[To face p. 541.]

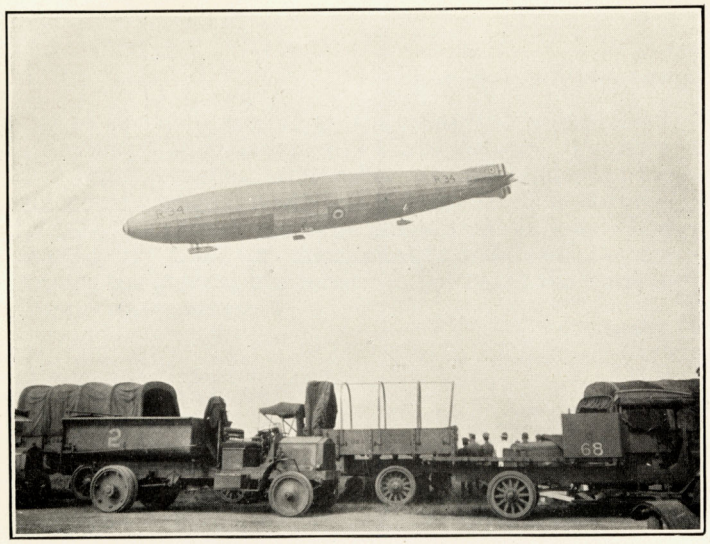

FIG. 1.—The *R. 34* approaching Roosevelt Field.

FIG. 2.—The *R. 34* landed (at dusk).

FIG. 3.—The *R. 34* at night.

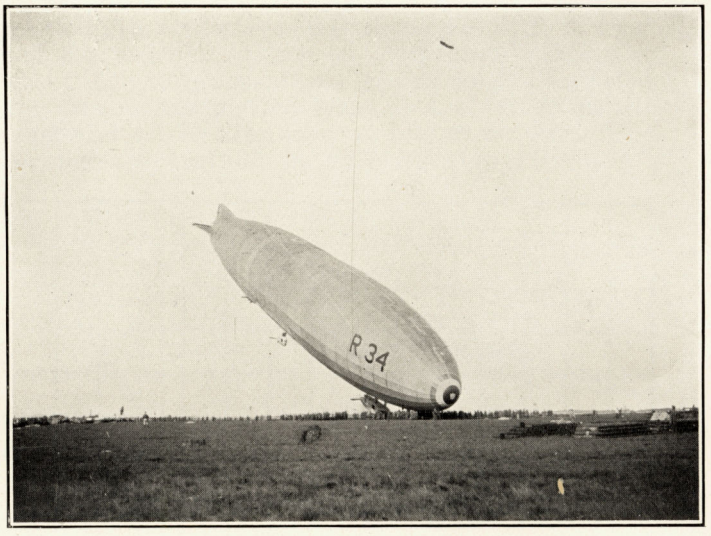

FIG. 4.—One of the difficulties of mooring an airship in the open. (See text, p. 542).

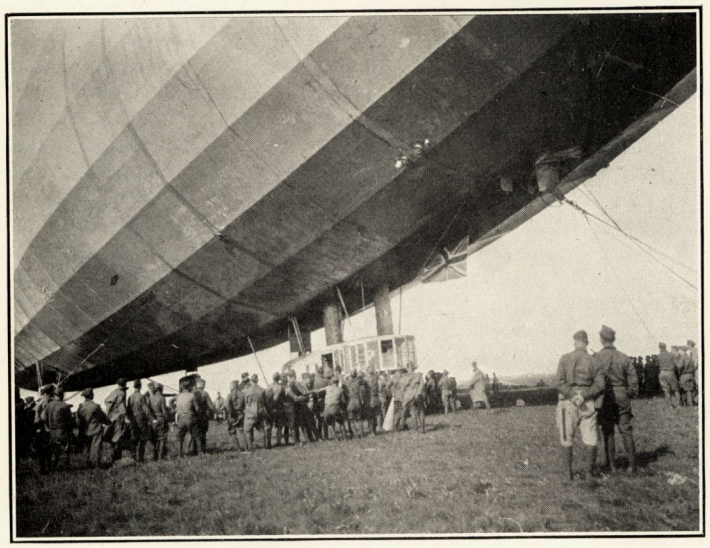

FIG. 5.—Close-up view of the *R. 34*, showing slight damage done as result of its position as shown in figure 4.

