Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2591191 C 2015/01/27

(11)(21) **2 591 191**

(12) **BREVET CANADIEN
CANADIAN PATENT**

(13) **C**

(22) **Date de dépôt/Filing Date:** 2007/06/07

(41) **Mise à la disp. pub./Open to Public Insp.:** 2007/12/08

(45) **Date de délivrance/Issue Date:** 2015/01/27

(30) **Priorité/Priority:** 2006/06/08 (DE10 2006 027 001.0)

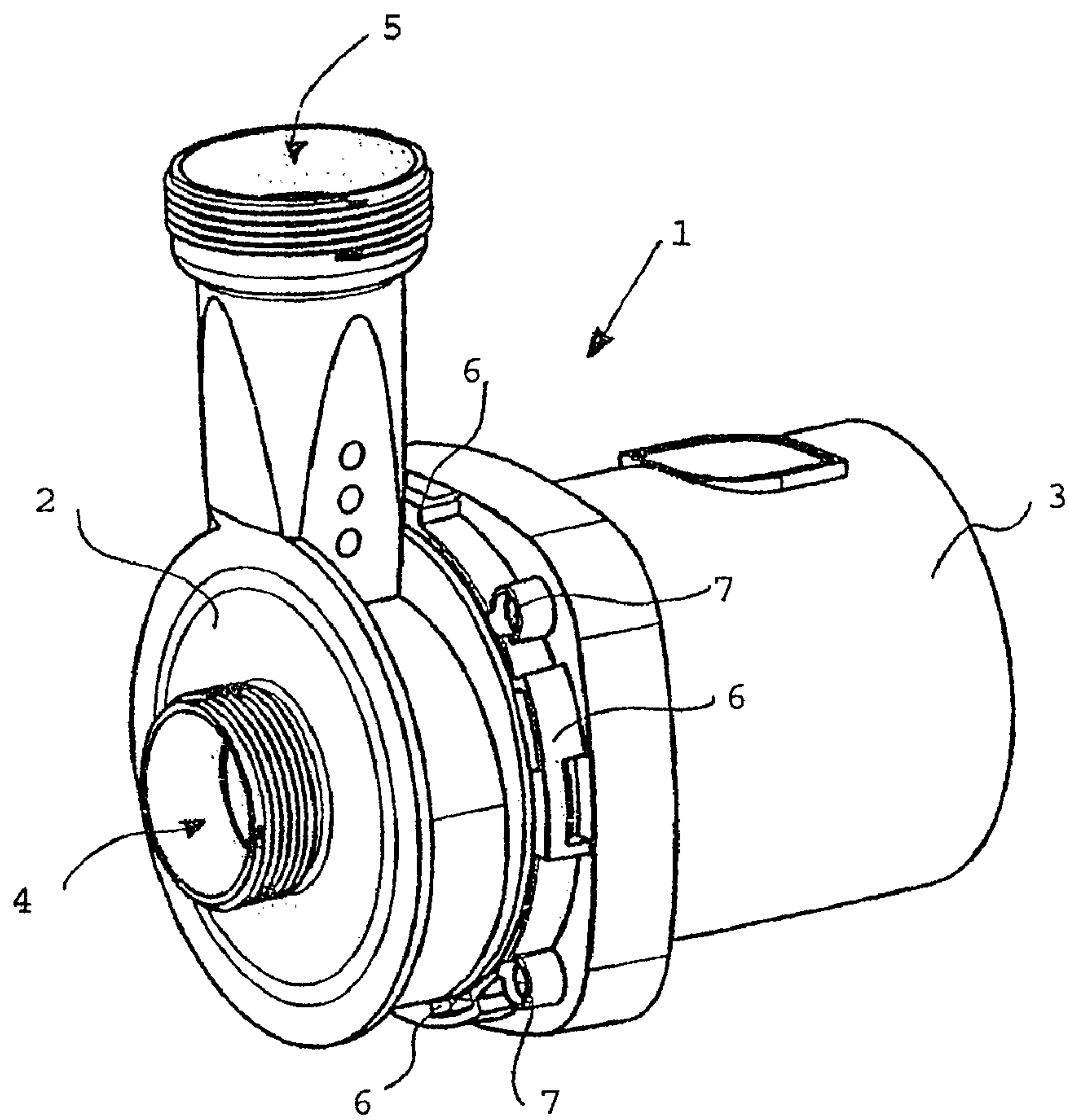
(51) **Cl.Int./Int.Cl.** ***F04D 13/08*** (2006.01), ***A01K 63/04*** (2006.01), ***H02K 1/27*** (2006.01), ***H02K 29/00*** (2006.01), ***H02K 5/10*** (2006.01), ***H02K 7/14*** (2006.01)

(72) **Inventeurs/Inventors:**
HANKE, ANDREAS, DE;
LAMBERS, HERBERT, DE

(73) **Propriétaire/Owner:**
OASE GMBH, DE

(74) **Agent:** MARKS & CLERK

(54) **Titre : POMPE A EAU, EN PARTICULIER, POUR BASSINS, AQUARIUMS, FONTAINES OU AMENAGEMENTS SEMBLABLES**
(54) **Title: WATER PUMP ESPECIALLY FOR PONDS, AQUARIUMS, FOUNTAINS OR THE LIKE**



(57) **Abrégé/Abstract:**
A water pump having a housing (1) comprising a pump housing part (2), provided with an intake opening (4) and an exit opening (5) and in which an impeller (8) with a shaft (9) is rotatably arranged, and further comprising a motor housing part (3), in which an

(57) **Abrégé(suite)/Abstract(continued):**
electric motor with a stator (12) with several coils (13) arranged on several stator poles (22) and a rotor (14) rotating therein is received, characterized in that the motor is an electronically communicated motor; the stator (12) is comprised of a pack of unitary laminations, respectively; control electronics (16) for the motor are arranged in the motor housing part (3); and the stator (12) with the coils (13) and the control electronics (16) is water-tightly encapsulated.

