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[Patent] Electric motor wheel assembly

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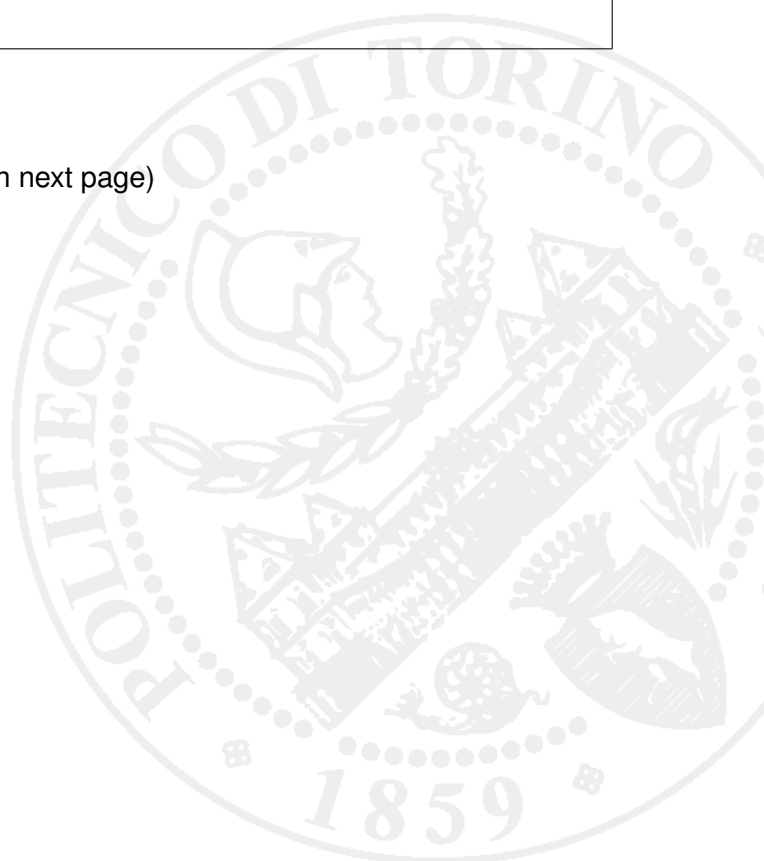
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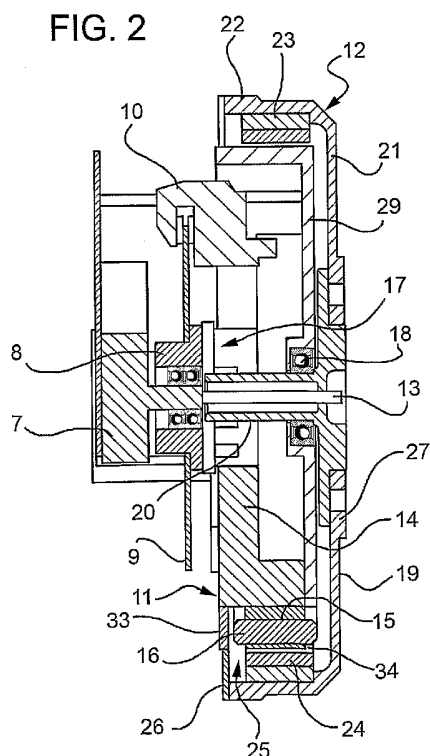




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(54) **Title:** ELECTRIC MOTOR WHEEL ASSEMBLY



(57) **Abstract:** A motor wheel assembly (2) for a motor vehicle- comprises a radial flux brushless electric motor (2) having a plurality of stator magnets (16) arranged along a circumferential path; a wheel (3); first connecting means (27) to connect motor (2) to wheel (3) in a torque transfer manner and second connecting means (6) suitable for connecting motor (2) to the motor vehicle. The motor wheel assembly defines a seat (35) interrupting the sequence of stator magnets (16) along the circumferential path and is suitable for housing a caliper (10) of a braking system of the motor vehicle.

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ELECTRIC MOTOR WHEEL ASSEMBLY.

TECHNICAL FIELD

The present invention relates to an electric motor wheel assembly for a motor vehicle, for example for a car.

BACKGROUND ART

Recently, the increased sensitivity of the market to environmental issues led car makers to spend efforts in developing hybrid vehicles and electric power vehicles having an electric engine to drive the wheels.

