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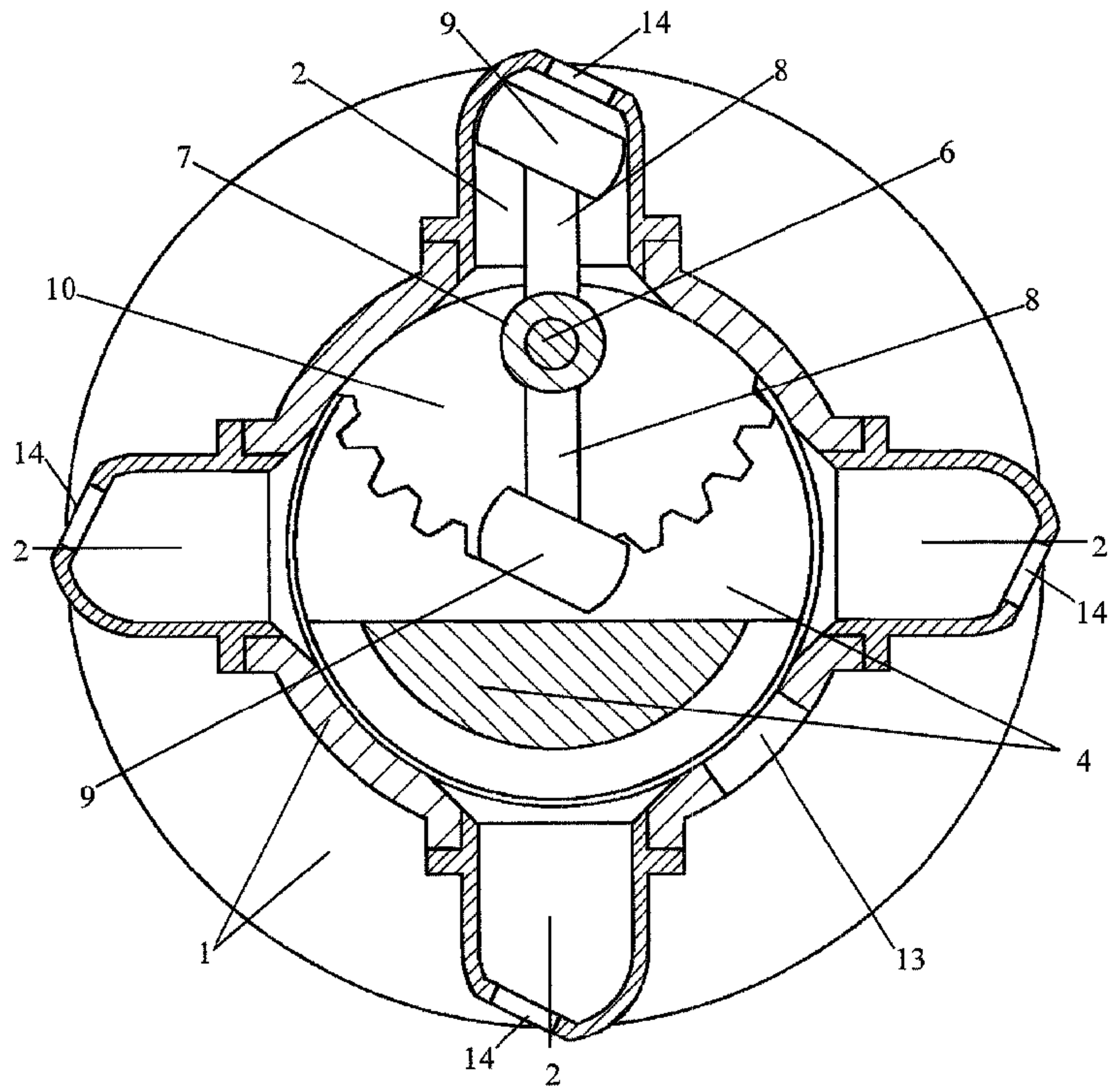


(57) Abrégé/Abstract:
The invention contained herein is a mechanical device capable of, among other things, fluid compression and/or displacement, and can be used for any of the applications traditionally associated therewith. The device is comprised of a block housing with radially mounted chambers. The housing contains a central crank mechanism and fixed near the crank mechanism's circumference is a rotor that terminates in two specially shaped heads. A driver is then attached to the crank mechanism's axle and the rotor's axle is geared so as to counter-rotate the rotor one revolution for each revolution of the central crank mechanism. The sum of the two rotations creates a linear compression or displacement stroke, with rotor heads alternating between diametrically opposed chambers. Intake is directed into the block housing and output (controlled by unidirectional valves) is at the anterior end of each chamber.

Abstract of Invention

The invention contained herein is a mechanical device capable of, among other things, fluid compression and/or displacement, and can be used for any of the applications traditionally associated therewith. The device is comprised of a block housing with radially mounted chambers. The housing contains a central crank mechanism and fixed near the crank mechanism's circumference is a rotor that terminates in two specially shaped heads. A driver is then attached to the crank mechanism's axle and the rotor's axle is geared so as to counter-rotate the rotor one revolution for each revolution of the central crank mechanism. The sum of the two rotations creates a linear compression or displacement stroke, with rotor heads alternating between diametrically opposed chambers. Intake is directed into the block housing and output (controlled by unidirectional valves) is at the anterior end of each chamber.

This invention, called a Di-Rotary Compressor/Pump (herein after referred to as the device or the invention), relates to the compression and/or displacement of fluids and the applications stemming therefrom (for instance, with some minor modifications it may be used as an air motor) by a true rotary device, which uses two non-eccentric circular motions to create linear motion.

There are three basic types of compressors/pumps currently in widespread use: the helical screw, reciprocating piston and centrifugal rotary designs.

Within the range of helical screw type compressors, an important distinction must be made between those that operate with lubrication, and those that do not. The benefits of using a lubricated helical screw type include: in practical operation, it is both quiet and vibration free, the lubricant also acts as a coolant, (combining two important systems into one), and the lubricant functions as the seal. The problems are that since the lubricant cools this design, the cooling system is highly complex, (Heat transfer is from lubricant to water to air, and all of these fluids must be circulated by pumps), and the output must be filtered where lubricant free fluids are required.

The benefit of a lubricant-free helical screw compressor is that, obviously, the output is free of lubricant. The difficulty faced in operation of a lubricant-free helical screw compressor is that it must be run at high speeds in order to minimize leakage. This factor limits adaptability.

The benefits of both lubricated and non-lubricated helical screws is that there is no efficiency lost due to the acceleration and deceleration of reciprocating masses (i.e. pistons), the flow is nearly continuous, and operation speed is not severely limited by a large number of parts or friction losses. The inherent problem with both the lubricated and non-lubricated helical screw types is that it is difficult to seal such a large operating surface. Another significant negative attribute is that the helical screw compressor is not cost-effective on a small scale.

The reciprocating piston type of device allows for high compressions and is not quite so dependent on oil lubrication. It is also very adaptable to a wide variety of applications, because it can run at mid to low speeds and achieve a wide range of displacement or compression ratios. It is also a thoroughly tested and proven technology. There are, however, a number of inefficiencies relating to reciprocating motion, valves, and friction. Because of the linear motion of the piston moving back and forth in the cylinder, whatever inertial energy not utilized in compression or displacement of the fluid during the forward stroke will be lost when the crank mechanism slows, stops, and draws the piston back for the next stroke. Further, because the flow is not unidirectional, a complex valve system is required to regulate direction of flow into and out of the cylinder. This valve system limits the speed of operation as well as robs the machine of some of its energy. The complexity of the valve system of this compressor can make it difficult to manufacture, and prone to breakdown, as well as difficult to fix. Finally, there are significant friction losses due to the multiplicity of interacting parts in the reciprocating piston-type compressor.

