Rotation of a ferromagnetic cylindrical core under the simultaneous influence of a constant and an alternating magnetic field

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ABSTRACT. The experiment herewith described confirms the effect obtained by V. Kashinov (1) : a ferromagnetic cylindrical core, with one degree of freedom, starts to rotate under simultaneous influence of a constant and an alternating magnetic fields.

1 Observation of the effect

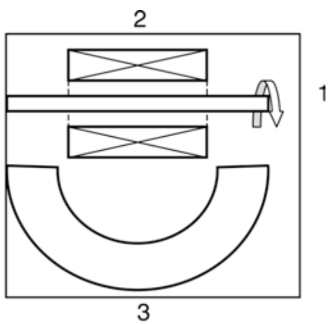

Fig. 1

1. A rotor (an iron cylindrical core) freely rotating in plain bearings, inside the coil 2.
2. A multilayer coil : 200 turns/cm, is fed by an alternating current I = 1A, 50 Hz)
3. Permanent magnet.

Observation : The Fig. 1 shows the experiment on which the effect was found for the first time.

When approaching the magnet 3 to the symmetry axis of the coil 2, the core begins to rotate (see the arrow) in a direction presently unpredictible with a speed depending on the position of the permanent magnet and on the current in the coil : the velocity increases with the current intensity and the rotor stops when the current is cut off.

The direction of the rotation does not depend on polarity of the magnet.

2 Variants of the observed effect

1. a. Rotor is iron.
   b. The coil is fed by an alternating current
   c. The permanent magnet is replaced with an external electromagnet (is fed by a direct current).
2. a. Rotor is iron
   b. The coil is fed by a direct current
   c. An external electromagnet is fed by an alternating current.

One finds the same result with the same rotation.

The effect is conserved if the iron cores of electromagnets are replaced by ferrits, or when the source of the permanent external magnetic field is a ceramic permanent magnet.

It allows to hope that Foucault's currents are not involved in the effect.

Further variants of the experiment were carried out both with steel and with ferrite cores.

A. The coil with two coaxial windings

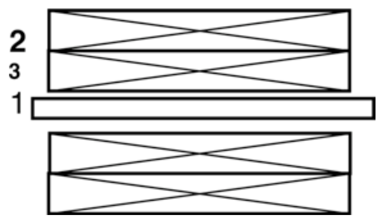

Fig. 2
1. Rotor, 2. External winding, 3. Internal winding. The rotor freely rotates on the axis.

When connecting one of the windings (indifferent which one) to a source of alternating current, and to the second winding to a constant current, the rotor remains motionless for any values of the current (the torque moment does not arise).

B. Two coils with divided cores (rotors)

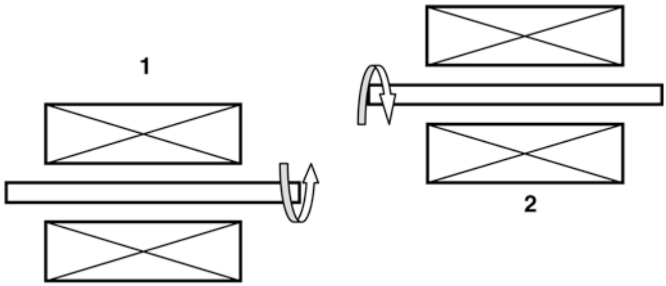

Fig. 3.

On the Fig. 3, we have two independent systems, the axis of which are shifted, each with respect to the other.

In this case connecting the coil (1) to an alternating current and the coil (2) to a direct one, or conversing the rotors start to rotate. Rotors always have mutually opposite rotations. The direction of rotation arising during the initial moment, has a casual character.

For coinciding axes of rotors rotation stops for any currents.

C. Experiment with bar magnets

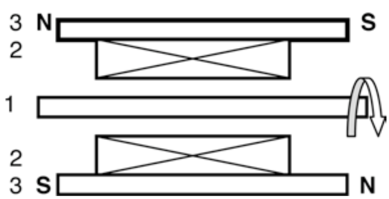

Fig. 4.

On Fig. 4 the circuit of experiment in which constant bar magnets (3) are used, the winding of the coil (2) are fed by an alternating current.

A rotation occurs, if permanent magnets, are oriented in opposite directions, as it is shown on the figure. If the same poles of the magnets are oriented in the same side, the rotation does not occurs.