Power density of electric engines is such that it is possible to design a motor radially mounted within the rim of the wheel in all or some of the wheels of the vehicle, thus defining respective motor wheel assemblies.

Normally, a braking device, either a caliper or a shoe brake, is mounted within the radial dimension of the rim. Therefore, a design problem rises how to configure the electric motor and the braking device for the new vehicles.

In a known proposed solution to this problem, the electric motor is radially housed within the rim

and the braking element is a shoe brake is concentric with the electric motor. Such solution requires the design from scratch of the braking element and is not suitable for retrofitting an already existing vehicle. In case of a restyling of the vehicle, the eventual redesign of the braking element would also require a new homologation procedure and is therefore costly.

In another solution, the braking element is eliminated and the electric motor is used to brake the vehicle. Also in this case the braking system shall be redesigned and the vehicle homologated again.

DISCLOSURE OF INVENTION

The scope of the present invention is to provide an electric motor wheel assembly free from the aforementioned drawbacks.

The scope of the present invention is achieved by an electric motor wheel according to claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, said vehicle is further described also with reference to the attached figures, wherein:

- Figure 1 is a perspective view of a the motor

wheel assembly according to the present invention;

- Figure 2 is a radial cross section of figure 1;

- Figure 3 is a frontal perspective view of figure 2 with removed portions for a clearer understanding; and

- Figure 4 is a rear perspective view of figure 3.

BEST MODE FOR CARRYING OUT THE INVENTION

In Figure 1, indicated as a whole by 1 is motor wheel assembly for a motor vehicle such as a car or another two/three wheeled vehicle.

Motor wheel 1 comprises a radial flux reverse brushless motor 2, a wheel 3 having a rim 4 and a tyre 5, and connecting means 6 to connect motor 2 to a suspension system of the vehicle (schematically shown).

In particular, (figure 2) the suspension system comprises a hub carrier 7 connected to a shock absorber (not shown) of the suspension system, a hub 8 rotatably mounted to hub carrier 7 and a breaking device. Breaking device preferably comprises a disk 9 rigidly connected to hub 8 and a caliper 10 rigidly connected to hub carrier 7 and cooperating with disk

9.

Motor 2 comprises a stator 11 connected to hub carrier 7 through a pair of arms 12 of connecting means 6 and a rotor 12 connected to hub 8 through a threaded joint 13 of connecting means 6. In particular arms 12 are spaced and are substantially loaded by the torque acting on stator 11. Threaded joint 13 rigidly connects rotor 12 to hub 8. In this way, connecting means 6 has two constraint units specifically designed for stator 11 and rotor 12 respectively. According to a further embodiment of the present invention, stator 12 is connected to caliper 10 or to other elements fixed with respect to hub carrier 7.

Stator 11 comprises a body 14 to support a plurality of magnetic packs 15 along a circular path and a plurality of electromagnets 16. Body 14 has a through hole 17 defining a seat for a bearing 18 that radially supports rotor 12.

Rotor 12 comprises a support element 19 defining a tubular portion 20 supported by bearing 18 inside through hole 17, a web 21 perpendicular to tubular portion 20 and a cylindrical wall 22 axially extending from a periphery of web 20.

Cylindrical wall 22 has an internal surface surrounding body 14 and supporting a ring 23 made of a ferromagnetic material and a plurality of permanent magnets 24 supported on ring 23 and facing electromagnets 16.

Body 14 and support element 19 define a chamber 25 sealed from the external environment and protecting electromagnets 16 and permanent magnets 24 from contaminants. Preferably, to achieve sealing of chamber 25, stator 12 comprises a ring plate 26 fixed to cylindrical wall 22 and extending towards body 14, a sliding seal interposed between body 14 and ring plate 26 and a sliding seal advantageously integrated in bearing 18.

On an opposite axial side of ring plate 26, web 21 of rotor 12 defines releasable connecting means 27 for rim 4 of wheel 5. Connecting means 27 may comprise through hole to house bolts or studs coupling with suitable holes of the rim.

According to a preferred embodiment of the present invention, support element 19 comprises two parts, namely a body defining said tubular portion 20 and a flange 28 extending from an end portion of tubular portion 20, and a body comprising web 21

rigidly connected to flange 28 and cylindrical wall 22. In this way, the shape of the two bodies is simple to obtain and manufacturing is improved.

