(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 September 2005 (22.09.2005)

PCT

(10) International Publication Number
WO 2005/087358 A1

(51) International Patent Classification[7]: B01F 7/00, 9/00, B02C 4/08

(21) International Application Number: PCT/CA2005/000399

(22) International Filing Date: 16 March 2005 (16.03.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2,461,269 16 March 2004 (16.03.2004) CA

(71) Applicant *(for all designated States except US)*: **PLASTIQUES GYF LTÉE** [CA/CA]; 37, rue Tremblay, Saint-Jean-sur-Richelieu (secteur Saint-Athanase),, Québec J2X 2T5 (CA).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **VÉRONNEAU, Germain** [CA/CA]; 1245 du Sommet, Saint-Paul-d'Abbotsford, Québec J0E 1A0 (CA).

(74) Agent: **LÉGER ROBIC RICHARD**; Centre CDP Capital, 1001 Victoria Square-Bloc E -8th Floor, Montréal, Québec H2Z 2B7 (CA).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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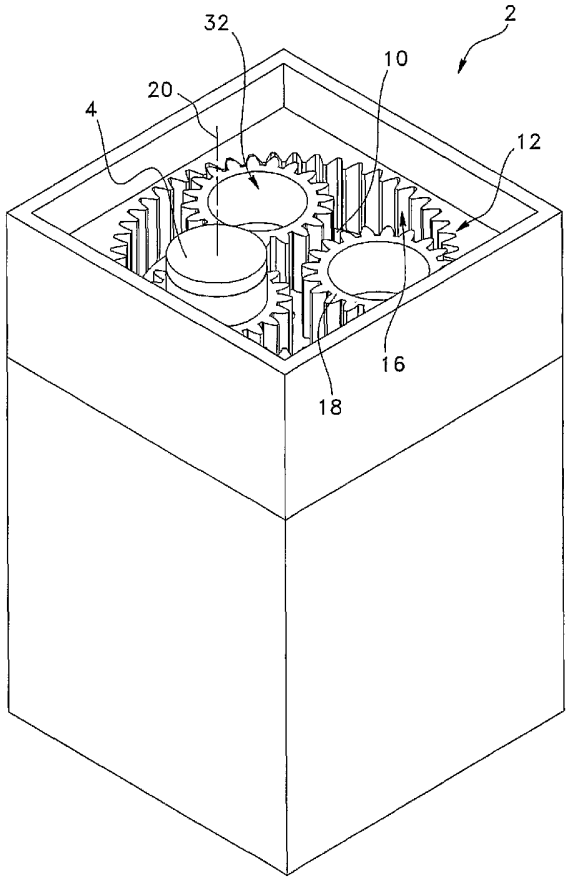
(54) Title: BLADELESS MIXER



(57) Abstract: A bladeless mixer/mill for agitating and mixing a compound/product. The mixer/mill comprises a driving shaft rotatable about a first vertical axis of rotation, and a motor unit operatively coupled to the driving shaft for rotating the same. A support plate is mounted onto the driving shaft and is rotatable about the first vertical axis. The mixer/mill also has a stationary ring gear coaxial to the support plate. The stationary ring gear has a portion with an inner surface extending above the support plate. At least one pinion gear is rotatably mounted onto the support plate about a second vertical axis of rotation parallel to the first vertical axis of rotation. The pinion gear has an outer surface complementary to the inner surface of the stationary ring gear. The outer surface of the pinion gear meshes with the inner surface of the stationary ring gear. The pinion gear has a cavity wherein the compound/product to be agitated and mixed/milled is inserted.

WO 2005/087358 A1

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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BLADELESS MIXER

FIELD OF THE INVENTION

The present invention relates to a mixer, and more particularly to a mixer which can fully and uniformly mix and agitate compounds using a planetary-like motion.

BACKGROUND

Agitating and mixing compounds in a container is generally done with mixers having impellers producing a flow pattern within the container to achieve the desired results. These impellers are usually of the type straight-blade turbine radial flow, pitched-blade turbine mixed flow or hydrofoil impeller axial flow, depending of the flow pattern required. Dirty accumulations surrounding the work area are usually produced during the mixing process. Therefore, cleaning these mixers often require large quantity of solvents.

Moreover, although these known mixers are appropriate for mixing a large range of compounds, they are not suitable for some others because the impellers may create a lot of friction on the compounds, which can result in substance damage and change.

In addition, good mixing often requires that the impellers mix the content of the entire container, which can be a difficult task to accomplish. Mixing of compounds with these mixers can thus result in poor or uneven mixing of the compounds, poorly dispersed solid particles or their agglomeration.

Known in the art are Japanese Patents Nos 2003/093862 (HIROSHIGE), 2001/276592 (HIROSHIGE) and 2000/271465 (HIROSHIGE), which disclose apparatuses that fully agitate and mix compounds to be kneaded. The apparatuses disclosed in these patents use rotation and revolution to agitate and mix the compounds. These apparatus, also referred to as bladeless mixers, mix the compounds by simultaneously rotating a batch container and revolving it in a

planetary motion, thus producing acceleration forces of 400 G and higher. The mixing principle underneath these apparatuses is generated by both centrifugal and centripetal forces. The advantage of such mixers is that they mixed liquids and powders evenly in seconds while imparting no heat. Since the containers are rotated at a predetermined angle, air may be entrapped within the containers. Therefore, once the mixing is complete, an additional step may be required to remove submicron bubbles present within the compounds. Another problem with these apparatuses is that they are very costly and complicated to build, due to their complex mechanical structure.

