Many meteorological problems of the highest importance can apparently only be solved by a more systematical co-operation between meteorologists and oceanographers. The proposed investigation of the North Atlantic (1) seems to offer an exceptionally favourable opportunity for taking steps in this direction.

THE STELLA DUAL MAGNETIC COMPASS.

Since the unsteadiness of the ordinary form of dry-card compass renders it unsuitable for accurate steering, the liquid compass is generally employed for that work, although the liquid type of compass lacks the delicacy, sensitivity and lightness of the dry-card instrument. Recently, however, a new type of compass has been designed by Mr. N.-C. BAIRD and this instrument, it is claimed, while retaining all the advantages of the large-diameter dry-card compass, is not less steady than the liquid type. This compass, known as the STELLA DUAL MAGNETIC COMPASS, is made by Messrs. Stella Engineering Company, 38 Bath Street, Glasgow.

The appliance includes an outer and an inner vessel. Figure 1 is a section of the outer vessel in which the inner vessel is suspended on gimbals formed by two pairs of knife-edges at right angles, so that the inner vessel always remains horizontal if the outer vessel is tilted. The latter is completely filled with a non-freezing liquid which serves to damp out any oscillations of the inner vessel, and the weight of the inner vessel is adjusted, by means of a lead weight, to give critical buoyancy. A section of the inner vessel is reproduced in Figure 2, while Figure 3 is a perspective drawing which serves to make the principle of the instrument clear.

In the inner vessel an annular dry card is suspended by four radial arms from a pivot mounted on a central cylindrical box, and four sets of 4 short magnetic needles are mounted on stirrups carried by the radial arms as shown in Figure 3. The magnets are also shown in Figure 2.

Neglecting for the moment the contents of the cylindrical box above referred to, it will be seen that the annular card (and its attached magnetic system) moves entirely in air and that it will set itself in the magnetic meridian, but it will also be obvious that unless means are taken to prevent it, the card will continue to oscillate about a mean position for a long period. The method of preventing this oscillation is particularly interesting and ingenious. Referring to Figure 3, it will be seen that the cylindrical box contains another magnetic system consisting of eight comparatively long needles mounted on a bar supported by a pivot from the bottom of the box so that they lie in the same plane as those of the dry card. The central box is filled with non-freezing liquid, so that the movement of the magnetic system is highly damped. If now the compass is turned away from the magnetic meridian, the central magnetic system will turn back to the meridian comparatively slowly, but with almost dead-beat motion. The annular card will oscillate slightly about its mean position, but the oscillations are kept of small magnitude and are rapidly damped out by the interaction between the magnets suspended from the dry card and those enclosed in the central box. Experience has shown that when the compass is turned through an angle of 180° from its equilibrium position and then neglected, the card will come completely to rest in the right direction in a little less than 50 seconds after having made only four oscillations.

The total weight of the dry card and its system is only 60 grains as compared with about 200 grains, which is the weight of the moving system in ordinary dry-card compasses. (The weight of the card for 7 in. compass is about 25 grains).

Another advantage claimed for this new system is that disturbance from outside magnetic influences is reduced.

(1) O. PETTERSSON & C. F. DRESCHEL. — Mémoire sur des recherches dans l'Atlantique avec programme. *Copenhagen. Imprimerie J. Jorgensen & Co.*, 1913.

The primary magnetic system consists of eight 35 % cobalt steel magnets, 2 mm. broad, 1 mm. thick, set in two copper or brass foil discs with sealed periphery. The secondary magnetic system consists of sixteen 35 % cobalt steel magnets 1 in. long.

The compass is designed in two sizes with card of 10 in. and card of 7 in. diameter. The following is a description of the salient features of this new instrument:

10 IN. DRY CARD INSTRUMENT. 1. *Rapidity in returning to the Earth's Magnetic Meridian after deflection.* — This is explained by reason of the fact that there are two distinct magnetic systems, each system endeavouring to lie in the earth's field normally. The outer magnetic system being of a low order of weight comparatively, and being freely suspended, interacts magnetically with the inner magnetic system which is heavier than the outer magnetic system, is highly damped and in a critical state of buoyancy. The magnetic distortion as between the two magnetic systems obviously determines the return to the magnetic axis, which is established in a comparatively short period of time. This form of magnetic linking, together with the fact that both magnetic systems are under the Earth's controlling force, accounts for the very high order of magnetic damping and resultant reduction of angular vibrations which would normally be established if each system were isolated and freely suspended.

2. *Very low magnetic moment.* — This is explained by reason of the fact that the weight of the card is considerably reduced. The standard 10 in. Dry Card of the instrument being approximately 60 grains as compared with approximately 200 grains in existing Dry Card instruments, calls for comparatively low magnetic value to respond to the Earth's field.

3. *Damage to Pivot and Jewel Cap practically impossible.* — Again as mentioned above the reduced weight of the new 10 in. Card cannot establish any considerable mechanical reaction as between pivot point and cap.

4. *Disturbance from outside magnetic influence reduced.* — This evident fact is due to the low magnetic value of the dual magnetic system, and the mutual interaction of the two magnetic systems.

5. *High order of sensitivity. Not subject to errors arising from friction.* — The low weight of the Card, which is controlled by the inner magnetic system and which is in a critical state of buoyancy, engages very lightly on the pivot and reduces any considerable moment of friction; also, the double magnetic system will endeavour to form a true magnetic axis. Both systems being controlled by the Earth's horizontal force determines the return to the position of rest from which angular movement commenced.

6. *The Card is approximately one-third of the weight of the lightest* 10 *in. Card in use at the present time.* — Notwithstanding the very low weight of the Card of the new instrument, the construction is robust and rigid, and it is not subject to distortion arising from temperature changes. The periphery is a well-defined sharp edge and the incline of the Card surface, being approximately normal to the eye, lends itself to ease of direct reading.

7. *The Card is free from disturbance arising from vibration and mechanical shocks.* — This is due to the fact that the vessel containing the Card and magnetic system is immersed in a critically buoyant state, having universal freedom of movement in another vessel containing a non-freezing and transparent fluid. It will be readily seen that this method gives the ideal form of damping for high frequency vibration and crude mechanical disturbance.

8. *Angular Dip.* — The new Card is damped in its azimuthal or angular movement and also in movements in a vertical plane.