D. Experiment with a transverse constant magnetic field

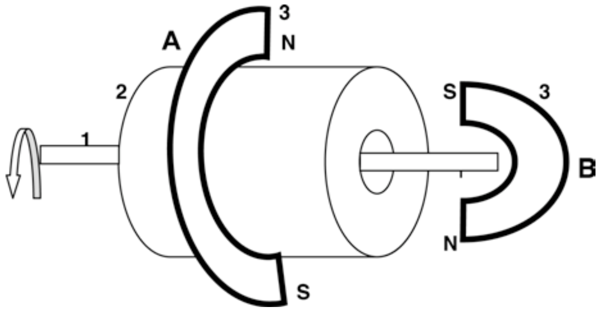

Fig. 5.

On Fig. 5, we give a variant with a transverse magnetic field.

The rotation of the rotor 1 is obtained when the constant magnetic field 3 crosses the coil (magnet A), or when the constant magnetic field crosses any of end of the rotor (magnet B).

The coil 2, as before, is fed by an alternating current. Correlation between the polarities of magnets and the direction of rotation was not examined.

E. Experiment with a vertical suspension of a rotor (levitation in a magnetic field)

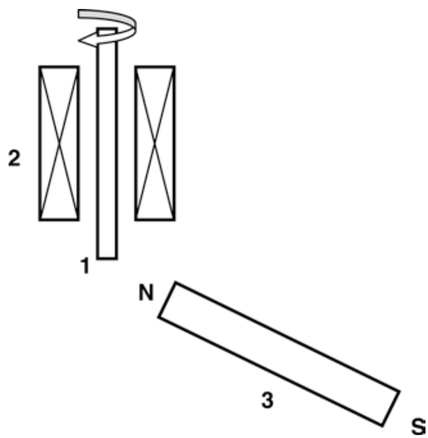

Fig. 6.

Here is a variant in which a vertical orientation of the rotor allows to remove the reaction of bearings.

When the alternating current is connected to the coil 2, the ferromagnetic core 1 is attracted in the axial channel of the coil and for a given current intensity, the magnetic force oriented upwards, counterbalances gravity. When the magnet 3 is placed near the rotor, a rotating moment arises and the rotor begins to rotate. We did not find any correlation between the direction of rotation and the polarity of the magnet (fig. 6).

F. Arbitrary orientation of the elements

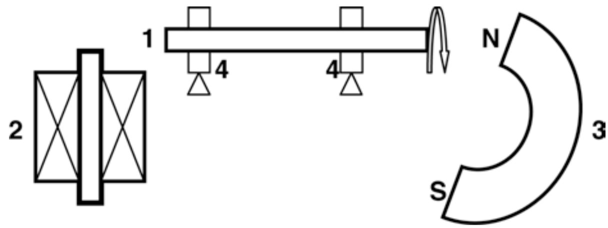

Fig. 7

In the present variant the rotor 1 is put out of limits of the electomagnet with a fixed ferromagnetic core 2.

The rotor 1 freely rotates in the bearings 4. The electromagnet is fed by alternating current. At approach to the rotor permanent magnet 3, the rotor begins to rotate. As before, correlation between the direction of rotation and polarity of the magnet were not determined.

So, the effect is observed even in the case of a space separation between the core and the electromagnet.

And thus, a set of experimental facts is obtained, that must be satisfied by theory.

3 Discussion

The behaviour of a ferromagnetic in a magnetic field is determined by the behaviour of elementary magnetic dipoles (spin magnetic moments) which actually constitute ferromagnetism. In an external field, the magnetic moment of a dipole is directed along a force line. In a variable magnetic field, the dipole, following the field, will rotate around its equilibrium center. In a periodic field the dipole will periodically change its orientation to the opposite one.

Superposition of a constant field and of an alternating magnetic field will cause, besides, a precession around an axis coinciding with the direction of the constant magnetic field $\mathbf{B}_c$ (axis **Z**, fig. 8).