ABSTRACT

A water pump having a housing (1) comprising a pump housing part (2), provided with an intake opening (4) and an exit opening (5) and in which an impeller (8) with a shaft (9) is rotatably arranged, and further comprising a motor housing part (3), in which an electric motor with a stator (12) with several coils (13) arranged on several stator poles (22) and a rotor (14) rotating therein is received, characterized in that the motor is an electronically communicated motor; the stator (12) is comprised of a pack of unitary laminations, respectively; control electronics (16) for the motor are arranged in the motor housing part (3); and the stator (12) with the coils (13) and the control electronics (16) is water-tightly encapsulated.

Water Pump Especially for Ponds, Aquariums, Fountains or the Like

The invention concerns a water pump especially for ponds, aquariums, fountains or the like. The pump is to be configured for a power range between approximately 100 and 900 Watt. Such already relatively large pumps for use in ponds have in practice asynchronous motors that require a high material expenditure and are therefore relatively expensive. Also, their efficiency is often not satisfactory.

Small pumps are partially already driven by synchronous motors but must be connected to complex control devices. In this case, the sealing of the electrical parts and connections is sometimes difficult.

The invention concerns therefore the problem of providing a water pump whose efficiency in comparison to conventional pumps of the same power class is increased and that can be manufactured less expensively and can be operated comfortably.

According to an aspect of the present invention there is provided a water pump having a housing, the water pump comprising a pump housing part, provided with an intake opening and an exit opening and in which an impeller with a shaft is rotatably arranged, and further comprising a motor housing part, in which an electric motor with a stator with several coils arranged on a plurality stator poles and a rotor rotating therein is received, wherein the motor is an electronically communicated motor; the stator is comprised of a pack of unitary laminations, respectively; control electronics for the motor are arranged in the motor housing part; and the stator with the coils and the control electronics is water-tightly encapsulated.

By using an electronically commuted motor, the efficiency of the pump can be significantly increased within a power range of approximately 100 to 900 Watt wherein the manufacture of the pump motor with a stator comprised of a pack of unitary sheet metal laminations can be effected in a material-saving and cost-reducing way. By incorporating control electronics for the motor control directly into the pump and arranging them within the motor housing part and encapsulating them together with the stator and the coils in a water-tight way, the risk of repairs of the pump can be minimized because all essential electric and electronic components are combined and perfectly protected from water by means of encapsulation.

With regard to efficiency and cost, the pump can be optimized when a two-pole permanent magnet is used as a rotor and a stator with six stator poles and therefore six coils received thereon is used. The two-pole permanent magnet rotor can be substantially comprised of a unitary two-pole magnet ring that is diametrically magnetized. It can be produced in a simple and thus inexpensive way.

The stator is comprised according to the invention of a plurality of stacked stator sheet metal laminations that are stamped as unitary parts. This reduces the assembly costs in comparison to multi-part stators in which the stator poles are individually inserted.

In one aspect, the invention provides a water pump, having a body which comprises a pump-body portion having an intake opening and an outlet opening, in which pump-body portion an impeller having a shaft is rotatably arranged, and which comprises a motor-housing portion in which is held an electronically commutated electric motor, which electronically commutated electric motor has a stator having a plurality of windings arranged on stator poles and has a rotor rotating in the said windings, the stator comprising a set of laminations which are each in one piece, and the stator and the rotor, which takes the form of a two-pole permanent magnet, being separated from one another by a gap-creating tube, wherein the stator poles, which are each formed on the inside, to be substantially free of any widening, have windings which are slid on from the interior of the stator, these components, together with an electronic control system for the motor, are arranged in the motor-housing portion, and the stator, together with the windings and the electronic control system, is encapsulated in the said motor-housing portion to be sealed against water, in such a way that the interior of the entire motor-housing portion is provided with an encapsulating material which fills all the open spaces.

Further advantages and details result from the dependent claims and an embodiment illustrated in the drawings which will be described in the following. It is shown in:

Fig. 1 a perspective external view of a pump according to the invention;

Fig. 2 a longitudinal section of the pump of Fig. 1;

Fig. 3 a cross-section of the stator of the pump motor in the plane III of Fig. 2 when mounting the coils;

Fig. 4 the object of Fig. 3 with completely mounted coils; and

Fig. 5 a perspective illustration of the object of Fig. 4 without windings on the coils.

The pump illustrated in Fig. 1 has a housing 1 that is substantially comprised of a pump housing part 2 and a motor housing part 3. The pump housing part 2 has an intake opening 4 and an exit opening 5 for water to be pumped. The two housing parts 2, 3 are connected in a simple way with one another, for example, as illustrated, by a bayonet closure 6 with additional screw connection 7.