The centrifugal-rotary type design of compressor has a number of positive attributes. By design, all centrifugal compressors' output is oil free (due to the axle's bearing being isolated from the compression chamber). The centrifugal compressor is also highly efficient, and, like the helical screw design, has no reciprocating masses. The airflow is continuous and unidirectional, and complexity is therefore minimized. The problem in a centrifugal rotary design is that it is only efficient at very high speeds. If speed is reduced, efficiency drops dramatically, eventually reaching a point at which it does absolutely no work, but continues to waste energy. Another problem is that centrifugal rotary compressors cannot achieve very high compression. Where varied pressure and flow (adaptability) are design requirements, these types of compressors are not viable. Centrifugal rotary compressors are only practical in very large volume applications.

It has been found that the majority of the problems with existing pumps/compressors (as noted above) may be solved and the respective strengths of the three types may be retained and even magnified. This may be achieved by combining the two principles on which they operate: the circular and linear motions of the helical screw/centrifugal rotary and reciprocating piston respectively.

This invention is the first of its kind in the sense that it combines two *non-eccentric circular* motions to produce what is in essence a *linear* movement. Because nothing oscillates, (note that although the rotor heads appear to describe a reciprocating path, this is actually the sum of the displacement caused by rotation and counter-rotation), this invention may be called *truly rotary.*

True rotary motion gives this invention a number of significant advantages over existing compressors. First and foremost, this invention can be run at very high speeds, meaning that a smaller unit can match the output of a much larger conventional reciprocating compressor or pump. The other obvious benefit of rotary motion is that it eliminates reciprocating masses and the losses associated therewith. Similar to the other two rotary compressors, this device vibrates very little or not at all during normal operation. This device also shares with its rotary cousins the characteristic unidirectional flow of the working fluid. Whereas in the reciprocating piston compressor the working fluid flows in and out of the same end of the cylinder, (necessitating dual valves and a system for controlling their opening on each cylinder), this device intakes from the posterior end of the chamber and directs output out the anterior end, limiting the operational controls to a single valve at the anterior end of each working chamber. Additionally, this device, like the other two rotary designs, has very few moving parts, which limits efficiency losses, as well as facilitating repair and maintenance.

Although both the helical screw and centrifugal rotary compressors are also true rotary compressors, this device is far more versatile. Unlike the centrifugal rotary device, it can be run at extremely low speeds without any significant change in efficiency, and can also match the extremely high speeds associated therewith. This device, unlike both the helical screw and centrifugal rotary, is cost effective and practical on any scale.

The linear path of the device's rotor heads gives all the benefits of a reciprocating piston design without the reciprocating masses. Because a given chamber in the device is equivalent to a reciprocating piston device's cylinder, and a given rotor head's operating surface is equivalent to a piston head, the working portion of the device's stroke can be seen as simply the operation of a standard reciprocating piston compressor. The primary benefit of a piston-based design is its minimal sealed area. (Mathematically, a circle offers the smallest sealed perimeter for a given area). Furthermore, a linear compressing or displacing action may be the closest one can practically come with a mechanical device to an ideal compressing or displacing action. This device, like a piston-based design, can also achieve very high compressions at any speed, unlike the centrifugal rotary design, which must operate at extremely high speeds to achieve high compressions, but because it is limited in its operational speed by its tip speed, cannot match this device. The helical rotary device can achieve relatively high compressions at any speed as well as this device, but its compression ratio is always fixed, and not variable based on the amount of work it needs to do, unlike the piston-based designs or this device. It is also much easier to air-cool this device than the helical screw design because all the thermal energy is concentrated in the chambers, which are located at the periphery of the device, and can therefore be cooled using heat exchange fins, which communicate with the ambient air. The rotor heads also exit the chambers at the completion of each stroke, allowing them to cool somewhat in the housing proper (which is closer to ambient temperature) before entering the next chamber.

Figures 1-8 illustrate the principle on which this device operates:

If point *C'* rotates about an axis *C* at distance *r,* and *C'* itself serves as an axis for another point *P* to rotate about at the same distance *(r)* from this axis and the angular velocity *(x)* of *C'* is of the same magnitude and opposed in direction (*-x*) to the angular velocity of *P* then *P* will describe a reciprocating linear path (M_p).

Figure 9 illustrates the principle on which this device operates using displacement graphs.

This principle may be explained by a series of graphs. The displacement of a point on a circle as the circle rotates may be represented by the function $f(x)= sin(x)$ *(represented by* Y_1 *in Fig. 9)*. The displacement of a point on a circle of equal radius rotating in the opposite direction may be represented by the function $f(x)= sin(-x)$ *(*Y_2 *in Fig. 9)*. If the circles are related as in Figures 1-8, then the displacement of a point on the circumference (there labelled *P*) is the sum total of the two circles' displacement. In terms of a function this is $f(x)=sin (x) + sin (-x)$ or, simplified, $f(x)= 0$. (Y_3 *in Fig. 9)*.

In drawings which illustrate embodiments of this invention, Figure 10 is a partially cross-sectioned side view of the device, and Figure 11 is a partially sectioned overhead view.

Applying this to the device we have a working system for compressing or displacing fluids. The device illustrated comprises: a housing, (1), comprising four radially situated chambers, (2), and a bottom plate (3). The housing contains a central crank mechanism (4) whose axle (5) passes through the housing and is attached to a driver (not illustrated). Attached to the crank mechanism is the rotor's axle (6). Rotating upon the rotor axle is the rotor, (7), which is comprised of the rotor arms, (8), and the rotor heads (9). Also attached to the rotor axle is a gear, (10), which follows an internal gear race (11) of twice its circumference, and orbits within the housing. Both the primary (or crank) axle and the rotor's axle are freed to rotate by a bearing system (12). Intake is directed through an inlet port (13) on the exterior of the housing, approximately midway between two compression/displacement chambers, and output is directed through outlet ports (14) on the anterior end of each chamber, which may be controlled by unidirectional valves (not illustrated).

In the embodiment illustrated, a two-way valve system is not required because each head seals upon entry into the chambers and seals only for the duration of the working portion of the stroke. This is made possible by removing the upper and lower sections of the rotor head to the maximum permissible extent which still allows immediate sealing upon entry into the chamber and ceasing to seal after reaching the acme of the stroke, so that the head is in such a position that it ceases to seal and begins allowing the fluid to flow from the open central area of the housing block proper into the chamber. This unidirectional flow is characteristic of the device's entire working cycle.

Some applications require a seal that is as close to absolute as possible. The unique motion of the rotor heads within the chambers may require an alternate method of sealing. One proposed method is one in which the rotor head is fitted with a jacket made of spring steel or a similar material. This jacket, which is similar to a wide piston ring, when viewed from above, would resemble a bowtie. This shape allows the seal to flex slightly when the rotor head presses against the chamber wall in order to fit correctly and seal. Other sealing methods may include: determining the device's operating temperature and using a material which will expand to exactly seal during normal operation, using plastics, or choosing not to fit a seal at all, instead using precise manufacture and running at high speeds to mitigate losses due to leakage, similar to a non-lubricated helical screw device. However, due to the (comparatively) minimal unsealed area losses would be significantly less in the Di-Rotary Compressor/Pump.

