US 20090060770A1

(19) United States

(12) Patent Application Publication

Okada

(10) Pub. No.: US 2009/0060770 A1

(43) Pub. Date: Mar. 5, 2009

(54) GEAR PUMP

(75) Inventor: Motohiro Okada, Shiga-Ken (JP)

Correspondence Address:
J C PATENTS, INC.
4 VENTURE, SUITE 250
IRVINE, CA 92618 (US)

(73) Assignee: SHIMADZU MECTEM, INC., Otsu-shi (JP)

(21) Appl. No.: 11/816,954

(22) PCT Filed: Feb. 17, 2006

(86) PCT No.: PCT/JP2006/302890

§ 371 (c)(1),
(2), (4) Date: Aug. 23, 2007

(30) Foreign Application Priority Data

Feb. 24, 2005 (JP) 2005-048965

Aug. 29, 2005 (JP) PCT/JP2005/015675

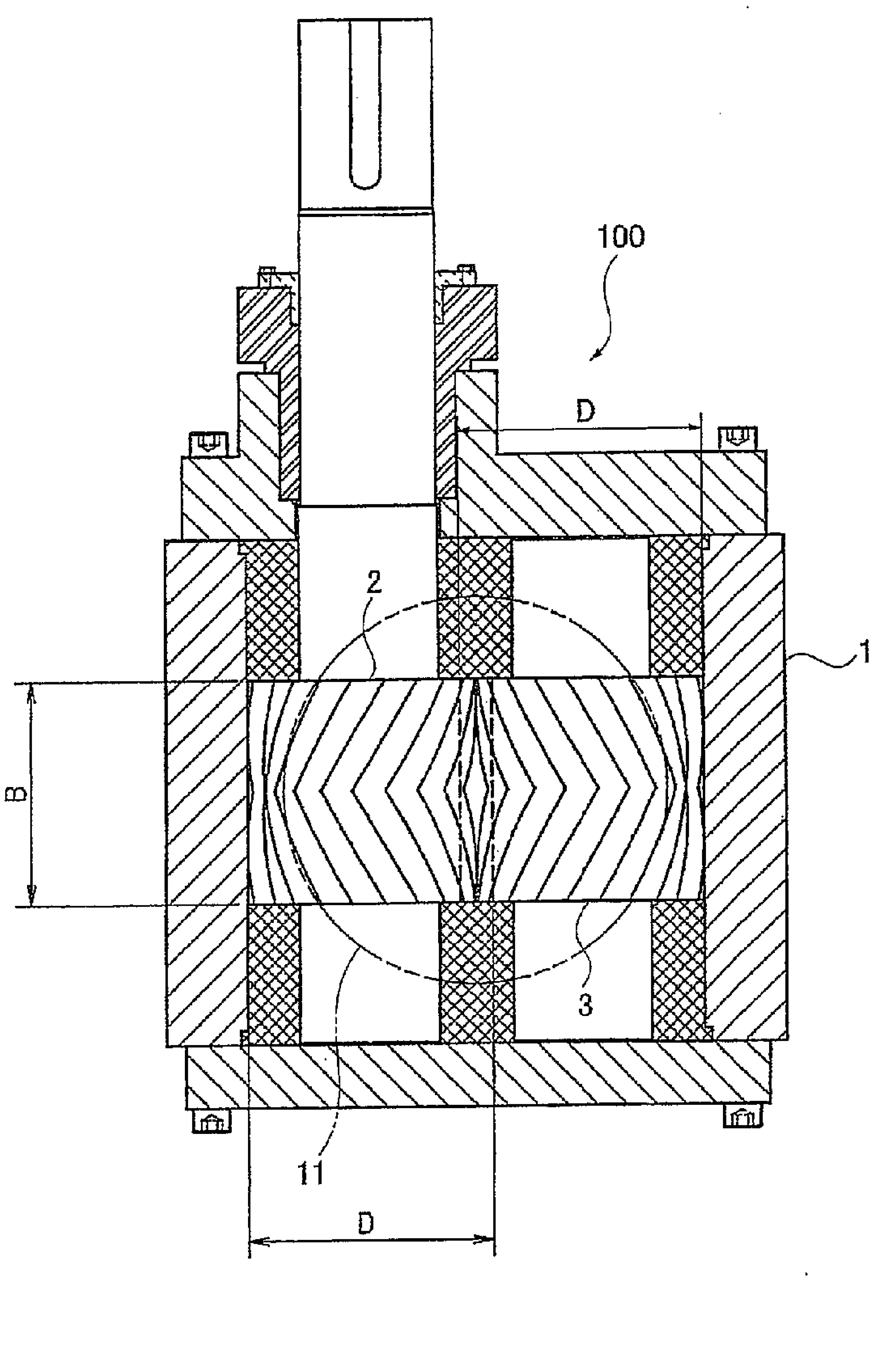
Publication Classification

(51) Int. Cl.
F04C 2/18 (2006.01)

(52) U.S. Cl. 418/206.5; 418/201.3

(57) ABSTRACT

A gear pump applicable for feeding a high-pressure and high-viscosity fluid, such as a molten resin is provided. In the gear pump **100**, the fluid is fed from a suction port side to a discharge port side by the rotation of gears. The gears are formed in a pair and meshing with each other. The gears are double-helical gears having a one-point continuous contact tooth profile. For the gears, the ratio D/B of the outer diameter D and the tooth width B are set to 1.1 to 1.15. When the ratio D/B is equal to or smaller than 1.1, a bearing may be damaged due to an excessively increased bearing load. On the other hand, when the ratio D/B is larger than 1.15, in accordance with an increase in the overall size of the pump external dimension, the mechanical efficiency is lowered, and the overall efficiency is also lowered.



