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(71) Applicant(s)

The Whitaker Corporation
(Incorporated in USA - Delaware)
4550 New Linden Hill Road, Suite 450, Wilmington,
Delaware 19808, United States of America

(72) Inventor(s)

Kenneth F Folk

(74) Agent and/or Address for Service

Baron & Warren
18 South End, Kensington, LONDON, W8 5BU,
United Kingdom

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(56) Documents Cited

GB 1267672 A **WO 97/33358 A** **US 5585711 A**
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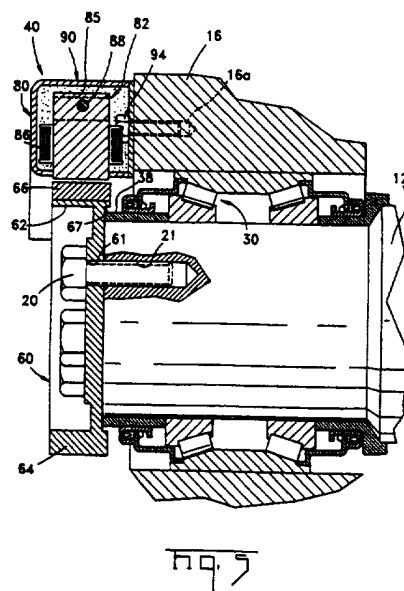
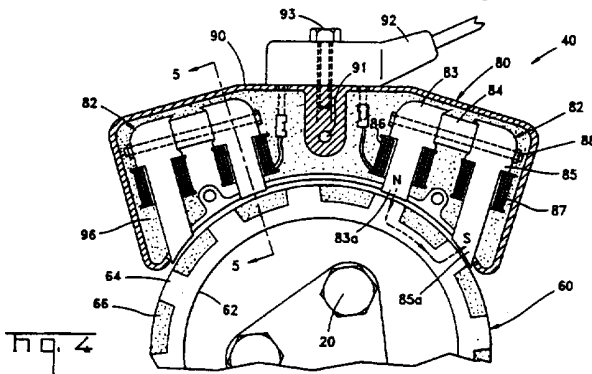
(58) Field of Search

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INT CL⁶ B61D 43/00 , H02K 7/18 21/38
ONLINE: WPI, CLAIMS, JAPIO; OPTICS: H2A

(54) Abstract Title

Axle-mounted inductor generator

(57) An electrical generator (40) is mounted to the end of an axle of a vehicle, such as, a railroad car. The generator includes a rotor (60) attached to the end of the axle in place of the standard bearing end cap. The rotor has an outer periphery (62, 64) of non-permanent magnet material. A stator (80) is attached to the vehicle and includes first and second spaced apart magnetically permeable elements (83, 85) having first and second pole ends (83a, 85a), respectively, closely adjacent the peripheral surface of the rotor (60). A permanent magnet (84) interconnects the first and second magnetically permeable elements (83, 85) and electrical stator windings (86, 87) are arranged around each element so that, when the rotor (60) is rotated by the axle (12), an electrical current flows through the stator windings (86, 87).



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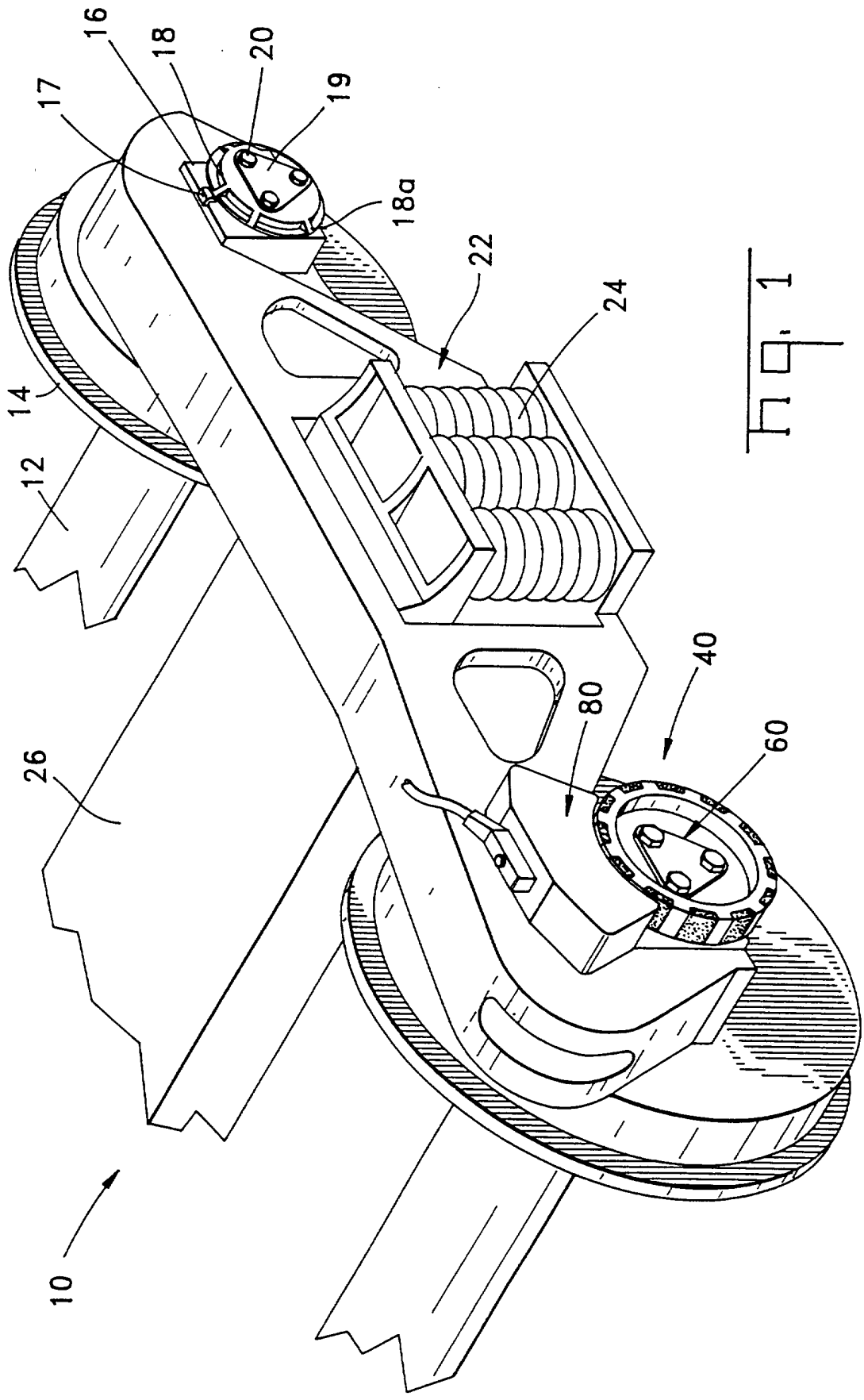