U.S. Patent No 6,334,583 (Li) discloses a planetary-like high-energy ball mill for milling powders. Two cup-like rollers are mounted onto a turntable that is driven in rotation by a vertical main shaft. A mill pot containing the powders to be mixed is fixed within each of the cup-like rollers. A stationary circular ring is mounted over the turntable and is disposed coaxially with the shaft. The cup-like rollers may rotate about their own pivotal shafts while rotating along with the turntable. Sides of the cup-like rollers are in contact with an inner surface of the stationary ring and are therefore rotating about their own pivotal axis due to friction counterforce with the stationary ring. A vertical movement may also be applied to the vertical shaft in order to further mill the powders. One potential problem with such a mill is that at a high velocity of rotation, control over the speed of rotation of the cup-like rollers may be lost if the cup-like rollers spin on themselves. As a result, the uniformity and quality of the milled powder may not be constant. Furthermore, in some cases, the frictional force required to drive into rotation the cup-like rollers upon beginning of rotation of the turntable may not be sufficient. Therefore, there may be a delay before the cup-like rollers may begin to rotate about their own pivotal axis.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a bladeless mixer capable of overcoming at least one of the above-mentioned drawbacks and problems.

More specifically, a first object of the present invention is to provide a bladeless mixer which design is simple and cheap to mass produce.

Another object of the invention is to provide a bladeless mixer which considerably reduces the use of solvent for cleaning purposes.

A further object of the invention is to provide a bladeless mixer which improves the mixing of compounds disperses solid particles and reduces agglomeration of solid particles.

Still another object of the invention is to provide a bladeless mixer which is easy to operate and wherein the mixing of the compound is done over a short period of time.

Still another object of the invention is to provide a bladeless mixer which does not damage and change the compound.

Another object of the invention is to provide a bladeless mixer which avoids air entrapment within the container wherein the compound is inserted.

A further object of the invention is to provide a bladeless mixer providing a uniform and constant quality of a resulted mixed compound.

Still another object of the invention is to provide a bladeless mixer which may also be used as a miller for crushing solid particles in a fine powder by using a planetary-like motion.

In accordance with the present invention, the above objects are achieved with a bladeless mixer for agitating and mixing a compound. The mixer comprises a driving shaft rotatable about a first vertical axis of rotation, and a motor unit

operatively coupled to the driving shaft for rotating the same. A support plate is mounted onto the driving shaft and is rotatable about the first vertical axis. The mixer also has a stationary ring gear coaxial to the support plate. The stationary ring gear has a portion with an inner surface extending above the support plate. At least one pinion gear is rotatably mounted onto the support plate about a second vertical axis of rotation parallel to the first vertical axis of rotation. The pinion gear has an outer surface complementary to the inner surface of the stationary ring gear. The outer surface of the pinion gear meshes with the inner surface of the stationary ring gear. The pinion gear has a cavity wherein the compound to be agitated and mixed is inserted.

In accordance with the present invention, the above objects are also achieved with a bladeless mill for producing a powder from a product. The mill comprises a driving shaft rotatable about a first vertical axis of rotation, and a motor unit operatively coupled to the driving shaft for rotating the same. A support plate is mounted onto the driving shaft and is rotatable about the first vertical axis. The mill also has a stationary ring gear coaxial to the support plate. The stationary ring gear has a portion with an inner surface extending above the support plate. At least one pinion gear is rotatably mounted onto the support plate about a second vertical axis of rotation parallel to the first vertical axis of rotation. The pinion gear has an outer surface complementary to the inner surface of the stationary ring gear. The outer surface of the pinion gear meshes with the inner surface of the stationary ring gear. The pinion gear has a cavity wherein the product to be milled is inserted.

Furthermore, there is also provided a method for agitating and mixing a compound using the bladeless mixer, comprising the steps of: a) inserting the compound into a container; b) securing the container into the cavity of one of said at least one pinion gear; c) agitating and mixing the compound in the container by actuating the motor unit for a predetermined time, thereby obtaining a mixed compound; and d) removing the mixed compound from the container.

The invention and its advantages will become more apparent upon reading of the following non-restrictive description of preferred embodiments thereof, given with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a bladeless mixer according to a first embodiment of the present invention.

Figure 2 is a top plan view of the bladeless mixer shown in Figure 1.

Figure 3 is a side elevational view of the bladeless mixer shown in Figure 1.

Figure 4 is a cross-sectional view taken along the line IV – IV of the bladeless mixer shown in Figure 3.

Figure 5 is a perspective view of a bladeless mixer according to a second embodiment of the present invention.

Figure 6 is a top plan view of the bladeless mixer shown in Figure 5.

Figure 7 is a side elevational view of the bladeless mixer shown in Figure 5.

Figure 8 is a cross-sectional view taken along the line VIII – VIII of the bladeless mixer shown in Figure 7.

Figure 9 is an enlarged view of a portion of the bladeless mixer shown in Figure 8, illustrating a crushing device inserted within one of the containers.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 1 to 4 illustrate a bladeless mixer 2 according to a first preferred embodiment of the invention, which is devised to agitate and mix a compound and/or mill a product for producing powders.

The mixer 2 has a support plate 10 rotatably mounted onto a driving shaft 6 about a first axis 8 of rotation. A stationary ring gear 12 is coaxially mounted around the support plate 10 and has a portion 16 extending over the support plate 10. Preferably, the ring gear 12 has teeth 13 located on its inner surface 24. The support plate 10 is driven into rotation by the driving shaft 6. A motor unit 14 is operatively coupled to the driving shaft 6 in a driving engagement therewith.