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

1. A sealed and lubricated motor-driven fluid displacement or compression device comprised of a chamber block housing with a number of radially situated chambers, the housing containing a central rotating crank mechanism with a rotor or rotors which are fixed to the central crank mechanism near its circumference, the rotor head or heads being of any shape which will seal within the chambers only for the compression/displacement stroke (and not for the inlet stroke), the chambers being designed to accommodate the path and shape of the rotor heads, the central crank mechanism being attached by an axle to a drive unit and rotating in a direction, and an axle passing through a point near the circumference of the central crank mechanism, through the centre of each rotor's arm to a gear intermeshed with an internal gear race of twice the first gear's circumference so that the rotor or rotors rotate in a direction opposed to the central crank mechanism while their axle travels on a circular path within the housing, the rotor heads describing linear paths in and out of diametrically opposed chambers, the intake or intakes being situated on the main housing, and the output being directed out the anterior ends of the compression chamber and controlled by unidirectional outlet valves.

2. A device as in claim one (1) in which the direction of the rotation of both the central crank mechanism, and rotor or rotors is reversed, the direction of the unidirectional valves is reversed, and the intake port becomes an exhaust port, so that the displacement or compression of the working fluid is negative.

3. A sealed fluid-driven motor comprised of a chamber block housing with a number of radially situated chambers, the housing containing a central rotating crank mechanism with a rotor or rotors which are fixed to the central crank mechanism near its circumference whose heads are any shape which will seal within the chambers for the duration of the power stroke, (and not from the time of the rotor head's entry to the acme of the stroke), the chambers being any shape that will accommodate the path and shape of the rotor, the central crank mechanism having an axle which is the drive shaft and rotating in a direction, and an axle passing

through a point near the circumference of the central crank mechanism, through the centre of each rotor's arm to a gear intermeshed with an internal gear race of twice its circumference; the rotor or rotors being driven by a compressed fluid in a direction opposed to the central crank mechanism, the axle travelling on a circular path within the housing, the rotor heads being driven on linear paths in and out of diametrically opposed chambers, the central crank's axle (the drive shaft) being driven by the action of the rotors, the intake being controlled by unidirectional valves at the anterior of the chambers and the housing's pressure-relief port or ports being situated on the main housing.

4. A device as in claims one two and three, (1, 2, and 3) in which the central crank mechanism is instead fixed while the housing is free to rotate, the original gear system is eliminated, the entire device is placed within a casing, the rotor or rotors' axis or axes are no longer orbiting within the chamber block and both the chamber block housing and the rotor or rotors are instead directly driven by a motor and the intake or output at the anterior of the chambers is through ports, which align with ports on the casing at specific times either for intake or output, depending on the application (as either a compressor or a vacuum).

5. A device as in claims one two and three, (1, 2, and 3) and using the innovation described in claim four, (4) in which only the rotor or rotors are driven by a motor and the housing is driven by the action of the rotor or rotors as they move in and out of the chambers.

6. A device as in claims one two and three, (1, 2, and 3) and using the innovation described in claim four, (4) in which only the housing is driven by a motor and the rotor or rotors are driven by the action of the housing's rotation.

7. A device as in claims one two and three (1, 2, and 3) in which only the central crank mechanism is driven by a motor, the gears having been eliminated, and the rotor or rotors are driven along by the linear action of the rotor heads due to their interaction with the chamber walls.

8. A device as in claims one, two, and three, (1, 2, and 3), in which only the drive gears are lubricated, the drive gears being isolated from the rotors by means of an intervening plate which is sealed within the housing and around the rotor or rotors' axle(s) to prevent leakage and ensure lubricant-free output.