The interior of the pump is illustrated in section in Fig. 2. Between the intake opening 4 and the exit opening 5, an impeller 8 is arranged in the pump housing part 2 on the shaft 9; the shaft is preferably made of ceramic material. The impeller and the shaft 9 are driven in rotation by means of an electronically commutated motor (EC motor) that is arranged in the motor housing 3. The shaft 9 extends from the pump housing part 2 into the motor housing part 3 wherein the motor is shielded from the impeller 8 mechanically by a bearing bracket 10.

The motor is comprised substantially of a stationary stator lamination pack 12 on which coils 13 that are also stationary are provided as well as a rotor 14 which in the illustrated embodiment is advantageously formed as a two-pole permanent magnet. Between rotor 14 and shaft 9 there is a solid, closed iron ring 15 that is fixedly connected to both rotor and shaft and increases the magnetic flux of the motor significantly.

On the back of the motor a circuit board 16 is arranged that comprises the entire control electronics. Finally, the motor has a ground 17 at the stator 12 and a ground plate 18 at the back of the motor housing part 3.

For sealing the housing part 2 through which the water flows relative to the housing part 3 that receives the electric components, the rotor 14 with all movable parts and the stator 12 with all parts through which current flows are separated from one another by a can 19 surrounding the rotor 14. Toward the pump housing part 2 the can 19 widens into a large color-shaped flange 19' for completely separating the pump housing part 2 and the motor housing part 3. The interior of the entire motor housing part 3 is encapsulated so that all free spaces are filled, for example, with a synthetic resin. The encapsulating compound 20 thus embeds also the entire control electronics 16 so that the latter are not only protected from moisture but also protected mechanically against vibrations. At the same time, the encapsulating compound 20 also supports the can 19 so that it can be manufactured inexpensively of plastic material that is not reinforced externally.

The control electronics 16 may comprise a signal evaluation unit, not illustrated in detail, by which the received signals are used for speed regulation of the pump motor. The control signals can be modulated directly by the mains voltage that is supplied to the motor. In this way, it is not necessary to provide a complex phase cutting control for speed regulation of the pump as it has been used up to now for conventional motors. The operation for speed regulation can be realized in particular by means of an intermediate switch that can be remote-controlled and is arranged between the mains supply and the current supply cable for the pump. This intermediate switch comprises a receiving module that receives the signals emitted by the remote control for changing the motor speed. In the intermediate switch element these signals are modulated onto the mains current and in this way transmitted to the control electronics of the pump. The intermediate switch thus takes on only the task of signal transfer so that no power electronics are required.

In the illustrated embodiment the stator 12 and the correlated coils 13 are preferably configured such that the coils 13 when being mounted can be slipped onto stator poles 22 of the stator 12 from the interior. This and the configuration of the stator 12 with the coils 13 is illustrated in more detail in Figs. 3 through 5. By being able to simply slip on the coil bodies 13, there is no need for using expensive threading machines for winding the coils as is needed in regard to other unitary laminations with pole shoes formed on the inner side. The stator poles 22 of the stator 12 of the pump according to the invention are therefore to be configured at their inner side substantially without widened portions so that slipping on the coils is possible.

The geometric conditions that enable that the coils 13 can be slipped onto the stator poles 22 are illustrated substantially in Fig. 3. For this purpose, the length a of the coils 13 must be smaller than the minimal spacing A1 of two opposed inner pole sides as well as smaller than the length A2 of the individual stator poles 22. Moreover, the width b of the coils 13 must be less than the minimal spacing B1 of an inner pole edge 42 to the inner pole edge 42 of the second to next stator pole 22, respectively; i.e., between the two stator poles in question precisely one additional stator pole 22 is located. The width b of the coils 13 must also be smaller than the minimal spacing B2 of two outer edges of the coils in the mounted state between which again a further coil 13 or a further stator pole 22 is located. Finally, the width c of the stator poles 22 is to be selected smaller than the inner width C of the coils 13.

The pump according to the invention is optimized in that, on the one hand, its dimensions are to be kept as small as possible and, on the other hand, its efficiency should be as high as possible; this should be achieved while the assembly should be improved. For increasing the efficiency at predetermined maximum dimensions, the geometric conditions must be selected such that the coils 13 on the one hand can still be slipped on and, on the other hand, as many windings as possible can be arranged on the coils 13. For this purpose, an arc length BL of the stator poles 22 must be defined. If in the interior of the stator 12 in which the rotor 14 rotates an imaginary circle of maximum size were positioned that contacts the inner sides 32 of the stator poles precisely, the sum of the arc length BL of all poles 22 could be precisely half of the circumference of the defined circle. For the benefit of the copper quantity to be arranged in the coil windings and for preventing flux scattering, the arc length BL of each stator pole 22 is however reduced preferably by approximately 11 percent to 12 percent relative to the above defined initial length.

Advantageously, an angle ∀ can be defined between two straight lines 50 that extend from the stator center and touch the inner pole edges 42 of the stator poles; the angle is between 0.88 times 360 degrees divided by the number n of the stator poles 22 and approximately 0.89 times 360 degrees divided by the number n of the stator poles 22. For conditions optimized in this way, the coils 13 are inserted into the opening ds illustrated in Fig. 3 and are then slipped onto the stator poles 22 until they meet the stop.