The mixer 2 also has at least one pinion gear 18 rotatably mounted onto the support plate 10 about a second axis 20 of rotation parallel to the first axis 8 of rotation. The pinion gear 18 has an outer surface 22 complementary with the inner surface 24 of the ring gear 12. The inner surface 24 and the outer surface 22 mesh together. Upon rotation of the driving shaft 6, the support plate 10 rotates in a direction depicted by arrow 26, and the pinion 18 rotates on itself about the second axis of rotation 20, but in a direction opposed to a rotation of the support plate 10, as depicted by arrow 28. The pinion gear 18 is preferably mounted onto the support plate 10 near the outer perimeter of the same to be submitted to a greater centrifugal force. Although the ring gear 12 and the pinion gear 18 illustrated have teeth 13, 30, it will be understood that other meshing surfaces may be used instead.

The pinion gear 18 has a cavity 32 wherein the compound to be mixed (or the product to be milled) is inserted. The pinion gear 18 may also have more than one cavity 32. Preferably, the cavity is an upwardly opening cavity formed within the pinion gear 18. A container 4 containing the compound to be agitated and mixed is inserted in the cavity 32 in a tight-fitting manner, thus preventing great vibrations within the mixer 2. Of course, other securing devices, such as bolts and

nuts (not shown), may be used for fixing the container 4 into the cavity 32 of the pinion gear 18. It is also possible to use an adaptor (not shown) to fit a smaller container 4 in a larger cavity 32. Instead of using the container 4, the cavity may be provided with a removable lid.

The container 4 may have a different shape than the one illustrated. For example, the container 4 may have a square shape, a circular shape, an oval shape or any other suitable shape. Of course, the cavity 32 may be designed to receive such containers 4 having different shapes.

At least one pinion 8 may be used for mixing compound(s) and/or milling product(s). However, in order to maximize the process, a plurality of pinions 8 with containers 4 is used to allow simultaneous agitation and mixing/milling of one or more compounds/products. According to the pinion gear configuration chosen, it may be necessary to add some weight, to balance the support plate 10.

As shown in Figure 4, the pinion gears 18 are rotatably mounted onto the support plate 10 through bearings 34 enabling the pinion gears 18 to rotate on themselves during rotation of the support plate 10.

The container 4 is preferably rotated in an upright position for avoiding air entrapment within the container 4. Therefore, there may be no need for an additional step to deaerate down submicron bubbles present within the compounds.

The rotation speed of the drive shaft 6 is controlled by the motor unit 14 to submit the containers 4 to predetermined G forces. In another preferred embodiment of the invention, the driving shaft 6 may be driven by a different motor arrangement for driving the support plate 10 in rotation at a desired speed.

There is no need to use a large quantity of solvents for cleaning the mixer 2 because there is no impeller in contact with the compound(s). Consequently, since there is no mechanical part directly in contact with the compounds, there is no undesired substance damage or change.

Figures 5 to 9 illustrate a second preferred embodiment of the bladeless mixer 2, wherein the cavity 32 is off-centered from the second axis of rotation 20. Therefore, the container 4 is also off-centred from the center of rotation of the cavity 32 and the container 4 is submitted to greater gravitational forces. This configuration generates a multi-planetary movement that may be referred as a molecular or electronic pattern.

As better illustrated in Figure 9 and as previously mentioned, the mixer 2 may also be used as a mill for producing a powder from a product. To that effect, the container 4 may incorporate crushing devices 36, such as balls or rolls, to better disperse solid particles into compounds and to provide increased deagglomeration of the solid particles. The crushing devices 36 also crush the solid particles into a fine powder.

In all possible embodiments of the present invention, the ring gear 12 and pinion gear 18 may be made of plastic, metal or any other material conventionally used for ring and pinion structures. Moreover, the speed at which the compound in the container 4 will be agitated and mixed may be modified by changing the ring-pinion gear ratio. Thus, a pinion gear 18 having a smaller diameter will rotate on itself at a higher speed of rotation than a pinion gear 18 having a greater diameter.

To agitate and mix a compound using the bladeless mixer 2, the following steps may be performed: inserting the compound into a container; securing the container into the cavity of one of the pinion gears; agitating and mixing the compound in the container by actuating the motor unit for a predetermined time,

thereby obtaining a mixed compound; and removing the mixed compound from the container.

Although the present invention has been explained hereinabove by way of preferred embodiments thereof, it should be pointed out that any modifications to these preferred embodiments within the scope of the appended claim are not deemed to alter or change the nature and scope of the present invention.

For example, various containers 4 may be used depending of the compound to mix or product to mill. Mixing a compound or milling a product often creates a considerable amount of energy, therefore resulting in a potential explosion. The containers may be design to prevent such explosion. Preferably, the containers are airtight.

CLAIMS

1. A bladeless mixer for agitating and mixing a compound, comprising:

a driving shaft rotatable about a first vertical axis of rotation;

a motor unit operatively coupled to the driving shaft for rotation of the same;

a support plate mounted onto the driving shaft and rotatable about the first vertical axis;

a stationary ring gear coaxial to the support plate, said stationary ring gear having a portion with an inner surface extending above said support plate; and

at least one pinion gear rotatably mounted onto the support plate about a second vertical axis of rotation parallel to the first vertical axis of rotation, said at least one pinion gear having an outer surface complementary to the inner surface of the stationary ring gear, the outer surface of the pinion gear meshing with the inner surface of the stationary ring gear, the pinion gear having a cavity wherein the compound to be agitated and mixed is inserted.

