several women and children were injured in a panic rush from a cinema. Records have been received from the central stations at Strasbourg and of the United States Coast and Geodetic Survey, and from individual stations at Cleveland (Ohio), De Bilt (Netherlands), Durham, Kew, Pasadena, Stuttgart, Toledo, Zurich and the Swiss observatories.

DEVIATION OF RADIO WAVES AT THE IONOSPHERE

INVESTIGATIONS in radio direction-finding have been conducted in Great Britain under the auspices of the Department of Scientific and Industrial Research since the formation of the Radio Research Board in 1920. This work has had a two-fold objective: first, to ascertain the possibilities of direction-finding at various frequencies for practical application to such purposes as station identification, navigation and meteorology; and secondly, to explore the phenomena involved in the propagation of radio waves over the surface of the earth and through the upper and lower atmosphere. The research towards these objectives has entailed a continuous improvement in instrumental technique, the results of which have had a far-reaching influence on the development and use of radio direction-finding equipment all over the world. In the high-frequency range of about 3–30 Mc./s., radio waves are transmitted mainly as a result of one or more reflexions from the ionosphere; and unless precautions are taken to avoid them, errors in the indication of the direction-finders result from the reception of waves coming down from the ionosphere under certain conditions of polarization.

Such instrumental errors are, however, reduced to a negligible magnitude in the spaced-loop type of direction-finder, which was developed as a practical tool in Great Britain more than ten years ago. With suitable equipment of the spaced-loop type the actual azimuth of arrival of radio waves can be determined to within a fraction of a degree. But this may not be the correct bearing of the sending station unless the propagation of the waves has been confined to the great-circle plane containing both sending and receiving stations. The results of experimental investigations on this problem carried out during 1938–47 are described in a recent report* from the Department of Scientific and Industrial Research, entitled "Lateral Deviation of Radio Waves Reflected at the Ionosphere", by W. Ross.

The investigations included large numbers of observations of the direction of arrival of waves from various transmitting stations at distances ranging from 90 to 8,500 km. The deviations from the great-circle path were found to be of a random and variable nature; at distances less than about 300 km., the rapid moment-to-moment fluctuations were superimposed upon slowly varying deviations with quasi-periods of 10–30 min. The standard deviations of the observed departures from the true bearing of the sending station ranged from about 8° for a distance of 90 km. to 3° for a distance of transmission of 260 km. These figures are mutually consistent, and suggest that the cause lies in a random tilting of the *F*2 layer of the ionosphere, the standard deviation of the tilt being about 1–1·5°. For ranges of transmission beyond 500 km. the fluctuations, although still very marked, decrease in magnitude. Typical values for the standard deviation of the fluctuations ranged from 0·9° to 1·3° for distances of 500–5,000 km.

At the close of the Second World War an opportunity arose of comparing the bearing deviations obtained in the above manner with a spaced-loop direction-finder of small aerial spacing (a tenth of a wave-length) with observations taken on a different system, which had been developed by the Germans, and using an aerial spacing of about two wave-lengths. For comparable conditions the close agreement in the results obtained supports the conclusion that the fluctuations in observed bearings are due to a tilting or corrugation of the ionosphere at the point where the waves are reflected from it. The extent of these tilts is not known; but the experiments suggest that they may be measured in tens of kilometres. The study of the lateral deviation of radio waves propagated by way of the ionosphere has been greatly extended in the present programme of work at the Radio Research Station, Slough, as a result of these investigations.

* Department of Scientific and Industrial Research: Radio Research. Special Report No. 19: Lateral Deviation of Radio Waves Reflected at the Ionosphere. By W. Ross. Pp. iv+32. (London: H. M. Stationery Office, 1949.) 9*d*. net.

DAYTIME METEOR STREAMS OF 1948

TWO papers, under the title "The Daytime Meteor Streams of 1948", the first by A. Aspinall, J. A. Clegg and A. C. B. Lovell, and the second by C. D. Ellyett, have recently been published (*Mon. Not. Roy. Astro. Soc.*, **109**, 3; 1949). The first paper deals with the measurement of the activity and radiant positions of the daylight meteor streams between May and August, 1948, which were first studied by the radio-echo method in 1947. The results of the 1948 work confirm those of the previous year and also provide some additional information, in particular on four other major showers in July and early August. The radiants of these were at $\alpha = 85°$, $\delta = +11°$, $\alpha = 96°$, $\delta = +21°$, $\alpha = 108°$, $\delta = +13°$, each of which gave echo-rates of 20–35 per hour, and remained active between July 12 and 17, after which their activity remained at a low level. The other shower became active on July 23 and reached its peak two days later, when its hourly rate rose to 30 per hour. The radiant was rather diffuse, in Auriga, varying from 80° + 39° on July 23 to 91° + 38° on August 4, after which it disappeared. Numerous tables, charts and details on individual showers are given in the paper, which should be carefully studied by everyone interested in meteor work.

The second paper is concerned with the measurements of velocities of meteors associated with the showers described in the previous paper. The automatic recorder gives a photographic record of the range and individual amplitudes of the first sixty pulses reflected from the meteor trail[1]. The mean velocity for ten Geminid meteors was found to be 34·4 ± 1·45 km./sec., which is in good agreement with Whipple's photographic results[2]. From the geocentric velocities thus determined, it is possible to deduce approximate results for the heliocentric velocities, and up to the present these confirm elliptic orbits—a view which is now practically accepted for most, if not all, meteor streams.

[1] For reference to the apparatus, see *Nature*, **161**, 596 (1948).
[2] *Proc. Amer. Phil. Soc.*, **79**, 499 (1938).