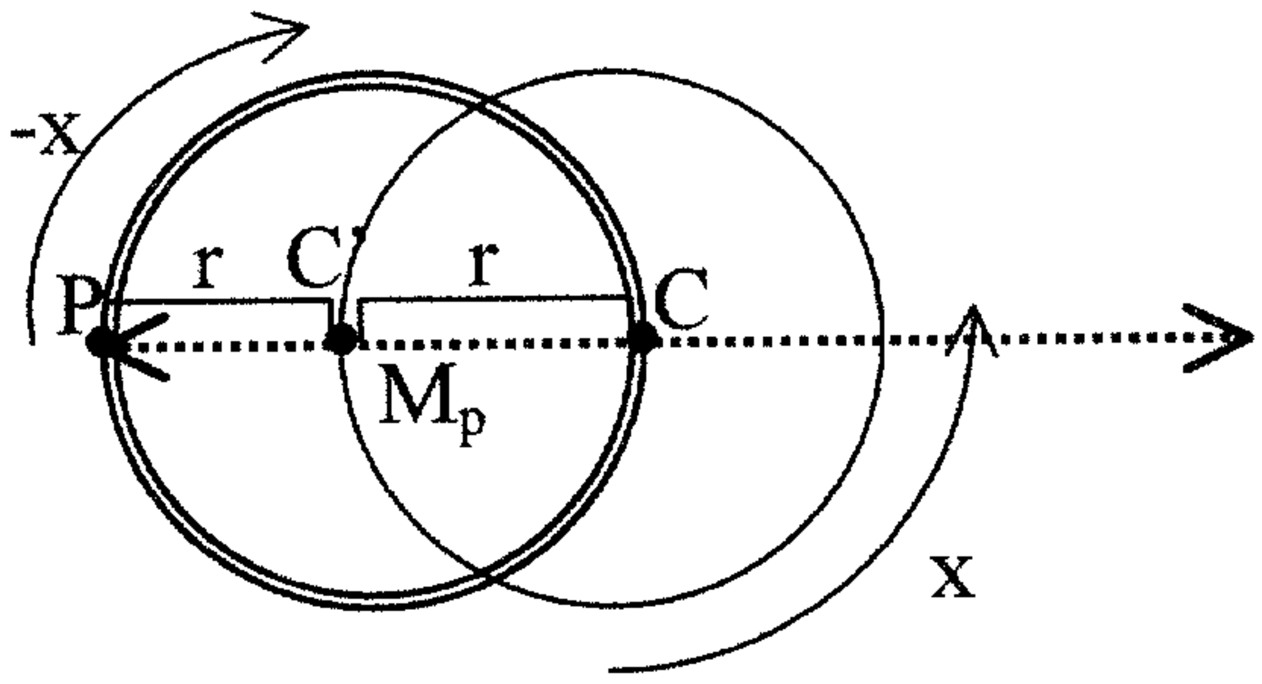


Figure 1

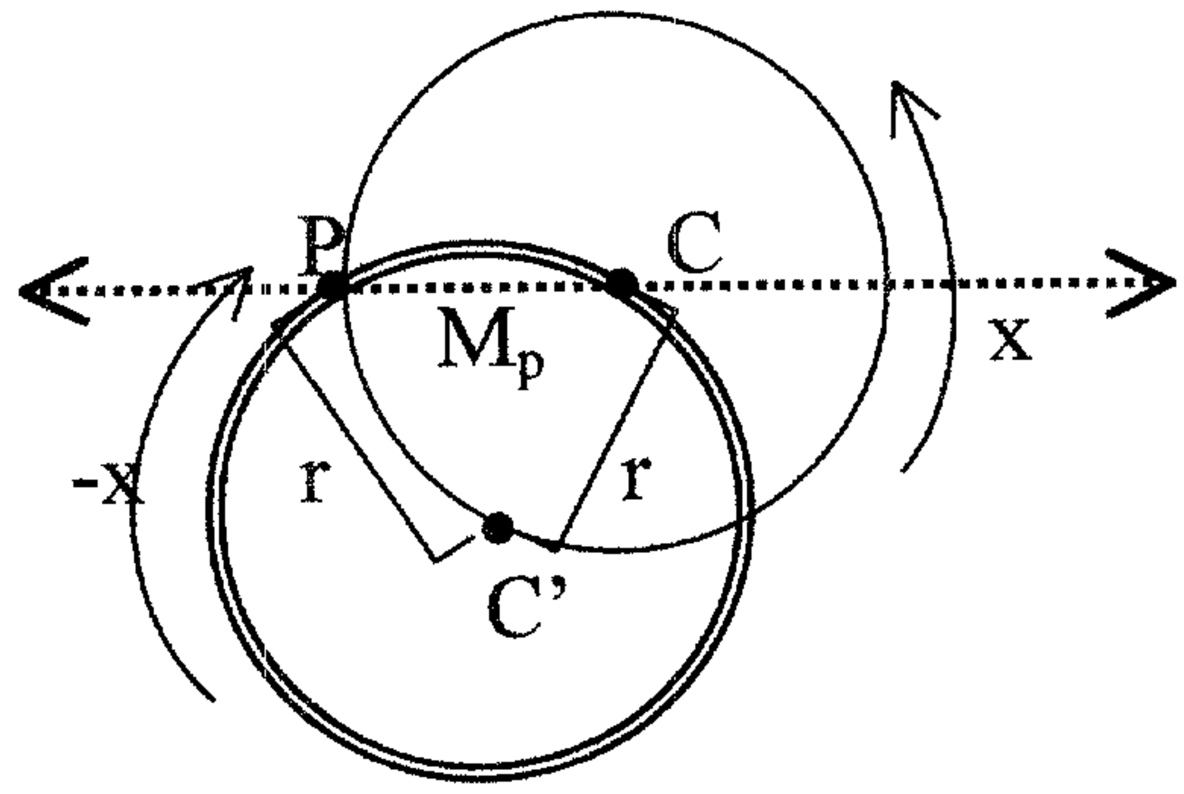


Figure 2

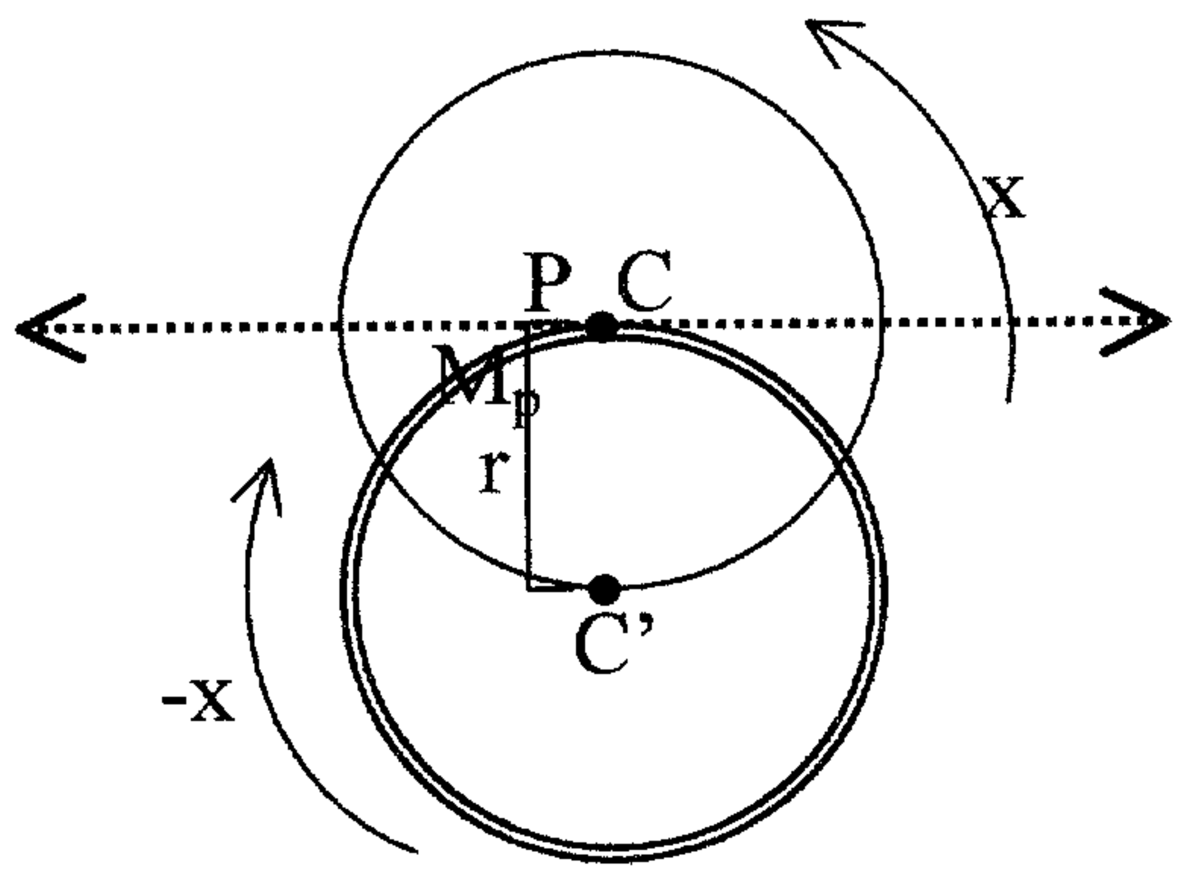


Figure 3

