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PLANETARY GEARING ASSEMBLY

DESCRIPTION

5 This invention relates to a planetary gearing assembly having wide applications for decelerator or accelerator, especially to an asymmetric planetary gear assembly with unified asymmetric planetary gears and an asymmetric internal gear.

10 A planetary gearing assembly may consist of a sun gear, three or four planetary gears, an internal gear and a carrier.

At six or eight points planetary gears mesh with a sun gear or an internal gear.

15 The number of engagement points exceeds the number of parts. Therefore it is difficult to equalize all the transmitting forces acting upon the engagement points. Owing to very small size errors the transmitting forces are likely to be uneven.

20 Uneven engagement means too deep engagement on the one hand and too shallow engagement on the other hand.

Deep engagement between planetary gears and a sun gear or an internal gear causes great vibration, loud noise and big energy loss.

To solve the problem of uneven engagement, improved planetary gear assemblies having planetary gears with discs and an internal gear with rings on both sides or on one side thereof have been proposed.

5 The diameters of the planetary discs or the internal rings are equal to the diameters of pitch circles of the planetary gear or the internal gear respectively.

FIG.8 shows a planetary gear using this improvement.

10 The planetary discs contact with and roll on the internal rings. These pitch discs and pitch rings effectively forbid an excess engagement between planetary gears and an internal gear. Now this type of improvement is referred to as a pitch circle type for convenience.

15 Many variations of this type have been proposed so far. This is because the pitch circle is a unique circle for a gear.

20 When pitch discs and pitch rings are rotated at the same speeds with their gears, the line velocities of the pitch discs and pitch rings are equal at the contact points. No slipping occurs between the pitch discs and pitch rings.

Therefore transmitting efficiency is not reduced. The defacements of pitch discs and rings are insignificant.

25 However the pitch circle type of planetary gear assembly has a drawback that a great number of parts are

required to construct an assembly. The pitch circle has an intermediate size between a tooth-edge circle and a tooth-root circle. Thus two pitch discs and a planetary gear cannot be made in one piece. Similarly
5 pitch rings and an internal gear cannot be made in one piece. In the case of the pitch circle type, a planetary gear consists of three parts and an internal gear consists of three parts. Because the number of parts is large, the cost for manufacturing parts is increased.
10 Furthermore because an internal gear consists of three parts ——— a gear in the middle and two pitch rings on the sides, a problem of misalignment occurs among the three parts in radial directions.

This applicant then invented a novel
15 planetary gear assembly, which is now referred to as a tooth-edge circle type (Japanese Patent Application No.56-193113, Laying Open No.58-94656, Laying Open Date 4, June, 1983).

In this type, a planetary gear has two discs
20 larger than the tooth-edge circle on both sides. An internal gear has two ring portions larger than the tooth edge circle on both sides. Because the side ring portions are larger than the tooth-edge circle, two side ring portions can be made in one piece with a central
25 gear portion.

Therefore an internal gear can be made as a single part. In practice such an internal gear is made by injection molding of polyacetal.

5 The number of parts is reduced by two, because an internal gear consists of one part instead of three.

This fact reduces is only the cost for manufacturing individual parts but also the cost for constructing an assembly.

10 At first there was a theoretical question whether all the gears of the planetary gear assembly could smoothly rotate, because the contacting and rolling circles deviated from the pitch circles. However when the applicant had constructed such a planetary gear assembly and had examined the rotational property of the
15 gear assembly, all the gear rotated as smoothly as an assembly of the pitch circle type.

This tooth-edge type is symmetrical with regard to the axial direction.

20 The applicant has also invented a novel planetary gear assembly which is asymmetrical with regard to the axial direction.

(a) Patent Laying Open No.60-34553

Laying Open Date ; 22, February, 1985

(b) Patent Laying Open No.60-252845

25 Laying Open Date ; 13, December, 1985

(c) Patent Laying Open No.61-27337

Laying Open Date ; 6, February, 1986

(a) is an asymmetric planetary gearing assembly in which every gear has a disc or a ring on one side.

