**Title:** ELECTRICITY GENERATING DEVICE

**Abstract:** A generating device is provided, for example for use as a battery charger to be carried around and operating with the movement of the person carrying it e.g. by walking etc. It can be used for charging the battery of a mobile telephone and suitably comprises a spherical magnet (2) which rolls around in side a toroidal shaped tube (1) which tube has wire coils (3) wound round it. As the magnet (2) passes through the coils (3) electricity is generated which can be fed the battery to be charged. The generating device could be used to power electrical devices directly, and can be on a larger scale than may be carried personally, for example for extracting wave energy from the sea, or may be on a very small scale.
ELECTRICITY GENERATING DEVICE

Field of the Invention

This invention relates to an electricity generating device which can, for example, be used to power low voltage portable equipment, and especially, but not exclusively, devices which rely on re-chargeable batteries, such as mobile telephones.

Background to the Invention

Mobile telephones are operated by a re-chargeable battery which needs to be re-charged when it has run out of available electricity. This is normally done by means of a re-charger which is plugged into the mains electricity supply and provides a low current at the required voltage to recharge the battery. This is inconvenient and cumbersome and it would be advantageous if the battery could be re-charged on a continuous basis whether or not the mobile telephone was in use.

Mobile telephones and like battery-powered electrical devices are normally carried by people in their everyday lives and we have now devised a generator which will generate an electric current which can re-charge a battery and which is powered by the movement of, for example, a person carrying the generator.

Summary of the Invention

According to the invention there is provided an electricity generating device, comprising a curved surface, a magnet adapted to roll on the curved surface in response to movement of the surface, and at least one coil arranged adjacent to the surface such that rolling of the magnet thereon induces an electrical charge in the coil.

It will be understood that, while the magnet will typically be caused to roll, and thereby generate electricity in the coil or coils, by movement of the curved surface, other external influences could also cause the magnet to roll, for example a changing external magnetic field.

The curved surface may be a toroidal tube or a portion thereof, with a spherical magnet rolling in the tube. Alternatively, the curved surface may be a cylindrical surface or a portion thereof, the magnet being spherical or cylindrical or including a cylindrical bearing surface. In another embodiment, the curved surface is an ellipsoid or a portion thereof, the magnet again being spherical. In the latter embodiment, guide means may be
provided for constraining the magnet or magnets to roll in contact with the curved surface, irrespective of the orientation of the generator. For example, the generator may comprise a hollow sphere containing a number of spherical magnets held in dimples or recesses in a core within the hollow sphere in such a manner as to roll freely across the internal surface of the hollow sphere while maintaining their relative positions. Coils wrapped around the sphere have a voltage induced in them as the magnets roll around the sphere.

Preferably, the curved surface is formed of a low magnetic permeability material, for example copper or aluminium or a plastics material. The or each coil may be formed around a body containing the curved surface. The coils are conveniently windings of wire, but they could be formed in other ways, for example as printed circuit elements.

In a preferred embodiment, the generator comprises a toroidal tube made of a non electrically conductive material and a magnet located inside the tube and free to move within the tube, there being at least one wire coil wound around the tube so that, when the magnet moves within the tube, the magnet will pass through the wire coil and generate an electric current therein.

The toroidal tube can have a circular, oval or elliptical or other similar shape and can have a substantially circular cross section or the cross section can be elliptical or oval or other convenient shape. Such shapes are sometimes referred to as doughnut shaped.

While a complete circular, oval or elliptical path may be provided, it may be sufficient to use only a segment of the path, for example a U-shape in elevation, the generator being arranged so as to be oriented in use with the arms of the U-shape generally upwards, so that the magnet tends to roll towards the centre of the U-shape. Where the tube is not a continuous path, springs or magnets may be provided at each end thereof to store the kinetic energy of the moving magnet as it reaches the limit of its movement, and then release the stored energy to accelerate the magnet again towards the other end of the tube. This is effective in avoiding loss of energy, especially when the device is shaken vigorously.

