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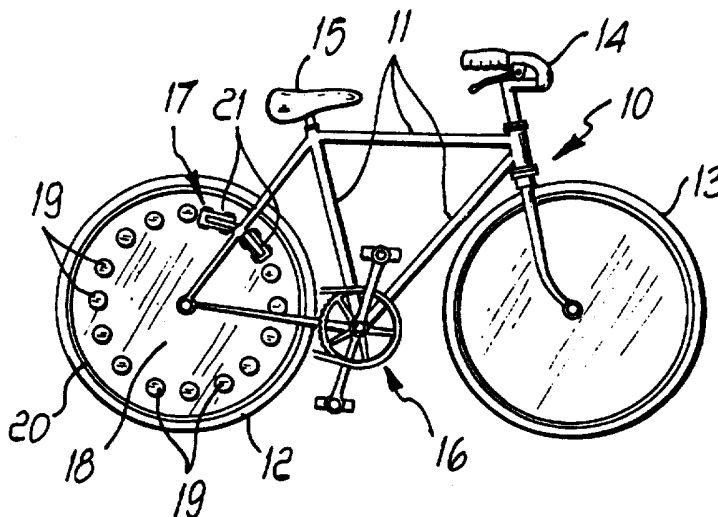
(71)(72) Applicant and Inventor: ZOTTI, Ezio [IT/IT]; Via Circuito Montebello, 26, I-35037 Tre Ponti di Teolo (IT).

(74) Agent: MODIANO, Guido; Modiano & Associati, Via Meravigli, 16, I-20123 Milano (IT).

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(54) Title: POWERPLANT FOR WHEELED VEHICLES



(57) Abstract

The powerplant (17) for wheeled vehicles (10) has a permanent-magnet rotor (18, 19) of an electric motor associated with at least one wheel (12). The stator (21-23) of the motor has electromagnets (21) the number whereof is a multiple of the phases of the electric motor (18, 19, 21-23). The electromagnets (21) are supported by the frame (11), and devices are provided for the alternative power supply to the electromagnets (21).

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POWERPLANT FOR WHEELED VEHICLES

Field of the Invention

The present invention relates to a powerplant for wheeled vehicles.

Background Art

Currently there is a wide variety of models of motorized cycles, ranging from bicycles with an auxiliary
5 propulsion device to the actual motorcycles, in which the powerplant is primary and permanent.

Whether auxiliary or primary, motorization is provided by means of internal-combustion engines which have long been known and tested.

10 Although these engines achieve their tasks, they are, even for small displacements, rather heavy and bulky, including the fuel tank, which is a severe drawback especially in light cycles such as for example motorized bicycles.

15 In particular in the case of motorized bicycles, models have been marketed in which the internal-combustion engine has been replaced with an electric motor, but in both cases the devices for transmission to the wheel absorb a very large amount of power, which often heavily
20 affects the overall power delivered by the powerplant (whether an internal-combustion engine or an electric motor), which cannot be large due to the above mentioned reasons of bulk.

Disclosure of the Invention

A principal aim of the present invention is to
25 provide a powerplant for wheeled vehicles, particularly bicycles, in which power is transmitted to the bicycle

wheel without requiring transmission devices and without having any electrical connections between the power source and the wheel.

An object of the present invention is to provide a powerplant having minimal bulk, whereby to allow freedom of movement so that a person riding a bicycle provided with an auxiliary powerplant can also easily pedal the bicycle manually.

A further object of the invention is to provide a motor which can be installed in most existing bicycles without having to alter the essence of their structure.

Another object of the present invention is to provide a powerplant that generates an amount of power sufficient to give it a speed that is significant in its field of use.

Another object of the present invention is to provide a powerplant that can also act as a generator, for example, applied to a cycle, during downhill travel or during propulsion with the pedals alone.

Another object of the present invention is to provide a motor for wheeled vehicles that can be produced with conventional technologies and with power levels that are adequate for the particular use.

Another object of the present invention is to provide a motorized cycle having competitive costs with respect to conventional cycles and wherein maneuverability is not compromised by the powerplant.

With this aim, these and other objects in view, there is provided a powerplant for wheeled vehicles, characterized in that a permanent-magnet rotor of an

electric motor is associated with at least one of the wheels, the stator of said motor being constituted by electromagnets the number whereof is a multiple of the phases, said electromagnets being supported by the frame,
5 means for the alternative power supply to said electromagnets being also provided.

Brief description of the Drawings

Further characteristics and advantages of the present invention will become apparent from the following detailed description of two preferred embodiments of a motorized
10 cycle, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a general side view of a bicycle including a powerplant according to the invention, in a first embodiment;

15 figures 2 and 3 are, respectively, an axonometric view and a sectional view of a detail of the bicycle of figure 1;

figure 4 is a schematic view of the powerplant related to figure 1;

20 figure 5 is a block diagram of the electrical operation of the powerplant of figure 1;

figure 6 is a fragmentary side view of a bicycle including a powerplant according to the invention, in a second embodiment;

25 figure 7 is a perspective view of the motor of figure 6;

figure 8 is a partially sectional view of the powerplant of figure 6;

figures 9 and 10 are front elevational views of two

different components of the powerplant of figure 6.