2. The bladeless mixer according to claim 1, wherein the cavity of each of said at least one pinion gear has a removable lid.

3. The bladeless mixer according to claim 1, wherein the cavity of each of said at least one pinion gear is located at a position off-centered from the second axis of rotation.

4. The bladeless mixer according to claim 1, wherein the cavity of each of said at least one pinion gear is an upwardly opening cavity wherein a container containing the compound to be agitated and mixed is inserted in a tight-fitting manner.

5. The bladeless mixer according to claim 4, wherein the upwardly opening cavity of each of said at least one pinion gear is located at a position off-centered from the second vertical axis of rotation.

6. The bladeless mixer according to claim 4, further comprising at least one airtight container shaped for tight-fitting into the upwardly opening cavity.

7. The bladeless mixer according to claim 5, further comprising at least one airtight container shaped for tight-fitting into the upwardly opening cavity.

8. The bladeless mixer according to claim 1, further comprising two additional pinion gears mounted onto the support plate at equidistant positions from each others and from the at least one pinion gear.

9. The bladeless mixer according to claim 8, wherein the cavity of each of said at least one pinion gear is an upwardly opening cavity wherein a container containing the compound to be agitated and mixed is inserted in a tight-fitting manner.

10. The bladeless mixer according to claim 9, wherein the upwardly opening cavity of each of said at least one pinion gear is located at a position off-centered from the second axis of rotation.

11. The bladeless mixer according to claim 9, further comprising at least one airtight container shaped for tight-fitting into the upwardly opening cavity.

12. The bladeless mixer according to claim 10, further comprising at least one airtight container shaped for tight-fitting into the upwardly opening cavity.

13. A method for agitating and mixing a compound using the bladeless mixer according to claim 1, comprising the steps of:

a) inserting the compound into a container;

b) securing the container into the cavity of one of said at least one pinion gear;

c) agitating and mixing the compound in the container by actuating the motor unit for a predetermined time, thereby obtaining a mixed compound; and

d) removing the mixed compound from the container.

14. A bladeless mill for producing a powder from a product, comprising:

a driving shaft rotatable about a first vertical axis of rotation;

a motor unit operatively coupled to the driving shaft for rotation of the same;

a support plate mounted onto the driving shaft and rotatable about the first vertical axis;

a stationary ring gear coaxial to the support plate, said stationary ring gear having a portion with an inner surface extending above said support plate; and

at least one pinion gear rotatably mounted onto the support plate about a second vertical axis of rotation parallel to the first vertical axis of rotation, said at least one pinion gear having an outer surface complementary to the inner surface of the stationary ring gear, the outer surface of the pinion gear meshing with the inner surface of the stationary ring gear, the pinion gear having a cavity wherein the product to be milled is inserted.

15. The bladeless mill according to claim 14, wherein said at least one pinion gear comprises a crushing device inserted within its cavity.

16. The bladeless mill according to claim 14, wherein the cavity of each of said at least one pinion gear has a removable lid.

17. The bladeless mill according to claim 14, wherein the cavity of each of said at least one pinion gear is located at a position off-centered from the second vertical axis of rotation.

18. The bladeless mill according to claim 14, wherein the cavity of each of said at least one pinion gear is an upwardly opening cavity wherein a container containing the compound to be agitated and mixed is inserted in a tight-fitting manner.

19. The bladeless mill according to claim 18, wherein the upwardly opening cavity of each of said at least one pinion gear is located at a position off-centered from the second axis of rotation.

20. The bladeless mill according to claim 18, further comprising at least one airtight container shaped for tight-fitting into the upwardly opening cavity.

