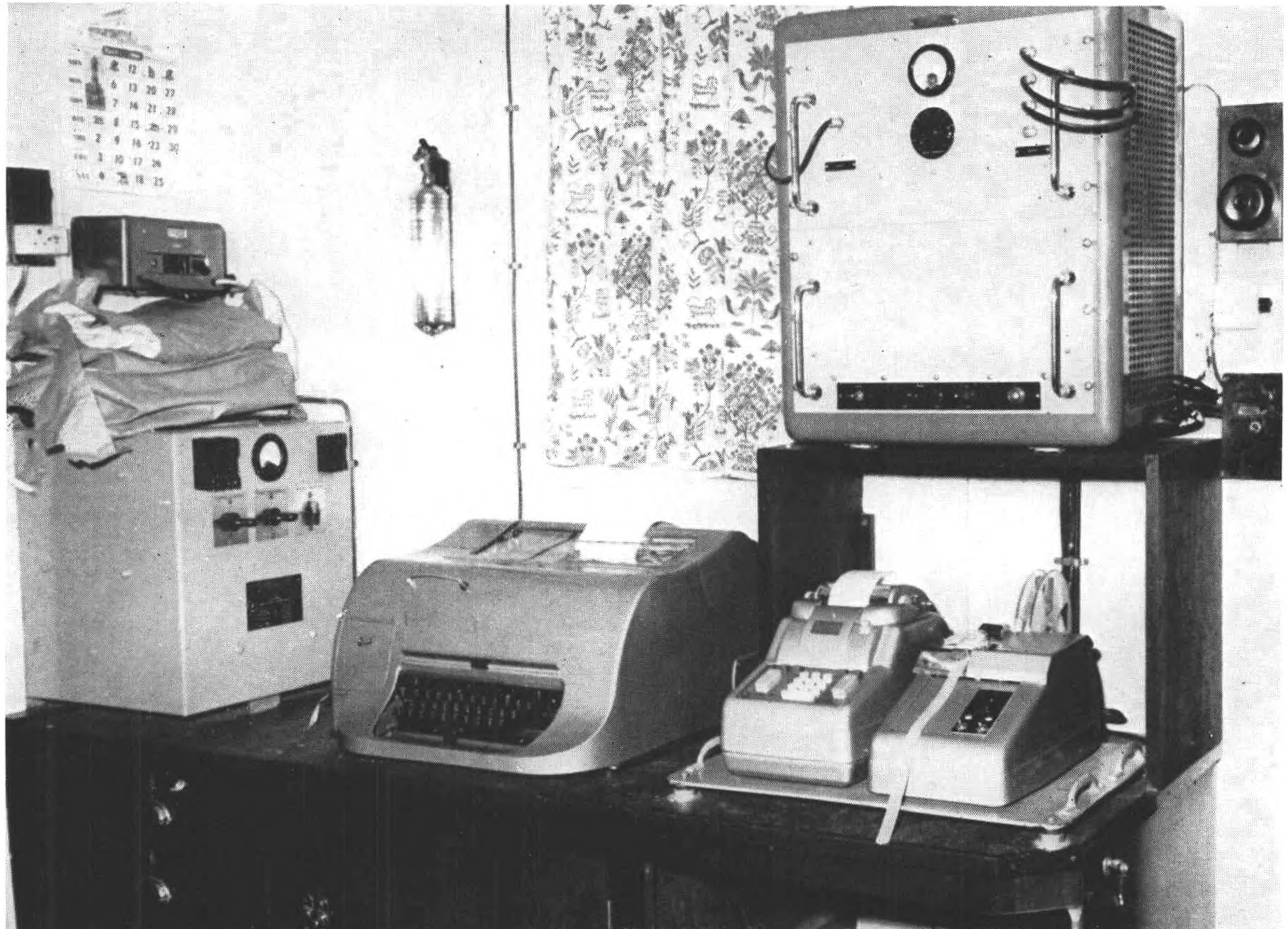
The wave curvature buoy developed by the National Institute of Oceanography being used during the seakeeping trials carried out by *Hemifusus* in 1964 (see page 188).



Photograph by courtesy of BSRA

The strain gauge on the upper deck of the *Hemifusus* (see page 188).

(*Opposite page 189*)



Photograph by courtesy of BSRA

The data handling equipment in the radio office of the *Hemifusus* as used in conjunction with the Autospec equipment (see page 188).

as she had embarked a six-man trials team consisting of research staff from the British Ship Research Association (BSRA) and a scientist from the National Institute of Oceanography (NIO). Already on board was an extensive set of recording instruments which had been installed when the ship had undergone annual refit and dry docking at Malta earlier in the year.

As the vessel moved slowly down channel in thick fog, the trials team made their final preparations to carry out an ambitious programme of trials at sea, the latest in a series which began in 1959 when a similar team—including two members of the present party—accompanied o.w.s. *Weather Reporter* to Ocean Station 'Kilo'. Since then other teams have sailed in the cargo liner *Cairndhu* three times across the North Atlantic in 1960, and yet another team spent an uncomfortable fortnight in 1961 steaming to and from the Faroe Islands in the Research Trawler *Ernest Holt*.

These trials have a common purpose—to obtain scientific data on the performance and behaviour of ships at sea. Only in this way can the reaction of ships to waves be understood better, and advances made towards the design of more seakindly ships or improvements made in the manner in which ships are operated.

The story of the trials voyage of *Hemifusus* is therefore an account of how this work is being tackled in the United Kingdom. Similar work is being done on behalf of the Royal Navy by staff of the Royal Naval Scientific Service and by members of the Royal Corps of Naval Constructors, with whom there has been a free exchange of ideas and experience. This story principally concerns the work undertaken by BSRA in conjunction with NIO and Ship Division of the National Physical Laboratory.

The story of the trials really starts in the headquarters of the principal organizations involved. *Hemifusus* is owned by Shell Bermuda Overseas Ltd., managed by Shell Tankers (U.K.) Ltd. and chartered by Shell International Marine Ltd. All these companies are, of course, closely inter-related subsidiaries of the vast Royal Dutch Shell Group and all are accommodated in the mighty Shell Centre in London. Situated also on the South Bank of the River Thames and about two miles further upstream is the comparatively modest headquarters of BSRA.

The offer of the use of a tanker for seakeeping trials came from Shell International Marine, who are keenly interested in the behaviour of tankers in general and of their own ships in particular; they undertook to make a ship available for special trials for a total period of 96 hours during the course of a normal service voyage. The choice of *Hemifusus* arose from the fact that this vessel had been the subject of an extensive series of repeat measured mile trials since entry into service in 1954, and also because propulsion data recorded during all voyages had been regularly supplied to BSRA. Consequently a good deal was known at BSRA about the propulsive characteristics of *Hemifusus*. Another factor influencing the choice of ship was the expected route to be taken during the trials voyage. For reasons which are explained later on, it was hoped to carry out an important part of the trials in the particular sea conditions which are described by oceanographers as long-crested, unidirectional waves. This is the kind of swell which is met when the local wind is light and the waves have travelled into the area from afar, or when moderate or fresh winds blow steadily in the same direction for several days at a time.

A study was made of meteorological data to find out where there was a reasonable chance of meeting these particular wave conditions. Prospects seemed good in the region of the south-easterly trades in the South Atlantic. Now *Hemifusus* is chiefly employed in the world-wide distribution of lubricating oil from the Shell refinery at Curaçao, and Durban is among the major ports to which Shell deliver supplies. It was therefore arranged by Shell that the seakeeping trials would be carried out during a voyage from Curaçao to Durban and then from Durban to Lagos, Nigeria. This was to give an opportunity for trials to be carried out with the ship loaded and in ballast. The trials party joined the ship in Rotterdam in order to carry out calibration trials at Plymouth and to test the recording installation under realistic conditions during the passage to Curaçao.

The trials party wanted to find out how waves influenced the speed made good, the stresses induced in the main hull structure, and the amount of pitching and rolling. These are obviously related to the particular wave conditions encountered. The important thing is to be able to relate 'cause and effect', in other words to be able to show that a specific set of wave conditions caused the ship to behave in an equally specific manner. If information of this kind can be secured for a wide variety of wave conditions, scientists can then say how far it will be possible to predict the behaviour of the ship in wave conditions different from those actually encountered. This must be done in order to assess the seakeeping qualities of the ship on all stages of its normal trading. If this can be done for different ships, their respective qualities can be compared and their suitability for each particular trade route can be judged accordingly. Behaviour in waves is only one of the factors to be considered in attempting to produce optimum designs for particular purposes, but it is obviously an important factor. It is therefore essential to develop a satisfactory technique for determining the sea-going qualities of a ship designed to operate on a particular trade route, and the impracticability of experimenting with different designs on the full scale means that calculations must be made or model tests used to provide the information required.

The nature of the interaction between a ship and a wave is complex enough, even when the wave is one of a number of identical ones forming part of a system of regular waves. Wave systems encountered at sea are much more complicated than this even when all waves travel in the same direction. It is not hard to appreciate why, purely from the scientific point of view, the uniform wave system, if it ever existed at sea, would provide an ideal starting point for experiments on ships. The relationship could easily be determined between the amount of pitch and the wave height when the ship was moving at a particular speed and at a course angle relative to the direction of the waves. Such experiments could easily be repeated in the model testing tank and the results would show directly if there was any significant effect attributable to changing the scale of the experiment. The next best thing is to experiment in sea states which have all the waves travelling in one direction but which contain waves of different heights and lengths. This is, of course, the long-crested unidirectional sea mentioned earlier on. By analysing a continuous record of wave height, it is possible to say what combination of regular waves, all present simultaneously and all travelling in the same direction, would produce a wave pattern which to all intents and purposes is identical with that actually recorded.

Now there are various ways in which wave records can be taken, but as the waves of prime interest are those causing the ship to pitch or roll, it would appear logical to record them from the ship itself. Unfortunately this is not a simple matter even in regular waves as the ship affects the waves around it and a false measure is obtained of the wave heights. The influence of the ship varies according to its speed and direction of encounter with the waves. Waves must therefore be measured a short way from the ship. It is unimportant that the measured waves may not actually be those causing the ship motions which are being recorded; by taking wave records of sufficiently long duration it is possible effectively to isolate all the regular wave components which are present and it is safe to assume that similar component waves are reaching the ship. No information can, however, be obtained about the phasing of each regular wave component to the corresponding components of pitch, roll or wave-induced stress unless the waves are recorded from the ship.

Since the waves at sea are seldom completely unidirectional, the real problem is how to deal with situations where there are waves coming from several directions. In particular, it is possible for waves coming from different directions to have the same period of encounter at the ship. Since all the separate responses due to these waves will also have the same encounter period, it will be impossible to say how much of the overall response at this period is due to the waves in any particular direction. This is an unsatisfactory situation for the scientist, and is best avoided by taking records in sea states in which waves have a limited spread of direction, a feature of long-crested waves.

Scientists at NIO have developed several different types of wave recorder. One is known as the shipborne wave recorder or Tucker meter and is installed in a ship. Others are called wave recording buoys and usually take the form of freely floating discs containing sensing instruments and are either attached by floating line to recording instruments in the ship, or are completely self-contained. In the trials on *Hemifusus*, a more sophisticated piece of equipment known as a wave curvature buoy was used in addition to a shipborne wave recorder. The former was the result of considerable development work by NIO and represents the most advanced method of recording waves yet devised. The buoy itself contains only sensing equipment and records are taken in the ship. By a suitable method of analysis, the heights, periods and directions of the component waves can be identified from these records, (see photograph opposite page 188).