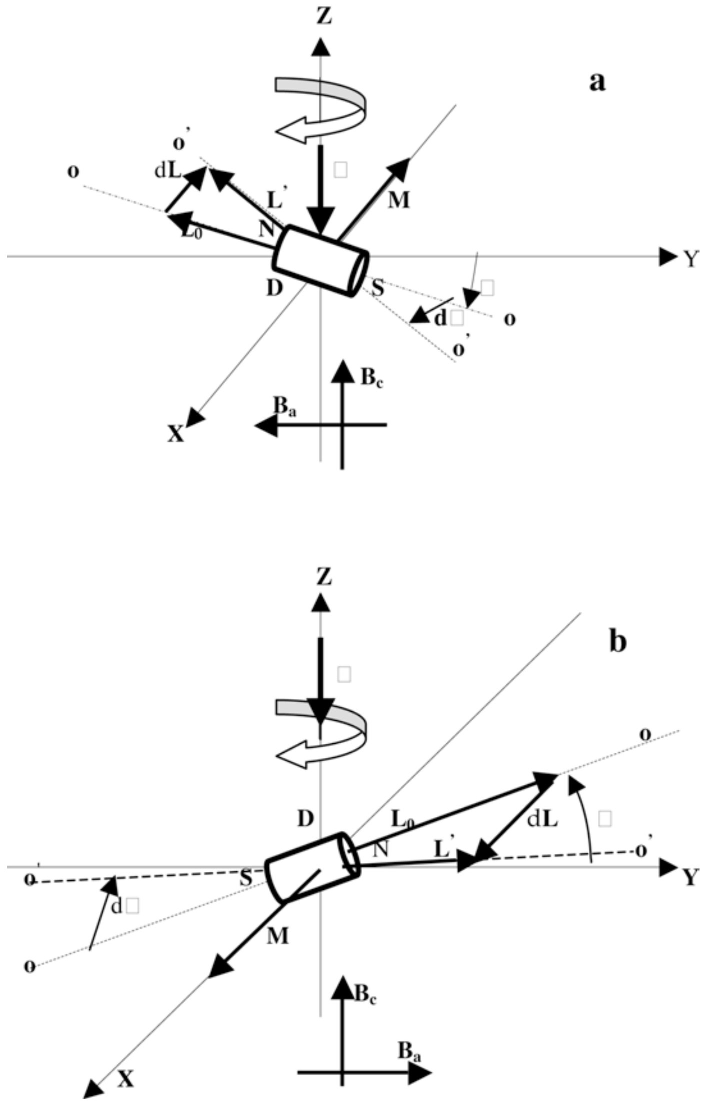

Fig. 8

D is an elementary magnetic dipole (with a constant magnetic moment **μ** and a constant moment of pulse $\mathbf{L_0}$). $\mathbf{B_c}$ and $\mathbf{B_a}$ are: vectors of magnetic induction of the constant and alternating fields.

B_c / B_a = tg α, **M** is rotating moment, **dL** is moment of precession, (instantaneous values).

Figures **a** and **b** correspond to an opposite direction of the vector $\mathbf{B_a}$ (shift ½ period).

Really, a rotation moment **M** of the field, tends to turn the axis of the dipole in the plane **ZY**. But the dipole has its own constant kinetic moment $\mathbf{L_0}$ and is actually a gyroscope. The moment **M** is perpendicular to the plane **ZY**. Therefore, as follows from the theory of a gyroscope, the vector $\mathbf{L' = L_0 + dL}$ will rotate, concerning vector $\mathbf{L_0}$, on angle $d\varphi$ (in a time dt). Therefore an induced rotation of the gyroscope will occur around the normal to the horizontal plane as it is shown on the Fig. 8 by an arrow (around the axis **Z**).

It is easy to see, that changing the orientation of the dipole **D** on the opposite one (changing sign of the field B_a and hence changing the orientation of the kinetic moment), the axis of rotation (precession) of the dipole remains constant (axis **Z**). And as far as the vector **M** will also change its sign, the direction of precession will not change (see fig. 8a and 8b, arrows).

In an alternating magnetic field, the polarization of the ensemble of elementary magnetic dipoles will not be spatially coherent : each separate dipole can have an individual plane and a direction of rotation. Thus, the kinetic moment of a pulse averaged on the ensemble will be equal to zero.

If we impose an additional constant field all the dipoles will rotate in a plane synchronously and in phase owing to the moment **M**. In such a case, the kinetic moments of pulses of elementary dipoles are summarized : the collective rotation becomes coherent.

By virtue of the law of conservation of the kinetic moment a body (presently ferromagnetic axis)

gets an equal and opposite moment (the total moment is equal to zero) and there is a rotation which is observed in experiment. Thus, the spatial configuration of the device should be such that the rotating axis coincides with the axis of rotation of the ensemble of micro dipoles.

The given interpretation of effect does not apply for completeness, but shows a basic opportunity of its occurrence.

Conclusion

i. The effect of the rotating moment in a ferromagnetic core is confirmed at superposition of constant and alternating magnetic fields.

ii. The effect is caused by the precession of the elementary magnetic dipoles, arising at imposing on an alternating magnetic field of an additional constant field from which results to coherent rotation of the ensemble of dipoles.

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References

[1] V. V. Kashinov, The private message, 2005, Kashinov@VK3109.spb.edu.