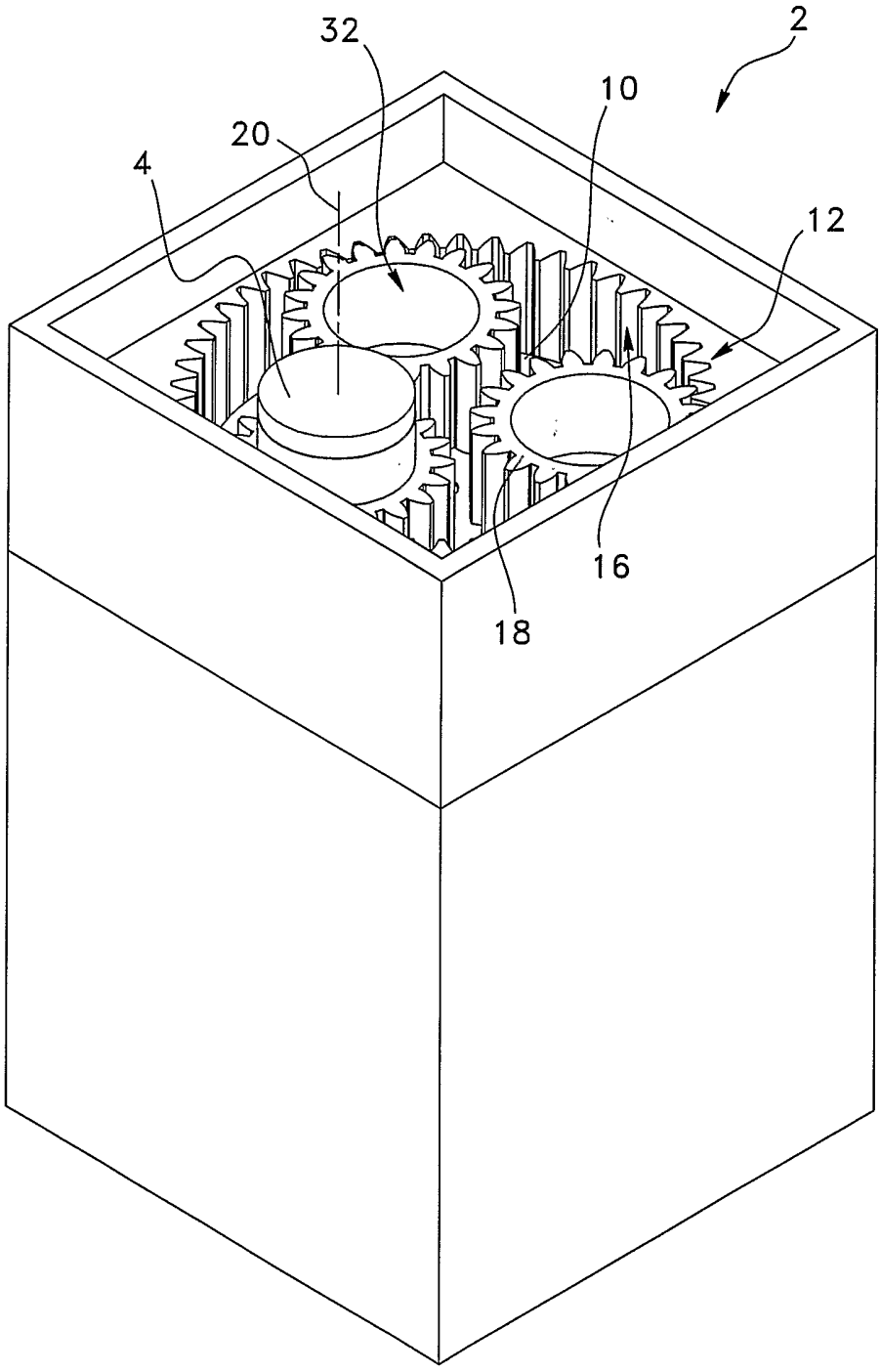

FIG. 1

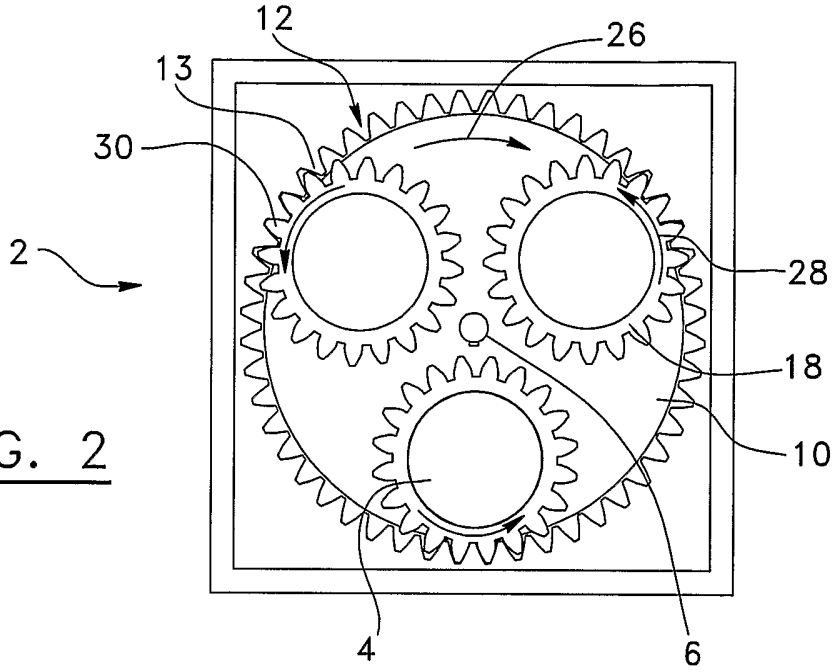

FIG. 2

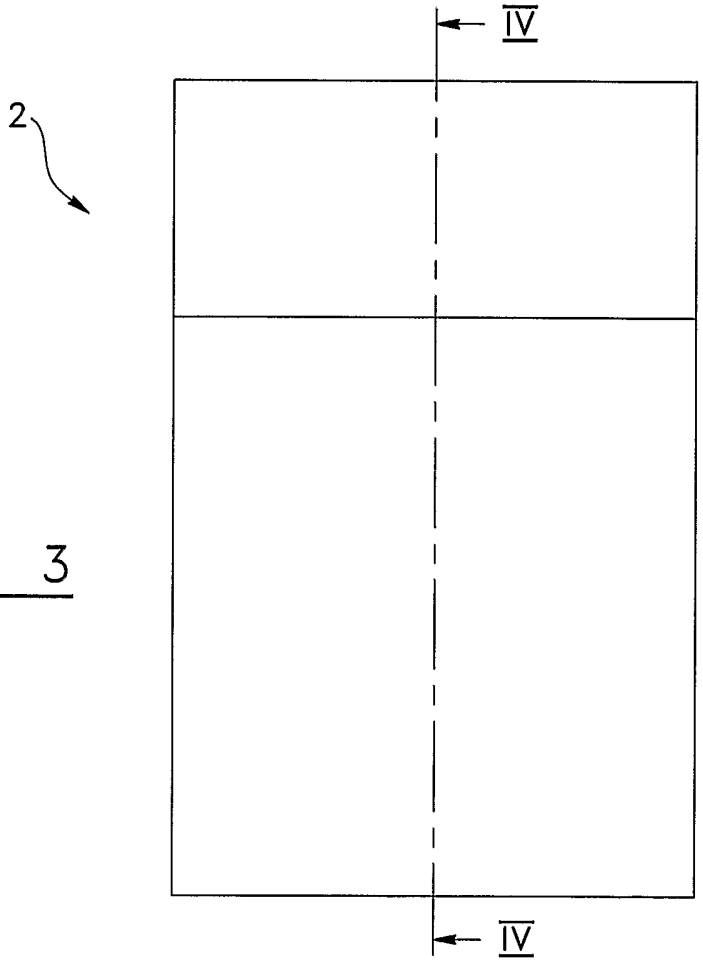

FIG. 3

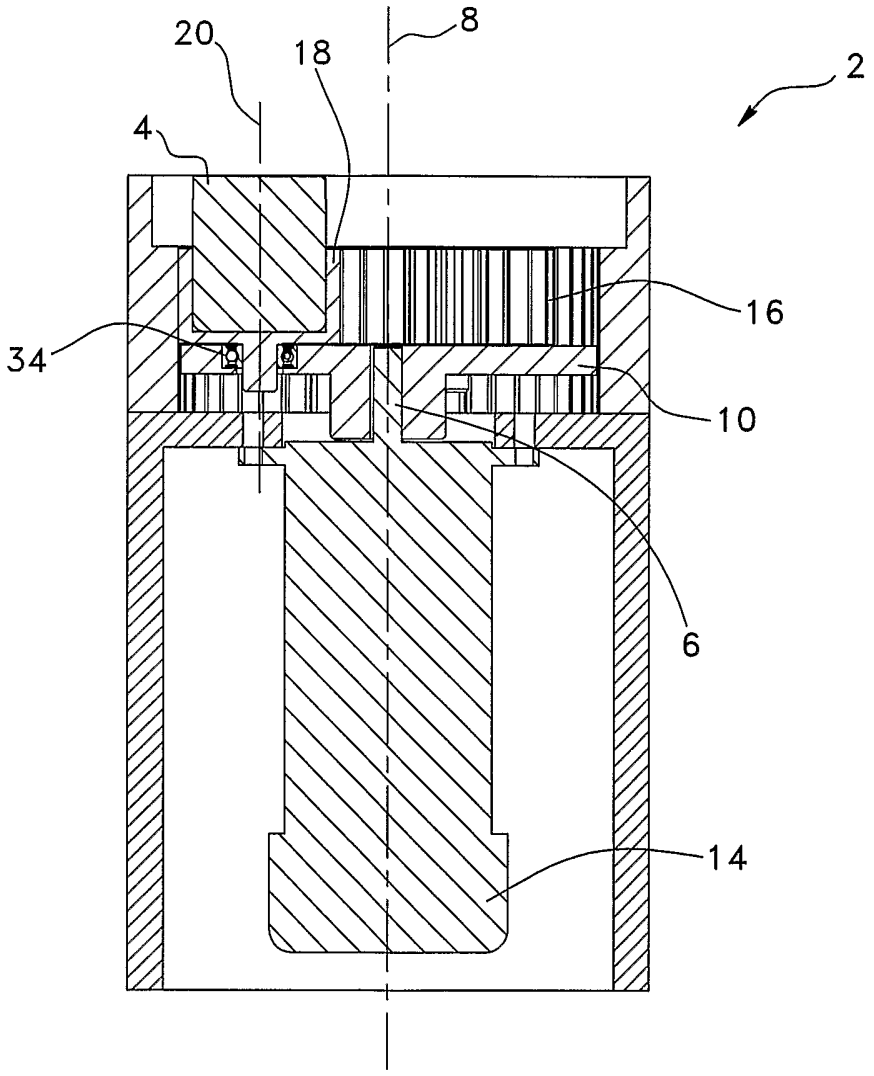

FIG. 4

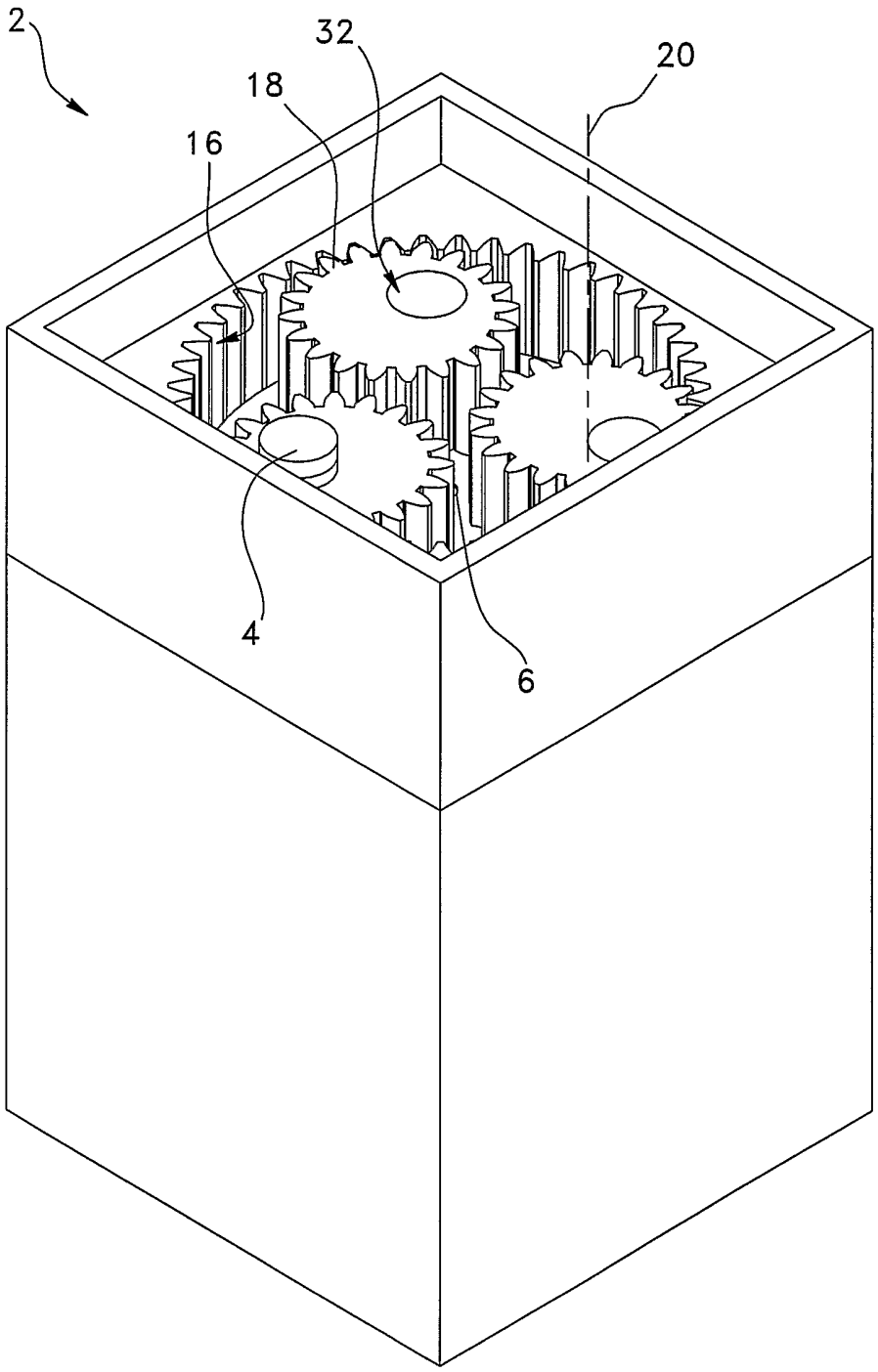

FIG. 5

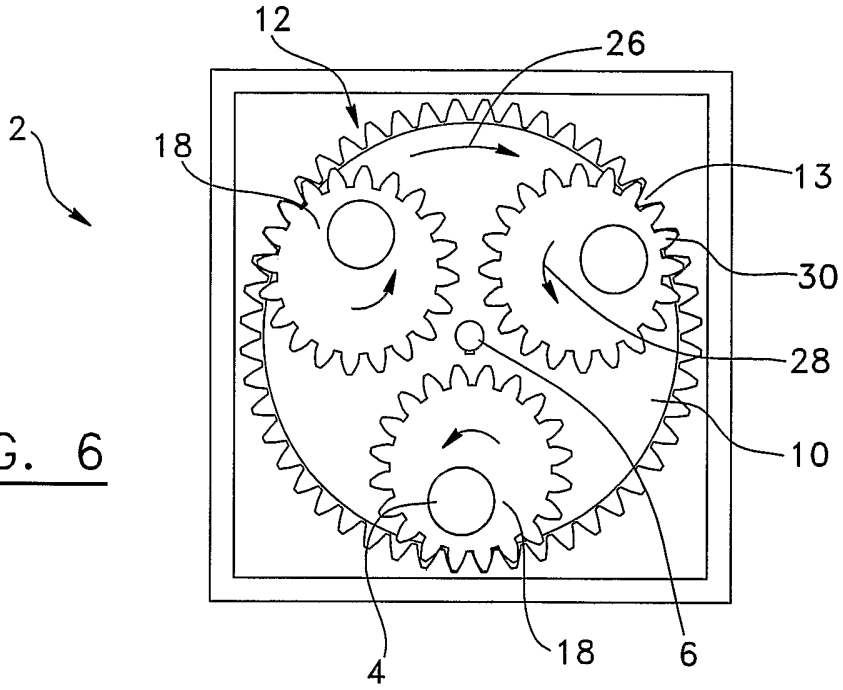

FIG. 6

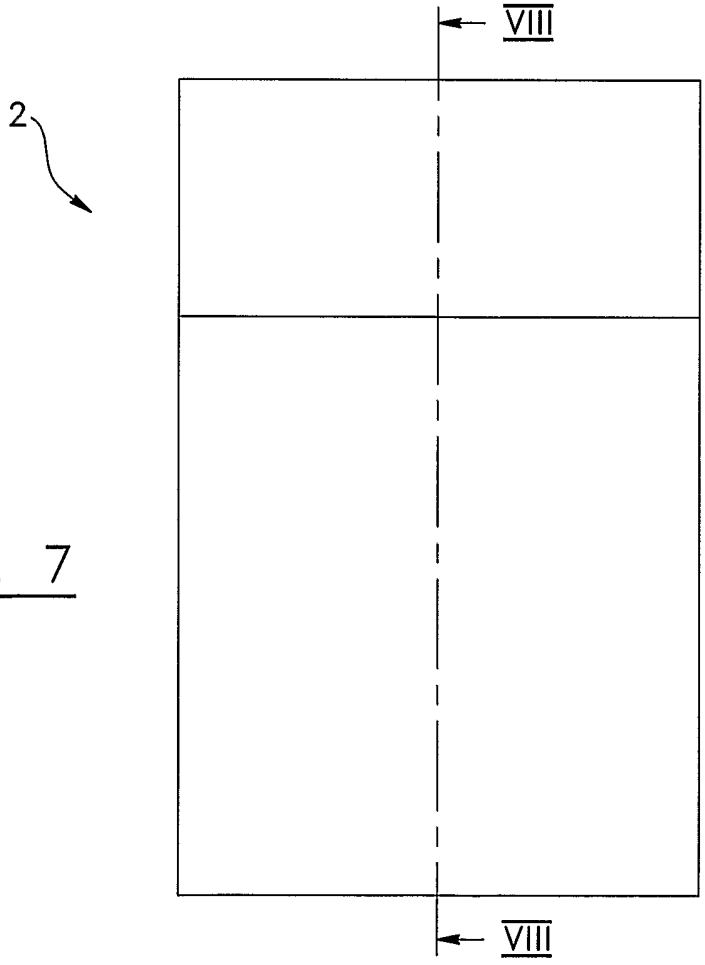

FIG. 7

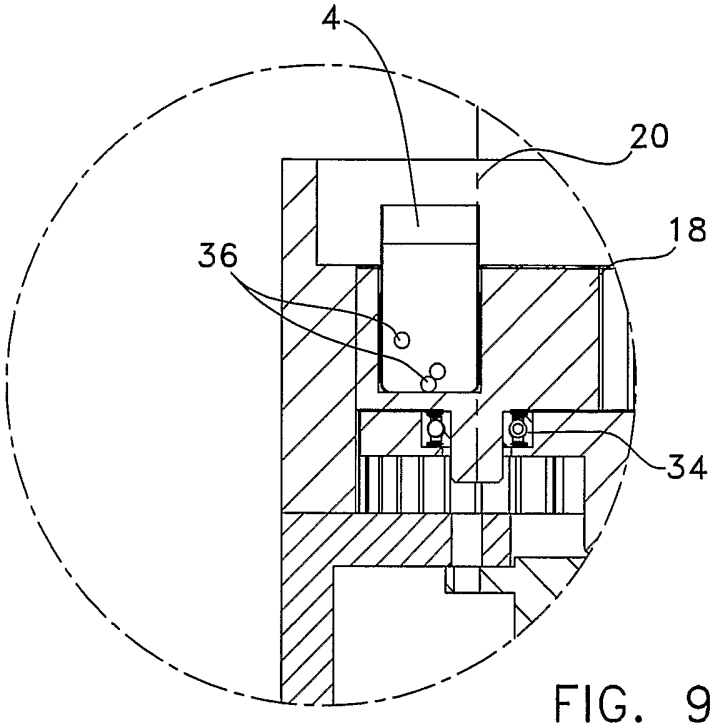

FIG. 9

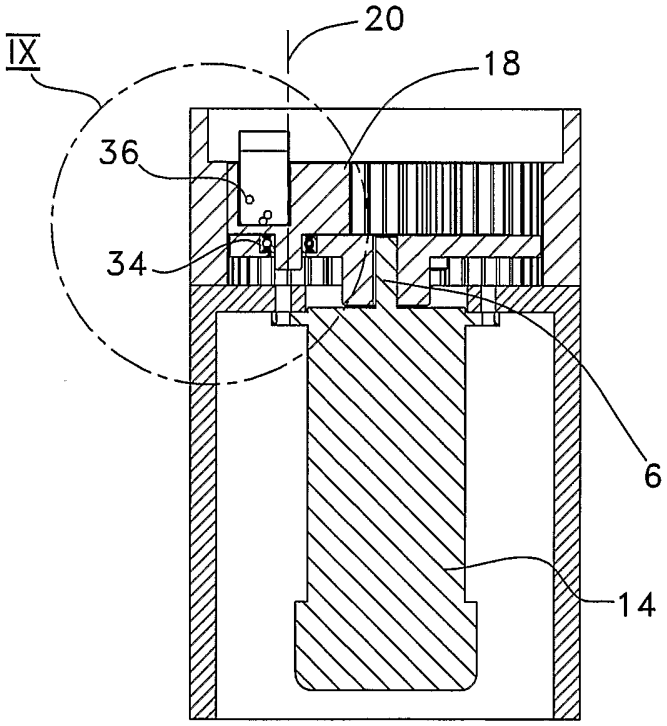