The stator 12 of the illustrated embodiment has precisely six stator poles 22. Depending on the requirements, it is also possible to provide the motor with a stator 12 having three, nine, twelve, fifteen stator poles. However, for more than six poles 22 the spacings for the windings of the coils 13 are very narrow so that the mounting expenditure and cost expenditure will be increased. However, a motor that has only three poles has a reduced efficiency.

The pump according to the invention is characterized by high mounting comfort, minimal manufacturing costs, a high efficiency, and an optimized operating comfort. It is not prone to failure and therefore can be used without requiring much maintenance. Because of its high efficiency and the reduced material expenditure, the energy demand of such a pump in regard to manufacture as well as operation is minimized.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A water pump, having a body comprising:

a pump-body portion, provided with an intake opening and an outlet opening, and a motor-housing portion;

an impeller having a shaft rotatably arranged in the pump-body portion;

an electronically commutated electric motor arranged in the motor-housing portion; wherein the electronically commutated electric motor comprises a stator having a plurality of windings arranged on stator poles and a rotor rotating in the windings;

an electronic control system for the electronically commutated electric motor arranged in the motor-housing portion;

wherein:

the stator comprises a set of laminations which are each in one piece;

the stator and the rotor, which takes the form of a two-pole permanent magnet, are separated from one another by a gap-creating tube;

the stator poles, which are each formed on an interior of the stator and are substantially free of any widening, have windings which are slid on from the interior of the stator; and

the stator, together with the windings and the electronic control system, is encapsulated in the motor-housing portion to be sealed against water, so that all open spaces in an interior of the entire motor-housing portion are filled with an encapsulating material.

2. The water pump according to claim 1, wherein the gap-creating tube is composed of a plastic material which is not externally reinforced.

3. The water pump according to claim 1 or 2, wherein a solid iron ring which is partially or fully closed is arranged between the rotor and the shaft.

4. The water pump according to any one of claims 1 to 3, wherein the electronic control system comprises a signal analysing unit which analyses signals modulated onto a mains voltage received and uses the signals to regulate a speed of the electronically commutated electric motor.

5. The water pump according to any one of claims 1 to 4, wherein the following geometrical conditions apply to the stator and the windings:

$$a < A1,$$

$$a < A2,$$

$$b < B1,$$

$$b < B2,$$

$$c < C,$$

wherein:

a = length of the windings;
$A1$ = minimum distance between two opposite inside faces of the stator poles;
$A2$ = length of the stator poles;
b = width of the windings;
$B1$ = minimum distance between inner edges of two stator poles between which there is precisely one further stator pole;
$B2$ = minimum distance in the installed state between the outside edges of two windings between which there is precisely one further winding;
c = width of the stator poles; and
C = inside width of the windings.

6. The water pump according to any one of claims 1 to 5, wherein the arcuate length of inside faces of the stator poles is reduced by approximately 11% to 12% from the circumference of a circle touching the inside faces of the stator poles divided by twice the number of stator poles which are present.

7. The water pump according to any one of claims 1 to 6, wherein the following geometrical condition applies to the stator:

$$0.88 \times 360° / n <= \alpha <= 0.89 \times 360° / n$$

wherein:

α = the angle between two straight lines which extend from the centre of the stator and are tangent to inner edges of the stator poles; and
n = the number of stator poles.