Ways of carrying out the Invention

With particular reference to figures 1 to 5, a bicycle including a powerplant according to the invention is generally designated by the reference numeral 10 in a first embodiment.

The bicycle 10 comprises, in a conventional manner, a frame 11 provided with wheels 12 and 13, a handlebar 14, a saddle 15, and pedals 16.

The wheel 12 includes the powerplant, which is generally designated by the reference numeral 17.

More specifically, the wheel 12 is of the disc type, with a disc 18 that supports a rim 20 and a plurality of equidistant permanent magnets 19 arranged along the circumference proximate to said rim 20.

Each one of the permanent magnets 19 is substantially cylindrical, and has end surfaces lying on respective planes which are inclined by an angle of 30 to 45 sexagesimal degrees with respect to the longitudinal axis of the corresponding permanent magnet 19. The end surfaces diverge symmetrically along the path of movement (see figure 4) defined by the permanent magnets 19 upon rotating the wheel 12 during forward travel of the bicycle 10.

All the permanent magnets 19, which are inserted in the disc 18, are furthermore concordantly polarized; upon assembly, the poles of each magnet protrude from the opposite sides of the wheel 12.

In alternative embodiments, it is also possible to provide disk-like permanent magnets that are fixed

externally to the disc wheel or to the spokes of a conventional wheel.

The frame 11 supports, in this case, four electromagnets 21 which are arranged in pairs and opposite to each other on a corresponding side of the wheel 12 and are furthermore mutually offset and arranged adjacent to the path of movement of the permanent magnets 19.

The electromagnets 21 are all identical, and each one is constituted by a C-shaped core 22 made of ferrite; a conductor 23 is wound around the central region of said core, and the center distance between the ends of said core is smaller than the center distance between two successive permanent magnets 19.

The frame 11 furthermore supports sensors 24 (in this case, only one is shown); said sensors are located at a passage defined between the electromagnets 21 along the path of movement of the permanent magnets 19. The sensors indicate the position of the permanent magnets 19 when they are about to pass between the pairs of electromagnets 21.

The powerplant 17 furthermore comprises rechargeable batteries, of a per se known type, represented by the blocks 25 and 26 in figure 5.

The powerplant 17 furthermore comprises an oscillating circuit, represented by the block 27 in figure 5, and a pulse counter circuit, represented by the block 28 in figure 5.

The oscillating circuit produces a variable frequency on the supply current, with an amplitude, in this case, of 24 volts, and allows a more or less time-invariant power

supply to the electromagnets.

The pulse counter circuit instead allows, in relation to the position of a speed regulator of a per se known type, represented by the block 29 in figure 5, to activate
5 the power supply of the electromagnets after the acquisition of the pulses arriving from the sensors 24.

The counter circuit furthermore controls a power circuit that is also represented by a block 30 in figure
5.

10 In practice, operation is as follows: the wheel 12, by supporting the permanent magnets 19, substantially becomes the rotor of an electric motor, in which the stator is substantially constituted by the electromagnets 21 which are fixed to the frame 11.

15 Power is supplied to the electromagnets 21 in an alternating manner, so as to avoid creating points of equilibrium (which would otherwise be produced if the electromagnets were powered simultaneously).

The sensors 24 for detecting the presence of the
20 permanent magnets 19 furthermore allow to synchronize the power supply of the electromagnets 21 according to the rotation rate of the wheel 12 and to commands, imparted by the driver, by means of the speed adjustment device.

It should also be noted that the powerplant can also
25 act as a current generator which supplies power to the batteries for recharging, for example in downhill travel or during deceleration or when only the pedals are used for propulsion.

With particular reference to figures 6 to 10, a
30 bicycle, which includes a powerplant according to the

invention, in a second embodiment, is generally designated by the reference numeral 100.

The bicycle 100 comprises, in a conventional manner, a frame 101 provided with two wheels, only one whereof, designated by the reference numeral 102, is shown; a handlebar, not shown; a saddle, also not shown; and pedals, generally designated by the reference numeral 103.

The powerplant according to this second embodiment is associated with the wheel 102 and is generally designated by the reference numeral 104.

More specifically, in this second embodiment, the wheel 102 supports a first annular metallic support 105 that is fixed axially, in this case at the side of the wheel lying opposite to the pedals 103; said support carries a plurality of permanent magnets with alternating polarities, designated by the reference numeral 106 and arranged radially.

In this case, the permanent magnets are substantially flat and have a substantially trapezoidal profile.

The powerplant 104 furthermore comprises a second annular support 107 that is fixed (for example by means of screws, not shown) to the frame 101.

The second support 107 accommodates and locks, by cooperating with locking plates 108 detachably associable therewith, the stator windings 109 that constitute the electromagnets of the powerplant 104.

The stator windings 109, in this case, are executed according to three-phase motor layouts.

In this embodiment, the power supply means are constituted by per se known batteries, designated by the

reference numeral 110 and contained in a case 111 which can be opened and accessed by the user and is supported by the frame 101.

The batteries 110 are connected to the stator
5 windings 109 by means of a cable 112 that is also supported by the frame 101.

The stator windings 109 and the second support 107, in this embodiment, are covered by a protective housing 113.

