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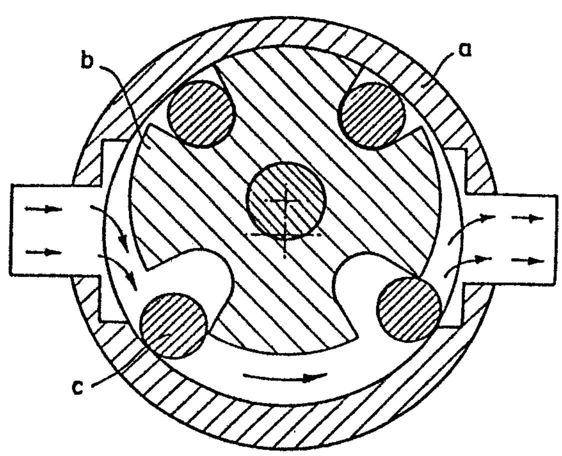
(54) Reversible system for the transfer of energy from a fluid to a rotating shaft.

(57) The reversible system for the transfer of energy from a fluid to a rotating shaft by a positive closed displacement device is characterized in that it comprises a first stationary unit, consisting of a cylindrical chamber directly connected to the fluid line, a second rotary unit, consisting of a cylindrical rotor having radial grooves associated to a shaft which extends through the top and bottom of the first unit, its axis being parallel but not coincident with the axis of the first unit, a third unit formed by a set of rolls which loosely fit into the grooves and are as long as the two first mentioned units, thus ensuring that the pressure of the fluid urges the rolls against the internal surface of the chamber and that the walls of the grooves form tight movable spaces filled with fluid, and the respective volumes being dependent upon the angular position of the rotor in relation to the chamber, the energy of the fluid thus being transferred to the rotating shaft or, vice versa, from the rotating shaft to the fluid.



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The present invention refers to a reversible system for the transfer of energy from a fluid to a rotating shaft through a device of positive displacement.

There is already known a positive displacement device consisting basically of a rotor associated to a shaft, installed eccentrically in a cylindrical chamber through which the fluid flows. The rotor has radial slots fitted with sliding vanes which, due to centrifugal force are urged against the internal wall of the chamber whenever the rotor rotates. Due to the eccentricity of the rotor in relation to the chamber, the vanes partially and gradually slide in and slide out of the slots. In this way,there are formed movable, tight, separated spaces which are limited by the external surface of the rotor, the internal surface of the chamber and two successive vanes, the corresponding volumes depending upon the angular position of the rotor in relation to the chamber and changing from a minimum value. If the inlet and outlet points for the fluid are provided adequately around the periphery of of the chamber, it is possible to use this device for the transfer of energy from the fluid to the rotating shaft or, vice versa, from the rotating shaft to the fluid.

In fact, if the fluid is, for instance, compressed air, it is possible to use this device as a compressed air motor by selecting for the fluid inlet a point at which the volume between the vanes is minimum, the air being allowed to expand to the outlet positioned at a point where said volume is maximum. Under such conditions, the fluid energy is transferred to the rotating shaft and used as mechanical energy. Vice versa, if the shaft is rotated by external means, it is possible to use the device as an air compressor, by selecting for the air inlet a point in the chamber at which the volume between the vanes is maximum, the air being compressed as far as to the outlet at a point where said volume is minimum. In this case, the mechanical energy of the rotating shaft is transferred to the fluid.

This system of energy transfer involves, however, important disadvantages which restrict its applications.

As a matter of fact, the system is effective only if the spaces between the vanes are really tight which implies that the vanes must be adjusted very accurately in the slots and that the edges of the vanes scrape on the internal surface of the chamber at a pressure sufficient to prevent the fluid from escaping out of one and to another space between the vanes. As a result thereof, there is caused mechanical friction which still develops substantially with the increase of working pressure, once the vanes are exposed to constant friction in the slots and by the internal surface of the chamber. This friction is a source of energy losses and leads to a comparatively rapid wear of the materials and to frequent maintenance work. Moreover, sudden changes in pressure or temperature of the fluid that could deform the vanes are not admissible, so that the use of the system is not advisable in cases in which such conditions may occur.

The system of the present invention does not show such disadvantages because it does not comprise vanes sliding into slots and the internal surface of the chamber is not exposed to any scraping action.

In fact, although the system includes a rotor and a cylindrical chamber instead of vanes, there are rolls, and instead of slots, there are grooves for the rolls to fit loosely. Further, instead of scraping, there is a rolling action on the internal surface of the cylindrical chamber thus keeping tight the spaces between the rolls and decreasing substantially the mechanical friction. Therefore, energy losses are negligible, material wear is low and maintenance is reduced considerably. Moreover, due to the use of rigid rolls, the devices based on this system are able to withstand hard conditions of temperature and pressure, so that their field of applicability may be broader.