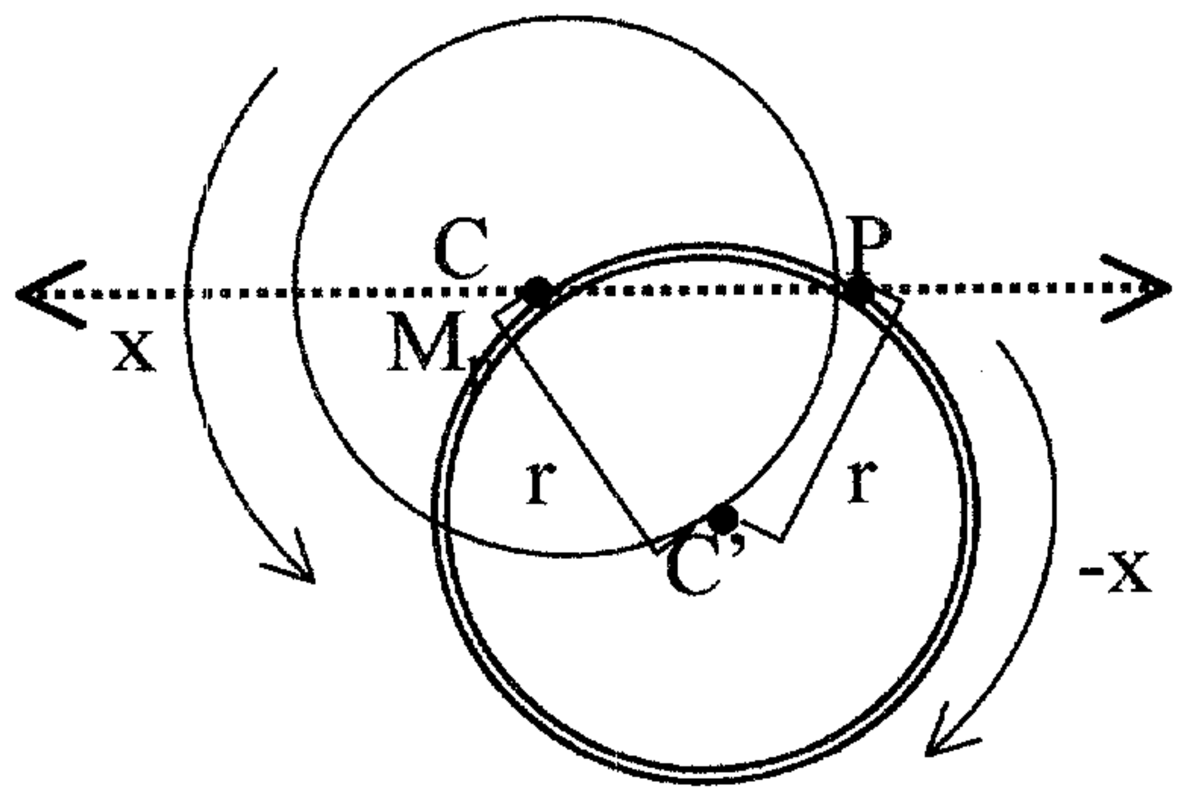


Figure 4

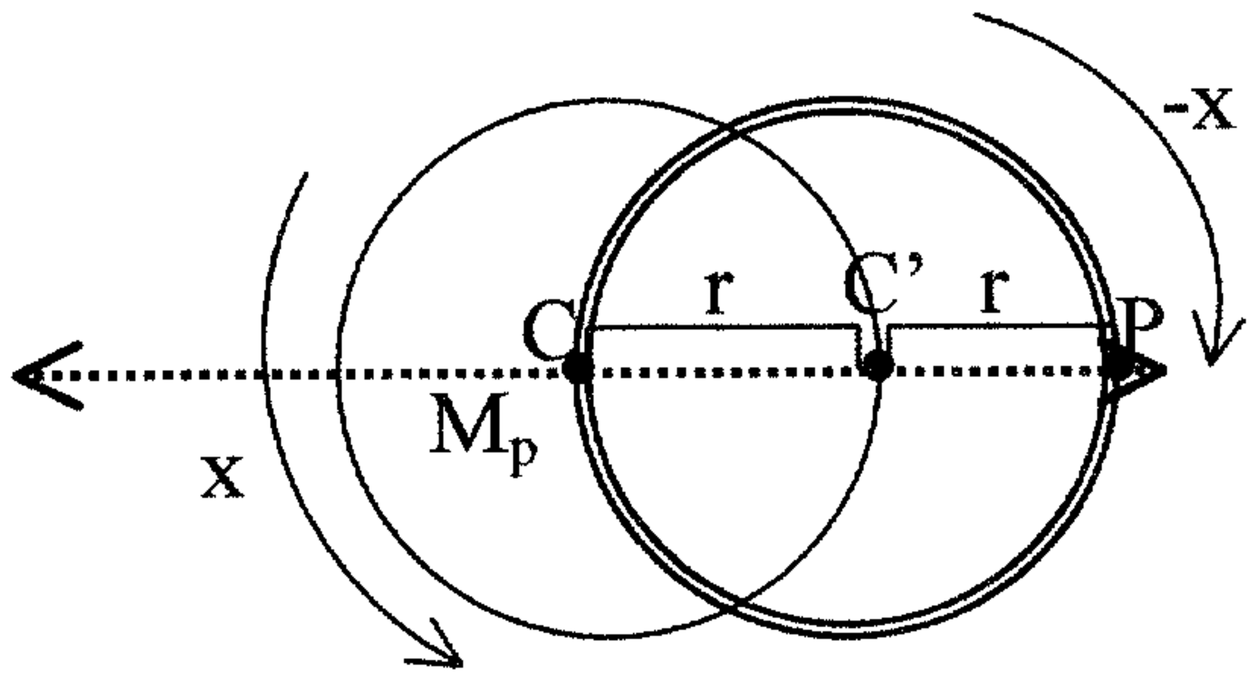


Figure 5

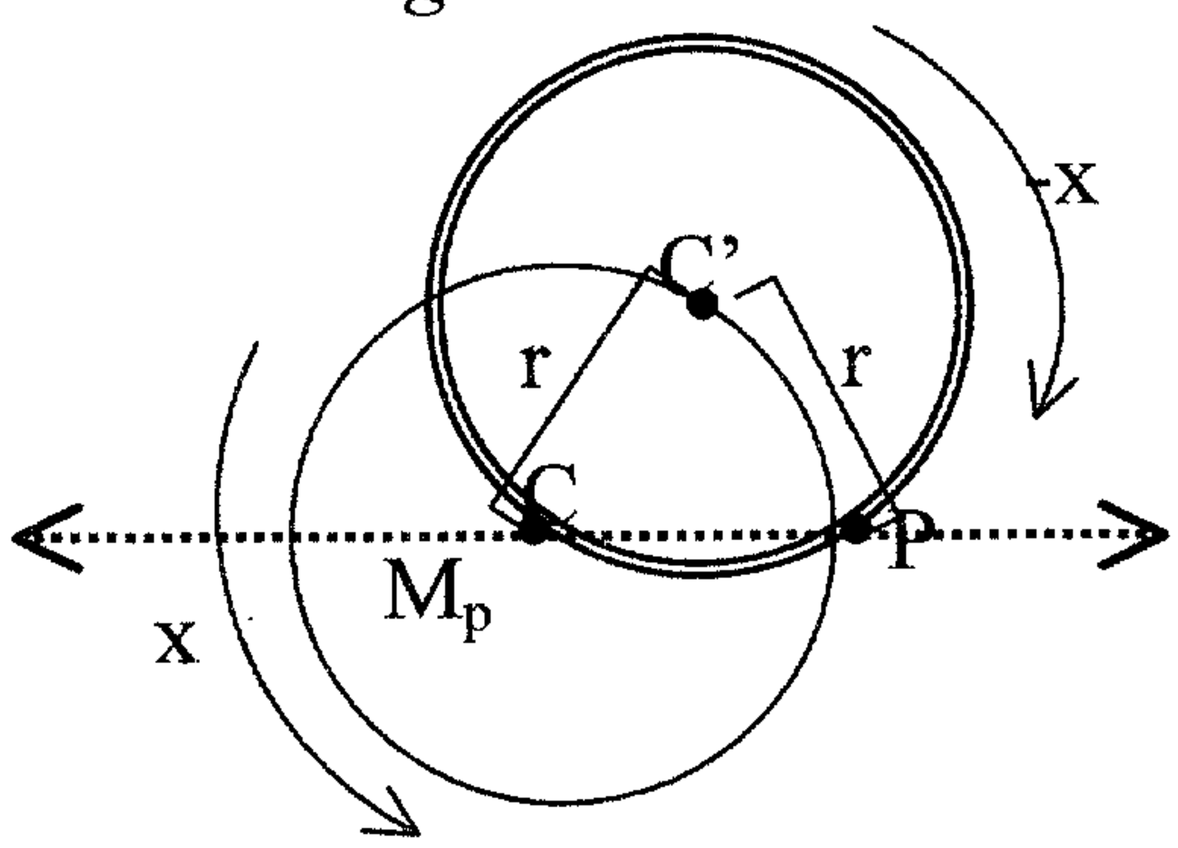
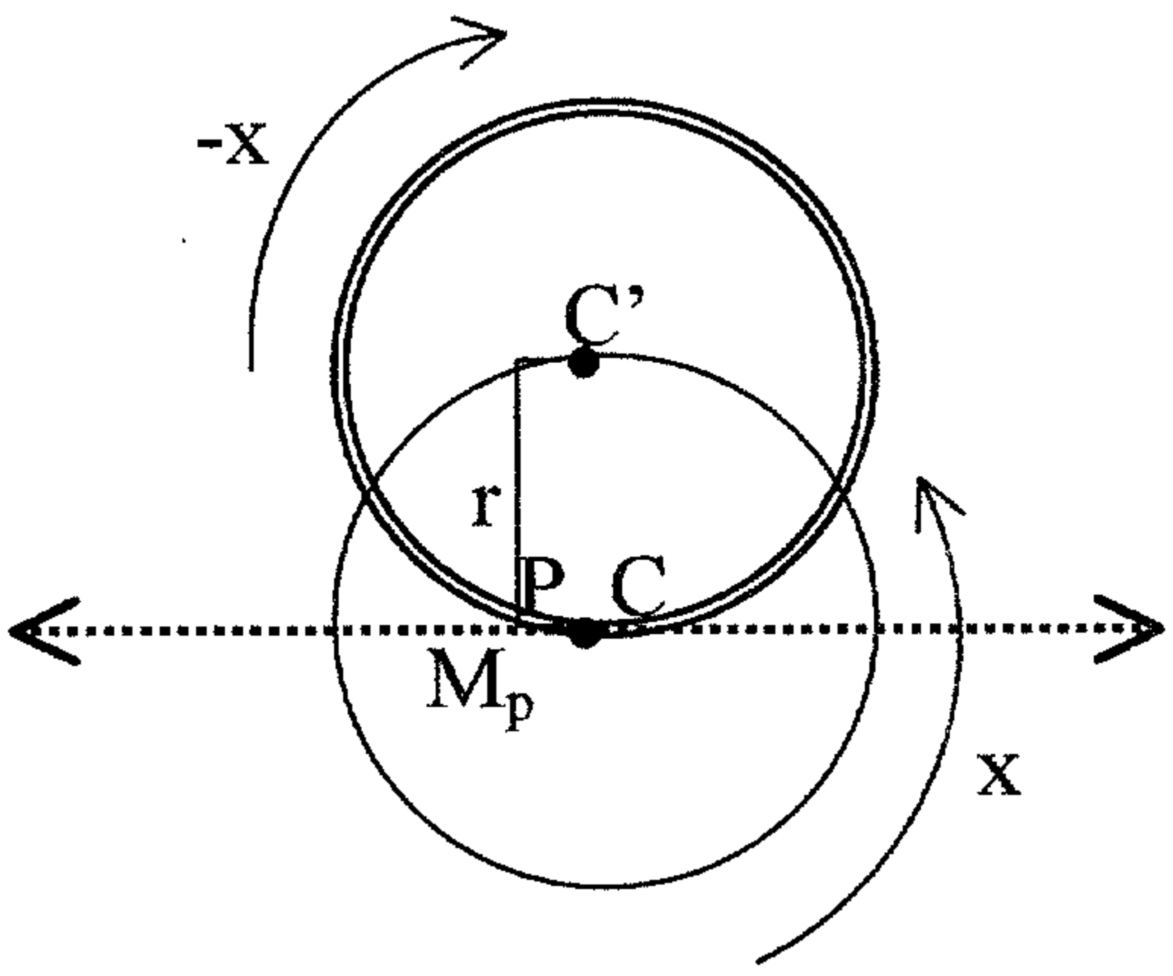


