SPECIAL PURPOSE MACHINES

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ABSTRACT:

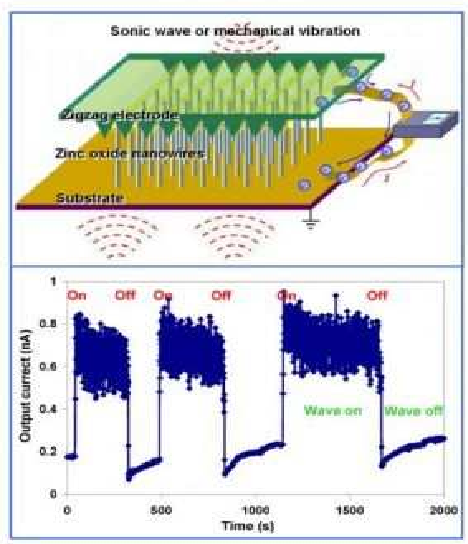
Day by day the interest on special machines increases. Because these machines serves for several applications.For instance,the nano generator could drive biological sensors by making use of wind energy or water flow,eliminating the need for external batteries.This not only reduces the device cost but also at the same time reduces the entire equipment size.

Integrated starter generator which is used in electric vehicles acts as a bidirectional energy converter as a motor when powered by the battery or a generator when driven by the engine.Linear motors are used to propel high speed MagLev trains.Micro motors plays an important role in computer hard drives,optics,sensors and actuators.A special type of outer rotor motors used to drive the polygonal rotating mirrors which are mounted directly on the rotor in laser printers.

Our paper tries to introduce some of these machines and their applications in various fields.The recent developed technology of nano generators is included and its working is also explained.

Nano generator

Researchers have demonstrated a prototype nanometer-scale generator that produces continuous direct-current electricity by harvesting mechanical energy from such environmental sources as ultrasonic waves, mechanical vibration or blood flow. The nanogenerators take advantage of the unique coupled piezoelectric and semiconducting properties of zinc oxide nanostructures, which produce small electrical charges.

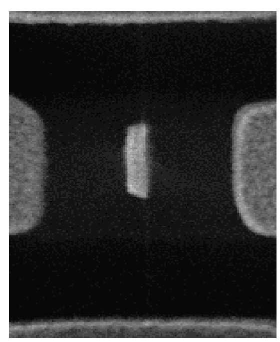


Fabrication begins with growing an array of vertically-aligned nanowires approximately a half-micron apart on gallium arsenide, sapphire or a flexible polymer substrate. A layer of zinc oxide is grown on top of substrate to collect the current. The researchers also fabricate silicon “zig-zag” electrodes, which contain thousands of nanometer-scale tips made conductive by a platinum coating.

The electrode is then lowered on top of the nanowire array, leaving just enough space so that a significant number of the nanowires are free to flex within the gaps created by the tips. Moved by mechanical energy such as waves or vibration, the nanowires periodically contact the tips, transferring their electrical charges. By capturing the tiny amounts of current produced by hundreds of nanowires kept in motion, the generators produce a direct current output in the nano-Ampererange. If we had a device like this in our shoes when we walked, we would be able to generate our own small current to power small electronics.Anything that makes the nanowires move within the generator can be used for generating power. Very little force is required to move them.

Nano motor

Even smaller motors have been made using nanotechnology. An example is shown below. It consists of a tiny gold slab rotor, about 100 nm square, mounted on concentric carbon nanotubes.The outer tube carries the rotor, driven by electrostatic electrodes, rotating around an inner tube which acts as a supporting shaft. By applying voltage pulses of up to 5 Volts between the rotor plate and stators, the position, speed and direction of rotation of the rotor can be controlled. It measures about 500 nanometers across, 300 times smaller than the diameter of a human hair.



The motor was built from multiwalled nanotubes created in an electric arc and deposited on the flat silicon oxide surface of a silicon wafer. A rotor, nanotube anchors and opposing stators were then simultaneously patterned in gold around the selected nanotubes using electron beam lithography. A third stator was already buried under the silicon oxide surface. The silicon was then etched to create a trough beneath the rotor with sufficient clearance for the rotor to rotate.Possible applications are moveable mirrors for optical switches or paddles for moving fluids.

