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ELECTROMAGNETO ENERGY CONVERSION

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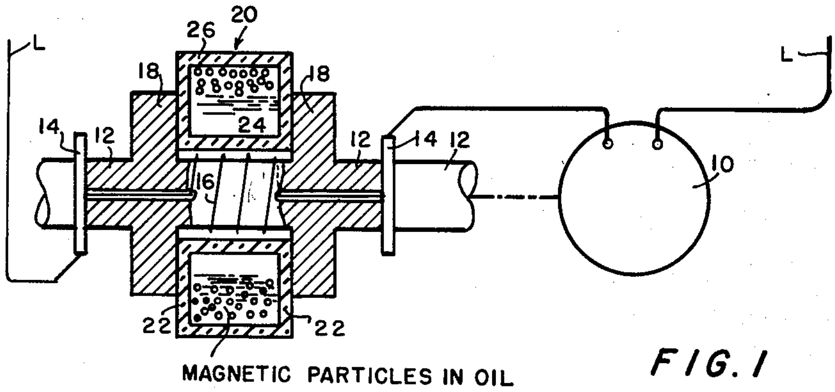

FIG. 1

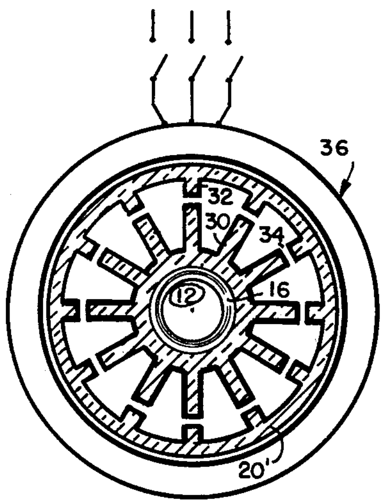

FIG. 2

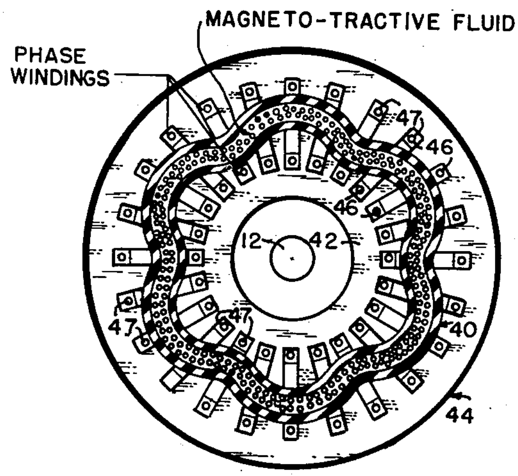

FIG. 3

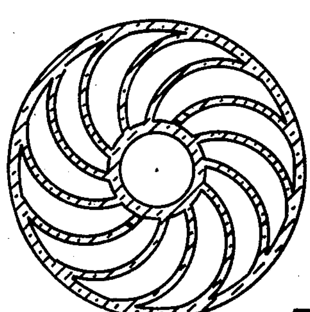

FIG. 4

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ELECTROMAGNETO ENERGY CONVERSION

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5 Claims. (Cl. 318—161)

This invention is in electrical energy conversion.

It is one of the objects of the invention to provide improved methods of converting energy from electrical to mechanical manifestations.

Other objects and advantages will be evident from a consideration of the following description with reference to the accompanying drawings, in which:

Fig. 1 shows schematically apparatus for interchanging energy between rotating masses;

Fig. 2 is a fragmentary section transverse the axis of components of kinetic energy translating apparatus.

Fig. 3 is a section transverse the axis of a magneto-kinetic energy engine; and

Fig. 4 is a modified form of the device shown in Fig. 2.

Referring to Fig. 1, the apparatus comprises an electric motor **10** driving a shaft **12** carrying slip rings **14** joined by a conductor including a solenoid winding **16** about a ferromagnetic core portion of shaft **12** between two annular magnetic pole forming rings **18** magnetically integral with the core portion and forming therewith an annular groove within which is fixed for rotation with the shaft an energy interchanging assembly comprising a closed hollow housing **20** formed as of two radial discs **22** and two concentric cylinders **24** and **26**, the housing being formed preferably of non-ferromagnetic material such as rubber, aluminum, glass, plastic, brass, or the like. The housing forms a closed annular chamber within which there is placed a magneto-responsive fluid or semi-fluid such as ferro-magnetic particles in oil, similar to that employed in magnetic particle clutches and brakes.

