THE TROUTON-NOBLE ETHER DRIFT EXPERIMENT

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ABSTRACT

In view of recent theoretical investigations by Epstein which show that the sensitivity of this experiment is less than had been supposed and thus render inconclusive the previous performance of the experiment by the author, the experiment has been repeated once more with still greater sensitivity. The present apparatus should detect a motion in the ether of as low as 3 km/sec. and no such motion is found.

INTRODUCTION

If a parallel plate condenser whose plates are in a vertical plane and which is moving with respect to a stationary ether, is charged, there will under certain conditions exist a couple tending to rotate the condenser about a vertical axis. This couple is given by the expression[1,2]

$$K=(CV^2v^2/10\epsilon c^2)\sin 2\psi \sin^2 Z$$

where C is the capacity of the condenser; V, the potential to which it is charged; ϵ, the dielectric constant of the dielectric used in the condenser; v, the velocity of the condenser with respect to the ether; c, the velocity of light; ψ, the azimuthal angle between the direction of motion and the plane of the plates; and Z, the angle between the direction of motion and the vertical direction (the zenith distance of the direction of motion). This expression includes Epstein's correction[1] which made necessary a repetition of the experiment.

If the condenser is suspended by means of a delicate fiber, the angular rotation that will be produced by the couple can be computed when the elastic constants of the fiber are known.

The improvements in the present apparatus over the previous arrangement consist of the following: higher potential, better shielding from both temperature and electrostatic disturbances, finer suspending wires, and more suitable material for these wires. Also, the improved shielding makes possible the use of a greater scale distance.

APPARATUS

The apparatus is in general similar to that which was used before, except that in this case the condenser is surrounded by a copper sphere specially spun for the purpose, instead of a cylinder. This sphere is 20 cm in diameter with walls 3 mm thick. The suspending wires (one above and one below the condenser) are of tungsten, 0.0013 cm in diameter and 90

[1] Epstein, Phys. Rev. 29, 753 (1927).
[2] Chase, Phys. Rev. 28, 378 (1926).

cm long. Means are provided for accurately and smoothly adjusting the height and angular position of the ends of these wires, either together or separately. The wires are protected by tubes of brass, each 2.5 cm in diameter and 100 cm long with walls 2 mm thick. Cylinders of hard rubber at the outer ends of these tubes insulate the wires from the case. A small mirror for observing deflections is fixed to a piece of No. 14 aluminum wire which is securely fastened to the lower terminal of the condenser. The mirror can be seen through a small hole in the lower tube just below the sphere, the hole being covered with mica.

The condenser is the same one that was used before, having a capacity of 0.04 mf and weighing 10 grams. It is built up of discs of mica and aluminum foil, and is 4 cm in diameter with a thickness of 3 mm. As before, it is wrapped with a coating of foil which connects to the lower terminal and completely covers the condenser except for a small space around the upper terminal. The period of the swinging condenser is 80 seconds, when suspended as described.

The potential is supplied by a storage battery giving 2420 volts and remained constant within 6 volts during a run. A resistance of 8000 ohms is placed in each battery lead, and the lower suspending wire (and thus the foil wrapping of the condenser) is connected to the case through a resistance of 50,000 ohms. The case is grounded.

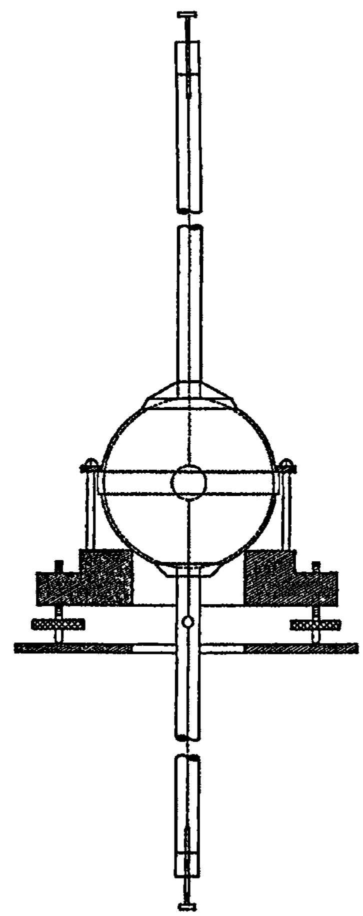

Fig. 1. Diagram of apparatus.