Axial Field Motors

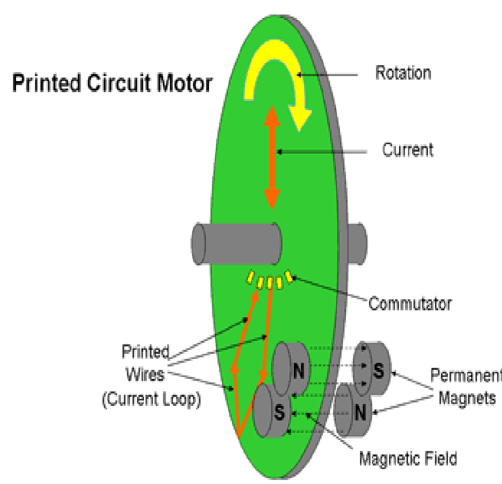
Axial field motors have been developed for applications which require short, flat, "pancake" construction.

Printed Circuit (PCB) or "Pancake" Motor:

The printed circuit motor is an example of an ironless or coreless motor with several unique features. The pancake construction uses an axial magnetic field to achieve the short flat construction. Radial field PCB motors are also possible.

Construction:

The rotor windings are printed, stamped or welded onto a thin, disc shaped glass fibre circuit board which rotates in the air gap between pairs of permanent magnets arranged around the periphery of the disk. The windings fan out in a series of radial loops around the surface of the disk. The magnets are arranged alternatively north and south so that the magnetic fields in the air gaps of adjacent magnet pairs are in opposite directions. The magnets are held in place by two iron end caps in a compact "pancake" shaped block to complete the magnetic circuit. Current is fed to the rotor windings via brushes through precious metal commutator segments printed on the disc.



Operating Principle:

Traditional electric motors have a radial magnetic field or flux with the rotor current flowing axially along the length of the rotor. In typical printed circuit motors the construction is reversed. The magnetic field is axial (oriented along the axis of the machine) and the current flows radially from the axis to the edge of the disc and back again. A tangential force on the disk is created by the current passing through the magnetic fields in the air gaps between the pole pairs of the permanent magnets. So that the return current does not cancel out the effect of the outgoing current, the return wire is physically separated or displaced to one side from the outgoing wire by the width of the magnet. In this way it interacts with the magnetic field of the adjacent magnet which is in the opposite direction and thus reinforces the tangential force on the disk.

In many ways it is similar to Faraday's 1831disk or homopolar motor which used a single magnet and was driven by a unidirectional current fed by brushes at the centre and on the periphery of the disk.

Applications:

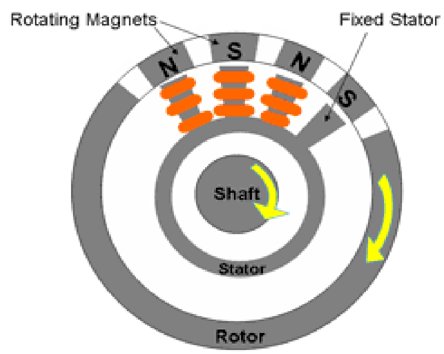
The printed circuit motor is a very compact and light weight design making it useful in confined spaces. Since the rotor does not have drag a lump of iron around, it has very low inertia and can run up to speed very quickly. Because of the many commutator segments and the low current capability of the windings, the PCB motor is only suitable for low power applications and is not suitable for continuous operation. It is however ideal for servo systems and industrial controls and automotive applications such as electric window winders.

Outer Rotor Motors

There are many designs using this construction, mostly for small sizes. Two examples of low power motors are shown below. High power versions are used for "in wheel" automotive applications.

Inside Out Motor

These are permanent magnet motors with the moving magnets arranged around the periphery of a multi pole fixed stator carrying the field windings.

