A PORTABLE APPARATUS FOR MEASURING MAGNETIC FIELDS. A THESIS SUBMITTED FOR THE DEGREE OF BACHELOR OF PHILOSOPHY

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BY

REINHARD CONRAD WINGER

A Thesis Submitted for the Degree of

BACHELOR OF PHILOSOPHY

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A Portable Apparatus for Measuring Magnetic Fields.

The problem assigned for this thesis was to design and construct a portable apparatus which is capable of measuring accurately, magnetic fields varying from very weak fields to fields of great intensity.

In constructing a portable apparatus of this nature a number of essential factors must be considered. In the first place it must be compact so as to take up as little space as possible, and of such weight as to permit it being carried about easily. The instrument must be fairly sensitive in order to permit an accurate determination of very weak fields as well as of very strong ones. Lastly, it must be constructed with a view of reducing the effects of external conditions to a minimum. The above mentioned factors have beenkept in mind in working out the details of the problem assigned for this thesis.

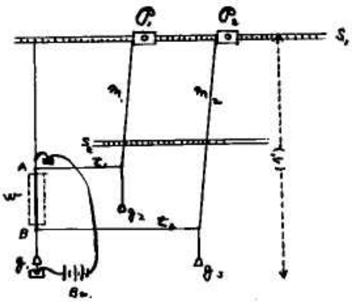
Before going into details regarding the construction and use of this apparatus it may be well to briefly review the various methods in use for determining the strength of magnetic fields. There are four general methods in use,viz.

(1) The traction method.
(2) Comparison by use of earth inductor.
(3) The ballistic method.
(4) The fluxmeter.

The traction method:

This method was devised by Lord Kelvin and has a wide range of use in magnetic measurements.

The following diagram shows the method as originally devised.



AB = wire between pole pieces.
G = known weights.
W = pole pieces of magnet.
Ba= battery.

To operate, move P_1 and P_2 so that t_1 and t_2 are slack. Mark position of AB on pole of magnet and send a measured current through AB in such a direction that AB is forced to the left. Now P_1 and P_2 are moved so as to bring AB back to its original position. Knowing the weight of G, the displacement on the scales S_1 and S_2, the vertical distance between scales, and other measured conditions, it is possible to find the value of the field by substituting the values in the following equation:

$$I = \frac{WG(d_1 + d_2)}{L\ C\ l}$$

where

I = average intensity of field.
W = the mass of each pendulum bob in grams.
g = the attraction of gravity.
L = length of opposing pole faces.
$d_1 + d_2$ = sum of the differences over which wires M and M have moved on S_1 and S_2.
l = perpendicular distances between point of suspension of wires to bottom of lower scale.

In using this method the operator will find the following difficulties:

1. The apparatus is not a convenient one to carry about as it occupies too much space.

2. In order to use this method it is necessary to have a measured current. This makes it necessary to carry batteries and to depend on ammeters at all times .

(3) The method does not seem to adapt itself to the measuring of vertical fields, or to fields that lie between curved pole pieces.

(4) As the apparatus is shown above, it can be used only to determine the average intensity of the field. The apparatus has been modified in a number of ways but several of the difficulties mentioned still exist. The instrument uses a measured current at all times and this fact makes it inconvenient to use it as a portable instrument.

Comparison by Use of Earth Inductor:

This method consists in comparing the throw of a ballistic galvanometer due to an exploring coil, placed in the field to be measured and suddenly withdrawn, with the deflection of the galvanometer due to the swinging of the coil of an earth inductor through a suitable angle. In order to get the value of the quantity of electricity induced by the inductor it is necessary to know the horizontal component of the earth's magnetic field. This force varies according to the time, and the place where determined, and therefore is not sufficiently constant to be used for the purpose of standardizing a galvanometer. The apparatus has not been made compact so as to be readily carried about.

The Ballistic Method:

The essential principle of the ballistic method consists in comparing the deflection of a ballistic galvanometer caused by an exploring coil in the field, with the deflection caused by the induced