The apparatus stands on a tripod made of a piece of boiler plate and three iron pipes. It is set up in the center of a constant temperature room below ground, in which the temperature variation during a run is less than two-tenths of a degree. The room is kept closed during and immediately before a run, observations being made from outside through a small hole in the wall in which a ground glass scale has been inserted. Deflections are observed by reading on this scale the position of the image of a galvanometer lamp as reflected from the mirror attached to the condenser. The scale distance is three meters, and under normal conditions readings can be taken to a tenth of a millimeter with confidence. A thermometer is hung near the instrument and is read from outside the room by means of a telescope.

Method of Observation

Observations were made every ten minutes for twelve consecutive hours. Although there is a certain advantage in continuing the observations for twenty-four hours at a time, it was found impossible with the increased sensitivity to find twenty-four hours during which there would be no disturbances of sufficient magnitude more than to offset the advantages of the longer run. It was, however, possible to find twelve hour periods during which conditions were quiet enough to give significant results.

The condenser is charged and after a few moments five consecutive turning points of the lamp image are read. The battery is connected to the condenser during the whole time that the condenser is charged, in order that the potential shall remain constant. As soon as these turning points have been read, the condenser is discharged and at the next ten minute point five more turning points are read. Thus the condenser is allowed to swing for about five minutes after the switch has been thrown and before the readings are made, eliminating the effect of any possible shock or ballistic throw that might be caused by charging or discharging (such shocks are largely eliminated by the resistances in the battery leads), and one "resting point" is obtained for each ten minutes, alternately for the condenser charged and discharged. To obtain the deflections resulting from charging the condenser, any three consecutive resting points are used, say two for the condenser discharged and one for the condenser charged. The mean of the two discharged positions is subtracted from the charged position. Thus any zero drift is eliminated from the results, and one deflection is obtained for each ten minutes during the run.

Results

The deflections observed during two of the runs for June, 1927, are plotted against time in Figs. 2 and 3, and a scale of corresponding ether drift velocities as computed by means of the above formula from the constants of the

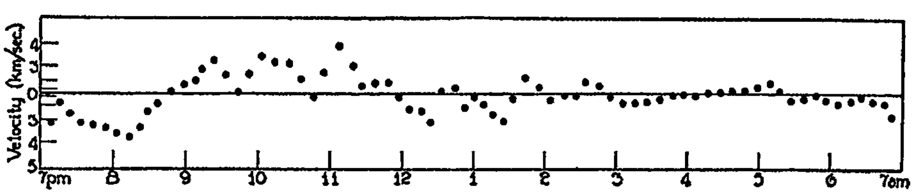

Fig. 2. Observed deflections, 7 P.M. to 7 A.M., E. Std. Time. Condenser in East-West plane.

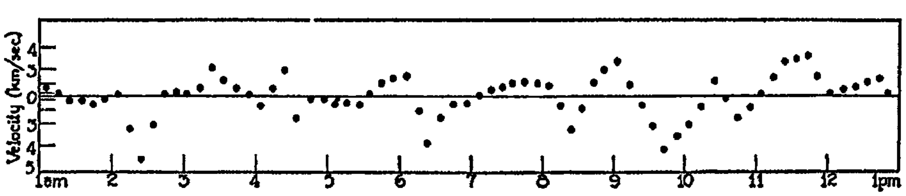

Fig. 3. Observed deflections, 1 A.M. to 1 P.M., E. Std. Time. Condenser in East-West plane.

apparatus is given. A velocity of 3 km/sec. should give a deflection of 5 mm, 6 km/sec. should give 21 mm deflection, and so on. There appears to be no systematic change in the deflections that would correspond to a velocity in a stationary ether of more than 3 km/sec.

CONCLUSION

Thus the experiment has been repeated with sufficiently increased sensitivity to compensate for theoretical reduction in the sensitivity of the experiment. The apparatus should detect a motion in the ether as small as 3 km/sec., and no motion is detected.

The author wishes to express his thanks to Professor G. W. Pierce for putting the facilities of Cruft Laboratory at his disposal, and for his interest as the work progressed. He also wishes to thank Messrs. E. W. Pike, H. A. Blackmun, D. P. Adams, and F. V. Hunt for their invaluable and voluntary assistance in making the observations.

CRUFT HIGH TENSION ELECTRICAL LABORATORY,
HARVARD UNIVERSITY,
June 28, 1927.