5 (b) and (c) are asymmetric planetary gearing assemblies in which every planetary gear and an internal gear have two discs or two rings on both sides. However the discs and the rings are asymmetrical with regard to the axial direction. A disc mounted on one side of the planetary gear is larger than the tooth-edge circle of
10 the planetary gear, and another disc mounted on the other side is smaller than the tooth-root circle. Following from this, a ring formed on one side of the internal gear is larger than the tooth-edge circle of the internal gear, and another ring formed on the other side is smaller than
15 the tooth-root circle of internal gear. At first in the same way as in the former invention of the tooth-edge type, there was a theoretical question whether such an asymmetric planetary gear assembly could smoothly rotate, because the line velocities of side discs and side rings
20 appeared to be different at the contacting and rolling points on both sides.

Then the applicant had constructed such an asymmetric assembly, had examined its rotational property, and had confirmed that there was smooth rotations of all gears.

25 The asymmetric type of planetary gearing assembly has an advantage that a sun gear or a sun gear shaft can

be inserted from the side after construction.

So far the applicant has been inventing various kinds of anomalous planetary gear assembly in seeking an ideal planetary gear assembly with low vibration, high transmission efficiency and low cost for construction.

Both in the cases of the tooth-edge circle type or the asymmetric type, a planetary gear consists of three parts. They are a gear in the middle and two side discs which hold the gear therebetween.

A planetary gear assembly has three or four planetary gears and each planetary gear consists of three parts. Then a great number of parts have been required to construct an assembly. This fact has heightened the cost for manufacturing parts and the cost for assembling them.

If a planetary gear could be formed integrally as a single body, the costs for manufacturing and for assembling would be significantly reduced.

In the pitch circle type a planetary gear consists of three parts. It might be possible to make a planetary gear in two parts, but such an asymmetric structure would cause an undesirable unbalance in the planetary gear.

In the tooth-edge circle type, it is unavoidable to constitute a planetary gear with three parts, because

it is equipped with two discs larger than the gear part on both sides of the gear part.

5 A purpose of this invention is to provide a planetary gear assembly having planetary gears unified in a single part.

Another purpose of the invention is to provide a planetary gear assembly with low noise and low vibration by improving the material of the internal gears.

10 The planetary gearing assembly of this invention provides a planetary gearing assembly comprising:

a sun gear,

a plurality of planetary gears meshing with the sun gear,

15 a internal gear meshing with the planetary gears,

a carrier rotatably supporting the planetary gears with planetary shafts; characterised in that the planetary gear consists of a planetary gear part in
20 the middle, a planetary smaller disc part smaller than the tooth-root circle of the planetary gear part on a side thereof, a planetary bigger disc part bigger than the tooth-edge circle of the planetary gear part on another side thereof and a planetary boss axially

perforated with a shaft hole, the planetary gear part,
the planetary smaller disc part, the planetary bigger
disc part and the planetary boss are integrally formed
as a single body; the internal gear includes an
5 internal gear part meshing with planetary gear part, a
smaller inner cylindrical part smaller than the
tooth-edge circle of the internal gear part on a side
thereof and a bigger inner cylindrical part bigger
than the tooth-root circle of the internal gear part
10 on another side thereof;
the internal gear part, the smaller inner cylindrical
part and the bigger inner cylindrical part are made of
nylon or polypropylene; the planetary smaller disc
parts roll on smaller inner cylindrical part and the
15 planetary bigger disc parts roll on the bigger inner
cylindrical part.

Namely in this invention a gear part and two
side discs are integrally unified in a single body.

Furthermore the internal gear of this invention
20 is made from elastic material with low rigidity e.g.
nylon 66, nylon 6 or polypropylene instead of
polyacetal.

The invention will be more fully understood from
the following description given by way of example only

with reference to the several figures of the accompanying drawings in which:

FIG. 1 is a partially sectioned front view of a unified asymmetric planetary gear assembly as an
5 embodiment of the invention.

FIG. 2 is a partially sectioned rear view.

FIG. 3 is a sectional view taken along a line III - III in FIG. 1 .

FIG.4 is an enlarged sectional view only of a planetary gear shown in FIG.3.

5 FIG.5 is a front view of a planetary gear.

FIG.6 is a sectional view near a planetary gear of another embodiment of this invention.

FIG.7 is a sectional view of a planetary gear of the tooth-edge type.

10 FIG.8 is a sectional view of a planetary gear of the pitch circle type.

Referring now to the drawings a unified asymmetric planetary gear assembly consists of a sun gear (1), planetary gear (2), an internal gear (3) and a carrier (4).
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There is a sun gear (1) in the center. In this example four planetary gears (2) enclose and mesh with the sun gear (1). Three planetary gears (2) are also available instead of four.