Another factor of considerable importance to the success of the trials was the desirability of conducting trials when wave heights, periods and directions are not changing rapidly. Stable conditions were expected in the South Atlantic, but the problem was how to ensure as far as possible that valuable trials time was not expended fruitlessly owing to sudden changes occurring in sea state. Discussions took place between BSRA, Shell and the Meteorological Office and a scheme was devised for providing the ship with weather and sea state forecasts during the voyage.

Hemifusus is one of a number of ships in the Shell fleets selected by the owners for extended performance studies. On this account the ship had been equipped with Marconi Autospec equipment for transmitting coded data between ship and shore, (see photograph opposite page 189). The method used is an adaptation of the teleprinter system of communication, a radio link replacing the usual telegraph line. Plain language messages or numerical data are coded on punched tape which is fed into a tape reader when the radio link has been set up in the usual way. A teleprinter at the receiving end prints out the message or data. Each Shell ship equipped with Autospec is in daily contact with Shell Centre by this means. On *Hemifusus* the system could be used in either direction for the duration of the trials voyage. As this facility was available, it was decided by Shell that weather information should be passed to *Hemifusus* each day via Shell Centre. The Meteorological Office therefore made arrangements with their opposite numbers in Pretoria and Washington for each authority to provide special forecasts each day, on request, of wind, weather and predominant wave data within 100 miles of a stated position and a statement as to the likelihood of suitable waves prevailing during a 12-hour daylight period, while the ship was within the limits of their particular forecast area. Shell also arranged for a Hellfax Facsimile recorder to be installed in the ship for the duration of the trials. This was used for receiving weather charts from Bracknell, Nairobi and Washington. The link between the ship and the various Meteorological Offices via Shell Centre was highly successful and the special daily forecast was nearly always received on board ship in time to programme trials for the next day. The accuracy of the forecast was good when the ship was in established forecasting areas, particularly in regard to wind speed and direction and information about sea waves. Unfortunately much of the routes taken by *Hemifusus* was in comparatively ill-frequented ocean waters, and it was then impossible for the meteorological authorities to give adequate information about swell conditions.

In addition to the various instruments and equipment previously mentioned a Sal speed log had been installed in the ship specially for the trials jointly by Shell and BSRA. Already fitted in the ship for recording routine propulsion data were an AEI electric torsionmeter and a Michell thrustmeter for measuring propeller shaft torque and thrust respectively. Shell also installed a Maihak torsionmeter specially adapted by them for recording purposes. BSRA installed instruments for sensing pitch and roll angle, heave acceleration, rudder angle, ship's course, wind speed and direction, and a number of long-base gauges for measuring strains at various points in the Upper Deck, (see photograph opposite page 188). All sensing instruments were connected by electrical cables to a central recording position set up in the ship's office. Installed here were analogue and digital recording systems. The analogue version consisted of a standard multi-channel ultra-violet light recorder. In this kind of recorder spots of ultra-violet light are focussed by mirrors on light-sensitive moving chart paper. The mirrors are attached to galvanometers and are deflected according to variations in the electrical signals received from the sensing instruments. The digital system comprised a digital voltmeter, a device which measured the instantaneous value of each signal and passed the information to a high speed tape punch. The digital voltmeter is rapidly connected to each signal in turn, the process being repeated continuously. The results are stored on punched paper tape. In this way 16 measurements were transferred to punched tape every second while recording was in progress.

As previously mentioned, the passage from Rotterdam to Curaçao was mainly occupied by speed log calibration trials on the measured mile close to Plymouth and in testing the recording installation. The passage could not be utilized for trials purposes as tank cleaning had to be completed before the ship arrived at Curaçao, but the special wave forecasts were regularly received by radio from U.K. or U.S.A. as appropriate. The tank cleaning was finished in good time and towards the end of the passage the ship was stopped for a test launching of the wave curvature buoy. By special arrangement with the GPO the data recorded on punched tape during this test were transmitted that evening by radio link to Portishead and thence by telephone line to Shell Centre, where a duplicate tape was punched from the incoming signals. This tape was delivered next day to NIO who examined it for faults. A satisfactory report was sent to the ship while loading at Curaçao. Less than 48 hours after arriving at Curaçao the ship was setting course for Durban.

Moderate to fair weather conditions were experienced during the first half of the passage and the sea state remained unsuitable for special trials. The expected south-easterly trade winds were encountered less than one week after leaving Curaçao, but there was also swell from the east. The wind remained steady in direction for a further week, generally between force 3 and 5 but occasionally reaching force 6, whilst the direction of the swell changed from easterly to southerly. At the end of this period the wind rather unexpectedly veered to the south and increased to force 7 or 8. After blowing steadily for 24 hours the wind died away but there remained a substantial swell with a maximum wave height of about 35 feet. This provided a valuable opportunity of studying the behaviour of the ship in heavy seas, and a manoeuvre was carried out in which the ship was steamed at two different speeds on courses taking her in turn into head, bow, beam, quartering and following seas. At the end of this manoeuvre the wave curvature buoy was successfully launched and recovered in difficult circumstances, thereby adding to the value of the exercise. The approximate position of the ship at the time was 23°s, 6°w.

From then until passing Cape Agulhas the wind remained at force 3–5 between south-east and south-west and the swell from south-east or south. Several other manoeuvres were carried out in waves of 10–15 feet maximum height, and the total time spent on trials during the passage was nearly 36 hours. Over 50 sets of records were also taken while normal course and speed were maintained.

Durban was reached 22 days after leaving Curaçao, the passage from Cape Agulhas being uneventful. Discharging took three days. On leaving Durban the ship was in a very light condition since, in order to avoid contaminating the remaining cargo of lubricating oil, tanks had to be filled with ballast water from hoses. This is a slow business and the valuable time is saved by doing this at sea. Because the forward draught was so light, the ship started to pound in quite a moderate head sea and speed had to be reduced for the next 24 hours. The maximum wave height was only about 9 feet but the waves appeared to be unusually steep, and this was attributed to the wind and swell being in opposition to the Agulhas current.

On rounding Cape Agulhas course was set for St. Helena instead of directly for

Lagos. This had been planned beforehand to take advantage of any long-crested wave conditions existing in the trade wind area. A seakeeping manoeuvre was carried out in a southerly swell and light wind on the day after rounding the Cape. This southerly swell persisted on reaching the trade winds, and eventually it was decided to set course for Lagos. As it happens, good conditions for further trials were met after leaving behind the trade winds owing to the continued existence of southerly swell. Time spent on trials between Durban and Lagos finally totalled 33 hours, and nearly 30 sets of records were taken under normal steaming conditions.

The last two days of the passage saw the trials party making preparations to leave the ship at Lagos and to land all the specially installed recording equipment. By the time Lagos was reached they had used approximately 1½ miles of recorder chart paper and no less than 54 miles of punched tape. The work of analysing this large quantity of recorded data began in earnest as soon as the party returned home. The complexity of the analysis programme requires a very large computer for the task of reducing the digital data to more meaningful results, and this is now being done by ATLAS computer. Already the full results of two seakeeping manoeuvres have been analysed, and others will follow in quick succession now that all the extremely complicated computer analysis programmes have been prepared and tested.

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'Freak' Ocean Waves

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The following article, which originally appeared in the May 1964 (Vol. X, No. 4) issue of *Oceanus*, is reproduced by kind permission of the Editor. *Oceanus* is the magazine of the Woods Hole Oceanographic Institution, Massachusetts, U.S.A.

Stories abound of monstrous waves; every sailor has his tale of how a great wave arose from nowhere and hit his ship leaving a trail of damaged lifeboats and shattered crockery. Estimates of the heights of the highest waves which can be encountered at sea vary widely. Cornish reported a freak wave 70 feet from crest to trough seen in the North Pacific in 1921, and waves of 80 feet and possibly higher in the North Atlantic in 1923. More recently, in 1956, Captain Grant of the cargo vessel *Junior* reported a wave estimated to be 100 feet high about 100 miles off Cape Hatteras. There must be many more reports of similar waves in the history of the seas. As early as 1826 Captain Dumont d'Urville, a French scientist and Naval Officer in command of an expedition, reported encountering waves 80 to 100 feet high. The poor fellow was openly ridiculed for making such an outrageous report, even though three of his colleagues supported his estimate. Perhaps the most famous reliable report was that of the wave encountered by U.S.S. *Ramapo* in the North Pacific in 1933; that wave was estimated to be 112 feet high, a monster indeed.

Although such events happen only rarely, this does not mean that their likelihood of occurrence is not predictable. There are two aspects of this problem. One concerns what happens on a sea when a large number of wave components each with its own period and height, are travelling along together at slightly different but constant speeds. As the components continually get into and out of step with each other they produce the groups of high waves followed by brief intervals of relatively quiet water which are characteristic of all sea waves. Every now and then, just by chance, it so happens that a large number of these components get into step at the same place and an exceptionally high wave ensues. The life of such a wave is only a transient one, being not much more than a minute or two. Because each wave component is travelling at its own characteristic speed, the faster ones will escape from the others and the monster wave will die just as surely as it was born. The energy it contains belongs to its component wave trains, which still exist and travel on, taking their energy with them. Somewhere else in the storm at some other time some other wave trains will, again just by chance, coincide and produce another large wave which will have its brief moment of glory before disappearing for ever into the random jumble of the sea. Although we are never likely to be able to predict just where and when an exceptionally high wave will appear, because the instrumentation problems involved are immense. The probability of occurrence of any such wave is finite and can be predicted; its calculation has the apparently contradictory title of Statistics of a Stationary Random Process. Using this theory, it has been shown that whilst one wave in 23 is over twice the height of the average wave, and one in 1,175 is over three times the average height, only one in over 300,000 exceeds four times the average height.

The second aspect of the problem, also concerned with the prediction of the occurrence of exceptional waves, has a different basis. The probability of occurrence of unusual events such as severe storms, heavy rainfall, or hot summers, can be predicted by the Statistics of Rare Events. This technique has been used extensively by meteorologists in the study of natural phenomena and has proved to be a useful tool. The probability of occurrence of storms of any severity can therefore be calculated. From a series of recordings of wave conditions over a period of time such as a year, it is possible to estimate how often waves of any given size will occur by using these two methods. The longer the time over which the recordings have been made, the more reliable will be the prediction.

It is only about 13 years since it became possible to measure waves in the open sea from a ship with acceptable accuracy, and so provide a check on whether or not the stories of monstrous waves were to be believed. One of the British Ocean Weather Ships, operating in all weathers in the North Atlantic, has carried such a shipborne wave recorder for 12 years. As the ship is on station for about two-thirds of the time, the National Institute of Oceanography now has a long series of wave records which were taken for 15 minutes every three hours. At first the scale of the instrument could record waves 50 feet high from crest to trough, but very soon it was found that waves higher than this were not uncommon and the scale was increased to 60 feet. This proved to be adequate for about nine years, but on 12th September 1961 the *Weather Reporter* lay close to the track of the dying hurricane 'Betsy', and as she made her routine recording at 0900 the pen dipped and touched the lower edge of the chart and then rose rapidly and 'hit the stops' at the top—a wave over 60 feet high. A crest was fitted to this wave and it is estimated that the true height of the wave was not less than 67 feet from crest to trough. The period of this wave was 15 seconds, which meant that the Weather Ship was lifted over 60 feet in 7½ seconds and then dropped almost as far in the succeeding 7½ seconds! The probability that we actually recorded the highest wave which hit the vessel is fairly small, because the instrument is operated for only about 8 per cent of the time. Using the first method described above one can compute that the highest wave which was felt by the Weather Ship during that storm was probably about 80 feet from crest to trough. At the present time the wave which *Weather Reporter* measured is the highest one which has ever been recorded by an instrument—conservatively estimated to be 67 feet from crest to trough.