10 In this second embodiment, too, the powerplant 104 comprises three sensors and a counter circuit, not shown, for which reference is made to the description given in relation to the first embodiment.

In practice, it has been observed that the intended
15 aim and objects have been achieved; in particular, it should be noted that the powerplant according to the invention is extremely compact and fully eliminates the problem of power transmission, since the driving wheel itself is a component of the motor.

20 It is also noted that this solution leads to a considerable saving in the power absorbed by friction and allows, if applied in vehicles such as motorized bicycles, free action of the passenger when he decides to use the pedals.

25 The extreme constructive simplicity of the invention allows manufacture thereof with rather low costs.

Finally, it should be noted that the powerplant is also adapted to be provided in a kit form for use also in cycles that are already in use, and that it is possible to
30 provide for its application also to vehicles with more

than two wheels, even in more than one unit per vehicle.

The present invention is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept.

- 5 All the details may be replaced with other technically equivalent elements.

The materials and the dimensions may be any according to the requirements.

CLAIMS

1 1. Powerplant for wheeled vehicles, characterized in
2 that a permanent-magnet rotor of an electric motor is
3 associated with at least one of the wheels, the stator of
4 said motor being constituted by electromagnets the number
5 whereof is a multiple of the phases, said electromagnets
6 being supported by a frame, means for the alternative
7 power supply to said at least two electromagnets being
8 provided.

1 2. Powerplant according to claim 1, characterized in
2 that at least one of the wheels has at least one
3 circumferential region that forms a permanent-magnet rotor
4 of an electric motor the stator whereof is constituted by
5 at least two oppositely arranged and offset electromagnets
6 supported by said frame.

1 3. Powerplant according to claim 2, characterized in
2 that said at least one wheel supports a plurality of
3 equidistant permanent magnets arranged along the
4 circumference proximate to the wheel rim.

1 4. Powerplant according to claims 2 and 3,
2 characterized in that each one of said permanent magnets
3 is substantially cylindrical, its end surfaces lying on
4 respective planes that are inclined with respect to the
5 longitudinal axis of the corresponding said permanent
6 magnet and diverge symmetrically from each other.

1 5. Powerplant according to claims 2 to 4,
2 characterized in that all the permanent magnets of said
3 plurality of permanent magnets have a concordant
4 polarization, upon assembly, the poles of each magnet

5 protruding from the opposite sides of said at least one
6 motorized wheel.

1 6. Powerplant according to claims 2 to 5,
2 characterized in that said at least one wheel is of the
3 disc type, said permanent magnets being supported by the
4 disc-shaped part of said at least one driving wheel.

1 7. Powerplant according to claims 2 to 6,
2 characterized in that said at least two electromagnets are
3 arranged opposite to each other, each at a corresponding
4 side of said driving wheel, said at least two
5 electromagnets being arranged at the movement path of said
6 plurality of permanent magnets.

1 8. Powerplant according to claims 2 and 3,
2 characterized in that said permanent magnets have a disk-
3 like shape and are fixed externally to the disc wheel or
4 to the spokes of a conventional wheel.

1 9. Powerplant according to claims 2 to 8,
2 characterized in that each one of said electromagnets is
3 constituted by a C-shaped core, a conductor being wound at
4 its central region, the center distance of the ends of
5 said core being shorter than the center distance between
6 said permanent magnets.

1 10. Powerplant according to claim 1, characterized in
2 that said at least one wheel axially supports, at one of
3 its sides, a first annular support for a plurality of
4 permanent magnets that are arranged radially.

1 11. Powerplant according to claims 1 and 10,
2 characterized in that it comprises a second annular
3 support that is fixed to said frame, is associated with
4 removable locking plates, and is adapted to accommodate

5 and lock the stator windings that constitute said at least
6 two electromagnets.

1 12. Powerplant according to claims 10 and 11,
2 characterized in that said permanent magnets are
3 substantially flat and have a trapezoidal profile.

1 13. Powerplant according to claims 10 to 12,
2 characterized in that said permanent magnets are arranged
3 with alternating polarities.

1 14. Powerplant according to one or more of the
2 preceding claims, characterized in that it comprises
3 sensors located at the passage of said permanent magnets
4 and indicate the position of said permanent magnets when
5 they pass between said at least two electromagnets.

1 15. Powerplant according to one or more of the
2 preceding claims, characterized in that it comprises an
3 oscillating electronic circuit, a pulse counting circuit
4 associated with a speed adjustment device and with said
5 sensors, and a power circuit, all being of a per se known
6 type and supplying power to said at least two
7 electromagnets in accordance with the speed and position
8 of said permanent magnets.

1 16. Powerplant according to one or more of the
2 preceding claims, characterized in that said power supply
3 means comprise batteries fixed to said frame.