20 An internal gear (3) encloses and meshes with all the planetary gears (2).

A carrier (4) is built with a main carrier disc (4a) and a sub-carrier disc (4b). The carrier (4) rotatably supports the planetary gears (2) by planetary shafts (5).
25

The main carrier disc (4a) has four (or three) projecting parts (10) on the inner surface.

Correspondingly the sub-carrier disc (4b) has four (or three) second projecting parts (11) on the inner surface.

A plug part (12) is formed on a second projecting part (11) of the sub-carrier disc (4b). A socket (13) is
5 perforated in the axial direction in the first projecting part (10) of the main carrier disc (4a).

To connect two carrier discs, an operator inserts the plug parts (12) of the sub-carrier disc (4b) into the sockets (13) of the main carrier disc (4a)
10 till the ends of the plug parts (12) project out of cavities (29). And the projecting ends are crushed round. The crushed ends (28) firmly couple the main carrier disc (4a) with the sub-carrier disc (4b).

This method of connection is available if the
15 main carrier disc (4a) and the sub-carrier disc (4b) are made from sintered alloy or aluminium die-casting. If the carrier discs (4a) and (4b) are made from plastics, the projecting ends (28) of the plug parts (12) are bonded to the sockets (13) by ultra sonic bonding.

20 Four (or three) inwardly projecting parts (18) perforated with shaft-supporting holes (16) are formed on the inner surface of the main carrier disc (4a). The inwardly projecting parts (18) are positioned at the middle of two neighbouring projecting parts (10).

25 Similarly four (or three) further projecting parts (19) perforated with shaft-supporting holes (16) are formed on the inner surface of the sub-carrier disc (4b).

Boths ends of the planetary shafts (5) are fixed in the shaft-supporting holes (16) of the main carrier disc (4a) and the sub-carrier disc (4b).

5 The shape of the planetary gear is a novel feature of this embodiment of the invention. Therefore it will be explained in detail referring to FIG. 4 and FIG. 5.

The planetary gear (2) has a planetary gear part (8) in the middle, a planetary smaller disc part (6) and a planetary bigger disc part (7) on both sides. Thus the
10 planetary gear (2) is asymmetric regarding its axial direction.

An inner portion of the planetary gear part (8) connects with a planetary boss (9) through which a shaft hole (21) is perforated. A planetary shaft (5) pierces the shaft hole (21).

15 The planetary smaller disc part (6) is smaller than the tooth-root circle of planetary gear. On the other hand the planetary bigger disc parts (7) is bigger than the tooth-edge circle of the planetary gear.

The important matter is that the planetary gear part (8),
20 planetary smaller disc part (6), planetary bigger disc part (7) and planetary boss (9) are made in a body. The planetary gear (2) is not divided in three parts but is integrally unified in a single part. This is one of the characteristics of the invention. Such an asymmetric planetary gear is
25 able to be made by plastic injection molding or sintering

of powder metal.

To correspond with the planetary gear (2), the internal gear (3) consists of three parts.

5 Namely the internal gear (3) has an internal gear part (23) in the middle, an smaller inner cylindrical part (26) and a bigger inner cylindrical part (27) on both sides.

10 The internal gear part (25) meshes with the planetary gear part (8) to transmit rotation torque thereto. The planetary smaller disc part (6) contacts with and rolls on the smaller inner cylindrical part (26) of the internal gear (3). Of course there is some clearance between two rolling surfaces. Sometimes two parts (6) and (26) touch each other but other times they do not touch.

15 Similarly the planetary bigger disc part (7) contacts with and rolls on the bigger inner cylindrical part (27). There is also some clearances between two rolling surfaces. Two parts (7) and (27) sometimes touch but other times do not touch each other.

20 Owing to the contact between the planetary smaller disc part (6) and the smaller inner cylindrical part (26) and the contact between the planetary bigger disc part (7) and the bigger inner cylindrical part (27), radial forces are transmitted from the planetary gears (2)
25 to the internal gear (3).

A sun shaft hole (14) is axially perforated in the sun gear (1). A spline, serration or D-shape hole is formed on the inner surface of the sun shaft hole (14).

5 A boss part of the main carrier disc (4a) is thickened to reinforce it. A carrier shaft hole (15) is axially perforated in the thickened boss part. A spline, serration or other coupling device is formed also on the inner surface of the carrier shaft hole (15).