Because the proportional area of an ocean which is occupied by vessels is incredibly small, it follows that only a minute proportion of the exceptional waves which must occur each year in an area such as the North Atlantic are ever noticed by man. It therefore seems reasonable to suppose that with only one vessel equipped with a wave recorder regularly at sea in the North Atlantic, the chance that our 67-foot wave is the highest which ever occurred is small indeed. We must by no means claim that the report from the *Ramapo* was exaggerated.

Although one is inevitably surprised when an exceptional wave appears to rise from an apparently ordinary rough sea, and everyone who sees or feels it labels it as a freak, it is fair to say that no miracle is being witnessed; the chance of this occurring does seem to obey well established physical laws, so that the probability of occurrence of a wave of any specified height, or the probable height of the highest wave which will occur in any specified length of time, can be calculated with an acceptable degree of precision. After all, the latter problem is raised by every good engineer who hopes to build a structure in the sea, and oceanographers are expected to provide the answer.

551.466.3

THE ONE FROM NOWHERE

Under the above heading in the February 1965 number of *The British and Commonwealth Review* (the 'house magazine' of The British and Commonwealth Shipping Company), Commodore W. S. Byles, R.D., Master of the *Edinburgh Castle*, wrote an article concerning an experience which he had on 21st August 1964 when bound along the South African Coast from Durban to East London. By kind permission of the Editor, we quote from his article.

"Ever since the *Waratah* was lost without trace, having sailed from Durban to Cape Town on 26th July 1909, Cape coastal waters have been suspect and especially in the vicinity of Port St. Johns. There was a report that she had been 'spoken' and reported 'all well' off Port Shepstone; she had a morse lamp but no wireless.

"On 21st August 1964 in 31° 39'S, 29° 46'E, the *Edinburgh Castle* was experiencing a strong south-west wind and a heavy south-west swell but, being 750 feet long and of 28,600 gross tonnage, these conditions presented no serious problem to her. As she dipped to the swell she was spraying forward a little, and (on the big ones) shovelling up a little water through the hawse-pipes. The reputation of the coast, my previous experiences and my desire to avoid damage of any sort, decided me to abandon the benefit of the Agulhas current, put up with a later arrival and close the coast. For the benefit of those who have no experience of the coast, I should state here that in soundings of 100 fathoms or less the heavy swell is much less steep and has a longer wavelength than in the deeper water so that you may keep the benefit of full speed or near it, on the other hand you have to sacrifice the help of the current further offshore which can be as much as 4 knots, but in which you may find that you have to heave to should the swell become too steep. To further ensure that no untoward incident should occur, I took a knot off her speed and, to close the coast I had, of course, put the swell cosily on the bow instead of driving into it head-on. Under these conditions she was very comfortable for three-quarters of an hour or so. The distance from one wave top to the next was about 150 feet and the ship was pitching and scending about 10–15 degrees to the horizontal. And then it happened. Suddenly, having scended normally, the wavelength appeared to be double the normal, about 300 feet, so that when she pitched she charged, as it were, into a hole in the ocean at an angle of 30° or more, shovelling the next wave on board to a height of 15 or 20 feet before she could recover, as she was 'out of step'.

"It was a hot night and so that the passenger accommodation might get some air, the steel doors at the after end of the foredeck had been left open but, due to an oversight, this information was not passed to the Bridge, so that not only was the foredeck swept with a wall of water which unseated the insurance wire reel which damaged a winch in its travel, and swept away the athwart-ship rails and the ladder to the well-deck, but a great quantity of water flooded into the passenger accommodation.

"The lessons to be learned are twofold. Firstly, that whatever the weather prevailing the forward steel doors must always be shut and remain shut on passage from Durban to East London because when this happens there will be no warning. The waves are no higher than their fellows, and in perspective the 'hole' is not visible until the ship is about to fall into it! Secondly, that as this is out of keeping with the weather prevailing at the time, such a thing could happen in conditions of little or no wind at all.

"Inevitably one wonders about the cause of such irregularity and I call to mind that some years ago when the late Captain J. C. Brown, R.D., was in the *Pretoria Castle* he reported having discovered a fissure in the ocean bed somewhere off St. Johns. It was clearly shown on the echo-sounder paper. He was in deep water at the time and possibly the report did not receive the attention it deserved.

"It is conceivable that this is a case of a local disturbance due to a rift in the sea bed. It may be very local, or possibly on a line of unknown length. It may always be there or it may only be there when the current is running strongly and there is a heavy south-westerly swell. As to the current, I might here remark that divers operating in the anchorage at East London have found that often when there is no surface current there is a strong current over the bottom and vice-versa so that observations at ship are by no means an infallible guide.

"Another question which poses itself is: why, after hundreds of voyages between Durban and East London, have I never experienced this before? I think the answer to that is that, in any event, it is very locally confined, and if it be a line as opposed to a spot, it is still easily possible to pass outside it, inside it, or to close or open the coast north or south of it. I have closed the coast before to get out of an awkward swell, but the decision to do this was taken at the time and my ship may well have been north or south of her position on this occasion, though, as far as I can recall, the action was always taken somewhere 'off St. Johns'. In this case the ship was just closing the hundred fathom line on a true course of 260°."

Commodore Byles's article was reported in the national press and brought the following comments from Commander I. R. Johnston, R.N. (retired):

"When I was serving in the cruiser *Birmingham* during the Second World War we had a similar experience in those waters one night which I recall the more vividly for being on watch at the time. We were about 100 miles south-south-west of Durban on our way to Cape Town, steaming fast but quite comfortably into a moderate sea and swell when suddenly we hit the 'hole' and went down like a plummet into the next sea which came green over A and B turrets and broke over our open Bridge. I was knocked violently off my feet, only to recover and find myself wading around in 2 feet of water at a height of 60 feet above normal sea level.

"The ship was so jarred by the impact that many of the watch below thought we had been torpedoed and went to emergency stations. The Captain immediately reduced speed but the precaution proved unnecessary as the moderate conditions returned as before and no further 'holes' appeared.

"This experience, occurring as it did in pitch darkness in a blacked-out ship, was quite one of my most alarming at sea and I can well believe that a deeply laden ship might founder under similar circumstances.

"In subsequent discussions we put the phenomenon down to the shelving of the Agulhas bank; this would account for the steepness of the swell but not entirely for the sudden increase in swell length."

Mr. L. Draper, whose work at the National Institute of Oceanography over the past 12 years has been mostly concerned with ocean waves, comments:

"This report is extremely interesting. The conditions were quoted as being of 'heavy swell', the familiar characteristics of which are groups of large waves followed by an interval of relatively small waves. In this type of situation the continual change of high to low groups is caused by the components of the waves getting into and out of step with each other. The heights of the waves in any particular group will depend on just how well they are in step; just occasionally all the components will coincide and a particularly high wave will seem to appear from nowhere, and then die as rapidly. Such a wave would be labelled a 'freak wave'. Although this is what one generally thinks of as a freak wave (an unusually high crest) there is just as much chance of a freak trough occurring, but such a depression could only be seen by a vessel which was very close to the 'hole'; this is probably why they are only rarely reported. If the depth of this 'hole' were, say, more than five times the average trough-depth, the chance of it occurring once would require the time equivalent of scores of lifetimes at sea, so perhaps there is no wonder that such things are rarely seen. If this is so, perhaps Commodore Byles is a very privileged man to have seen something which he is unlikely to encounter again until he has spent another thousand years at sea!

"The predominance of heavy swells near the Southern Ocean means that the chance of such a 'hole' occurring is probably higher there than in other parts of the world."

An article on freak ocean waves by Mr. Draper appears on page 193 of this number of *The Marine Observer*.

L. B. P.

551.5:341.24:614.86:656.6

METEOROLOGY AND THE INTERNATIONAL CONVENTION ON SAFETY OF LIFE AT SEA (1960)

In June 1960 after a month's conference in London under the auspices of the Inter-Governmental Maritime Consultative Organization (IMCO), a new International Convention for the Safety of Life at Sea to replace the 1948 Convention was drawn up and signed by the representatives of over 40 countries. But the mere signing of such a convention by delegates from various countries does not mean that it comes into force right away; its implementation costs money on the part of the countries concerned and the necessary legislation has to be prepared on a national level, the convention, which is necessarily a lengthy technical document, has to be translated into the national language, and much preparatory work has to be done by the countries concerned before it can come into effect. It was not until May 1965 that this new convention came into force internationally.

Chapter 5 of the Convention is entirely devoted to safety of navigation and Regulations 2, 3 and 4 are directly concerned with meteorology. Regulation 2—"Danger messages"—prescribes that the master of every ship which meets with "dangerous ice . . . or a tropical storm or encounters sub-freezing air temperatures associated with gale force winds causing severe ice-accretion on superstructures or winds of force 10 or above on the Beaufort scale for which no storm warning has been received, is bound to communicate the information by all the means at his disposal to ships in the vicinity and also to the competent authorities at the first point on the coast with which he can communicate." The Regulation goes on to say that the message may be transmitted either in plain language or by means of the International Code of Signals and that it must be broadcast and transmitted point-to-point to a suitable radio station ashore, for onward transmission to the appropriate authorities. Each Government must ensure that such information after receipt ashore is properly disseminated for the information of all concerned.

Regulation 3 prescribes the information to be contained in these danger messages. Thus a tropical storm message should include, a statement that a tropical storm has been encountered or that the master has good reasons to believe that such a storm is developing or exists in the neighbourhood, the GMT date and position of the ship, barometric pressure and tendency, wind force and direction, state of the sea in general terms, state of the swell and direction from which it comes, and the true course and speed of the ship. In addition, when a master has reported a tropical or other dangerous storm, it is desirable but not obligatory that further observations be made and transmitted hourly if practicable but in any case at intervals of not more than three hours as long as the ship remains under the influence of the storm. This Regulation explains that the provision of messages concerning winds of force 10 or above, "for which no storm warning has been received", is intended to deal with storms other than tropical ones; in other words this is meant to provide for such instances in temperate zones. The danger message in this case should contain similar wording to that used for tropical storms but can exclude detail about sea and swell. Reports concerning ice accretion should include the air temperature, sea temperature (if practicable) and wind force and direction. Examples of all these messages are given at the end of this Regulation.

Under Regulation 4—Meteorological services—the contracting governments undertake "to encourage the collection of meteorological data by ships at sea and to arrange for their examination, dissemination and exchange in the manner most suitable for the purpose of aiding navigation". In order to do this, the contracting governments agree to co-operate in the recruitment of selected ships and to equip them with the appropriate tested instruments and "to encourage other ships that take observations in a modified form, particularly in areas where shipping is sparse, to transmit their observations by radio." The contracting governments also undertake to arrange for the reception and transmission by coast radio stations of weather messages from and to ships; to warn shipping of gales, storms and tropical storms both by radio and by visual signals; to broadcast radio weather bulletins for shipping containing actual data and forecasts and, when practicable, "sufficient additional information to enable simple weather charts to be prepared at sea and also to encourage the transmission of suitable facsimile weather charts"; to provide whatever publications are necessary for meteorological purposes; and to arrange, if practicable, the issue of daily weather charts for ships leaving harbour.