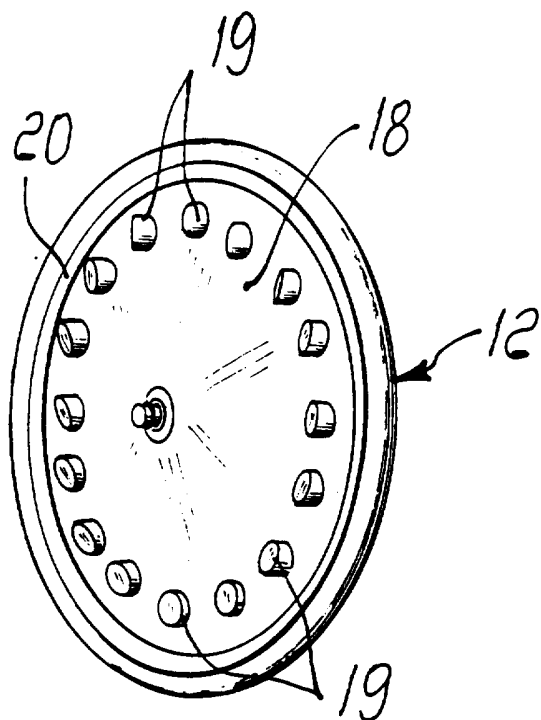
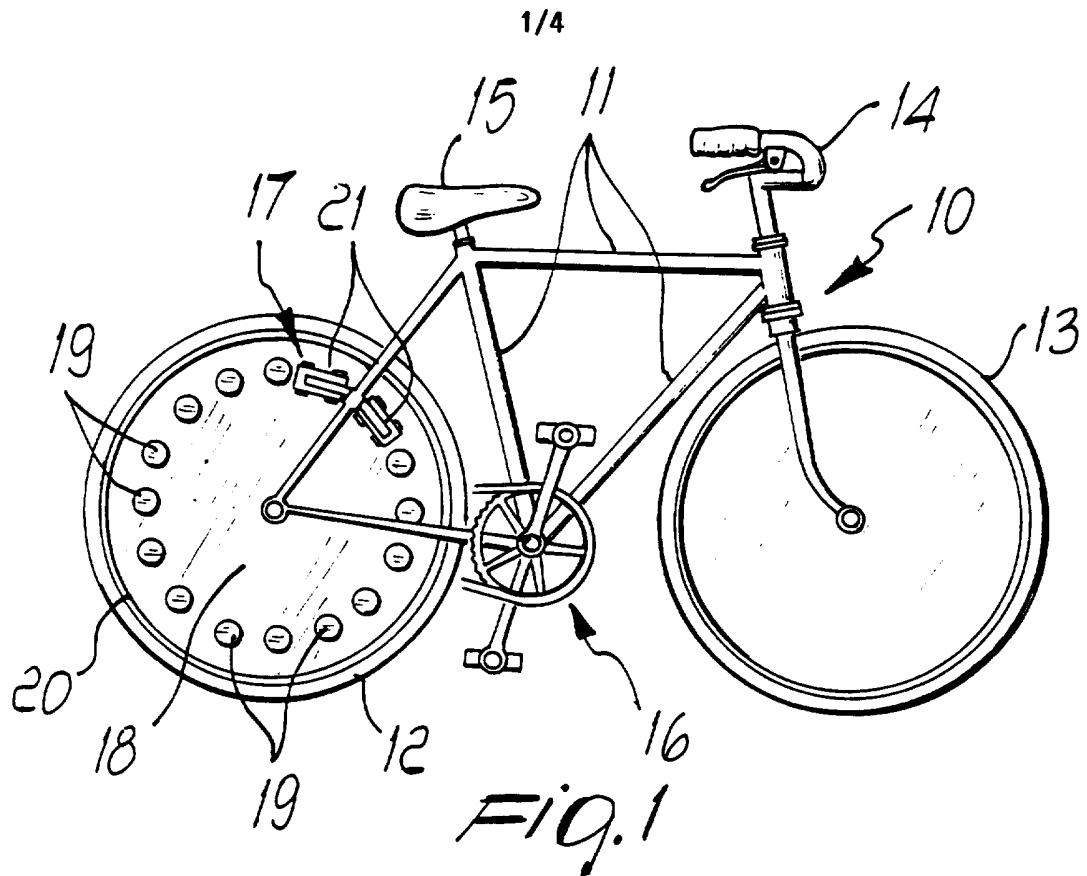