The behaviour of the apparatus is somewhat as follows. Upon applying voltage to the lines L current flows through the motor **10** and winding **16** thus forming a magnetic field between the poles **18** and causing the shaft **12** to be rotated by the motor **10**. The initial current flow is usually large because of the initial low impedance of the circuit. The iron particles in the oil are drawn into the magnetic field between poles **18** adjoining the inside surface of wall **24**. The moments of inertia of these particles is thereby minimized yet their motion peripherally is resisted or arrested with respect to the shaft by the magnetic field. The high current and resulting low gross inertia allows a more rapid initial acceleration of shaft **12** to speeds of shaft **12** at which motor **10** efficiently translates electrical energy into mechanical kinetic energy. As the shaft speed reaches higher values the impedance increases and the current flow decreases while at the same time the centrifugal force on the particles increases. The magnetic field between poles **18** decreases with the decrease in current flow and the magnetic particles tend to move radially outward toward wall **20**, as well as tending to slip back with reference to the shaft.

As shown in Fig. 2, the housing **20** may be provided with axial vanes such as **30** and **32** extending radially from the cylinders and between walls **22**. These tend to prevent slippage of the particles peripherally. A peripheral escape channel **34** may be provided between the vane tips whereby some slippage is introduced.

Assume that, normally, the motor **10** operates at a fixed speed. When a sudden load is applied to shaft **12** the motor **10** slows down abruptly and a surge of current passes therethrough tending to resist the further slowing thereof. This current draws the magnetic particles in housing **20** radially inward, thus causing them to deliver part of their kinetic energy to the vanes **30** and thereby assisting the motor **10** to resist the slowing of shaft **12**.

Most motors **10** have a maximum speed under given load conditions. In order to increase the speed of shaft **12** beyond this speed momentarily, an auxiliary winding **16'** is provided about the magnetic core portion of shaft **12**, such auxiliary winding being provided for large current carrying capacity or to provide for a large ampere turn product. Through winding **16'** a current may be passed while the motor rotates so as to cause the iron particles to be drawn toward the shaft and in doing so to impart part of their kinetic energy to the vanes **30** for increasing the shaft speed, or for maintaining the speed when a load increases. Such may be effected in response to motor load current acting on a suitable control for increasing the current through such winding **16'**. It is believed to be clear that, in the absence of vanes **30** and **32** the magnetic particles are controlled only by the wall friction and the magnetic and centrifugal forces if any, wherefore, when not magnetized they form little resistance to starting and deceleration.

In Fig. 2 the housing **20'** is shown surrounded by an electromagnetic structure **36** of somewhat conventional design and including the magnetic core and phase windings with which to produce the familiar effect of a rotating magnetic field around the periphery of housing **20'**. Considering the structure **36** to be stationary, the rotation of the magnetic field, depending upon its sense with regard to the rotation of shaft **12**, accelerates or retards the housing **20'** by magnetic pull on the particles of iron therein. The magnitude of the pull is influenced by the current in windings at **16** or **16'** on the core part of shaft **12**.

The apparatus of Fig. 3 comprises laminated magnetic iron core structure rigidly mounted on a shaft **12** and providing a continuous magnetic gap in the core structure between poles of the structure which gap is occupied by a wholly closed ring shaped envelope **40**, or housing, formed of non-ferromagnetic material such as rubber, ceramic, porcelain, glass, plastic, or a metal of low magnetic induction.

A housing **40** may have a rectangular cross section in planes including the axis of shaft **12** and, as shown, may have the concentric walls thereof each formed in a wavy peripheral and continuous closed curved surface, the purpose of the variation in radial distances of the walls being to provide tractive engagement of fluid contained by the housing, though circularly cylindrical concentric walls provide considerable traction also. The housing is substantially filled with a magneto-tractive fluid such as a mixture of iron particles and oil, or a fluid metal such as mercury.

The magnetic core structure may comprise two concentric core groups of almost standard iron laminations **42** and **44** having facing axial conductor slots **46** for the reception of phase winding conductors **47** corresponding for example to the windings of the rotor and stator of a plural phase wound rotor induction motor. The concentric core groups **42** and **44** are rigidly held on the shaft **12** by suitable spiders or the like, not shown, in such a way that, preferably, substantially all magnetic flux from each pole produced by registering pole windings in the inner and the outer slots must pass radially through housing **40** and the fluid.

The windings placed in the slots **46** are such that a rotating magnetic field is produced thereby through the housing **40** in accordance with well understood and known principles. The windings are excited from alternating current sources of electricity, usually of the polyphase source type, slip rings being carried by the shaft 12 for the conduct of current to the windings in slots 46, both the windings on the core group 42 and those on the core 44 being fed from the same slip rings, either in series or in parallel and connected in such manner that phase pole windings in opposite areas of cores 42 and 44 produce magnetomotive forces in the same sense through the housing 40 and adjoining core flux paths. Each pole pair formed by and between the core groups 42 and 44 has a similar gap filled by the housing 40.

With the housing 40 filled with oil and iron magnetic particles, upon the occurrence of the rotating magnetic field in the housing, the magnetic particles tend to form radial bridges from wall to wall between the groups 42 and 44 which bridges tend to slide peripherally with the magnetic field, but behaving somewhat as a fluid and pushing against the walls of 40 in a tangential sense to impart rotation to the housing, cores, and shaft 12.