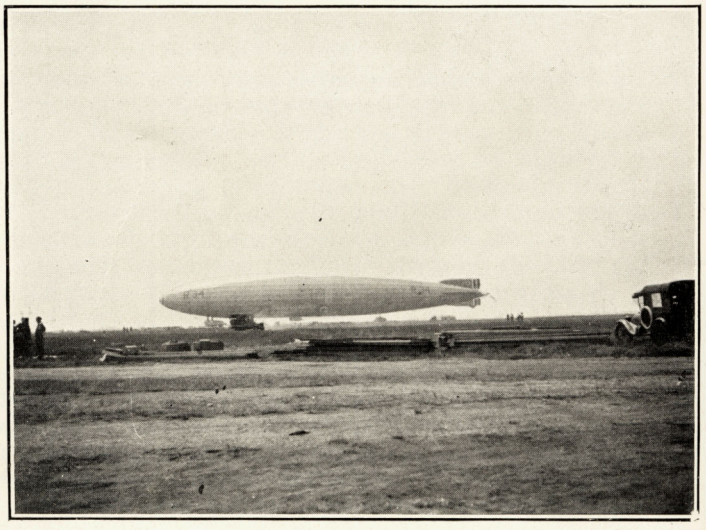

FIG. 6.—The *R. 34* at its moorings.

THE TRANS-ATLANTIC FLIGHT OF THE BRITISH DIRIGIBLE "R.34."

By WILLIS RAY GREGG, Meteorologist.

[Dated: Weather Bureau, Washington, Sept. 23, 1919.]

SYNOPSIS.—The British dirigible *R.34* flew from the British Isles to the United States in 108 hours and made the return trip in 75 hours, a good illustration of the influence of the prevailing westerlies in trans-Atlantic flight. During the first day of the westward trip northeasterly and easterly winds furnished some assistance, but thereafter cross winds or head winds were encountered most of the time. On the return trip southwesterly and westerly winds added considerably to the air-speed of the ship. Inasmuch as it was necessary to moor the ship in the open at Roosevelt Field, arrangements were made for the receipt and study of meteorological reports in order that warnings as to expected changes in weather conditions could be given to the officers in charge. The most difficult conditions to guard against were the sea breeze, thunderstorms, and alternate heating and cooling of the gas through the interruption of insolation by passing clouds.

The experiences of the NC crews, Hawker and Grieve, Alcock and Brown, and the *R.34* emphasize the necessity of wind assistance and the difficulties presented by the frequency of fog and clouds. The latter will cause less and less trouble as radio communication becomes better developed and more accurate.

event has been justly acclaimed as one of the most striking achievements of modern science in its resistless determination to overcome the seemingly antagonistic forces of nature.

The routes followed by the *R. 34* and the times required to traverse successive portions of those routes are shown in figure 7. Briefly, the record is as follows, times being given in G.M.T.: Left East Fortune, Scotland, 1:42 a. m., July 2; arrived Mineola, N. Y., 2 p. m., July 6; left Mineola 4 a. m., July 10; arrived Pulham, England, 6:56 a. m., July 13. The total distance covered was approximately the same for both routes, viz., about 3,200 miles. The time taken was a little more than 108 hours for the westward journey, and practically 75 hours for the eastward journey. No better illustration than this could be