Fig. 2

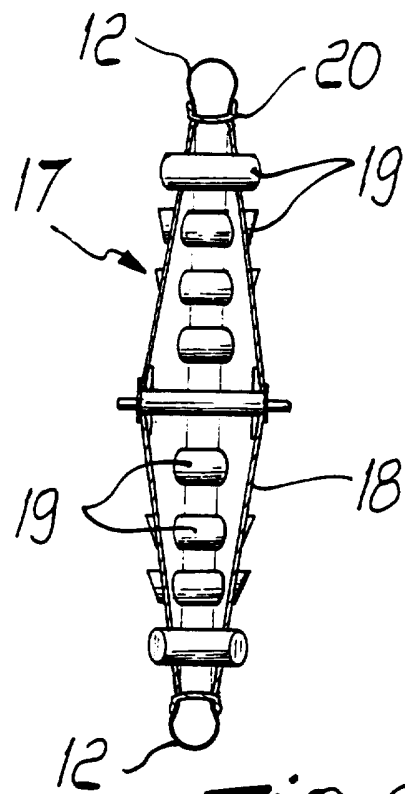
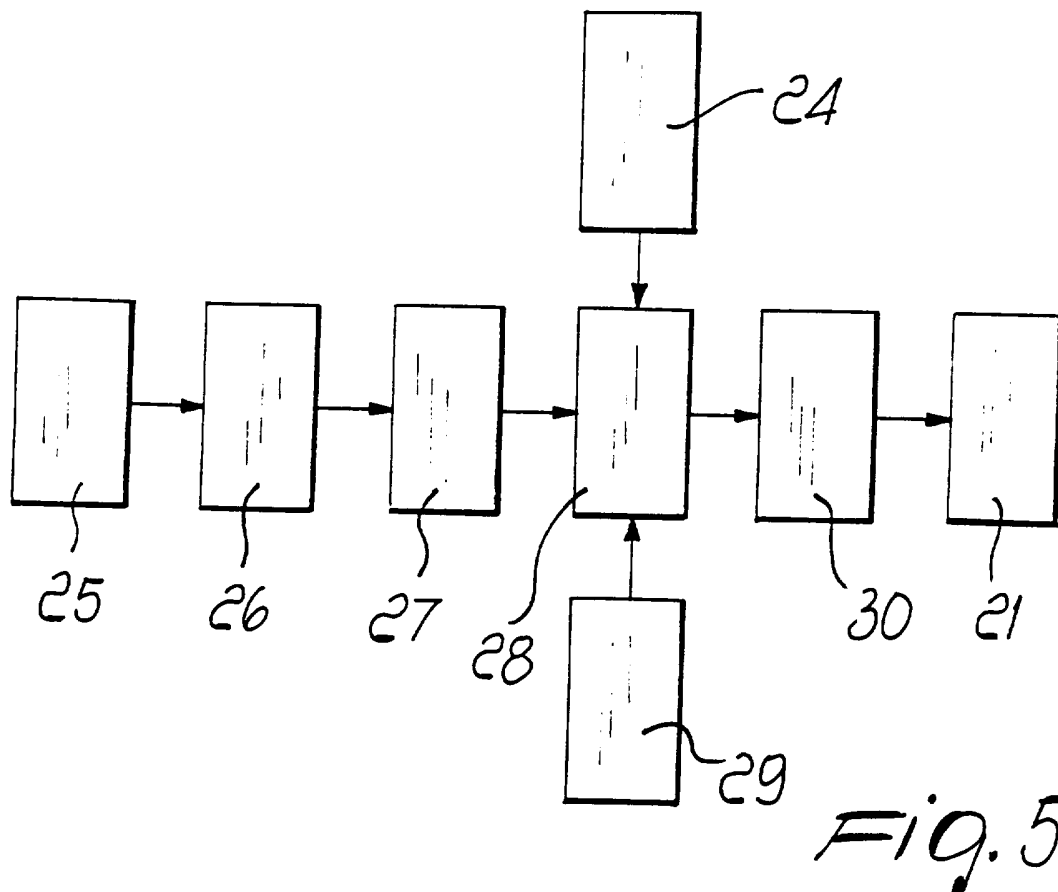
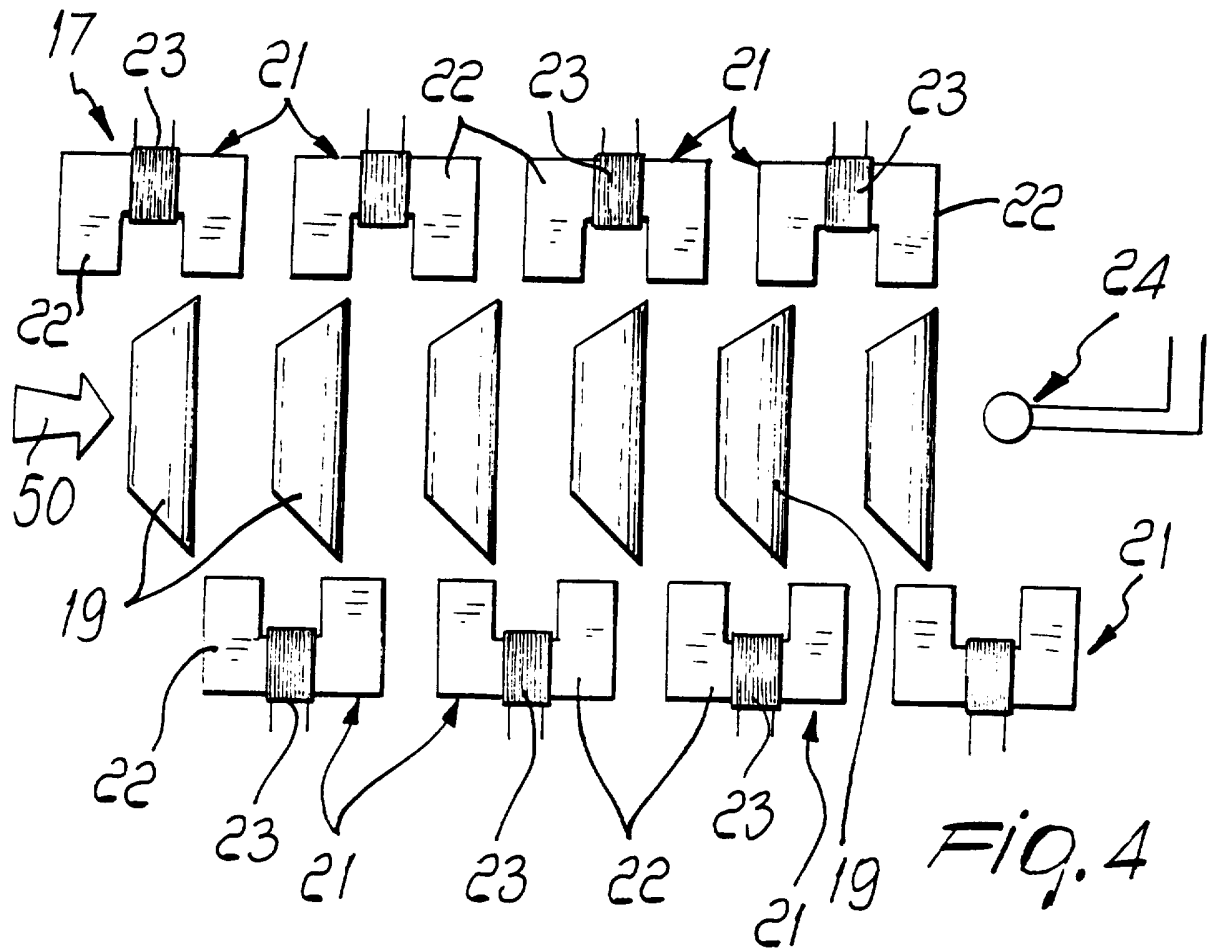