10 When the planetary gear assembly is used as a reduction gear, an input shaft (shall be) is inserted into the sun shaft hole (14) and an output shaft is inserted into the carrier shaft hole (15). On the contrary when it is used as a step up gear, an input shaft is inserted into the carrier shaft hole (15) and an output shaft
15 is inserted into the sun shaft hole (14).

The internal gear (3) is mounted in a casing. To prevent the internal gear (3) from rotating with regard to the casing, several radial projections (31) are formed on smooth cylindrical surface (32). The casing
20 is formed to have complementary projections on its inner surface. In this example the internal gear (3) is rather loosely mounted in the casing.

Of course other kinds of mounting are also possible. For instance by perforating axial holes on an
25 internal gear and the flange of a casing, one can fix the internal gear to the casing by screwing bolts in the holes.

In the embodiment shown in the figures, the radial projections (31) deviate from the middle plane.

The plane for receiving torque is axially spaced from the plane on which the radial projections (31) exist.

5 If a strong torque acts, the internal gear (3) can distort in a spiral manner between two planes.

Such spiral distortion is effective to absorb any abrupt, strong shock.

10 Furthermore the internal gear (3) of this invention is molded in a body from nylon 66, nylon 6 or polypropylene. These materials are more elastic than polyacetal which the applicant has been employing so far as the material of the internal gear. Because of their high elasticity nylon 66, nylon 6 or polypropylene is effective to alleviate vibration
15 or noise-generation.

In the example shown by FIG. 3 the inwardly projecting parts (18) and further projecting parts (19) are formed on the inner surface of carrier discs (4a) and (4b) to prevent the planetary gear (2) from displacing axially by
20 holding the planetary boss (9) therebetween.

The planetary bigger disc parts (7) prevent the sun gear (1) from coming out leftward in FIG.3. An inner boss (22) of the thickened main carrier disc (4a) prevents the sun gear (1) from coming out rightward.
25 Thus the sun gear (1) is kept at a correct axial position.

Furthermore in this example, the main disc (4a) is larger than the smaller inner cylindrical part (26) of the internal gear. This fact prevents the carrier (4) from coming out of the internal gear (3) leftward.

5 Another embodiment of this invention is shown in FIG.6. Its fundamental structure is the same as the former embodiment. In this embodiment circular protrusions (36) and (37) are shaped on the inner surfaces of the main carrier disc (4a) and sub-carrier disc (4b) to
10 prevent the planetary gears (2) from displacing in an axial direction. Because the sides of planetary smaller disc part (6) and bigger part (7) touch with the circular protrusions (36) and (37), the planetary gears (2) are kept at a correct axial position. Besides in this
15 embodiment bolt holes (38) are perforated in an axial direction. By inserting bolts in the bolt holes (38) and screwing them into screw holes of a casing, the internal gear (3) is safely fixed on the casing.

20 The sun gear (1) is made from plastics, sintered alloy, zinc or steel. The planetary gear (2) is made from plastics or sintered alloy. In spite of the anomalous shape, the planetary gear can be made in a body by molding. The carrier (4) is made from plastics, aluminium, aluminium alloy, sintered alloy, zinc or steel.
25 The internal gear (3) can be molded from nylon 66, nylon 6 or polypropylene.

In the embodiment shown in FIG.1 to FIG.6, the

planetary smaller disc part (6) neighbours to the main carrier disc (4a) and the planetary bigger disc part (7) neighbours to the sub-carrier disc (4b) to prevent the sun gear (1) from coming out.

- 5 This disposition can be safely reversed. If the disposition is reversed, the sun gear (1) can be freely inserted or drawn out after construction.

Desirable size relations of gears, disc and cylindrical parts will now be explained.

- 10 The planetary smaller disc part (6) of the planetary gear (2) is 0 to 2 modules smaller in radius than the tooth-root circle of the planetary gear. The planetary bigger disc part (7) is 0 to 2 modules bigger in radius than the tooth-edge circle of the planetary gear. The
15 smaller inner cylindrical part (26) of the internal gear (3) is 0 to 2 modules smaller in radius than the tooth-edge circle of the internal gear. The bigger inner cylindrical part (27) is 0 to 2 modules bigger in radius than the tooth-root circle of internal gear.