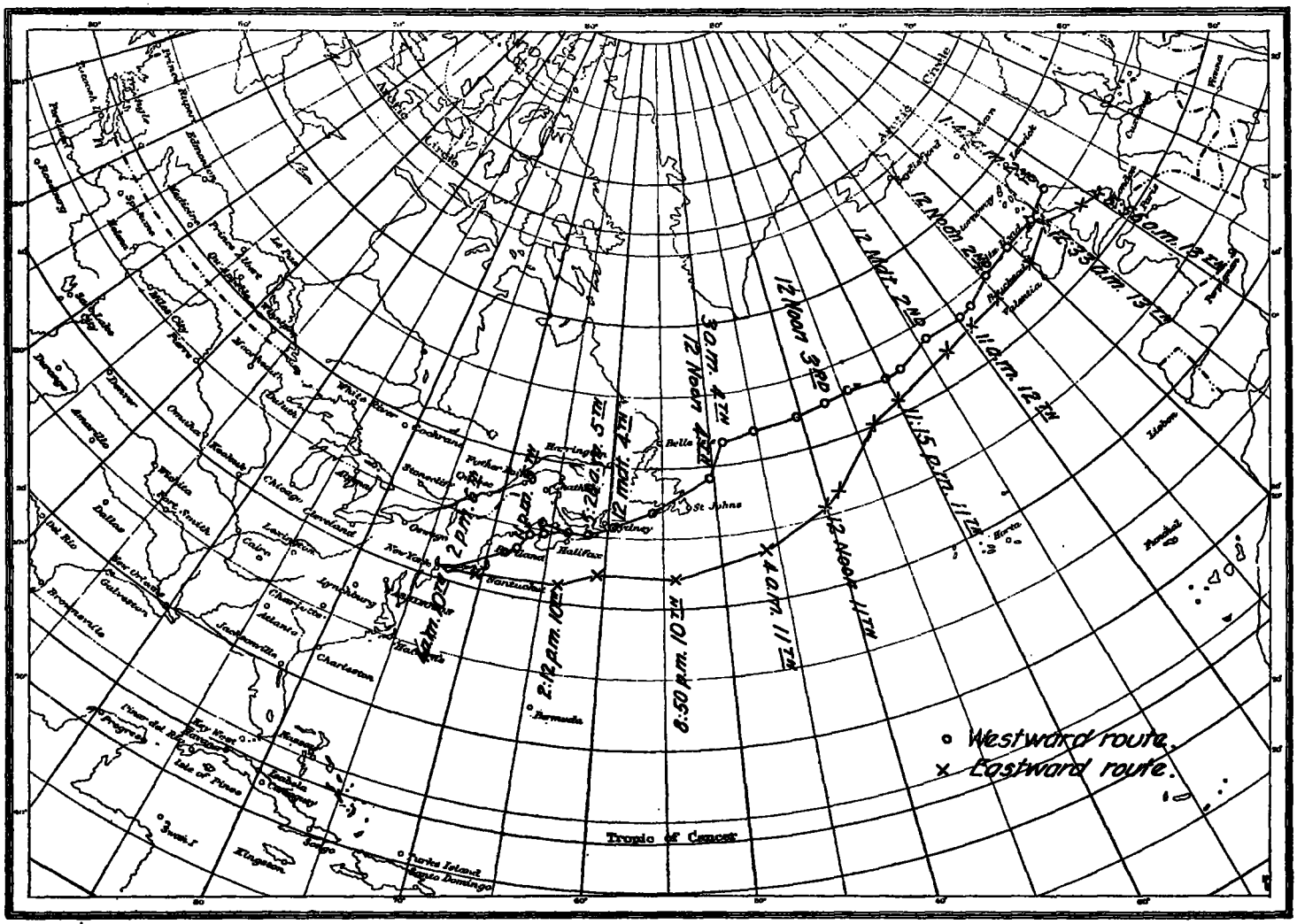

FIG. 7.—Routes followed by the *R. 34* in its trans-Atlantic flight.

As a fitting climax to the series of attempts to cross the Atlantic by air, the British dirigible *R.34* on July 13, 1919, successfully completed its memorable journey from the British Isles to the United States and return. Although third in the list of aircraft to cross the ocean, it was first of its type, lighter than air, to do so, and it was the first of any type to make the westward trip. The given of the influence of the prevailing westerlies in connection with trans-Atlantic flight. Not only was a longer time required for the trip to America, but a much larger amount of fuel was necessarily consumed. In the development of marine aviation on a commercial basis these factors will undoubtedly be given consideration in fixing passenger and freight rates for the two journeys.

Meteorological conditions during the flights are described in copious notes by Gen. E. M. Maitland, the official British observer on the *R.34*.[1] Pressure distribution and resulting winds are shown in Charts IX to XVII, inclusive, in the MONTHLY WEATHER REVIEW for July, 1919. During the first day, July 2, under the influence of an area of low-pressure central over southeastern England, northeasterly and easterly winds prevailed, thus materially increasing the airship's speed. Thereafter for the most part cross winds were encountered until Newfoundland was reached on July 4. The journey from this point to Mineola was extremely difficult owing to strong head winds as the result of a well-developed low over the St. Lawrence Valley. For a time practically no headway was made, but fortunately the eastward movement of the storm area brought northeasterly winds to New England early on July 6, and the airship reached Mineola with less than an hour's supply of fuel on board.