The wire coil is preferably wound around the tube so that it covers a section of the tube, preferably there are a plurality of coils of wire spaced around the tube so that wherever the magnet is moving within the tube it will pass through a coil.
The magnet is preferably substantially spherical so that it will roll freely within the tube. In one embodiment of the invention the cross section of the tube is substantially circular and the magnetic is also substantially spherical and there is a sufficient clearance between the walls of the tube and the magnet so that the magnet rolls easily within the tube but the gap between the magnet as it moves and the coils is minimised to reduce electromagnetic losses.

The magnet can be made of any ferromagnetic metal and the strongly ferromagnetic alloys which are capable of retaining a very strong magnetic field are preferred. There can be more than one magnet in the generator and the tube can be divided into sections so that each magnet will roll in a separate section. Or a series of magnets all free to roll all the way around the toroid like a bearing race, the magnets would have to be separated by non-metallic or magnetic material. It might be possible to separate the magnets by arranging the poles of the magnets so as to repel the adjacent magnets to achieve spacing.

As the magnet will move backwards and forwards through the coils, the direction of electric current will vary, so a rectifier is preferably incorporated within the generator so that direct current is taken from the generator. A power management circuit may also be employed to ensure that a substantially constant output voltage is produced from the varying DC output from the rectifier. Such a circuit might incorporate a switched mode power supply or DC/DC converter.

The generating device of the invention could be, for example, a hand-portable device for use in providing electrical power for portable devices such as mobile telephones. However, the invention is not limited to this scale of device. It would be possible to construct a larger-scale device, for example for extracting energy from wave motion in a floating or semi-submerged construction, or a smaller-scale device, for example for providing power for a medical device implanted in or otherwise associated with a human or animal body.

In use as a hand-portable device, the generator can be carried by a person who has a mobile telephone or other portable electric device, e.g. in a pocket, handbag or other convenient location, or even incorporated into clothing. As the person moves
around during their normal activities the generator is shaken or moves around with the
person and this causes the magnet to roll around in the tube and to generate an electric
current. This current is then fed through a rectifier to a battery and so charges the bat-
tery. The battery can be in the portable electric device or it can be a spare battery. Alten-
aturally, the generator may directly power the device where continuous operation is not
required, or it may charge a capacitor which in turn powers the device.

We have found that with such a generator electricity at four volts and 8 milliamps
can be generated by walking carrying the generator and fast shaking e.g. by running or
shaking by hand can generate 12 volts at 51 milliamps. This current is adequate to charge
an electric battery of the type used in mobile telephones, for example. It will be appreci-
ated, however, that the invention is not limited to these levels of power output and volt-
age.

It is a feature of such a device in accordance with the invention that it is portable
and compact and so is easily carried and will operate during all the time it is being carried
so that, although the power generated is relatively small, it is adequate to trickle charge a
battery.

While specific embodiments of the invention are described herein generally as de-
vices to be carried by a person and to generate electricity as a result of the normal move-
ments of that person, it will be understood that the invention is not limited to such use.
For example, the generator may be used in any environment where movement of the
device occurs, for example in a motor vehicle, for powering accessories without the need
for a wired connection to the vehicle’s electrical system. The generator of the invention
could be used, for example, to power a communication device attachable to a vehicle’s
window, perhaps in turn connecting to other equipment, such as a cellular telephone,
within the vehicle by short-range radio. An example of a suitable short-range radio sys-
tem is that identified under the trade mark Bluetooth.

The generator can also be incorporated in a mobile telephone or other device so
that no connections or wires are needed and the battery is charged continuously whilst
the device is being carried around.
In addition to mobile telephones a hand-portable generator according to one embodiment of the invention can be used to provide electrical power for other portable electric devices, examples being PDA’s, GPS systems, displays, lap top computers, calculators, and portable audio reproduction devices, such as minidisc players, and other portable radio devices, including communications devices.

