CENTRAL SCIENTIFIC COMPANY

OPERATING INSTRUCTIONS

Tangent Galvanometer
No. 70712-01

1. Introduction

The Tangent Galvanometer (70712-01) is a basic teaching device used to illustrate the operating principles of electrical meters. Operation is based on the fact that the magnetic field surrounding a current-carrying coil will deflect a suitably mounted magnetic needle. The instrument derives its name from the fact that the tangent of the angle through which the needle is deflected is proportional to the current.

2. Description

The Tangent Galvanometer consists of a magnetic compass placed at the center of a coil of wire. The coil consists of fifteen turns of No. 20 copper magnetic wire wound around an aluminum ring attached to the galvanometer base. The wire is connected to three binding posts on the base in such a manner that 5, 10, or 15 turns of the wire can be used.

3. Operation

Place the Tangent Galvanometer so the plane of the coil is parallel to the earth's magnetic meridian. Place the compass on the center stand of the Tangent Galvanometer so that the North/South indicator on the compass is in line with the coil diameter. Twist the apparatus until the magnetic needle points to the North on the compass. Earth's magnetic field is now perpendicular to the axis of the coil (see Figure 1).

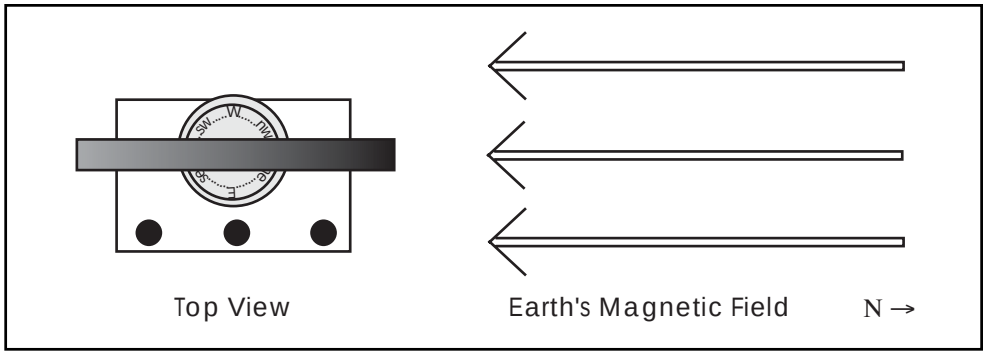

Figure 1

Connect a DC power source capable of supplying 5 amps at 5 volts, such as a low voltage DC power supply (our 31382) or a dry cell, to the binding posts. Five turns of coil are connected between the right and center binding posts. Ten turns of coil are connected between the center and the left binding posts. All fifteen turns of coil are connected between the left and the right binding posts.

Apply power and observe the needle deflection. Determine the current by using Equation (4) of the Section 4, "Theory." The horizontal component of Earth's magnetic field varies according to geographic location and can be obtained from a chemistry or physics handbook.

4. Theory

The magnetic field produced by the current in the coil is perpendicular to Earth's magnetic meridian. Thus, the magnetic needle rotates until its magnetic axis lies along the direction of the resultant of two magnetic fields — the field produced by the current and the horizontal component of Earth's magnetic field.

Consider a coil of mean radius **a**, having **n** closely wound turns and carrying a current **i**. The magnetic field **H** at the center of the coil due to the current is given as

$$H = 2\pi ni / 10a \qquad (1)$$

The field **H** is expressed in Oersteds when **a** is measured in centimeters and **i** is measured in Amperes. If the plane of the coil is parallel to the magnetic meridian, the magnetic field **H** is at right angles to the horizontal component **H'** of Earth's magnetic field. The resultant magnetic field at the center of the coil is the vector sum of **H** and **H'** (see Figure 2), and it makes an angle α with the magnetic meridian where

$$\tan \alpha = H / H' \qquad (2)$$

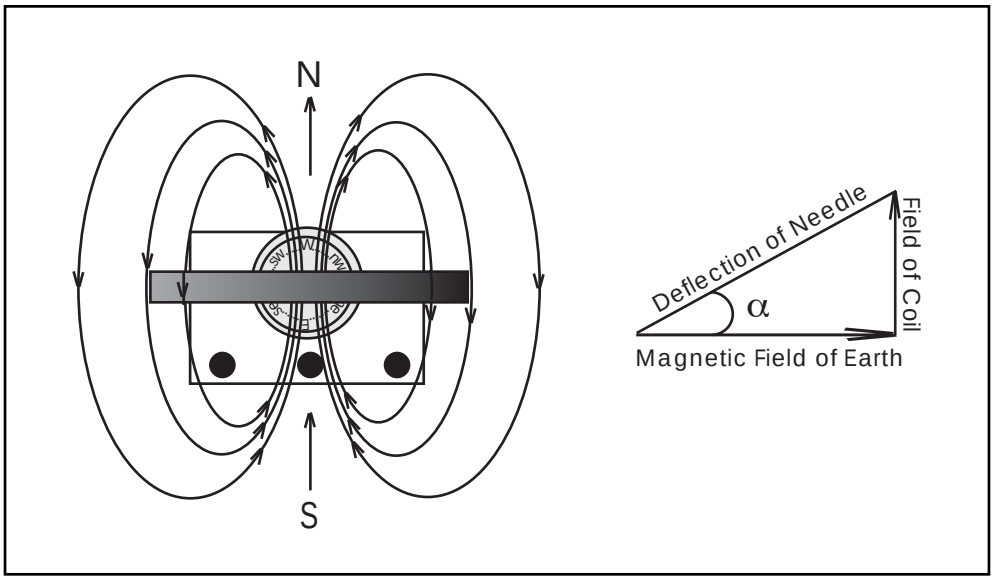

Figure 2

Thus, a small magnetic needle placed at the center of a coil is deflected through an angle α by a current **i** in the coil where

$$\tan \alpha = 2\pi ni / 10aH' \qquad (3)$$

The quantity $\mathbf{2\pi n / 10a}$ is a constant for a particular galvanometer and is called the galvanometer constant **G**. From Equation (1) we see that **G** is numerically equal to the magnetic field at the center of a coil produced by a current of one Ampere.

From both Equation (3) and the definition of **G** it follows that

$$i = (H' / G) \tan \alpha \qquad (4)$$

Since **H' / G** is constant for any particular galvanometer and location, the tangent of the angle of deflection is proportional to the current. It should be noticed that in the derivation of Equation (3) it is assumed that the magnetic field due to a current in the coil is sensibly uniform over the region occupied by the compass needle. It is for this reason that a small needle is used.

5. Maintenance

The Tangent Galvanometer needs no special maintenance. If you should experience any difficulty with this piece of equipment, please contact Central Scientific Company, giving details of the problem. To ensure better service, please do not return any item to Central Scientific Company until we have sent you authorization.

6. Accessories

Description	Cat. No.
Low Voltage Power Supply	31382
Replacement Compass	78430-03

7. Copyright Notice

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