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000399

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7): B01F 7/00, B01F 9/00, B02C 4/08

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)
IPC(7): B01F 7/00, B01F 9/00, B02C 4/08

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
TECHSOURCE, DELPHION, ESP@CENET, USPTO, INTERNET (kneader, gear, mixer, stationary gear, not blade, bladeless mixer, shaft, pinion gear, stationary, ring gear)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages		Relevant to claim No.
Y	US 3, 559, 956 (DUPONT) (whole doc.)	Feb. 02, 1971	1, 2, 3, 8, 14, 16, and 17
A			4 to 7, 9 to 13, 15, and 18 to 20
Y	US 5, 487, 606 (KELLER) (whole doc.)	Jan. 30, 1996	1, 2, 3, 8, 14, 16 and 17
A			4 to 7, 9 to 13, 15, and 18 to 20
A	EP 1, 218, 094 B1 (WAGNER ET AL.) (whole doc.)	April 12, 2001	1 to 20
A	US 6, 334, 583 B1 (LI) (whole doc.)	Jan. 01, 2002	1 to 20
A	JP 2003/093862 (THINKY CORP) (abstract & drawing)	April 02, 2003	1 to 20

[ ] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 May 2005 (19-05-2005)	11 July 2005 (11-07-2005)

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(819) 956-0759

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000399

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
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