It is to be observed that the rotating magnetic field has a rotational speed with respect to the shaft determined by the number of magnetic poles for which the cores are wound, and the frequency. The speed of the particles with respect to the shaft tends toward the speed of the magnetic rotating field with respect to the shaft, and the particles have absolute speed with respect to earth which is always greater than the shaft speed with respect to earth. The tangential acceleration of the particles is proportional to the magnetomotive force of the windings and, in turn, to the applied current in the windings. It will be seen that the acceleration of the particles causes them to push on the walls of 40 in the tangential sense, causing the same to move in the direction of rotation of the magnetic field. The angular velocity of the magnetic field with respect to earth, is, then, equal to the sum of: the speed of the shaft and the speed of the field with respect to the shaft. The particles therefore receive the same acceleration at all speeds of the shaft, the current and frequency being constant.

It is to be observed that the entire structure becomes an inertia wheel or flywheel, and may itself be mounted within a working body, such as within a gear, a pulley wheel, a grinding wheel, a vehicle wheel such as in the landing wheels of aircraft, a pump rotor for centrifugal and like pumps, a lathe chucking plate, a propeller or fan, and the like, thus allowing shaft 12 to be very short, sufficient only to provide adequate bearing support for radial thrust, with very little length of shaft devoted to transmission of power. The shaft 12 may, beyond its bearings, be flexible and be hollow for the passage therein of the conductors from slip rings at any distance along its axis.

A second type of energy translating device is a modified conventional electric motor wherein the motive action is conveniently produced by a rotating magnetic field across a somewhat conventional axial air gap instead of a somewhat cylindrical air gap such as in Fig. 3. A section through the magneto-tractive fluid housing employed is shown in Fig. 4 to comprise somewhat spiral vanes. The radial position of the magneto-tractive fluid in the compartments between the vanes and radial side walls may be controlled by both or either of means corresponding to the winding 16 in Fig. 1, and the rotating magnetic field windings of the axial air gap type, whether carried in core structure for rotation with the housing as in Fig. 3, or stationary adjacent thereto as in Fig. 2.

It will be observed that the direction of the vanes as respects rotational direction influences the functions. If, in Fig. 4, the rotation is to be anti-clockwise, starting with only the rotating magnetic field tends to bring the fluid toward the center thus producing a more rapid acceleration. When running, a sudden increase in speed of the rotating magnetic field as by decreasing the frequency of the current causes the fluid to move radially inward and to deliver some of its kinetic energy to the

vanes. A sudden decrease in speed of the magnetic field causes the fluid to instantly decelerate the rotor by developing instantly a maximum decelerative torque.

If the rotation in Fig. 4 is clockwise, at starting the vanes themselves assist centrifugal force and the field in radiating the fluid and initiating more rapid storage of kinetic energy therein and less acceleration to the shaft. At any speed a sudden increase in magnetic field speed is instantly and directly effective on the rotor to accelerate it, without yielding any of the fluid kinetic energy to the shaft. However, by exciting the winding 16, the kinetic energy of the fluid may be transmitted into the shaft partially, while the fluid moves radially inward over the convex surfaces of the vanes. Deceleration is more pronounced when the rotating magnetic field speed is rapidly decreased or reversed since the energy of the fluid is given up against the concave surfaces of the vanes in the braking effort.

For some purposes holes may be placed through the vanes adjacent the inner and/or the outer radial ends thereof so that the fluid may escape peripherally therethrough at a desired rate. Moreover, two sets of oppositely directed vanes in separate housings on the same shaft and, permissibly, in the same air gap, may be associated with controls for the elective diversion of the fluid from one to the other, thus obtaining alternatively the characteristic of either for either direction of rotation of the shaft.

Having thus described various forms of structure embodying my invention and their modes of operation, I claim:

1. A variable inertia device, comprising: a rotor having formed therein a plurality of radially extending and circumferentially arranged pockets, a magnetic powder in said pockets, and flux producing means arranged to move said powder in said pockets to vary the inertia of said rotor.

2. A variable inertia device, comprising: a rotor having formed therein a plurality of radially extending pockets, a mixture of liquid and magnetic powder in each of said pockets, and flux producing means arranged to move said powder radially in said pockets to vary the inertia of said rotor.

3. The combination of claim 2 in which said pockets are of such an extent that as the radial displacement of said powder is reduced the inertia of said rotor is reduced.

4. A variable inertia device, comprising: a rotor having formed therein a plurality of circumferentially arranged and connected pockets, a mixture of liquid and magnetic powder in said pockets, means establishing a flux which moves from pocket to pocket and thereby moves said fluid and powder circumferentially of said rotor.

5. The combination of claim 2 including: an electric motor, means connecting said motor to said rotor for rotation thereof, and a power connection between said motor and said flux producing means, whereby the density of said flux and the radial displacement of said powder will be a function of variations in the performance of said motor.

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