Figure 6



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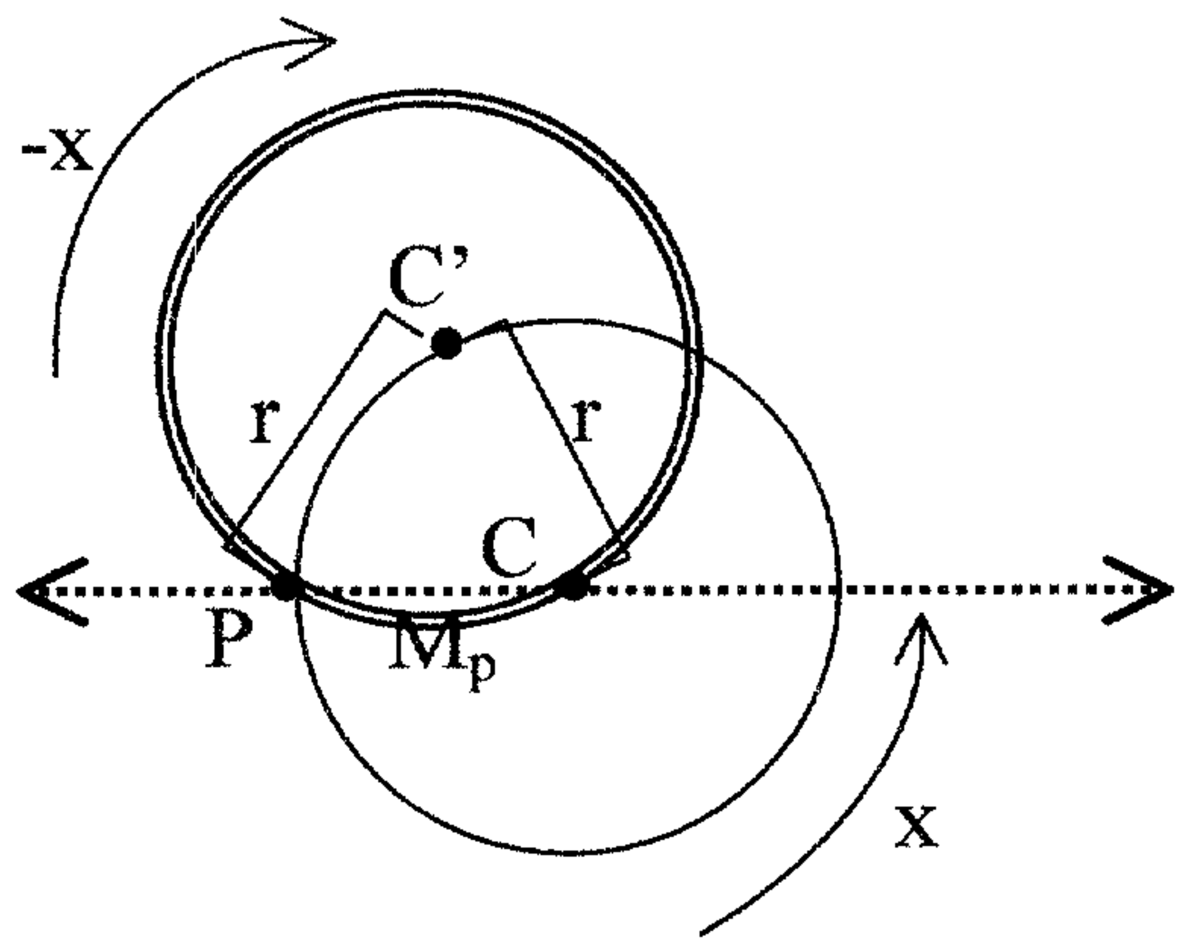


