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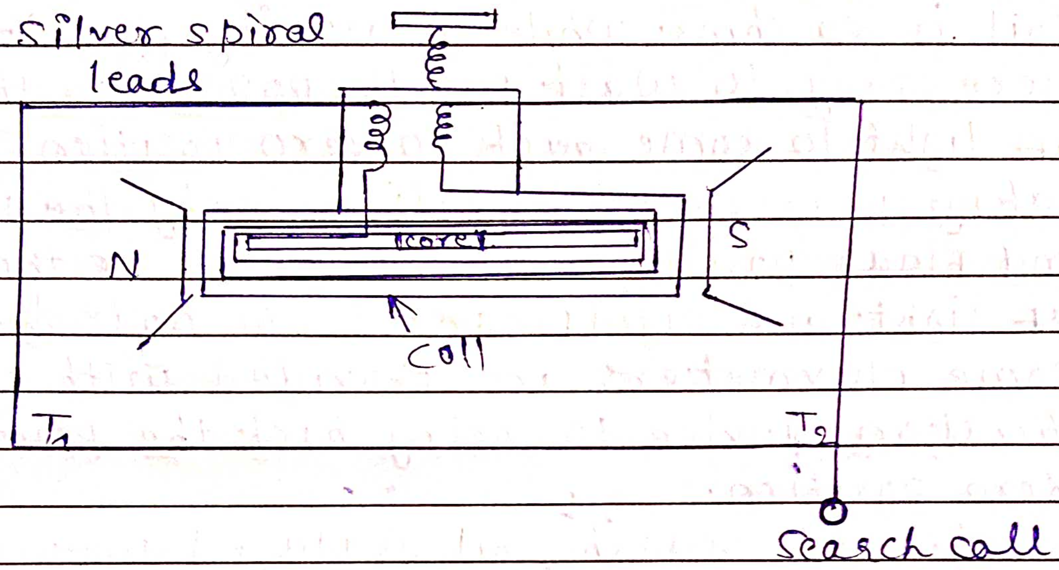
* Grassot's fluxmeter → This is a modified form of moving coil ballistic galvanometer. In ballistic galvanometer, there is very small controlling torque and air damping but there is very large electromagnetic damping which damps the rotation of the coil. It is used to measure the magnetic flux with the help of a search coil.



The fluxmeter coil is suspended between the pole-pieces of the magnet NS from a single silk fibre as shown in fig. The silk fibre experts practically zero restoring couple. The fibre has its upper end attached to a flat spiral spring to prevent damage due to shock as shown in the figure. The current through the coil sent through two light thin silver springs which introduce very little mechanical damping. The search coil is connected to the terminals T_1 and T_2.

The deflection of the coil is connected to the terminals and indicated by the usual

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mirror, lamp and scale arrangement or a pointer moving over a previously calibrated scale. The moving coil has a periodic time of the order of 60 seconds. The external circuit is connected to the terminals T_1 and T_2. This circuit usually consists of only the search coil. should not have very large resistance otherwise the electromagnetic damping will be to small. The usual value of the resistance of the search coil is 20 ohms. while measuring flux it is not necessary to wait for the pointer or the spot of light to come back to zero position. Before taking a fresh observation, only the initial and final positions of the pointer or the spot of light are significant to be noted. However some fluxmeters are provided with a push-button device to bring back the pointer to zero position.

When the search coil is placed into or withdrawn from the magnetic field to be determined, say between the pole-piece of a horse-shoe shaped magnet, an e.m.f. is induced in the circuit which gives rise to a current. The corresponding deflection of the fluxmeter can be shown to be directly proportional to the change of flux in the search coil and not the rate of change of flux.

The e.m.f. induced in the circuit due to change in magnetic flux through the search coil $= \frac{d\phi}{dt}$. where ϕ is the total change in flux linked with the search coil when it is placed into or removed from the field.

When the current due to this e.m.f. flows through the fluxmeter coil, the latter turns within the magnetic field of the permanent magnet NS; this causes the flux linked with the fluxmeter coil to change giving rise to an induced e.m.f. in a direction opposite to that of the e.m.f. set up due to change in the flux linked with the search coil according to Lenz's law. The resultant e.m.f. E which is the difference of these two induced e.m.fs. produces a current in the circuit given by

$$i = \frac{E}{R} \quad \ldots\ldots (1)$$

where R is the total resistance of the circuit including that of the fluxmeter coil.

Now let A be the effective face-area (i.e. total number of turns x area of one turn) of the fluxmeter coil and B be the intensity of magnetic field between the pole-pieces NS. Then the flux linked with the fluxmeter coil at any instant when its plane makes an angle θ with the field B is

$$\phi' = AB \sin\theta = AB\theta, \text{ if } \theta \text{ is very small.}$$

$\therefore$ The e.m.f. induced due to the rotation of the fluxmeter coil is,

$$e = \frac{d\phi'}{dt} = AB \frac{d\theta}{dt}$$

Hence the resultant e.m.f. in the circuit is

$$E = \frac{d\phi}{dt} - AB \frac{d\theta}{dt} \quad \ldots\ldots (2)$$

When the current i due tot his e.m.f. flows through the fluxmeter coil, it experiences a couple $= ABi$

If I be the moment of inertia of the fluxmeter coil and $\frac{d\omega}{dt}$ is its angular acceleration, then we have

$$Bi = I\frac{d\omega}{dt} \quad \text{or,} \quad \frac{ABE}{R} = I\frac{d\omega}{dt} \quad \text{[From eqn.(1)]}$$

Substituting the value of E from eqn.(2) we have

$$\frac{AB}{R}\left(\frac{d\phi}{dt} - AB\frac{d\theta}{dt}\right) = I\frac{d\omega}{dt}$$

Integrating this we get

$$\int_0^t \frac{AB}{R}\left(\frac{d\phi}{dt} - AB\frac{d\theta}{dt}\right)dt = \int_0^t I\frac{d\omega}{dt}dt$$

$$\text{or,} \quad \frac{AB}{R}\left(\int_0^{\phi} d\phi - AB\int_0^{\theta} d\theta\right) = I\int_0^{t} d\omega \quad \text{---(3)}$$

Since the fluxmeter coil is at rest before and after the change in flux linked with the search coil. We have both at $t = 0$ and $t = t$. $\omega = 0$. The integral on the R.H.S of eqn.(3), therefore, vanishes for both the limits and we have

$$\int_0^{\phi} d\phi - AB\int_0^{\theta} d\theta = 0 \quad \text{or,} \quad \phi = AB\theta = K\theta \quad \text{---(4)}$$

Where, $K = AB$ is a constant. The eqn.(4) shows that the deflection θ of the fluxmeter coil is proportional to the change in total flux linked with the search coil, and not the rate of change of flux. Therefore, the displacement of the fluxmeter coil, when the search coil is placed into or removed from the unknown field, measures the flux linked with the search coil.