Figure 3 shows a perspective view of electric motor 2 wherein web 21 and cylindrical wall 22 are removed.

Body 14 comprises a circular web 29 facing web 21 and a peripheral portion 30 attached to web 29 and defining a slot 31. Slot 31 has a radial dimension suitable to house permanent magnets 16 and is open in the axial direction towards web 21 and in the radial direction towards permanent magnets 24. Slot 31 is defined by a cylindrical wall 32 and by a shoulder 33 radially extending from cylindrical wall 32 towards plate ring 26. The sliding seal cited above is interposed between plate ring 26 and shoulder 33. Slot 31 is further delimited along the radial direction by a plurality of digits 34 substantially equispaced along the circumferential dimension.

According to the present invention, body 14 defines a seat 35 interposed between two adjacent electromagnets 16 along the circumferential direction and designed to house along the circumferential and radial dimension caliper 10 when motor wheel 1 is

mounted on the suspension system.

In particular, seat 35 is delimited by body 14 through a pair of lateral walls 36, 37 along the circumferential direction, a rounded head wall 38 on top and web 29 towards rotor 12. In order to guarantee the sealing of chamber 25, lateral walls 36, 37 and head wall 38 are continuous along the circumferential direction and web 29 is continuous in the radial direction. Furthermore, head wall 38 has the same outer diameter as shoulder 33 and sliding sealing means are continuous along the circumferential direction and are interposed between ring plate 26 and head wall 38 also.

In use, motor 2 is controlled by a control unit and powered by chargeable batteries (not shown). Seat 35 defines an interruption in the regular series of electromagnets 16 whose effects on the regularity of output torque can be controlled by the electronic control unit. For example, each electromagnet 16 has a respective power terminal (not shown) connected to the control unit. In this way, each electromagnet can be controlled independently.

In forward and backward running of the vehicle, motor 2 drives wheel 3 and caliper 10 brakes on disk

9 to decelerate. Particles of the friction element sliding on disk 9 during braking are prevented from entering inside motor 2 because electromagnets 16 and permanent magnets 24 are sealingly housed within chamber 25.

The advantages of motor wheel 1 according to the present invention are the following.

When motor wheel 1 is mounted on the suspension system, caliper 10 is housed in seat 35 so that no real modifications to the braking system are needed. Furthermore, with a suitable redesign of the rim only, axial dimension is compact.

The perturbation introduced by seat 35 can be controlled and improved by the engine control unit especially in the case where the power terminal are different from those of a standard DC brushless motor, i.e. power terminals are more than three.

Chamber 25 is sealed and maintenance of motor wheel 1 is reduced.

Radial flux brushless motor allows to obtain compact axial dimensions.

Lastly, it is clear that modifications and variations are can be made to the above described embodiment without departing from the scope of

protection as defined by the appended claims.

The motor wheel assembly 1 can be used in electric vehicles or in hybrid vehicles. In the latter case, the motor wheel assembly 1 has the same configuration as the one showed in the attached figures and the internal combustion engine drives other wheel(s). In an example of a three-wheeled vehicle having two front steering wheels, the rear wheel is driven by the internal combustion engine only and the two front wheels are motor wheels not connected to the internal combustion engine. However, with appropriate changes, motor wheel assembly 1 can also be configured to receive the axle connected to the differential.

CLAIMS

1. Motor wheel assembly (2) for a motor vehicle comprising a radial flux brushless (se fosse axial?) electric motor (2) having a plurality of stator magnets (16) arranged along a circumferential path; a wheel (3); first connecting means (27) to connect said motor (2) to said wheel (3) in a torque transfer manner and second connecting means (6) suitable for connecting said motor (2) to said motor vehicle, wherein said motor wheel assembly defines a seat (35) interrupting the sequence of said stator magnets (16) along said circumferential path and is suitable for housing a caliper (10) of a braking system of said motor vehicle.

2. Motor wheel assembly according to claim 1, comprising more than three power terminals to power said stator magnets (16).

3. Motor wheel assembly according to claims 1 or 2, wherein said motor (2) comprises a stator body (14) shaped to define said seat (35) with continuous walls (29, 36, 37, 38) configured to seal said stator magnets (16) from said seat (35) at least along the circumferential and axial direction.