The Regulation further prescribes that all these arrangements shall conform, as far as practicable, to the Technical Regulations and Recommendations of the World Meteorological Organization (WMO), and that the radio weather bulletins etc., shall be issued and disseminated in such a way as to provide the best service for shipping in the various oceanic areas, in accordance with mutual arrangements. In other words, this Convention supports the endeavours of the WMO to provide an adequate network of observations from ships so that national authorities can, in their turn, provide adequate meteorological advice for shipping, in all oceans.

Regulations 5 and 6 describe the North Atlantic Ice Patrol Service.

Concerning tropical storms, these Regulations only differ in one matter of detail from those of the 1948 Convention, which, in turn, only amplified to a minor extent the 1932 Convention. The 1932 and 1960 Conventions both prescribed that a danger message should be issued "whenever the master has a good reason to believe that a tropical storm is developing or exists . . ."; the 1960 version reads "whenever the master has good reason to believe that a tropical storm *is developing* or exists . . .". It is not very surprising that there have only been minor changes in this Regulation since 1932, because the danger from tropical storms was just as real then as it is now and the need for reports from as many ships as possible in such conditions is just as great now as it was in 1932. It is quite impossible to issue accurate storm warnings if the meteorological service concerned has not enough reports to build up its weather map.

There is evidence that, despite the long time that this obligation upon shipmasters of reporting tropical storms has been in force, not all ships transmit these danger messages on all pertinent occasions. At the Fourth Session of the Commission for Maritime Meteorology of the WMO it was recommended that the necessity of fully complying with this regulation be drawn particularly to the attention of shipmasters. At a subsequent meeting of the Maritime Safety Committee of IMCO, in May this year, the Chairman suggested that if all ships fully complied with this regulation, there would be an appreciable improvement in the accuracy of tropical storm warnings—which are known to be somewhat deficient in this respect in some areas due to a shortage of ship reports.

The 1960 Convention also differs from its predecessor in the provision of danger messages when winds of force 10 or above are experienced, for which no storm warning has been received, or when ice accretion is being experienced on superstructures, and in the inclusion of a reference to wave data, the use of facsimile charts and the availability of daily weather maps when practicable for ships leaving harbour.

C. E. N. F.

551.326.7(261)

NOTES ON ICE CONDITIONS IN AREAS ADJACENT TO THE NORTH ATLANTIC OCEAN FROM APRIL TO JUNE 1965

Canadian Arctic Archipelago. There was a continuous covering of ice in this area over most of the period, but there was temporary breaking and weakening of the ice cover around the islands in the south late in May. Throughout the period there were large breaks and leads in the Beaufort Sea which became more evident late in June. Snow cover remained 1–2 feet deep over most of the period but it had almost cleared generally by the end of June. There was much hummocking and ridging, probably slightly more than normal, and towards the end of June extensive puddling occurred in the north of the Archipelago.

Baffin Bay. The normal complete covering of ice was experienced but it was lighter and there were only small amounts of polar ice. Off east Baffin Island beyond the fast-ice there was hummocking and openings in the ice cover all along the coastline. Early in April, a large area of open water developed towards Cape Dyer which is unusual. The amount of ice in Smith's Sound and Kane Basin and other areas in the far north of Baffin Bay was greater than normal but it was mobile.

In all areas the seasonal decrease and retreat of ice was largely normal. Early in the period the general snow cover was about 1 foot deep; by the end of June it had decreased materially.

Foxe Basin. This area was largely normal and the snow cover was approximately 1–2 feet deep. Late in May breaks in the ice and hummocking with leads were observed in the north-west of the area and off the north-west of Foxe Peninsula. The latter developed and increased steadily onward to the end of June. The pack-ice was mainly winter and well broken in the above areas.

Hudson Bay. In April the ice situation was again largely normal. There was large scale hummocking, with leads and open water in the southern half of the Bay. In the latter half of May large areas of open water developed in the north and north-west and leads and openings in the south-west. Towards the end of June the areas of open water increased generally north of 61°N and further large areas of open water developed along the east shore of the Bay. Throughout the period the covering of winter ice was well broken when observed. The break-up in the north was more rapid than normal.

Hudson Strait. Very open pack appeared against the north shore in April west of 70°W and there were icebergs reported off the eastern entrance to the Strait. Towards the middle of May the openings had disappeared. The seasonal break-up appeared with extensive areas of open water west of Ungava Bay. Mainly well broken winter ice was experienced here. Towards the middle of June the break-up was rapid particularly at the eastern entrance and along the north shore where well broken winter ice was experienced mainly in the form of open pack.

Davis Strait. Throughout the period warm Atlantic water was evident in the Strait but much cold water with associated pack-ice and icebergs moved northwards along the west Greenland coast. During May there were large areas of cold surface water west and south of Cape Farewell.

Off Baffin Island and at the mouth of the Hudson Strait conditions fluctuated but open water and weak ice predominated. Large areas of open water occurred north-east of Cape Dyer and in Frobisher Bay temporarily in late April but the more permanent break-up began towards the end of May.

Labrador Sea. During April the extent of the southward flow of pack-ice was normal. It consisted mainly of winter ice with small, medium and large floes. Snow cover over the coast early in April was about 5 feet deep and this steadily decreased throughout the period. Late in May a large mass of Arctic water moved southwards and accumulated off southern Labrador and Newfoundland. The cold water and the pack-ice steadily dispersed. In the latter half of June there was little pack-ice south of 55°N and by the end of June there was little ice south of Cape Chidley. This was a very light year for pack-ice.

East Newfoundland Coast and Great Bank. All types of ice dispersed rapidly during April. Icebergs penetrated east to 45°11'W (49° 04'N) and south to 42° 45'N (49° 30'W). Early in May no ice remained off Newfoundland except in close proximity to the north-east coast.

Belle Isle Strait. The amount of ice in the Strait was below normal. During April there were areas of open water against the north shore but otherwise the Strait was obstructed by close pack consisting of winter ice mainly in the form of moderate-sized floes. Towards the end of May there was an increase in the amount of pack-ice passing through the Strait into the Gulf of St. Lawrence and filling a considerable part of the north-east arm of the Gulf. However by

Table 1. Icebergs sighted by merchant ships in the North Atlantic

(This does not include growlers or radar targets)

Limits of Latitude and Longitude		Degrees North and West												
		66	64	62	60	58	56	54	52	50	48	46	44	42
Number of bergs reported south of limit	April	*	*	598	578	519	474	403	363	339	90	0	0	0
	May	*	*	*	*	*	154	153	149	148	128	18	8	0
	June	*	*	381	369	337	234	209	186	64	5	0	0	0
	Total	*	*	*	*	*	862	765	698	551	223	18	8	0
Number of bergs reported east of limit	April	598	597	562	494	460	404	319	222	140	113	3	0	0
	May	*	*	*	*	*	154	138	80	43	30	2	0	0
	June	381	380	354	254	217	189	48	2	0	0	0	0	0
	Total	*	*	*	*	*	747	505	304	183	143	5	0	0
Extreme southern limit	April	46° 05′N 47° 25′W on 1.4.65												
	May	42° 45′N 49° 30′W on 28.5.65												
	June	46° 05′N 52° 00′W on 3.6.65												
Extreme eastern limit	April	49° 04′N 45° 11′W on 24.4.65												
	May	47° 50′N 45° 45′W on 4.5.65												
	June	46° 17′N 51° 45′W on 7.6.65												

* Probably large numbers, but none sighted in excess of those reported in further south positions or in further east positions.

Table 2. Baltic Ice Summary: April–June 1965

No ice was reported at the following stations during the period: Kiel, Tonning, Husum, Emden, Lubeck, Gluckstadt, Bremerhaven, Flensburg, Stettin, Goansk, Göteborg, Aarhus, Copenhagen, Kristiansandfjord.
No ice was reported at any of the stations during June.

Station	April 1965									May 1965								
	Length of Season		Ice Days			Navigation Conditions			Accumulated Degree Days	Length of Season		Ice Days			Navigation Conditions			Accumulated Degree Days
	A	B	C	D	E	F	G	H	I	A	B	C	D	E	F	G	H	I
Leningrad	1	30	13	3	9	12	0	0	364	1	1	1	0	1	1	0	0	—
Riga	0	0	0	0	0	0	0	0	227	0	0	0	0	0	0	0	0	—
Pyarnu	1	20	20	14	6	6	14	0	724	0	0	0	0	0	0	0	0	—
Viborg	1	30	30	30	0	0	0	30	—	1	1	1	0	1	1	0	0	—
Klaipeda	0	0	0	0	0	0	0	0	190	0	0	0	0	0	0	0	0	—
Ventspils	1	3	3	0	3	3	0	0	—	0	0	0	0	0	0	0	0	—
Tallin	7	9	3	0	3	2	1	0	—	0	0	0	0	0	0	0	0	—
Helsinki	1	28	18	0	12	14	1	10	904	0	0	0	0	0	0	0	0	—
Mariehamn	0	0	0	0	0	0	0	0	240	0	0	0	0	0	0	0	0	—
W. Norrskar	1	26	16	0	16	7	11	0	—	0	0	0	0	0	0	0	0	—
Turku	1	12	12	0	0	5	0	0	385	0	0	0	0	0	0	0	0	—
Mantyluoto	1	13	13	12	0	1	12	0	—	0	0	0	0	0	0	0	0	—
Vaasa	1	26	26	25	0	11	12	1	607	0	0	0	0	0	0	0	0	—
Oulu	1	30	30	30	0	0	9	21	1021	1	7	7	4	0	2	4	0	—
Roytaa	1	30	30	30	0	0	0	30	—	1	20	20	11	0	0	11	0	—
Lulea	1	30	30	30	0	0	0	30	1053	1	14	13	8	3	6	5	1	—
Bredskar	2	23	22	0	3	9	5	0	—	12	12	1	0	1	1	0	0	—
Alnosund	1	7	7	0	7	0	0	0	337	0	0	0	0	0	0	0	0	—
Stockholm	1	19	18	0	18	12	0	0	143	0	0	0	0	0	0	0	0	—
Kalmar	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	—
Visby	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	—
Skelleftea	1	30	30	30	0	0	7	23	—	1	4	4	0	3	3	0	0	—
Oslo	0	0	0	0	0	0	0	0	889	0	0	0	0	0	0	0	0	—

CODE:
A First day ice reported.
B Last day ice reported.
C No. of days that ice was reported.
D No. of days continuous land-fast ice.
E No. of days of pack-ice.
F No of days dangerous to navigation, but assistance not required.
G No. of days assistance required.
H No. of days closed to navigation.
I Accumulated degree-days of air temperature (°c) where known.*