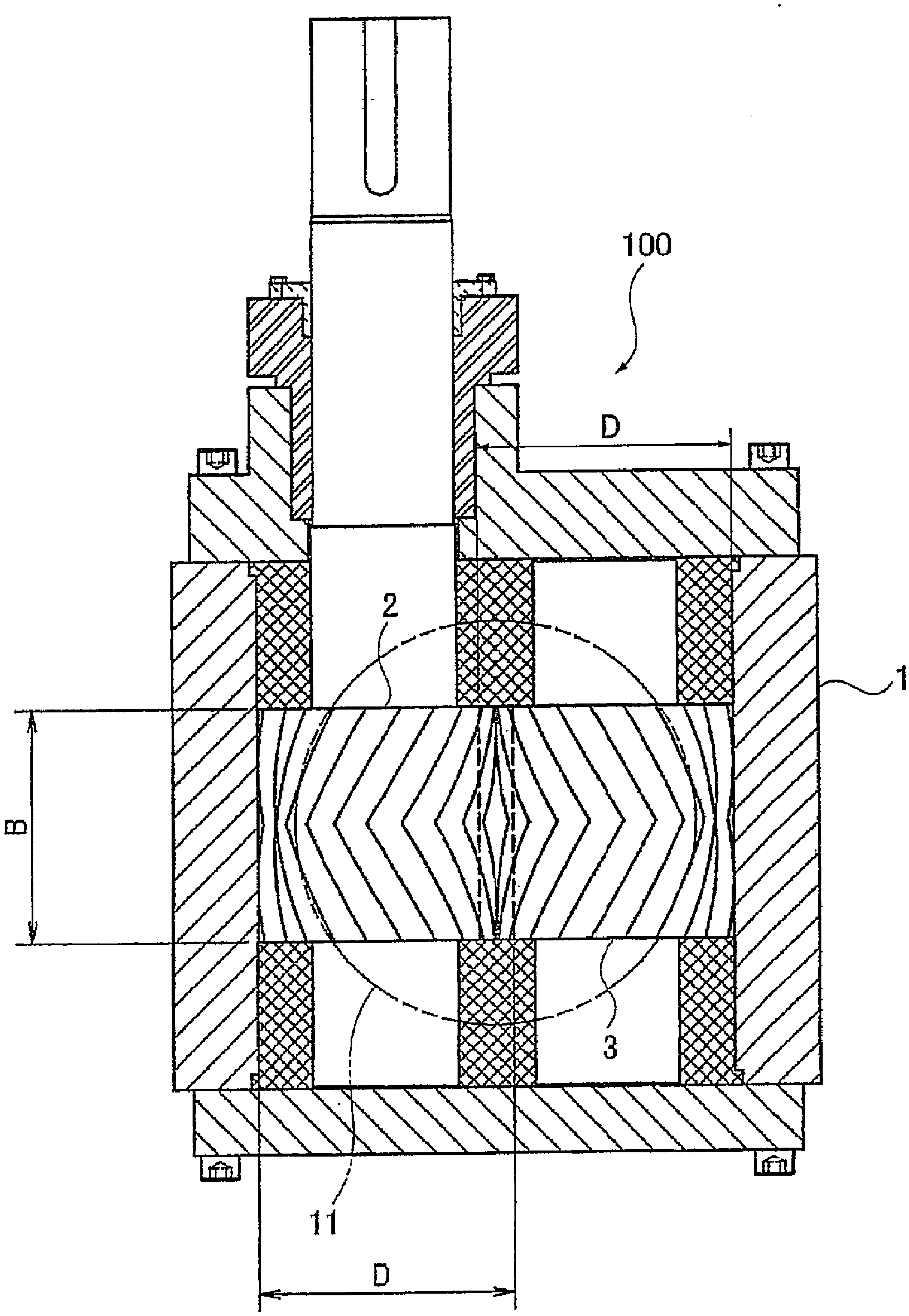


FIG. 1

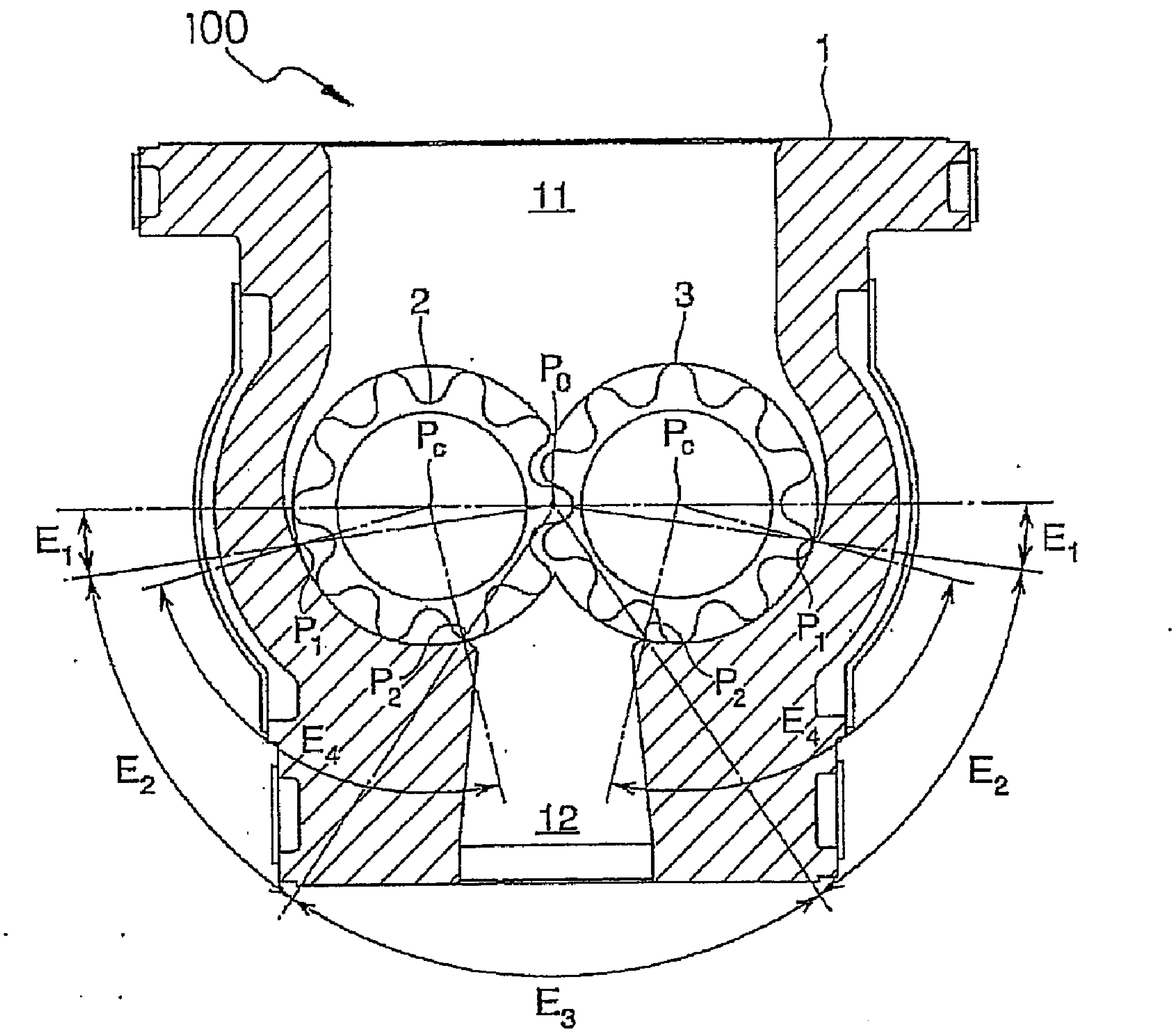


FIG. 2

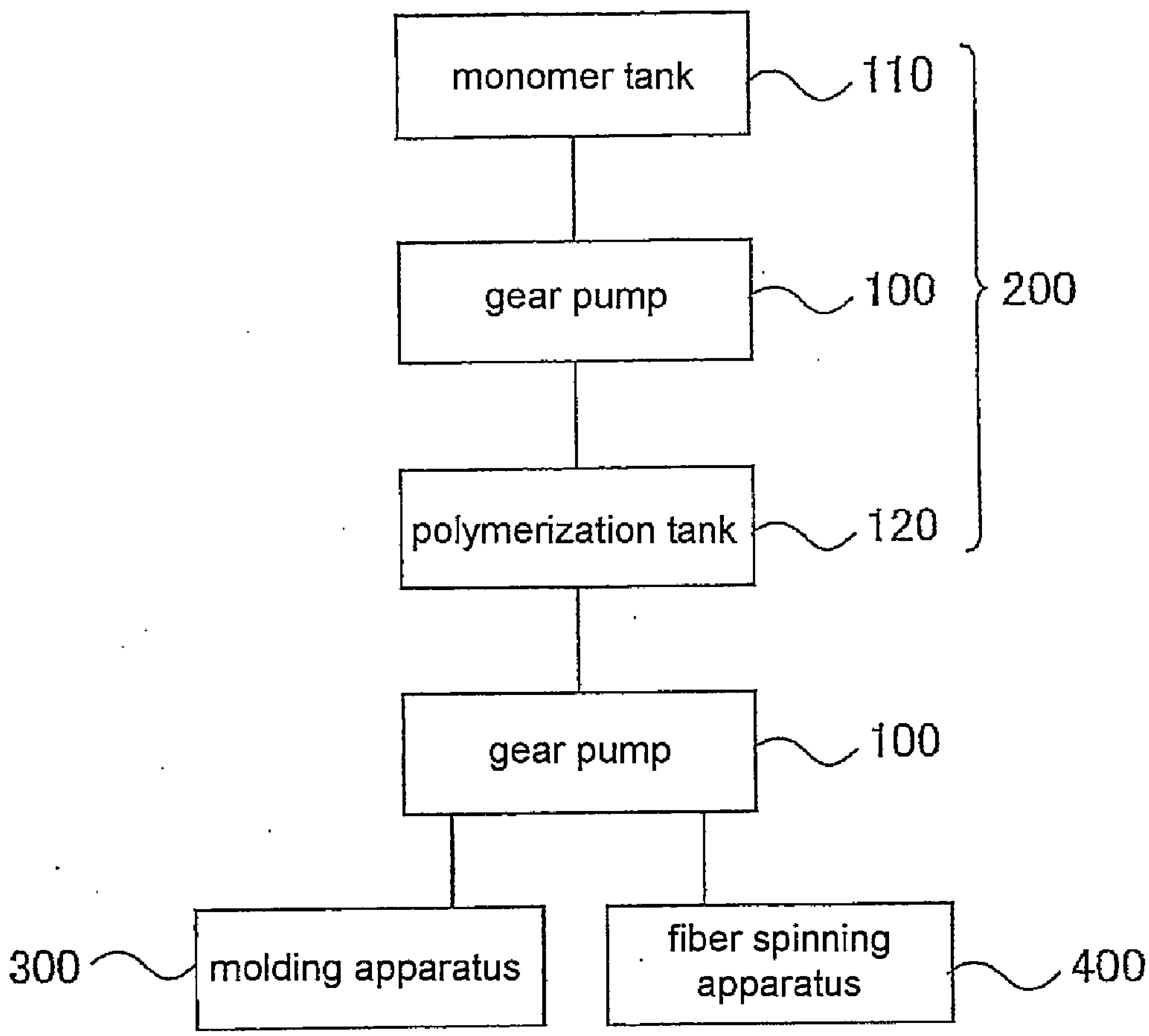

monomer tank
110
gear pump
100
200
polymerization tank
120
gear pump
100
300
molding apparatus
fiber spinning apparatus
400