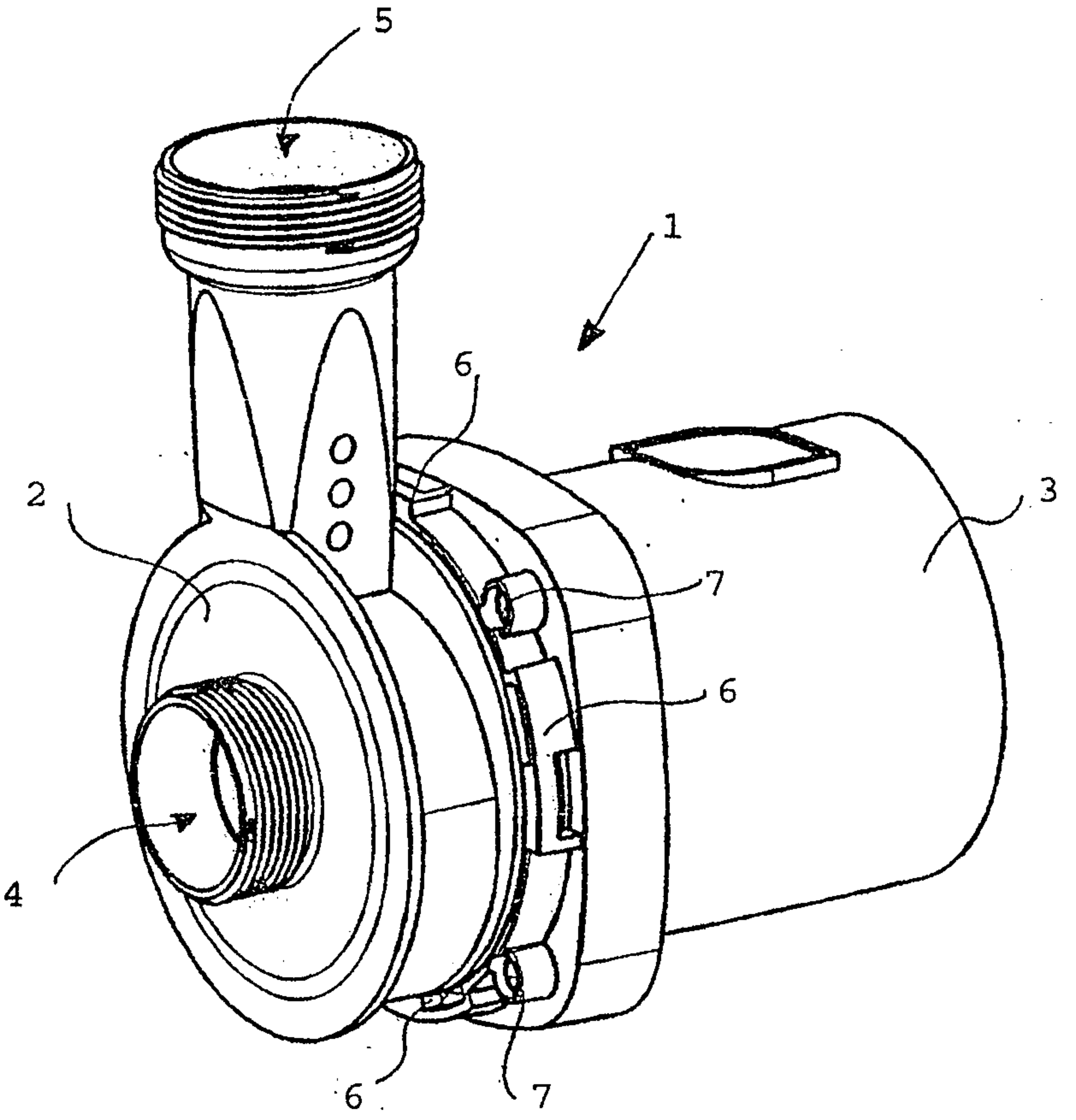


Fig. 1

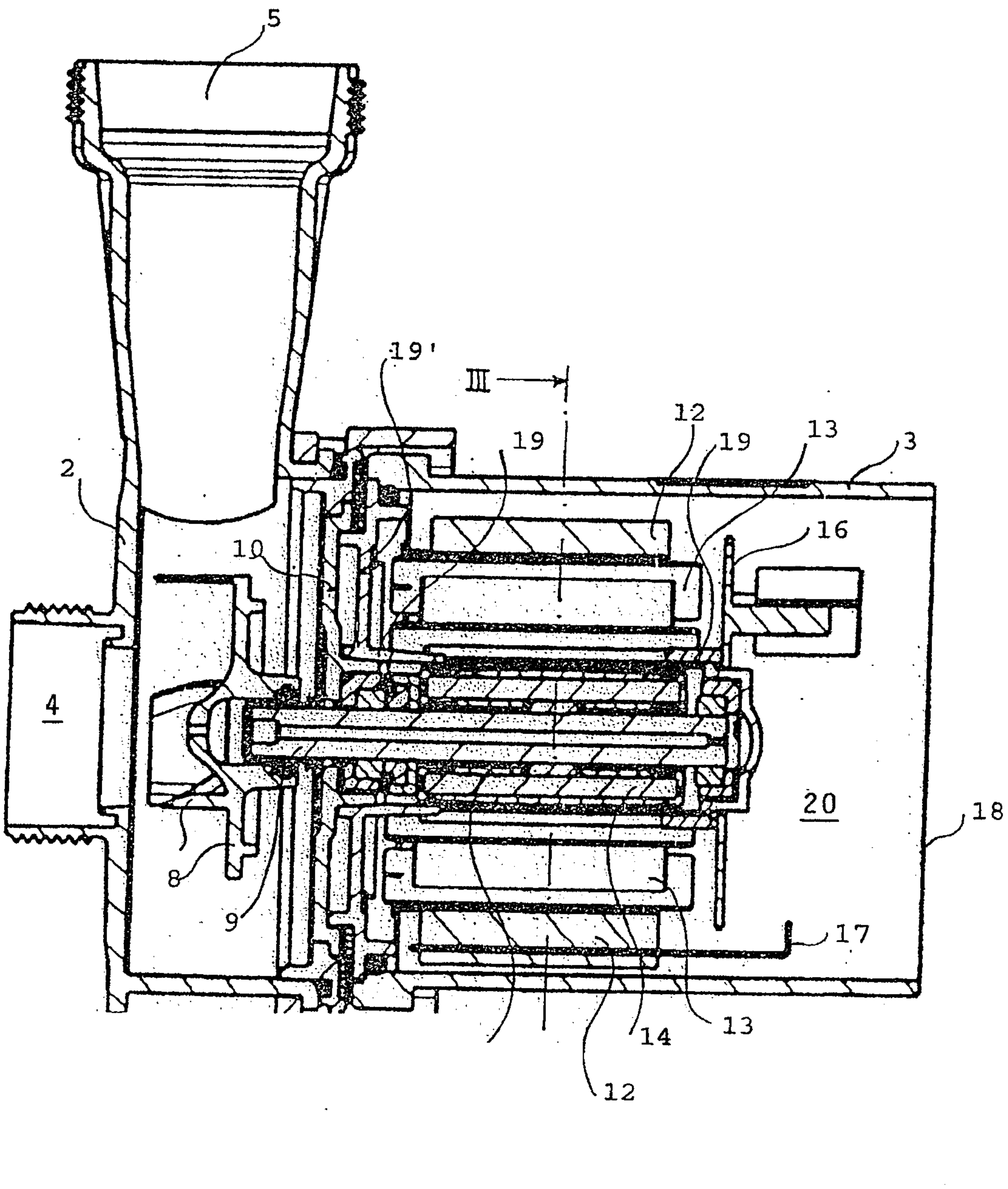