- 20 (By way of explanation, the module of a gear wheel is defined in Chambers Technical Dictionary as being the pitch diameter divided by the number of teeth).

The functions of the planetary gear assembly will now be explained.

- 25 The planetary gear parts (7) of the planetary gears (2) mesh with the internal gear part (25) to transmit rotation torque.

The planetary bigger disc parts (7) contact with

and roll on the bigger inner cylindrical parts (27) of the internal gear (3). The planetary smaller disc parts (6) contact with and roll on the smaller inner cylindrical parts (26).

5 Radial forces are transmitted from the side disc parts (6) and (7) to the side cylindrical parts (26) and (27). The contacts of the side disc parts and cylindrical parts forbid excess engagement between the planetary gears and the internal gear.

10 Although the line velocities of the disc parts and the inner cylindrical parts are different at the rolling points, the difference of line velocities does not hinder a smooth rotation of gears.

15 Some amounts of tolerances are usually allocated to the side disc parts (6) or (7) and the side inner cylindrical parts (26) or (27). The disc parts and the inner cylindrical parts are not always contacting each other. But they are separated nearly all time owing to tolerances.

For this reason the difference of line velocities does not hinder smooth rotation of gears.

20 The assembly of gears will now be explained.

(1) A sub-carrier disc (4b) is put on a table as the second projecting parts (11) face upward.

(2) Planetary shafts (5) are inserted into the shaft-supporting holes (16).

25 (3) Planetary gears (2) are inserted around the planetary shaft (5) as the planetary bigger disc parts (7) face downward.

- (4) An internal gear (3) is inserted around the planetary gears (2) as the bigger inner cylindrical part (27) face downward.
- (5) A sun gear (1) is slightly rotated and inserted into the center of planetary gears (2).
- (6) A main carrier disc (4a) is fitted onto the sub-carrier disc (4b).
- (7) Top ends of plug parts (12) projecting on the cavities (24) are pressed and flattened.

10 The advantages of this invention will now be explained.

First of all, a planetary gear is integrally unified. It consists of one part instead of three.

15 The reason why the planetary gear can be unified in one piece can be understood by referring FIG.3, FIG.5 or FIG.6. One side of the planetary gear part (8) is a planetary smaller disc part (6) smaller than the tooth-root circle. The other side of the planetary gear part (8) is a planetary bigger disc part (7) bigger than the tooth-edge circle. The peripheral diameter changes continuously in the axial direction.

20 Therefore such an anomalous planetary gear can be made by injection molding with a paired metallic mold. On the other hand the planetary gears shown in FIG.7 or FIG.8 cannot be molded in one operation, because
25 the peripheral diameter does not change continuously.

The unified planetary gear reduces the costs for manufacturing and assembling parts.

Because the internal gear is made from elastic material-nylon 66, nylon 6 or polypropylene, the internal gear distorts elastically and alleviates the abnormal torque when an excess torque acts on the gears. The elastic distortion of the internal gear reduces noise-generation and vibration.

To confirm this advantage of the invention, the Inventor has made the following examination.

Four kinds of planetary gear assemblies of the same size and using the same materials except in the matter of internal gears have been manufactured. The internal gears have been made from nylon 66, nylon 6, polypropylene or polyacetal.

The outer diameter of the internal gears is 75 mm. The module of the gears is 0.75. The tooth number of the internal gears is 75. The reduction ratio is 4.8. The tooth number of the sun gears is 20. The tooth number of the planetary gears is 28. The sun gears are made of sintered alloy. The planetary gears are made of polyacetal. These planetary gear assemblies have been mounted in electric washers for testing the noise-generation property. 4 kg of clothes have been thrown into each electric washer. Then the electric washers have been switched on. Then the Inventor has measured the

noise loudness at a point distanced 1 meter from the electric washer. The number of samples is ten for each kind. The results of the measurements are shown in Table 1.

Table 1 Measurement of noise-loudness of electric washers equipped with different kinds of planetary gear assemblies

Material of internal gear	Noise loudness
nylon 66	48 - 43 phon
nylon 6	49 - 43 phon
polypropylene	49 - 46 phon
polyacetal	54 - 47 phon

These results have proved that the planetary gear assemblies of this invention can reduce noise loudness about 4 to 6 phons in comparison with the case of polyacetal.