FIG. 3

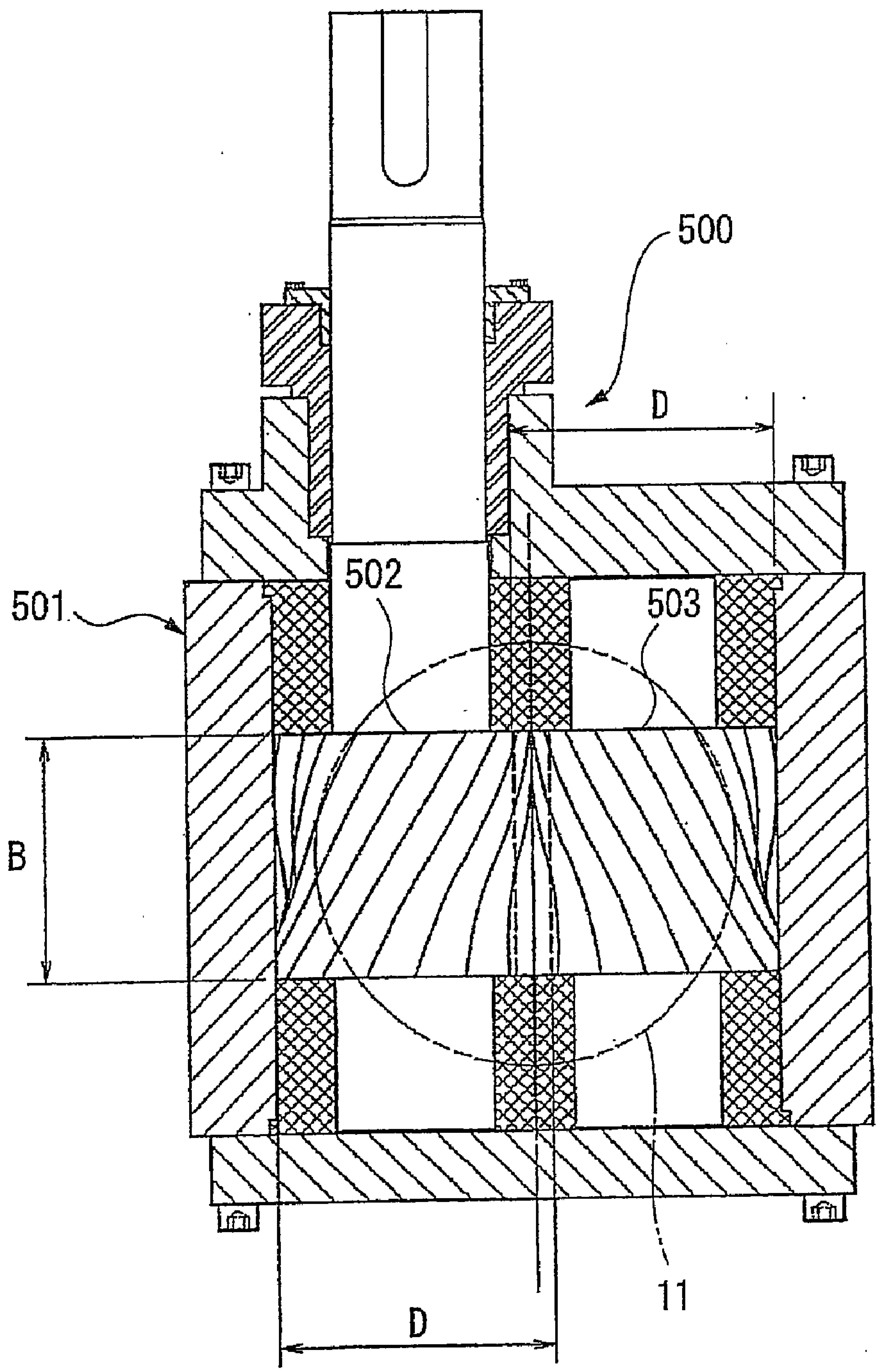
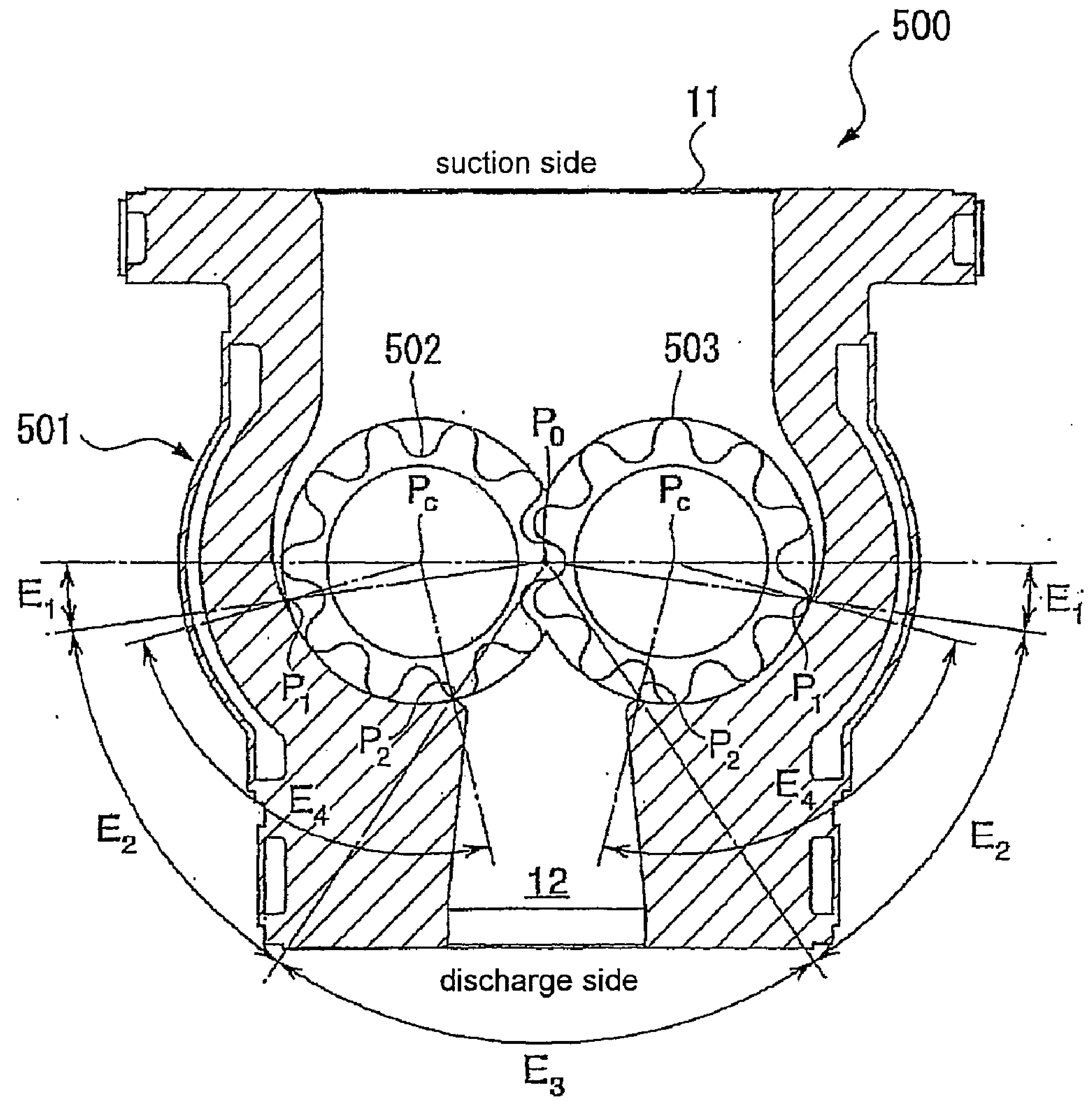


FIG. 4



500
11
suction side
502
503
501
P_0
P_c
P_c
E_1
E_1
P_1
P_1
P_2
P_2
E_4
E_4
E_2
E_2
12
discharge side
E_3

FIG. 5

GEAR PUMP

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a gear pump suitable for feeding a high-pressure and high-viscosity fluid such as a molten resin.