During its stay at Mineola the *R.34* was moored in the open, and it was necessary, therefore, to keep close watch of meteorological conditions, with a view to informing those in charge as to probable changes so that there might at all times be enough men present to keep the ship properly oriented with respect to wind direction. Besides the forecasts from Washington, D. C.,[2] there were regularly received synoptic reports for the United States, and special reports of thunderstorms in adjoining States. The latter proved of great assistance on July 6, the day of the ship's arrival. During the afternoon indications pointed to a severe thunderstorm at Mineola. Reports from the New York office, however, showed that, although thunderstorms were quite general, none of them was accompanied by any wind. Fortunately the storm that later broke over Roosevelt Field, although severe as to lightning and precipitation, was likewise practically free from wind, and no damage resulted.

The most serious feature of the weather in its effect on the airship was the sea breeze, which, particularly at that season of the year, is well developed and very strong. This usually sets in during the late forenoon and continues until sunset, being most pronounced at about 2 to 4 p. m. On July 7 and 8 the sea breeze, in combination with the light gradient northeasterly wind, produced a southeasterly wind, which at times attained a velocity as high as 20 miles per hour. On the 9th, however, the gradient wind had changed to south and southwest and this, together with the sea breeze, produced a resultant wind of 25 to 30 miles per hour, thus putting the ship to a severe test. That it was able to meet this test is a remarkable tribute to those who designed this type of dirigible. During the evening of the 9th the wind diminished for a time to about 20 miles per hour, owing to the dying out of the sea breeze, but later increased under the influence of an area of low-pressure central over the St. Lawrence Valley. The *R.34* accordingly left at midnight on its return trip. For the most part the homeward voyage was without incident, there being assisting winds at practically all points along the course, due to an extensive area of high pressure, central at about latitude 45° N. and longitude 25° W. (See Charts XIV to XVII, inclusive, July, 1919, MONTHLY WEATHER REVIEW.)

As was to be expected, a dirigible of the size of the *R.34* is much more easily controlled when it is in the air, its natural element, than when it is moored in the open. In the air it may run into ascending or descending currents and into winds of high velocity, but a skillful pilot can usually overcome these difficulties providing the ship is traveling at a sufficient height above the earth's surface. Descriptions of experiences of this kind are contained in Gen. Maitland's log, wherein he tells of severe bumps that were felt in or near thunderstorms over Newfoundland and New Brunswick, yet the airship was safely brought through them.

When moored in the open, an airship is not only subject to considerable strain because of sudden changes in the wind, but greater care is required in maintaining a proper balance between lift and ballast, for if, on the one hand, the lift becomes large the ship can be held down only with great difficulty; if, on the other hand, the lift is insufficient, the ship will settle to the earth and crush the gondolas. Naturally the most troublesome kind of weather in this connection is that characteristic of summer afternoons when insolation is at intervals intercepted by small patches of cumulus clouds. The sudden heating or cooling of the gas requires quick action in adjusting the dirigible's equilibrium. How serious this problem may become is shown in figures 4 and 5. During the first three nights at Mineola there was practically no wind, and the ship was therefore allowed to float at an altitude of 100 to 200 feet, as in figure 3. In the early morning it was usually brought down to the earth, as in figure 6, but on the morning of July 7 this operation was not undertaken until the sun was fairly high, with the result that the lift had greatly increased and the ship was with difficulty brought under control.

The experiences of the NC planes, of Hawker and Grieve, Alcock and Brown, and the *R.34* all emphasize the important part that wind assistance plays in the success or failure of trans-Atlantic flight. They also show that the frequency of fog and clouds over the Atlantic is a factor that must be given more serious consideration than was perhaps given it in a previous paper by the writer.[3] In several cases fog or clouds absolutely prevented astronomical observations for a day or more at a time, and the only means of determining position was through communication by radio with nearby ships. As this method of communication becomes better developed and more accurate, less dependance on astronomical observations will be necessary, and fogs and clouds will then become less serious obstacles. Rather unexpectedly the air over the ocean has been found to be quite "bumpy." Particularly is this true in the vicinity of Newfoundland, where the NC crews reported decidedly perturbed conditions, even when there were no clouds present. This "bumpiness" is no doubt due in part to the effect of the adjacent land masses, but in all probability is due principally to the mixing of air currents of different densities over the Gulf stream and the Labrador current. This is a subject that should be investigated very thoroughly by means of kites and balloons.

