In his conclusions the author finds that, for remedial action, two fundamental necessities exist. There is the need for further financial assistance; there is the need for guidance and direction. The first implies substantial aid from the State; for the second, trust is placed in "the predominant authority of the university . . . as against the claim of proprietary interest," the State assuming only the functions of supervision and advice, "with due regard to the freedom of the university." How far such "due regard" can persist side by side with subvention and supervision it is not easy to say. But if departments and officials were endowed with Sir George Newman's knowledge, and imbued with his temper of sweet reasonableness, a way would be found of reconciling the bureaucratic and the academic points of view. That a way must be found for advance, along the lines of his vividly clear and deeply wise survey, is certain, unless England is, in the Reconstruction, to lose her opportunity and miss the lessons of her time of trial and testing.

THE DYNAMICS OF CYCLONIC DEPRESSIONS.[1]

THE publication in 1906 of Shaw and Lempfert's "Life-History of Surface Air-Currents" marked the passing of a milestone in the progress of our knowledge concerning the mechanism of travelling cyclonic depressions, and it is a matter of surprise that so little further advance along the same lines has been made since that time. This lack of progress obviously could not continue for ever, and two recent publications by Sir Napier Shaw suggest that the next milestone has now been passed.

In the earlier of the two papers[2] a travelling rotating disc of air was considered in which all the air particles had the same relative tangential velocity around the centre. This hypothesis led to valuable conclusions concerning the "secondaries" which so frequently form upon the southern side of the centre, but did not throw much light upon the cyclone as a whole. On consideration it became evident that the mathematics would be much more manageable if the disc of air were assumed to have uniform vorticity ζ, so that the relative velocity $v = \zeta . r$, and, working on this assumption, valuable results have been obtained. This hypothesis implies a disc of air revolving about its centre as a solid like a cartwheel, and the "normal cyclone" considered in the present paper has within itself a circulation of this type. The air particles will trace out trochoids formed by the rolling of the disc of relative motion along the line of motion of the instantaneous centre, and, if sufficiently extended in all directions, the mass will possess intrinsically two centres, (1) a centre of instantaneous motion, or *kinematic centre*, about which the resultant winds shown upon the map at any instant will be revolving (surface incurvature being neglected), and (2) a centre of revolving fluid or *tornado centre*—that is, the centre of the "cartwheel"—which is found at a distance V/ζ on the right-hand side of the path of the instantaneous centre, where V is the velocity of travel of the depression as a whole.

The "normal cyclone" has, however, yet a third centre. If upon the pressure field of a stationary circular depression a uniform pressure gradient from N. (high) to S. (low) be superposed, it is shown that every air particle will commence to follow its appropriate trochoid curve, and the effect will be that the depression will advance across the map from W. to E. with a speed V, while at the same time the system of isobars will be displaced a distance $V/(2\omega . \sin\phi + \zeta)$ to the south from the centre of instantaneous motion (ω equals angular velocity of the earth, ϕ equals latitude). This centre of isobars is termed the *dynamic centre*, and forms the third centre of the travelling depression. As a numerical example, if the rotation of the disc be such that a velocity of 20 m./sec. (gale force) is found 200 km. from the centre of instantaneous motion, and if the eastward speed of progression of the depression be 10 m./sec. in our latitude, the tornado centre will be 100 km., and the dynamic centre 45 km., to the south of the instantaneous or kinematic centre.

Viewed in another way, the pressure system may be taken to be compounded of a set of circular isobars round the tornado or "cartwheel" centre, and a uniform pressure gradient from S. to N., when the rate of advance V of the depression will equal the geostrophic wind corresponding with this field. Since this superposed field may reasonably be taken to be the same as the general field surrounding an isolated cyclonic depression, the conclusion is reached that the speed of progression of such a depression will depend directly upon the strength of the surrounding field, and in certain examples shown this is satisfactorily confirmed. One of the most interesting results reached is undoubtedly that the winds shown on a map for an eastward moving depression will circulate, not about the isobaric centre, but about a point to the north which may be of the order of 50 km. distant. Practical examples of this are also adduced. Other conclusions of importance, such as the probability of secondaries developing at the tornado centre, cannot be more than alluded to in a short notice like the present. The demonstration of the fact that a normal travelling cyclonic depression has three distinct "centres" is the outstanding feature of the paper.

To the reader the treatment appears a little disjointed and to lack mathematical sequence, but the author has forestalled criticism on this point by explaining that he considered it better to set out the matter in the order in which it was developed, since this method would bring directly under review the various aspects of the subject that are presented to the student of weather maps. A straightforward theoretical discussion would lack this advantage. J. S. D.

[1] "The Travel of Circular Depressions and Tornadoes and the Relation of Pressure to Wind for Circular Isobars." By Sir Napier Shaw. Meteorological Office. Geophysical Memoirs, No. 12, 1918.

[2] "Revolving Fluid in the Atmosphere." Proc. Roy. Soc., A, vol. xciv., p. 34, 1917.