Fig. 1

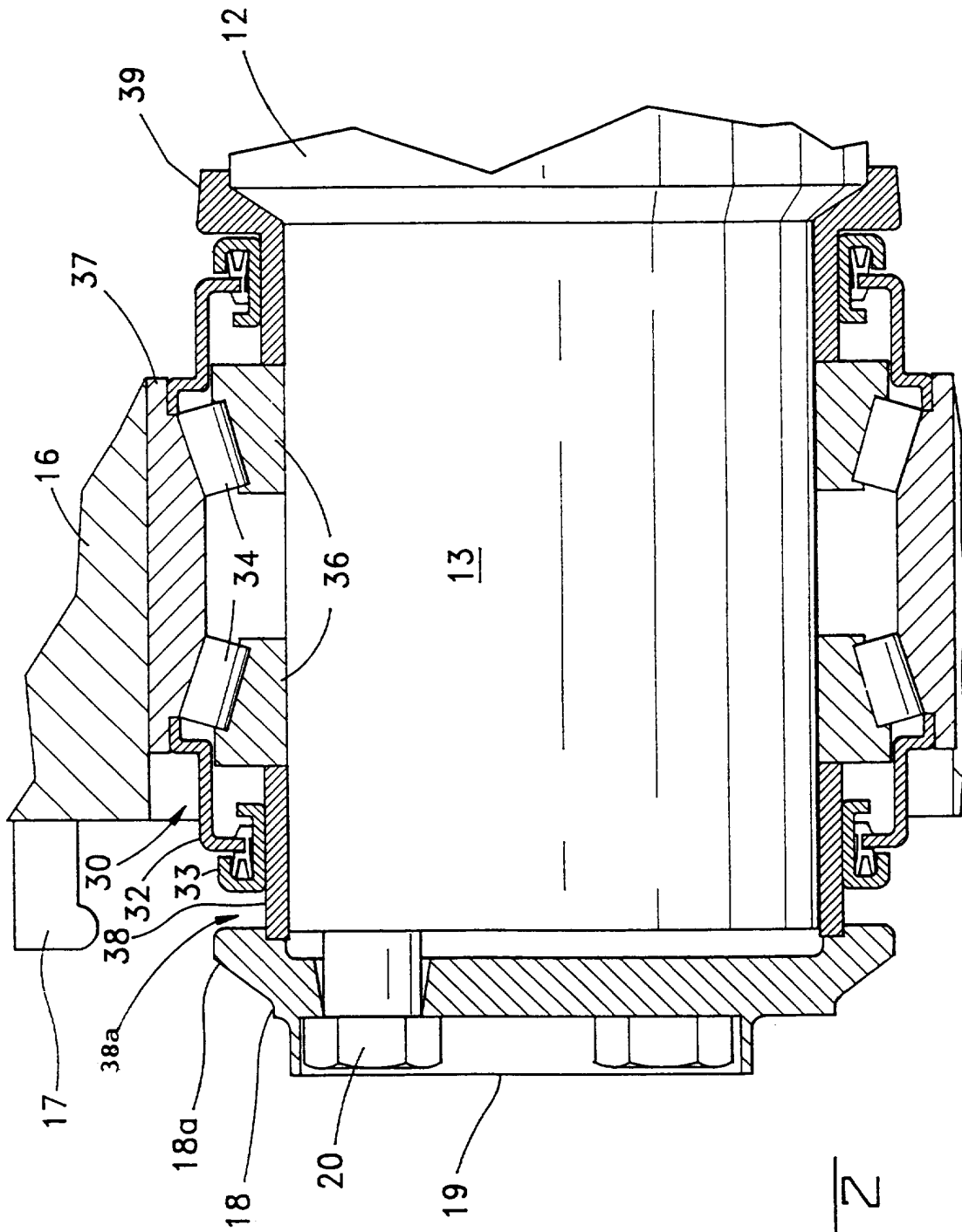


Fig. 2

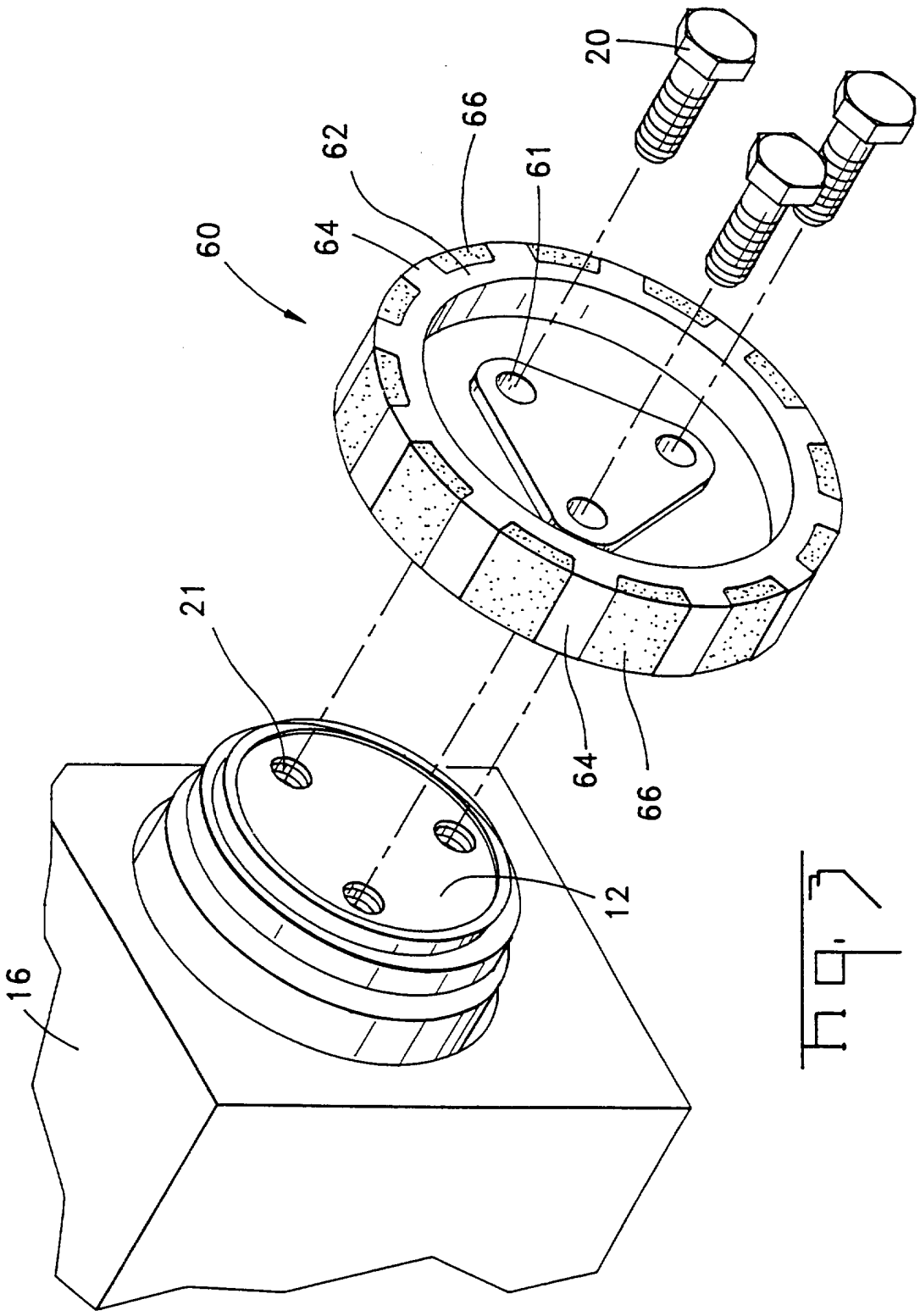


Fig. 2

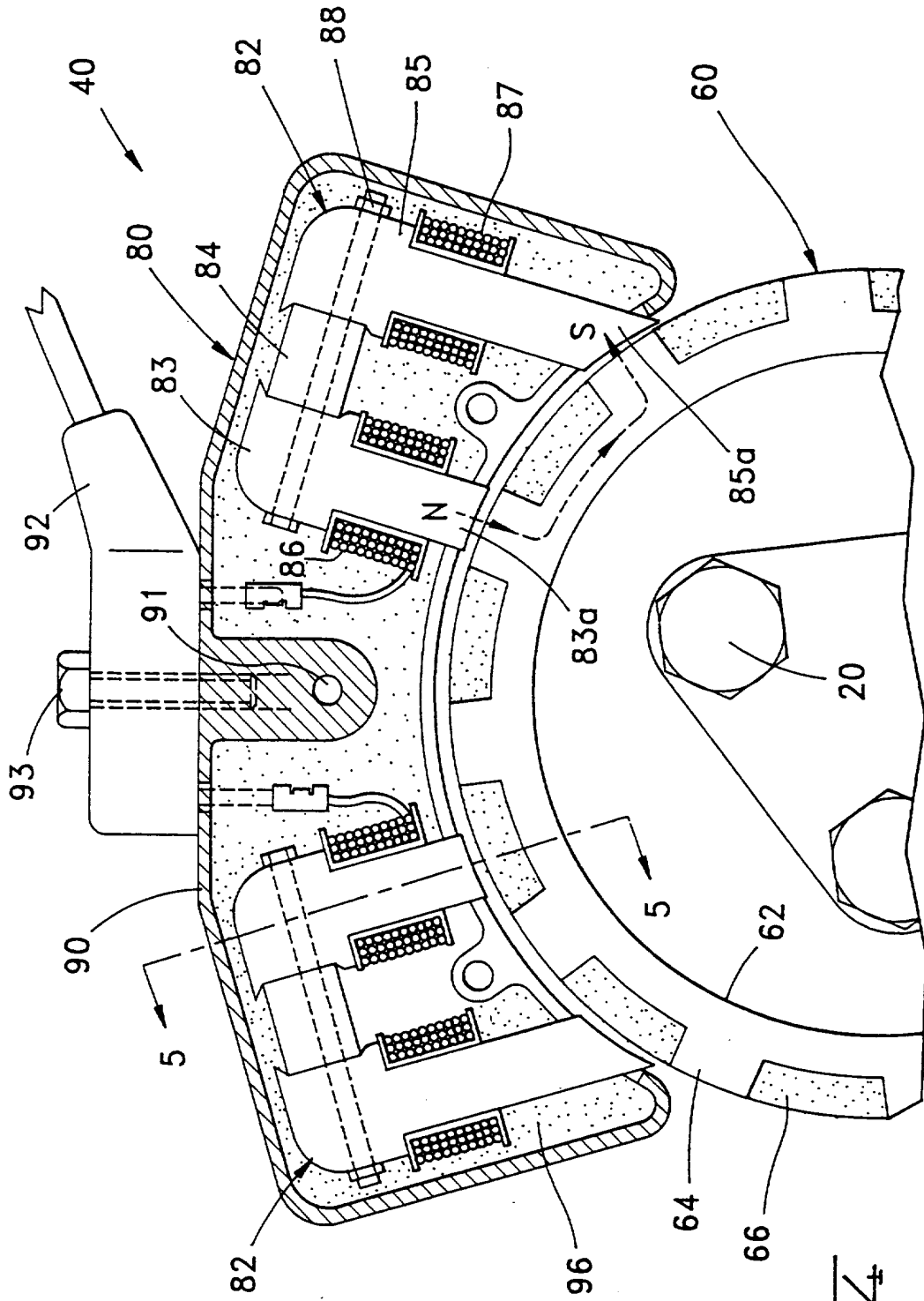


Fig. 4

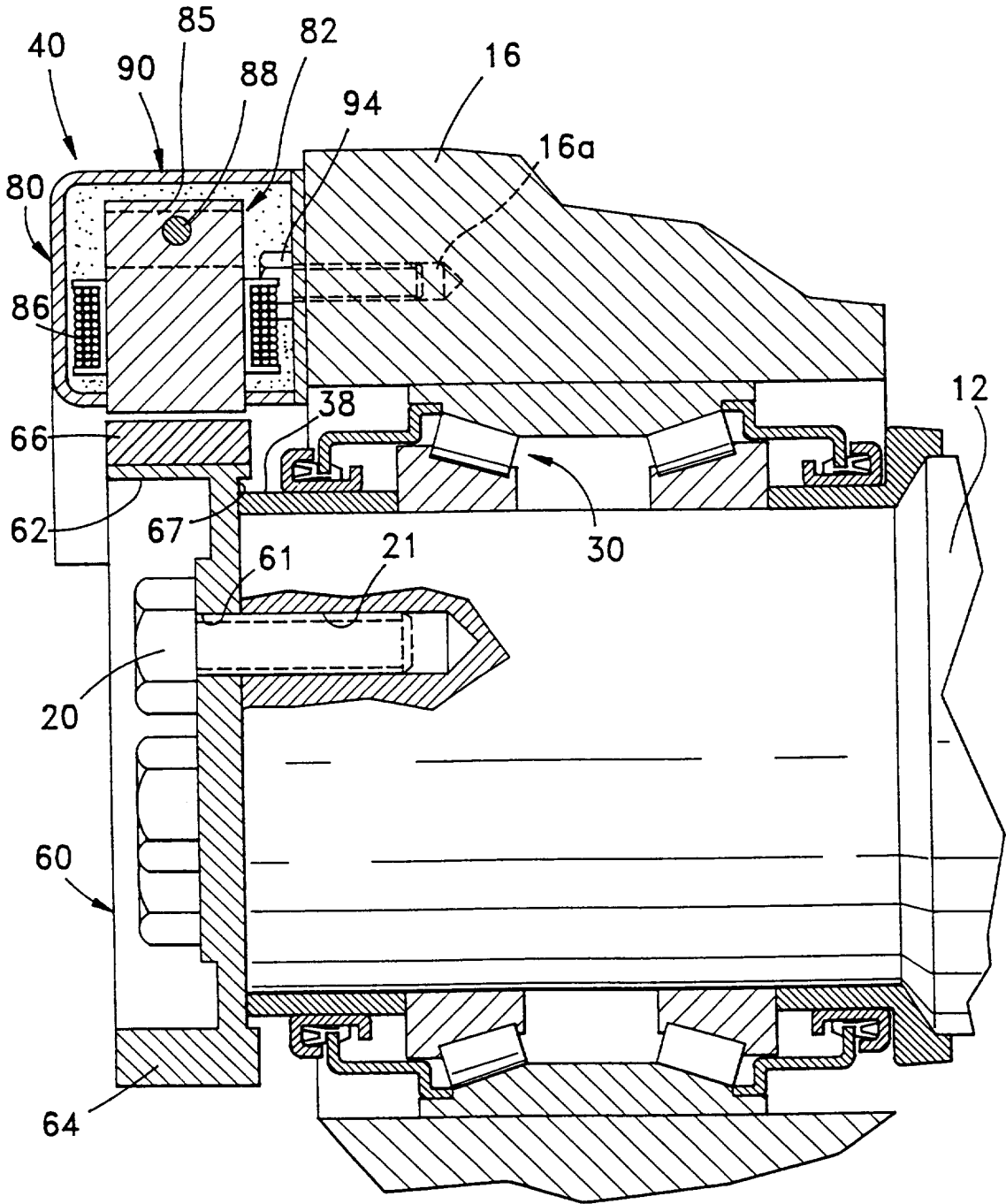


Fig. 5

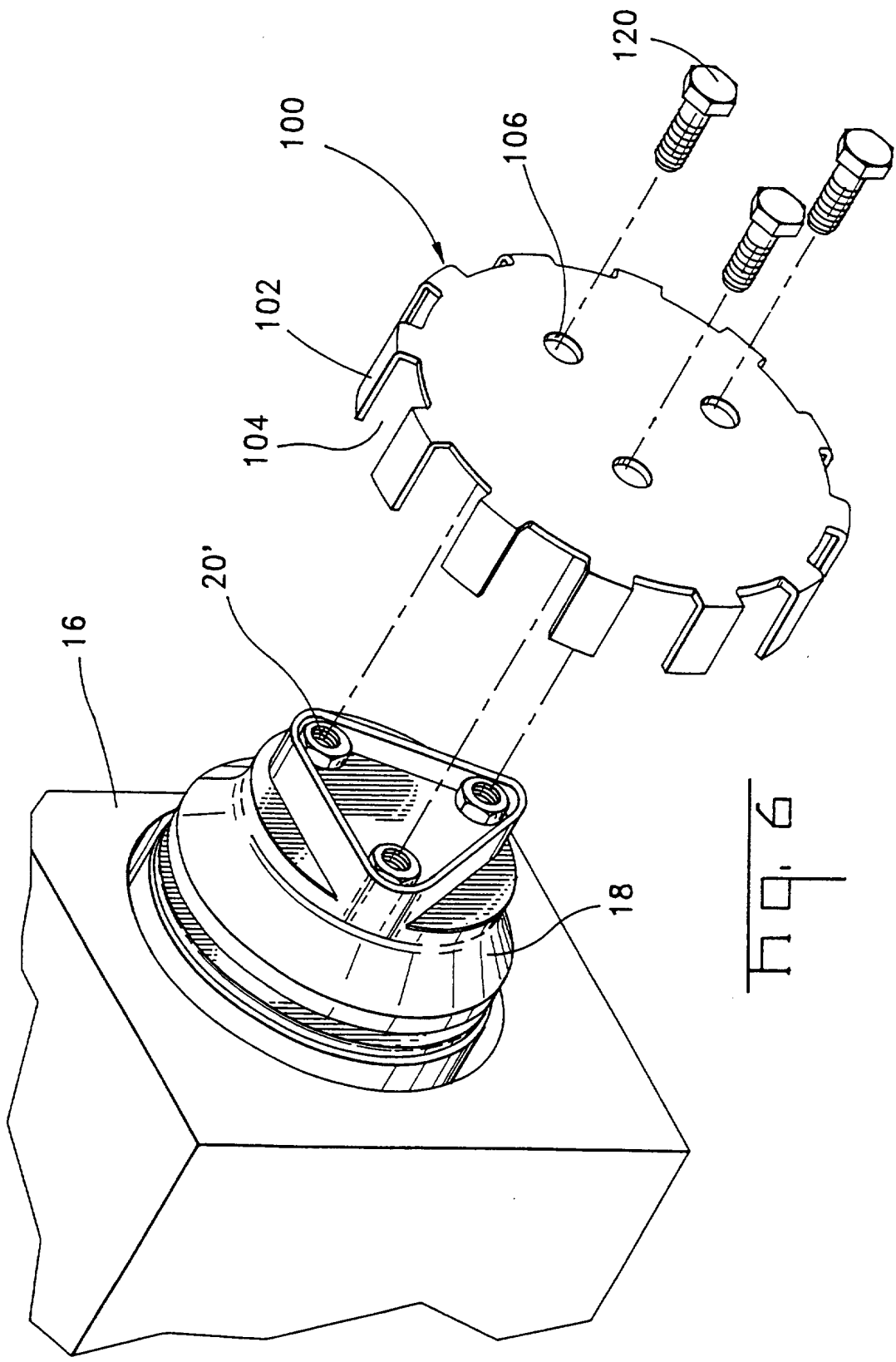


Fig. 6

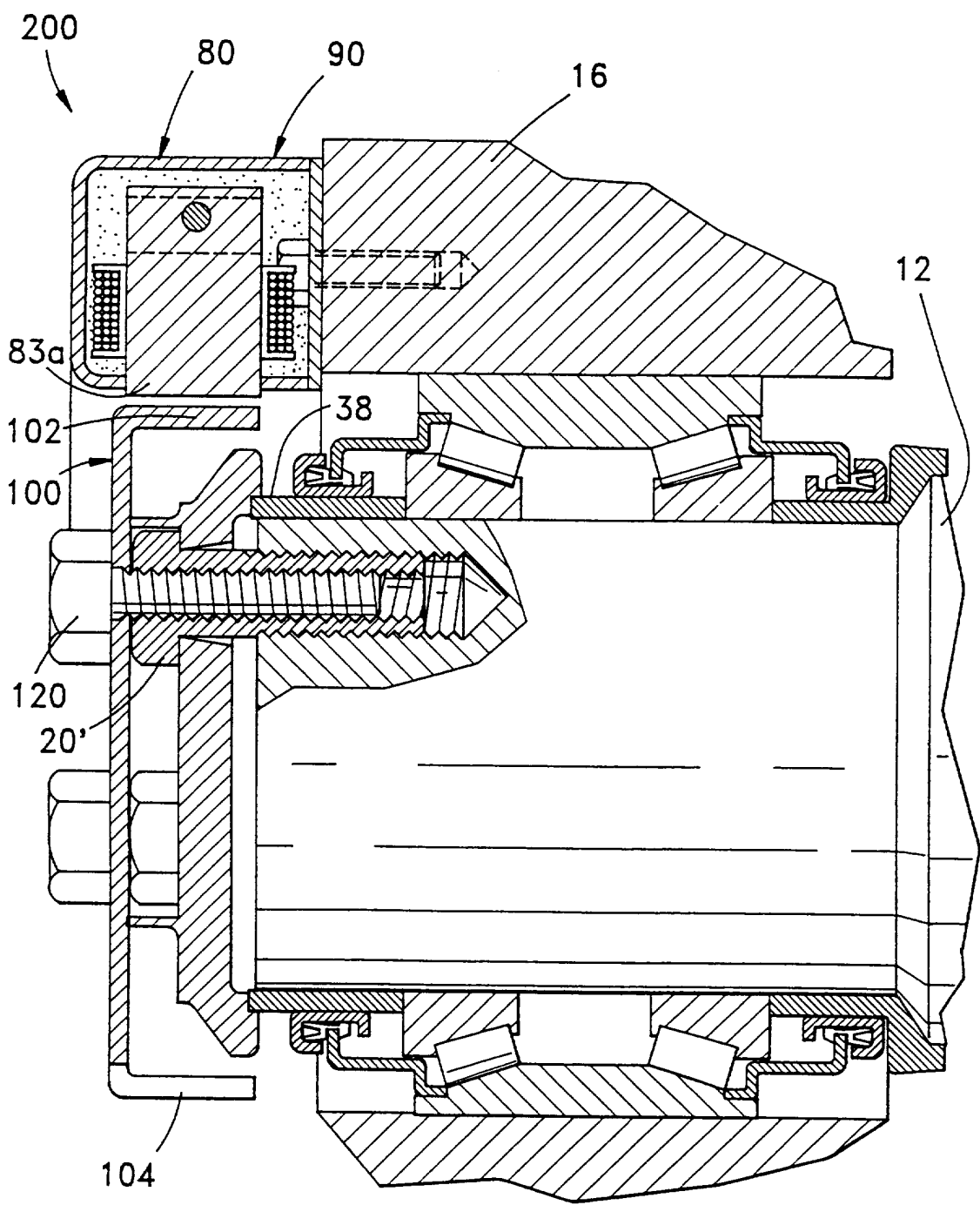


Fig. 7

AXLE-MOUNTED ELECTRICAL POWER DEVICE

The present invention relates to an electrical power device comprising an electrical inductance type generator for mounting to the end of an axle of a moving vehicle, such as a railroad car. The electrical generator includes a rotor attached to the end of the axle and arranged to rotate therewith. A stator is attached to the vehicle and includes first and second spaced apart magnetically permeable elements having first and second pole ends, respectively, closely adjacent the peripheral surface of the rotor. A first electrical stator winding is associated with one of