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Permanent Magnet Moving Coil (PMMC)

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Abstract:

The permanent magnet moving coil instrument ***or*** *PMMC type instrument uses two permanent magnets in order to create stationary magnetic field. These types of instruments are only used for measuring the dc quantities as if we apply ac current to these type of instruments the direction of current will be reversed during negative half cycle and hence the direction of torque will also be reversed which gives average value of torque zero. The pointer will not deflect due to high frequency from its mean position showing zero reading. However it can measure the direct current very accurately.*

Keywords:

PMMC, Damping ,Fleming left Hand Rule ,Moving Coil ,Ohm ,Torque.

I. Introduction

When a current carrying conductor is placed in a magnetic field, it experiences a force and tends to move in the direction as per Fleming's left hand rule. If the first and the second finger and the thumb of the left hand are held so that they are at right angle to each other, then the thumb shows the direction of the force on the conductor, the first finger points towards the direction of the magnetic field and the second finger shows the direction of the current in the wire.

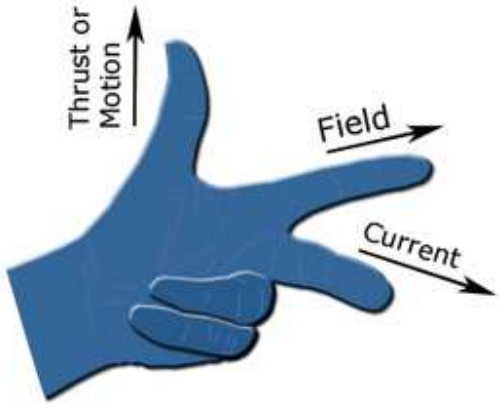

Figure 1. Fleming left hand rule:

II. Construction

Let us move towards the constructions of permanent magnet moving coil instrument**s.** We will see the construction of these types of instruments in five parts and they are described below:

1. Stationary part or magnet system:

In the present time we use magnets of high field intensities, high coercive force instead of using U shaped permanent magnet having soft iron pole pieces. The magnets which we are using nowadays are made up of materials like alcomax and alnico which provide high field strength.

2. Moving coil:

The moving coil can freely moves between the two permanent magnets as shown in the figure given below. The coil is wound with many turns of copper wire and is placed on rectangular

aluminium which is pivoted on jewelled bearings.

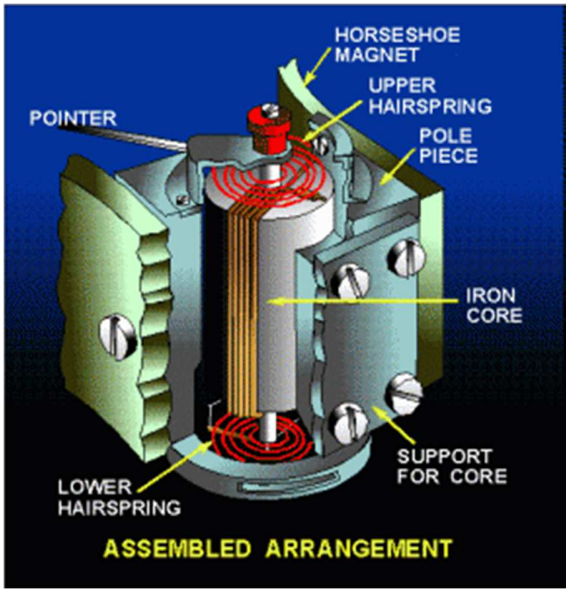

Figure 2. Assembled Arrangement

3. **Control system:** The spring generally acts as control system for PMMC instruments. The spring also serves another important function by providing the path to lead current in and out of the coil.

4. **Damping system:** The damping force hence torque is provided by movement of aluminium former in the magnetic field created by the permanent magnets.

5. **Meter:** Meter of these instruments consists of light weight pointer to have free movement and scale which is linear or uniform and varies with angle.

III. Working

When a current flow through the coil, it generates a magnetic field which is proportional to the current in case of an ammeter. The deflecting torque is produced by the electromagnetic action of the current in the coil and the magnetic field .The controlling torque is provided by two phosphorous bronze flat coiled helical springs. These springs serve as a flexible connection to the coil conductors.

Damping is caused by the eddy current set up in the aluminum coil which prevents the oscillation of the coil.

IV. Errors

There are three main types of errors:

(a) Errors due to permanent magnets: Due to temperature effects and aging of the magnets the magnet may lose their magnetism to some extent. The magnets are generally aged by the heat and vibration treatment.

(b) Error may appear in PMMC Instrument due to the aging of the spring. However the error caused by the aging of the spring and the errors caused due to permanent magnet are opposite to each other, hence both the errors are compensated with each other.

(c) Change in the resistance of the moving coil with the temperature: Generally the temperature coefficients of the value of coefficient of copper wire in moving coil is 0.04 per degree Celsius rise in temperature. Due to lower value of temperature coefficient the temperature rises at faster rate and hence the resistance increases. Due to this significant amount of error is caused.

V. Applications

The PMMC has a variety of uses onboard ship. It can be used as:

1. Ammeter:

When PMMC is used as an ammeter, except for a very small current range, the moving coil is connected across a suitable low resistance shunt, so that only small part of the main current flows through the coil.

Figure 3. Ammeter

The shunt consists of a number of thin plates made up of alloy metal, which is usually magnetic and has a low temperature coefficient of resistance, fixed between two massive blocks of copper. A resistor of same alloy is also placed in series with the coil to reduce errors due to temperature variation.

2. Voltmeter**:**

Figure 4. Voltmeter

When PMMC is used as a voltmeter, the coil is connected in series with high resistance. Rest of the function is same as above. The same moving coil can be used as an ammeter or voltmeter with an interchange of above arrangement.

3. Ohm Meter:

Figure 5. Ohm Meter

The ohm meter is used to measure resistance of the electric circuit by applying a voltage to a resistance with the help of battery. A galvanometer is used to determine the flow of current through the resistance. The galvanometer scale is marked in ohms and as the resistance varies, since the voltage is fixed, the current through the meter will also vary.

VI. Advantages and Dis-Advantages:

A. Advantages:

1. The PMMC consumes less power and has great accuracy.

2. It has uniformly divided scale and can cover arc of 270 degree.

3. The PMMC has a high torque to weight ratio.

4. It can be modified as ammeter or voltmeter with suitable resistance.

5. It has efficient damping characteristics and is not affected by stray magnetic field.

6. It produces no losses due to hysteresis.

B. Dis-Advantages:

1. The moving coil instrument can only be used on D.C supply as the reversal of current produces reversal of torque on the coil.

2. It's very delicate and sometimes uses ac circuit with a rectifier.

3. It's costly as compared to moving coil iron instruments.

4. It may show error due to loss of magnetism of permanent magnet.

VII. Conclusion

For permanent-magnet moving-coil instrument magnetic field is caused by the permanent-magnet, When the DC current passes the moving coil, rotational torque is resulted, so the deflection angle indicate measured DC current. As AC current passes the moving coil, because inertia of moving parts of meter

the deflection angle indicate rotational torque average, but rotational torque average is zero in cycle, moving parts of meter isn't deflect, so permanent-magnet moving-coil instrument only is used in DC circuit.

VIII. References

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