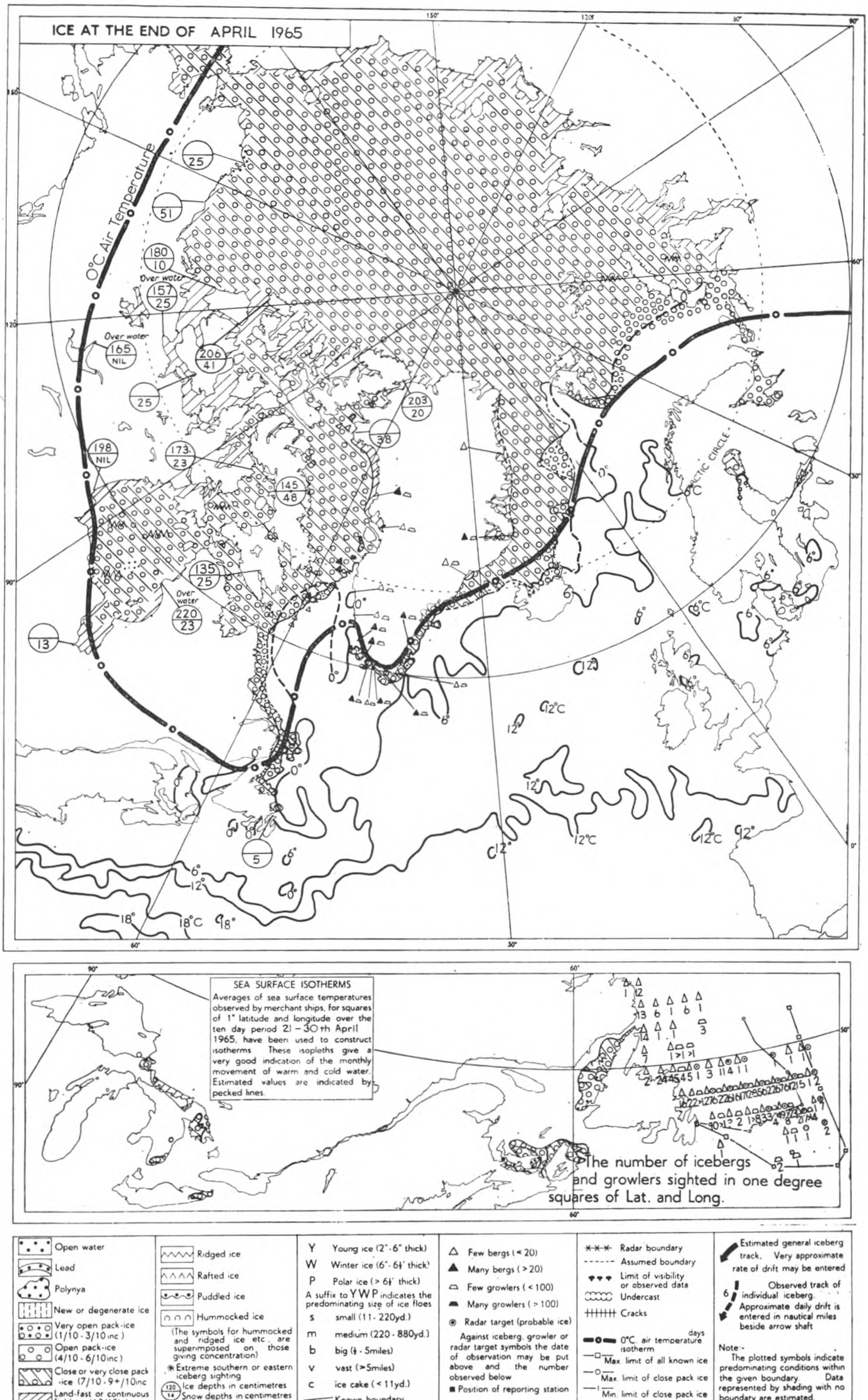
* These figures give a rough measure of first the probability of the formation of sea ice, and later the progress of the growth and of its thickness. They are derived from daily averages of temperature (00 + 06 + 12 + 18 GMT) and are the sum of the number of the degrees Celsius below zero experienced each day during the period of sustained frost.

(Opposite page 200)

Photograph by courtesy of the Liverpool Daily Post & Echo Ltd.

The presentation of a barograph to Commodore J. Whayman on board s.s. *Denis* berthed at Queens Docks, Liverpool, on 31st May 1965 (see page 202); left to right: Cdr C. E. N. Frankcom, Mr. B. C. V. Oddie, Mr. L. G. Deyes, Capt. R. D. Thomas, Cmdre Whayman, Capt. Radley.

(Opposite page 201)



early June the Strait was free of pack-ice. During most of the period the Strait was obstructed by icebergs at its entrance.

Gulf of St. Lawrence. This was a light ice year in the Gulf but severe for places on the south side of Cabot Strait. Early in April there was fast-ice and much pack-ice around the edges of the Gulf but large clearances in the centre. During most of April navigation channels and port entrances were severely obstructed south of Cabot Strait by the movement of pack-ice from the southern half of the Gulf through the southern side of the Strait. Ice breakers gave continuous assistance under difficult conditions of wind which tended to drive the ice inshore. Areas around Prince Edward Island were also obstructed. However by the end of April little ice remained in the Gulf, or its southerly exit.

Great Lakes and River St. Lawrence. Early in April Lake Michigan was largely clear of ice but Lake Huron was covered by close pack and Lake Superior had close pack with hummocking over the areas of shallow water with big and vast floes; there were areas of new ice over the deeper water of these Lakes. Over Lake Erie there was much heavy close pack but Lake Ontario was largely clear. Ice 1 foot thick was reported in Lake St. Clair.

Early in April the River St. Lawrence was full of open pack west of 70°W but open east of this. The St. Lawrence Seaway opened on the 8th April but there was ice obstruction in the Great Lakes at this time. Towards the middle of April the Great Lakes and River St. Lawrence were clear of ice. Reports suggest that Montreal as well as Quebec had operated with icebreaker assistance throughout the winter.

Greenland Sea, Spitsbergen and Bear Island. During this period the ice edge off eastern Greenland fluctuated considerably; there was widespread and extensive mixing between Arctic water and Atlantic water east of the Greenwich Meridian. In June leads and open water were reported north of Spitsbergen. The extent of the fast-ice off eastern Greenland was greater than normal in the north but less than normal to the south; land stations south of 77°N reported fast-ice exceeding half a foot in thickness. Icebergs continued to move southwards in the pack. Bear Island was largely free of ice over the whole period.

Denmark Strait and Iceland. This was a very abnormal period in that during April the polar pack moved southwards along the east Greenland coast and extended from that coast right up to the north Icelandic coast. The polar pack contained vast floes. From time to time there were considerable areas of open water off the north Icelandic coast and warm Atlantic water was to the west of Iceland.

Early in May shore leads appeared off the Greenland coast. Throughout May the amount of polar pack between Iceland and Greenland fluctuated particularly off the Icelandic coast but the large mass of mainly polar pack began to move southwards along the Greenland coast. The Atlantic water to the west of Iceland retreated before an increase in the extent of cold water off south-east Greenland. Towards the end of June the warm Atlantic water again advanced into the Denmark Strait and the limit of the polar pack retreated westwards generally.

Barents Sea. Conditions were severely cold in the north of the area and less severe in the southern half of the area during this period. Over the whole area particularly in the south-east the pack-ice appeared less than normal in extent although very severe conditions had existed over the polar pack in the north-east throughout the period. The masses of polar pack moved southwards east of Spitsbergen but the southerly extent was not greatly in excess of normal.

In the south it was a light ice year. The pack-ice persisted at the entrance to the Kara Sea but elsewhere there was a steady decrease in the amount of ice from the west until the end of June when there was little or no pack-ice in the south of the area.

White Sea. It was again a light ice year although shipping had experienced considerable difficulties off the Kola Peninsula in the approaches to the White Sea. Towards the end of April the approaches to the White Sea had become navigable but there was fast-ice and various types of pack-ice covering the White Sea. All this dispersed steadily and by early in June there was little or no ice present.

Baltic Sea. Towards the end of April there was a considerable area of fast-ice 2 feet thick north of 65°N and variable amounts of pack-ice north of 63°N with small amounts of pack in the Gulf of Finland. Early in May there was a rapid decrease in all of the ice with large areas of open water developing around the northern shores of the Gulf of Bothnia. Only small remnants of ice remained in the Gulf of Finland and by 20th May there remained small remnants in the Gulf of Bothnia only.

Note. The notes in this article are based on information plotted on ice charts each month, similar to the map opposite, but on a much larger scale (39 in × 27 in). They are available at the price of reproduction on application to the Director-General, Meteorological Office (Met.O.1), Eastern Road, Bracknell, Berks. Alternatively, they may be seen at any Port Meteorological Office or Merchant Navy Agency.

G. A. T.

551.5:06:629.12

NAUTICAL OCCASIONS AT BRACKNELL

The range of nautical visitors to the Meteorological Office is large: parties of cadets undergoing their pre-sea training, cadets from a mid-apprenticeship release course and parties of shipmasters and senior officers comprising a Senior Officer's Refresher Course, to say nothing of the individual masters and officers who happen to be in the district when on leave. All are welcome.

Highlighted among these visits are those of the shipmasters who come down to Bracknell to be presented with a barograph in recognition of their long and zealous voluntary service for us. Four such awards are made annually and, though we are always hoping for the day when these may all be made on the one occasion, so far this has only been possible once, in 1956.

The long-service awards for 1964 were announced in the October 1964 number of *The Marine Observer* and on 20th January 1965 two of them were made: to Captain H. C. R. Dell of the New Zealand Shipping Company and to Captain R. G. James of the Shaw Savill Line.

Captain Dell was accompanied by Mrs. Dell, by Mr. S. G. Fowler, Managing Director of the Company and by Captain F. G. Bevis, their Assistant Marine Superintendent.

Mrs. James was unhappily unable to be present owing to a recently broken leg but Mr. R. A. Huskisson and Captain A. E. Lockhart, Assistant Manager and Marine Superintendent respectively, came from Shaw Savill's to support Captain James.

The presentations were made by the Director-General of the Meteorological Office, Sir Graham Sutton, at an informal pre-luncheon sherry party attended by many senior officers of the Meteorological Office from the branches which are primarily concerned with ships' observations.

In making the presentations, Sir Graham mentioned that Captain Dell was the eighteenth shipmaster from the New Zealand Shipping Company to receive one of these awards in the seventeen years since they have been given and that our association with the company went back to our own very earliest days, for it was as long ago as March 1855 that Money Wigram's full-rigged ship *Kent* became a voluntary observing ship. Since her day the company's name had seldom, if ever, been absent from our registers and today 33 of their 39 ships were observing for us and 1 for the Australian Meteorological Service. Captain James was the seventh shipmaster from Shaw Savill's to receive a long-service award and this company also had a most impressive record of voluntary observing, their first meteorological logbook coming here from the full-rigged ship *Crusader* in 1874. Today 21 of their 29 ships were observing for us.

After the presentations the party took luncheon with the Director-General and were subsequently shown the work of the Office.

The presentations to Captain F. W. S. Roberts of the Canadian Pacific Steamships and Commodore J. Whayman of the Booth Line were arranged for 4th March 1965 but this day unhappily followed a night of blizzard which resulted in all transport in our area being all but paralysed.

Captain and Mrs. Roberts had fortunately come south from Edinburgh on the previous day and, staying the night in the district, they were able to reach the Office with little difficulty though no representative from the company was able to get through. Similarly, Commodore Whayman, travelling from Derbyshire, was unable to get any nearer to us than Waterloo and went home again from there.

It was thus a small, but none the less pleasant party which assembled for the presentation which, in the absence of the Director-General, was made by Mr. B. C. V. Oddie, Deputy Director (Central Services), who mentioned that Captain Roberts's first meteorological records were received here more than forty years ago when he was a cadet in the *Montrose*. Once again the recipient came from a company with which we had had a long association, their first voluntary observing ship being the *Empress of China* in 1900.

As customary, the presentation was made over a glass of sherry and followed by an informal luncheon party and a tour of the Office which unhappily had to be shortened a little in view of the weather.