the first and second magnetically permeable elements so that when the rotor is rotated by the axle, an electric current flows through the stator winding.

Figure 1^{of the accompanying drawings} shows a railroad car undercarriage assembly 10 which includes a rotatable axle 12. A railway wheel 14 is rigidly connected to axle 12, and axle 12 is rotatably received in a bearing adapter block 16. Bearing adapter block 16 includes a handling hook 17 which is used in assembly of bearing adapter block to axle 12, and adapter block includes a standard bearing end cap 18 for retaining bearing assembly 30 in place on axle 12. End cap 18 includes an outer peripheral section 18a, and a bolting face 19 which receives bolts 20 therethrough. Bearing end cap 18 is a standard end cap in the sense that bolt holes are provided therein only for the purpose of attaching the end cap 18 to the axle 12. Axle 12 receives bolts 20 therein for rigidly mounting end cap 18 to axle 12. Bearing adapter block supports a yoke 22 so that axle 12 rotates freely relative to yoke 22. Yoke 22 supports suspension springs 24 which, in turn, support a frame 26. Frame 26 comprises an integral part of a rail car, for example, a box car or flat car (not shown).

As is best shown in Figure 2, axle 12 includes a reduced diameter end section 13 to which a bearing assembly 30 is fixed. Bearing assembly 30 includes a set of rollers 34 which are arranged for rolling

movement between axle collars 36 and a bearing box collar 37. Bearing assembly 30 also includes a bearing casing 32 and a seal casing 33 rigidly connected to axle end section 13 for preventing the influx of foreign matter into bearing assembly 30. Axle collars 36 are rigidly connected to axle end section 13 for rotation therewith, and collars 36 are axially fixed between outboard and inboard axial locking