Figure 8

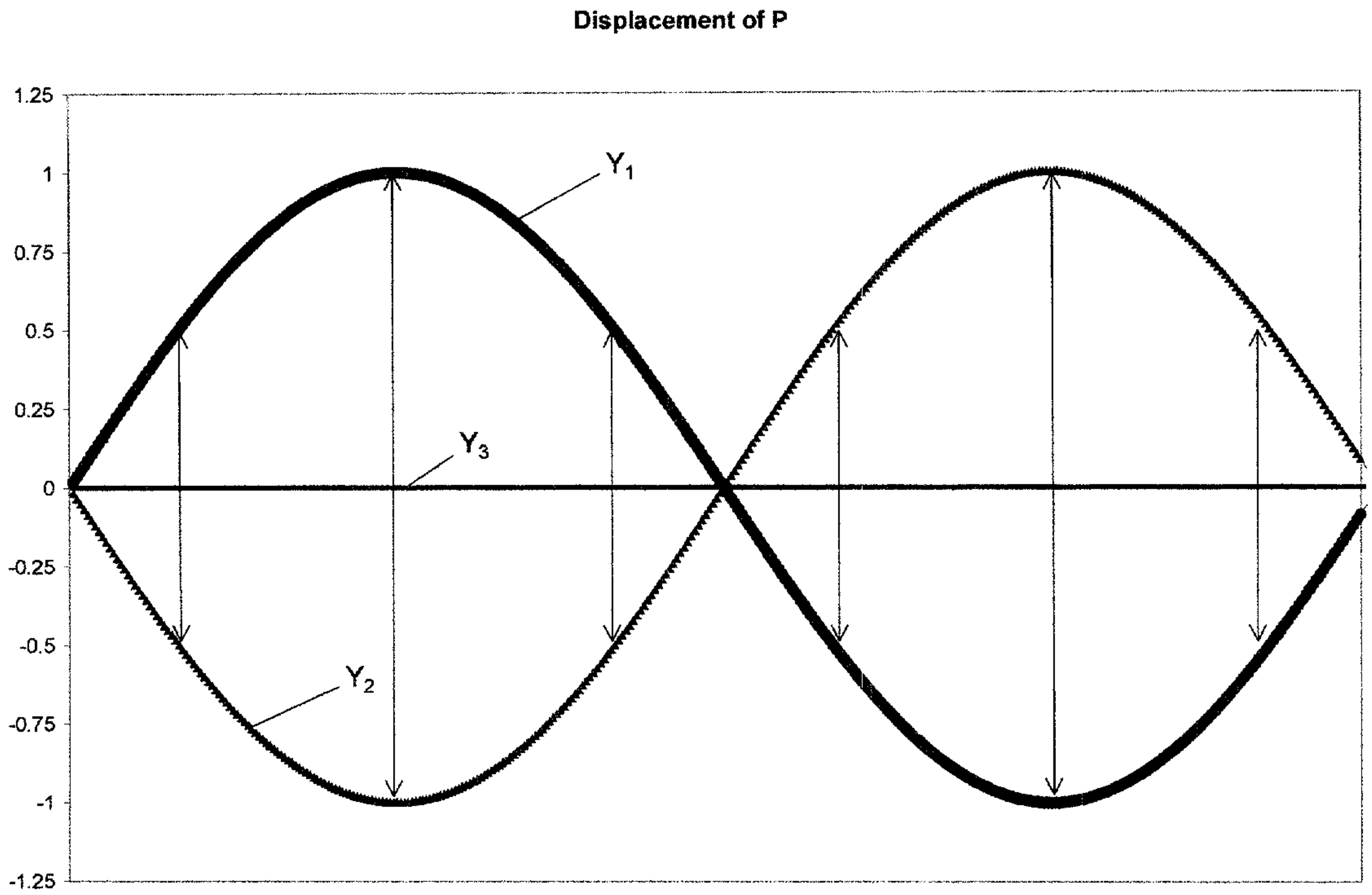


Figure 9

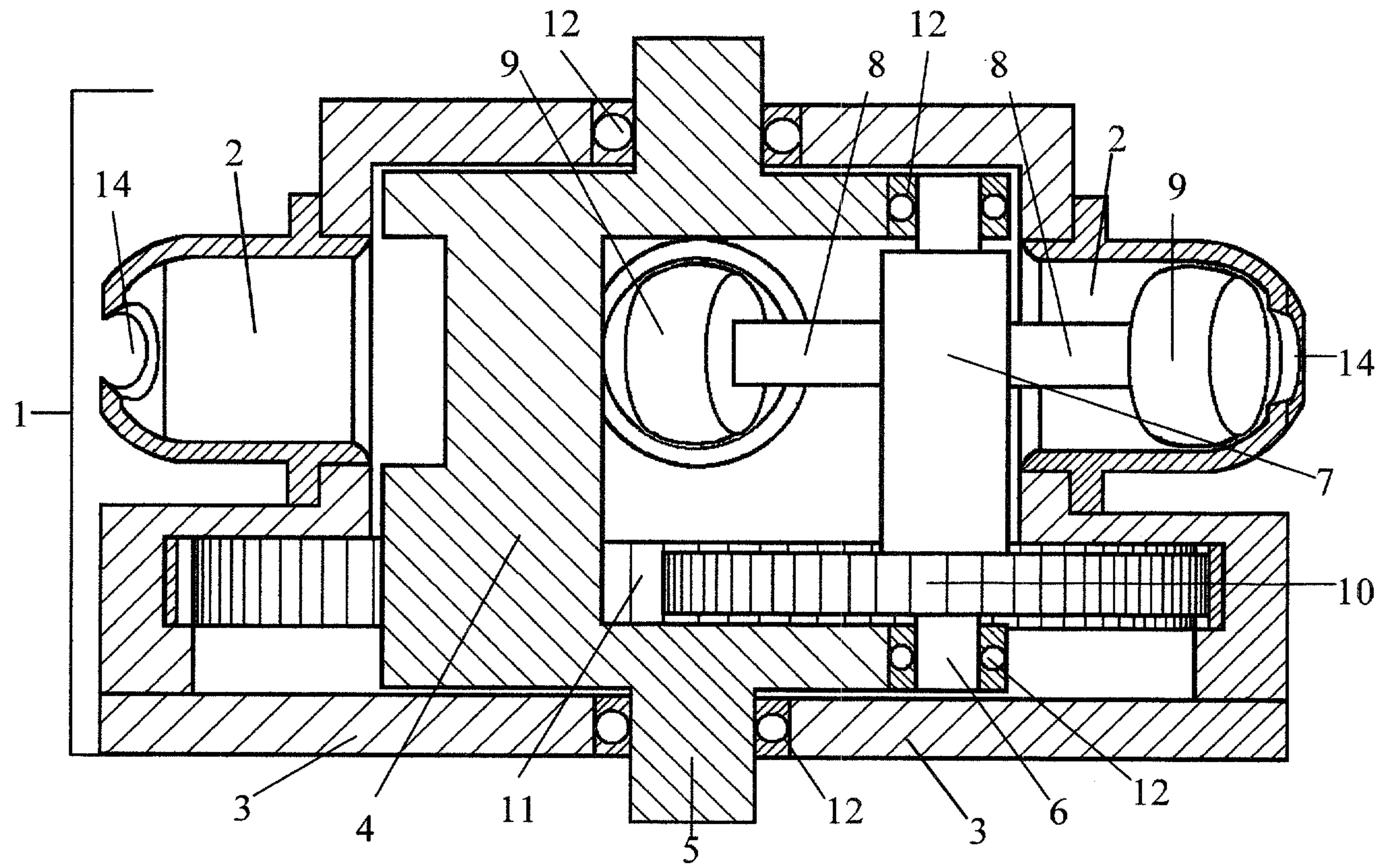


Figure 10