Fig. 3



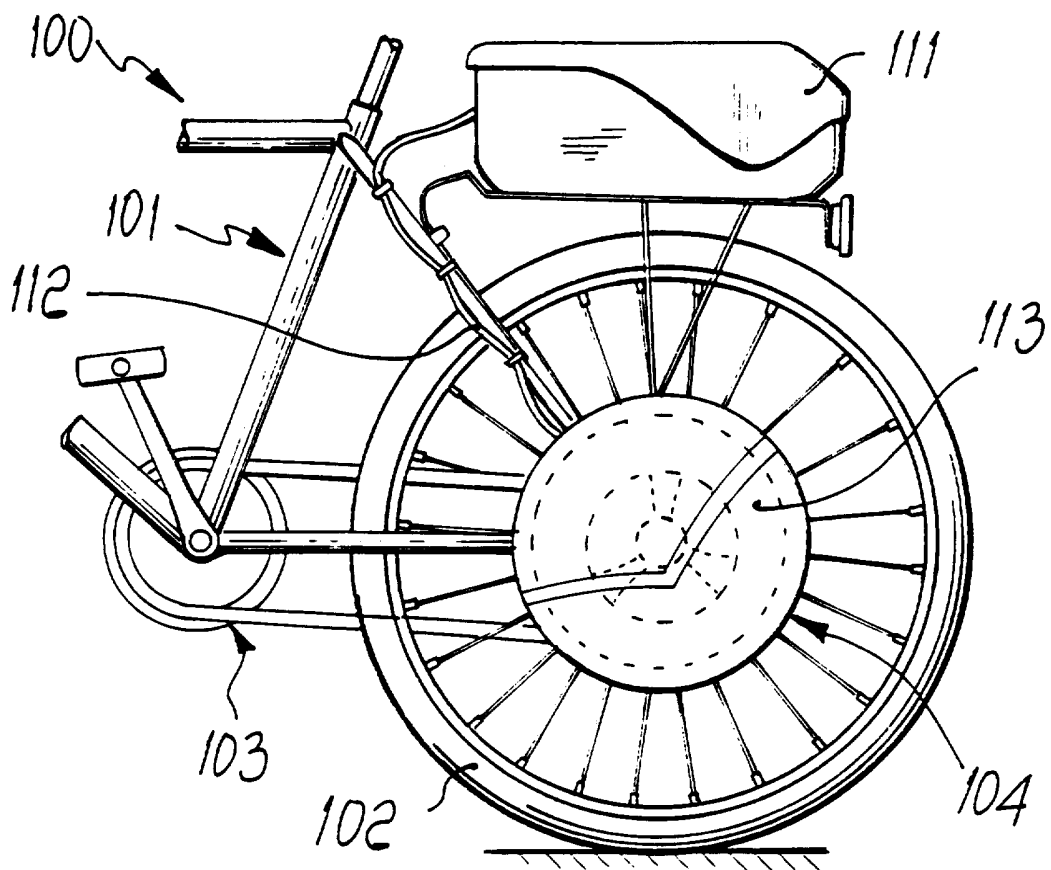


Fig. 6

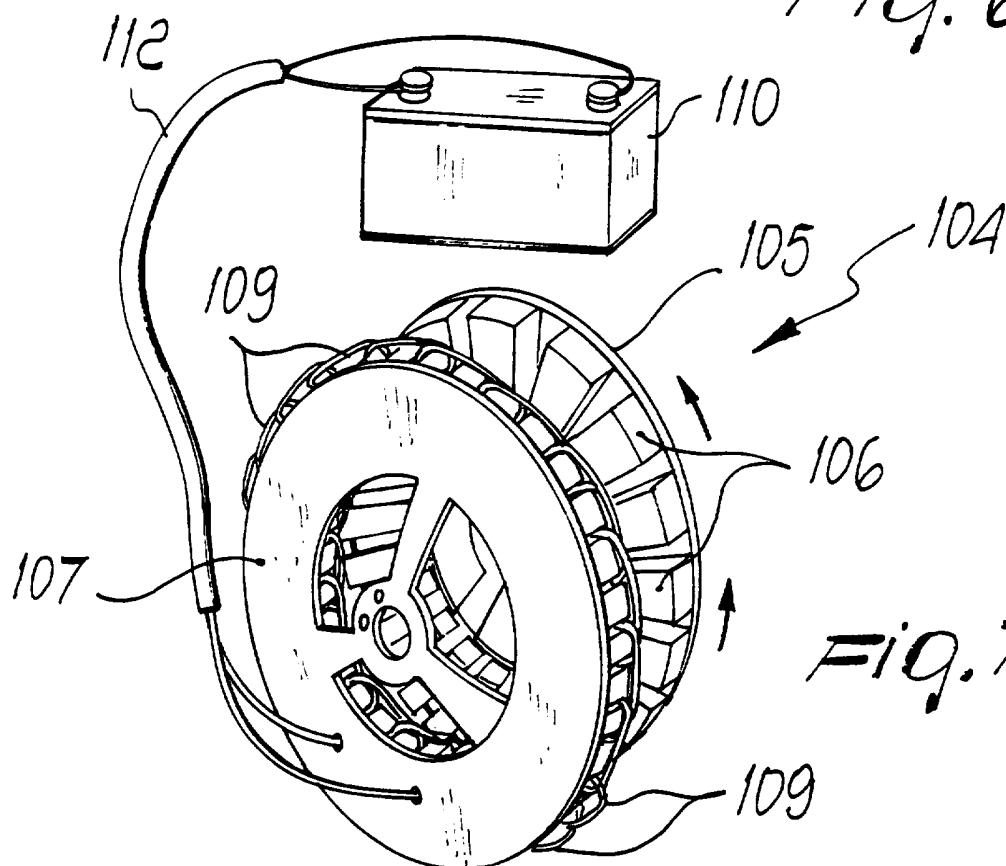