members comprising rings 38,39, respectively. An interstice 38a exists between outer peripheral section 18a of end cap 18, axial locking ring 38, and seal casing 33.

The foregoing bearing assembly, however, is selected for illustrative purposes, and is not representative of all possible bearing assembly designs. For example, the axial locking ring may be formed integrally with the bearing end cap, as is disclosed in EP-A-449538, which document is discussed more fully hereinbelow. In any event, the integrity of the bearing assembly must be preserved to prevent failure thereof and thereby avoid derailment of the rail car due to bearing failure. An electrical power device used in combination with a rotating axle, such as axle 12, can be of several types. For example, electrical power devices of the inductance or reluctance motor types convert electrical energy to mechanical energy in the form of torque applied to rotate the axle. Conversely, electrical inductance or reluctance type generators use a rotating axle to generate electrical energy in the form of electrical current. In the railroad car context, electrical generators are used to provide power for anti-lock braking systems, anti-wheel slide control devices, for monitoring wheel speed, or to send data signals to "black box" recorders. Typically, such a generator is mounted to the end of an axle of the rail car, such as axle 12, in the vicinity of the bearing adapter block. Such a generator is disclosed in EP-A-449538, wherein a rotor is rigidly connected to a bearing end cap by bolts which are threaded into threaded holes in the axle. The bearing end cap is

specialized in the sense that an additional set of bolts pass therethrough, which set is for a purpose other than merely attaching the end cap to the axle, namely, they are a set of generator attaching bolts.