[0003] 2. Description of Related Art

[0004] The gear pumps suitable for feeding a fluid from the suction port to the discharge port by means of the rotation of meshing gears mostly by adopting an involute tooth profile. The reason lies in that, the involute tooth profile is easy to cut, and the process size of the tooth profile is easy to measure; thus, a high-accuracy gear can be obtained, which is suitable for the operation conditions under a high pressure.

[0005] [Reference 1] Japan Patent Publication No. H11-013642

[0006] The fluid containment phenomenon is taken as an example of the problems of the gear pump having an involute tooth profile. It is a general example for the involute gear to have a meshing rate larger than 1 and have a meshing period of two groups of teeth. Under this circumstance, when the fluid is contained between the above two groups of teeth, the volume of the contained area changes with the rotation of the gear, such that if the pressure of the contained fluid is increased during compression, the power is wasted, and meanwhile, the so-called unsuitable phenomenon of vacuum or air bubbles is generated during expansion. However, the containment phenomenon causes more severe effects during the compression than that during the expansion.

[0007] Additionally, the above containment phenomenon causes more obvious influences especially when the viscosity or suction pressure and discharge pressure of the fed fluid are relatively higher. More particularly, as for the application of feeding the molten resin, the fluid at a high temperature of about 300° C., a high pressure of about 20 MPaG, and a high viscosity of about 300 Pa·s is fed. Since the containment phenomenon causes an excessive load applied on the gear bearing, the lifetime of the bearing is shortened. Now, the process of improving the bearing or providing a sufficient allowance or margin between each unit of the bearings (for example, increasing the bearing diameter, reducing the rotation speed) have been proposed currently, whereas such a process causes an increase in the overall size of the pump external dimension and an increase in the driving force.

SUMMARY OF THE INVENTION

[0008] In view of the above facts, the present invention provides a gear pump suitable for feeding a high-pressure and high-viscosity fluid such as a high molecular polymer or a molten resin.

[0009] As embodied and broadly described herein, the gear pump of the present invention is characterized in including: a casing, having a suction port for guiding in a fluid and a discharge port for discharging the fluid; and a pair of gears, disposed within the casing, wherein the fluid is fed from the suction port to the discharge port by the rotation of the gears meshing with each other. The pair of gears is double-helical gears having a one-point continuous contact tooth profile. The ratio of the gear diameter to the gear width of each gear is set to 1.1~1.15.

[0010] That is, a circular-arc tooth profile, an elliptic tooth profile, or a sine-curve tooth profile always has one contact point and they will not cause the fluid containment phenomenon. As for a double-helical gear, the axial thrust is balanced, and the axial thrust will not act on the gear. Therefore, the ratio D/B is set to 1.1~1.15, so as to restrain the bearing load and ensure the efficiency. When the ratio D/B is smaller than 1.1, a bearing may be damaged due to the excessively increased bearing load, and the gear pump is unsuitable for feeding the molten resin. On the other hand, when the ratio D/B is larger than 1.15, in accordance with an increase in the overall size of the pump external dimension, the power that can be achieved is decreased. The power loss caused by the friction between the gear and the casing increases rapidly as the gear diameter increases, and with respect to a fixed discharge amount, the gear width is reduced and the diameter is increased. Such facts directly cause an increase in the overall size of the pump external dimension, as well as the decrease of the mechanical efficiency and the overall efficiency. In view of the above reasons, persons skilled in the art intend to set the ratio D/B to be 1.1~1.15.

[0011] Furthermore, other gear pumps of the present invention are characterized in including: a casing, having a suction port for guiding in a fluid and a discharge port for discharging the fluid; and a pair of gears, disposed within the casing, wherein the fluid is fed from the suction port to the discharge port by the rotation of the gears meshing with each other. The pair of gears is helical gears having a one-point continuous contact tooth profile. The ratio of the gear diameter to the gear width of each gear is set to 1.1~1.15.

[0012] Besides the above effects, the pair of gears made as helical gears also can be integrated with a gear shaft, and due to the simple structure, the processing and productivity are improved.

[0013] In view of the above, the present invention can achieve a gear pump suitable for feeding a high-pressure and high-viscosity fluid such as a high molecular polymer or a molten resin.

[0014] In order to make the aforementioned and other objectives, features and advantages of the present invention comprehensible, embodiments accompanied with figures are described in detail below.

[0015] It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0017] FIG. **1** is a plan sectional view of a gear pump according to a first embodiment of the present invention.

[0018] FIG. **2** is a cross-sectional view of the gear pump shown in FIG. **1**.

[0019] FIG. **3** is a flow chart of a process for manufacturing a molding of a high molecular polymer suitable for the gear pump of the present invention.

[0020] FIG. **4** is a plan sectional view of a gear pump according to a second embodiment of the present invention.

[0021] FIG. **5** is a cross-sectional view of the gear pump shown in FIG. **4**.

DESCRIPTION OF EMBODIMENTS

[0022] Hereinafter, the embodiments served as the implementation aspects of the gear pump of the present invention are illustrated with reference to the accompanying drawings.

Embodiment 1

[0023] A gear pump **100** of Embodiment 1 shown in FIGS. **1** and **2** is, for example, used in petroleum plant, chemical plant, polymer plant, and molding/fiber spinning apparatus for feeding high-viscosity substances such as molten resin and other high molecular polymers under a high pressure. The high-viscosity substance can be an intermediate or final product. The gear pump **100** is a so-called external gear pump. In the internal space within the casing **1**, a drive gear **2** and a driven gear **3** are disposed therein to mesh with each other. By rotating and driving the gears **2** and **3**, the pump functions to feed the fluid obtained in the tooth space from the suction side to the discharge side. In fact, the suction side is located at the above part, whereas the discharge side is located at the lower part. A tank is disposed right above the suction port **11** for storing the high molecular polymer or molten resin, and the molten resin in the tank is sucked therein and discharged under a specific discharging pressure.

[0024] The drive gear **2** and the driven gear **3** are respectively set to be double-helical gears having a one-point continuous contact tooth profile. In the example shown in the drawing, the teeth of the two gears **2** and **3** are set to have circular-arc tooth profile. For the gears **2** and **3**, the ratio D/B of the gear diameter D to the gear width B is set to 1.1~1.15, which is set under the condition that the gear pump **100** is used to feed a high-temperature molten resin of about 300° C. under a high pressure of about 20 MpaG. The specific values of the gear diameter D and the gear width B are limited by a gear shaft diameter required for transmitting the rotation driving force to the gear, and a shaft diameter required for restraining the bending deformation of the gear shaft.