It was not until Commodore Whayman had made another deep-sea voyage in the *Boniface* that we had an opportunity to present him with his barograph. This ceremony took place aboard the s.s. *Denis*, berthed at Queens Docks, Liverpool, on 31st May. Once again Mr. Oddie acted for the Director-General and was accompanied by the Marine Superintendent of the Meteorological Office, the Port Meteorological Officer, Liverpool, and the Senior Meteorological Officer from Liverpool Airport. The party included Mr. L. G. Deyes, General Manager of the Booth Line, Captain R. D. Thomas, Marine Superintendent of the Company, and Commander A. Brown, representing the Honourable Company of Master Mariners. In making the presentation, Mr. Oddie observed that this was the first time that a long-service award had gone to a shipmaster of the Booth Line, a company with which we had been associated ever since 1906 when we recruited the *Dominic* as a voluntary observing ship. Today two of their eight ships were observing for us and Commodore Whayman's own voluntary observing record went back nearly 40 years.

After the ceremony the Booth Line were the hosts at a very pleasant luncheon party aboard the *Denis*.

At these gatherings, the recipient's personal card, which records each one of his meteorological logbooks since he started observing, is always produced together with his own first meteorological logbook or form and these are always items of interest. The remarks of the wife of one shipmaster are apt: "His writing hasn't improved".

L. B. P.

SPECIAL LONG-SERVICE AWARDS

In 1948, in addition to the annual Excellent Awards which had been a feature of the voluntary observing system for many years, special awards, up to an annual maximum of four, were instituted for officers whose long and zealous voluntary work at sea on our behalf was considered as deserving special recognition.

The minimum qualification for a special award is fixed at 15 years in which meteorological records bearing the officer's name, either as observer or master, have been received, including of course, the year previous to that in which the award is made. Service in ships not in the Voluntary Observing Fleet, service in a rank which does not participate in the work, time ashore for certificates and periods of lay-up are some of the things which preclude these 15 years from being continuous and it is by no means unknown for them to be spread over 40 or more years.

But when the first meteorological logbook bearing an officer's name is received, a personal card is started for him and this card bears a note of his every subsequent meteorological logbook and the character awarded to it, no matter how many years have passed since his previous book. An officer's personal card therefore is a complete record of the extent and standard of his voluntary observing.

Every year the cards of all masters and officers with the required 15 or more years voluntary service are put under close scrutiny. A mathematical formula which considers their actual number of years service and the character awarded to each individual meteorological logbook, effectively places them in an order of merit and the top four are nominated for a special award.

This year there were 65 such cards; the formula was applied to each one of them with the result that the Director-General of the Meteorological Office is pleased to award inscribed barographs to the following:

1. COMMODORE A. HOCKEN (New Zealand Shipping Co. Ltd.), who sent us his first meteorological logbook in 1928 when he was in the *Norfolk*. In 25 years he subsequently sent us 52 meteorological logbooks of which all but nine were classed 'excellent'.

2. CAPTAIN L. T. PETERSON (Royal Mail Lines), who first observed for us in the *Darro* in 1926. In 23 years he has sent us 50 meteorological logbooks of which 18 have been classed 'excellent'.

3. CAPTAIN J. CROSBIE DAWSON, D.S.C., R.D. (Cunard Line), whose first meteorological logbook came to us in 1923 from the *Bernini*. Captain Dawson has sent us 72 meteorological returns altogether and has received the 'excellent' classification 34 times.

4. CAPTAIN C. A. HODSON (Port Line), whose first meteorological logbook came here from the *Port Adelaide* in 1925. Since then he has, in 19 years, sent us 32 meteorological logbooks of which 19 have been classed 'excellent'.

We congratulate these four shipmasters on this recognition of their valuable voluntary service over many years. They will be personally notified of the award and of the arrangements which will be made for its presentation.

An account of the presentation of the previous year's special awards appears on page 202 of this issue.

L. B. P.

INDIAN EXCELLENT AWARDS

(From the Deputy Director-General of Observatories (Forecasting), India)

The Indian Meteorological Department had 44 Selected and 78 Supplementary Ships on the list of Voluntary Observing Fleet, during the year ending 31st March 1964. 1,144 logs consisting of 13,512 meteorological observations were received from these ships in the Department during the year. More than 50 per cent of the observations were received by W/T at different Forecasting centres and they were of great value in the day-to-day forecasting of the Department, and in particular for issuing warnings to ships.

The Department wishes to convey its appreciation to all the officers concerned for their valuable co-operation.

It is customary to give awards in the form of books to Captains, Observing Officers and Radio Officers of ships whose meteorological work has been adjudged to be 'excellent', and the following ships have been selected for such Excellent Awards for the year 1963–4:

NAME OF VESSEL	OWNER
State of Bombay	Shipping Corporation of India Ltd.
State of Madras . .	Shipping Corporation of India Ltd.
Rajula	British India Line
Jalamudra . .	Scindia S.N. Co. Ltd.
Jaladhruv . .	Scindia S.N. Co. Ltd.
Jalaputra . .	Scindia S.N. Co. Ltd.
Jalaprakash . .	Scindia S.N. Co. Ltd.
Jalavihar . .	Scindia S.N. Co. Ltd.
Mozaffari . .	Mogul Line Ltd.
Bahadur . .	Asiatic S. N. Co. Ltd.

In addition to the ships mentioned above, the following have been awarded a "Certificate of Merit" for commendable work done during the same year:

Jalajawahar, *Jaladuhita*, *Vishva Prabha*, *Sirdhana*, *Jalapushpa*.

CANADIAN EXCELLENT AWARDS

(The following statement has been received from the Director of the Canadian Meterological Branch)

The winners of the 17th annual Canadian Excellent Awards for marine weather observing in 1964 have been announced, and are listed on page 206.

This year, 47 awards, in the form of suitably inscribed books, will be presented to the Captains, Principal Observing Officers and Radio Officers of certain ocean-going observing vessels reporting for Canada.

A 'Ship Award' is presented to the captains of the 20 ships which have returned the best logbooks, in regard to both quantity and quality of observations, in 1964. The book chosen for this award was *Oceans—An Atlas History of Man's Exploration of the Deep*, edited by Dr. G. E. R. Deacon of the National Institute of Oceanography. This award is usually placed in the ship's library for the benefit of all officers.

The 15 Principal Observing Officers, whose records were considered to be the best during the year, will receive a copy of the *National Geographic Atlas of the World*, published by the National Geographic Society, Washington, D.C.

Awards were presented to the 12 Radio Officers who made the greatest number of transmissions. The book chosen was *Canada* by Peter Varley and Kildare Dobbs.

The Canadian Meteorological Branch congratulates all award-winning captains and officers, and extend their thanks for the splendid work done by all the officers of the marine weather observing vessels.

HONG KONG EXCELLENT AWARDS

(From the Marine Liaison Officer, Royal Observatory, Hong Kong)

Five meteorological logbooks classified as 'excellent' have been returned by the masters of Hong Kong Selected and Supplementary Ships since the presentation of awards was authorised by the Hong Kong Government in 1964.

The masters, who returned these logs together with the names of their ships and of the deck and radio officers who have qualified for awards are listed on page 207.

Book Reviews

The Flight of Thunderbolts (second edition) by Sir Basil Schonland, C.B.E., F.R.S. 8¾ in × 5¾ in, pp. x+182, *illus.*, Oxford University Press, Amen House, London, E.C.4, 1964. Price: 30*s*.

This is a very well produced book with clear diagrams. It has little or no mathematics and, although almost void of any specialized jargon, goes very deeply into many aspects of lightning and is very readable. Sir Basil Schonland, utilizing the great frequency of thunderstorms in South Africa, where most of his early work was carried out, has been able to contribute much to our understanding of the physics of lightning.

There are eight chapters. The first two chapters describe early historical records of lightning and pioneer work including that of Benjamin Franklin on lightning conductors. As one might expect many great names in physics and such classical pieces of equipment as the Leyden Jar, frictional electrical machines and the voltaic cell appear in the history of early lightning researches carried out in the latter half of the 18th century.

Chapter 3 deals with the form of lightning, objects struck and their geographical and atmospheric locations and effects of lightning. There is an interesting discussion of fulgarites, which provide a natural record of lightning discharge in dry rocks and sand of the deserts. The track of the discharge is shown by the fusing of the sand. There are many such records in parts of the Kalahari Desert where lightning is now rare, suggesting a considerable change of climate.

Recipients of Canadian Excellent Awards—1964

Name of Vessel	Captain(s)	Principal Observing Officers	Radio Officer	Owner/Agent
Acadia	J. W. Taylor	F. W. Sheppard	—	Government of Canada
Athelduke	W. O. Williams, T. Gorst, E. Elliott	J. E. Bolton	—	Athel Line Ltd., Liverpool
Baffin	P. M. Bick, W. N. Kettle	G. C. Dale	J. L. Palmer	Government of Canada
Bluenose	—	H. Whitehead, D. Vail	—	Government of Canada
Camsell	—	—	E. P. Clarkson	Government of Canada
Cyrus Field	F. W. Mauger, H. R. Phinney	S. B. Briggs	—	Western Union Telegraph Co.
d'Iberville	—	—	B. A. Laxson	Government of Canada
Edward Cornwallis	G. Williams	—	—	Government of Canada
Emerillon	S. Henderson	J. C. Lough	M. MacNaughton	Shell Canadian Tankers Ltd.
Erwin Schroder	K. Braunwarth, E. Slapka	—	—	Canadian Pacific Railways
Gypsum Countess	R. T. Luckey	—	R. M. Johnston	Fundy Gypsum Co. Ltd.
Gypsum Empress	R. S. Kelly	—	—	Fundy Gypsum Co. Ltd.
Harengus	H. H. Butler	—	—	Government of Canada
Hudson	W. J. Vieau	H. J. Martin	V. Griffin	Government of Canada
Imperial Quebec	H. MacDonald, P. W. Perry	—	—	Imperial Oil Ltd.
Imperial St. Lawrence	L. Espinosa, D. E. Fournier	—	—	Imperial Oil Ltd.
John A. Macdonald	—	—	N. Kristensen	Government of Canada
Kapuskasing	W. Thorne	—	—	Government of Canada
Labrador	—	—	A. W. Murray	Government of Canada
Lake Bosomtwe	S. Oliviero	—	—	Black Star Line Ltd.
Lakemba	D. M. Dodds, G. L. Cleveland	G. L. Cleveland	—	Pacific Shipowners Ltd., Singapore
Lord Kelvin	—	D. O. Dutfield	C. Kearney	Western Union Telegraph Co.
Maxwell	S. Baggs	—	—	Government of Canada
Narwhal	—	P. Whitehead	—	Government of Canada
N. B. Maclean	—	—	J. P. Roy	Government of Canada
Oriana	C. Edgecombe, E. G. Riddelsdell	M. D. Rushan	E. R. LeGear	P. & O.-Orient Line
Princess of Acadia	W. G. Goodwin	J. A. Blinn	C. F. MacMillan	Canadian Pacific Railways
Sir Humphrey Gilbert	—	D. Daly	—	Government of Canada
Thorsriver	—	R. Myrsve	—	A. S. Thor Dahl, Sandefjord, Norway
Wolfe	A. Piercey	—	—	Government of Canada

Recipients of Hong Kong Excellent Awards—1964

Name of Vessel	Captain	Observing Officers	Radio Officers	Owner/Manager
Eastern Glory	F. H. Main	G. T. Norton, J. Liang	D. J. Greffiths	Indo-China S.N. Co. Ltd.
Galle	D. W. R. Gash	A. C. Walker, Tai Lin Yung, Yeung Kwok Ming	W. G. McLaren	Tech Cheong Enterprises (H.K.) Ltd.
George Anson	A. R. Dyason	G. R. Macdonald, C. R. McArthur	D. Murphy	Dominion Line
Kuala Lumpur	A. Watson	M. Swift, D. W. Boys, C. E. Royle, J. Melward	Mak Yan, Chan Wing	China Navigation Co. Ltd.
Kweichow	R. E. Brooks	R. J. Shipp, L. R. Stevens, T. W. Allsop	—	China Navigation Co. Ltd.