4. Motor wheel assembly according to any of

claims 2 or 3, wherein a rotor (12) of said motor (2) comprises a support unit (20, 21, 22, 26, 28) supporting a plurality of permanent magnets (24) and said first connecting means (27) are interposed between said support unit (20, 21, 22, 26, 28) and said wheel (2).

5. Motor wheel assembly according to claims 3 and 4, wherein said stator body (14) and said support unit (20, 21, 22, 26, 28) define a chamber (25) closed around said plurality of stator magnets (16) and permanent magnets (24).

6. Motor wheel assembly according to claim 5, comprising a sliding sealing means (18) interposed between said stator body (14) and said support unit (20, 21, 22, 26, 28) to prevent contamination of said chamber (25).

7. Motor wheel assembly according to any of claims 5 or 6, wherein said stator body (14) and said rotor (12) are permanently connected to form a non-demountable unit and wherein said first connecting means (27) are demountable.

8. Motor wheel assembly according to any of claims 5 to 7, said stator body (14) defines a slot (31) housing said stator magnets (16), wherein said

chamber (25) comprises said slot (31).

9. Motor vehicle comprising an internal combustion engine, at least a second wheel and a motor wheel assembly (1) according to any of the preceding claims, wherein said internal combustion engine drives said at least second wheel and not said motor wheel assembly (1).

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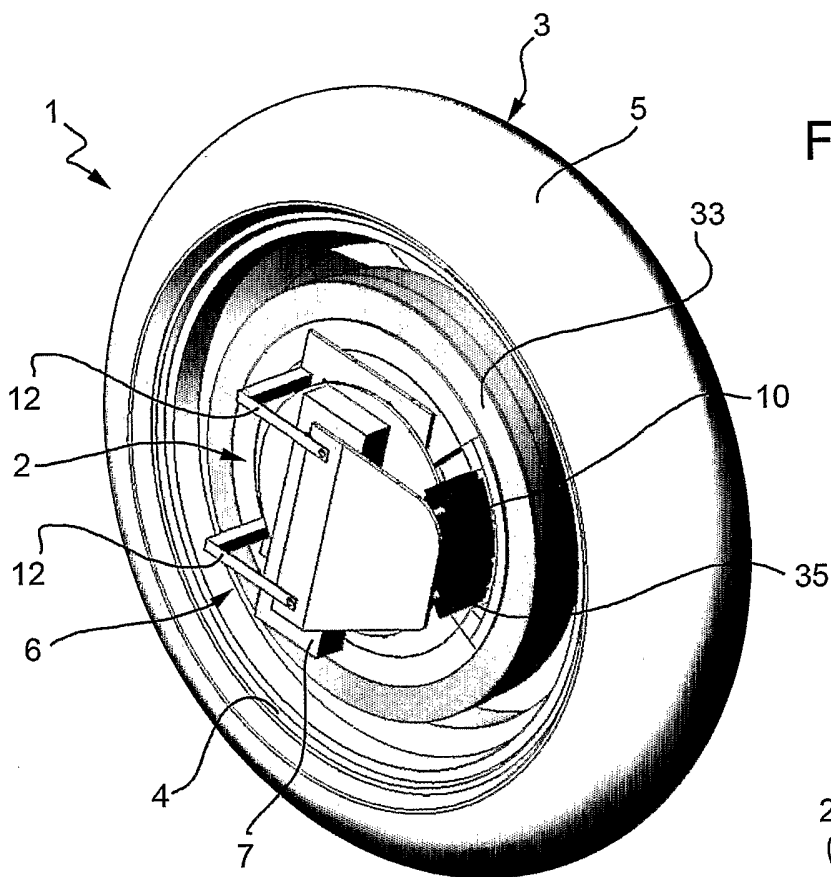