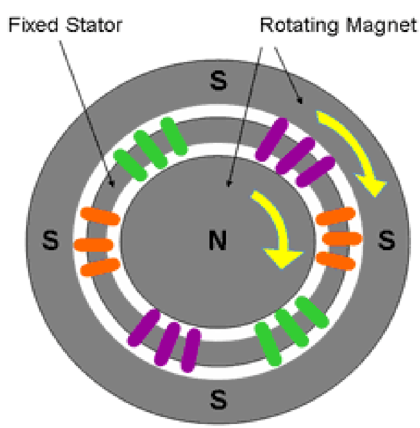


Inside Out Motor (Outer Rotor)

Used for automotive drive systems including in-wheel motors. Low power versions used in small cooling fans and direct drive record.

Toroidal Coil Motor

This is an "inside out" brushless permanent magnet motor with a toroidal wound stator covered by a cup shaped permanent magnet outer rotor.

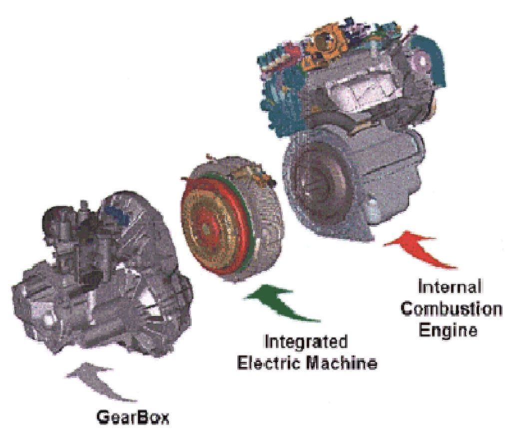


Toroidal Coil Motor (Outer Rotor)

Because of the low inertia and friction free rotor, the toroidal motor is capable of speeds up to 25,000 RPM. Suitable for low power applications it is used for example to drive the polygonal rotating mirrors which are mounted directly on the rotor in laser printers.

Integrated starter generator(ISG):

The electronically controlled integrated starter generator used in mild hybrid electric vehicles (HEVs) combines the automotive starter and alternator into a single machine.



"Design of a Switched Reluctance Machine for Extended Speed Operation"

The conventional starter is a low speed, high current DC machine, while the alternator is a variable speed 3 phase ac machine.

The ISG has four important functions in a hybrid vehicle application

- It enables the "start-stop" function, turning off the engine when the vehicle is stationary saving fuel.
- It generates the electrical energy to power all the electrical ancillaries.
- It provides a power boost to assist the engine when required, permitting smaller engines for similar performance.
- In some configurations it recuperates energy from regenerative braking.

In a typical implementation (below), the ISG is a short axis, large diameter "pancake" shaped switched reluctance machine mounted directly on the end of the engine crankshaft between the engine and the clutch in the gearbox bell housing.The ISG is a bi-directional energy converter acting as a motor when powered by the battery or a generator when driven by the engine.

The system voltage in a mild HEV is 42 Volts which means that, for the same cranking power as a 12 Volt machine, the starter current can be reduced. Typical power throughput is between 5kW and 15 kW with a possible peak power of 70 kW for cold cranking.

The brushless ISG design eliminates one rotating machine completely as well as the associated commutator and brushes from the DC machine and the sliprings and brushes from the AC machine. The starter solenoid, the Bendix ring (starter gear) and the pulley or gear drive to the alternator are also no longer needed and because of the higher system voltage, the diameter and weight of the copper cabling is also reduced substantially.

The savings however come at a cost. The system must be integrated with several subsystems as follows

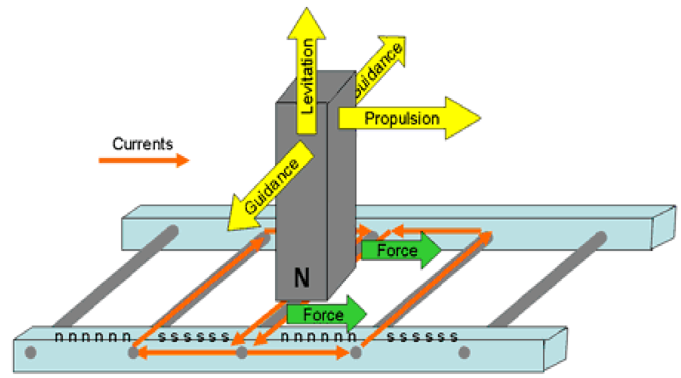
- An AC/DC converter to rectify the generator output voltage.
- A DC/DC converter to supply the vehicle's electrical power system voltages.
- Power electronics and software to control the ISG current, voltage,

speed, torque and temperature as appropriate.