Chapters 4 and 5 are concerned with the practical and theoretical investigation of the structure of lightning discharge. The instrument used was the rotating camera invented by Sir Charles Boys. It was not completely successful at first but Sir Basil Schonland and fellow workers developed it to a state of high efficiency enabling them to study the multiple electrical discharges that take place in micro-seconds and constitute the whole phenomena of lightning. These cameras revealed that the discharge from cloud to earth consists of a number of downward leading discharges which branch; when one of these finally reaches the ground there is a rapid upward discharge.

Chapter 6 is a slight diversion for the consideration of the protection of buildings from lightning. It is stated that a lightning rod placed on a building with a good earth will give protection over a 45° cone-shaped volume, with its apex at the top of the rod.

The final chapters are devoted to the physical processes within clouds that produce the dense distribution of electrical charge sufficient to cause the lightning discharge.

These chapters tell us that very strong vertical currents (at times 60 miles per hour), the release of latent heat of water vapour and ice, collisions between, and breaking up of, liquid water and ice particles, frictional processes, and electrical induction may all contribute towards the build-up of the electrical charge.

Artificial rain-making is touched upon and finally the life history of a thunder cloud as a whole is described showing the build-up and decay of the giant circulatory system which contains not only the strong upward currents but also downward ones.

Finally large-scale electric fields resulting from thunderstorms are described. The careful examination of radio impulses from thunderstorms reveals their location at great distances and great heights. However, great distance introduces complications which are described. Radio waves from thunderstorms are affected and modified as are all radio waves by atmospheric phenomena in the upper atmosphere, e.g. the ionosphere. They can of course adversely affect radio communications and knowledge about this aspect of thunderstorms is of considerable commercial importance. A further interesting fact brought out is that thunderstorms over the earth as a whole are responsible for maintaining the earth's surface (as a whole) permanently negatively charged. It is also suggested tentatively that intense thunderstorms in the atmosphere of the planet Jupiter may be a source of radio waves.

G. A. T.

Progress in Oceanography, Vol. 2, edited by M. Sears. 9½ in × 6¼ in, pp. vi+272, *illus.*, Pergamon Press Ltd., Headington Hall, Oxford, 1965. Price: 80*s.*

This is the second volume of a series produced by Pergamon Press which gives articles on recent oceanographical work.

The first article is historical, G. Wust an eminent oceanographer reviews deep-sea expeditions over the period 1873–1960. Famous ships like the *Challenger*, the *Fram*, the *Meteor* and the *Carnegie* are given their place in oceanographical history with regard to the great oceanographers and oceanographical institutes of Europe and America. Wust in his history picks out three eras; 1873–1914 the era of exploration when famous old ships and early oceanographers created the basic observing and analytical tools; 1925–40 the era when physical oceanography matured as a science and recognized fundamental difficulties; 1947–56 a period of rapid expansion in new marine, geological, geophysical, biological and physical methods. Conditions at the sea bottom and the general circulation of the oceans in particular came under careful scrutiny during this period.

Finally, 1957 to the present can be styled the era of international co-operation with the International Geophysical Year (IGY) and the recent work in the Indian Ocean.

This article has tables listing oceanographic research vessels with their ages, tonnage, nationality and main studies, and maps showing the tracks and areas over which surveys were made. Finally there is a very full bibliography.

The second article by K. Base deals with vertical distribution of zooplankton. It is a detailed survey of the great amount of available information. The influence of the physical environment on the development and migration of plankton is described. There is a very full bibliography at the end of the article.

The third article is by D. A. McGill and is the results of the analysis of the 1957–8 IGY survey of the Atlantic Basin. The distribution of phosphorus and oxygen in the waters of the Atlantic are analysed with reference to the equations of diffusion of matter. The results of this analysis are used to examine the use made of these elements by plankton and similar organisms in the sea.

The author states that his analysis is largely consistent with earlier work but a number of anomalies are investigated—for example the differences in oxygen and phosphorus distribution between the North and South Atlantic. Again there is a very full bibliography to this article.

The last article is by T. L. Hopkins and is a survey of marine bottom samplers. These are described briefly with diagrams and a bibliography. There are in all 105 samplers each described in a single paragraph giving the devices and principles used in the design of grabs, corers, buckets, dredges and further miscellaneous samplers.

The book is well produced with clear diagrams and is a very 'handy' and valuable book of reference.

This particular volume although readable, deals with four subjects expertly. I can therefore recommend this book only to those particularly interested in these subjects. For a specialist however the first article and the last are easily readable but the contents of the second and third, which are detailed analyses of data, were, to the reviewer more difficult to absorb.

G. A. T

Personalities

OBITUARY.—We regret to record the death of CAPTAIN G. N. JENKINS, our Merchant Navy Agent in the Forth Area.

George Nicholas Jenkins was born in 1905 and educated at the George Heriot's School, Edinburgh. He subsequently received his pre-sea training at the Leith Nautical College and went to sea in 1920. He sailed under numerous house-flags during his first 14 years at sea including those of the Royal Fleet Auxiliary, the Commissioners for Northern Lights, Chr. Salvesen & Co., Ltd., Gow Harrison & Co. and the Edinburgh Shipping Co. Ltd.

He passed for Master in 1934 and in 1935 joined the Shell Tanker *Cliona* as 3rd Officer. He remained in this company for the next 20 years.

Captain Jenkins was appointed to his first command, the m.v. *Sulphur Bluff*, which was then being managed for the Ministry of War transport by Shell Tankers, in March 1944. In June 1955 he came ashore from his last command, the *Dolabella*, for health reasons. He was appointed our Merchant Navy Agent for the Forth area early in 1957.

As a Voluntary Marine Observer, Captain Jenkins sent us three meteorological logbooks from the *Theliconus* in 1953 and from them two observations were subsequently published in *The Marine Observer*: one of phosphorescence in the Gulf of Aden and the other of aurora in the North Atlantic Ocean.

Many voluntary marine observers who have visited ports in the Forth area during the last eight years will, we are sure, join us in extending sincere sympathy to his widow.

L. B. P.

OBITUARY.—We regret to record the sudden death of CAPTAIN B. R. SIMONS, M.B.E., of Furness Lines, when on leave at his home in Belfast.

Bertram Richard Simons was born in 1910, and commenced his sea-going career in December 1925, as an apprentice with the Prince Line. He obtained his Second Mates' Certificate in 1930 and attained his first command in July 1945; since then he commanded 14 vessels of the Furness Line Fleet, his last command being the *Pacific Fortune*.

In 1942 Captain Simons was made a Member of the Order of the British Empire, this honour being bestowed upon him for conspicuous gallantry which he displayed during the war, particularly when serving on the *Northern Prince* as 2nd Officer, when she was bombed and sunk during the evacuation from Greece.

Captain Simons's record with the Meteorological Office dates back to 1952, when serving in command of the *Nordic*, and in 11 years he has sent in 20 meteorological logbooks, of which 14 were classed as 'excellent'. He received Excellent Awards in 1954, 1955, 1956, and 1963.

We tender our sympathy to his widow and daughter.

J. C. M.

RETIREMENT.—SKIPPER J. H. ELLIS, D.S.C., manager of Trawler Owners Thomas Hamling & Co., retired at the end of March 1965 after being associated with the Hull Fish Dock since 1919.

John Herbert Ellis was born in Stepney, London, in 1899, the son of an officer in the Metropolitan Police. He won a scholarship to a West Horsham College, but his mother, left a widow with five children, thought it better that he should earn a living. So, at 15 he became a deck boy aboard a private yacht. Then came the 1914–18 War, and he joined the RNR serving first aboard minesweepers, then salvage craft.

After the Armistice in 1918 he decided to join the trawling fleet. After first sailing out of Grimsby, he joined the deep-sea trawlers in Hull, and in 1920 signed on with Hamlings as a 'spare hand'. He became Mate in 1922, and Skipper three years later.

In 1939 the Admiralty requisitioned the entire fishing fleet, and later returned a number of trawlers to their owners. Before Dunkirk Skipper Ellis was 'admiral' of a small convoy of Hull trawlers until he went back to the Navy minesweeping. Off Spurn Point his command, *St. Winston*, was blown up by an acoustic mine, but by excellent seamanship he got his ship back to port. For this he was awarded the D.S.C.

After the war he rejoined his Company and re-formed the Trawler Officers' Guild, becoming president until he came ashore in 1950 because of ill-health. He made one last trip in 1951, testing new gear, and then worked his way up the firm from assistant ship's husband to manager.

Skipper Ellis has always shown great interest in the work of the Meteorological Office, and has been of great assistance both afloat and ashore. His enthusiasm and encouragement have been a great help in the recruitment of Hull trawler skippers as voluntary meteorological observers.

We wish him health and happiness in his retirement.

E. R. P.

RETIREMENT.—After 43 years at sea, all of them in the service of the Canadian Pacific Steamships, CAPTAIN L. H. JOHNSTON, M.B.E., made his last voyage in the *Empress of Canada*, flagship of the fleet, and retired on her arrival in Liverpool, on the 7th April.

Leonard Hamilton Johnston, from Vancouver B.C., after some training at the Royal Victoria Yacht Club, joined the Canadian Pacific as a 17-year-old cadet in November 1922, in the *Empress of Asia*.

Passing for all his certificates in Vancouver B.C., for second Mate in 1927 and

Master in 1930, Captain Johnston was appointed to his first command, the *Gatineau Park* in 1942, and subsequently commanded many of the company's Beaver-class ships and all the present-day *Empresses*.

During the early years of the last war Captain Johnston was First Officer of the *Empress of Asia* and when she was sunk in Singapore by the Japanese in January 1942; he set out in charge of a small party of evacuees for Java, in a small boat, but severe weather forced them to land on Sumatra, from whence they made their way through jungle and swamp, and across to Batavia, where help was received from the Dutch. He then navigated a small ship, with his party, to Australia.

He later saw service in the Mediterranean, in command of the *Princess Kathleen*, transporting troops for the invasion of Italy.

Captain Johnston's record with the Meteorological Office dates back to 1925, when serving in the *Empress of Asia*, and in 15 years observing, he has sent in 30 logbooks, 15 of which have been classed 'excellent'. He received Excellent Awards in the four years 1957 to 1960.

Captain Johnston and his wife, who made the last voyage in the ship with him, are returning to Canada to live.

We wish him health and happiness in his retirement.

J. R. R.

RETIREMENT.—MR. D. MACRAE retired recently after more than 48 years at sea as a radio officer.

Donald MacRae, at the age of 16½, gained his first PMG certificate and joined the then Marconi International Marine Co. Ltd.; he served them continuously until he retired.

His first ship was the *Cambrian* of the Leyland Line which he joined in May 1916. Subsequently during the First World War he was torpedoed three times: in the *Glenelg*, the *Westfield* and the *War Firth*.

For 20 years he led a peaceful life at sea but, within 8 hours of the Second World War being declared, he was torpedoed in the *Athenia* of which he was then Second Radio Officer. He later became Chief Radio Officer of the *Ile de France* in which he remained until the end of the war.

After the war he spent 7 years in Orient Line ships and 12 years with the Shaw Savill Line.

Service for 48½ years with an independent marine radio company naturally gave Mr. MacRae a very wide experience of the British Merchant Navy: in all he served in some 70 ships which ranged, in size, from MacBrayne's *Lochiel* of 326 gross tons to the French Line's *Ile de France* of 43,000 gross tons which, during the war, was managed by the Ministry of Transport.