5 Several disadvantages exist in the use of such an inductance-type generator. For example, the generator attaching bolts and mounting holes require a specialized bearing end cap part which is expensive to manufacture. In addition, the rotor requires permanent magnets which
10 increase the generator's weight and cost of production. Furthermore, the rotor presents a substantial extension of the end cap, outboard of the rail car, which increases the likelihood of a collision thereof with objects adjacent the rail car. The present invention,
15 on the other hand overcomes these disadvantages by providing an electrical generator mounted to the end of an axle of a vehicle including a rotor attached to the end of the axle and arranged to rotate therewith. A stator is attached to the vehicle and includes first and
20 second spaced apart magnetically permeable elements having first and second pole ends, respectively, closely adjacent the peripheral surface of the rotor. The stator includes a first electrical stator winding associated with one of the first and second magnetically
25 permeable elements so that when the rotor is rotated by the axle, an electric current flows through the first stator winding. A permanent magnet interconnects the first and second magnetically permeable elements. The rotor has an outer peripheral surface of non-permanent
30 magnet material.

The invention will now be described by way of example with reference to the accompanying drawings in which:

35 Figure 1 shows an isometric view of a railroad car undercarriage assembly having an electrical power device according to the present invention mounted on an axle thereof.

Figure 2 shows a cross sectional view of a portion of a conventional axle and bearing box as shown in Figure 1.

5 Figure 3 shows an isometric view of a bearing end cap assembly for use with an electrical power device according to the present invention.

10 Figure 4 shows an elevational view of an electrical power device assembly comprising an electrical power take-off assembly mounted adjacent the end cap of Figure 3, according to the present invention.

Figure 5 shows a cross sectional view of the electrical power device assembly of Figure 4 taken along line 5-5.

15 Figure 6 shows an exploded isometric view a second embodiment of the present invention comprising a retrofitable reluctance plate.

20 Figure 7 shows a cross sectional view of the reluctance plate of Figure 6 used in conjunction with the power take-off assembly of Figures 4-5, according to the present invention.

25 Relevant reference numbers used in Figures 1 and 2 have been used again in Figures 3-7 to illustrate how an electrical power device according to the present invention is used in the context of a railroad car. Such reference numbers refer to the same features in Figures 3-7 as they did in Figures 1 and 2 and therefore further description thereof is not necessary.

30 Referring to Figure 1, electrical power device assembly 40 according to the present invention is connected to an axle 12 and comprises an end cap 60 and a power take-off assembly 80. As axle 12 rotates, electrical power device 40 is operative to generate electrical current for use by electrical systems of a rail car.

35 As shown in Figure 3, end cap 60 comprises a robust cast or machined part and includes mounting structure comprising bolt holes 61 for receiving mounting bolts 20 therethrough. A stub end of axle 12 projects from bearing adapter block 16 and includes threaded holes 21.

Additionally, end cap 60 includes a cylindrical section comprising a ring 62. The radially outer portion of ring 62 includes outwardly extending reluctance poles 64 between which are formed individual interstices 66.

5 Preferably, interstices 66 are filled with a dielectric material, e.g. plastic, which is bonded to the end cap 60 by an adhesive or other conventional bonding technique. No permanent magnets need be mounted to end cap 60. An axle face 67 of end cap 60 (Figure 5) is
10 arranged to abut axle 12 and bearing assembly 30. End cap 60 advantageously requires only bolt holes 61 therefore obviating the need for rotor bolt attaching holes as of prior end caps.

As best shown in Figure 4, power take-off assembly
15 80 includes stator assemblies 82 and a casing 90. Each stator assembly 82 includes magnetically permeable elements 83,85 preferably comprising conventional laminated ferrous plates. Each permeable element includes a respective terminal end 83a,85a. Permeable
20 elements 83,85 have respective stator windings 86,87 wrapped therearound in the conventional fashion. A conventional permanent magnet 84 is mounted between permeable elements 83 and 85 by a fastener 88. Casing 90 houses both stator assemblies and is preferably
25 formed of a non-ferrous material, e.g. an aluminum or a rigid plastic material. Through holes are provided for receiving respective mounting bolts 94 therethrough, e.g. as shown in Figure 5. A power cable is attached to the top surface of casing 90 by a mounting bolt 93, as
30 shown in Figure 4, which is threaded into a hole in a midsection of casing 90. Electrical terminals connect windings 86,87 to a power cable 92. Preferably, a non-conductive potting compound 96 fills casing 90 and encapsulates stator assemblies 82.

35 Referring to the foregoing, the mounting of electrical power device 40 to the axle of a vehicle will now be described. First, a standard bearing end cap 18 is removed from axle 12. Then, end cap 60 is mounted to the axle by bolts 20 which are threaded into respective

holes 21. Bolts 20 are torqued until axle face 67 of
end cap 60 abuts the stub end of axle 12 ring 38 of
bearing assembly 30, thereby advantageously holding
bearing assembly 30 in place on axle 12. Next, threaded
5 holes 16a (Figure 5) are made in bearing adapter block
16. Then, power take off assembly 80 is mounted to
bearing adapter block by inserting respective mounting
bolts 94 through respective mounting holes 91 and
screwing the same into threaded holes 16a. In selecting
10 the location of threaded holes 16a care must be taken to
provide for a proper air gap distance between terminal
ends 83a,85a of permeable elements 83,85 and poles 64 of
end cap 60. The air gap distance is kept to a minimum
so that a maximum amount of magnetic flux will flow
15 between permeable elements 83,85 and poles 64, as shown
by the North (N) to South (S) magnetic flux flow
depicted in Figure 4. Finally, cable 92 is mounted to
casing 90 by mounting bolt 93.