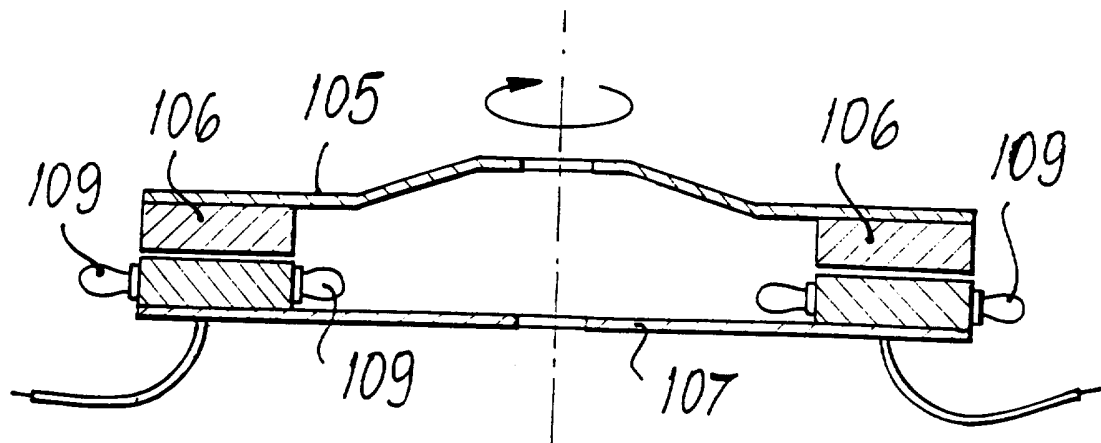
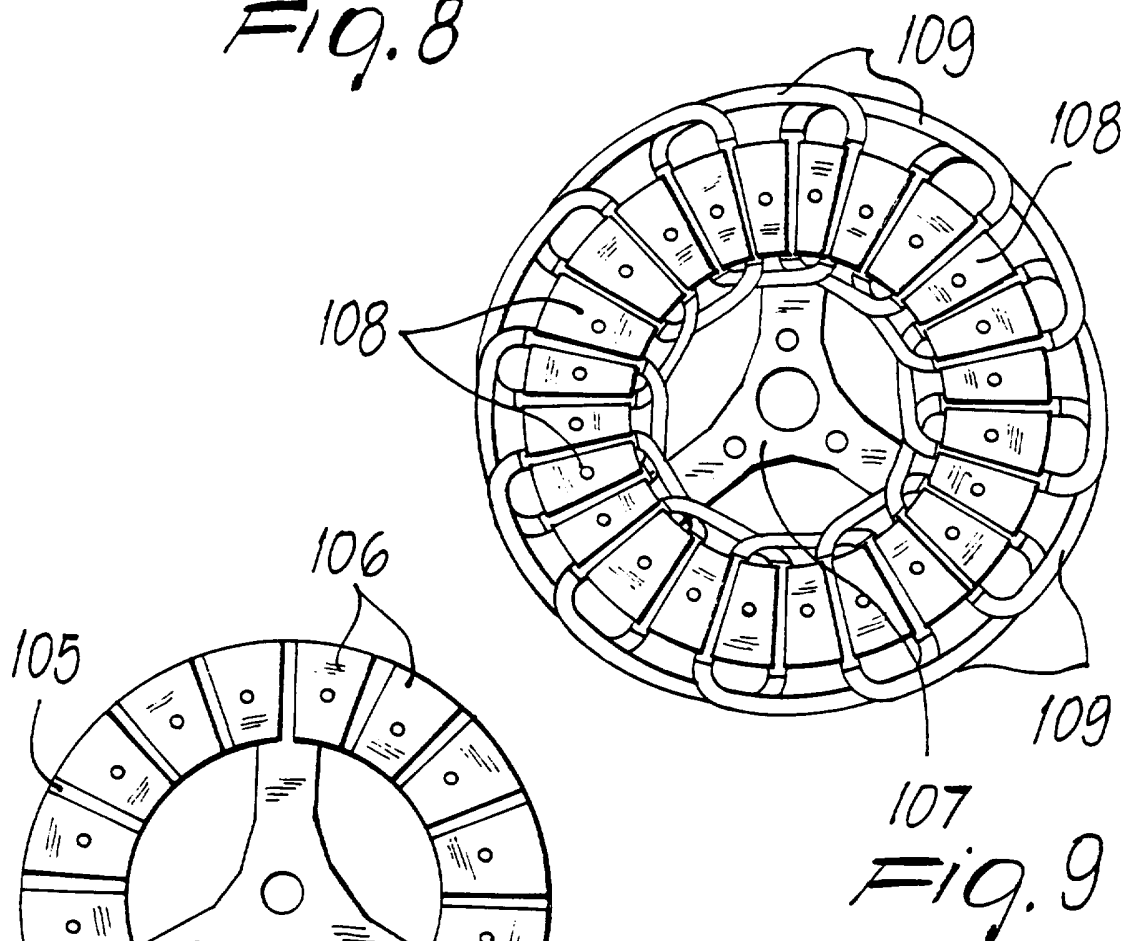
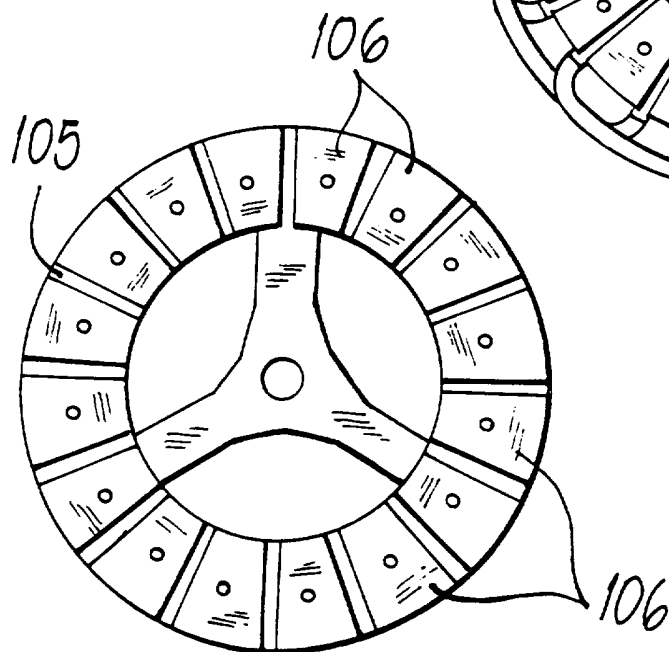


