

March 15, 1883.

THE PRESIDENT in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The Right Hon. Joseph Chamberlain was admitted into the Society.

The following Papers were read:—

- I. "On the Changes which take place in the Deviations of the Standard Compass in the Iron Armour-plated, Iron, and Composite-built Ships of the Royal Navy on a considerable Change of Magnetic Latitude." By Staff-Commander E. W. CREAK, R.N., of the Admiralty Compass Department. Communicated by Captain Sir FREDERICK J. O. EVANS, R.N., K.C.B., F.R.S., Hydrographer of the Admiralty. Received March 1, 1883.

(Abstract.)

The period comprised between the years 1855–68 was one of active research into the magnetic character of the armour-plated and other ships of the Royal Navy, and iron ships of the Mercantile Navy.

Among other contributions to this subject, a paper by F. J. O. Evans, Esq., Staff Commander R.N., F.R.S., and Archibald Smith, Esq., F.R.S., was read before the Royal Society in March, 1865, relating to the armour-plated ships of the Royal Navy, and containing the first published results of the system of observation and analysis of the deviations of the compass established four years previously.

From lack of observations in widely different magnetic latitudes, the authors of that paper were unable to define the proportions of the semicircular deviation arising from vertical induction in soft iron, and that arising from the permanent or sub-permanent magnetism in hard iron.

During the last fifteen years vessels of all classes—except turret ships—have visited places of high southern magnetic inclination or dip, and the analysis of the deviation of their standard compasses has been made, showing the constants for hard and soft iron producing semicircular deviation.

The constants for soft iron provide a means of predicting probable changes of deviation on change of magnetic latitude for certain vessels of the following classes, and others of similar construction:—

1. Iron armour-plated.
2. Iron cased with wood.
3. Iron troop ships.
4. Steel and iron ships cased with wood.
5. Composite-built vessels.
6. Wooden ships with iron beams and vertical bulkheads.

These vessels were all in a state of magnetic stability previous to the observations which have been discussed, and their compasses have had the semicircular deviation reduced to small values, or corrected in England by permanent bar magnets.

This correction may be considered as the introduction of a permanent magnetic force acting independently, and in opposition to the magnetic forces of the ship proceeding from hard iron.

It is now proposed to consider the effects of a change of magnetic latitude on the component parts of the deviation.

Semicircular Deviation.

On semicircular deviation from fore and aft forces time has but little effect, and the greater part of it is due to permanent magnetism in hard iron, which may be reduced to zero for all latitudes by a permanent magnet.

A second but small part of the semicircular deviation proceeds from sub-permanent magnetism in hard iron. It is subject to alterations slowly by time, from concussion, and from the ship remaining in a constant position with respect to the magnetic meridian for several days, and is more intensely affected by a combination of the two latter causes.

Deviations from sub-permanent magnetism which have been temporarily altered in value as described, return slowly to their original value on removal of the inducing cause.

The principal cause of change in the semicircular deviation on change of magnetic latitude in corrected compasses, arises from vertical induction in soft iron which changes directly as the tangent of the dip.

In standard compasses judiciously placed with regard to surrounding iron, this element of change is small, and similar in value for similar classes of ships.

With very few exceptions nearly the whole of the semicircular deviation from transverse forces is due to permanent magnetism in hard iron subject to the same laws as that proceeding from fore and aft forces.

In the exceptional cases alluded to, there is a small part due to

vertical induction in soft iron, changing directly as the tangent of the dip.

Quadrantal Deviation.

This deviation, caused by induction in horizontal soft iron symmetrically placed, does not change with a change of magnetic latitude. Time alone appears to produce a gradual change in its value during the first two or three years after the ship is launched, when it becomes nearly permanent.

The diminution of the mean directive force of the needle, which is common to all modern vessels of war, improves slowly at first by lapse of time, and finally assumes a permanent value.

Relative Proportions of Hard and Soft Iron.

It has been found that the relative proportions of the hard and soft iron affecting the standard compasses of twenty-five vessels examined differ considerably, even in ships of similar construction.

This difference may be accounted for by the compasses not being placed in the same relative position in the ships considered as magnets of various forms, and containing numerous iron bodies introduced during equipment.

General Conclusions.

The following general conclusions have special reference to the standard compass of the six classes of vessels previously mentioned:—

1. A large proportion of the semicircular deviation is due to permanent magnetism in hard iron.

2. A large proportion of the semicircular deviation may be reduced to zero, or corrected for all magnetic latitudes, by fixing a hard steel bar magnet or magnets in the compass pillar in opposition to and of equal force to the forces producing that deviation.

3. A very small proportion of the semicircular deviation is due to sub-permanent magnetism, which diminishes slowly by lapse of time.

4. The sub-permanent magnetism produces deviation in the same direction as the permanent magnetism in hard iron, except when temporarily disturbed, (1) by the ship remaining in a constant position with respect to the magnetic meridian for several days, (2) by concussion, (3) or by both combined, when the disturbance is intensified.

5. To ascertain the full value of changes in the sub-permanent magnetism, observations should be taken immediately on the removal of the inducing cause.

6. In the usual place of the standard compass the deviation caused

by transient vertical induction in soft iron is small, and of the same value (nearly) for ships of similar construction.

7. The preceding conclusions point to the conditions which should govern the selection of a suitable position for the standard compass with regard to surrounding iron in the ship.

II. "Atmospheric Absorption in the Infra-Red of the Solar Spectrum." By Captain ABNEY, R.E., F.R.S., and Lieut.-Colonel FESTING, R.E. Received March 5, 1883.

Any investigations on the subject of atmospheric absorption are of such importance in the study of meteorology, that we have deemed it advisable to present a preliminary notice of certain results obtained by us, without waiting to present a more detailed account which will be communicated at a future date. From 1874, when one of us commenced photographing the spectrum in the above region, till more than a year ago, the extremely various manners in which the absorptions took place caused considerable perplexity as to their origin, and it was only after we had completed our paper on the absorption of certain liquids,* that a clue to the phenomena was apparently found. Since that time we have carefully watched the spectrum in relation to atmospheric moisture, and we think that more than a year's observations in London, when taken in connexion with a month's work, at an altitude of 8,500 feet on the Riffel, justify the conclusions we now lay before the Society.

A study of the map of the infra-red region of the solar spectrum,† and more especially a new and much more complete one, which is being prepared for presentation to the Royal Society by one of us, shows that the spectrum in this part is traversed by absorption lines of varying intensity. Besides these linear absorptions, photographs taken on days of different atmospheric conditions, show banded absorptions superposed over them. These latter are step by step absorptions increasing in intensity as they approach the limit of the spectrum at the least refrangible end. In the annexed diagram,‡ fig. 4 shows the general appearance of this region up to λ 10,000 on a fairly dry day: the banded absorption is small, taking place principally between λ 9420 and λ 9800: a trace of absorption is also visible between λ 8330 and λ 9420. On a cold day, with a north-easterly

* "The Influence of the Atomic Groupings of the Molecules of Organic Bodies on their Absorption in the Infra-Red Region of the Spectrum." "Phil. Trans.," Part III, 1881.

† "Phil. Trans.," 1880.

‡ The lines shown in the diagram are merely reference lines, and have nothing to do with the absorptions under consideration.