Fig. 2

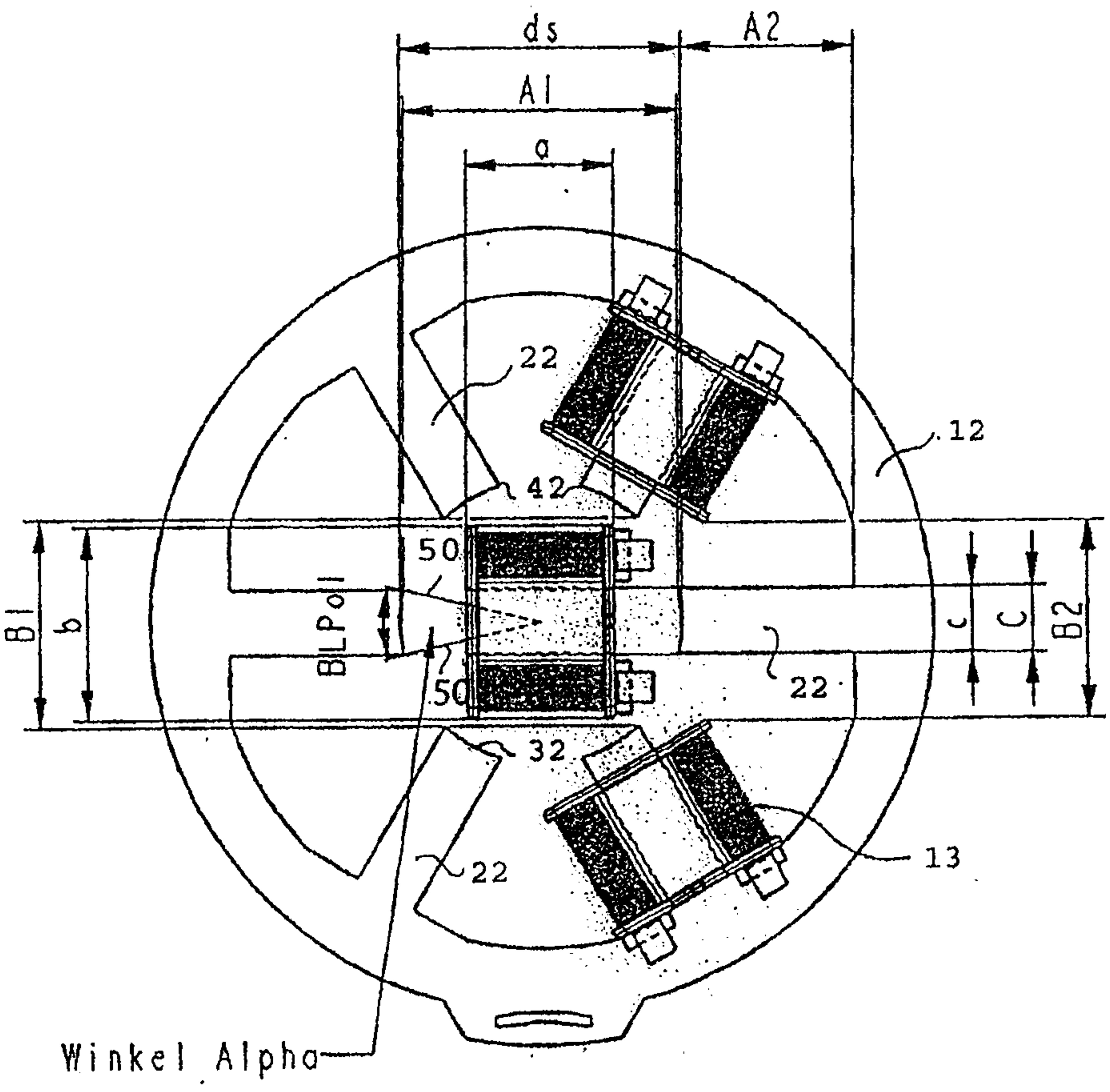


Fig. 3