Radial forces are transmitted in two ways : one way is between the planetary bigger disc parts (7) and the bigger inner cylindrical part (27) and the other way is between the planetary smaller disc parts (6) and the smaller inner cylindrical part (26).

Radial forces are not transmitted from gears to gears. Because the radial forces are small, teeth of gears

do not deeply mesh each other.

Even if strong centrifugal forces, or other abnormal forces e.g. The forces induced by size errors are applied to the input or output shafts, the gears can smoothly rotate by the actions of the discs and the inner cylindrical surfaces.

CLAIMS:

1. A planetary gearing assembly comprising:
 - a sun gear,
 - 5 a plurality of planetary gears meshing with the sun gear,
 - a internal gear meshing with the planetary gears,
 - a carrier rotatably supporting the planetary
 - 10 gears with planetary shafts; characterised in that the planetary gear consists of a planetary gear part in the middle, a planetary smaller disc part smaller than the tooth-root circle of the planetary gear part on a side thereof, a planetary bigger disc part bigger than
 - 15 the tooth-edge circle of the planetary gear part on another side thereof and a planetary boss axially perforated with a shaft hole, the planetary gear part, the planetary smaller disc part, the planetary bigger disc part and the planetary boss are integrally formed
 - 20 as a single body; the internal gear includes an internal gear part meshing with planetary gear part, a smaller inner cylindrical part smaller than the tooth-edge circle of the internal gear part on a side



thereof and a bigger inner cylindrical part bigger than the tooth-root circle of the internal gear part on another side thereof;

5 the internal gear part, the smaller inner cylindrical part and the bigger inner cylindrical part are made of nylon or polypropylene; the planetary smaller disc parts roll on smaller inner cylindrical part and the planetary bigger disc parts roll on the bigger inner cylindrical part.

10

2. A planetary gearing assembly as claimed in claim 1, wherein the planetary smaller disc part is 0 to 2 modules smaller in radius than the tooth-root circle of the planetary gear part and the smaller inner
15 cylindrical part is 0 to 2 modules smaller in radius than the tooth-edge circle of the inner gear part.

3. A planetary gearing assembly as claimed in claim 2, wherein the planetary bigger disc part is 0 to 2
20 modules bigger in radius than the tooth-edge circle of the planetary gear part and the bigger inner cylindrical part is 0 to 2 modules bigger in radius than the tooth-root circle of the inner gear part.



4. A planetary gearing assembly as claimed in claim
3, wherein a carrier consists of a main carrier-disc
having a carrier shaft hole for fitting an output
shaft and a sub-carrier disc with a wide opening, and
5 the planetary bigger disc part and the bigger inner
cylindrical part are located on the side neighbouring
to the sub-carrier disc.

5. A planetary gearing assembly as claimed in claim
10 3, wherein a carrier consists of a main carrier disc
having a carrier shaft hole for fitting an output
shaft and a sub-carrier disc with a wide opening and
the planetary bigger disc part and the bigger inner
cylindrical part are located on the side neighbouring
15 to the main disc.

6. A planetary gearing assembly as claimed in claim 4
or 5, wherein the main carrier disc has an inner boss
inwardly projecting on the inner wall for forbidding
20 the sun gear from displacing in the axial direction.

7. A planetary gearing assembly as claimed in claim
3, wherein the internal gear has a flat smooth
cylinder surface, and a plurality of radial



projections for preventing the relative rotation of the internal gear in a casing and the radial projections lie in a plane axially distanced from a middle plane of the internal gear.

5

8. A planetary gearing assembly as claimed in claim 7, wherein the planetary gears are made of plastics or sintered alloy.

10

9. A planetary gearing assembly as claimed in claim 8, wherein the main carrier disc has a plurality of inwardly projecting parts defining axial shaft-supporting holes, the sub-carrier disc has a plurality of inwardly projecting parts defining with axial shaft-supporting holes and the shaft-supporting holes support both sides of the planetary shaft.

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10. A planetary gearing assembly as claimed in claim 9, wherein the sun gear is made of plastics, sintered alloy, zinc, or steel.

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11. A planetary gearing assembly as claimed in claim 9, wherein the carrier is made of plastics,



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fibre-reinforced plastic, aluminium, aluminium alloy, sintered alloy, zinc or steel.

- 5 12. A planetary gearing assembly substantially as hereinbefore described with reference to Figures 1 to 6 of the accompanying drawings.
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