While physical movement of the generator will typically be required to generate electricity, there are certain locations at which the generation of sudden transient magnetic fields will cause the magnet or magnets within the generator to move, and the residual kinetic energy in the magnets is sufficient to induce a short-term electrical charge in the coil or coils. For example, a device mounted adjacent to a cathode ray tube incorporating automatic degaussing coils will be activated briefly as the cathode ray tube is first switched on. The resultant small electrical charge could, for example, be used to power a device which releases treating molecules into the air, for example a fragrance or an antibacterial substance. The device may operate by vibrating a surface carrying the substance, for example in gel form, as described and claimed in our co-pending application GB0209673.3.

It will be appreciated that the uses of the generator are not limited to powering mobile telephones or other devices mentioned herein. The generator may be configured as an integral part of the device it is powering, or as a separate unit connectable to the device by a plug-in lead or by direct plug-in connection between the generator and the device.

**Brief Description of the Drawings**

In the drawings, which illustrate exemplary embodiments of the generator of the invention:

Figure 1 is a plan view of a generator according to one embodiment of the invention;

Figure 2 shows a cross section on line AA in Figure 1;

Figure 3 is a cross-sectional view through a generator according to a second embodiment of the invention;
Figure 4 is a cross-sectional elevation through a generator according to a third embodiment;

Figure 5 is a cross-sectional elevation through a generator according to a fourth embodiment; and

Figure 6 is a circuit diagram showing a typical electrical circuit for a generator according to the invention.

**Detailed Description of the Illustrated Embodiment**

Referring to Figures 1 and 2, a toroidal tube 1 made of a non-electrically conductive plastics material has a spherical permanent magnet 2 made of strongly ferromagnetic material mounted within it so the magnet can roll in the tube. Wound around the outside of the tube are six coils of wire 3 each of which consists of 2000 turns of wire. The ends of each coil of wire are connected to rectifier 4. The output from the rectifier is fed out at 5. There is an outer protective covering 6. The tube 1 as shown in Figure 1 can be circular or elliptical, oval etc. and the cross-section of tube 1 as shown in Figure 2 can be circular, elliptical, oval etc. and

In use a person carries the generator on him or her and, as they move about, the magnet 2 will roll around inside the tube 1 and so pass through one or more of coils 3. This movement will generate an electric current in the wire which is rectified by a rectifier unit 4, described hereinafter in more detail with reference to Figure 6, and led off via an output lead 5. The output can then be fed to a battery in a mobile telephone where the battery is charged. Such a generator generated electricity at about four volts and 8 milliamps by walking carrying the generator and fast shaking e.g. by running or shaking by hand can generate 12 volts at 51 milliamps. This current is adequate to charge an electric battery of the type used in mobile telephones, for example.

The generator shown in Figure 3 comprises a hollow spherical body 30 around which are wound a plurality of coils 31 (It will be understood that the number and configuration of the coils may vary from what is illustrated) connected to a rectifier unit (not shown), for example of the type described with reference to Figure 6, contained within the hollow sphere 30 is a free core 32 having a number of dimples or recesses 33 in the surface thereof, the core having a diameter sufficiently smaller than the internal diameter.
of the hollow sphere 30 to permit a respective spherical magnet 34 to be located in each
of the dimples 33 and to roll freely over the internal surface of the hollow sphere 30. It
may be desirable to position the dimples 33 on the surface of the core 32 in such a man-
er that the arrangement is dynamically imbalanced relative to the centre of the core 32
and the sphere 33, so that the magnets are more readily induced to move relative to the
coils as the generator is moved, in use.

In the generator shown in Figure 4, the curved surface 40 is an ellipsoid, provided
by a generally bowl-shaped container 41 having a cover 42, which may, if desired, be at
least partially concave to constrain the spherical magnet 43 contained within the genera-
tor to roll across the curved surface in response to movement of the generator without
lifting off the surface to any significant extent. Coils 44 are provided around the container
41 arranged such that rolling movement of the magnet 43 on the curved surface 40 in-
duces a voltage into each adjacent coil, the outputs from the coils being rectified and regu-
lated, for example by a rectifier unit of the type described with reference to Figure 6.