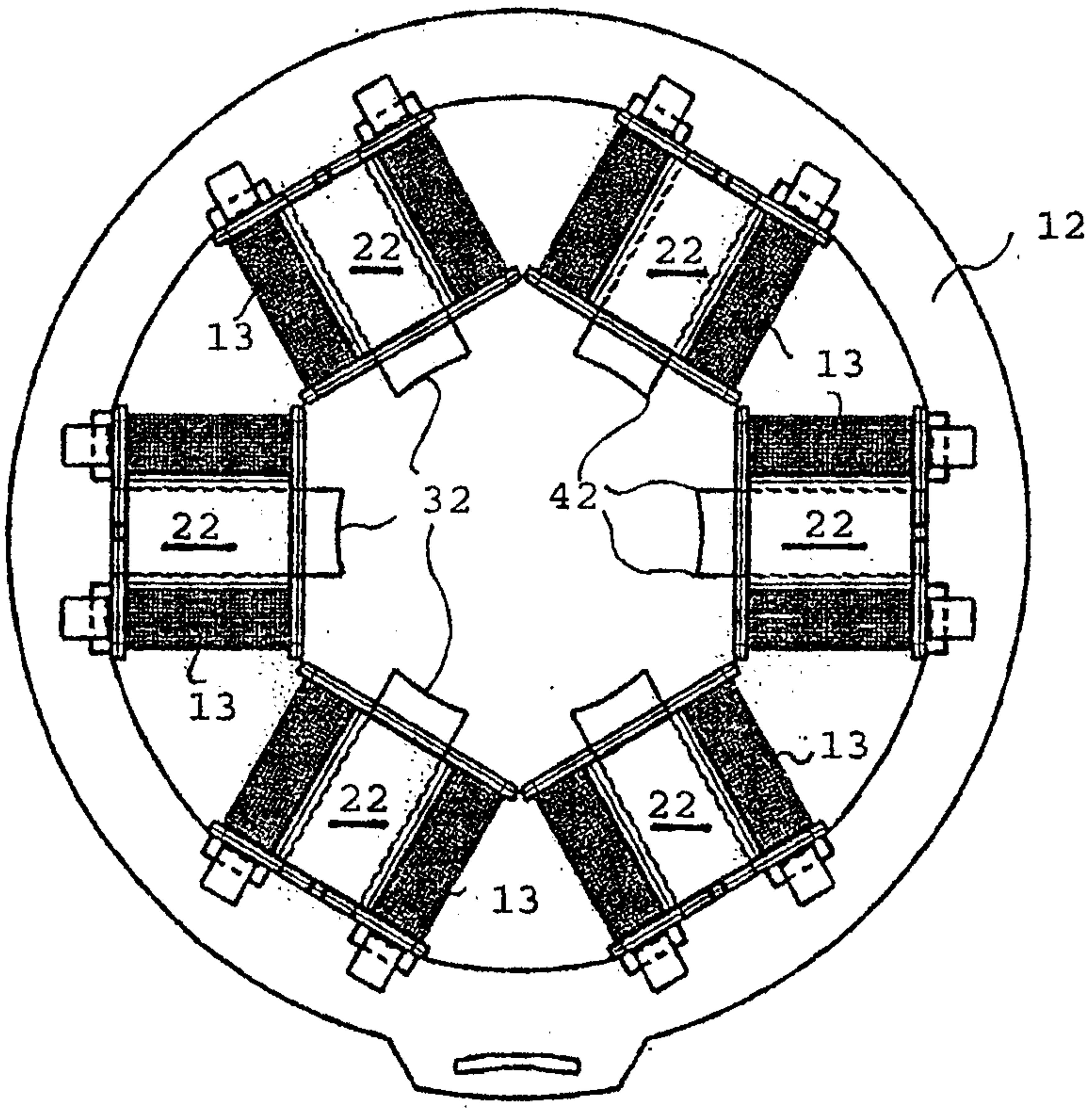


Fig. 4

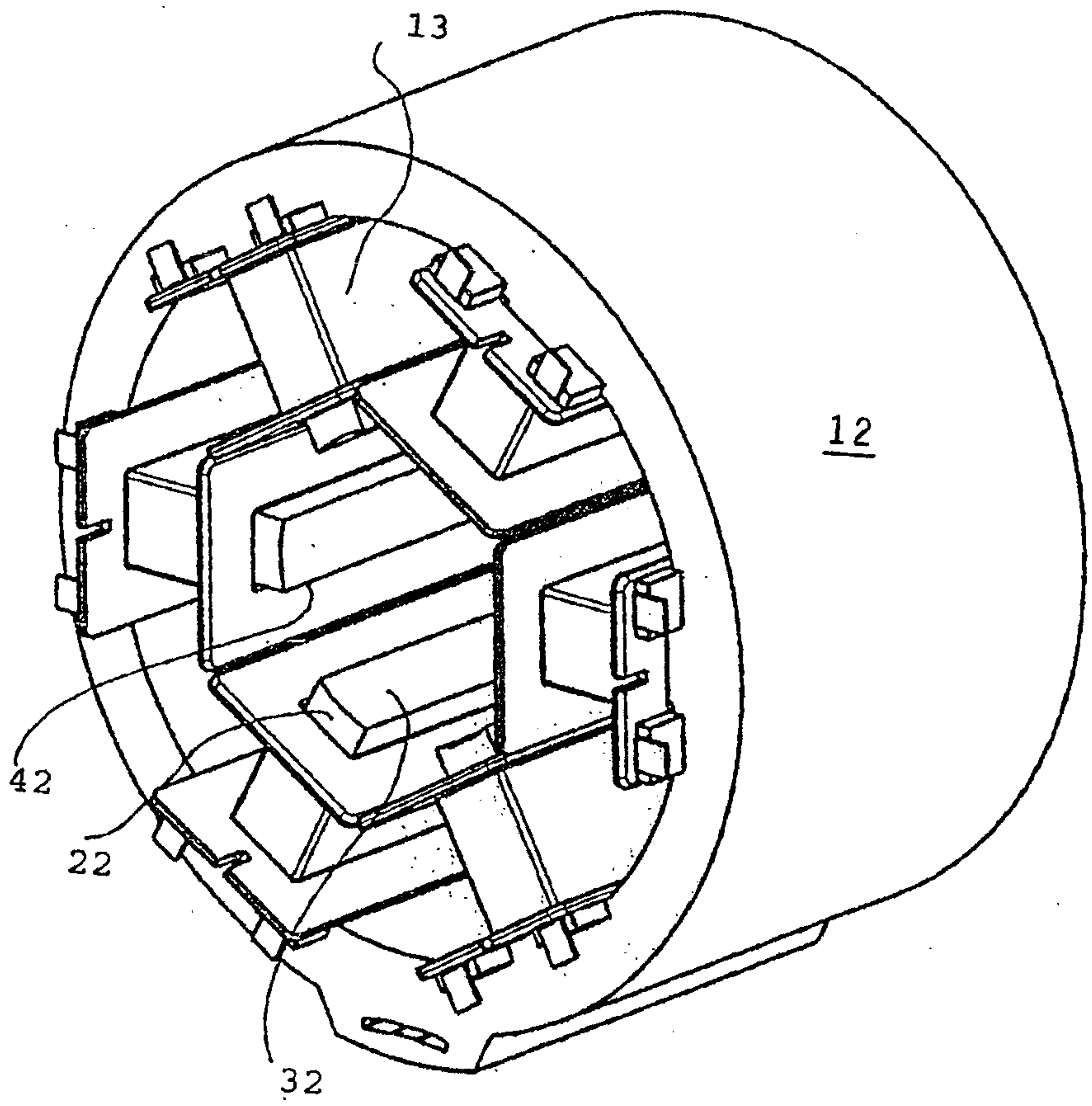