Referring to the foregoing, operation of electrical
20 power device 40 will be described. Permanent magnet 84
induces magnetic flux into permeable element 83, then it
flows out of terminal end 83a thereof and into a given
pole 64. The magnetic flux path continues out of the
next nearest pole 64, as measured counterclockwise from
25 the first pole 64 as viewed in Figure 4. The magnetic
flux also permeates stator windings 86,87. As axle 12
rotates, causing end cap 60 to rotate, dielectric
material sections 66 become aligned with ends 83a,85a,
and thus the magnetic flux field is broken. When this
30 happens, the electrical energy induced in stator
windings 86,87 flows in the windings and generates an
electrical current pulse. As axle 12 continually
rotates a continuous alternating power current flows in
the windings. This current is conveyed via cable 92 to
35 electrical systems on the rail car. Moreover, as the
wheel and axle 12 rotate and the rail car moves, end cap
60 presents a compact design which avoids collisions
with objects adjacent to the rail car.

Where it is not desirable to remove an existing bearing end cap 18, an electrical power device assembly 200 comprising reluctance plate 100 can be retrofitably installed on axle 12 without disturbing the existing bearing end cap. Referring to Figures 6-7, reluctance plate 100 comprises a stamped metal plate having reluctance poles 102 extending therefrom with interstices 104 therebetween. No dielectric material other than air is required in the interstices 104. Mounting holes 106 are sized to receive mounting bolts 120 therethrough. Assembly of reluctance plate 100 to bearing end cap 18 requires removal of bolts 20 one at a time and replacement thereof with bolts 20' which comprise threaded center holes, or drilling and threading the center holes in each bolt 20 *in situ* to form bolts 20'. Either way, there is no need to disturb bearing end cap 18. Bolts 120 are then inserted through holes 106 and are screwed into respective threaded holes in bolts 20'. Casing 90 is then mounted to bearing adapter block, as in the foregoing embodiment, with attention given to a proper air gap distance between the terminal ends 83a,85a and reluctance poles 102. Operation of electrical power device 200 is substantially the same as in the foregoing embodiment, i.e. an alternating current will be produced as axle 12 rotates.

Importantly the electrical power device of the present invention is easily mountable to the axle of a vehicle. The device is compact to minimize potential collisions with objects adjacent the axle and its mounting structure is robust enough for use with a rail car vehicle. The rotor does not require the use of permanent magnets thereby rendering a simpler and less expensive unit. The electrical power device is also operative to hold a portion of a bearing seal in place on an axle.

CLAIMS

1. The combination of an electrical generator and a vehicle axle, comprising a rotor attached to an end of the axle and arranged to rotate therewith, a stator attached to the vehicle and including first and second spaced apart magnetically permeable elements having pole ends closely adjacent the peripheral surface of the rotor, an electrical stator winding associated with one of said magnetically permeable elements so that, when the rotor is rotated by the axle, an electrical current flows through the stator winding, and a permanent magnet interconnecting the first and second magnetically permeable elements, said rotor having an outer peripheral surface of non-permanent magnet material.

2. The combination according to claim 1 wherein the outer peripheral surface of the rotor includes a series of equally spaced apart reluctance poles separated by a dielectric material and arranged so that, as said rotor rotates, pairs of adjacent reluctance poles are alternately moved into close proximity with the pole ends of the stator and out of said close proximity.

3. The combination according to claim 2 wherein the dielectric material is air.

4. The combination according to claim 2 wherein the dielectric material is a plastic bonded to the rotor.

5. The combination according to claim 4 wherein the stator includes a second electrical stator winding associated with the other of the first and second magnetically permeable elements so that, when the rotor is rotated by the axle, an electrical current flows through the second stator winding.

6. The combination according to any preceding claim wherein the stator includes

third and fourth spaced apart magnetically permeable elements having pole ends closely adjacent the peripheral surface of the rotor and spaced from the first and second pole ends,

a permanent magnet interconnecting the third and fourth magnetically permeable elements, and

electrical stator windings associated with the third and fourth magnetically permeable elements so that when the rotor is rotated by the axle, an electrical current flows through the stator windings.

7. The combination according to any preceding claim including an electrical cable attached to the stator and electrically interconnected to one or more of the stator windings.

8. The combination according to any preceding claim wherein the vehicle is a railroad car and the stator is attached to a bearing block adjacent an end of an axle of the railroad car.

9. The combination according to claim 8 wherein the rotor is a bearing end cap bolted to the end of the axle and arranged to hold in place a bearing between the axle and the bearing block.

10. The combination according to claim 8 wherein the rotor is attached to bolts securing a bearing end cap to the end of the axle by means of screws in threaded engagement with threaded holes in the bolts.

11. The combination of an electrical generator and a vehicle axle, constructed, arranged and adapted to operate substantially as hereinbefore described with reference to Figures 1 to 5 or 6 and 7 of the accompanying drawings.



Application No: GB 9726798.3
Claims searched: 1-11

Examiner: John Cockitt
Date of search: 22 May 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK CI (Ed.P): H2A [AKR5, AKX1, AKX2A, AKX2B, AKX2]; B7L [LUW]
Int CI (Ed.6): H02K [21/38, 07/18]; B61D [43/00]
Other: ONLINE: WPI, CLAIMS, JAPIO; OPTICS: H2A (AK115+AK804)

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	US4639626A MAGNETICS - see fig 2a	1 at least
Y	GB1267672A TOKAI - see rotor	2,3
Y,P	WO97/33358A WHITAKER - see rotor mounted to axle end	1-3 at least
Y	US5585711A KEMNER - see rotor mounted to axle end	1-3 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.