Figure 5 shows another alternative to the configuration of the generator shown in
Figures 1 and 2, in which, in place of the complete toroidal tube, the generator has a por-
tion thereof. In the embodiment illustrated, the generator has a semi-circular segment,
but it will be appreciated that a greater or smaller segment could be employed, and that,
while the cross-section of the tube itself will need to be circular to accommodate a spheri-
cal magnet, the path of the tube need not be a segment of a circle, but may be elliptical or
such other non-linear shape as to cause the magnet to move readily in response to
movement of the generator in use. As in the embodiment of Figures 1 and 2, the device
has a cover or casing 6 in which the segment of the toroidal tube 1 is mounted, with coils
3 wound around the tube and connected to a rectifier unit 4 provided with an output lead
5. The magnet 2 rolls within the tube, which needs to be maintained with the centre of
the tube generally lowermost in use, to ensure that the magnet remains free to roll,
thereby inducing a voltage in the coils. It will be appreciated that the number of coils may
be greater or fewer, extending over more or less of the tube.

The rectifier unit of the generator illustrated in the Figures may incorporate an
electrical circuit generally as shown in Figure 6. The coils 60 into which the moving mag-
nets induce a voltage, of which only one is shown in the figure for clarity, are connected to a rectifier 61. As illustrated, this comprises a full wave diode rectifier bridge, but it will be appreciated that other configurations of rectifier may also be employed. A capacitor 62 is connected across the output of the bridge, and a DC/DC converter 63 receives the varying DC output resulting from the random interaction of the rolling magnet with the coil or coils and outputs a predetermined constant DC voltage when the input is within the specified input voltage range of the converter, for example from 1.25V to 15V. This output voltage is applied to a storage battery 64 within the unit, which in turn is connected to a second DC/DC converter 65 whose function is to control the discharge rate from the storage battery 64, allowing it to discharge fully. The second converter 65 also allows control of the voltage at the supply terminals 66 of the output lead to ensure that it is at the desired value for any of a range of different electronic or electrical devices which might be connected to it, operating individually at different voltages and drawing different currents.
Claims

1. An electricity generating device, comprising a curved surface, a magnet adapted to roll on the curved surface in response to movement of the surface, and at least one coil arranged adjacent to the surface such that rolling of the magnet thereon induces an electrical charge in the coil.

2. A device according to Claim 1, wherein the curved surface is a toroidal tube or a portion thereof, and the magnet is spherical.

3. A device according to Claim 1, wherein the curved surface is a cylindrical surface or a portion thereof, and the magnet is spherical or cylindrical or includes a cylindrical bearing surface.

4. A device according to Claim 1, wherein the curved surface is an ellipsoid or a portion thereof, and the magnet is spherical.

5. A device according to Claim 4, wherein guide means are provided for constraining the magnet or magnets to roll in contact with the curved surface irrespective of the orientation of the device.

6. A device according to any preceding claim, wherein the or each coil comprises wire wound around a body containing the curved surface.

7. A device according to Claim 2, which comprises a toroidal tube made of a non electrically conductive material and a magnet located inside the tube and free to move within the tube, there being at least one wire coil wound around the tube so that, when the magnet moves within the tube, the magnet will pass through the wire coil and generate an electric current therein.

8. A device according to Claim 7, in which the wire coil is wound around the tube so that covers a section of the tube.

9. A device according to Claim 6, comprising a plurality of coils of wire spaced around the body so that wherever the magnet is moving on the curved surface it will pass through a coil.

10. A device according to any preceding claim, in which the ends of the coil or coils are electrically connected to a rectifier.
11. A device according to any preceding claim, comprising more than one magnet moving on the curved surface, and means for spacing the magnets apart from each other.

12. A hand-portable electrical device incorporating a generating device according to any preceding claim.

13. A hand-portable electrical device according to Claim 12, which is a mobile telephone or other wireless communications device, a portable computer, a portable radio receiver, or an audio reproduction device.