Fig. 7

*Fig. 8**Fig. 9**Fig. 10*

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/00510

A. CLASSIFICATION OF SUBJECT MATTER

B 62 M 7/12, B 62 M 23/02, B 60 L 11/18

According to International Patent Classification (IPC) or to both national classification and IPC⁶

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B 60 L, B 62 M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 3 884 317 (KINZEL) 20 May 1975 (20.05.75), fig. 6.	1, 16
Y	--	2, 3, 5-7
Y	US, A, 4 095 663 (GAFFNEY) 20 June 1978 (20.06.78), fig. 4.	2, 3, 5-7
A	--	1
A	EP, A, 0 587 120 (FUJI) 16 March 1994 (16.03.94), fig. 1.	
A	--	
A	AU, A, 68 621/81 (PAYNE) 16 September 1982	14, 15

☒ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

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Date of the actual completion of the international search
14 May 1996

Date of mailing of the international search report
19.06.96

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Authorized officer
BAUMGARTNER e.h.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/00510

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	(16.09.82), page 2, lines 31,32. -----	

ANHANG

zum internationalen Recherchen-
bericht über die internationale
Patentanmeldung Nr.

ANNEX

to the International Search
Report to the International Patent
Application No.

ANNEXE

au rapport de recherche inter-
national relatif à la demande de brevet
international n°

PCT/EP 96/00510 SAE 126722

In diesem Anhang sind die Mitglieder
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US A 3884317	20-05-75	keine - none - rien	
US A 4095663	20-06-78	keine - none - rien	
EP A2 587120	16-03-94	CA AA 2105884 EP A3 587120 JP A2 6098409 US A 5487438	12-03-94 13-07-94 08-04-94 30-01-96
AU A 68621		keine - none - rien	