The system of the instant invention comprises a rotor associated to a shaft installed eccentrically in a cylindrical chamber in which fluid flows. The rotor is provided with radial grooves extending longitudinally for the rolls which loosely fit in them. Due to the centrifugal force and fluid pressure, the rolls are urged against the internal surface of the chamber whenever the rotor rotates. Since the rotor is eccentric in relation to the cylindrical chamber, the rolls partially and gradually roll into and out the the grooves when the rotor rotates. By this means, there are formed separate tight spaces which are limited by the external surface of the rotor, the internal surface of the chamber and two successive rolls, the corresponding volumes depending upon the angular position of the rotor in relation to the chamber and changing from a minimum to a maximum value. By adequately providing inlet and outlet points for the fluid around the periphery of the chamber as well as a cylindrical profile of the internal surface of the cylindrical chamber, it is possible to use this system for the transfer of energy from a fluid (liquid or gas) to a rotating shaft or, vice versa, from a rotaing shaft to a fluid.

For the purpose of illustration, the following devices are examples based on foregoing system,

a) Gas compressor

The fluid inlet is positioned at the point of the chamber where the volume between rolls is maximum, the outlet being located at the point where said volume is minimum (compressor zone). Energy is transmitted from the shaft to the fluid.

b) Gas expander

The fluid inlet is positioned at the point of the chamber where the volume between rolls is minimum, the outlet being located at the point where said volume is maximum (expansion zone). Energy is transmitted from the fluid to the shaft.

c) Internal combustion engine

This device is a combination of a compressor (as per a)) with an expander (as per b)) connected by ths same shaft. The compressor compresses the air-fuel mixture or only air mixed with fuel just before entering into the expander where combustion takes place and combustion gases are expanded. The transfer of energy iseffected from the fluid to the shaft.

d) External combustion engine

This device is a combination of a compressor (as per a)) with an expander (as per b)) connected by the same shaft. The compressed air is heated by an external heat source before entering into the expander where the hot air is expanded. The transfer of energy is realised from the fluid to the shaft.

e) Steam engine

As per b).

f) Compressed air motor

As per b).

g) Hydraulic motor

In this device, the inlet and outlet of the pressurized fluid (liquid) are provided in such a way that the fluid flows through the chamber in spaces between rolls of equal volume. The transfer of energy takes place from the fluid to the shaft.

h) Volumetric pump

In this device, the inlet and outlet of the fluid are provided to ensure that fluid flows through the chamber of adequate profile and in spaces of equal volume. Energy is transferred from the shaft to the fluid.

i) Volumetric meter

As per g), where a conventional sensor detects the the rotor speed which is proportional to the volume of the fluid flowing through the chamber.

In the enclosed schematic drawing, the Figure shows a cross section of the arrangement on which the referred system is based.

As shown schematically in the Figure, the system of the present invention is basically formed by three units. The first unit (a) is stationary and consists of a cylindrical chamber having a closed top and bottom to be connected to the fluid line. The second rotatory unit (b)is a stationary unit and consists of a cylindrical rotor with grooves associated to a shaft which extends through the top and bottom of the first unit, its axis being parallel but not coincident with the axis of the first unit. The third unit (c) formed by a set of rolls which fit loosely into the grooves is of the same length as the two previous units. The position of fluid inlet and outlet is adequate for the use of the device as a hydraulic motor.

CLAIMS

1. Reversible system for the transfer of energy from a fluid to a rotating shaft by a positive, closed displacement device
c h a r a c t e r i z e d in that it comprises a first stationary unit consisting of a cylindrical chamber directly connected to the fluid line, a second rotary unit consisting of a cylindrical rotor having radial grooves associated to a shaft which extendss through the top and bottom of the first unit, its axis being parallel but not coincident with the axis of the first unit, a third unit formed by a set of rolls which loosely fit into the grooves and are as long as the length two above mentioned units so that the pressure of the fluid urges the rolls against the internal surface of the chamber, the walls of the grooves forming tight movable spaces, filled with fluid, the respective volumes being dependent upon the angular position of the rotor in relation to the chamber, the energy of the fluid being in this way transferred to the rotating shaft or, vice versa, from the rotating shaft to the fluid.

2. System according to Claim 1, characterized in that, in case of use as a gas compressor, the inlet is located in a zone of the chamber where the volume between rolls is maximum, while the outlet is located in a zone where said volume is minimum (compression zone), the energy being transferred from the shaft to the fluid.

3. System according to Claim 1, characterized in that, in case of use as a gas expanser, the inlet is located in a zone of the chamber where the volume between the rolls is minimum while the outlet is located in a zone where the volume is maximum (expansion zone), the energy being transferred from the fluid to the shaft.