The important bearing that meteorological reports and forecasts have on trans-Atlantic, or, indeed, any long distance, flight was strikingly shown by the arrangements that had been made for such information in connection with the *R. 34's* trip. In addition to the forecasts that were regularly issued from the Weather Bureau, Washington, D. C., as to conditions over the North Atlantic, special reports were received and studied at Roosevelt Field by Lieut. C. N. Keyser and Mr. Samuel Gottlich of the Navy and by the writer of this paper, in order that the officers in charge might be kept constantly informed as to probable changes in local conditions, such as thun-

[1] See *Aeronautics*, July 10 and 17, 1919.
[2] See "Forecasts for the *R. 34*," by E. H. Bowie, MONTHLY WEATHER REVIEW, July, 1919, p. 505.
[3] Trans-Atlantic flight from the Meteorologist's Point of View. MONTHLY WEATHER REVIEW, February, 1919, 47: 65-67.

derstorms, high winds, etc. These special reports included observations every two hours with pilot balloons at Hazelhurst Field, under the direction of Lieut. Paul S. Wagner, Signal Corps meteorologist; and information as to the occurrence of thunderstorms in adjacent States. The pilot balloon records gave data of great value in predicting changes in the wind conditions both at the surface and at higher levels. During its flight the *R. 34* was furnished with European reports and with messages from ships at sea. These reports were studied by the airship's meteorological officer, Lieut. Guy Harris, R. A. F., who, in addition to advising Maj. Scott as to the best routes to follow, so as to avoid head winds, thunderstorms, etc., also kept a detailed record of the meteorological features of the flight, including some fine photographs of clouds and fog. It is sincerely to be hoped that Lieut. Harris will give us a complete history of the trip from the meteorologist's point of view.

THE GEOSTROPHIC (GRADIENT) WINDS OF THE NORTH ATLANTIC.

(Abstracted from back of Monthly Meteorological Chart of the North Atlantic July, 1919.)

Although surface winds cross the isobars at a slight angle, even at sea, the winds at only a small elevation blow essentially parallel to the isobars. Therefore, "geostrophic," or gradient, winds, parallel to the isobars are of interest to aviators.

The prevailing geostrophic winds have been worked up for three points—two in the Atlantic Ocean, namely, lat. 50° N., long. 40° W., and lat. 50° N., long. 25° W., and for the Valencia Observatory. The methods employed were to make use of weather maps for a 28-year period for the two Atlantic points and for a six-year period at the Valencia station. The results are summarized in diagrams which show the frequency distribution of the winds for the periods covered. For Valencia they are grouped by seasons, and for the two Atlantic points simply for the month of June.

Comparison of the three diagrams for the summer months shows considerable uniformity of conditions. In all cases there is a preponderance of west and southwest winds and those from the east are rare. In lat. 50° N. and long. 40° W., winds are well distributed around the compass, for the centers of deep cyclones occasionally pass south of that point. A more important detail is the high frequency of the northwest winds as compared with those of the two points farther east. The distinguishing feature of the summer diagram for Cahirciveen (Valencia) is the comparatively large proportion of northeast winds.

Taking the four diagrams for Cahriciveen together, we notice the high proportion of strong "geostrophic winds" in winter and also in autumn. The preponderance of southwest winds which is so marked a feature of the winter and spring diagrams disappears entirely in autumn. Northeast winds are found to be characteristic of autumn as well as spring.—*C. L. M.*

CLOUD FREQUENCIES WITH VARIOUS WINDS.*

The Meteorological Chart for the North Atlantic for August gives two interesting charts showing the frequencies of clouds with winds of various directions at Valencia and at St. Johns, Newfoundland. At the Valencia Observatory, of 100 occasions on which the wind at night is from the north, there is a clear sky on six occasions, the sky is one-fourth clouded on 15, one-half clouded on 15, three-fourths clouded on 27, and overcast on 34; it is raining on two occasions and foggy on one. At St. Johns, the very great percentage of fog is the outstanding feature; indeed, it is only with a calm or a southwest or a west wind that clear weather is experienced—all winds sweeping in from the ocean bring a large percentage of fog. At both stations evening and night are the clearest. The general trend of the air at both stations is from the southwest, which, as was mentioned above, brings clear weather at St. Johns, but has quite the opposite effect at Valencia. While the data do not cover a long period of time, the charts are of value especially because of their relation to trans-Atlantic flying.—*C. L. M.*

* Cf. Prof. Notes No. 1, p. 572, below.