[0025] Thereby, the ratio D/B of the gear diameter D to the gear width B is limited in the range of 1.1 to 1.15, and the number of teeth Z and the twisting angle (helical angle) β of the gears **2** and **3** are determined. The module of the gears is set to M, the diameter of the pitch circle is set to A, so the following equations are established:

[0026] $A=MZ$,

[0027] $D=M(Z+2)$. In this embodiment, the teeth of the gears **2** and **3** have a one-point continuous contact tooth profile. Therefore, the rotation action cannot be performed unless it is twisted for 1 pitch in the direction of the gear shaft. It should be satisfied that:

[0028] 1 pitch $=\pi A/Z=\pi M$,

[0029] $B/2=\pi M/\tan\beta$. If it is set to $D/B=x$, based on the above description, then Z satisfies:

[0030] $Z=(2\pi x/\tan\beta)-2$

[0031] Furthermore, preferably, in the procedures of processing the teeth, the twisting angle β is set to 32° or smaller. According to the above equations, if the D/B=x is limited in the range of 1.1~1.15, when the twisting angle β is set to 28°~32°, the number of teeth is 10~12.

[0032] According to the circular-arc teeth, a circular-arc gear pump with M=20, Z=10, A=200, β=31°, B=209, and the capacity=4189 cc/rev is fabricated and compared with the conventional involute gear pump. In the involute gear pump used for a performance comparison, M=14, Z=14, A=200, β=2.4°, B=209, and the capacity=4080 cc/rev. The shaft diameter and the bearing length relevant to the performance are set to be identical in the two gear pumps. When the fluid viscosity is about 300 Pa·s, and the discharge pressure is 20 MpaG, the circular-arc gear pump achieves the same performance as the involute gear pump. Furthermore, theoretically, the circular-arc tooth profile will not generate the containment phenomenon. However, if the containment is evaluated by measuring the discharge pressure pulse, the discharge pressure pulse in the circular-arc gear pump is 0.4%, and that in the involute gear pump is 4%, and these two values are obtained under the operation conditions of a fluid viscosity of about 300 Pa·s, a discharge pressure of 20 MpaG, and a rotation number of 30 rpm. The discharge pressure pulse changes with the measurement position and other measurement environments, and the discharge pulse of the circular-arc gear pump is reduced to 1/10 of that of the involute gear pump.

[0033] Herein, as described above, the gear pump **100** of this embodiment is mainly used for feeding high-pressure and high-viscosity fluids. Therefore, the inner peripheral profile of the casing **1** must be molded to sufficiently draw-up the high-viscosity fluid into the tooth spaces of the gears **2** and **3**, and prevent the high-pressure fluid obtained in the tooth space from leaking from the tooth tip. Hereinafter, detailed illustration is given with reference to FIG. **2**. Herein, the positions where the tooth tip of the rotating gears **2** and **3** closely approaches the inner peripheral surface of the casing **1** are set to be P_1, P_1, the positions where the tooth tip begins to depart from the inner peripheral surface of the casing **1** are set to be P_2, P_2, the pitch point of the two gears **2** and **3** is set to be P_0, and the centers of the gears **2** and **3** are set to be Pc, Pc.

[0034] In order to lead the high-viscosity fluid into the tooth space smoothly, an angle E_1 formed between the line passing through the centers Pc and Pc of the two gears **2** and **3** and the line segment connecting the center Pc of the gears **2** and **3** and the slip-start point P_1 of the tooth tip must be ensured to be about 0°-6° as seen from the side section (as seen from the section vertical to the surface of the gear shaft). The position of the slip-start point P_1 is closer to the discharge side than the line passing through the centers Pc, Pc of the two gears **2** and **3**. Moreover, in order to decrease the fluid from leaking from the tooth tip, the circular arc angle E_4 formed from the slip-start point P_1 to the slip-end point P_2 of the tooth tip (taking Pc as the center) is preferably ensured to be 72° or larger than 72° as seen from the side section. The circular arc angle E_4 is based on ensuring two or more tooth spaces of the gears **2** and **3**. In spite of this, if E_4 is increased, the flow path communicating with the discharge port **12** becomes narrowed, which is more likely to affect the discharge process of the fluid, and thus E_4 should be restrained to be about 108° as seen from the side section.

[0035] When E_1 is set to 0° or larger than 0°, and E_4 is set to 72°~108°, an angle E_2 formed between the line segment connecting the slip-start point P_1 and the pitch point P_0 and the line segment connecting the slip-end point P_2 and the pitch point P_0 is 33°~66° as seen from the side section. Therefore, an angle E_3 formed between two line segments respectively connecting the slip-end point P_2, P_2 and the pitch point P_0 of the two gears **2** and **3** is 48°~102° as seen from the side section. On the contrary, in order to ensure the required E_1, E_2 (or E_4), the upper limit of E_3 must be set to be about 102°.

Definitely, the lower limit of E_3 is set to be about 48°, so as to allow the transmitted fluid obtained in the gear space to smoothly flow down to the discharge port **12**.

[0036] According to this embodiment, in the gear pump **100** for feeding the fluid from the suction side to the discharge side by the rotation of two gears **2** and **3** formed in a pair and meshing with each other, the gears **2** and **3** are double-helical gears having a one-point continuous contact tooth profile, and for the gears **2** and **3**, the ratio D/B of the gear diameter D to the gear width B is set to be 1.1~1.15; thus the undesirable influence on the bearing caused by the fluid containment phenomenon is avoided. Moreover, the ratio D/B is set to be 1.1~1.15, which can restrain the bearing load and ensure the efficiency, and the increased in the overall size of the pump external dimension is avoided. Compared with the conventional involute gear pump, the gear pump **100** of this embodiment is more suitable for feeding the high-pressure, high-viscosity fluid.

[0037] Moreover, the angle E_3 is set to be 48°~102° and the angle E_4 is set to be 72°~108°, such that the fluid can be sufficiently sucked into the gear spaces of the gears **2** and **3**, and the fluid obtained in the tooth space is prevented from leaking from the tooth tip.