FIG. 1

FIG. 2

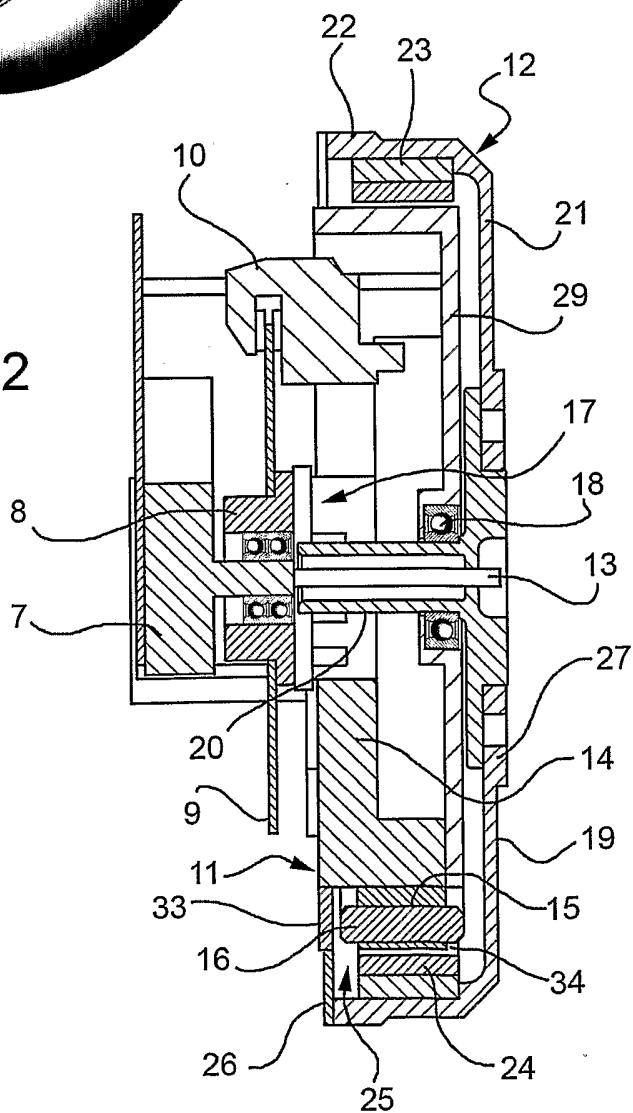


FIG. 4

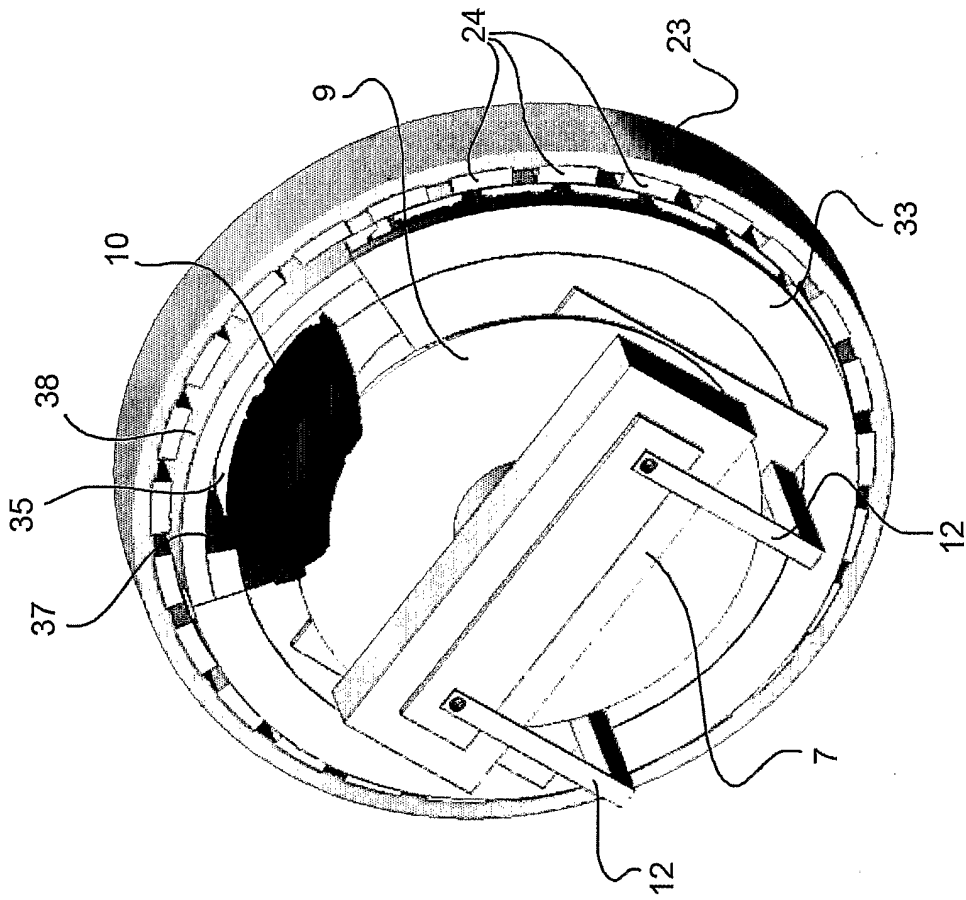
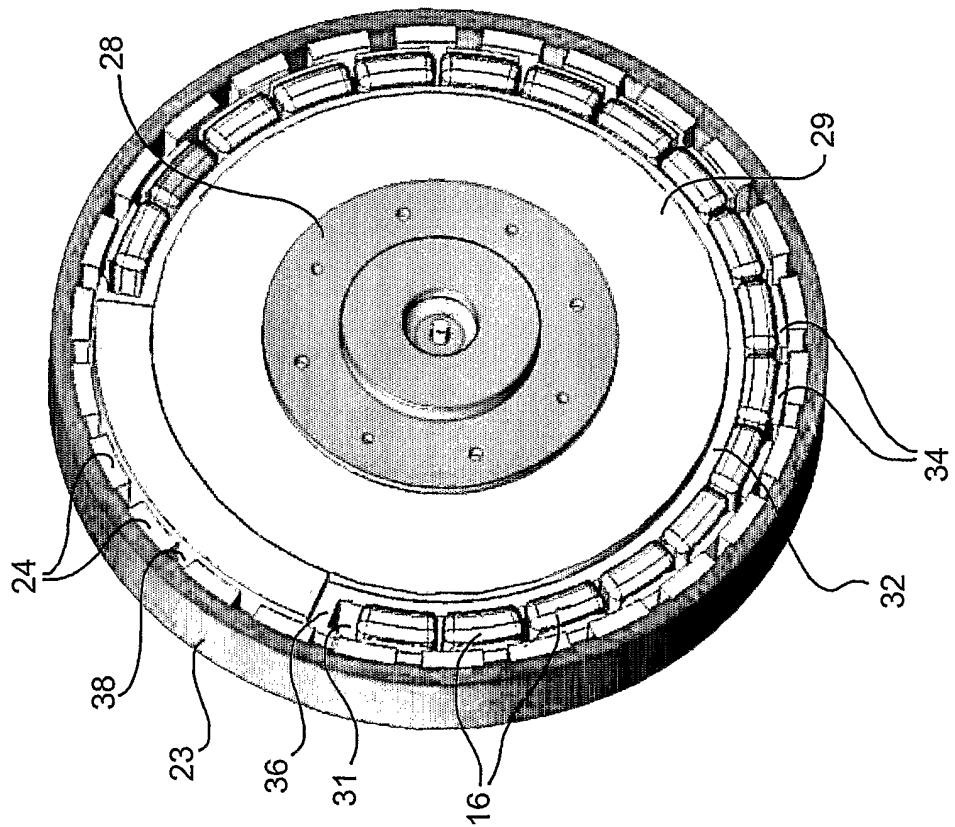


FIG. 3



INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2008/000712

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B60K7/00 H02K41/03 H02K7/102
 ADD. H02K1/27 H02K21/22

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

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 B60K H02K

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)
 EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 91/13779 A (LIFT VERKAUFSGERAETE GMBH [AT]) 19 September 1991 (1991-09-19) page 1, paragraph 2 page 5, line 5 - page 6, line 24; figures 1,2	1-4,9
Y	-----	5-8
Y	JP 2007 145060 A (MITSUBISHI MOTORS CORP) 14 June 2007 (2007-06-14) abstract; figures 1-3	5-8
A	GB 1 451 165 A (ELECTROLUX AB) 29 September 1976 (1976-09-29) page 1, line 22 - line 23 page 1, line 51 - line 55 page 1, line 73 - page 2, line 34; figure 1	1

Further documents are listed in the continuation of Box C.

See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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Patent document cited in search report		Publication date		Patent family member(s)	Publication date
WO 9113779	A	19-09-1991	AT	395567 B	25-01-1993
JP 2007145060	A	14-06-2007	NONE		
GB 1451165	A	29-09-1976	DE	2401846 A1	25-07-1974
			SE	368488 B	01-07-1974