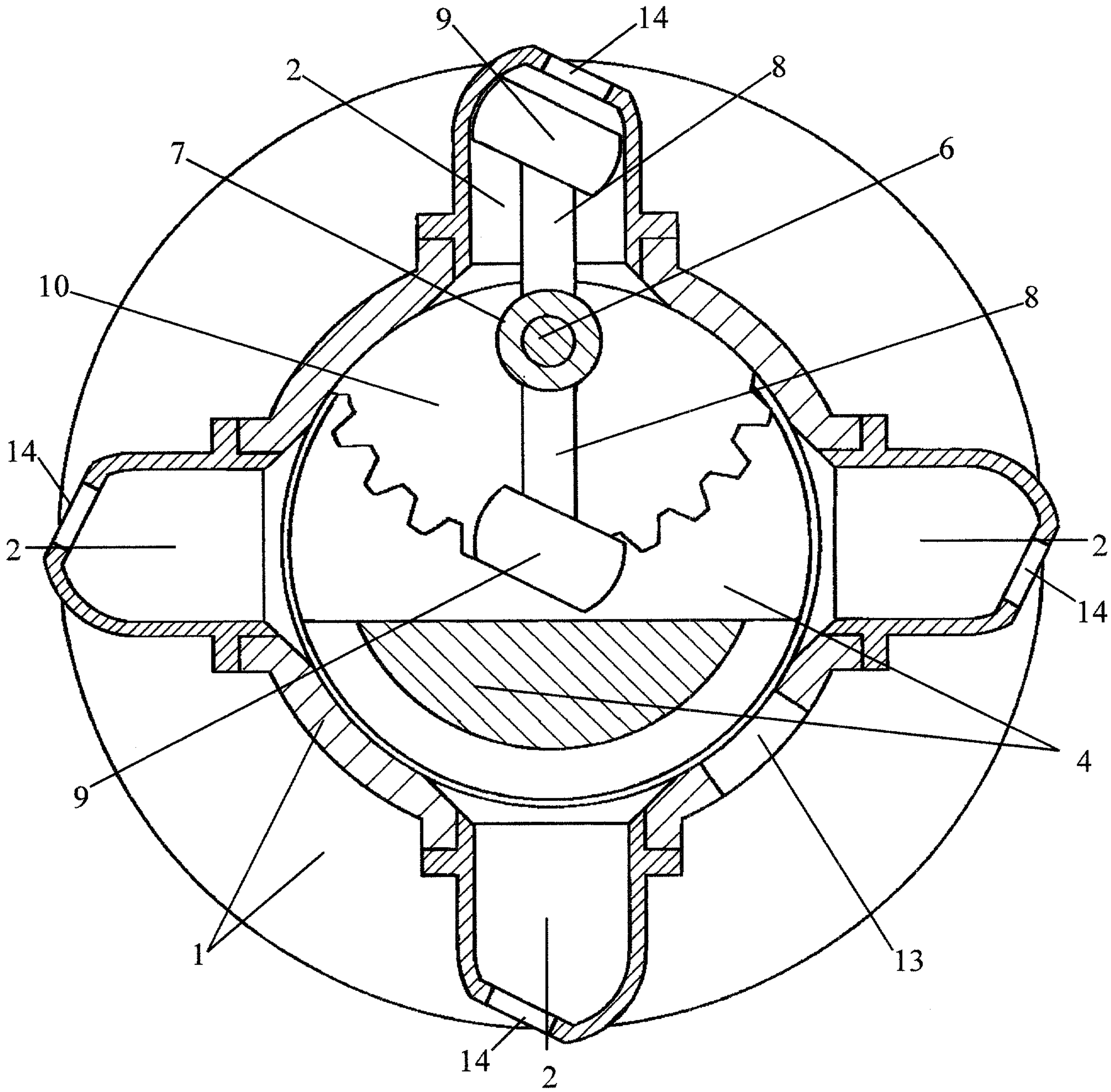
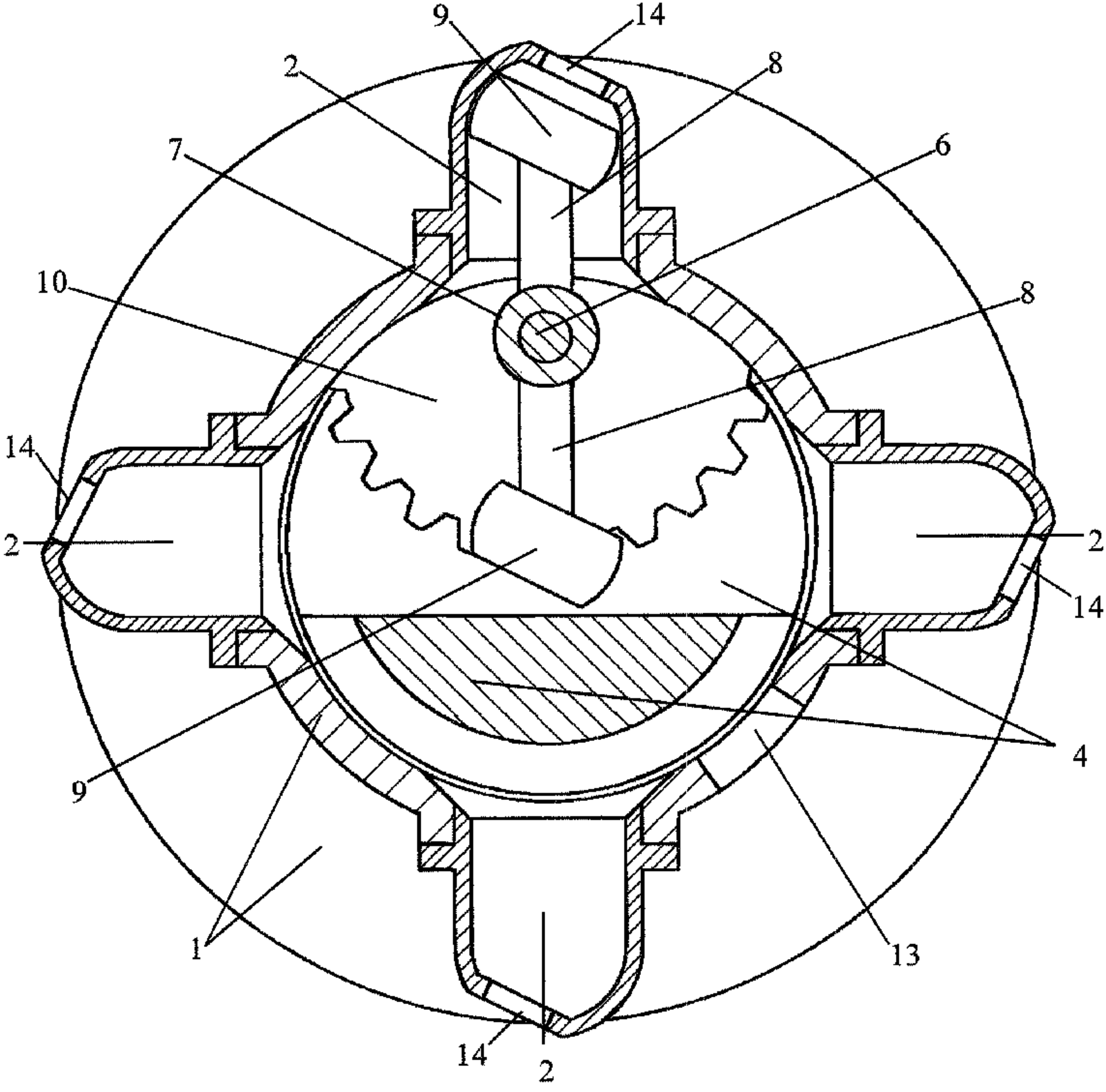


Figure 11



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