[0038] The gear pump **100** of the present invention having the above structure is used in the process for manufacturing the high molecular polymer or the molten resin, or the process for manufacturing the molding of the high molecular polymer or the molten resin. Hence, the gear pump **100** is suitable for the applications of manufacturing high molecular polymer, molten resin, or the molding thereof.

[0039] For example, as shown in FIG. **3**, the gear pump **100** of the present invention is used to feed the monomer from the monomer tank **110** to the polymerization tank **120**, for being used in the process of manufacturing the high molecular polymer; otherwise, the gear pump **100** is used to feed the high molecular polymer into a molding apparatus **300** or a fiber spinning apparatus **400**, for being used in the process of manufacturing the molding thereof. Moreover, the process of using the gear pump **100** of the present invention to produce the high molecular polymer can be integrated with the process for manufacturing the molding thereof to constitute a single production line shown in FIG. **3**. Furthermore, the monomer tank **110** and the polymerization tank **120** shown in FIG. **3** can also be replaced with a resin particle tank and a molten resin tank, so as to form a production line for manufacturing the molten resin and the molding thereof.

[0040] Furthermore, the monomer tank **110**, the gear pump **100**, and the polymerization tank **120** shown in FIG. **3** can also constitute a polymerization apparatus **200**. Moreover, the molding apparatus **300** or the fiber spinning apparatus **400** can be separated from the gear pump **100**; otherwise, the gear pump **100** can be integrated into the molding apparatus **300** or the fiber spinning apparatus **400**.

Embodiment 2

[0041] FIGS. **4** and **5** show a gear pump **500** according to a second embodiment of the present invention. In the same manner as that of Embodiment 1, the gear pump **500** is formed by disposing a drive gear **502** and a driven gear **503** meshing with each other within the internal space of the casing **1**. By rotating and driving the gears **502** and **503**, a pump functions to feed the fluid obtained in the tooth space from the suction lo side to the discharge side.

[0042] The drive gear **502** and the driven gear **503** are both helical gears having a one-point continuous contact tooth profile. In the example of the drawings, the teeth of the two gears **502** and **503** are circular-arc teeth.

[0043] Herein, generally speaking, the less the teeth number of the gear pump is, the higher the overall efficiency is; in addition, the smaller the gear diameter is and the larger the gear width is, the higher the overall efficiency is. Furthermore, the factors, such as the necessary shaft diameter required for transferring the drive force and the shaft diameter when the shaft is bent caused by the bearing load, set limits to the gear diameter and the gear width, and the most appropriate number of teeth is determined based upon the above factors.

[0044] Furthermore, when the gear pump **500** is used under a high pressure of 20 Mpa, in the same manner as Embodiment 1, the ratio D/B of the diameter D to the gear width B is 1.1~1.15.

[0045] Then, in the same manner as Embodiment 1, if the gear diameter is set to D, the gear width is set to B, the modulus of the gears is set to M, the number of teeth is set to Z, the diameter of the pitch circle is A, and the tooth twisting angle of the helical gear is β, then

[0046] $A=MZ$,

[0047] $D=M(Z+2)$.

[0048] The teeth of the gears **502** and **503** have a one-point contact tooth profile. Therefore, the rotation action cannot be performed unless it is twisted for 1 pitch in the direction of the gear shaft,

[0049] 1 pitch$=\pi A/Z=\pi M$, then

[0050] $B=\pi M/\tan\beta$. If it is set to $D/B=x$, based on the above description, then Z satisfies:

[0051] $Z=(2\pi x/\tan\beta)-2$.

[0052] The β of the helical gear is ½ of β of the above double-helical gear, and β=14°~16°. Preferably, the above double-helical gear is set to 32° or less than 32° in the above tooth processing steps. In the helical gear, β is 16° or larger than 16°, which does not affect the tooth processing steps.

[0053] Under the circumstance of β=18', when D/B=1.1, Z=8, and D/B=1.15, then Z=9.

[0054] Therefore, in the helical gear, when Z=8~12 and β=14°~18°, an effect equivalent to the above effect can be achieved.

[0055] In the circular-arc tooth profile, a helical gear pump with M=32, Z=10, A=320, β=16.75°, B=334.5, and a capacity=17152 cm^3/rev is fabricated and compared with a conventional double-helical gear pump with circular-arc teeth.

[0056] In the performance comparison, in the double-helical gear with a circular-arc tooth profile, M=32, Z=10, A=320, β=31°, B=334.5, and the capacity=17152 cm^3/rev. Certainly, except for the twisting angle, all the others are the same.

[0057] Under the operation conditions of a fluid viscosity of about 300 Pa·s, a discharge pressure of 20 MpaG, a rotation number of 30 rpm, the helical gear with circular-arc tooth profile can also achieve substantially the same performance.

[0058] In the helical gear pump with circular-arc tooth profile, even if the containment is evaluated by measuring the discharge pressure pulse, the effect substantially equaled to 0.4% of the above double-helical gear pump can also be achieved. The above values are obtained under the operation conditions of the fluid viscosity of about 300 Pa·s, a discharge pressure of 20 MpaG, and a rotation number of 30 rpm. Since substantially the same effect as the above is obtained, the difference with the conventional involute gear pump is quite obvious.

[0059] According to Embodiment 2, if the same effect as Embodiment 1 can be obtained, and the drive gear **502** and the driven gear **503** are both helical gears, a gear/shaft can be integrated and produced. Thus, the processing and productivity are improved due to the simple structure.

[0060] The gear pump **500** can be used to replace the gear pump **100** shown in FIG. **3**, and can also be incorporated into the molding apparatus **300** or the fiber spinning apparatus **400**.

[0061] Furthermore, the present invention is not limited to the above detailed embodiments. The detailed structure of each portion is not limited to that described in the above embodiments, but can have various alternations without departing from the scope of the present invention.

[0062] The present application claims the priority right based upon the Japan Patent Application No. 2005-048965 filed on Feb. 24, 2005, and the specification, lo drawings, and claims of the priority application all are enclosed herein for reference.

INDUSTRIAL APPLICABILITY

[0063] The gear pump of the present invention can be, for example, applied in (but not limited to) the petroleum plant or chemical plant, polymerization plant, and molding/fiber spinning apparatus for feeding high-viscosity substances such as molten resin and other high molecular polymers under a high pressure. The present invention is not limited to such an application. The present invention can also be used in all transmitting applications of feeding the high-pressure, high-viscosity fluids.