Records of the voluntary service of radio officers were not kept in the Meteorological Office until the end of the Second World War but when their personal cards were started in 1946, Mr. MacRae's was one of the first; he was then serving in the *Largs Bay*. Since then he served us in six different ships, contributing in all to 45 meteorological logbooks, 18 of them from Shaw Savill's *Tamaroa*. He received Excellent Awards in 1955, 1957, 1960 and 1964.

We wish him health and happiness in his retirement.

L. B. P.

RETIREMENT.—CAPTAIN R. WILLCOCKS retired recently after nearly 44 years at sea, all spent in the service of Messrs. Trinder Anderson & Co. Ltd.

Roy Willcocks, a native of St. Austell in Cornwall, commenced his sea-going career as an apprentice with Trinder Anderson in 1921. He was appointed to his first command, the *Kaikoura*, in March 1945 and has since commanded most of the Company's vessels until his recent last voyage in the *Araluen*.

Captain Willcocks's record with the Meteorological Office commenced in 1951 when he was in command of the *Ashburton*. Since then, in twelve years, he has sent in 21 meteorological logbooks, 9 of which were classed 'excellent'.

We wish him health and happiness in his retirement.

J. C. M.

Notice to Mariners

OCEAN WAVE PHOTOGRAPHIC COMPETITION

The National Institute of Oceanography (NIO), in conjunction with the Seafarers' Education Service (SES), is building up a library of sea wave photographs. These photographs should give the impression of the power of sea waves, be attractive and, if possible, picturesque. They may be taken from a ship in a storm, or show waves pounding over rocks or structures. Some object such as another ship or lighthouse may help to indicate size. Notes on where the photograph was taken, the weather at the time, and estimates of wave heights and periods would be very helpful; the absence of such comments will not be a disadvantage at the judging of the photographs.

PRIZES: £20, £5 and £3 will be paid to the owners of the three best photographs. Up to 20 further prizes of £2 will be paid for good photographs.

RULES:

1. Anyone may enter, except staff and employees of the NIO and the SES and their families.
2. Entries may be monochrome or colour, prints or transparencies. Prints should be approximately within the sizes 9″ × 7″ and 6″ × 4″ and should be on glossy paper, unmounted. Transparencies should preferably be mounted between glass.
3. The name and address of the owner of the copyright must be clearly written on or attached to each entry.
4. On submitting a photograph, entrants will be deemed to agree that the NIO and SES will have the right to reproduce prizewinning photographs for their own purposes without further payment or consultation. Acknowledgement will be made to the photographer wherever possible, and the owner will retain copyright for any other purpose.
5. All colour slides will be returned, copies being taken of prizewinning ones. If requested, non-prizewinning photographs will be returned.
6. Whilst every care will be taken of photographs, no responsibility for loss or damage can be accepted.
7. The decisions of the judges will be final.

Entires should be sent to L. Draper, National Institute of Oceanography, Wormley, Godalming, Surrey, or (in the case of merchant seamen) to the Secretary, Seafarers' Education Service, Mansbridge House, 207 Balham High Road, London, S.W.17.

Closing date: 31st December 1966.

The Editors of *The Journal of the Institute of Navigation* and of *The Marine Observer* have agreed to publish a selection of the winning photographs. Winners will be notified individually.

Notice to Marine Observers

NAUTICAL OFFICERS AND AGENTS OF THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE, GREAT BRITAIN

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Bristol Channel.—Captain F. G. C. Jones, Port Meteorological Officer, 2 Bute Crescent, Cardiff. (Telephone: Cardiff 21423.)

Humber.—Lieut.-Commander E. R. Pullan, R.D., R.N.R., Port Meteorological Officer, c/o Principal Officer, Ministry of Transport, Trinity House Yard, Hull. (Telephone: Hull 36813.)

Clyde.—Captain R. Reid, Port Meteorological Officer, 118 Waterloo Street, Glasgow, C.2. (Telephone: Glasgow City 4379.)

Forth.—To be appointed: all enquiries to Port Meteorological Officer, Clyde.

Tyne.—Captain C. J. D. Sutherland, c/o F. B. West & Co., Custom House Chambers, Quayside, Newcastle upon Tyne. (Telephone: Newcastle 23203.)

Southampton.—Commodore D. M. MacLean, D.S.C., R.D., Southampton Weather Centre, 160 High Street, Southampton. (Telephone: Southampton 20632.)

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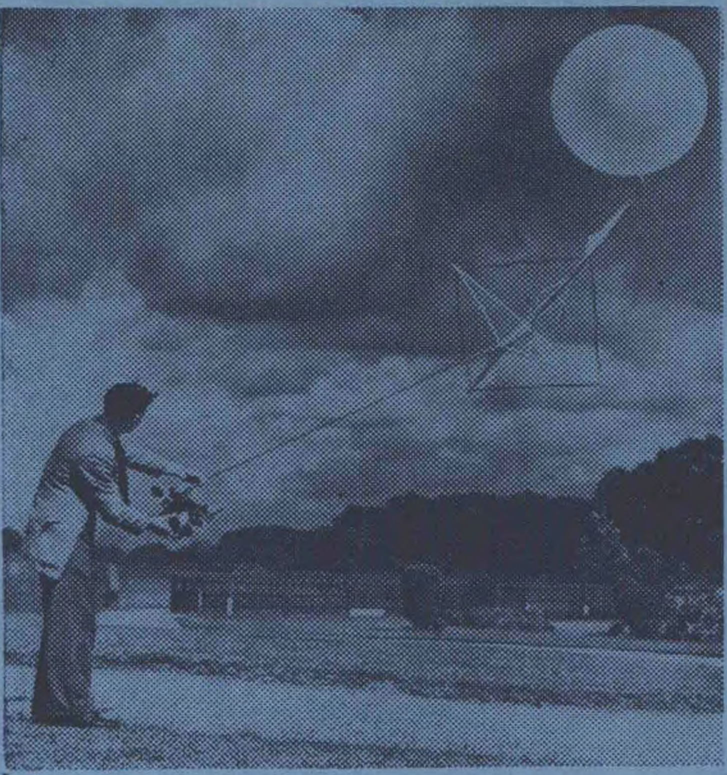

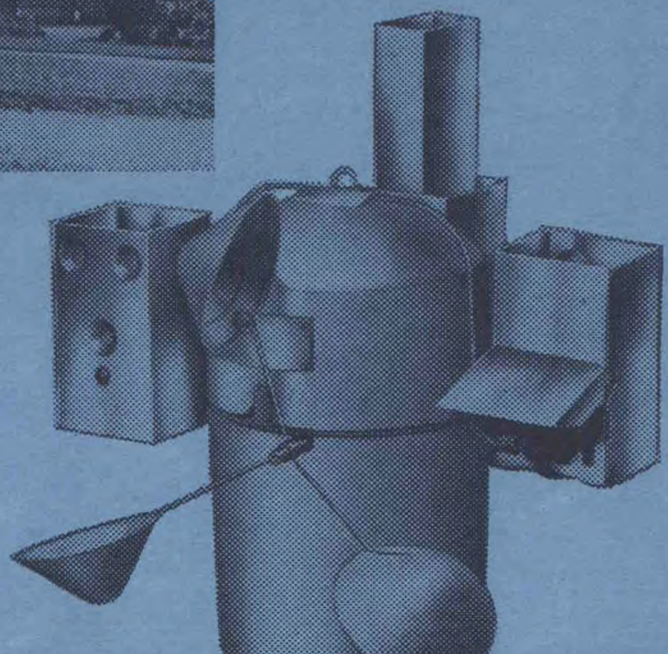

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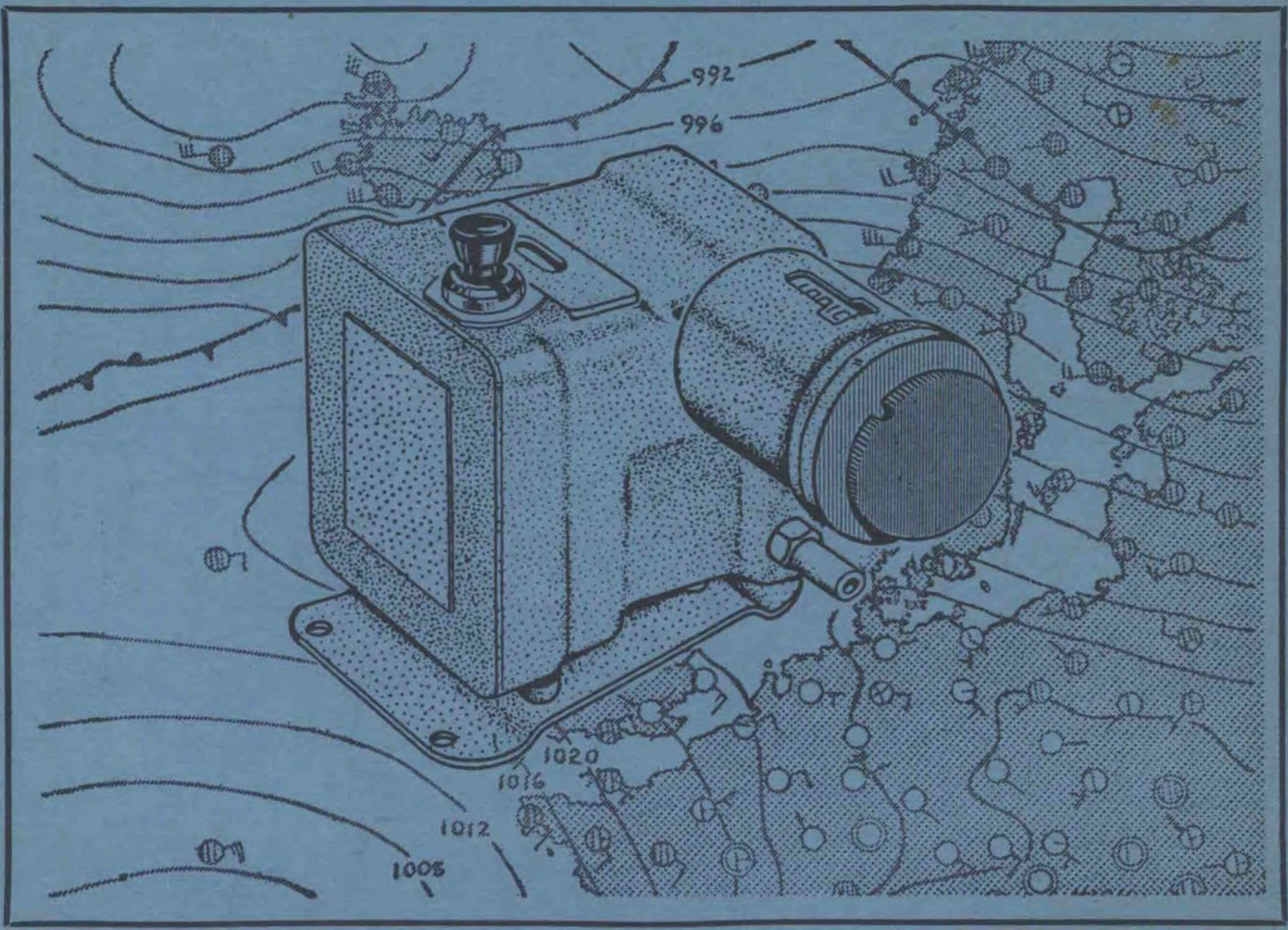

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