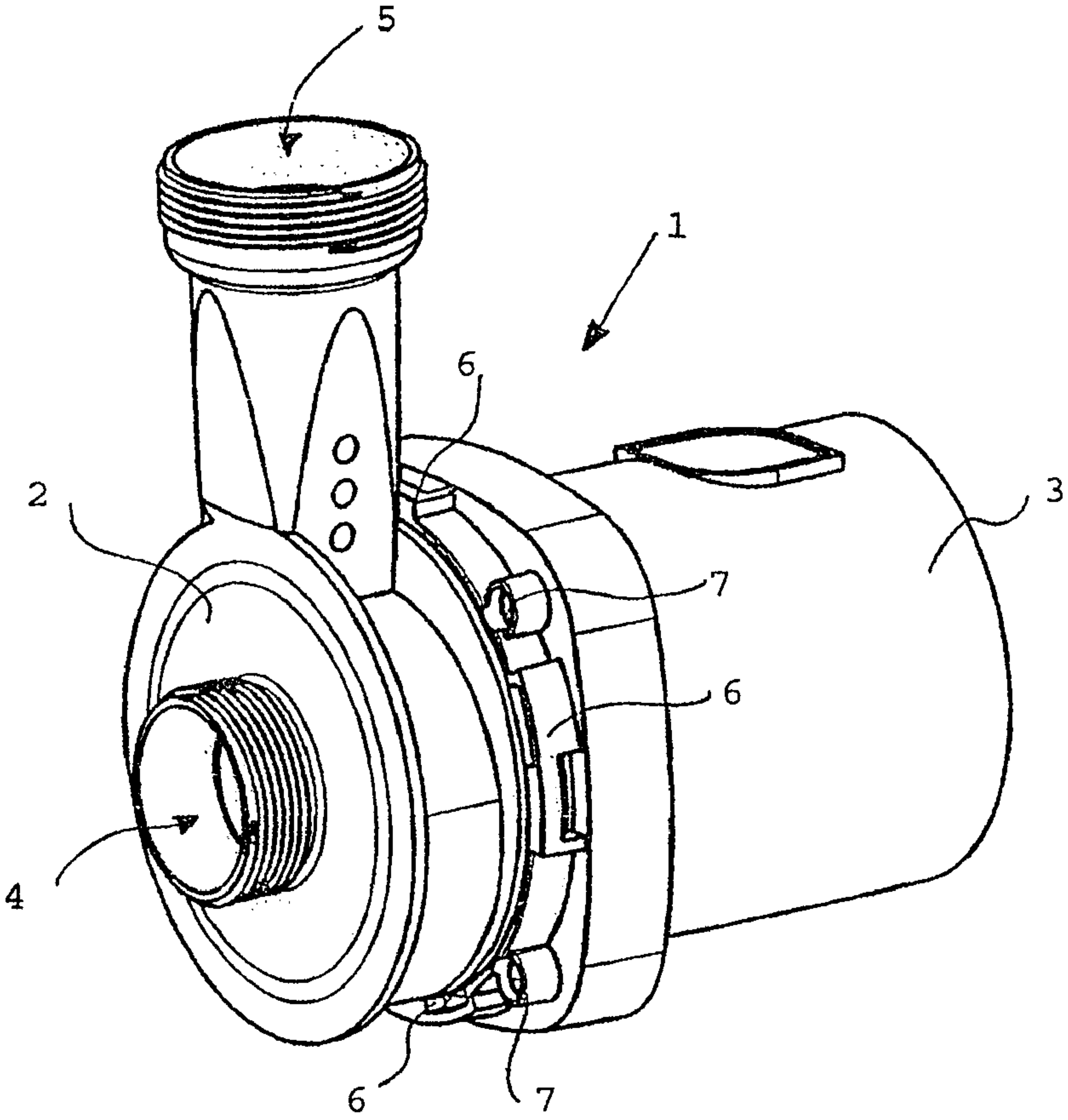


Fig. 5



5
1
6
2
3
7
6
4
6
7