- An overall energy management system integrated with the vehicle's engine, battery and brakes.Larger versions of this construction are also used in full hybrid electric vehicles. The switched reluctance machine with its simple rotor of inert iron is very robust, able to operate at high speed and to withstand the harsh operating conditions in the engine compartment.

MagLevTraction Motors:

The principle of the linear induction motor is used to propel high speed Maglev (Magnetic Levitation) trains which float on a magnetic field created by electromagnets in the trackbed under the train . A separate set of trackside guidance magnets is used to control the lateral position of the train relative to the track. Thus the maglev train uses electromagnetic forces for three different tasks, to suspend, to guide and to propel the train.

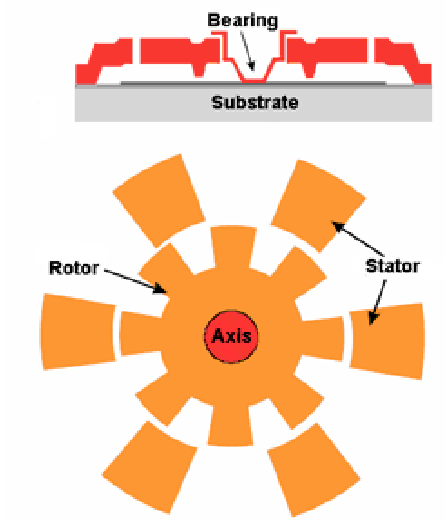


Linear Motion and Magnetic Levitation

In the diagram above, when the magnet is directly above the current carrying conductor as shown, the magnetic forces (north and south poles) from the two adjacent current loops cancel out and there is no lift. If however the magnet is moving very quickly over the coils, it will reach a position over like, repulsive, poles (north poles in the diagram) which are displaced from the attractive south poles so that the net effect is a force repelling the magnet away from the track. This is only possible because the current in the trackbed magnets lags the voltage due to the inductance of the windings, creating a delay in the build up of the balanced field by which time the magnet has moved into the adjacent region where there is a net repulsive force. This effect only happens when the magnet on the train is moving at high speed across the trackbed magnets. Thus the train needs to be in motion for this system to work and the train needs wheels for support as it accelerates from rest and when it is slowing to a halt.

Micro-motors

The motor shown below is an example of semiconductor manufacturing technology used to fabricate very small mechanical components. It measures 100 microns across, or about the width of a human hair. Similar in principle to a reluctance motor, it depends on electrostatic attraction, rather than magnetic attraction, between the stator and rotor poles. Because the dimensions are so tiny, very high electric fields can be built up with only a few volts between the motor poles.



The motor is not assembled from individual components. Instead the components are built up on a semiconductor substrate by masking and etching and a mask-less post-processing release step is performed to etch away sacrificial layers, allowing the structural layers to move and rotate.

Micromachined micromotors can be monolithically integrated together with the necessary CMOS drive circuits, containing oscillators, frequency dividers and counters, and transistors for the drive circuit all on one silicon chip.Common uses include defense/munitions applications, computer hard drives, optics, sensors and actuators.

Conclusion:

All these special machines plays a key role in their respective fields.These machines reduces the time of operation of the system and at the same time provides smooth operation.The researchers of nano generator said, “You could envision having these nanogenerators in your shoes to produce electricity as you walk. This could be beneficial to soldiers in the field, who now depend on batteries to power their electrical equipment. As long as the soldiers were moving, they could generate electricity.”This statement indicates the importance of the special machines.

Reference:

1)http://en.wikipedia.org

2)http://www.nanoscience.gatech.edu/zlwang/

3)www.mpoweruk.com

4)The world’s first Magnetic Levitation wind turbines unveiled in China