[0064] Though the present invention has been disclosed above by the preferred embodiments, they are not intended to limit the present invention. Anybody skilled in the art can make some modifications and variations without departing from the spirit and scope of the present invention. Therefore, the protecting range of the present invention falls in the appended claims and their equivalents.

What is claimed is:

1. A gear pump, comprising:

a casing, having a suction port for guiding in a fluid and a discharge port for discharging the fluid; and

a pair of gears, disposed within the casing, wherein the fluid is fed from the suction port to the discharge port by a rotation of the gears meshing with each other, the pair of the gears is double-helical gears having a one-point continuous contact tooth profile, and a ratio of a gear diameter to a gear width of each gear is set to 1.1 to 1.15.

2. The gear pump as claimed in claim **1**, wherein a number of teeth for the gear is 10~12, and a twisting angle of the gear is 28°~32°.

3. The gear pump as claimed in claim **1**, wherein in an inner peripheral profile of the casing, an angle formed by line segments respectively connected between positions where each tooth tip of the rotating gear departs from an inner peripheral surface of the casing and a position of a pitch point of the gear is 48° to 102° as seen from the section of the axis direction.

4. The gear pump as claimed in claim **2**, wherein in an inner peripheral profile of the casing, an angle formed by line segments respectively connected between positions where each tooth tip of the rotating gear departs from an inner peripheral surface of the casing and a position of a pitch point of the gear is 48°~102° as seen from the section of the axis direction.

5. The gear pump as claimed in claim **1**, wherein in an inner peripheral profile of the casing,

a circular-arc angle formed between a position where a tooth tip of the rotating gear approaches closely to an inner peripheral surface of the casing and a position where a tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

6. The gear pump as claimed in claim **2**, wherein in an inner peripheral profile of the casing,

a circular-arc angle formed between a position where a tooth tip of the rotating gear approaches closely to an inner peripheral surface of the casing and a position where the tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

7. The gear pump as claimed in claim **3**, wherein in the inner peripheral profile of the casing,

a circular-arc angle formed between a position where the tooth tip of the rotating gear approaches closely to the inner peripheral surface of the casing and a position where the tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

8. The gear pump as claimed in claim **4**, wherein in the inner peripheral profile of the casing,

a circular-arc angle formed between a position where the tooth tip of the rotating gear approaches closely to the inner peripheral surface of the casing and a position where the tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

9. A method for manufacturing a high molecular polymer, a molten resin, or a molding thereof, wherein the gear pump as claimed in claim **1** is used in a process for manufacturing the high molecular polymer or the molten resin, or in a process for manufacturing the molding of the high molecular polymer or the molten resin.

10. A method for manufacturing a high molecular polymer, a molten resin, or a molding thereof, wherein the gear pump as claimed in claim **2** is used in a process for manufacturing the high molecular polymer or the molten resin, or in a process for manufacturing the molding of the high molecular polymer or the molten resin.

11. A polymerization apparatus, using the gear pump as claimed in claim **1**.

12. A polymerization apparatus, using the gear pump as claimed in claim **2**.

13. A molding apparatus, using the gear pump as claimed in claim **1**.

14. A molding apparatus, using the gear pump as claimed in claim **2**.

15. A fiber spinning apparatus, using the gear pump as claimed in claim **1**.

16. A fiber spinning apparatus, using the gear pump as claimed in claim **2**.

17. A gear pump, comprising:

a casing, having a suction port for guiding in a fluid and a discharge port for discharging the fluid; and

a pair of gears, disposed within the casing, wherein the fluid is fed from the suction port to the discharge port by a rotation of the gears meshing with each other, the pair of the gears is helical gears having a one-point continuous contact tooth profile, and a ratio of a gear diameter to a gear width of each gear is set to 1.1~1.15.

18. The gear pump as claimed in claim **17**, wherein a number of teeth of the gear is 8~12, and a twisting angle of the gear is 14°~18°.

19. The gear pump as claimed in claim **17**, wherein in an inner peripheral profile of the casing, an angle formed by line segments respectively connected between positions where each tooth tip of the rotating gear departs from an inner peripheral surface of the casing and a position of a pitch point of the gear is 48°~102° as seen from the section of the axis direction.

20. The gear pump as claimed in claim **18**, wherein in an inner peripheral profile of the casing, an angle formed by line segments respectively connected between positions where each tooth tip of the rotating gear departs from an inner peripheral surface of the casing and a position of a pitch point of the gear is 48°~102° as seen from the section of the axis direction.

21. The gear pump as claimed in claim **17**, wherein in an inner peripheral profile of the casing, a circular-arc angle formed between a position where a tooth tip of the rotating gear approaches closely to an inner peripheral surface of the casing and a position where the tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

22. The gear pump as claimed in claim **18**, wherein in an inner peripheral profile of the casing, a circular-arc angle formed between a position where a tooth tip of the rotating gear approaches closely to an inner peripheral surface of the casing and a position where a tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

23. The gear pump as claimed in claim **19**, wherein in the inner peripheral profile of the casing,

a circular-arc angle formed between a position where the tooth tip of the rotating gear approaches closely to an inner peripheral surface of the casing and a position where the tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

24. The gear pump as claimed in claim **20**, wherein in the inner peripheral profile of the casing, a circular-arc angle formed between a position where the tooth tip of the rotating gear approaches closely to an inner peripheral surface of the casing and a position where the tooth tip of the gear departs from the inner peripheral surface of the casing is 72°~108° as seen from the section of the axis direction.

25. A method for manufacturing a high molecular polymer, a molten resin, or a molding thereof, wherein the gear pump as claimed in claim **17** is used in a process for manufacturing the high molecular polymer or the molten resin, or in a process for manufacturing the molding of the high molecular polymer or the molten resin.

26. A method for manufacturing a high molecular polymer, a molten resin, or a molding thereof, wherein the gear pump as claimed in claim **18** is used in a process for lo manufacturing the high molecular polymer or the molten resin, or in a process for manufacturing the molding of the high molecular polymer or the molten resin.

27. A polymerization apparatus, using the gear pump as claimed in claim **17**.

28. A polymerization apparatus, using the gear pump as claimed in claim **18**.

29. A molding apparatus, using the gear pump as claimed in claim **17**.

30. A molding apparatus, using the gear pump as claimed in claim **18**.

31. A fiber spinning apparatus, using the gear pump as claimed in claim **17**.

32. A fiber spinning apparatus, using the gear pump as claimed in claim **18**.

* * * * *