4. System according to Claim 1, characterized in that, in case of use as an internal combustion engine, it is formed by the combination of a gas compressor according to Claim 2 with a gas expanser according to Claim 3, connected by the same shaft, to compress the air-fuel mixture or only the air to which fuel is mixed just before entering into the expanser where the combustion is effected and the combustion gases are expanded, the energy being transferred from the fluid to the shaft.

5. System according to Claim 1, characterized in that, in case of use as an external combustion engine, it is formed by the combination of a gas compressor according to Claim 2 with a gas expanser according to Claim 3, connected by the same shaft, the air compressed by the compressor being heated by an external source before entering into the expanser where the hot air is expanded, the energy being transferred from the fluid to the shaft.

6. System according to Claim 1, characterized int that, in case of use as a steam engine, the design referred to in Claim 3 is applied.

7. System according to Claim 1, characterized in that, in case of use as a compressed air motor, the embodiment referred to in Claim 3 is applied.

8. System according to Claim 1, characterized in that, in case of use as a hydraulic motor, the the inlet and outlet are provided in such a way that the pressurized fluid (liquid) flows through the chamber in tight spaces of equal volume, the energy being transferred from the fluid to the shaft.

9. System according to Claim 1, characterized in that, in case of use as a volumetric pump, the inlet and outlet are provided in such a way that the fluid flows through the chamber of adequate profile in spaces of equal volume, the energy being transferred from the shaft to the fluid.

10. System according to Claim 1, characterized in that, in case of use as a volumetric meter, the embodiment referred to in Claim 8 is applicable, in which a conventional sensor detects the rotor speed which is proportional to the volume of the fluid flowing through the chamber.

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August 19, 1987

European Patent Application 87 107 033.0
SERVOTROL - SISTEMAS DE COMANDO AUTOMATICO, LDA.

In response to the Communication dated August 14, 1987.

In the enclosed copies of original pages 6 and 9 we have inserted the changes of the corrected pages filed with our letter of May 25, 1987.

The requested corrections are:

1) on page 6, line 10: insert behind "the" (first occurrence) the words "number of revolutions of," delete the word "speed"

2) on page 6, line 21, delete "rotatory",

3) in claim 10, line 5 insert behind "the" the words "number of revolutions of the ".

We trust that this is a clear specification of the requested corrections.

(Selting)
Patent Attorney

Encls.:

For the purpose of publication only
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☐ ~~allowed~~
☐ ~~allowed with exception of the deleted points~~
☐ ~~not allowed~~
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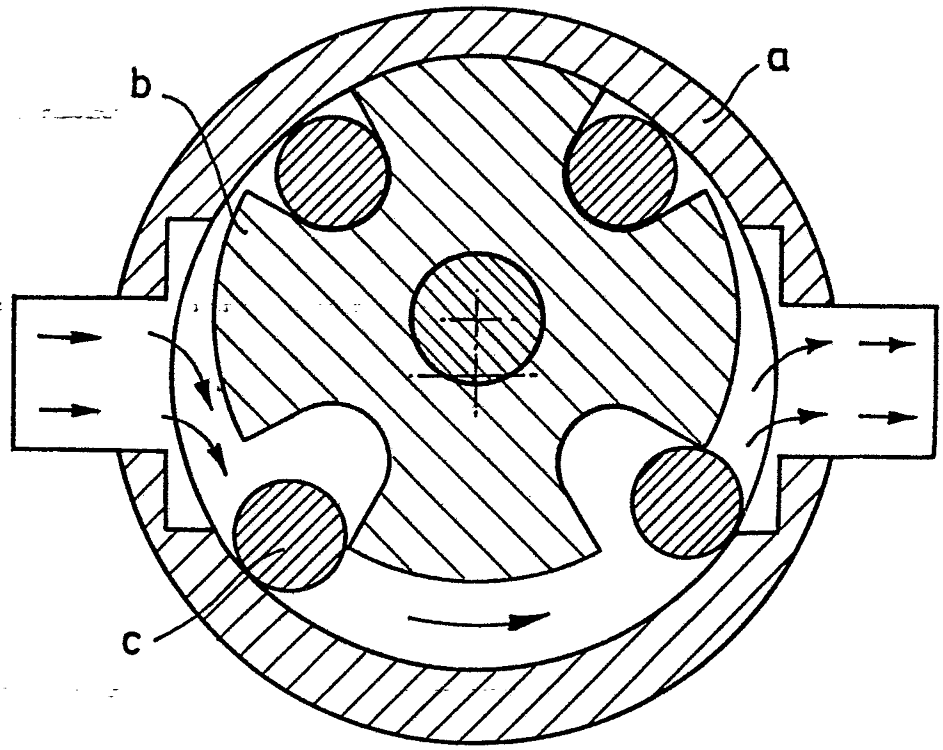
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